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

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BRIEF OF EVIDENCE OF KATIE JANE BEECROFT ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

LAND TREATMENT

DATED 29 MARCH 2019

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EVIDENCE OF KATIE JANE BEECROFT ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

1. My full name is Katie Jane Beecroft. I am an Environmental Scientist with Lowe Environmental Impact Limited.

RELEVANT EXPERIENCE

2. I have the following qualifications and experience relevant to the evidence I shall give:

    a. Master of Science (Honours in in Earth Science); and

    b. Bachelor of Science (Earth Science).

3. I am a member of several relevant associations including:

    a. New Zealand Society of Soil Science;

    b. Water New Zealand; and

    c. New Zealand Land Treatment Collective.

4. I have the previously assisted with land treatment and assessment of effects to land for Greytown and Martinborough WWTPs.

CODE OF CONDUCT

5. I have read the Code of Conduct for Expert Witnesses in section 7 of the Environment Court's Practice Note (2014). I agree to comply with that Code of Conduct. Except where I state that I am relying upon the specified evidence of another person, my evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions which I express.

MY ROLE IN THE PROJECT

6. I am part of the multi-disciplinary consultancy team advising the South Wairarapa District Council ("**SWDC**") in relation to the consenting process for discharges from the Featherston Wastewater Treatment Plant (the "**Project**"). I provide advice to SWDC on irrigation system design and environmental effects of land application of wastewater, and developed the land discharge regime proposed as part of the Project. I also provided advice and evidence in relation to the Greytown and Featherston proposals. The current proposal is similar in many respects to those schemes which are now operational.

7. I have been actively involved in the investigations for Featherston's wastewater improvements since 2012. I have visited the site and am familiar with all aspects of the proposal. I undertook or supervised the following investigations:

   a. GIS desktop investigation of land suitability for land treatment of wastewater to land surrounding Featherston and FWWTP;

   b. Site investigation of land adjacent to FWWTP (Site A)

   c. Assess land treatment scenarios for FWWTP wastewater

   d. Preliminary assessment of discharge to land adjacent to FWWTP (Site A) and review expected improvements to Donald Creek from riparian planting

   e. Desktop evaluation of Hodder Farm (Site B)

   f. Site investigation of Hodder Farm (Site B)

   g. Develop irrigation regime and prepare Land AEE for Sites A and B

   h. Assist with Section 92 request for further information responses

   i. Further site investigation of Site B

   j. Attend community meeting 23 August 2018 – Presentation for that meeting attached

k. Assist with preparation of Joint Witness Statement (GWS, PDP, LEI) regarding groundwater effects.

SCOPE OF EVIDENCE

8. My evidence will address the following:

   a. Description of the land treatment concept and terminology;
   b. Characterise the land treatment sites;
   c. Describe the land and water discharge regime and its development;
   d. Describe the land treatment design;
   e. Outline the effects to the environment due to the proposed land treatment;
   f. Mitigation and management of effects
   g. Response to matters raised in the GWRC reporting officers s42A reports;
   h. Response to submissions
   i. Review of conditions
   j. Conclusion

PRINCIPLES OF LAND TREATMENT

9. The discharge regime proposed for FWWTP is a land treatment discharge.

10. The intent of wastewater land treatment is to discharge wastewater to land in a manner which results in the removal of a substantial proportion of wastewater derived contaminants (particulate organic matter, soluble organic compounds, environmentally sensitive

nutrients, pathogens and suspended solids). Land treatment is distinct from land disposal, with land disposal relying on the passage of wastewater through land to filter and diffuse the wastewater, with only minor nutrient and pathogen removal.

11. Land treatment provides a significantly greater level of nutrient and pathogen attenuation and also has the additional advantage of beneficially using the applied wastewater for productive use.

12. Land treatment systems are now common in New Zealand, whereas historically the focus has been direct water discharges and if land application has been, it has predominately been land disposal.

13. A critical driver for development of land treatment systems has been the increased impetus to reduce direct and indirect discharges of wastewater to freshwater environments, such as the current discharge of wastewater from the Featherston Wastewater Treatment Plant ("**FWWTP**") to Donald's Creek. This impetus has been driven by both cultural and environmental concerns. Instead of a direct discharge, land based systems provide the ability to treat or further treat discharged wastewater while also providing for a productive use of the land (for example, through a cut and carry system).

TERMS USED IN WASTEWATER IRRIGATION DESIGN

14. There are key terms relating to water use for irrigation which are relied upon for the design of an irrigation regime for the FWWTP discharge. A summary of these terms and how they are applied in this project follows.

15. **Soil porosity** is the volume of void space between particles in the soil. The amount and size of those voids, referred to as pores, controls how much water can be held in the soil. Figure 1 below gives a simple representation of how water is held in the soil.

16. **Soil moisture status** is a measure of the soil moisture content at a point in time i.e. the amount of the soil pore space that is full with water. Soil moisture changes continually due to climate (rainfall, temperature, evaporation), plant use (transpiration), movement of water in the soil profile (drainage, occlusion or sorption). In the case of the FWWTP discharge to land, the soil moisture status is used as a criterion to determine if discharge can occur to land on any day.

17. **Field capacity** refers to the soil moisture content at which drainage from the soil due to gravity ceases and the water is held by the retention force (suction/matrix potential) that the soil applies to it. The force applied by the soil is a function of the size of pores in the soil, and of the surface tension of water.

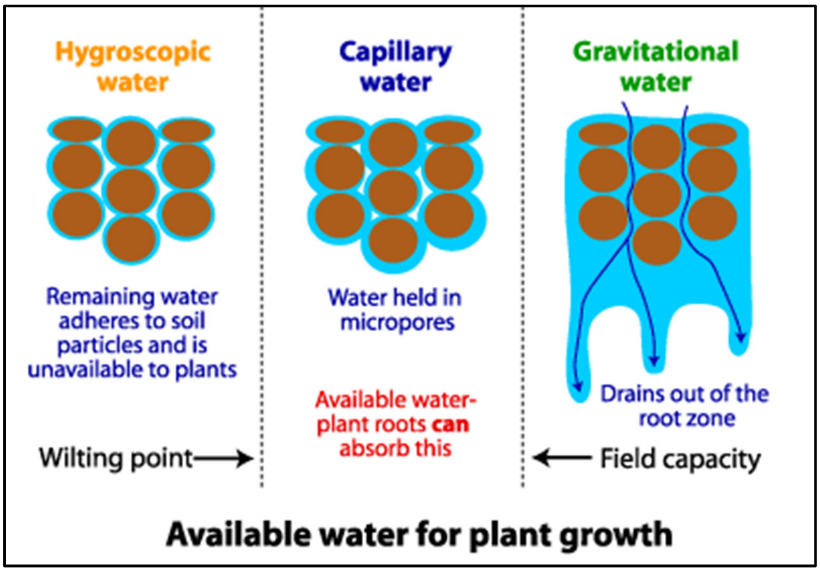


Figure 1: Water in soil

18. **Available water capacity** is the amount of pore space in the soil between field capacity and a lower moisture content (wilting point) beyond which plants cannot remove the water from the soil. Irrigation typically aims to keep the water content of the soil at within this range. Figure 2 gives a simple representation of soil water storage.

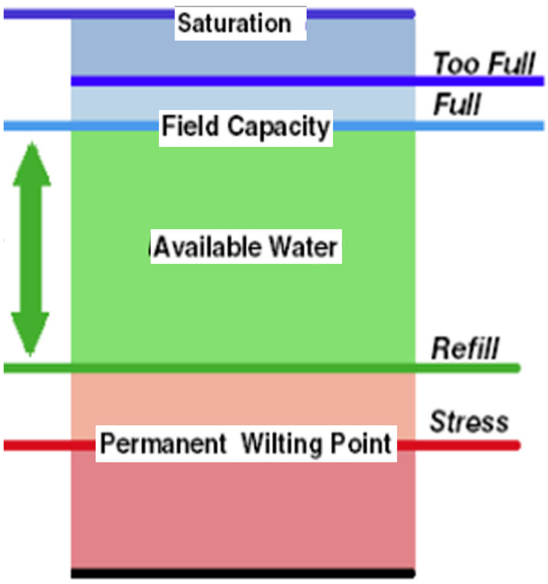


Figure 2: Soil Water Storage

19. **Drainage** of water from the soil occurs when water in the soil moves by gravity drainage. This occurs when the amount of water exceeds the field capacity of the soil as represented in Figure 1, and approaches saturation (Figure 2). In addition to drainage occurring when soil moisture is over field capacity, the irrigation regime proposed for Featherston assumes that drainage to groundwater occurs when water passes below 400 mm from the land surface. In fact additional absorption into the lower, unsaturated soil can occur. However, a shallow soil zone has been adopted for additional conservatism in the assessment.

20. **Deficit irrigation** as it applies to this scheme is the application of water so that it does not result in the soil moisture content exceeding field capacity. Drainage may occur if rainfall is received to the irrigated site which is in excess of the remaining deficit (difference between soil moisture and field capacity).

21. **Non-deficit** allows for irrigation in excess of the soils field capacity to occur. As it applies to this scheme, non-deficit refers to a allowing irrigation up to 3 mm above in excess of field capacity (reaching into the "full" zone shown in Figure 2 but not reaching saturation), resulting in some drainage.

22. **<u>Deferred irrigation</u>** refers to the ability to withhold irrigation when soil, climatic or land management conditions are not appropriate for irrigation to occur. In the case of the FWWTP discharge, this is achieved by alternative discharge (Stages 1A, 1B and 2A) or storing the wastewater (Stage 2B).

WASTEWATER QUALITY FOR LAND TREATMENT

23. A summary of the wastewater quality to be produced by the FWWTP is given in Section 2.5.2 of the consent application. I note that this is the quality of the wastewater before it is land treated or discharged to the stream. As discussed below the land treatment process further treats the waste stream.

24. A key objective of land treatment is the removal and beneficial use of remaining wastewater derived nutrients. The land is part of the wastewater treatment train and can provide a high degree of additional treatment before wastewater enters the wider environment.

25. Land treatment impacts on nutrient, contaminant and pathogen concentrations in wastewater.

26. Land treatment performs best when the rate of application and nutrient content are matched to plant and soil microbe use. For example nitrogen exists in several forms, and when considering environmental effects, nitrate-nitrogen and ammoniacal-nitrogen are commonly discussed. For plant use and soil retention the preferred nitrogen form is ammoniacal. Advanced at plant treatment systems typically include conversion of ammoniacal nitrogen to nitrate nitrogen (and some to nitrogen gas). A wastewater from an advanced treatment system may be at greater risk of nitrogen leaching when applied to a land treatment site due to this high portion of nitrate nitrogen.

PRELIMINARY INVESTIGATIONS

27. An investigation into the suitability of land around Featherston and FWWTP for land treatment of wastewater was undertaken by LEI in 2012. This investigation was a desktop GIS analysis of mapped data at 1:50,000 and 1:63,000 scale.

28. All areas within the investigation area were scored for a range of parameters and the combined score was used to Zone from A (most preferred) to E (least preferred), each area according to its suitability for land treatment.

29. The Sites which have been evaluated to receive FWWTP wastewater are identified as:

    a. FWWTP adjacent land (Site A) is within "Zone C" which is described as: *Zone C – Some limitations are experienced within areas of this rating zone. Zone C is suitable for land treatment when appropriately managed.*

    b. Hodder Farm (Site B) has a mix of "Zone C" and "Zone A" areas described as: *Zone A – No significant limitations are experienced within areas of this rating zone. Zone A represents the preferred zone for siting of a land treatment system.*

SITE CHARACTERISATION

30. Site specific information which is relied upon in this evidence is summarised as follows.

31. The area that is proposed to receive wastewater irrigation has been divided into two zones referred to as Site A and Site B respectively. The division reflects the duration of SWDC ownership of the properties. Site A has been owned for a number of years prior to the acquisition of

Site B (Hodder Farm). Figure 3 shows the location of the properties in relation to the FWWTP.

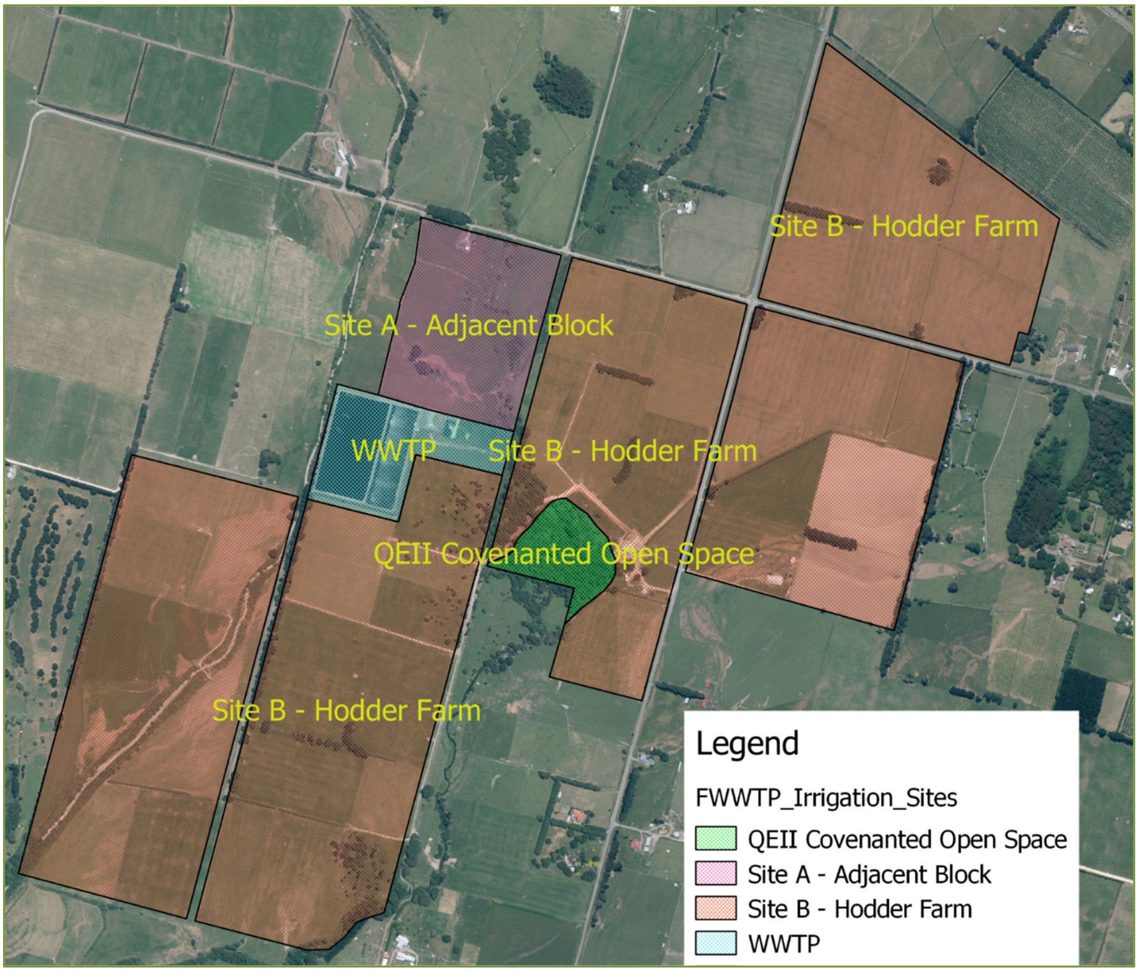


Figure 3: Site Layout

32. Documents produced by LEI for SWDC and pertaining to site characterisation are:

a. Site Investigation – FWWTP adjacent land (February 2013)

b. Desktop assessment – Hodder Farm (pre purchase) (October 2015)

c. Site Investigation – Hodder Farm (November 2015)

d. Subsurface investigation – (unreported)

33. LEI staff undertook field investigations on 15 February 2013 for Site A and 3 and 4 November 2015 for Site B. Table 1 summarises the key

parameters measured as part of the field investigations. Figure 4 shows soil profiles observed at the sites and identifies whether they are suitable for deficit or non-deficit irrigation.

