

**Before the Hearings Panel
At Wellington**

Under the Resource Management Act 1991

In the matter of an application for resource consent to discharge contaminants to land, air and water associated with the proposed long term upgrade and operation of the Featherston Wastewater Treatment Plan

Applicant **South Wairarapa District Council**

Statement of evidence in response by Daryl Irvine on behalf of Greater Wellington Regional Council (wastewater treatment and irrigation)

Date: 10 May 2019

INTRODUCTION

1. My full name is Daryl Davidson Irvine. I am a Technical Director and Senior Environmental Engineer in the Auckland office of Pattle Delamore Partners Ltd.
2. My evidence in response is given on behalf of Greater Wellington Regional Council (GWRC) in relation to the resource consent applications from South Wairarapa District Council (Applicant) for a suite of consents corresponding with the activities and discharges associated with the receipt, treatment, storage, surface water discharge, land application and general management of wastewater received at the Featherston wastewater treatment plant (WWTP) (the "Application"). In particular, my evidence in response relates to the wastewater treatment and irrigation system aspects of the Application.

Qualifications and Experience

3. I hold a degree of Bachelor of Technology (Environmental Engineering), from Massey University and I hold Advance Level certification in Sustainable Nutrient Management in New Zealand Agriculture from Massey University (2017).
4. I am a member of Engineering New Zealand and a collaborative member of the New Zealand Land Treatment Collective.
5. In the course of my work, I have obtained extensive experience in the treatment and disposal of industrial and municipal wastewaters, in particular in land treatment of wastewaters and associate solid waste streams. Wastewater and biosolids, land treatment operations and assessments that I have been involved in include: Fonterra Hautapu, Reporoa, Edendale, Te Awamutu, Stirling and Brightwater sites, Silver Fern Farms Takapau wastewater irrigation, Wallace Corporation wastewater irrigation, Inghams Enterprises (NZ) Limited wastewater irrigation, Taranaki By-products wastewater irrigation, Omaha treated sewage irrigation, Taupo treated sewage irrigation, Cooks Beach treated sewage irrigation and alternatives assessments for irrigation of treated wastewater to land for Wellsford, Warkworth, Waiuku, and Palmerston North.

My role

6. I have been involved in the Featherston wastewater Treatment Plant (FWWTP) treated wastewater consent application review since December 2018, standing in for Mr Robert Docherty, who is unavailable for this Hearing process.

7. I co-authored the Section 42A Appendix Report dated 27 February 2019 (FWWTP RC Review Report). This was attached to the GWRC's Section 42A Officers Report. I reaffirm the contents and conclusions of the FWWTP RC Review Report, subject to the matters noted below.
8. I participated in conferencing with Ms Beecroft (LEI), Mr Chris Simpson (GWS), Mr Robert Docherty (PDP), Mr Aslan Perwick (PDP), and Mr Jack Feltham (PDP) on 18 December 2018 and signed a Joint Witness Statement (Land Treatment and Groundwater JWS) dated 20 December 2018.
9. In preparing my evidence in response I have:
 - i. Read the evidence of Ms Beecroft, Mr Chris Park, Mr Steven Couper and the proposed conditions from Mr Sven Exeter, for the Applicant;
 - ii. Read the evidence in response of Mr Aslan Perwick (PDP), Mr Jack Feltham (PDP), and Dr Ausseil for GWRC and related Technical Expert Conferencing Statements of Water Quality and Land Treatment and Groundwater;
 - iii. Read the evidence of Dr. Lee Burbery on behalf of Wairarapa Regional Public Health.

Code of conduct

10. I have read and agree to comply with Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. My qualifications as an expert are set out above. 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 except where I state that I am relying on the evidence of another person, this evidence is within my area of expertise.

Scope of evidence

11. My evidence in response addresses the following matters:
 - i. A summary of my evidence in response;
 - ii. An overview of key points from Land Treatment and Groundwater JWS;
 - iii. An overview of key points from the Section 42A report that relate to my area of expertise;
 - iv. Response to issues raised in the Applicant's evidence (Response to the Applicant's evidence);
 - v. Response to submitter evidence (Response to other evidence);

- vi. Draft conditions and proposed mitigation (Conditions/Mitigation);
and
- vii. Conclusions.

