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 Martinborough Wastewater Treatment Plant**

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

EXPERT EVIDENCE ON THE EFFECTS OF PROPOSED LAND TREATMENT OF WASTEWATER

DATED 17 April 2014

Solicitor:	**Andrew Hazelton** **Hazelton Law**	**Counsel:**	**Philip Milne** **Waterfront Chambers**
Address:	Level 3, Molesworth House, 101 Molesworth Street PO Box 5639, Wellington	**Address:**	Level 5, Legal House, 101 Lambton Quay PO Box 5494, Wellington
Telephone:	(04) 472 7570	**Telephone:**	(04) 499 6653
Fax:	(04) 472 7571	**Fax:**	(04) 499 2323
Email:	Andrew.hazelton@hazelton.co.nz	**Email:**	philip.milne@waterfront.org.nz

EVIDENCE OF KATIE 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.

2. 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 Martinborough 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 combined land and water discharge ("**CLAWD**") regime proposed as part of the Project.

3. 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).

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

   (a) New Zealand Society of Soil Science;

   (b) Water New Zealand;

   (c) New Zealand Land Treatment Collective; and

   (d) Water Environment Federation (WEF).

4. I have been involved in the investigation, design and consent preparation, of a number of small community wastewater projects in the central and lower North Island. These include:

   - Greytown
   - Featherston
   - Levin

- Shannon
- Foxton
- Himatangi Beach
- Piopio
- Waipawa
- Waipukurau
- Mahia Beach

5. I am familiar with the recent changes to both, the Masterton and Carterton WWTP discharges.

6. I have also worked on several large industrial waste discharges including at AFFCO Manawatu and Fonterra Pahiatua.

7. I confirm that I have read the 'Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2011. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

8. My evidence will address the following:

   (a) Description the land treatment concept;

   (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) Response to matters raised in the GWRC reporting officers s42A reports; and

(g) Response to matters raised in submissions.

LAND TREATMENT

9. 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 which relies on the passage of wastewater through land to filter and diffuse the wastewater, with only minor nutrient removal.

10. Land treatment aims to beneficially use the applied wastewater for productive use, while using the environment to provide further treatment of the wastewater.

11. Land treatment systems are now common in New Zealand and, in my opinion, likely to become more so. A critical driver for their development has been the increased impetus to reduce direct discharges of wastewater to freshwater environments, such as the current discharge of wastewater from the Martinborough Wastewater Treatment Plant ("**MWWTP**") to the Ruamahanga River. 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).

OVERVIEW OF THE STAGED DEVELOPMENT OF THE PROJECT

12. The resource consent application outlines a staged programme over the term of the consent which progressively reduces the volume of wastewater which is discharged directly to the Ruamahanga River. Further detail regarding the staging, including timing is given in the evidence of Mr Mark Allingham. The key aspects of the staging which relate to the land treatment and the evidence presented here are as follows.
13. Stage 1A includes treatment plant upgrades and has no land treatment component.
14. Stage 1B includes irrigation of an average of 24 % of the annual wastewater production from Martinborough to land adjacent to the treatment plant.
15. Stage 2A includes the irrigation of an average of 42 % of the annual wastewater production from Martinborough to land referred to as Pain Farm.
16. Stage 2B includes the irrigation of an average of up to 100 % of the annual wastewater production from Martinborough to Pain Farm. There is allowance for some discharge to river where the available storage volume is near to capacity and Ruamahanga River flow exceeds 3 * median.

CHARACTERISATION OF LAND TREATMENT SITES

MWWTP Adjacent Site (Stage 1b)

17. The land to be used for land treatment at Stage 1b is located adjacent to the Martinborough wastewater treatment plant (MWWTP) and is referred to in the consent application and reporting as the MWWTP adjacent site. Presently the land is owned by SWDC and is used for grazing of cattle by the adjoining land owner. The property has a total area of 7.9 ha, of which 5.3 ha has been identified as irrigable following

the exclusion of a 25 m buffer to the adjoining property, a 5 m buffer to the base of the Ruamahanga River stopbank which runs through the property and exclusion of land on the river side of the stopbank. There are a number of site characteristics which influence the land treatment system design and the effects of land treatment, including the soil, groundwater, surface water and climate. A description of the site characteristics is as follows.