Table 1: Site Characteristics

Landform unit	**Coarse elevated plain**	**Coarse lower plain**	**Wet lower plain**	**Source**
Soil series name	Tauherenikau stony silt loam	Opaki and Greytown silt loam	Ahikouka silt loam	**In field evaluation**
S-Map soil sibling	Darn17 a.1 Darn9 a.1 Selw25 1.a Selw42 a.1	Bram8 a.1 Rang18 b.1	Tait42a.1	**S-Map database**
Area available for irrigation (ha)[1]	53	42	21	Field mapping and desktop GIS
Daily irrigation rate (mm/d)[2]	From most limiting measurement: Up to 55 mm per event Site B Up to 19 mm per event Site A			From field measurement of unsaturated hydraulic conductivity
Limiting consideration	No significant limitations	Shallow depth to groundwater (~1 m)		Field observation (soil profiles) and measured depth to groundwater (on farm piezometers)
Soil unsaturated conductivity (mm/hr)	10 ±0.5 14 ±NA (lab)	8 ±5 (Site A) 8 ±3 (Site B)	8 ±5	Field measurement (plate permeameter) and Landcare soil physics lab measurement "(lab)"
Soil saturated conductivity (mm/hr)	172 ±31 133 ±50	240 ±120 (Site A) 71 ±22 (Site B)	33 ±14	Field measurement (double ring infiltration)
P Retention (%)	19	35	35	S-Map data sheets

[1]Buffers excluded

[2]Based on soil hydraulic conductivity only. Additional controls have been applied to manage depth to groundwater limitations – notably, incorporation of climate data and irrigation rotation/return period.

Figure 4: Soils of Site A and B

34. The groundwater resource in the vicinity of the land treatment areas has been described at an aquifer scale as part of GWRCs Wairarapa Basin work (2011). The information is relatively recent and considered to be well developed and robust. I consider that, based on the limitations associated with the soil of the land treatment areas and the corresponding need to use a hydraulically limited discharge regime for soil protection, the use of the existing published groundwater information provided sufficient certainty to assess the effects of the proposed land treatment system with regard to groundwater. Additional investigation of the site specific groundwater conditions is described in Mr Simpsons evidence.

35. Data from the Niwa Virtual Climate Station Network (VCSN) was used in investigations up to 2014 for rainfall and potential evapotranspiration (PET). Climate data was summarised in Table 3.6, Appendix 7 of the Consent Application. Data for the period 1993 to 2014 was evaluated.

36. Wind speed and direction is summarised in Section 3.8.2, Appendix 7 of the Consent Application.

LAND TREATMENT DESIGN

37. The development of a land treatment regime and details of the system management are given in Sections 4.4 to 4.13 of Appendix 7 of the consent application. The key components are as follows:

38. A brief summary of the design considerations that are relied upon for my evidence are as follows.

Project Staging

39. The project staging is described in the evidence of others. The staging has been adjusted by bringing forward stages 2A and 2B to the end of years 5 and 13 respectively.

40. The land treatment system will be developed in Stages as described in Mr Exeter's evidence. The stages are sequential and are referred to here as Stage 1A, Stage 1B, Stage 2A and Stage 2B. The changes to the discharge to land between the stages as given in Table 2 below.

Irrigation Regime Using A Water Balance Approach

41. In order to determine the relative volumes of wastewater to be discharged to land and stream at each stage of the consent an empirical water balance was prepared based on actual data.

42. The water balance gives, for each day, an estimate of how much water enters the treatment system from wastewater generation or rainfall (pond and land), and how much water leaves the treatment system as evaporation (pond), evapotranspiration (land) or drainage (land). The water balance also includes environmental data, including soil

properties and soil moisture status, and Operational data, including previous days irrigation, harvest or stock movement, informs how the applied water (rainfall or wastewater) moves through the land treatment site. For any day, based on the water balance:

a. If the criteria for discharge to land are met and there is sufficient wastewater in storage then discharge to land occurs; or

b. If no discharge to land can occur then the wastewater is directed to storage; or

c. If insufficient storage, or prior to storage being constructed, then discharge of wastewater to surface water occurs.

43. The criteria for discharge to land include:

a. Soil moisture status

    i. Irrigation will not cause the soil to exceed field capacity for Site A; and

    ii. irrigation will not cause the soil to exceed field capacity by more than 3 mm for Site B.

b. Depth to groundwater

    i. Appendix 7 of the consent application required that irrigation should occur when the groundwater table is less than 1 m from the surface of the area to be irrigated;

    ii. Subsequent to expert caucusing (18 December 2018), the agreed minimum depth to groundwater was adjusted to 0.6 m as given in the Joint Witness Statement (JWS) issued 20 December 2018.

c. Wind speed and direction

    i. Irrigation may occur if wind speed is less than 12 m/s, or 4 m/s in the direction of any dwelling within 300 m of the irrigated area.

d. Rainfall

   i. Irrigation may occur if less than 2 mm rain has fallen in the 24 hours prior to commencement of irrigation

e. Land Management

   i. Harvest or grazing should not occur within 48 h of irrigation ceasing, and irrigation should not be commenced within 24 h of completion of harvest or removal of stock.

44. If discharge to land criteria are not met direct FWWTP outflows are directed to alternative discharge (surface water at Stages 1A, 1B and 2A) or storage (Stage 2B).

45. At Stage 2B, the storage volume required to avoid discharge to land or water when the discharge to land criteria are not met is 395,000 m3. The water balance shows that a pond of this size would have been substantially underutilised for 9 out of 11 years of record (Figure 4.1, Appendix 7 of consent application). Therefore, it is proposed to construct storage for the 90th percentile stored volume (186,000 m3) and operate a contingency discharge to Donald Creek for volumes in excess of the 90th percentile. Details of this discharge are given in Ms Hammonds evidence.

Land and Irrigation Management

46. The land treatment scheme has been planned to operate within an agronomic farming system. The proposed irrigation regime is suitable for operation within either a cut-and-carry system, or a grazed pasture system.

47. The irrigation area (8 ha at Stage 1A, 70 ha at Stage 1B, 70 to 116 ha at Stage 2A and 116 ha at Stage 2B) is divided into blocks of 8 to 9 ha. If conditions allow irrigation to occur, then each block is on a 14 day return. The return period is longer if soil and climate conditions are not suitable. If sufficient soil moisture deficit occurs (deficit of at

least 52 mm) then a single application event (55 mm) over 1 block can occur. In this case the irrigation occurs in a single 8ha block and moves to a new block the next day. If the deficit is less than (52 mm) then the total application event of 55 mm may be carried out over up to 7 days. In this case a smaller application rate may be applied to multiple (up to 7) blocks up to a maximum daily application volume of 4,440 m3, and at least 7 days of no irrigation occur following a cumulative irrigation depth of 55 mm.

48. Table 2 summarises the irrigation regime for an average year, averaged across the irrigated areas.

Table 2: Land Treatment Summary

Parameter	Stage 1A	Stage 1B	Stage 2A	Stage 2B
Storage volume (m^3) - to satisfy 90th percentile flow conditions	None	None	None	186,000
Average annual outflow from FWWTP (m^3)	~830,000	~830,000	~538,000[1]	~538,000[1]
Irrigated Site	Site A	Site B (and potentially Site A)	Site B (and potentially Site A)	Site B (and potentially Site A)
Irrigation Regime	Site A: Deficit	Site A: Deficit Site B: Deferred	Site A: Deficit Site B: Deferred	Site A: Deficit Site B: Deferred
Landform	Alluvial flats	Alluvial flats	Alluvial flats	Alluvial flats
Total area (ha)	12	166-178	166-178	166-178
Irrigated area (ha)	8	70	70-116	116
Irrigated area per discharge event (ha)	8	8	8	8
Irrigation event application (mm/event)	up to 19	up to 55	up to 55	up to 55
Average annual application volume (m^3/y)[2]	32,500	385,000	305,200	510,300
Average annual application depth (mm)	406	480	360	447
Wastewater Nitrogen load (kg N/ha/y)[3]	35	42	42	51
Wastewater Phosphorus load (kg P/ha/y)[3]	7	8	8	10
Farm Management current	Stock grazing	Dairy		
Farm Management proposed	Pasture for removal (cut and carry)	Stock grazing and/or Cropping and/or Pasture for removal (cut and carry)		
Vegetation current	Pasture	Pasture		

Parameter	Stage 1A	Stage 1B	Stage 2A	Stage 2B
Vegetation proposed	Pasture and/or Cropping			

[1] Post I & I reduction

[2] At Stage 2A the total volume discharged to land decreases due to a reduction in the total volume discharged due to I & I reduction.

[3] Following I & I reduction the concentration of N and P in the wastewater will increase, resulting in the same mass loading of nutrients even though the application depth decreases slightly

Uncertainty and Conservatism

49. This section discusses the use of data certainty and conservatism to provide confidence that the land treatment scheme will perform as assessed.

50. A wide range of data has been relied upon to determine an acceptable discharge regime for Featherston. For the land treatment system, farm scale soil data was obtained to give a high level of certainty to predictions of soil behaviour under wastewater irrigation. For certainty, actual wastewater data (flows and quality) was used to develop discharge and storage requirements. Daily climate data was used from a range of sources, including the VCSN, which predicted daily climatic data for a point around 1 km from the site and was available from 1960 onwards.

51. Groundwater information was sourced from robust and reliable sources. However, the data is at a larger scale (estimated 1:50,000 scale) than the farm scale obtained for soil and landform information. This results in a greater degree of uncertainty that the groundwater data is accurate at the land treatment sites. There is limited certainty about future conditions, and assumptions need to be adopted to predict how the parts of the discharge system and the receiving environment will perform in the future.

52. In the situation that there is uncertainty in the data used or assumptions are adopted, the approach we have taken is to use a conservative value to minimise the potential for effects to be

underestimated. Multiple levels of conservatism have been applied to the discharge regime and effects assessment to provide confidence that the regime as proposed can be operated to achieve effects that are less than or equal the effects assessed.

EFFECTS ON THE ENVIRONMENT FROM LAND DISCHARGE

53. The effects of the discharge to land were assessed by LEI and reported in Appendix 8 of the consent application. Key wastewater parameters that may have an effect on receiving environments are nutrients (specifically nitrogen and phosphorus), organic material (measured by biochemical oxygen demand, BOD), pathogens (such as *E.coli* and virus') and the water component. The water component creates a potential for groundwater mounding which could (if not controlled) affect drainage on adjoining properties.

54. The receiving environments which may be affected by the discharge are:

    a. the soil and plants in the rooting zone and unsaturated zone of the soil;

    b. shallow groundwater;

    c. surface water; and

    d. air.

55. Potential and actual effects due to wastewater irrigation in each of these receiving environments are described in the following sections.

Nutrient Loading

56. For Stages 1b, 2a and 2b the average loading of nitrogen to the site from wastewater ranges from 35 - 51 kg N/ha/yr. This is a low rate

of nitrogen application for an agronomic system and will not result in losses to groundwater that are greater than occur on the surrounding land which includes pastoral farming, orcharding and, most likely, septic tanks.

57. In the event that nitrogen supplied from wastewater is unable to maintain sufficient pasture growth to, a) supply animal needs, or b) maintain an adequate grass sward to result in high evapotranspirative loss, it is proposed that supplementary nitrogen fertiliser will be applied to the site up to a total from all sources of 300 kg N/ha/y. This will be managed in accordance with fertiliser application best practice to minimise nitrogen losses.

58. Despite the careful management of the wastewater application, some limited nitrogen leaching may still occur due to the function of natural systems (soil heterogeneity, rainfall extremes, land management etc). However, the proposed conservative application rates enable a level of confidence that leaching will be minor, and typically will be less than occurs under the surrounding land uses. As a result, the overall effects due to nitrogen application are expected to be no more than minor on the soil. The impact on ground and surface water, including the modelled nitrogen leaching, is discussed in paragraphs 65-66 below.

59. The wastewater contains phosphorus and its application is unlikely to have an adverse effect on the soils of the site. Phosphorus is known to contribute to the eutrophication of waterways if in high enough concentration. However, soil transformation and plant uptake of the applied phosphorus is expected to utilise most of the applied phosphorus.

60. The concentration of total phosphorus discharged to land would provide an average input of 7 - 10 kg P/ha/y to the Site over the annual irrigation period. Phosphorus uptake by plants is in the range of 130-160 kg P/ha/y for NZ ryegrass pasture, with return by excreta in the order of 78-96 kg P/ha/y, resulting in a net removal

of between 34 and 82 kg P/ha/y. The applied phosphorus from wastewater is well within the capacity of the plants to utilise, so the overall effect of phosphorus on the soil and plant system is expected to be no more than minor.

Managing Soil Moisture

61. There is the potential for over-application of water to lead to saturation of the soil, resulting in mechanical damage, erosion, loss of soil structure and increased nutrient losses. In addition, the occurrence of saturation has the potential to produce anaerobic conditions, causing plant root damage, encouraging soil blinding and creating odours.

62. The wastewater application rate has been designed to avoid saturating the soil and causing ponding or run-off. The low instantaneous application rate planned at 3-5 mm/h, or to a total of up to 19 mm at Site A (depending on soil moisture content) and a total of up to 55 mm in a 14 day period, is expected to ensure that the risk of saturation is minimised. A limit to irrigation based on previous days rainfall further avoids excessive wetness due to irrigation of wastewater. Overall the adverse effects of the application of water on the soil will be no more than minor.

