BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL

UNDER	**the Resource Management Act 1991 ("the Act")**
IN THE MATTER OF	**Resource Consent Applications to Greater Wellington Regional Council pursuant to section 88 of the Act to discharge contaminants to land, air and water**
BY	**South Wairarapa District Council**
FOR	**the proposed staged upgrade and operation of the Featherston Wastewater Treatment Plant**

BRIEF OF EVIDENCE OF GRAHAM BURNLEY MCBRIDE ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

PUBLIC HEALTH RISK

DATED 29 MARCH 2019

Counsel: **Philip Milne**
Barrister
Telephone: 021803327
Email: philip.milne@waterfront.org.nz

EVIDENCE OF GRAHAM BURNLEY MCBRIDE ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

MY QUALIFICATIONS/EXPERIENCE

1. My name is Graham Burnley McBride. I am a Principal Scientist at the National Institute of Water and Atmospheric Research (NIWA), in Hamilton.

2. I hold a Bachelor of Science degree in mathematics (Victoria University, Wellington) and Master of Science degree (Water Resources) from the University of Newcastle-upon Tyne, UK.

3. I have been an active researcher in water-related issues for over 40 years and have published many scientific papers and a book on these matters. That book's title is "Using Statistical Methods for Water Quality Management: Issues, Problems and Solutions", published by Wiley, New York in 2005.

4. I am a Life Member of WaterNZ, and also hold membership of the New Zealand Hydrological Society, the New Zealand Statistical Association, the New Zealand Freshwater Sciences Society, and the New Zealand Society for Risk Management and the International Water Association. I received the 2008 Medal from the New Zealand Freshwater Sciences Society, for services in that field and WaterNZ's 'Association Medal' in 2017.

5. I have read the Environment Court's practice note 'Expert Witnesses – Code of Conduct' and agree to comply with it.

6. Whilst my evidence is necessarily of a qualitative nature, it none-the-less includes some important technical detail, including references to peer-reviewed science papers. In the interests of clarity, that material is included in footnotes, for which cited references are given on the last pages.

SCOPE OF EVIDENCE

7. The primary focus of my evidence is on public health risk, specifically the risks from pathogens entering groundwater and surface water via the irrigation of treated wastewater to land. I also address the health risk from direct pathogen discharge to surface water. I have been requested to address five separate tasks:

   a) Which virus is the most relevant for decay rates given the environment and nature of the discharge - rotavirus, adenovirus or norovirus?
   b) What is an acceptable decay rate[1] for the use of viral indicators in public health assessment to assess resulting risk & travel times from the land treatment scheme?
   c) Qualitative commentary around the proposal's overall public health risk and any recent learnings and obligations from NES/NZDWS/Havelock North.
   d) Commentary on adequacy of the relevant proposed conditions.
   e) Consideration of relevant submissions.

[1] 'Decay' refers to three processes causing a decline in virus concentrations in water: inactivation, predation and adsorption. Decay rate is faster in surface waters because natural UV (a component of sunlight) is a major driver of the decay rate (via inactivation).

RESPONSES

8. Task *a*: which virus? In the Featherstone situation, I expect human viruses to be the pathogen group of most interest.[2,3] Of these, Noroviruses are the most relevant, both as an indicator of virus decay rates and for direct assessment of health risk.[4,5] Their dual role as an indicator and as a pathogen is especially appropriate given four observations: their persistence; their relatively high concentrations in sewage; the widespread finding by many scientists worldwide that noroviruses are the most important pathogen associated with ingestion of water by recreational water use such as swimmers and by drinking water;[6] and their rather severe dose-response characteristics for which illness can arise from only a few norovirus particles.[7]

9. Task *b*: Appropriate decay rate. I agree with Dr Simpson's evidence — that treated wastewater applied to land will have a microbial residence time of up to about 5 years, during which time there will have been a

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2 Bacterial pathogens, such as *Campylobacter* or *Salmonella* are inactivated more readily than viruses. Furthermore, many of them are excreted particularly by animals, and so are not particularly relevant to town sewage. For example, the 2016 Havelock North campylobacteriosis drinking-water outbreak was attributable to defaecation of *Campylobacter* by animals (a large number of sheep in close proximity to drinking water bores).