18. ***Soil:*** I inspected the MWWTP adjacent site with two colleagues on the 13th of February 2013. A visual inspection of the site was undertaken and a total of 23 soil cores of 50 mm diameter with a maximum depth of 1,500 mm were taken across the site to inspect the soil profile. The site up to the stopbank is predominantly flat with a slight hummock and swale topography which is typical of the site's position on what would have been the active floodplain of the Ruamahanga River prior to the construction of the stopbank. It was determined that soil across the site is fairly consistent having a silt loam texture in the topsoil and with an alternating pattern of silt loam and sandy loam texture with depth corresponding to material deposited by the River over time. Slightly finer texture (higher proportion of silt and clay) occurred in the lower lying swale area.

19. Mottling in a soil profile is an indicator of periods of prolonged soil wetness which may suggest a limitation for land treatment due to either slow permeability or high groundwater. At this site no mottles were observed in cores over most of the site, however mottling below 1 metre was seen in a core closest to the stopbank and river. Minor mottling at shallow depth was observed in cores of the swale (lower elevation) area.

20. ***Groundwater:*** The MWWTP adjacent site is located in the Lower Ruamahanga Water Management Zone[1] (formerly the Tawaha zone[2]).

[1] Hughes, B. and Gyopari, M. 2011. Wairarapa valley groundwater resource investigation – Proposed framework for conjunctive water management. *GW/EMI-T-11/53.*
[2] Gyopari, M. and McAlister, D. 2010. Wairarapa valley groundwater resource investigation – Lower Valley catchment hydrogeology and modelling. *GW/EMI-T-10/75.*

The underlying shallow groundwater aquifer is connected hydraulically to the overlying material i.e. water can percolate downwards from the soil surface to the aquifer (unconfined to semi-confined). The aquifer is in gravels (of Holocene age) and is believed to have a high degree of connectivity to the Ruamahanga River, meaning that water in the aquifer can flow into and out of the river through these gravels. Properties of the groundwater are:

- The hydraulic conductivity of the zone is 100-400 m/day[(3) and (2)];
- The transmissivity of the zone has a geomean of 1,250 m^2/day[(3)] to 4,500 m^2/day[(2)]; and
- Storage constant is 0.016[(1)].

21. Groundwater depth monitoring data for 7 standpipes across the MWWTP adjacent site was provided to me by New Zealand Environmental Technologies Ltd. on behalf of South Wairarapa District Council. The data spanned an approximately 18 month period. The data indicates that groundwater below the site has maximum depth varying from 2.7 m to 4.3 m and a minimum depth varying from 0.95 m to 1.97 m below the land surface. The groundwater levels measured tended to reflect variations in the water levels in the Ruamahanga River which is adjacent to the site i.e. the groundwater moves up and down as the river level moves up and down.

22. ***Surface water*** – The surface water receiving body closest to the MWWTP adjacent site is the Ruamahanga River. The river runs along the northern property boundary. The river is separated from the irrigation area by a stopbank. Detailed description of the river receiving environment is given in the AEE and evidence of Dr Brian Coffey.

[3] Jones, A. and Gyopari, M. *Regional conceptual and numerical modelling of the Wairarapa groundwater basin.*

23. ***Climate:*** Using the NIWA Virtual Climate Station (station number P189128) it has been determined that the MWWTP adjacent site is subject to:

- Average annual rainfall of 758 mm/y;
- Potential evapotranspiration of 936 mm/y;
- Average temperature of 13.2℃; and
- Average windspeed of 3.3 m/s.

24. Potential evapotranspiration exceeds rainfall indicating irrigation will benefit plant growth in the area.

Pain Farm Site (Stages 2a and 2b)

25. The land which is proposed to be used for land treatment at Stage 2a and 2b is located around 2 km by pipe route from the MWWTP at 588 Lake Ferry Road. The site is referred to in the consent application and reporting as Pain Farm and is owned by SWDC. Presently the land is used for grazing of cattle and sheep by a leasee. The property has a total area of 85 ha, of which 53 ha has been identified as irrigable following the exclusion of a 25 m buffer to adjoining properties and 20 m buffer from surface water flow paths present on the site. A description of the site characteristics is as follows.