SUMMARY OF EVIDENCE IN RESPONSE

12. My evidence in response covers the review of the wastewater flows and loads assessment, review of the wastewater treatment system assessment and options and review of the proposed wastewater irrigation system, particularly around the proposed hydraulic loading management.
13. Review of the nutrient management modelling, conducted by the applicant, specifically around Overseer modelling, has been undertaken by Jack Feltham (from PDP), who will present evidence separately. Review of the groundwater investigations and modelling has been undertaken by Aslan Perwick (from PDP), who will also present evidence.
14. In my opinion, the proposal by SWDC, to reduce direct discharge of treated wastewater to Donald Creek by irrigating the treated wastewater to land is a move in the right direction as it helps reduce potential effects on the surface water environment (evidence by Dr Ausseil). However, I have concerns about the ability/capacity of the proposed wastewater irrigation system to manage wastewater volumes to a level where discharges to surface water can be reduced to the levels outlined in the consent application.
15. The applicant has outlined that sufficient conservatism has been included in the proposed system preliminary design and that “adaptive management” can be utilised during detailed design and operation to ensure that the proposed wastewater irrigation system can manage sufficient wastewater loads to limit discharges to surface water to no more than the frequency utilised in the application and as reviewed by Dr Ausseil.
16. However, I continue to have uncertainties. This is particularly around:
 - i. The level of reduction in wastewater volumes that can be achieved;
 - ii. The seasonal distribution of irrigation utilised in identifying the wastewater storage requirements;
 - iii. The soil drainage rates calculated from the soil moisture model and the soil drainage rates utilised for hydraulic modelling;
 - iv. The parameters utilised in groundwater modelling;
 - v. The calculated area where unacceptable groundwater mounding has occurred (i.e. where groundwater level means the depth to groundwater is less than 0.6m, see Paragraph 1.ii) and its impact

on the modelled irrigation distribution. Earlier groundwater models indicated smaller areas of unacceptable groundwater mounding within proposed irrigation area, however, more recent groundwater models (received in April 2019) indicate an increased unacceptable groundwater mounding area and it is unclear whether the reduced potential irrigation area (as a result of unacceptable groundwater mounding) has been incorporated into the irrigation model developed by LEI.

17. Due to these remaining uncertainties, there is the risk that there will be insufficient conservatism in the proposal to enable “adaptive management” within the proposed system to be utilised to prevent an increase in discharge to Donald Creek (beyond what is proposed in the application). It is my understanding from the Applicant's evidence (evidence of Mr Park) that proposed adaptive management methods may include, implementing additional sewer reticulation remediation works to further reduce I/I if the presently proposed reductions do not achieve the reduction estimated, increasing the size of the wastewater storage lagoon and/or implementation of additional irrigation areas.
18. The implementation of the additional “adaptive management” methods may require additional resource Consents, but most importantly from an implementation viewpoint the physical works required would all come at significant cost to SWDC and my concern is that there may be insufficient available capital to develop the system further particularly in a timely manner. In the meantime, the only rapid response solution available to SWDC would be to discharge to surface water (beyond that outlined in the proposal) and this in my opinion is not a suitable “adaptive management” tool given that it is contrary to the objective of the consent application of applying the effluent to land. An increase in the discharge of additional effluent to the Donald Creek over and above what the Applicant has assessed in the AEE may result in greater potential adverse effects than that assessed by the applicant and Dr Ausseil, and would be contrary to the objective of the consent.

LAND TREATMENT AND GROUNDWATER JWS

19. The Land Treatment and Groundwater Joint Witness Caucusing occurred on 18 December 2018 (JWS signed 20 December 2018). A number of items raised in both previous technical discussions (24 January 2018) and (25 September 2018) and the land treatment and groundwater expert brief (5 September 2018) were not addressed at the time of the JWS, as outlined in the “Materials relied on, b)” section of the signed JWS statement.

20. The points I discuss below relate to items addressed in the JWS, plus items subsequently addressed in evidence, and items that have not been fulfilled by the Applicant (even though they were agreed by the Applicant and PDP in the JWS to be provided), as well as items that in my opinion, have not been adequately addressed. Reference to Mr Aslan Perwick and Mr Jack Feltham's evidence has been made where appropriate:
- i. JWS Item 1 – A statement of agreement was reached between experts around the risks associated with groundwater mounding. I consider the key points of agreement to be:
 - a) Excess mounding occurs resulting in less land discharge capacity than currently assessed for the scheme.
 - b) Excess mounding occurs resulting in ponding and/or runoff.
 - c) Excess mounding occurs reducing available soil depth for pasture root penetration which will reduce nitrogen uptake and water removal by plants, and be contrary to the Overseer modelling results reported in the AEE.
 - ii. JWS Item 2 – Experts agreed on the definition of unacceptable groundwater mounding which is mounding that results in reduction of the vadose zone thickness to less than 0.6 m. (i.e. depth to groundwater from ground surface of <0.6 m unacceptable).
 - iii. JWS Item 3 – the Applicant was to provide details around the land area over which this unacceptable mounding may occur and how this may alter under different inflow, irrigation and climatic scenarios. This was not provided, so no agreement was reached. This has still not been provided in evidence. As per Mr Aslan Perwick's evidence, only a figure outlining a visual representation of unacceptable groundwater mounding has been provided. No evidence has been provided indicating this assesses anything other than an average year, e.g. varied inflow, irrigation or climatic scenarios not assessed.
 - iv. JWS Item 4 – Applicant was to provide details about the likelihood of unacceptable mounding at Stage 1B, 2A and 2B. No agreement could be reached on this as there was outstanding information and assessments to be provided by the Applicant's experts at the time of expert caucusing. PDP considers that Applicant's subsequent evidence has not sufficiently addressed these outstanding requirements as covered in Mr Aslan Perwick's evidence.