3 Protozoan pathogens, particularly *Giardia* cysts and *Cryptosporidium* oocysts, are persistent and infectious but are typically less prevalent in sewage cf. other pathogen groups. Giardiasis is often contracted as a result of overseas travel. Both cysts are commonly associated with animal sources.

4 Although adenoviruses can be expected to be the hardiest of the three viruses to be addressed in this task, they are a less important pathogen because their typical concentration in sewage (up to 10^3 per litre, Fong *et al*. 2010) is much less than for noroviruses (typically up to 10^5 per litre, Nordgren *et al*. 2009, Hewitt *et al*. 2011&2013— consistent with the recent ESR results for Featherston sewage). Indeed, the Mangere Wastewater Treatment Plant effluent can often be adenovirus-free whilst retaining some noroviruses (pers. comm. Peter Loughran, MWH). Adenovirus can be appropriate for risk assessment with respect to aerosolised treated wastewater.

5 For technical reasons associated with its dose-response characteristics, Rotaviruses pose extra difficulties with regard to their dose-response characteristics) when used as pathogens in a Quantitative Microbial Risk Assessment (QMRA). Also, their concentration in sewage in lower than noroviruses.

6 Soller et al. (2010).

7 Teunis et al. (2003).

substantial reduction in virus concentrations and an attendant reduction in risk during that time.

Task *c*: Qualitative assessment of public health risk arising from the discharge to water and to land.

10. I address four risk components for discharge of treated wastewater: (i) Risk to downstream recreational water users in dry periods in a situation of no direct discharge to Donald Creek; (ii) Risk to downstream recreational water users during periods of direct discharge to Donald Creek; (iii) Risk to consumers of drinking-water drawn from wells in areas affected by the irrigated wastewater; and (iv) Risk associated with aerosols from wastewater irrigation.

11. I conclude that the discharges to water and land, of themselves carry minimal risks, but consider that the consumption of drinking-water drawn from shallow bore-water in areas impacted by the irrigated land disposal and farm effluent disposal carries a risk that may be more than minor. I present analysis of this task later in this evidence (paragraphs 20–30). I conclude that this risk can be minimised and potentially avoided by requiring the Applicant to provide an alternative supply of potable water to all properties which take potable water from shallow bores.

Task *d*: Adequacy of proposed conditions.

12. The AEE proposes a twofold set of 'UV-related' (artificial ultra-violet) conditions, in section 5 of the AEE (2017, at page 21)

    a. For discharges up to 140 L/s no more than 5 of 10 consecutive *E. coli* values shall exceed 100 cfu per 100 millilitres, and no more than 2 out of 10 consecutive values shall exceed 1,400 cfu per 100 millilitres; or

    b. For discharges over 140L/s, UV treatment shall be applied to a minimum of 140L/s and the remaining flow may have no UV treatment.

13. I am satisfied that these conditions are feasible and appropriate, given the proposed wastewater treatment and discharge.

14. However, because this qualitative assessment is based on norovirus, it would be prudent to occasionally measure the concentrations of that pathogen in the inflow to the treatment plant and in its outflow (post UV). Comparing the inflow and outflow values would provide assessments of the efficacy of the wastewater treatment system. High inflow values would suggest the possibility of increased health risk to swimmers closest to the wastewater discharges (i.e. Lake Wairarapa which is 5km away). I note that Lake Wairarapa is not part of the GWRC/MfE recreational bathing monitoring programme (presumably because it is not used for swimming). Accordingly, this is a conservative assessment i.e. secondary contact activities are more likely than primary contact activities (refer to Mr Exeter's evidence). Therefore, I recommend that this monitoring be carried out every third month for at least the first year of the consent. The results from that monitoring should be advisory-only. I also note that by Stage 2B direct discharge to the stream is largely avoided.

15. As discussed above, I consider that there should be a condition requiring SWDC to provide an alternative supply of potable water to all properties within the affected area which currently use shallow ground water bores as a supply of potable water. In my opinion the use of these bores for potable water supply poses risks irrespective of the proposed land discharge, as a result of upgradient dairy farm land use. Continuing the use of the bores is undesirable.