26. ***Soil:*** I inspected the Pain Farm site with two colleagues on the 14th of February 2013. A visual inspection of the site was undertaken and a total of 6 soil cores of 50 mm diameter with a maximum depth of 1,300 mm were taken across the site to examine the soil profile. The site is gently rolling with a fall towards the north-west. Soils of the flats near to the north-west boundary of the site have silt loam topsoil underlain by silt loam and clayey silt. Between 400 and 600 mm a pan was present, being a layer of soil which was harder and more consolidated than soil above and below it. Below 800 mm the soil was strongly gleyed indicating it was wet for long periods of time. From 850 mm the soil was gravelly. Soils of the gently rolling terrain present over the remainder of the site were very similar to the soil of the flats but

with lenses (thin layers) of sandy and gravelly material present at depth with strong mottling throughout the profile and a pan varying from 350-500 mm below the soil surface.

27. Water entering the soil profile is likely to perch on the soil pan and the presence of mottling below the pan suggests additional restrictions to water percolation and drainage. As a result water entering the soil profile is expected to travel laterally towards the north-west to surface water, with only minor recharge to groundwater.

28. The saturated and unsaturated hydraulic conductivity, being the speed of water movement into and through soil, was measured *in-situ* to evaluate the rate of water movement into and through the soil. Measured saturated hydraulic conductivity of the soil was 50 ± 15 mm/h. The measured unsaturated hydraulic conductivity was 4 ± 2 mm/h at a matrix potential of -40 mm. The use of unsaturated hydraulic conductivity measurements allows application rates to be determined that avoid rapid drainage thought the soil profile. Water applied at a rate of 4 mm/h will avoid rapid drainage and saturation in the soil profile.

29. ***Groundwater:*** The Pain Farm site is located in the Martinborough Management Zone[4] near to the western boundary of the zone, aligned with the Martinborough fault. The underlying aquifer is semi-confined in river deposits and inferred to be contiguous with the Ruamahanga Valley alluvium, suggesting throughflow of groundwater across the Martinborough fault. Groundwater, as opposed to soil water perched on soil pans, is estimated at between 15-20 m below the site based on the groundwater contour map for the area. Properties of the groundwater are:

[4] Hughes, B. and Gyopari, M. 2011. Wairarapa valley groundwater resource investigation – Proposed framework for conjunctive water management. *GW/EMI-T-11/53.*

- The hydraulic conductivity of the zone has been recorded as 1 m/day(5);
- The transmissivity of the zone has been reported at a geomean of 530 m^2/day(3); and
- Storage constant is 0.0008(1).

30. ***Surface water:*** There are no significant rivers or streams associated with the Martinborough Management Zone. Along the north-western boundary of Pain Farm a permanently flowing, unnamed stream runs to the west towards the Ruamahanga River. Flows and water quality in the stream are not known. A number of ephemeral flow paths drain from Harris Ridge to the east of the site across the site to the stream on the north-west boundary.

31. ***Climate:*** Climatic conditions at Pain Farm are similar to those described for the MWWTP site.

COMBINED LAND AND WATER DISCHARGE REGIME

32. The primary objective of the proposed discharge regime following the commencement of Stage 1b is to provide for the management of Martinborough's wastewater for the foreseeable future in a manner that protects and enhances the Ruamahanga River. This mitigation of effects, is to be achieved by the progressive reduction in volume of wastewater discharged to the Ruamahanga River from MWWTP. The reduction in the effects of the MWWTP discharge on the Ruamahanga River are expected to be proportionally greater than the actual volume reduction by excluding wastewater discharge during low flows, when the River environment is most sensitive to wastewater associated contaminants.

[5] Jones, A. and Gyopari, M. *Regional conceptual and numerical modelling of the Wairarapa groundwater basin.*

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

34. 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). Environmental data, including soil properties and soil moisture status, informs how the applied water (rainfall or wastewater) moves through the land treatment site. River flow data is used to determine the maximum daily volume that can be discharged to the river (i.e. whereby effects are not detectable). For any day, based on the water balance:
    - If soil moisture meets the criteria for discharge and there is sufficient wastewater in storage then discharge to land occurs; or
    - If storage is greater than a critical level and the daily average river flow meets criteria for river discharge then discharge wastewater to river occurs; or
    - If no land or river discharge is possible then the wastewater is directed to storage.