Managing Drainage to Groundwater

63. Over-application of wastewater can lead to groundwater mounding (localised elevation of the groundwater table) and contaminant leaching. Over-application is avoided by the proposed discharge regime due to the rate and frequency of application being equal to or less than the soils capacity to transmit the water through the soil profile, as determined by the site specific testing. Because saturation will not result following the irrigation of wastewater the

contact with soil particles and plant roots is maximised, resulting in greater potential to remove wastewater borne contaminants.

64. Drainage to groundwater in excess of the natural drainage from the sites is predicted and discussed in Mr Simpsons evidence. The measured depth to groundwater in areas which receive wastewater irrigation vary from 0.6 m to over 3 m depth. The risk of groundwater mounding and actual effects due to the land treatment scheme are given in Mr Simpsons evidence.

65. Overseer^{R} has been used to evaluate the potential nutrient losses to groundwater from both the farming operation; whether cut-and-carry or grazed pasture, and the land discharge of wastewater. Predicted nitrogen losses based on Overseer^{R} are:

a. Baseline: 63 kg N/ha/y

b. Grazed and irrigated with wastewater: 43 kg/ha/y

c. Cut and carry and irrigated with wastewater: 21 kg/ha/y

66. Changing land use from a dairy farm to drystock farming or cut and carry with wastewater irrigation is predicted to result in a reduction in the nitrogen draining to groundwater. This is expected due to the change in stock classes, resulting in a reduction in urine spot leaching (a significant contributor to total nitrogen leaching), and to the cessation of dairy effluent discharge which results in a high instantaneous loading of nitrogen. In practice, the small frequent application of nitrogen in wastewater is expected to enhance its use by plants. Overseer^{R} is not able to model this process due to it working from monthly inputs.

67. The risks associated with pathogen transport to groundwater are discussed by Mr Simpson and Dr Mc Bride in their respective evidence. Measures to avoid transmission of pathogen through the soil that have been included in the irrigation regime design described in Paragraph 83 below.

Effects on Surface Water

68. The effect of the discharge to land of FWWTP wastewater is positive since the use of land treatment removes direct water discharge during low flow periods when the receiving waters are most sensitive to wastewater inputs. Ms Hammond and Mr Hamill discuss the effects of removing the current discharge from Donald Creek.

69. Overland flow of irrigation water from the site to adjacent surface water will not occur due to the adoption of application rates lower than the soils rate of infiltration and buffer distances from surface water including farm drains.

70. Ms Hammond discusses the quantum of contaminants which may enter surface water via groundwater and potential effects due to them. Other contaminants present in the wastewater are expected to be filtered and assimilated into the soil. Suspended solids, organic material (as measured by biochemical oxygen demand) and phosphorus are expected to be retained in the soil. The actual effects due to the land treatment scheme are given in Ms Hammonds evidence.

Air Quality and Odour

71. Two aspects of air quality that need to be managed are odour and spray drift

72. The wastewater for irrigation has a mild musty odour. While slightly different it is in keeping with odours from the surrounding rural land uses.

73. Odour effects will be addressed through a performance standard prohibiting any offensive or objectionable odour at or beyond the property boundary. This will be achieved through standard discharge system management tools, including:

a. The use of buffer zones;

b. Management of the rate and frequency of wastewater discharge;

c. Wind activated shut down controls;

d. The pre-treatment (low organic strength) of the wastewater; and

e. Flushing of pipelines with clean water if and when needed.

74. Odour is very subjective and different people respond differently however, the measures proposed will minimise any impact on neighbouring properties. In my experience, a well managed irrigation system is unlikely to cause any odour nuisance.

75. Overall it is considered that the odour effects of the project will be minimal and are able to be mitigated to avoid any more than minor adverse effects.

76. Spray drift occurs when droplets from the irrigation system are aerosolised and carried by the air rather than falling to the ground. Aerosols may contain microorganisms and other particulate matter which pose a risk to human or animal health.

77. Spray drift is proposed to be avoided by:

a. The use of buffer zones;

b. Selection of system pressure and nozzle size to produce a nominal droplet size of 200 μm to avoid the production of aerosols; and

c. Wind speed recording and automatic shut-off of irrigation to limit the impact on downwind receptors.

78. Buffer distances to avoid effects from spray irrigation to receptors have been adopted from information produced for the combined Wairarapa Plan Change 3 process. Hewitt (2001)[1] provides a comprehensive review of the impact of sprinkler/boom height, irrigation pressure, use of end guns (centre pivot), droplet size and wind speed on spray drift. Key conclusions that have influenced the

[1] Hewitt, A. J. 2011. Spray Drift Modelling of Wastewater Effluent. Lincoln Ventures Report No 1220-1-R1. 17p.

buffer distance and system design recommended for FWWTP land treatment are:

a. *“A level of 0.1% of the application rate could be considered to be “de minimus” drift for most applications but a complete assessment of exposure risk would require input by an expert on public health risk as to the level of exposure which constitutes a hazard (i.e. the level of concern as a fraction of the application rate).”*

b. *“As droplet size increases, the deposition rates at each distance downwind decrease but are still below 0.01 (1%) at 100 m downwind even for the finest spray.”*

c. *“If a level of protection to 0.1% is required with a 25 m buffer, then end guns and high pressure/ high boom systems must not be used. In other words, for <0.1% deposition rates with a 25 m buffer, low pressure (≤1.4 bar), low boom (≤1.52 m) sprinkler systems without end guns are required.”*

d. *“The off-target drift increased with higher wind speed, which is consistent with field study findings, but with deposition rates remaining below 0.005 (0.5%) of the application rate by 100 m downwind even at the highest modelled wind speed of 17.5 m/s (63km/hr).”*

79. Dr Mc Bride addresses the appropriateness of the 0.1% level of protection for public health in his evidence.

80. Based on Hewitt (2001) I consider that adopting the District Plan buffer distances, along with a requirement for a low pressure, low height discharge system will result in a low risk to receptors.

81. The effects of the project due to spray drift (including to people using the site) are able to be mitigated and in my view will be no more than minor.

SUMMARY OF MITIGATION AND MANAGEMENT OF EFFECTS

82. The inclusion of land treatment as part of the treatment train is a key method for mitigating the effects of the currently operating wastewater discharge on surface water.

83. The design and management of the irrigation regime is the predominant method for mitigating potential effects from land discharge. Specific design/management elements that avoid, minimise or mitigate effects to soil or groundwater are as follows.

a. Ensuring adequate irrigation area enables certainty that land treatment and land use management can be operated to avoid excessive irrigation or land damage.

b. The distribution of nutrients via a low rate irrigation system is an effect method for maximising removal of applied nutrients for example, compared to urine patches.

c. Small frequent discharges of nutrients result in lower leaching losses compared to higher loading for instance, from fertiliser application or dairy effluent application.

d. Instantaneous rate of application less than the soils unsaturated hydraulic conductivity maximises the contact with the soil and therefore the removal of nutrients and pathogens. It also avoids ponding or run-off occurring.

e. Maximum daily application depth which is a fraction of the soils unsaturated hydraulic conductivity and available water capacity further maximises the retention of water in the surface soil and optimises nutrient and pathogen removal.

f. A rainfall limitation to the discharge i.e. no discharge within 24 hours of more than 2 mm of rainfall assists to avoid ponding, runoff and excessive drainage.

g. Irrigation controlled by soil moisture assists to avoid damage to soil through excessive wetness, ponding, runoff and excessive drainage to groundwater.

h. Irrigation limited by groundwater depth creates a minimum treatment depth of unsaturated soil and helps to avoid creating areas where excessive irrigation could cause surface break-out of mounded groundwater.

i. Irrigation return period for Site B results in wetting and drying cycles in the soil which are important for oxidative degradation of organic matter to avoid adverse effects to the soil structure and to allow a deficit to build up in the soil in between irrigation events.

j. Provision of storage at stage 2B enables irrigation to be withheld in conditions where it would result in damage to the soil, excessive drainage to groundwater or runoff to occur.

k. Buffer areas (see paragraph 179 below) enable effects due to odour, spray drift to be mitigated and provide a separation between groundwater leaving the sites and potential receptors.

l. In the event that land treatment is developed on additional land known as the Golf course as discussed in Mr Milnes submission, this additional land would help to offset irrigation on the other sites, enabling the irrigation regime to be optimised to the land use i.e. applied during periods when the soil and plants have the highest demand for water and nutrients.

84. I consider that there are no effects that cannot be adequately mitigated or avoided through conditions of consent including the requirement for a discharge management plan to be followed. I consider the proposed conditions to be appropriate. I note that those have been modelled on the Greytown and Featherston consents to a large degree.

RESPONSES TO OFFICERS REPORT

85. I have reviewed the staff report, including Appendix 8 – letter from PDP and make the following comments.

86. At Section 6.5.2 Ms Arnesen notes that the proposed discharge to land activity does not meet proposed *permitted activity* Rule R79, or proposed restricted discretionary Rule R80 of the PNRP.

87. I agree with this assessment but note that these rules are not operative, but still carry some weighting. Non-compliance with the proposed rule is not indicative of there being an adverse effect but is simply a reason why consent is required. In consideration of Rule R80, the only provision that is not met is a requirement for deficit irrigation. Deficit irrigation is proposed for Site A. For Site B, as described in Appendix 7 of the consent application, the annual application depth proposed is similar to that which would occur under a deficit discharge regime. However, the distribution of the discharge throughout the year is different to a deficit irrigation regime. I consider the scale of the difference between provision (c) of Rule R80 and the proposal to be small and informative to the appropriate assessment of the activity.

88. At Section 9.1.1 Ms Arnesen summarises the site, soils and groundwater of the discharge area based on GWRC records. I note that two site investigation reports were provided to GWRC as part of the consenting package and these describe the environment based on specific field investigations. It is not clear if Ms Arnesen has reviewed the provided field investigation reports. I consider that the site-specific information given in the Site Investigation reports is fundamental to the adoption of correct data and appropriate assumptions for the land treatment regime design. It is my opinion that consideration of site-specific data provides a greater level of certainty than for catchment scale information which Ms Arnesen seems to be relying on. A detailed review of these reports would have informed Ms Arnesen's later conclusion that insufficient information was provided to enable effects to soil of the discharge

to land to be assessed. The information provided in the consent application allows an assessment against each of the provisions of Rules R79 and R80.

89. At Section 9.1.2 Ms Arnesen notes that:

"*It was bought to GWRC's attention that SWDC had been quoted in the paper11 saying that they were putting in an application to MBIE under the Provincial Growth Fund to take advantage of the Governments 1 Billion trees programme by planting seedlings on land set aside for wastewater disposal at Featherston.*"

90. A full assessment of the suitability of the site and proposed discharge to land for irrigation to trees has not been carried out. However, it is my opinion that the low nutrient and hydraulic loading to the site from treated wastewater is likely to be suitable for a tree crop. Additionally, emerging research indicates that a mānuka/kānuka planting may have additional benefits for pathogen reduction. The planting of trees would not limit the irrigation area or the proposed rate of irrigation.

91. At Section 9.1.3 Ms Arnesen notes that Longwood Water Race traverses the discharge site and discusses the status of the water race in terms of Section 13 of the Act. While I note that SWDC have indicated an intention to divert the water race, for the discharge design and assessment of effects, a 20 m buffer distance on either side of the water race in its current position has been applied. If the water race is diverted (which may require an additional consent) then that would increase the land available to be irrigated.

92. At Section 9.2 Ms Arnesen states:

"*A conclusion of the effects on groundwater and soils cannot be reached at this time. Based on advice from PDP, there is too much uncertainty with what is proposed, not enough robust information, and too many assumptions that have been made.*"

93. I disagree with this statement. This is discussed further below. I also note that it is the likely reliability of assumptions rather than the number of assumptions which is important. With any land discharge system there will inevitably be many assumptions required. Assumptions could be tested under the adaptive management approach during stage 1A. I also note that there has been extensive monitoring of the site and testing of soils. This includes the additional program of work which was carried out by agreement during the second half of 2018.

94. At Section 9.4.1 Ms Arnesen summarises an assessment by PDP included as Appendix 8 to the officer's report. I have provided additional comment with regard to Appendix 8 of the Officers Report below but consider it appropriate to address Ms Arnesen's points directly.

95. It is not clear if the treatment effects of the soil and plant environment have been considered, as no discussion of this is included in the officer's report or in Appendix 8, the letter from PDP. These effects have a significant impact on the effects to groundwater, therefore an assessment of these effects is needed to determine if sufficient information has been provided to enable a review of the effects assessment.

96. I agree that the information supplied with the consent application (and subsequent s92 requests) predominantly related to biologically active zone of the soil. This was because the design aims to retain wastewater in plant rooting zone for use. Subsequent investigation into the deeper vadose zone has been undertaken but was unreported in time for officer's report. In my experience it is normal for matters such as this to be addressed in evidence at the hearing.

97. Ms Arnesen discusses perceived uncertainty around inputs. Paragraphs 49-52 above discuss the approach that has been taken for the land treatment system to manage uncertainty. Additional discussion is given below in regard to specific points raised in

Appendix 8 of the officer's report. It is my opinion that there is sufficient certainty in the assessment of effects to soil and groundwater to determine the application in accordance with RMA provisions. provisions. Further, there is a need to put the proposal in the context of the wider environment and other lawfully established activities. For example, the proposed irrigation regime is consistent with normal farming irrigation operations. The amount of nutrient applied in the wastewater is considerably less that dairy farmers apply with farm dairy shed effluent.

98. An explanation of the irrigation regime detailed is in Appendix 7 of the consent application and describes the activity for which the environmental effects are to be assessed. Ms Arnesen lists information that is considered by her to be insufficient. I provide the following comments on the listed information.

a. Hydrogeology is discussed in Mr Simpsons evidence.

b. Geological units are described in Section 3.4, Appendix 7 of the consent application;

c. Key hydrogeological properties are discussed in Mr Simpsons evidence.

d. Groundwater levels and flow regimes are discussed by Mr Simpson in his evidence.

e. Climate conditions in the area include a discussion of climate change, and evaluation of daily climate data from a VCSN site around 1 km from the discharge properties. Wind speed and direction was sourced from GWRCs Tauherenikau at Alloa/Racecourse site. Additional discussion of the suitability of wind data is given Paragraphs 145-152 below.

f. A general discussion of topographic features is given in Appendix 7 of the consent application and subsequent information in memos prepared by GWS for SWDC. A detailed land surface map was provided in the GWS report attached to the JWS submitted 20 December 2018. The detailed assessment should be treated with caution since information at this scale is subject to changes due to cultivation and even the height of pasture at survey.

g. Average irrigation depths for each Stage of the programme are given in Sections 4.8, 4.9, 4.10 and 4.11 of Appendix 7 of the consent application. These Sections also describe the application regime and land management for each stage. A discussion of the use of average data is given in Paragraph 122 below.