16. Proposed consent condition 7 (Schedule 4) states:

The land discharge for all Stages shall be designed, where practicable, to ensure that the discharge of treated wastewater to the land discharge areas shall:

a. Be evenly distributed to the entire area being utilised for land discharge;

b. Not cause runoff or surface ponding;

c. Not lead to the development of anaerobic soil conditions; and

d. *Avoids the discharge of wastewater to land within 125 m of the property boundary, except that wastewater may be discharged to land within 25 m from the property boundary where:*

   i. *Median E. Coli. concentrations meet or are less than 100cfu/100ml; and*

   ii. *Irrigation is at low pressure (less than 1.4 bar);*

Where wind speed does not exceed 12 m/s (or 4 m/s sustained for a period of 15 minutes or more) in a direction toward an existing dwelling (at the time of commencement of these consents) on an adjoining site within 150 m of the irrigation area.

17. In my opinion these conditions are appropriate.

18. Proposed consent condition 8 (Schedule 4) states:

The discharge of treated wastewater to land discharge areas shall occur in accordance with the certified Discharge to Land and Water Management Plan (Schedule 1: Condition 3, Table 2).

And the objectives of the Discharge to Land and Water Management Plan are:

To maximise the discharge of treated wastewater to land within the constraints of the conditions of these consents and the constraints of: land availability, wastewater storage, soil and groundwater conditions, odour and aerosol control, and the avoidance of risks to human health.

The Plan must:

a. *Address the specific site conditions and limitations for all land discharge areas which are proposed to receive wastewater; (including those listed above).*

b. *Detail the Featherston WWTP wastewater discharge to land methods and systems;*

c. *Define storage volumes for Stage 2B;*

d. Establish a discharge regime for Stage 2B contingency discharges of treated wastewater to target when Donald Creek flows are greater than 3x median and wherever practicable greater than 2x median most of the time.

19. I expect any risk to be less than minor, provided that aerosolisation is kept to a minimum. This inference is based on the observation that inhalation rates are low, and that there will be substantial removal of adenovirus by the treatment system. Others will explain the measures proposed to minimise aerosolization.

Task *e*: Consideration of relevant submissions. Responses to relevant submissions are given in paragraphs 35 and 52 of this evidence.

PUBLIC HEALTH RISK, INDICATIVE CALCULATIONS

20. Qualitative assessments of items in (i)–(iii) above (paragraph 0) are based on Norovirus dose-response characteristics[8] while item (iv) uses adenovirus dose-response characteristics.[9] In either case a dose of 1 virus is sufficient to keep an individual's probability of illness to below 0.01 (i.e., less than 1 in 100).

21. Furthermore, the qualitative analysis reported here is based on drinking-water and primary recreational water contact, e.g., swimming, not on secondary contact (boating, fishing or wading).

[8] The choice of norovirus dose-response curve has been subject of some debate (Teunis *et al*. 2003, McBride 2014, Schmidt 2015, Messner *et al*. van Abel *et al*. 2016), all of which boils down to what assumption is made about any aggregation of virus particles in sewage. Herein I follow the prudent-and-reasonable public health practice of assuming no aggregation, and so the dose-response function is at its most severe. This choice is in accordance with analysis of noroviruses during periods when contaminated oysters were consumed in southern France resulting in norovirus illness (Thebault *et al*. 2013). Also, it is the standard approach in quantitative microbial risk assessment for aquatic systems (Boehm *et al*., 2015&2018).

[9] Adenoviruses (types 4 and 7) can give rise to respiratory illness, for which dose-response functions are available) Teunis *et al*. 2016).

22. I note that risk associated with other activities in this area are not included in this assessment; my calculations concern risks attributable to the discharge of treated wastewater from Featherston alone. In particular, I have not assessed the existing and ongoing risks from pathogens from farming sources.

23. I also assume that: Featherston sewage typically contains one hundred thousand (10^5) noroviruses per litre and one thousand (10^3) adenoviruses per litre (see footnote 4 for these choices); Recreational water users (e.g., swimmers) consume 100 millilitres of water each day;[10] Individuals consume 1 litre of drinking-water per day, every day (excluding hot water content of tea and coffee), ESR (2016) presents typical drinking-water consumption rates.