35. The water balance determined the volumes discharged to land or river and the volume of storage required. This has been modelled and a daily record for the period was prepared.

36. A summary table of water balance inputs and outputs is given in Annex A.

37. For Stage 1b the relative proportion of wastewater discharged on average is 24 % to land and 76 % to water. For Stage 2b the relative proportion of wastewater discharged on average is 42 % to land and 58 % to water. For Stage 2b it is possible to discharge the entire annual

wastewater volume to land if sufficient storage is available, however it is intended that a portion of the wastewater will be able to be discharged to wastewater where river conditions are suitable and storage is near capacity.

38. The criteria be met to allow discharge to water are discussed in the AEE, Section 3.2.1.4. The criteria for discharge to water are the same for both Stages 1b and 2a. A greater proportion of wastewater is discharged to land following commencement of Stage 2a due to the larger land area available even though the rate of discharge is reduced. Both stages rely on wastewater discharge to land by preference i.e. the ability for land to receive wastewater is the first consideration for each day as indicated in 34 above to achieve the predicted proportions to land and water. It is proposed that this directed by the Effluent Discharge Management Plan identified in draft Schedule 1 WAR 1202258, Condition 6.

39. The discharge regime proposed is conservative in its design. Specifically, the amount and rate of discharge to the river during stages 1b and 2a is determined based on the discharge causing no detectable change to dissolved reactive phosphorus following mixing in the Ruamahanga River. There may be a greater capacity to sustainably discharge wastewater to the River. However at the time of the discharge regime design there was uncertainty regarding the future impact of upstream point source discharges (Masterton WWTP, Carterton WWTP) on water quality. As a result the conservative option was adopted, whereby no detectable change in dissolved reactive phosphorus in the river would occur due to the Martinborough discharge.

40. Schedule 2, Condition 2 b) lists the step-wise rate of discharge to water adopted for Stages 1b and 2a. The rates given result in a minimum dilution ratio of 2266 times. This dilution ratio is substantially wider than achieved for many consented wastewater discharges to river

operated in New Zealand and so would be considered well within the bounds of good practice.

41. An additional source of conservatism was adopted for the discharge to land at Pain Farm (Stages 2a and 2b). Limited site specific data was available regarding the groundwater and surface water at Pain Farm. As a result the concept of the irrigation regime design was to apply the wastewater in a manner which would result in the minimum interaction with groundwater and surface water. This was achieved by:

- adopting a rate of discharge that will not result in saturation of the soil due to irrigation;
- adopting a per event discharge depth which is 10 % of the daily volume that can be transmitted through the unsaturated soil of the site;
- Discharging only when there is a soil moisture deficit; and
- Ensuring sufficient land is available to receive the annual wastewater volume from Martinborough.

42. Incorporation of conservatism into the design is intended to:

- Add certainty that the effects to the receiving environment will be no more than predicted; and
- Add certainty that the resources required to achieve the proposed programme have not been underestimated.

43. Key data from the water balance and regime design on which the assessment of effects of land discharge of treated wastewater relies includes:

- Maximum application per event of 15 mm/d for MWWTP site and 9 mm/d for Pain Farm site. For both sites, the irrigation will be applied at a rate not exceeding 4 mm/h;
- For an average rainfall year the annual depth of wastewater applied is:
  - 995 mm/y for the MWWTP adjacent site;

- 155 mm/y for Stage 2a at Pain Farm (low for an irrigated site due to a lack of available wastewater in storage late in summer); and
- 370 mm/y for Stage 2b at Pain Farm.

- At these application depths the water draining from the soil in excess of that which would occur naturally is:
  - 840 mm/y, a 170 % increase, for the MWWTP adjacent site;
  - 76 mm/y, a 16 % increase, for Stage 2a at Pain Farm;
  - 272 mm/y, a 60 % increase, for Stage 2b at Pain Farm; and
  - Drainage can be reduced by altering the soil moisture criteria to start land application.
- An average annual application of nitrogen and phosphorus from wastewater of:
  - 267 kg N/ha/y and 61 kg P/ha/y for the MWWTP adjacent site;
  - 48 kg N/ha/y and 11 kg P/ha/y for Stage 2a at Pain Farm; and
  - 113 kg N/ha/y and 26 kg P/ha/y for Stage 2b at Pain Farm.