99. At Section 9.4.2 Ms Arnesen discusses the use of Overseer. I have discussed PDPs comments regarding Overseer below.

100. At Section 9.11 Ms Arnesen notes:

"According to GWRC records (Tauherenikau at Alloa), the wind direction is south west for the largest percentage of time during the year, however these are also the lowest wind speeds. The strongest winds are predominantly north west, however these do occur a smaller percentage of the time than the south west winds. There are very minimal winds occurring in the north east direction. I would also note that during the summer months, when the discharge to land is proposed to occur, the strongest wind speed is north west."

101. I note that data from the Tauherenikau at Alloa site for the 20 year period preceding the consent application is shown on Figure 6 below. This data indicates that the most common wind direction is from the north east, and these winds are low speed. The next most common wind direction is from the south west and these winds are typically higher speed than from the north east. Strong wind from the north west is also common. common. I agree that the strongest winds come from the north west (off the Tararua Ranges), however it is not clear why there is a disparity between Ms Arnesens

assessment of the other directions and the observations provided in the consent application.

102. The following Paragraphs address Appendix 8 of the officer's report, letter from PDP titled "Featherston WWTP Resource Consent Review"

103. No review of the land discharge regime is given in Appendix 8 of the officers' report. However, comments by PDP which rely on an understanding of the discharge regime design and operation are addressed as follows.

104. In Section 1.1 PDP suggest that there is unacceptable uncertainty and risk to enable an assessment of the effects of the discharge to land. I agree that there is inevitable uncertainty associated with the discharge to land as will be the case with all untrialled land discharge proposals. I disagree that the effects of the proposed discharge to land cannot be assessed and managed with enough certainty to avoid unacceptable risk to human health, the environment and potentially affected parties. The scale of effects, and bounds of uncertainty, needs to be put in perspective.

105. For example, travelling at 101 km/h on the open road and exceeding the speed limit has a greater risk than travelling at 100 km/h. However, this risk is considerably less than travelling at 140 km/h. Relating back to the proposal, the nitrogen being applied is low (35-51 kg N/ha/y) when compared to farm dairy effluent applications (150 kg N/ha/y) and other fertiliser applications (potentially up to 300 kg N/ha/y); and as a result the scale of effects for the proposal will be less, even if there is a variation of +/- 20 kg N/ha/y.

106. A method to increase certainty would be to carry out a trial of the proposed irrigation on the land. This proposal allows for a trial by starting with small scale land discharge and then progressively increasing that. This is the essence of adaptive management and in my opinion is entirely appropriate. I note that the same approach

was not applied by the Regional Council when it consented the Greytown and Featherston consent applications.

107. A discussion of uncertainty and conservatism is given in paragraphs 49-52 above. Further comments are as follows.

108. In Paragraph 6, point 1, of Appendix 8, PDP comment on the risks and potential effects associated with groundwater. I note that additional information has been obtained regarding the groundwater of the site subsequent to the preparation of Appendix 8. Mr Simpsons evidence discusses the risks and potential effects associated with groundwater. Paragraph 83 above and Mr Simpson's evidence discuss measures to minimise the mounding risk. In addition to these measures the shape of the irrigation blocks can be used to offset mounding. I consider that the risk of mounding to the soils of the site and to neighbouring properties can be appropriately managed through monitoring prior to commencement of Stage 2B (when the highest volume of wastewater is applied, and through the use of a Management Plan detailing how the discharge regime can be managed in accordance with Appendix 7 of the consent application.

109. In Paragraph 6, point 2, of Appendix 8, PDP comment on the impact of a wet year scenario on the proposed system. I note that the water balance approach described in Paragraphs 41-45 above has calculated the daily water balance for the period 18 March 2005 to 30 May 2016. The highest rainfall year over this period was 2006. When reviewed against the climate data from 1960 to 2016 this year was identified as a 98th percentile high rainfall year (the second highest on record). As a result, I consider that the discharge system (land discharge, maximum storage and volume diverted to surface water discharge) at Stage 2B has been assessed against a 'wet-year' scenario. Figure 4.1, Appendix 7 of the consent application shows the daily storage for the evaluated period. It shows that the highest storage volume required occurs for the 2008 year, rather than the

2006 (highest rainfall) year. This is likely to have occurred due to prolonged rainfall periods which caused prolonged high soil moisture. As described in Paragraph 83 above, discharge to land is unable to occur if soil moisture is above field capacity.

110. In Paragraph 6, point 4, of Appendix 8, PDP comment on the potential risk from pathogen migration. Mr Simpson and Dr McBride address this issue in their evidence. The discharge design includes measures which will minimise transmission of pathogens in the wastewater to groundwater. They are:

a. The sites have soils in which matrix flow is the dominant way that water moves through the soil – having worked across Site A (near to the WWTP) in late summer, we have not seen any occurrence of surface cracking of the soils;

b. Application rate of 3 to 5 mm/hour which is equivalent to (or lower than) the unsaturated hydraulic conductivity of the soil i.e. increasing the potential for discharges in excess of field capacity to be absorbed, held and/or move through soil under unsaturated conditions lower in the soil;

c. Discharge amount and timing controlled by a daily water balance to avoid excess drainage and conditions which would favour pathogen survival (cool and wet near the soil surface);

d. Minimum soil depth for irrigation to occur. At a depth of 0.6 m of unsaturated soil is noted in some places and 1.0 m unsaturated soil is noted in others;

e. No irrigation is applied if >2 mm rainfall has occurred in the previous 24 hours to minimise excess drainage; and

f. The ability to rotate the irrigation allowing wetting and drying in the soil.

111. All of these measures aim to maximise the degree and length of time that the wastewater is in contact with the soil colloids in the

biologically active zone of the soil to maximise attenuation, attrition and predation of pathogens.

112. In Section 1.2, Paragraph 12, point 2, of Appendix 8, PDP suggest the potential for adverse infrastructure impacts due "*…the land treatment scheme turns out to have much less capacity to accept effluent than assessed at present, especially during winter conditions*". The capacity of the land treatment scheme to accept effluent has been planned with a high degree of conservatism to account for the known limitations of the discharge site, including high groundwater noted in site investigations referred to in Paragraph 32 above. I note that the annual rate of application is in-line with a clean water irrigation scheme that could be reasonably operated in the area surrounding Featherston. In addition, a review of relevant wastewater application schemes operated in New Zealand shows the annual application rate proposed is less than applied on average at a range of sites. Figure 5 shows the relative annual application rates for Masterton (in the Wairarapa), Taupo (having operated over a long term), Omaha (relatively recent example) and Pauanui (very sensitive receiving environment).

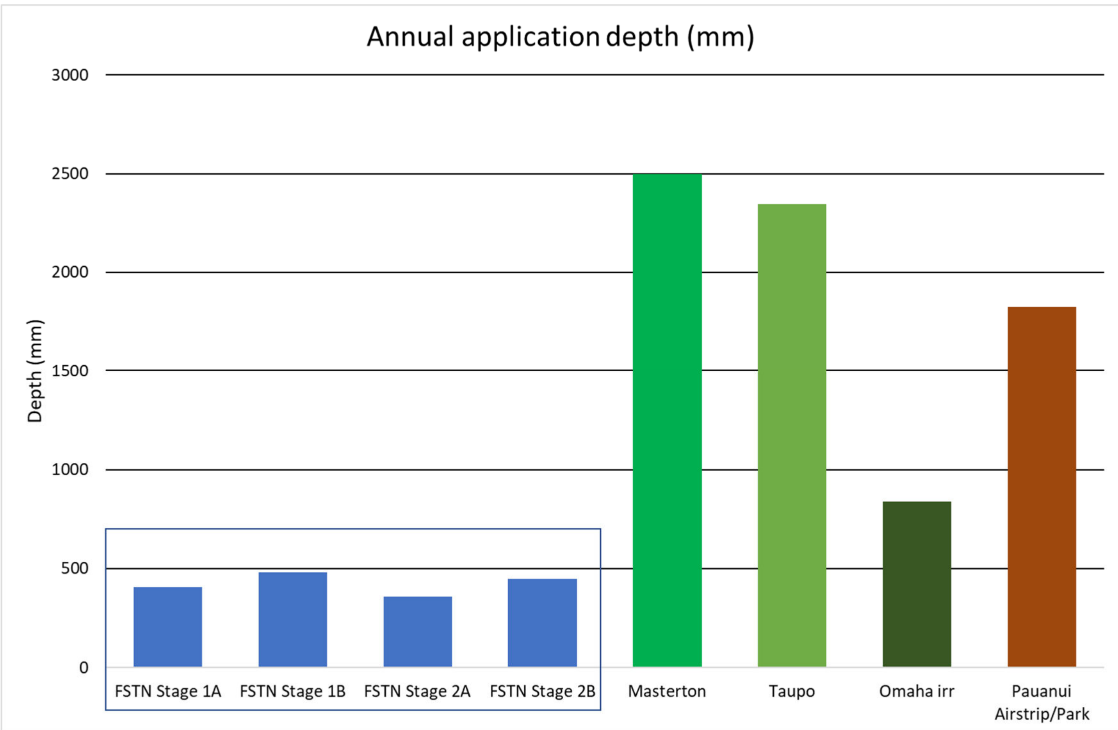


Figure 5: Annual Application Depth for Wastewater Discharges

113. With regard to managing winter conditions I observe that for Stages 1A, 1B and 2A discharge to water under the same discharge conditions as currently occur is proposed. This avoids risks related to winter discharge to land. At Stage 2B storage of 186,000 m^3 has been proposed. This volume is equivalent to 126 days of storage of the average daily flow of wastewater from Featherston at Stage 2B of the programme. This is substantially larger storage than is required for other land uses e.g. dairy farming which typically requires 30 to 90 days of storage; and, 61 days for Carterton's recently consented wastewater storage reservoir. Furthermore, if necessary (which I think is highly unlikely) that storage volume could be increased.

114. I conclude that the level of conservatism applied to FWWTP discharge to land results in a low risk of winter discharges in excess of that planned and described in the consent application documents. I consider that the risk is able to be managed by the review conditions currently proposed as Schedule 1, Condition 9 and Schedule 1, Condition 40 of the consent conditions submitted as part of the consent application.

115. In Section 3.1, Paragraph 25, point 1, of Appendix 8, PDP note the groundwater effects due to land application of wastewater are due to mounding and due to contaminant migration in groundwater. I agree that these are the primary concerns related to groundwater. Both of these risks have been addressed in evidence.

116. In Section 3.1, Paragraph 25, point 2, of Appendix 8, PDP give their opinion on information not considered to be sufficiently detailed. Mr Simpson, in his evidence, directly addresses the information provided and under development. My comments relate to PDPs assessment that the information provided is insufficient to

determine the effects of the proposed activity with an acceptable level of certainty for the grant of consent.

117. Paragraph 25, point 2a, of Appendix 8 refers to the geological units underlying the site. As noted earlier the underlying strata in the vicinity of the site has been mapped by [GWRC, GNS, DSIR] including information about depths of geological units and the presence of discontinuous lenses of finer grained material typical of the fluvial processes which have built up the land surface. I have spent time in the area including field investigations in and around the sites, and reviewed aerial photographs, published maps and reports. I consider that these investigations and reviews form a sound basis for the prediction of groundwater behaviour to a level whereby the remaining uncertainty can be accounted for in conservative regime design.

118. A site visit may have assisted PDP staff to have confidence that the information described in Appendix 7 of the consent application and relied upon for the irrigation regime design and assessment of effects on groundwater was appropriate for the site.

119. Subsequent to the initial field investigations, additional field work was undertaken to examine the underlying geology of the site. I have undertaken field work towards the southern end of the site (November 2018) and northern end of the site (December 2018). The investigations confirm the underlying geology described in Appendix 7 of the consent application.

120. Paragraph 25, point 2c, of Appendix 8 refers to groundwater level and flow regime. Our investigations, including soil pits and measured groundwater levels near the centre of the sites, enabled groundwater depth to be highlighted as a limiting parameter for the site, and was an early feature of the system design. The inclusion of a requirement to avoid irrigation to areas when groundwater was less than 1.0 m from the land surface was given in Section 4.8, Appendix 7 of the consent application. This would be intended to

be included in a Discharge to Land and Water Management Plan as proposed in consent conditions. Following expert caucusing (18 December 2018) a depth to groundwater of 0.6 m was agreed upon and a map produced identifying areas with seasonal high groundwater within 0.6 m of the land surface. The exclusion of these high groundwater level areas does not impact on the irrigation regime proposed. The management of this restriction could either be included in the Discharge to Land and Water Management Plan or as a specific condition of consent.

121. Paragraph 25, point 2d, of Appendix 8 refers to climate data with regard to groundwater assessment. Mr Simpson comments on the climatic impact on groundwater level and flow in his evidence. A daily record of climate has been used to determine the daily irrigation and storage requirements including for a 98th percentile high rainfall year and a year with prolonged wet weather. By this method, varying wastewater flows according to I&I and pond water capture, soil drainage and corresponding variations in the irrigation applied have been incorporated into the irrigation design. The inclusion of soil moisture, groundwater depth and rainfall criteria for the discharge regime limit the impact of the discharge on groundwater, and instead require storage (at Stage 2B) or surface water discharge (Stages 1A, 1B and 2A) to withhold discharge to land when excessive drainage would occur.

122. I consider that the assessment of the long-term average discharge regime is the appropriate method for assessing effects of the discharge to land. The detection of changes to the soil and groundwater environment due to land use changes, such as operation of a wastewater irrigation scheme, occur over a long period. Changes due to, for instance, unusually wet or unusually dry years tend to be short lived and can be avoided or mitigated by management. For example, as is the case for any farm whereby stock movement or stocking rates are altered to avoid damaging the soil and pasture. Consideration of short-term changes can confound

the detection of long term changes to the environment. It is my 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. This has been done for FWWTP.

123. Paragraph 25, point 2e, of Appendix 8 refers to land topography a suggested there is an unacceptable level of certainty in the information supplied by the applicant. A general description of the topographic features of the site were given in the AEE. Results of a high resolution aerial survey of the site were included in a report prepared by GWS and attached to the JWS issued 20 December 2018. No changes to the proposed irrigation regime are proposed on this basis.