- v. JWS Item 5 – Level of certainty of Item 4. No agreement could be reached as per comments on Item 4 above.
- vi. JWS Item 6 – The Applicant was to provide additional information to address residual uncertainty around groundwater mounding and effects. At the time of the Joint Witness Caucusing, the information forming the basis of groundwater assessments was not provided. Therefore, under Item 6 it was agreed between experts the following information would be provided by the Applicant.
 - a) Field investigation summary document for fieldwork undertaken by LEI in November/December 2018 and the supporting hydrogeological assumptions for the modelling work. As per Cl. 32.d. of Ms Beecroft's evidence this investigation work is still unreported and has not been provided to PDP.
 - b) Groundwater Modelling Technical Report Appendix B. This has been provided, however, Mr. Aslan Perwick has assessed that key information is missing from this document as discussed in his evidence.
- vii. JWS Item 7 – Extent to which potential for unacceptable mounding be managed through management plan, adaptive management. No agreement could be reached on this as there was outstanding information and assessments to be provided by the Applicants experts at the time of expert caucusing. Mr. Aslan Perwick has assessed subsequent information provided in his evidence. Further discussion on the ability of the proposed scheme to be managed adaptively is discussed in my evidence.
- viii. JWS Item 8 – Effect of discharge to land management to avoid unacceptable mounding. It was agreed that this could lead to an increased storage requirement, increased discharge to surface water, and/or higher loading to selected land areas. However, further information and assessments to be provided by the Applicants experts at the time of expert caucusing have still not been received by PDP. Mr. Aslan Perwick has assessed subsequent groundwater modelling information provided in his evidence.
- ix. JWS Item 9 – Pathogen risk. It was agreed Norovirus was an appropriate indicator pathogen, that a 5-year average groundwater travel time was appropriate, and that pathogen risk assessment by a suitable specialist expert was required. At the time of caucusing,

further information from a letter drop of potential dwelling receptors was to be provided by the Applicant. Subsequently, it appears that Mr. Graham McBride was engaged and has provided expert evidence on human health risks. Mr. Aslan Perwick has provided further discussion of pathogen risk in his evidence.

SECTION 42A REPORT

21. I consider the points made in the FWWTP RC Review Report and summarised in the s42A Officers Report to still be valid as the majority of concerns not addressed in the Land Treatment and Ground JWS as discussed above are still outstanding, particularly around groundwater mounding assessments and the impact on this on the proposed irrigation regime. I have re-affirmed above in my evidence the relevant concerns raised in the Section 42A report.
22. In particular I note that concerns I raised with the proposed conditions have been largely uncovered in Mr Sven Exeter's evidence.
23. The exception is the assessment of pathogen/human health risk, which has been progressed since the issue of the s42A Officers Report. Mr. Aslan Perwick has provided review of updated pathogen risk assessment in his evidence.

RESPONSE TO THE APPLICANT'S EVIDENCE

24. As outlined above, I have reviewed the evidence of Mr Chris Park (Reticulation Improvements), Mr Steven Couper (Wastewater treatment and Alternatives Assessment), and Ms Beecroft (Wastewater Irrigation Assessment). I have provided comments to the respective evidences as follows:

Response to Mr Chris Park's Evidence

25. In general, I do not doubt the work Mr Park has done which includes flow measurement of several catchments to assess the overall I/I effect and his assessment as to likely reductions which can be achieved. His overall assessment is that a 35% flow reduction seems possible but he notes there is variability in I/I effectiveness based on case studies (Paragraph 14.d.) – I agree with his comment that there will be variability in effectiveness of the I/I programme. Therefore, there is a need for conservatism in the calculation of reduction in wastewater flows that will be achieved and I am not convinced that this has been sufficiently applied. In addition, it is a normal engineering approach to undertake a sensitivity analysis when there is some uncertainty around the preciseness of calculations.

26. It is noted in Paragraph 9b of Mr Park's evidence, that night time flows have been utilised to gauge groundwater infiltration, upon which improvements to the reticulation system and subsequent sizing of the wastewater system has been gauged. This has been on the basis that skewing from large sources of trade waste is considered unlikely in Featherston. I note that there is a large sawmill at the urban boundary of Featherston, and it is unclear in Mr Park's evidence whether the contribution of trade waste from the sawmill (if any) has been considered.
27. Mr Park notes that post rehabilitation flows are expected to be well above typical sewage flows (Paragraph 12.b.).
28. Mr Park recommended a pilot catchment be used to demonstrate the I/I reduction effectiveness (Paragraph 12.e.). Presumably this was recommended in his 2013 report. He notes that this is still in progress and results are not available yet and that these results (particularly of the trunk sewer) will be of critical importance (Paragraph 12.e. & f.).
29. My comment is that; the reason that correctly predicting the actual amount of reduction in I/I is so important is that this is the basis of the modelled wastewater flows used in the AEE and hence as used for the irrigation modelling, storage pond assessment and discharge to river assessment.
30. Mr Park on (Paragraph 12.g.) notes that 'adaptive management options' are available including storage, further I/I work to rehabilitate the infrastructure and adjustments to the land application approach.
31. I have some concerns with the Adaptive Management Approach as follows:
 - i. Building additional storage and undertaking more rehabilitation of reticulation infrastructure can probably be done, however, it comes at a cost and takes time to implement and obtain consent for (if it is obtained). The quantum of this work and the associated cost remains an unknown and I am concerned that SWDC would embark on a project without having this well quantified.
 - ii. Based on the work undertaken by the Applicant I do not believe there are many other options available around the 'land application approach' in terms of applying more effluent to the existing parcel of land as it appears to be the ability of the land to accept the effluent due to groundwater constraints is the main issue. There is always an option to use additional land (e.g. the golf course which Lawrence Stephenson suggests in his evidence) or to buy additional land but again this comes at a cost and timeframe to implement and obtain consent for (if it is obtained).