44. The results of the water balance are limited by the reliability and length of the data inputs. Prior to the detailed design phase further refinement of the outputs given in the table above will be undertaken. Due to uncertainty in the input data a conservative approach has been taken. The conservative approach is likely to result in an overestimation of effect causing outputs. Refinement of the water balance is expected to result in lower output values.

MARTINBOROUGH LAND TREATMENT SYSTEM (STAGES 1b, 2a and 2b)

Design of Loading and Drainage Rates

45. An important issue for understanding irrigation regimes is the difference between a deficit irrigation regime and a non-deficit irrigation regime.

46. Deficit irrigation is the application of water at a rate that does not cause drainage to occur immediately following irrigation stopping. Water is applied at effectively the same rate as it can be used by plants. This approach is typically used for clean water irrigation on farms, as there tends to be limits on the amount of water that is allowed or able to be extracted and it is considered a waste to apply more than the plants need to maximise growth.

47. However, for wastewater irrigation the outcome sought is often different, where a land treatment scheme typically has the objective of sustainably discharging the wastewater at a rate that does not result in significant adverse effects. This means that irrigation **can** result in drainage, with more water being applied than plants can use. The key requirement however, is to avoid over irrigation and poor treatment of the wastewater as it passes through the soil.

48. A non-deficit irrigation approach can adopt a deferred irrigation component whereby, if the soils are excessively wet then storage is used to defer irrigation to a later time when irrigation is possible. This is to avoid excessive drainage, poor nutrient removal and unacceptable effects.

49. So long as it is well managed, irrigation-induced drainage achieves a sustainable outcome and maximises the ability to discharge treated wastewater to land. Key factors in considering the suitability of irrigation-induced drainage include:

    - the soil type, in particular its texture and structure. The soils of the MWWTP adjacent site are suited to this type of application approach but the soils of Pain Farm are not;

- the depth to a restriction to drainage such as a pan or high groundwater table, and hence the depth of soil available to absorb and treat the treated wastewater irrigated to the land. Near the MWWTP adjacent site groundwater is expected to be greater than 2 m during the irrigation period indicating soil depth is not limiting, whereas at Pain Farm a pan is present within 1 m of the surface and is likely to restrict the discharge; and
- the presence of other drainage systems that may lessen the time of water in the soil for treatment (for example subsurface drains).

50. The proposal for Stage 1b (MWWTP adjacent site) is to adopt a deferred irrigation approach, using storage or river discharge when the soils are too wet.

51. The proposal for Stage 2a and 2b (Pain Farm) is to adopt a deficit irrigation approach, applying wastewater at a rate equivalent to evapotranspirative loss and using storage (Stage 2a and Stage 2b) or river discharge (Stage 2a, only for Stage 2b under exceptional circumstances) when the soils approach field capacity[6].

52. The appropriate loading rates also take into account rainfall events. If the soil is already wet, less treated wastewater can be applied to ensure the maintenance of the soil structure and plant growth and to prevent ponding or preferential overland flow. Therefore, and typically as a result of plant growth, there is a greater ability to apply more wastewater during summer than winter.

53. It is intended that both sites will be planted in perennial pasture for the purpose of cut and carry baleage. The use of cut and carry maximises

[6] Field capacity refers to the soil moisture content at which drainage under gravity ceases from the soil.

the use of applied water and the removal of nutrients. There may be some limited grazing during winter to maintain pasture quality.

EFFECTS OF LAND TREATMENT OF MWWTP WASTEWATER

54. The effects of the discharge to land were assessed by LEI. Key wastewater parameters that may have an effect on receiving environments are nutrients (specifically nitrogen and phosphorus), organic loading (measured by biochemical oxygen demand, BOD), pathogens (estimated from E.coli) and water volume.

55. The receiving environments which may have effects from the discharge are:

    - the soil and plants in the rooting zone and unsaturated zone of the soil;
    - shallow groundwater;
    - surface water; and
    - air.

    Potential effects due to wastewater irrigation in each of these receiving environments is described in the following sections.