124. Paragraph 25, point 2f, of Appendix 8 refers to modelling of varying depths of irrigation on groundwater mounding and movement and suggests additional modelling is need to reduce perceived uncertainty. As discussed above, a long-term average is considered to better represent mounding and contaminant movement due to irrigation of wastewater, as distinct from short term perturbations due to climatic variations. Short term effects can be mitigated by land management decisions. As noted, the irrigation regime is controlled by the soil moisture status. The drainage adopted for modelling represents a worst-case for drainage under the proposed wastewater discharge. This provides conservatism in the evaluation by assessing conditions which are unlikely to be exceeded for the sites.

125. Paragraph 25, point 3, of Appendix 8 suggests that additional site specific data is needed for PDP to provide a review of the proposed effects. I agree that additional data should be collected, but disagree that that data is needed to provide sufficient certainty for the grant of consent. I consider that collection of actual data relating to the development of the sites for land application would

be more valuable than refinements of the predictive models. I consider the ability to optimise the system based on operational data to be a strength of the adaptive management approach.

126. The proposed adaptive management approach is well suited to the collection of data informative to future discharge regime development and allows for review and modification of approach as the project progresses. A high level of conservatism applied to the regime inputs and outputs means effects assessed represent a worst case scenario.

127. Paragraph 25, point 5, of Appendix 8 refers to assumption, uncertainty and provision of additional information and suggests that the remaining uncertainty is too high. I consider that the adoption of conservative (worst-case) information in areas where assumptions have been used provides confidence that effects are not underestimated. Assumptions that have been used are based on a sound understanding of the site and surrounds, and on published data. I strongly disagree that levels of uncertainty are too high to enable the effects of the proposed discharge to land to be assessed. Further, I note that no assessment of the management of the land and discharge has been described by PDP. This is key to the minimisation of effects to groundwater but seems to have been ignored.

128. Mr Simpson's evidence describes recent work undertaken. The new information largely supports my view that the approach taken to date is conservative. No changes to the irrigation regime are proposed based on the additional information collected.

129. Paragraph 25, points 6 and 7 discuss perceived risks due to groundwater mounding. It is unclear how these conclusions have been reached by PDP, however I have noted above that PDP appears to have ignored the proposed management regime which is a key to avoiding such effects. Mr Simpson discusses groundwater mounding

risk in his evidence. I agree with Mr Simpsons conclusions regarding groundwater mounding.

130. Paragraph 28, Appendix 8 notes a need to review updated Overseer[R] modelling in light of any changes to the irrigation regime. Overseer[R] is an annualised average model which is based on monthly inputs but representing a long term average nutrient loss, and therefore it is not necessarily relevant to model specific years in this case. Particularly, the model is not designed to detect the level of sensitivity that would be represented by any changes to the irrigation regime at the scale that may occur, especially with how the model utilises irrigation input information. Therefore, I consider that additional Overseer[R] modelling is not required and would add little value.

131. The most appropriate measure would be measure actual outputs once the scheme is operational. That can be achieved during the first 3 years of operation. What can be said with absolute confidence, is that nutrient losses below the plant rooting zone, and resulting outputs to surface water including Lake Wairarapa, will be significantly reduced by this proposal. This is further discussed in the evidence of Emma Hammond.

132. Paragraph 32, Appendix 8 discusses the impact of not achieving I&I reductions on the land discharge regime. As noted by PDP, the impact would be on the storage volume. Accordingly, the risk of under achievement impinges on pond sizing rather than the environment. Mr Park discusses I&I reductions in his evidence.

133. PDP notes that a peer review of the discharge and storage regime has not been undertaken. PDP notes that additional information would be required for a peer review. I disagree with this assessment and suggest that it is not the role of a peer review to repeat an analysis, but to assess the suitability of the methodology, appropriateness of the inputs and, based on their expertise, provide

a sensibility check of outputs. Information to meet these objectives is included in the consent application.

134. In Section 4.0 of Appendix 8, PDP review the proposed conditions. At Paragraph 36 PDP recommend the inclusion of Conditions which control the ability to discharge to land. I consider this to be appropriate and suggest the inclusion of conditions as discussed below.

135. At Paragraph 74 PDP recommend that Conditions should include separation distances and wind speed cut-offs. I agree with this recommendation as noted below.

RESPONSES TO SUBMISSIONS

136. A large number of submissions has been received. Due to the large number of submitters I have discussed issues in common to submitters without direct reference to each submitter.

Air Quality Matters

137. Issues relating to air quality were raised by a large number of submitters. In particular, submitters were concerned about odour and the potential for contact with wastewater via spray drift. Opportunities for contact with wastewater were identified as:

a. People using Longwood Road and Murphys Line for walking, pet exercise, biking or as transit route;

b. Through foraging on adjacent properties (mushrooms and watercress);

c. From spray drift deposition on roofs used for water supply;

d. From spray drift deposition on nearby apple orchards; and

e. And others.

138. The method to avoid contact with spray drift from wastewater irrigation is to avoid spray drift moving beyond the irrigation property boundaries. As noted in Paragraph 79 above the determination of buffer distances is based on a level of protection of 0.1% of irrigated wastewater going beyond the buffer distance. A level of protection 0.1% is considered to be *de minimus*, meaning the risk of an adverse health effect is negligible. I note that submitters would prefer a level of protection of 0.0% however this is not possible using a scientific approach.

139. A submitter (A and D Hosnell) describes concerns about pathogen survival in aerosols. I agree that the potential for pathogen survival in aerosols exists if they are:

h. not removed at the treatment plant stage; and

i. No deactivated by effects such as solar radiation or dessication.

140. Dr Mc Bride discusses viral transport via aerosols in his evidence and I concur with his comments.

141. Spray drift travels further with higher wind speeds and as a result the buffer distances are extended to 300 m from dwellings when average wind speeds exceed 4 m/s (possibly around 40 % of the time). All irrigation is ceased if the average wind speed exceeds 12 m/s. These speeds are below the maximum wind speed reviewed in Hewitt (2011).

142. The size of the droplet influences the distance it travels. A nominal size of 200 µm has been proposed since droplets of this size are unlikely to become aerosolised.

143. In its submission, Regional Public Health states "*Regional Public Health is satisfied that this setback distance is appropriate and is likely to ensure that aerosols (including associated odour) do not cross boundaries to adjoining properties.*"

144. Paragraphs 71-81 above outline the measures that are proposed to avoid adverse effects due to odours or aerosols. The measures are

intended to avoid the transmission of odour or aerosols past the property boundary. I consider that the risk of odour and aerosol effects to neighbours can be adequately mitigated.

Suitability and Correctness of Wind Data

145. Submitters have described inaccuracies in the description of wind directions for the site.

146. Most commonly, submitters identify the north westerly as the predominant wind direction. In addition, submitters state that the use of the Tauherenikau at Alloa / Racecourse monitoring site is not representative of wind conditions at the proposed irrigation sites.

147. Monitoring of wind speed and direction at the FWWTP started in mid-2018. A comparison of data from the Tauherenikau and FWWTP sites is given in Figures 7 and 8 below. Over that 8.5 month period differences in the wind speed and direction are noted. At the FWWTP wind speeds were lower overall. The most common wind was from the south to south east and north east winds were also common.

148. Over the same period the Tauherenikau at Racecourse site had stronger winds overall. Dominant winds were from the south west and north east. Strong north west winds were also common.

149. The Tauherenikau site had more commonality to the submitters views, and not the closer site at the FWWTP.

150. Figure 6 below shows results from the Tauherenikau site (at that time Tauherenikau at Alloa) for the 20 years preceding the consent application. As shown, the wind that occurs most often is from the NE, however this is a gentle wind compared to the NW (and SW) wind which tends to be higher speed and so would be more noticeable to residents in and around Featherston.

151. The effect of changes in wind speed and direction data to the proposed land treatment regime are negligible and do not alter my conclusions.

152. The wind speed controls as described in Paragraph 179 will be based on monitoring at the FWWTP and an up to date register of houses in the vicinity of the land treatment sites.

Suitability of Land

153. Concern has been expressed by submitters that the land is not suitable for the proposed activity, or that insufficient investigation has been undertaken.

154. I note that the farm, previously manged as a dairy farm, has historically received irrigation from two bores on or near the current farm. Consents for the bore water takes allowed for 3,733 m^3/day for 150 days per year (559,980 m^3/year) to 68 ha (823 mm/y equivalent). SWDC propose to apply 4,440 m^3 per day for around 120 days per year at Stage 2B (510,300 m^3/year) to 116 ha (447 mm/y average).

155. While I am unaware if the entire consented volume has been applied to the site, the property was consented by the Regional Council to have twice the loading rate proposed with this application.

156. The historic irrigation provides reassurance that the proposed hydraulic loading is capable of being received by the sites. As is reasonable for a wastewater irrigation regime, a substantially greater degree of control is proposed by SWDC for the irrigation regime, noting that there are very limited consent conditions for clean water irrigation when compared to this application.

157. In addition to bore water irrigation, the dairy farm had consent for a discharge of dairy shed effluent to land.

158. Overall, it is my opinion that the proposed activity will be operated more conservatively and with more controls than were required under its previous management as a dairy farm.

159. Paragraphs 32-39 describe investigation work which underpins the proposed irrigation regime and land management options. I consider that a diligent process has been followed to determine a sustainable long term regime for the sites.

160. In my opinion the site is suitable for wastewater irrigation under a regime which accounts for identified site limitations.

Lifespan of Land Treatment

161. A submitter concern was that the site would be unsuitable for use after ten years.

162. I consider that detailed evaluation has been undertaken to determine regime that can be operated in sustainable manner theoretically in perpetuity, especially as the nutrient removal rates in crops are comparable to the nutrient application in the wastewater.

Drip Irrigation

163. Submitters expressed a preference for drip or trickle irrigation and Lake Ferry was cited as an example of successful drip irrigation.

164. In my opinion, spray irrigation offers a number of benefits over drip irrigation for a large scale discharge such as Featherstons wastewater irrigation including:

a. Greater separation distance to groundwater compared to buried drip line;

b. More even distribution of water across the land area (greater distribution uniformity);

c. Less restrictions on land use; and

d. Irrigation delivered to plant rooting zone.

165. I consider that the advantages of drip irrigation such as:

a. Avoidance of spray drift; and

b. Ability to irrigate to within 5 m of a property boundary.

Are able to be mitigated for more easily at the proposed sites than the separation to groundwater that is needed in lower lying areas of the sites.

Mānuka

166. Planting of the sites with mānuka was raised by submitters.

167. This issue is discussed in Paragraph 90 above.

Errors in Maps of Sensitive Receptors

168. The absence of new houses and some associated bores in maps included with the consent application were noted by submitters.

169. New dwellings and other identified receptors will be subject to buffer distance as proposed (Paragraph 179) and the associated protections that the buffer distances afford. In the event that additional buffers reduce the area available for irrigation, SWDC will require additional land. It is understood that land known as the golf course may be available.

Planting and Screening

170. Submitters have indicated that planting and screening is wanted.

171. I consider that the proposed buffer distances will provide protection from spray drift however it is my opinion that boundary plantings would add additional protection, aesthetic value and a level of comfort for nearby residences and users of Longwood Road and Murphys Line. This is a matter for SWDC to confirm.

High Water Table, Groundwater Quality

172. Submitters have raised issues regarding the impact of wastewater irrigation on shallow groundwater, including bore water security and increases in groundwater springs.

173. Mr Simpson discusses these issues in his evidence. I consider that risks due to shallow groundwater are able to be managed by adopting the proposed irrigation regime.

Damage Cultural, Heritage and Amenity values of Longwood Homestead, Carkeek Observatory and Tarureka Estate.

174. Submitters have identified potential for damage to the cultural, heritage and amenity values of Longwood Homestead, Carkeek Observatory and Tarureka Estate Longwood homestead.

175. It is my opinion that the proposed consent conditions will result in effects to Longwood Homestead and Tarureka Estate which are less than minor.

176. Carkeek Observatory is located within the SWDC property boundary. A condition has been proposed to establish a buffer distance of 50 m from the wetted boundary to a historic site. I consider that this will avoid irrigation causing further degradation of the already significantly degraded Carkeek Observatory site.

APPROPRIATENESS OF PROPOSED CONDITIONS OF CONSENT

177. I consider that the adaptive management approach is appropriate for the proposed discharge to land. I agree with the conditions proposed in the main consent application. Additional conditions that may be considered are:

178. Land discharge conditions to include:

a. irrigation to result in soil moisture not exceeding field capacity for Site A and not exceeding 3 mm over field capacity for Site B

b. Irrigation not to occur to any area that has groundwater within 0.6 m of the land surface

c. Irrigation not to occur within 24 hours of 2 mm of rainfall.

d. A nitrogen load not exceeding 300 kg N/ha/y from all sources.

e. A phosphorus load not exceeding 60 kg P/ha/y from all sources.

179. General conditions to include:

a. 25 m separation distance from irrigated radius to property boundaries

b. 150 m separation distance from irrigated radius to dwelling or other occupied building

c. ~~50 m separation distance from bore~~s

d. 50 m separation distance from irrigated radius to identified waahi tapu, historic place or archaeological site

e. 20 m separation from all surface water including farm drains

180. Air quality conditions to include:

a. Irrigation shut down when 15 min average windspeed exceeds 12 m/s in any direction

b. Irrigation shut down when 15 min average windspeed exceeds 4 m/s in the direction of any dwelling within 300 m of the site.

CONCLUSION

181. In my opinion, a robust, technically based land treatment system can be implemented to acknowledge site limitations and minimise offsite effects for each of the Stages 1A, 1B, 2A and 2B.

182. The proposed irrigation and nutrient application rates are conservative and will not result in effects that are any greater than current observed farming practices in the general area. Additional consideration is needed with regard to human pathogens. I agree with the evidence of Mr Simpson and Dr Mc Bride on pathogen issues.

183. Where uncertainty over a design or contaminant parameter exists, the use of professional judgement to identify and adopt a worst case scenario for that parameter assists to provide certainty that the effects identified can be achieved.

184. Monitoring will allow verification of effects and adaptive management will allow any over or underestimation of effects to be addressed.

185. The proposed conditions and adaptive management provide a sound and usual approach to managing residual uncertainties. The proposed approach is the same as was proposed and adopted for Greytown and Featherston.

186. Subject to irrigation design and management, there are no effects from the land treatment of wastewater from FWWTP at Stages 1a, 1b, 2a or 2b which are likely to be more than minor.