- iii. The AEE effects may change if the “Adaptive Management” approach is used, depending on the nature of the approach and the change(s) that occur as a result. For example, a departure from the AEE would occur if more storage was added, if more effluent is discharged to Donald Creek or if the land application regime is changed or more land is used for irrigation.
 - iv. An increase in the volume of effluent discharged into Donald Creek would be contrary to the intent of the consent application (which is to put it onto land) and would certainly be different to that modelled and assessed in the AEE and by Dr Ausseil.
32. Mr Park recommends in Paragraph 14.e. that further investigations and analysis should be carried out. I agree that this is necessary in order to accurately predict the actual I/I reductions which can be achieved so that the Applicant does not have to rely on an Adaptive Management Approach in the event that expected flowrates are not met as I believe the Adaptive Management Approach in this situation may end in the District Council owning a system that becomes non-complying and has environmental effects which are different to those portrayed in the AEE and/or requires additional future expenditure which may not be budgeted for. These investigations should have been done prior to sizing and preliminary design of the irrigation system to provide confidence to both SWDC and GWRC that the proposed flow reduction can be achieved.

Response to Mr Steve Couper’s Evidence

33. I am satisfied with the evidence that Mr Couper has presented, in that it covers reasonably available alternatives and considers disposal and treatment options and balance benefits and costs. Key points to high light are outlined below.
34. As outlined in my evidence above, there are uncertainties around several aspects of the proposed reticulation upgrades, wastewater irrigation proposal and hydraulic modelling which may require additional investment to implement “Adaptive Management”, such as additional reticulation remediation, additional storage capacity and/or additional irrigation areas. It is noted that these measures would all require additional investment by SWDC. On this basis, would the proposed irrigation to land system remain a preferred option or would an alternative option provide lower investment risk for SWDC?
35. It is noted from the wastewater treatment performance summary and proposed system performance limits (Table 5) that the assessed system performance is based on 25th percentile, median, mean, 90th percentile and

95th percentile. The method for assessing compliance against the proposed limits are based on “5 out of 12 samples” for the mean average limit and “3 out of 12 samples” for 90th percentile limits. This is valid if utilising the method outlined in the NZ Municipal WW Monitoring Guidelines Table 13.2, which prescribed these numbers of exceedances as permitted, for a 12 sample monitoring period, and for a 10% dischargers risk. However, the value utilised for these limits is above the historic performance of the wastewater treatment plant on which the assessment of environmental effects has been based, in particular the proposed limit for ammoniacal nitrogen is approximately 50% higher than historic 90th percentile performance. The proposal of higher prescribed limits above the expected effluent quality of the wastewater treatment system effectively offers an additional factor of safety for the discharger against non-compliance due to variation in treated effluent quality. Given that the NZ Municipal WW Monitoring Guideline method of assessing compliance already limits the risk to the discharger to 10% by allowing for 25% of all samples to be above the prescribed 90th percentile limit, I do not consider any further allowance for variation in effluent quality to be appropriate. This essentially means that the Applicant is proposing limits that allow a worse quality of effluent to be discharged. This is contrary to what has been assessed by the Applicant in the AEE where historical effluent wastewater quality data was used. I recommend that effluent quality concentration limits in the proposed conditions are re-assessed to be representative of the existing treated effluent quality. This has been raised previously in the FWWTP RC Review Report attached to the section 42A report.

Response to Ms Katie Beecroft’s Evidence

36. I have reviewed the evidence provided by Ms Beecroft and have itemised my key areas of concern regarding the proposed wastewater irrigation system. My key concerns are around hydraulic management of the irrigation system. Review of nutrient management within the wastewater irrigation system has been provided by Jack Feltham.
37. In Figure 5 Ms Beecroft details the average annual hydraulic loading rate across the total irrigation area for the four stages, ranging between approximately 400mm and 500mm per year. This has been compared with four other irrigation systems, including Masterton, Taupo, Omaha and Pauanui. I am familiar with these systems and in my opinion they are not appropriate for comparison for the following reasons: Masterton is a border-dyke irrigation system, in close proximity to a river so is essentially a high rate disposal system with the river controlling groundwater levels. Taupo is a system which operates in very free draining pumice soils and with a deep

groundwater level underlying the site which is completely contrary to the soils and groundwater system at the Featherston site. Omaha includes irrigation to sandy soils, again contrary to the Featherston site. Pauanui relies on rapid infiltration to sandy soils and is completely different to the Featherston site in terms of ground conditions and method of disposal.