Stage 1b (MWWTP adjacent site)

Nutrient Loading

56. For Stage 1b the average loading of nitrogen to the site from wastewater is 267 kg N/ha/yr. It has been proposed that supplementary nitrogen may be applied to the site up to a total from all sources of 300 kg N/ha/y. This is less than the predicted 437 kg N/ha/y uptake for a targeted drymatter (DM) production (grass growth) of 12+ t DM/ha/y, assuming a nitrogen concentration in the pasture of around 3.6 % on a dry weight basis. It is acknowledged that some of this nitrogen deficit will be made up by nitrogen fixing by clover.

57. Despite the nitrogen deficit, limited leaching may still occur due to the function of natural systems (inhomogeneity, rainfall extremes, land management etc). However, the proposed conservative rates will enable a level of confidence that leaching will be minor, and typically will be less than occurs under the surrounding pastoral land use, which is a permitted activity, that receives fertiliser application and animal excreta. As a result the effects are expected to be less than minor on the soil. The impact on ground and surface water is discussed in paragraphs 62-70 below.

58. The discharge contains phosphorus and its application is unlikely to have an adverse effect on the soils of the site. Phosphorus is known to lead to the eutrophication of waterways. However, soil transformation and plant uptake of the applied phosphorus is expected to utilise most applied phosphorus.

59. The application rate of the treated wastewater on the 5.3 ha land treatment area is up to 15 mm/day. The concentration of total phosphorus discharged to land would provide an average input of 323 kg P/y on the 5.3 ha land treatment area over the annual irrigation period, or 61 kg P/ha/y. Phosphorus uptake by plants is in the range of 130-160 kg P/ha/y for NZ ryegrass pasture (Morton et al., 2000) managed as high producing cut and carry for baleage. The applied phosphorus from wastewater is well within the capacity of the plants to utilise, so the effect of phosphorus on the soil and plant system is expected to be no more than minor.

Managing Soil Moisture

60. There is the potential for over-application of water to lead to saturation of the soil, resulting in mechanical damage, erosion, and loss of soil structure. In addition, the occurrence of saturation has the potential to

produce anaerobic conditions, causing plant root damage, encouraging soil blinding and creating odours.

61. Due to the fine sandy texture of the predominant soil within the MWWTP adjacent site application area, the site is not likely to be susceptible to extensive pugging or other mechanical damage, especially as it is to be used as a cut and carry operation. The wastewater application rate has been designed to avoid saturating the soil and causing ponding or run-off. The low application rate planned at 15 mm/d, which when applied over no less than 3 hours, is expected to ensure that the risk of saturation is minimised. The adverse effects of the application of water on the soil will be not greater than minor.

Managing Drainage to Groundwater

62. 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. 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.

63. Some drainage to groundwater in excess of the natural drainage from the site is predicted as shown in the table above. Should this drainage occur it will be after considerable passage through soil (more than 2 m) as irrigation will occur predominantly when river levels are low.

64. Groundwater mounding has been estimated using the method of Hantush (1967). Estimated groundwater mounding under the MWWTP adjacent site is in the order of 0.00044 m. This is considered to be negligible.

65. As described in 20 and 21 above groundwater under the MWWTP site is likely to enter the Ruamahanga River rapidly, and there are considered

to be no other users of groundwater in a down-gradient position. It is considered that any wastewater derived nutrients entering groundwater will have a negligible adverse effect on groundwater.

Effects on the Ruamahanga River

66. The effect of the discharge to land of MWWTP wastewater is positive since the use of land treatment removes direct water discharge during low flow periods when the river is most sensitive to wastewater inputs.

67. Overland flow from the site to adjacent surface water will not occur since the site is separated from the river by a stopbank.

68. Since the discharge to land will occur predominantly during low flow conditions in the Ruamahanga River, any nutrients leached from the site are at risk of entering the Ruamahanga River during low flow conditions.