Signed:

Katie Beecroft

29 March 2019

Exhibit 1: Wind Figures

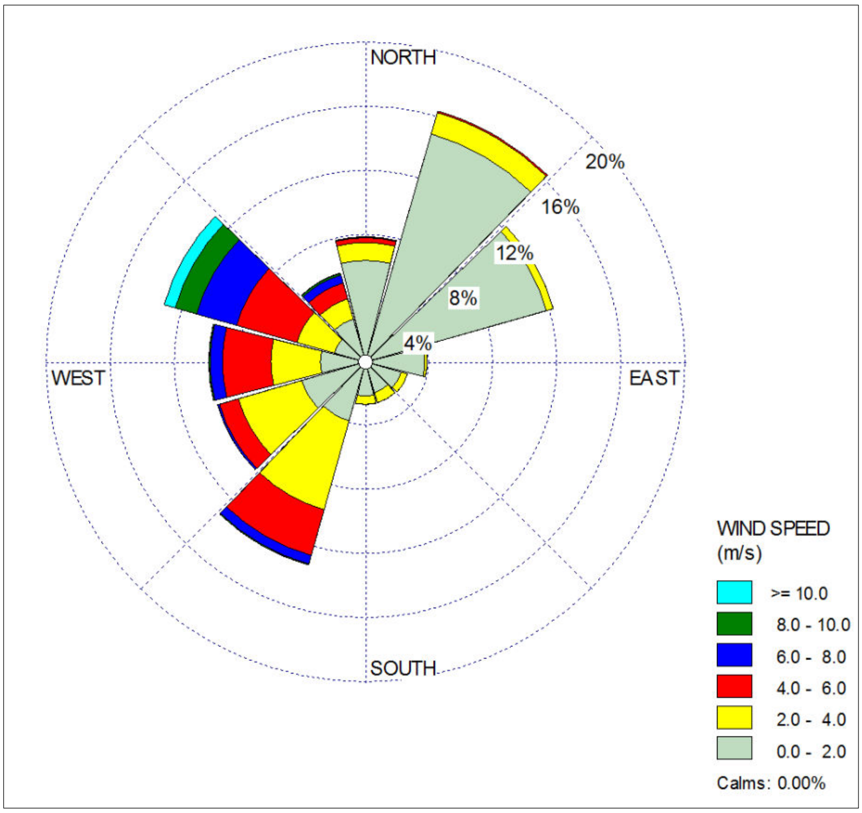


Figure 6: Tauherenikau at Alloa (1999 to 2013)

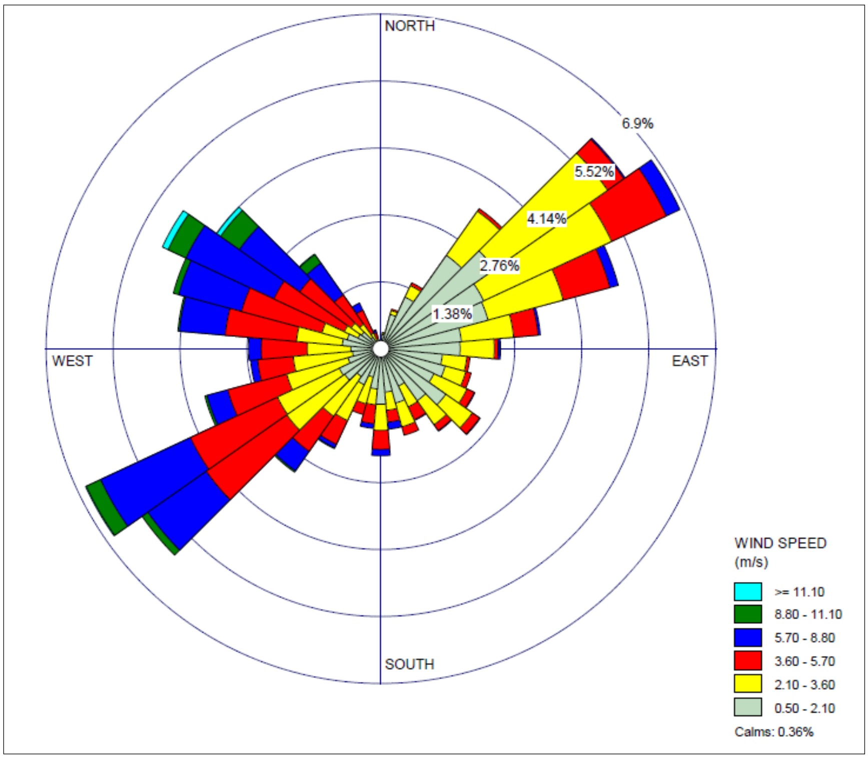


Figure 7: Tauherenikau at Racecourse (July 2018 to March 2019)

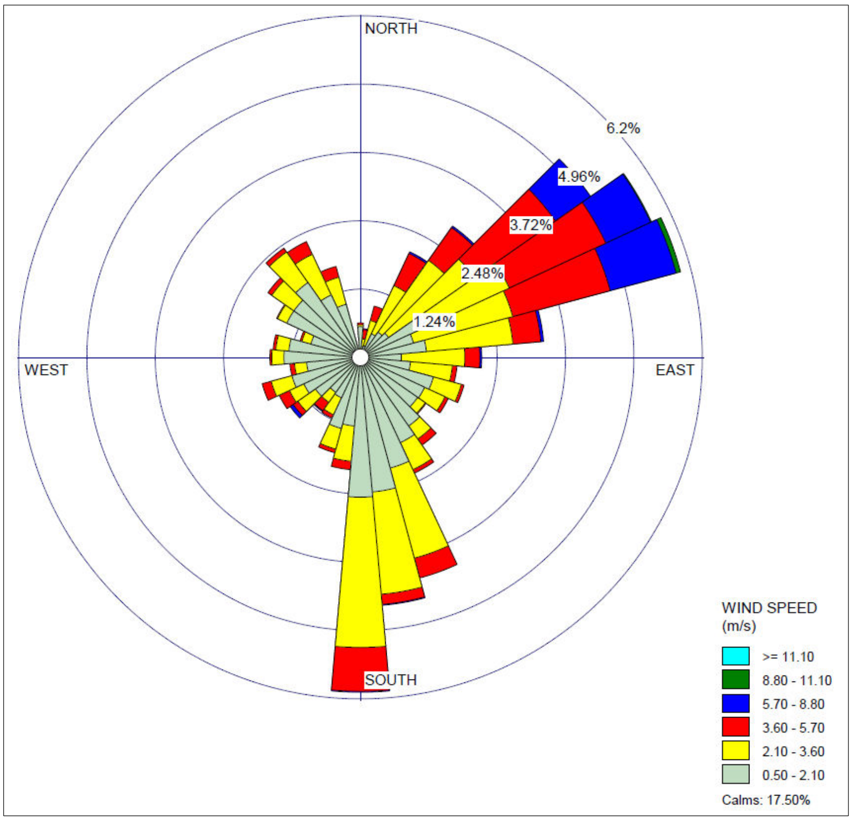


Figure 8: FWWTP (July 2018 to March 2019)

Exhibit 2: Presentation to community

LOWE Environmental Impact

Featherston Treated Wastewater Application to Land

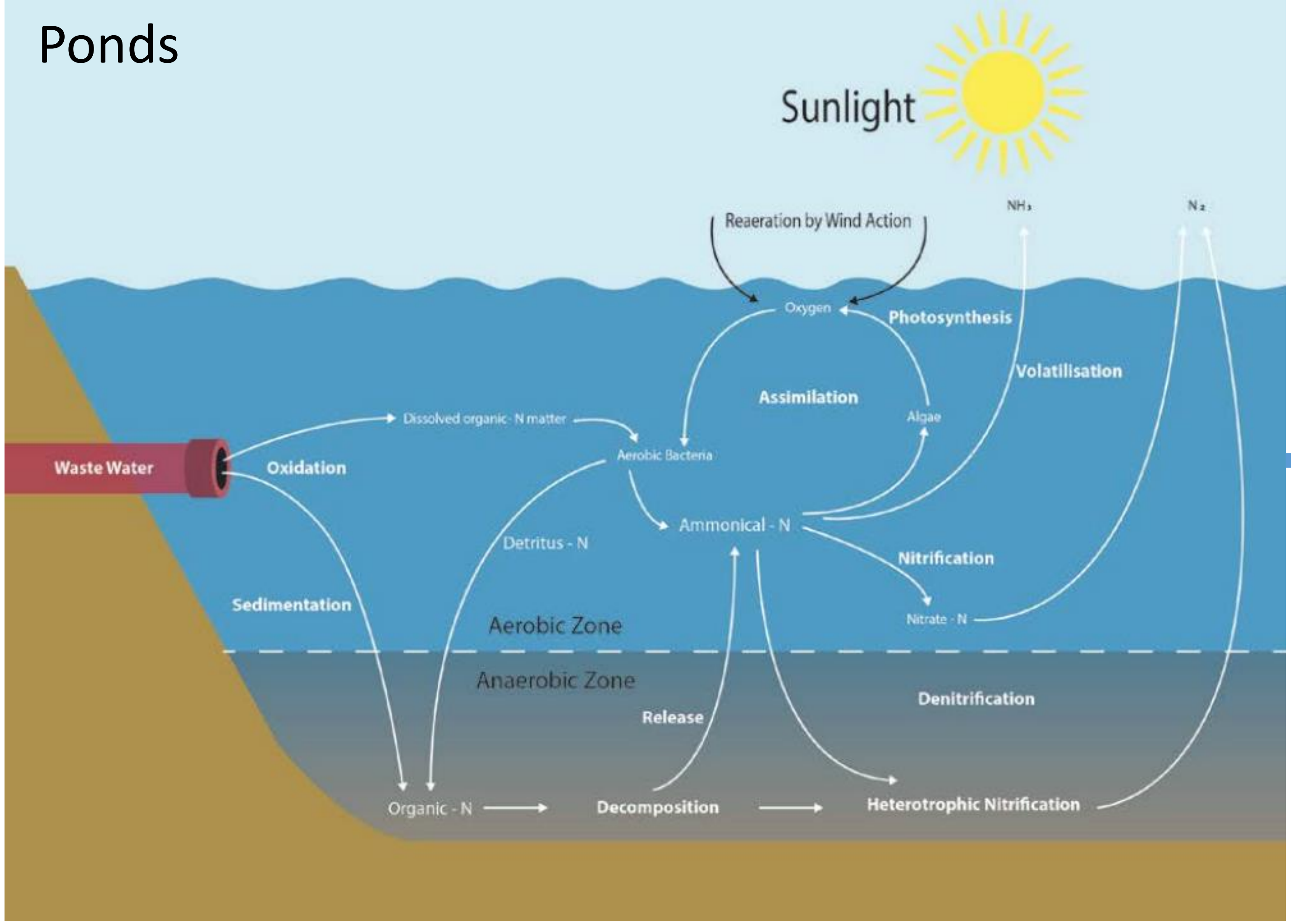
23 August 2018

Outline

- Featherston's Wastewater
- Why Land Application
- How it will be Achieved
- Use of Soil Moisture
- Deficit & Non-deficit Irrigation
- Irrigation Regime
- Groundwater
- Spray Drift & Odour

Featherston's Wastewater

Ponds



Discharge

Featherston's Wastewater

LOWE Environmental Impact

- Secondary treated, UV disinfected

Parameter	Mean
Outflow (m^3/d)	2,270
BOD_5 ($g\ O_2/m^3$)	18.3
TSS (g/m^3)	32.0
TN (g/m^3)	8.6
NH_4-N (g/m^3)	4.9
SIN (g/m^3)	5.8
DRP (g/m^3)	1.3
TP (g/m^3)	1.7
pH	7.6
E. coli (cfu/100 mL)	56

Land Application of Wastewater - WHY?

LOWE Environmental Impact

- Community wishes (2012 Process)
- Progressively remove direct discharge from Donalds Creek, Abbots Creek and Lake Wairarapa
- Beneficial use of water and nutrients
- Effective and natural additional treatment
- Resilient option

Land Application of Wastewater - HOW?

- Staged transfer to land
- Low rate application for agronomic benefit
- Soil moisture controlled for environmental protection
- Buffers from sensitive areas for air quality and public health