38. Notwithstanding this, the proposed annual average hydraulic loading rate of 400 – 500 mm/yr at Featherston is not unreasonable in my opinion and is in keeping with other wastewater land treatment systems, such as Cooks Beach municipal wastewater irrigation scheme (~450 mm/yr) and the Fonterra Reporoa industrial wastewater irrigation scheme (300 mm/yr – 400 mm/yr).
39. While the proposed annual hydraulic loading rate is in keeping with similar systems, the seasonal hydraulic loading rates must also be considered as this has implications on the required wastewater storage volumes. An unnumbered figure at the end of Ms Beecroft's evidence outlines the monthly hydraulic loading rates for each irrigation block. The graph details minimal discharge to surface water from June to August, meaning that irrigation would occur during 9 months of the year (September to May). Based on an annual average loading rate of 450 mm/yr, this would equate to a monthly loading rate of 50 mm/month, averaged across all areas. It is noted from the monthly irrigation distribution graph in Ms Beecroft's evidence that up to 230 mm of irrigation is proposed for Block 2B in September which is nearly five times the proposed average monthly rate and twice the average rainfall for September. While this block may be deemed the better block for hydraulic loading, it is proposed at a wetter time of the year and in my experience is well in excess of what could be expected for a pastoral based land treatment system.
40. It would be better practice to spread the hydraulic loading further into the summer months but this will likely require additional storage. It is unclear if sizing of the storage facility would allow additional volume balancing.
41. I note that we have requested the Applicant to update the storage balancing modelling but this has not been provided.
42. I have concerns around the irrigation limitations that are proposed, with the limits of concern summarised as follows:
 - i. No irrigation if >2mm of rain in the past 24 hours
 - ii. Irrigation event <55mm on a 14 day rotation (but not clarified in Paragraph 179)

- iii. For non-deficit irrigation, raise soil moisture no more than 3mm above FC.
43. The 2 mm rain limit will significantly restrict the number of days that irrigation can occur. There are many times when 2 mm of rainfall will have minimal effect on soil moisture level, therefore, a low rainfall limit will unreasonably restrict irrigation and promote discharge to surface water. Restrictions to irrigation would be better managed by utilising soil moisture monitoring or modelling.
44. In Paragraph 78, Ms Beecroft outlines that buffer distances are based on literature (Hewitt (2001)), which considers “*deminimus risk of drift for most applications but a complete assessment of exposure risk would require input by an expert on public health risk...*”. It is noted from Paragraph 30 of Mr Graham McBride’s evidence that respiratory illness causing adenoviruses is considered, however, I cannot see where potential contamination of roof water supplies has been addressed by Mr McBride.
45. In Paragraph 154, Ms Beecroft makes reference to bores being previously utilised for irrigation with a consented water take, equivalent to a loading rate of 823 mm/yr. However, Ms Beecroft has not supported this information with actual water take data and so it is unclear whether or not this has any relevance to the proposed wastewater irrigation depths. In Paragraph 156 Ms Beecroft implies that historic irrigation provides reassurance that the proposed wastewater irrigation system will work, yet the actual historic applied depths are not stated.
46. In Paragraph 32, Ms Beecroft makes reference to “subsurface investigation – (unreported)” among others that have been reported. In Paragraph 93 of her evidence, reference is made to this additional work, carried out in the second half of 2018, and in Paragraph 96 outlines that investigations into deeper vadose zone has been undertaken but as unreported in time for the s42A Officers Report. This still remains unreported. As this field investigation is unreported, this cannot be reviewed or considered in my evidence. In my opinion, it is concerning that the Applicant’s case is partly relying on information that is unreported and which has not been provided to support its case.
47. In Paragraphs 34, 88, 93, 95, 96, 97, 98, and 117, of her evidence, Ms Beecroft discusses the site characterisation information provided as the basis for the assessment of effects. Although I agree that the information provided is sufficient for the assessment of the proposed irrigation regime, I consider that an assessment on whether this information is suitable for groundwater modelling is outside the area of expertise of both my evidence

and Ms Beecroft's evidence. I have relied on Mr. Chris Simpson and Mr. Aslan Perwick to provide evidence on the basis of groundwater modelling assessments as these two people are recognised experts in this field.