69. Estimated nitrogen concentration increase in the Ruamahanga River for a worst case scenario of no nitrogen removal in the soil (plant uptake only), mean annual low flow (MALF) conditions in the Ruamahanga River and no dilution in groundwater has been determined as an increase of 0.023 g/m^3 in the river water concentration. Discharge to the river via groundwater under these conditions has been predicted to occur less than 2 % of the time[7]. This instream mixed concentration is well below the GWRC proposed limit of 1.7mg/L for chronic toxicity and ANZECC toxicant limit of 0.7 mg/L for 95% protection level. In reality this scenario is a worst case and the actual discharge to the river is likely to be substantially lower and well below any form of detection.

70. Other contaminants present in the wastewater are expected to be filtered and assimilated into the soil. Pathogens are deactivated by the use of UV in the treatment process. Suspended solids, biochemical oxygen demand and phosphorus are expected to be retained in the soil. In the case of phosphorus, plant uptake will also occur. The effects of

[7] Watts, L. and Perrie, A. 2007. Lower Ruamahanga River instream flow assessment – Stage 1: Instram flow issues report. *Greater Wellington Regional Council Technical Report GW/EMI-G07/135*

these contaminants to discharging to the Ruamahanga River indirectly from the discharge to the MWWTP adjacent site will be negligible.

Stage 2a and 2b (Pain Farm site)

Nutrient Loading

71. For Stage 2a the average loading of nitrogen to the site from wastewater application is 48 kg N/ha/y which rises to 113 kg N/ha/y for Stage 2b. As with Stage 1b, it has been proposed that supplementary nitrogen may be applied to the site up to a total from all sources of 300 kg N/ha/y. This is less than the predicted 437 kg N/ha/y uptake for a targeted drymatter (DM) production (grass growth) of 12 t DM/ha/y, assuming a nitrogen concentration in the pasture of around 3.6 % on a dry weight basis. Some of the deficit will be made up by nitrogen fixing by clover.

72. A key control for leaching of nitrogen from the Pain Farm site is the operation of a deficit irrigation system. This maximises the potential for plant uptake by delivering the nitrogen to plants when they are growing. Further, by applying wastewater under a deficit regime to unsaturated soils the nitrogen applied is more likely to be retained in the rooting zone of the soil and be incorporated into the soil and plant system rather than being leached.

73. As with Stage 1b (MWWTP adjacent site) the proposed conservative rates will enable a level of confidence that leaching will be minor, and typically will be less than occurs under the surrounding land use that receives fertiliser application and animal excreta. For example the proposed loading rate is 48 to 113 kg N/ha/y from wastewater with the potential to add fertiliser up to a total from all sources of 300 kg N/ha/y and dairy farms would typically apply 150 to 300 kg N/ha/y of nitrogen based fertiliser, of which 85 % is returned to the land in concentrated patches of excreta. As a result the effects are expected to be less than minor on the soil. The impact on ground and surface water is discussed in paragraphs 79-87 below.

74. The application rate of the treated wastewater on the 53 ha land treatment area is up to 9 mm/day. The concentration of total phosphorus discharged to land would provide an average input of 580 kg P/y (Stage 2a) to 1,380 kg P/y (Stage 2b) on the 53 ha land treatment area over the annual irrigation period, or 11-26 kg P/ha/y. Phosphorus uptake by plants is in the range of 130-160 kg P/ha/y for NZ ryegrass pasture (Morton et al., 2000) managed as high producing cut and carry for baleage. The applied P from wastewater is well within the capacity of the plants to utilise, so the effect of phosphorus on the soil and plant system is expected to be no more than minor.

Managing soil moisture

75. As described for Stage 1b above, there is the potential for over-application of water to lead to saturation of the soil, resulting in mechanical damage, erosion, and loss of soil structure. In addition, the occurrence of saturation has the potential to produce anaerobic conditions, causing plant root damage, encouraging soil blinding and creating odours.

76. The soil types present over the Pain Farm site have restrictions for drainage due to a soil pan within 1 m of the surface. If wastewater is applied at a rate in excess of the soil's ability to drain then perched water will mound in the subsoil of the site causing soil damage and limitations to site use.

77. To avoid mounding of water in the soil, the use of a deficit irrigation regime is proposed. By supplying water to the site at a rate equivalent to plant uptake the accumulation of water above the soil pan is minimised and mounding is avoided.