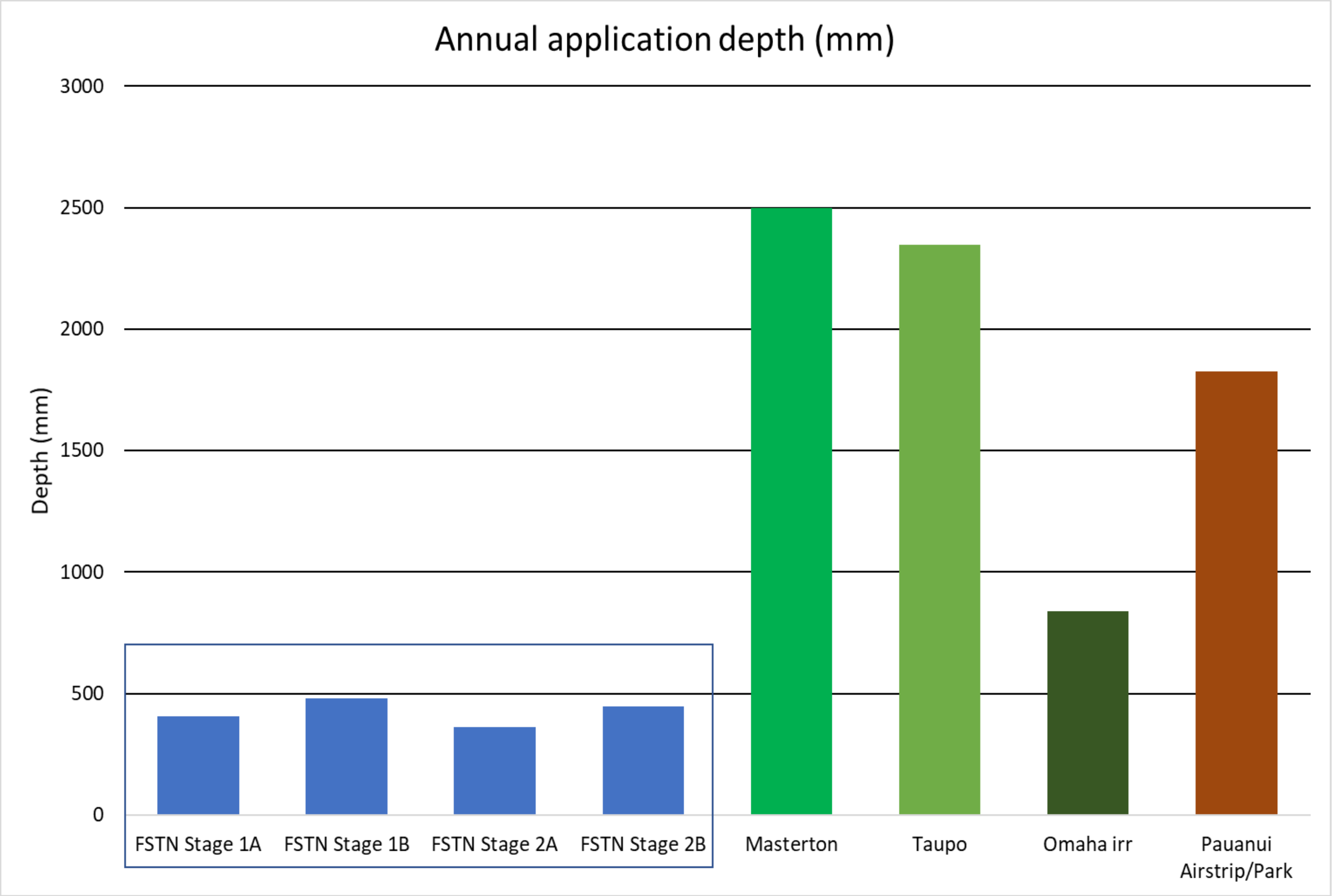
Land Application - Staging

- Lawrence has covered

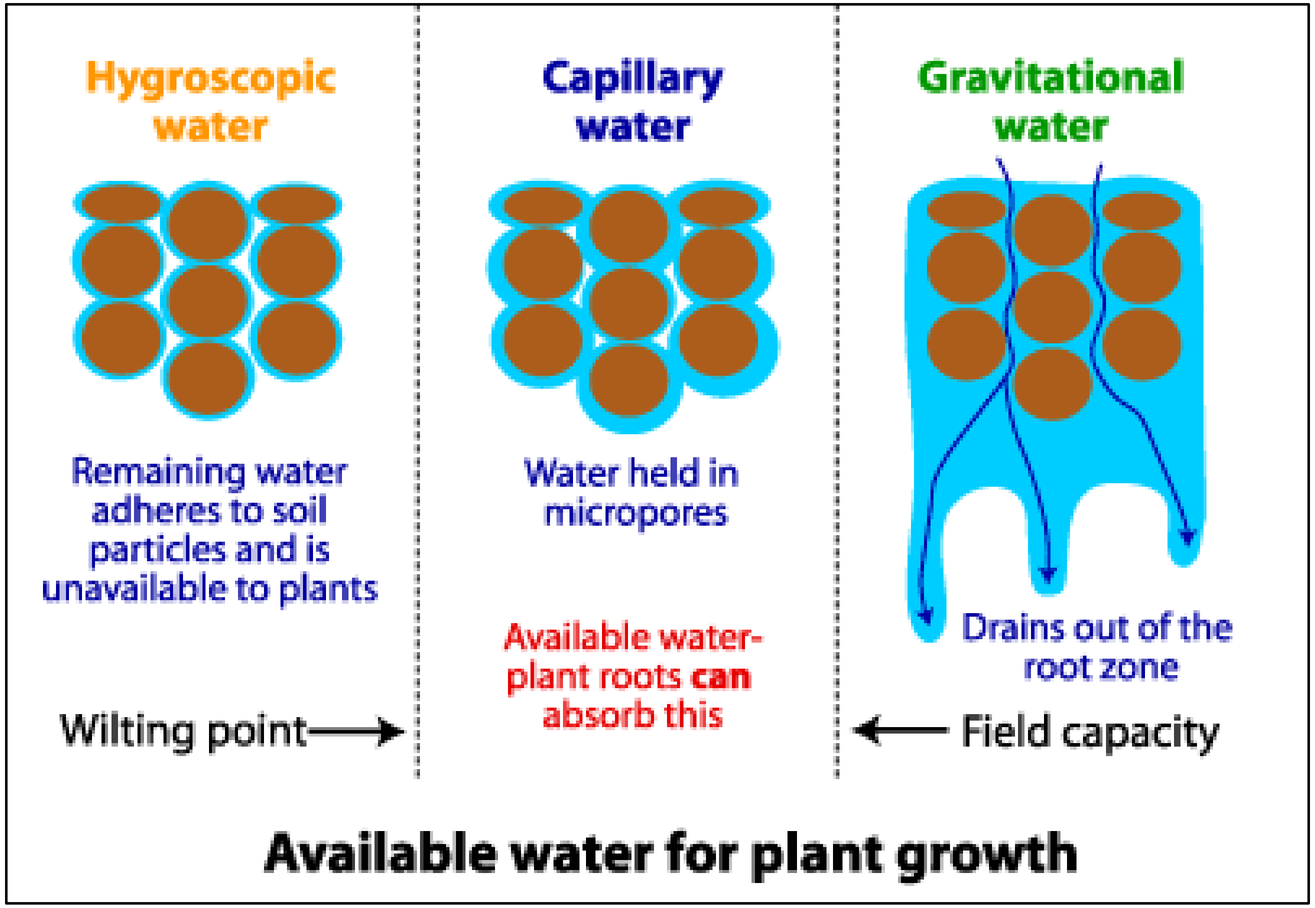
Land Application – Low Rate

Lowe Environmental Impact

- How does the proposed discharge compare to other land application systems around NZ?
- cf “clean” water irrigation 150 to 575 mm/y (Wairarapa Irrigation Project)

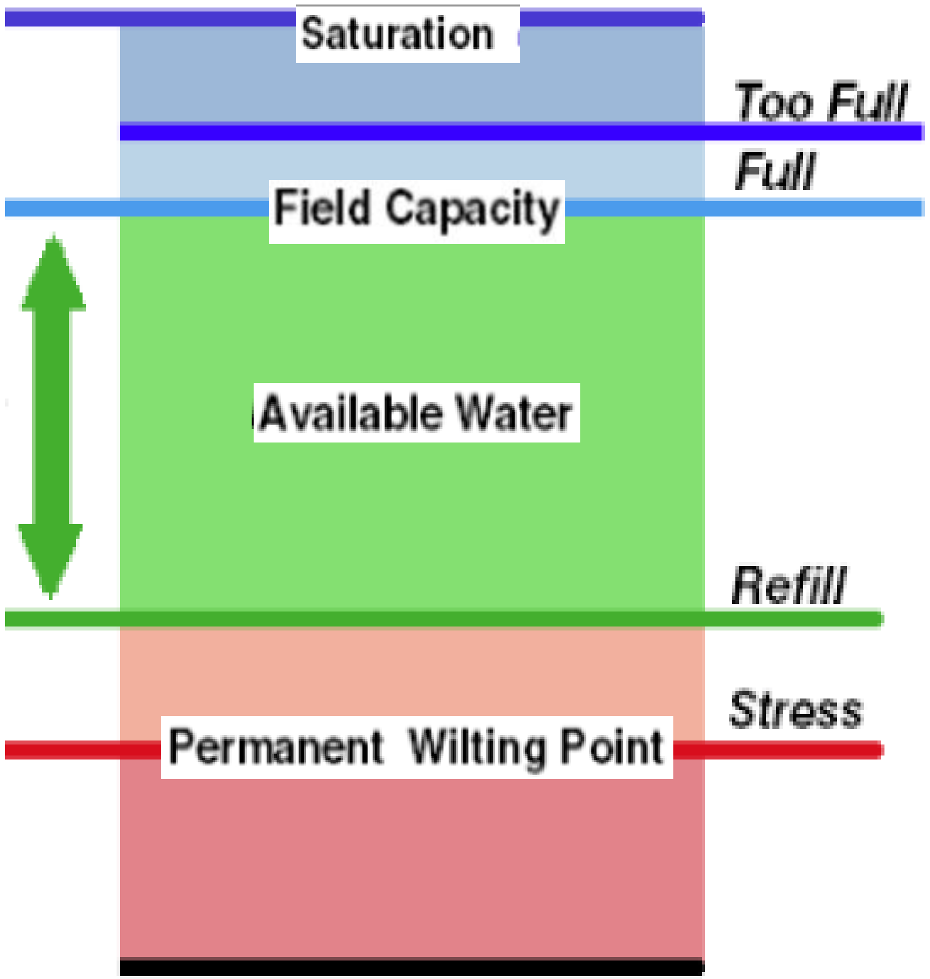


Land Application – Soil Moisture



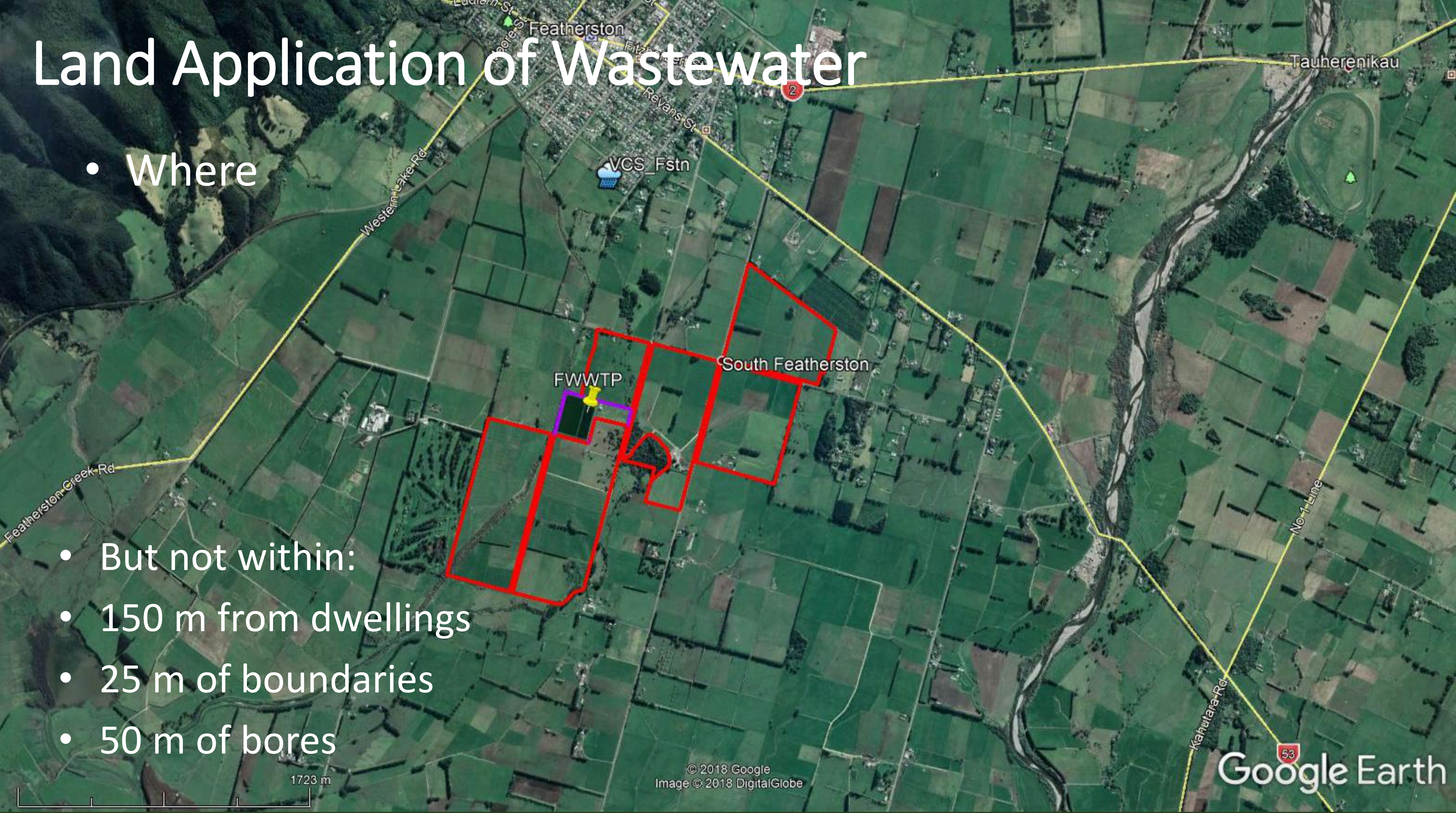
Land Application – Soil Moisture

- Deficit
  - * Minimal drainage to groundwater
  - * Matches plant use
- Deferred (non-deficit) Irrigation
  - * Stops during excessively wet periods
  - * Allows minor drainage