48. In Paragraph 64, Ms Beecroft outlines that soil drainage from the sites is predicted and discussed in Mr. Chris Simpson's evidence. However, I note that in Mr Simpson's evidence he states he has relied on input data from Ms. Beecroft for drainage reaching the aquifer from the below the rooting zone (Paragraph 22 of Mr Simpson's evidence). As drainage from shallow soils to groundwater is an output of soil moisture modelling, I would expect this information to be provided by Ms Beecroft, not calculated and provided by Chris Simpson. No drainage information (i.e. depth of drainage from below root zone to the aquifer) has been provided by Ms Beecroft in her evidence. As noted in Mr Aslan Perwick's evidence, no input drainage information has been provided in Chris Simpson's evidence. I note that the only drainage input information provided by Chris Simpson as the basis for groundwater modelling was provided in "20170602 Featherston WWTP Section 92 response Compiled" document in Table 2 of the 1st June 2017 GWS groundwater modelling report. This monthly drainage data is provided in Figure 1 below, and results in an annual drainage of 806 mm/yr. This does not align with the drainage information provided in the AEE "Appendix 7 LEI FWWTP Land AEE 2017" document prepared by Ms Beecroft. In Table 4.8 of that report is provided in Figure 2 below. This shows Stage 2B drainage ranging from 899 to 1,180 mm/yr for irrigated areas, and although it is not provided directly, the average drainage rate can be assessed to be approximately 1,023 mm/yr for the entire irrigated and non-irrigated area, based on the provided annual drainage volume of 1,821,420 m³ and total area of 178 ha. This represents an apparent under representation of expected drainage for the proposed irrigation regime in groundwater modelling of approximately 242 mm/yr. This casts further doubt on the impact of groundwater modelling presented by the Applicant and this matter is discussed in Mr Aslan Perwick's evidence.

Table 2 Average Monthly Drainage Depth Below the Root Zone (mm)

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Monthly	19	18	26	67	90	130	159	109	59	83	24	22
Daily	0.61	0.64	0.84	2.23	2.90	4.33	5.13	3.52	1.97	2.68	0.80	0.71

Figure 1: Table 2 from Section 92 GWS 1 June 2017 Report

Table 4.8: Annual Drainage from Sites A and B

ID	Area (ha)	Current		Stage 2B	
		Drainage depth (mm)	Volume (m ³)	Drainage depth (mm)	Volume (m ³)
Site A irrigated	8	705	56,453	899	71,920
Site A buffer non-irrigated	4	705	28,226	705	28,200
Site B current irrigated	70	899	629,210	1,180	826,000
Site B current non-irrigated and future expanded irrigated	46	705	324,602	1,180	542,800
Site B non-irrigated	50	705	352,500	705	352,500
Total	178	NA	1,390,991	NA	1,821,420
Increase in annual drainage		430,429 m ³ or 31 %			

Figure 2: Table 4.8 from "Appendix 7 LEI FWWTP Land AEE 2017" document

49. In Paragraph 87 of her evidence, Ms Beecroft outlines that the proposed annual irrigation depth is in line with a deficit system. However, overall the system cannot be deemed to be a deficit irrigation system as:

- i. The proposed irrigation regime allows irrigation above the field capacity of 3 mm/d for the majority of the irrigation area.
- ii. Table 4.8 of the AEE "Appendix 7 LEI FWWTP Land AEE 2017" document prepared by Ms Beecroft outlines an increase in drainage under the proposed irrigation regime of 31% at Stage 2B as provided in Figure 2 above.

50. In Paragraph 88, Ms Beecroft proposes that detailed review of site-specific soil investigations by Ms. Arnesen may have informed her conclusions in the s42A Officers Report around insufficient information being provided to enable effects to the soil from land discharge to be assessed. Ms Beecroft does not provide specific reference for the conclusions she is referring to, but I assume this is with reference to Section 9.4 "Effects on groundwater and soils". Ms. Arnesen conclusions here discussing insufficient information are informed by PDPs s42A Appendix 8 report, and refer to insufficient information characterising the underlying geology of the site. The reported site investigations outlined in Paragraph 32 of Ms Beecroft's evidence assess shallow soils. As outlined in Paragraph 46 of my evidence, further unreported field investigation cannot be considered as this information has not been provided by the Applicant. As outlined in Paragraph 47 of my evidence, consideration of whether site characterisation information is sufficient for groundwater modelling purposes is outside the area of expertise of both my evidence and Ms. Beecroft's evidence.