24. This analysis is based on the "$\log_{10}$ reduction" numbers associated with components of the wastewater scheme (hereafter using the simpler acronym "log-reduction'). For example, for wastewater treated by oxidation ponds followed by artificial UV, we can expect a log-reduction of 2, lowering the norovirus concentration from one hundred thousand (10^5) per litre in the inflow to the treatment plant to one thousand (10^3) per litre in the plant's effluent.[11] Similarly, the adenovirus concentration is reduced from one thousand (10^3) per litre to ten (10^1) per litre. Norovirus concentrations can be reduced in the receiving groundwater by at least a log-reduction of two (pers. comm., Dr Chris Simpson, GWS Ltd.).

25. Another log-reduction will occur from groundwater egress mixing with river water. Direct mixing and subsequent inactivation when treated wastewater is discharged directly to Donald Creek is assumed to give rise

[10] Ingestion of up to 100 millilitres per day is toward the top of the expected range for primary recreational water contact (Dufour *et al*. 2017). For secondary contact (boating, fishing, wading,…) the amount ingested it typically one tenth of this ingestion rate, i.e., up to 10 millilitres per day (pers. comm. Jeff Soller, Soller Environmental, California).

[11] Stott and Palliser 2012, McBride 2012, Palliser *et al*. 2014)

to a log-reduction value of two by the time that wastewater reaches Lake Wairarapa.

26. No discharge to Donald Creek (but ongoing irrigation to land [and movement through groundwater]). Under the above assumptions, the total log reduction is five: two (wastewater treatment) plus two (groundwater processes) plus one (for river mixing), so that an individual swimmer at Lake Wairarapa could be exposed to a norovirus concentration of one per litre. The actual dose received by individual swimmers then has to account for the water volume ingested (100 millilitres, one tenth of a litre). In that case each individual swimmer has a one-in-ten chance of ingesting a single norovirus, so that the overall illness risk is 0.1%. This risk is considerably below the border between 'Acceptable' and 'Alert' surveillance modes under the MfE/MoH (2003) recreational water quality guidelines.[12]

27. Discharge to Donald Creek. In this case the total log-reduction is 4: 2(wastewater treatment) plus 2 (river mixing and inactivation), so that an individual swimmer at Lake Wairarapa would be exposed to a norovirus concentration of 10 per litre. In that case the risk faced by *any* swimmer is close to 1%.[13] This risk is at the border of the 'Acceptable' and 'Alert' surveillance modes under the MfE/MoH (2003) recreational water quality guidelines, for which the *E. coli* value should not exceed 260 per one hundred millilitres.[14] [15] I note that this is the theoretical risk to a person who ingests water during swimming or some other contact recreation

[12] The relevant sections of the guidelines are 'Box 2' (page E9) and Table H2 (page H26).

[13] It is 'close to' because some swimmers may ingest more than one norovirus, in which case other swimmers would receive none.

[14] The relevant sections of the guidelines are 'Box 2' (page E9) and Table H2 (page H26).

[15] *On review of E. coli concentrations downstream of the current discharge, there has been only one occasion since UV disinfection was installed resulting in an exceedance in the MfE/MoH (2003) Guidelines' "Action Mode", indicating the Creek would not be suitable for recreation. It is unlikely that this would have resulted in an exceedance in the Guideline in Lake Wairarapa located approximately 5km downstream from the discharge (Aee, page 157).*

activity. Mr Exeter will discuss the likelihood of swimming occurring in the stream or in the Lake. [16]

28. Household supply from bore water. The 2016 Havelock North drinking-water-associated campylobacteriosis outbreak has highlighted the need for precaution with respect to drinking water. Furthermore, daily consumption of bore-water that gives rise to illness may not be identified as drinking-water-related, especially as the majority of relevant reported diseases tend to be endemic, not outbreaks. Absence of evidence isn't evidence of absence, unless the outbreak is in some sense large (for example, the 2016 drinking-water outbreak in Havelock North in which case the evidence was clear).

29. I note that: the affected bores will on occasion contain noroviruses; consumption of bore-water occurs daily; and a number of affected bores are shallow (and so not secure under the MoH Drinking-water standards). I therefore conclude that the potential effect of groundwater discharges on these water consumers (if such use continues) is more than minor.