Land Application of Wastewater

- Where



- But not within:
- 150 m from dwellings
- 25 m of boundaries
- 50 m of bores

Below the surface

Deficit

Non deficit / deferred

Non deficit / deferred

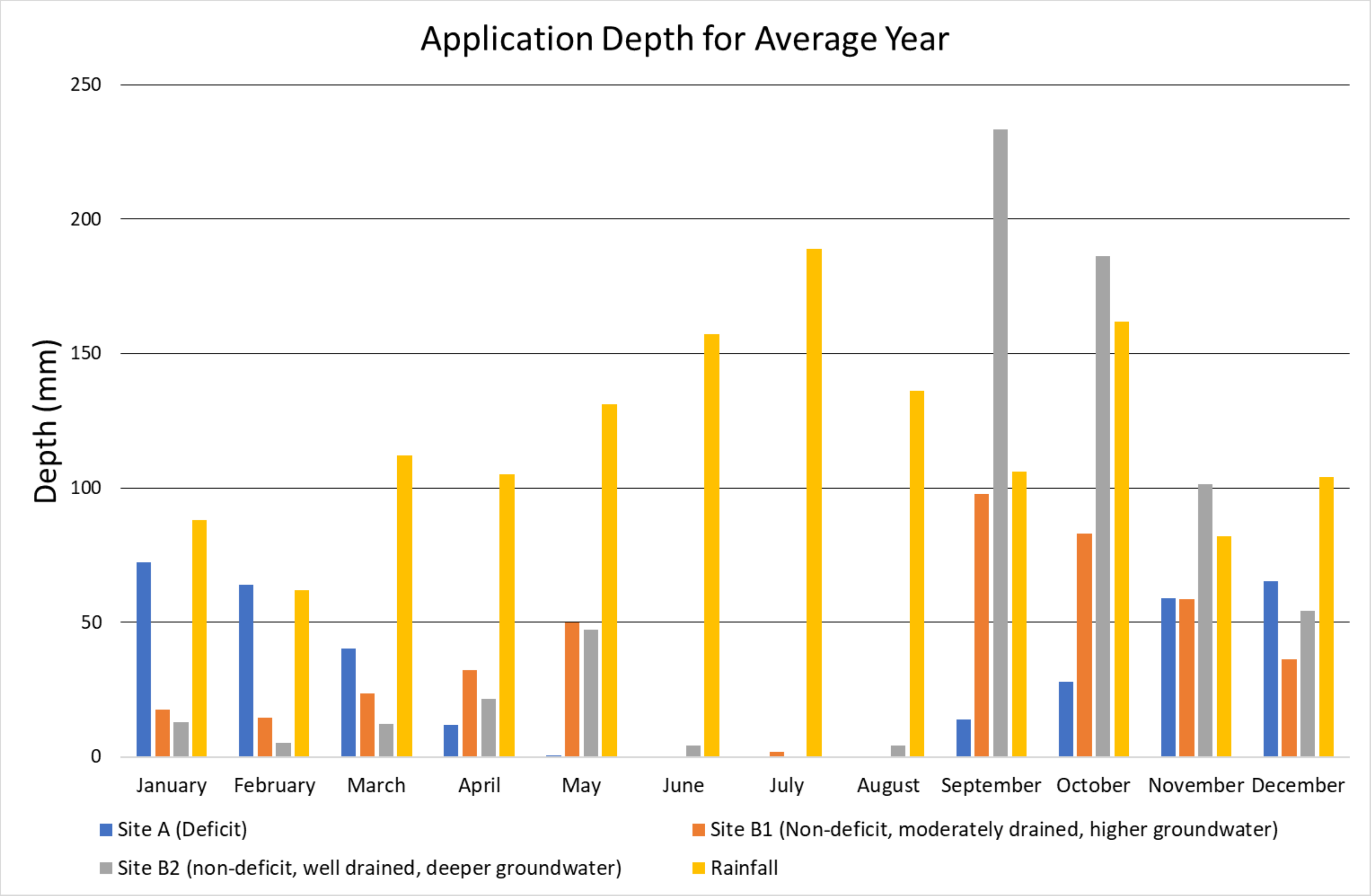
Irrigation Regime

Parameter	Stage 1A	Stage 1B	Stage 2A	Stage 2B
Storage (m^3)	None	None	None	186,000
Irrigation Regime	Site A: Deficit	Site A: Deficit Site B: Deferred	Site A: Deficit Site B: Deferred	Site A: Deficit Site B: Deferred
Total area (ha)	12	166-178	166-178	166-178
Irrigated area (ha)	8	70	70-116	116
Irrigation event application (mm/event)	up to 19	up to 55	up to 55	up to 55
Average annual application volume (m^3/y)	32,500	385,000	305,200	510,300
Average annual application depth (mm)	406	480	360	447
Nitrogen load (kg N/ha/y)	35	42	42	51
Phosphorus load (kg P/ha/y)	7	8	8	10
Farm Management proposed	Pasture for removal (cut and carry)	Stock grazing and/or Cropping and/or Pasture for removal (cut and carry)		

Land Discharge

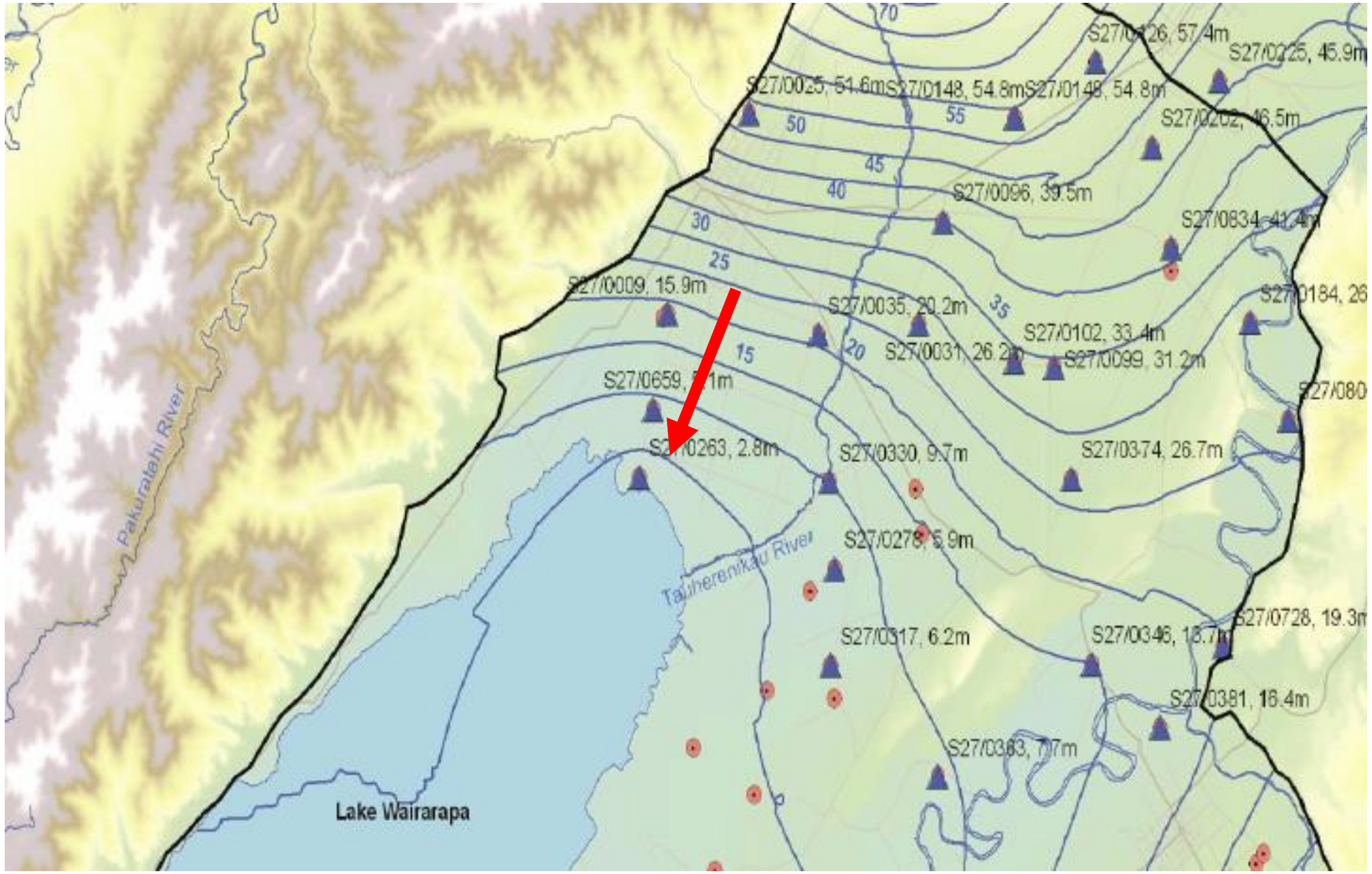
Land Discharge

How much Irrigation



Groundwater

Flow Direction



Depth

Varies by season (higher in winter)

Estimated range between 0 m and 7 m below ground

Measured (centre of site) between 0.88 m and 2.86 m below ground

May increase temporarily by 0.5 m at property boundary (south end)

Wind speed	Buffer for 1% of Application Rate	Buffer for 0.5% of Application Rate
20 km/h	25 m	35 m
35 km/h	35 m	75 m
45 km/h	50 m	100 m
55 km/h	60 m	110 m
65 km/h	75 m	120 m

Figure 1. Off-Target Deposition Rates for Chemigation Treatments in SDTF Field Studies

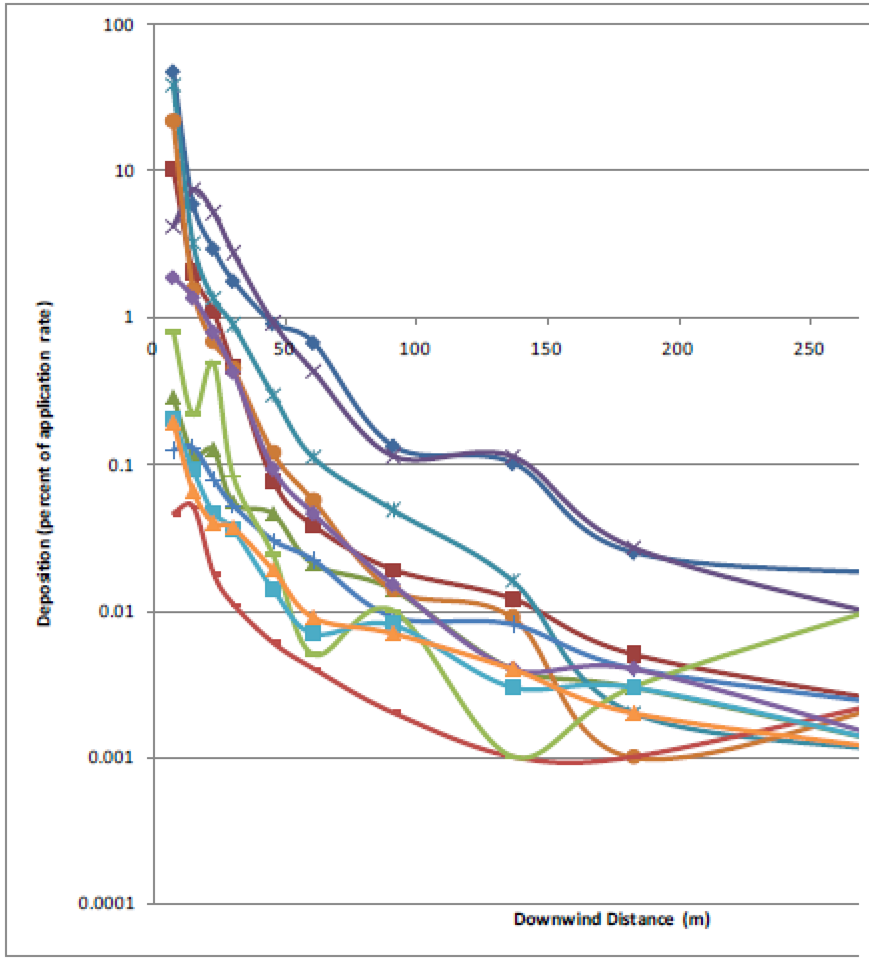
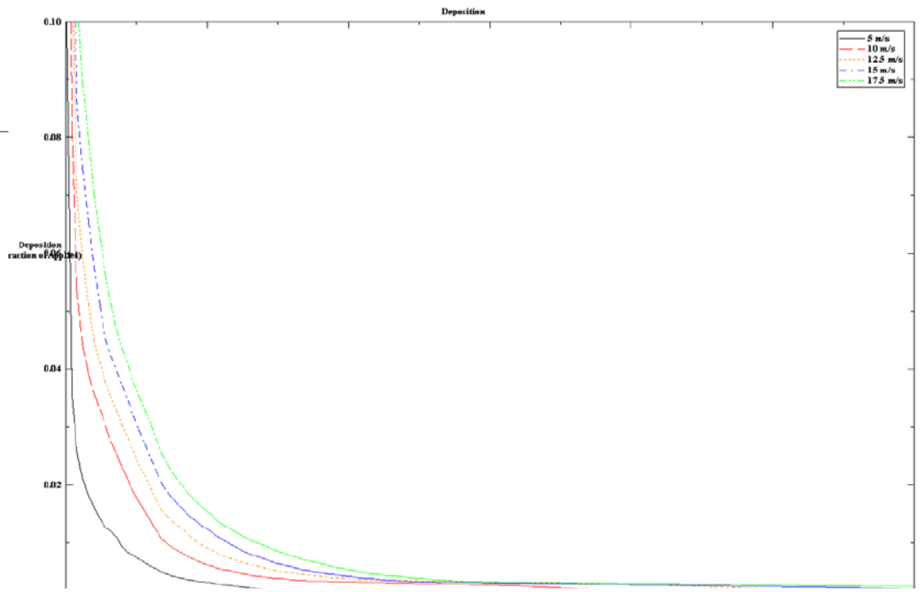


Figure 3. AGDISP-Predicted Deposition for Reasonable Worst-Case Chemigation Application at Different Wind Speed Conditions



When considered in conjunction with the field data, the modelling runs support the following recommendations for chemigation applications in the Masterton area for minimising off-target drift to de minimus levels (with options for deposition rates below 0.1 and 0.01 of the application rate):

- Observe a buffer zone distance of at least 100 m to 125 m **to keep deposition rates below 0.1% of the application rate**
- Buffer zones of 25 m will afford protection to 5% of the application rate without restrictions on end guns and other parameters, or protection to 1% of the application rate if low pressure systems and/ or wind speed limits (including sustained gusts) of 4 m/s (14.4km/hr) apply. If a level of protection to 0.1% is required with a 25 m buffer, then end guns and high pressure/ high boom systems must not be used. **In other words, for <0.1% deposition rates with a 25 m buffer, low pressure (≤1.4 bar), low boom (≤1.52 m) sprinkler systems without end guns are required.**

Featherston
VCS_Fstn
Western Lake Rd
2
Tauherenikau
FWWTP
South Featherston
No 1 Line
53
Kahutara
© 2018 Google
Image © 2018 DigitalGlobe
NORTH
SOUTH
WEST
EAST
20%
16%
12%
8%
4%
WIND SPEED (m/s)
>= 10.0
8.0 - 10.0
6.0 - 8.0
4.0 - 6.0
2.0 - 4.0
0.0 - 2.0
Calms: 0.00%
Long term
10.5%
8.4%
6.3%
4.2%
2.1%
WIND SPEED (m/s)
>= 11.10
8.80 - 11.10
5.70 - 8.80
3.60 - 5.70
2.10 - 3.60
0.50 - 2.10
Calms: 11.50%
June to August 2018
8.3%
6.64%
4.98%
3.32%
1.66%
WIND SPEED (m/s)
>= 11.10
8.80 - 11.10
5.70 - 8.80
3.60 - 5.70
2.10 - 3.60
0.50 - 2.10
Calms: 0.00%
June to August 2018

Questions

L O W E
Environmental
Impact

Advice AEE Agricultural Analysis Application Approachable Assessments Assimilation Assistance Biosolids Capability Client Communications Communities Compliance Compost Consents Consultation Contamination Coordinate Council Cultural Current Data Degradation Design Detention Developments Discharges Documentation Drafting E. coli Ecosystems Effects Engagement Environment Equipment Evidence Excellence Experienced Expert Facilitating Farming Feasibility Fieldwork First-flush Fit-for-purpose Flooding Fun Geology Graphs Greywater Groundwater Guidelines Handbag Hazardous Hydraulics Innovation Interpretation Investigation Irrigation Land Landfills Landscape Land-treatment Leaching Lodge Management Metals Microbiology Modelling Monitoring NES Nitrogen Nutrients Onsite Optimisation Organics Overseer Papers Pathogens Phosphorus Plain-english Plans Preparation Presentations Project Quality Relevant Remediation Reports Research Review Sampling Scientific Septage Sludge Soil Solutions Spreadsheets Standpipes Stormwater Strategy Support Surface Water Sustainability Systems Team Testing Timely Treatment Validation Wastewater Water Water-balance Waterways

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