51. In Paragraph 90 of her evidence, Ms Beecroft outlines her opinion that tree crops may be suitable for the irrigation areas, however, acknowledges that an assessment of the site and proposed discharge to tree crops has not been undertaken. As an assessment has not been provided for review, this is not considered in my evidence. I would consider such a change would require variation to the any consent which stipulates land use. Conditions restricting land use are recommended in Jack Feltham's evidence.
52. In Paragraph 95 of her evidence, Ms Beecroft indicates that the treatment effects provided by the soil and plant environment have not been considered or assessed in the s42A Officers report or PDPs report (FWWTP RC Review Report), and that this has a significant impact on the effects on groundwater. The effect of soil and plant environment on nutrient loss have been assessed in the Applicant's Overseer modelling, and this has been reviewed by Jack Feltham in his evidence. Groundwater mounding should be assessed based on groundwater modelling utilising drainage outputs from Ms Beecroft's soil moisture modelling as discussed, which assesses soil and plant processes such as evapotranspiration.
53. In Paragraph 97 of her evidence, Ms Beecroft puts the uncertainty around input data discussed in the s42A Officers report in the context of the proposed irrigation regime and applied nutrient loading compared with typical dairy farm operation rates. I consider that this may be misleading given that a key concern with the proposed activity, as discussed in my evidence, is that effects, such as unacceptable groundwater mounding, may limit the capacity to discharge to land potentially resulting in greater direct discharge to surface water above that assessed in the AEE. Similarly in Paragraph 105 risk is put into context of nutrient loss from the land treatment under the proposed irrigation regime, and doesn't considered risk from increased discharge to surface water.
54. In Paragraph 109 of her evidence, Ms Beecroft outlines that the water balance assessed in the AEE documents (outlined in Section 4.10.2 and Figure 4.1 of the "Appendix 7 LEI FWWTP Land AEE 2017" document prepared by Ms Beecroft) assesses wet year scenarios. I agree that this figure outlines the storage requirements to achieve land discharge for a number of years of historic data, transformed for an assumed flow reduction of 35% due to I&I reductions proposed. However, this assessment has not been updated following the assessment of unacceptable groundwater mounding, which will affect this assessment. Chris Simpson's evidence shows significant areas of proposed irrigation land have unacceptable groundwater mounding under the proposed irrigation regime. It was agreed between experts in the JWS that unacceptable groundwater could result in

reduced land irrigation capacity, and increased storage requirement, increased discharge to surface water, or higher loading to selected land areas. As discussed in Aslan Perwick's evidence, higher groundwater mounding can be expected during wetter years, and Chris Simpsons modelling has assessed groundwater mounding impacts in an average year only. There is no evidence that Chris Simpson has assessed groundwater mounding impacts for the same wet years as Ms Beecroft has considered in her assessment. As a result there is uncertainty around the assessment presented in Section 4.10.2 and Figure 4.1 of the "Appendix 7 LEI FWWTP Land AEE 2017" document prepared by Ms Beecroft. It is expected that if increased groundwater mounding above an average year is experienced during a wet year, the limitations to land discharge and the assessed storage and/or surface water discharge required will increase above that assessed. This will cause a change in the average assessed land discharge and the assessed storage and/or surface water discharge.

55. In Paragraph 118, Ms Beecroft outlines that a site visit may have provided PDP staff with confidence in the information provided. I do not consider this to be the case, as the concern raised in the FWWTP RC Review Report is whether site information is sufficient is primarily related to deeper hydrogeological/geological characteristics (as outlined in Aslan Perwick's evidence). A site visit would not have assisted with this. PDP staff were relying on the Applicant to provide characterisation of these hydrogeological/geological characteristics as agreed in technical discussions on 25 September 2018, and raised in earlier discussions.
56. In Paragraph 122 Ms Beecroft outlines her opinion that "it is essential to include climatic extremes, and their impact on the discharge regime in the assessed data set to ensure variations influence the long-term average". I agree with this statement, however, I do not agree this has been done for the proposed activity, as the impact of climatic extremes on the wastewater inflow volumes and groundwater mounding has not been considered, and therefore the impact of the variation in groundwater mounding on the long term averages has not been considered.
57. In Paragraph 129, Ms Beecroft states it unclear how PDP has assessed that there is perceived risk due to groundwater mounding. This has been discussed within my evidence, however, it is summarised as follows:
 - i. Groundwater mounding has been assessed for average year conditions, and a significant area (unstated and only represented visually) of the proposed irrigation area has been identified as being subject to unacceptable mounding. The duration and impact of this mounding on the overall capacity of the irrigation areas to receive

the wastewater volume continuously every year has not been provided.

- ii. The basis of the groundwater mounding assessed is not considered to be conservative as discussed in Aslan Perwick's evidence, therefore, there is a risk that groundwater mounding may be more extensive than the significant area currently assessed by the Applicant.
- iii. It was agreed between experts in the JWS that unacceptable groundwater could result in reduced land irrigation capacity, and therefore a requirement for increased storage volume, increased discharge to surface water, or higher loading to selected land areas or a combination of some or all of these.

58. Throughout Ms Beecroft's evidence, there is reference to "Adaptive Management" being utilised to overcome potential issues. However, it is unclear as to what this will entail and whether options extend beyond: increased reticulation remediation, increased storage and/or increased irrigation area. With decreasing irrigation area due to unacceptable groundwater mounding and limited storage, "Adaptive Management" options become very limited, without significant additional capital investment (plus a significant time frame to implement and consent such physical construction works), other than increased discharge to Donald Creek (above what has been proposed for the future). This has the potential to result in greater than assessed effects on the surface water environment.

59. Paragraph 186 outlines that there are no effects that are likely to be more than minor, from the proposed land treatment system, subject to irrigation design and management. I do not agree with this statement based on the information provided by the Applicant to date. In my opinion there are some significant questions that have not been addressed by the Applicant, which leads to a high level of uncertainty around how well the land irrigation system will work in the long term.