30. Aerosols from wastewater irrigation. The risk of illness risk attributable to this source of adenoviruses can be considered as less than minor. This is for two reasons: Firstly, because the total adenovirus concentration in the irrigated treated wastewater is calculated to be only 1 per litre; secondly the respiratory illness-causing adenoviruses (type 4 and 7) comprise less than 10% of the total; inhalation rates of such aerosols is small. Also, some mixing with the ambient air will occur between the point of irrigation and the nearest dwelling.

POTENTIAL EFFECTS OF LOW PROBABILITY BUT HIGH IMPACT

[16] *On review of E. coli concentrations downstream of the current discharge, there has been only one occasion since UV disinfection was installed resulting in an exceedance in the MfE/MoH (2003) Guidelines' "Action Mode", indicating the Creek would not be suitable for recreation. It is unlikely that this would have resulted in an exceedance in the Guideline in Lake Wairarapa located approximately 5km downstream from the discharge (AEE, page 157).*

31. Section 3(f) of the Resource Management Act (2001) defines 'effect' to include "any potential effect of low probability which has a high potential impact".

32. An application of this provision concerning public health risk assessment would occur were there to be an elevated concentration of noroviruses in the influent to the wastewater treatment plant.[17] This could occur were there to be an outbreak of norovirus illness in Featherston.

33. Or, more realistically, we may consider an example where the UV treatment is not functioning for some time (and so warning signs for swimmers would need to be posted). The concomitant increase in effluent norovirus concentrations will have minor effect on the egress of groundwater from irrigated wastewater, because the groundwater system is strongly buffered when present with a temporary concentration spike.

34. However, risk to swimmers at Lake Wairarapa would face an elevated risk because the log-reduction falls to four in which case health risks are between 5% and 10%, close to the 'Action mode' in the MfE/MoH guidelines.[18] The effect of upstream water contamination may well cause the risk to enter the red mode *E. coli* concentration (550 *E. coli* per 100 millilitres) downstream of the discharge. This risk could be addressed by the placement of warning signs. Whether or not this is necessary given the improbability of swimming occurring in the Lake is a matter best addressed by the Medical Officer of Health.

RESPONSE TO SUBMISSIONS:

35. A number of submitters have expressed concerns on the pathogen risk to groundwater and surface water.

36. Submitter 19: Diana Roslyn Leahy, concerns spray drift impacting roof water.

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[17] This has occasionally been found in New Zealand, for example at Napier in November 2010 (McBride 2011).

[18] Using the 'log removal' method herein, increasing the influent norovirus concentration by an order-of-magnitude would cause a similar rise in the calculated illness risk.

Response: My evidence (at paragraph 30) presents qualitative assessment of the possible health effects for spray drift, indicating that the risk is less than minor. More detailed calculations could be provided if required however Ms Beecroft has provided additional assessment in her evidence on this matter. I have considered her comments and the proposed mitigation measures and do not consider that a quantitative risk assessment is required, because the risk calculated in her evidence is less than 0.1%. I understand that the proposed irrigation setbacks are in line with the District Plan requirements which were the result of expert input including from the Medical Officer of Health.

37. Submitter 46: Malcolm Morgan, concerns impacts on groundwater pollution.

Response: I have discussed the issue of the potential impacts of land irrigation upstream of groundwater flows and extraction therefrom for potable water supply from shallow groundwater wells (paragraphs 28 and 29). I consider this risk is best addressed by the consent holder being required to provide alternative supplies of potable water for the affected bores used for this purpose.

38. Submitter 76: Maori Standing Committee for South Wairarapa District Council, concerning public health risk.

Response: My evidence (at paragraphs 20-30) presents an assessment on this issue. My expectation is that health risks from consumption of wild foods, especially tuna, would in the normal course of events be less that minor (especially if not eaten raw).

39. Submitter 82: Wendy Anne Devenport, concerns effects on other water supplies.

Response: See my response to submitter 46.

40. Submitter 87: Andrew John and Dianna Jane Hosnell, concerns (i) spray drift impacting roof water and (ii) notes that UV can be compromised by clumping which means *E. coli* are protected and can end up in spray.
Response: (i) See my response to submitter 19 paragraph (6) regarding spray drift. (ii) Mr Couper has addressed the clumping issue in his evidence.

41. Submitter 89: Chris Reed, concerns (*inter alia*) public health risk.
Response: My evidence (at paragraphs 20-30) presents an assessment of this issue.

42. Submitter 117: Garrick Ralph Emms, concerns (inter alia) (i) Spray drift (ii) Quality and Quantity of discharge (iii). groundwater levels and contamination and surface water contamination
Response: These issues have been addressed above.

43. Submitter 121: Patricia Rose Heuser, concerns: (i) Negative effects on groundwater; (ii) Negative effects on surface water. (iii) Serious negative actual and potential effects on human health are risked. There is a school nearby and many houses in close proximity which SWDC has not taken into account in its submission.
Response: These issues have been addressed above.

44. Submitter 122: Mark Thornton, concerns (*inter alia*) (is concerned that the discharge will contaminate their bore water which they use for drinking.
Response: I have addressed the concern regarding drinking water at paragraphs 28–29

45. Submitter 123: Mark Thornton, concerns public health, impacts on Donald Creek and Lake Wairarapa
Response: These issues have been addressed above.

46. Submitter 124 (Regional Public Health) is comfortable with the risk to public health so long as spray irrigation of treated wastewater meets median *E. coli* concentrations in the treated effluent less than 100 cfu/100ml. This level is achieved by the current UV disinfection as discussed by Mr Couper in his evidence. The risks are also minimised by sebacks from boundaries and the form of irrigation proposed as discussed by Ms Beecroft in her evidence and I have provided commentary on these proposed consent conditions above.
Response: Submission is supported.

47. Submitter 125 Dianne Connell concerns (i) proposed Featherston Wastewater Treatment Plant will only be able to discharge contaminants for a very limited time due to the strong winds and high water tables limiting its operation. (ii) smell. (iii) Contamination of bore water used for drinking.
Response: These issues have been addressed above.

48. Submitter 136 Daniel Neemia, concerns spray drift and odour.
Response: I have addressed these issues above.

49. Submitter 138 Georgia Marguerite Jamieson Emms, concerns (i) Food / public health risk (ii). Effects on groundwater (iii). Wind / spray drift, (iv)
Response: These issues have been addressed above.

50. Submitter 145 (Virginia Love and Liam Glancey), concerns spray drift effect on roof water supplies
Response: These issues have been addressed above.

51. Submitter 149 Helen Philippa Forlong, concerns public risk to groundwater
Response: These issues have been addressed above.

52. Submitter 156 Helena Glover Concerns public health risk
Response: I have addressed public health risk in my evidence above.

RESPONSE TO S42A OFFICERS REPORT

53. The section 42A officer's report (1 March 2019) states that *"In my opinion, based on the PDP advice in their report and the GWS report, the risk of pathogens and potential water quality effects is an issue which needs to be addressed in more detail than has been provided by the applicant."*

54. I agree with this comment. In response, in this evidence I have presented a qualitative assessment of pathogens and water quality effects, using 'log-removal' numbers. The results obtained should be similar to those that could be obtained by a detailed 'QMRA'—Quantitative Microbial Risk Assessment. In my view there is no need for such an assessment. There will always be some health risks associated with the discharge of wastewater. In my opinion the measures proposed by the Applicant are provide appropriate mitigation of risks.

CONCLUSIONS

55. Health risks for primary contact water use are less than minor, except for the possibility that a large inflow norovirus concentration coincides with an unusually high effluent flow rate in which case the risk may reach the 'Action mode' of the recreational water quality Guideline (MfE/MoH) and require advisory signage to be displayed at Lake Wairarapa or another suitable location downstream of the discharge depending on the level of recreational use. The risk in that situation is to those who ingest water in relatively large quantities. The AEE and Mr Exeter outlines the general recreational uses of these water bodies. I also note that the risk has been assessed at the point of entry to Lake Wairarapa and will decrease substantially after that.

56. The proposal for effluent irrigation and subsequent passage through the groundwater system, increases the existing health risks arising from use of shallow drinking water bores. I recommend that this risk be addressed by a condition requiring provision of alternative potable water supply systems from the commencement of land irrigation.

57. While the proposed conditions are appropriate, some further monitoring of norovirus concentrations for the inflow and outflow from the treatment plant is suggested. The results should be used to further assess the efficacy of the treatment plant and to reveal if there are unexpectedly high average norovirus concentrations in Featherston sewage.

Signed:

Graham McBride

29 March 2019

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