60. In my opinion, it is difficult to understand how a long term consent can be granted given the amount of doubt around how well the system will work in practice. In essence, insufficient work has been undertaken by the Applicant to date to provide the necessary level of technical confidence.

61. In my opinion, the Applicant has not robustly demonstrated what the effects of the proposed activity will be, and that therefore conclusions around effects being less than minor have not been demonstrated.

RESPONSE TO THE SUBMITTER'S EVIDENCE

62. I note that Dr. Lee Burbery's evidence mainly considers technical groundwater aspects outside my area of expertise and evidence scope. Aslan Perwick has considered Dr. Lee Burbery's evidence.
63. I note that in paragraph 55 of Dr. Lee Burbery's evidence, he outlines that the practicability of the proposed deferred irrigation is questionable, based on the groundwater mounding modelling results and concerns he raises with groundwater modelling. This aligns with my concerns around the effect of unacceptable groundwater mounding on the proposed irrigation regime, as discussed in my evidence.

CONDITIONS MITIGATION

64. I have reviewed the proposed consent conditions, prepared by Mr Sven Exeter, on behalf of the Applicant. PDP provided a review of proposed consent conditions previously in the FWWTP RC Review Report attached to the section 42A report. I make the following comments with regards to the proposed consent conditions, but also outline that many of the comments outlined in the FWWTP RC Review Report are still relevant.
65. Schedule 1 C. 29 details fencing of the oxidation ponds and discharge channel, however, fencing needs to include any irrigation storage lagoon.
66. Schedule 2, C. 2 details no discharge to Donald Creek during Summer Months. Summer months need to be defined in the consent.
67. Schedule 2, C. 4 details concentration limits, which adjust for a certain allowance of I&I improvements. Applying a load limit would be more effective as I&I improvements may vary.
68. Schedule 4, C. 2 details an irrigation depth of 55 mm/week but no return period is specified. To remain in keeping with Ms Beecroft's evidence (Paragraph 47 and 62) a return period of at least 14 days needs to be specified.
69. Schedule 4, C. 7 is difficult to understand and is not in keeping with Ms Beecroft's evidence (Paragraph 141). This needs to be written more clearly to be in line with Ms Beecroft's evidence.
70. Paragraph 178 in Ms Beecroft's evidence provides specific irrigation limits. These are not reflected in the proposed consent conditions and need to be. In addition, the proposed method of monitoring compliance i.e. soil moisture content, needs to be prescribed in conditions.

CONCLUSIONS

71. In summary, I consider the key concerns still remaining with the proposal are, in order of priority:

- i. Uncertainties around the groundwater modelling and the potential for increased groundwater mounding. It does not appear the applicant has taken into account the potential reduced irrigation area, as a result of unacceptable groundwater mounding, in calculating required storage volumes;
- ii. There appears to be inconsistencies between the annual soil drainage rates calculated by Ms Beecroft and the drainage rates utilised by Mr Simpson in the groundwater modelling assessments. It also appears that seasonal fluctuation in drainage rates have not been considered. This may result in higher than currently calculated areas of unacceptable groundwater mounding and further reduction to the available irrigation areas.
- iii. While the average annual loading rate may be reasonable, and in line with other land treatment systems, the proposed seasonal distribution of irrigation, particularly associated with Block 2B, is impractical and not achievable under the proposed condition of 55 mm/14 days. Additional storage needs to be allowed for to enable distribution of the September and October hydraulic loads over summer months.
- iv. Given the level of uncertainty around wastewater flow reductions and groundwater mounding, there is the risk that there is insufficient conservatism in the proposal. Relying on “adaptive management” to fix problems that may well occur further down the track because inadequate work has been undertaken at this stage is not a good approach and does not provide confidence.
- v. In my opinion, it is quite likely that the proposed system will result in an increase in discharge to Donald Creek (beyond what is proposed in the application).

72. The proposed “Adaptive Management” methods identified by the applicant include, implementing additional sewer reticulation remediation works, increasing the size of the wastewater storage lagoon and/or implementation of additional irrigation areas. The implementation of these additional “adaptive management” methods would all come at significant cost to SWDC and my concern is that there may be insufficient available capital to develop the system further with “Adaptive Management” to the required level. Due to the level of unquantified risk, the capital investment required

to allow for sufficient adaptive management remains unknown. If the required capital is not available, discharge to surface water (beyond that outlined in the proposal) may become the key “adaptive management” tool, resulting in greater potential adverse effects than assessed by the applicant and Dr Ausseil.

73. With the level of uncertainty associated with the proposal, particularly around hydrogeological factors, and limited investigations by the applicant to address these uncertainties, we (PDP) cannot sufficiently assess the proposal to a level where the risks can be reasonably quantified. For this reason, it is recommended that the applicant conduct sufficient further investigations to enable performance of the system to be assessed.

Daryl Irvine
10 May 2019