78. The wastewater application rate has been designed to avoid saturating the soil and causing ponding or run-off. The low application rate planned at 9 mm/d, which when applied over no less than 2.25 hours, is expected to ensure that the risk of saturation is minimised. The adverse effects of

the application of water on the soil of Pain Farm will be not greater than minor.

Managing Drainage to Groundwater

79. The presence of a pan in the soil of Pain Farm limits the potential for wastewater derived nutrients to travel to groundwater. Water in excess of plant requirements can be expected to perch on the pan and move laterally to nearby surface drainage with only a small fraction percolating through to groundwater located 15-20 m below the site.

Effects on Surface Water

80. The effect to the Ruamahanga River of the discharge to land of MWWTP wastewater to Pain Farm is positive since the use of land treatment removes direct water discharge during low flow periods at Stage 2a and at all flows at Stage 2b.

81. Irrigation of wastewater at a rate equivalent to the soil unsaturated hydraulic conductivity avoids ponding and run-off from the irrigation areas to surface water. The inclusion of a 20 m buffer from surface water avoids direct discharge to surface water from the irrigators.

82. As shown in Annex A, drainage in excess of that which occurs from the site when not irrigated is expected. Based upon a criteria to commence land application if the discharge will not cause the soil moisture to increase to 1 mm below field capacity, the following drainage is predicted. For Stage 2a the estimated average excess drainage is expected to be 76 mm/y. For Stage 2b the estimated average excess drainage is expected to be 272 mm/y. As described in 71 above drainage from the site is expected to mostly be intercepted by the soil pan and move laterally through the soil to surface water flowpaths. The accumulated drainage volume at the point that the west flowing stream leaves the site is expected to have an increased flow of 1.3 L/s at Stage 2a and 4.6 L/s at Stage 2b. This is considered to be minor based on a visual inspection of the stream size. Monitoring of flows in the waterway is needed prior to, and following the commencement of Stage 2a to

enable this assessment to be confirmed. If the monitoring indicates that an increase of 1.3 L/s at Stage 2a and 4.5 L/s at Stage 2b may have an effect that is not minor, then adjusting the soil moisture criteria to 5 mm below field capacity following irrigation will result in a reduction of the excess drainage, and correspondingly, flow to the waterway by around two thirds (this would increase the storage required for both Stage 2A and 2B).

83. The low nitrogen application rate, applied only during conditions which do not favour drainage, ensures that a substantial proportion of applied N will be taken up by plants, sequestered by soil, or volatilised and denitrified.

84. The use of a low rate application will maximise the retention of nitrogen in the soil for plant and microbe uptake. The use of the wastewater storage capacity, initially within the existing treatment system and eventually dedicated storage, provides assurance that the wastewater can be stored if needed and applied in a manner and at a rate which ensures minimal nitrogen leaching. The effect of nitrogen from wastewater on surface water is expected to be less than minor.

85. Where additional nitrogen is applied to meet plant requirements there is an elevated risk of nitrogen being transported to perched groundwater and subsequently surface water. The amount of nitrogen lost can be minimised by adopting best practice for nutrient application (NZFMRA, 2007). The supply of nutrients and water at a rate to meet plant needs will enable confidence that leaching will not be more than occurs under the existing and surrounding land use that receives fertiliser application and return from animal excreta.

86. The nitrogen entering surface waters due to application of wastewater and additional fertiliser is unlikely to be detected over and above the current land use-induced background. The potential for adverse effects due to the discharge is negligible.

87. Other contaminants present in the wastewater are expected to be filtered and assimilated into the soil. Suspended solids, biochemical oxygen demand and phosphorus are expected to be retained in the soil. In the case of phosphorus plant uptake will occur. The effects of these contaminants to surface water from the discharge to the Pain Farm site are negligible.

All Stages – Air Quality and Odour

88. The wastewater for irrigation has a mild musty odour in keeping with odours from the surrounding rural land uses i.e. dairy farming next to the MWWTP adjacent site; and farming on adjacent properties, and the refuse transfer station within the boundaries of the Pain Farm site.

89. 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.

90. Odour is very subjective and different people respond differently however, the measures proposed will minimise any impact on neighbouring properties.

91. Overall it is considered that the odour effects of the project will be minimal and are able to be mitigated to avoid adverse effects.

92. 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.

93. 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.

94. The wastewater to be irrigated is UV treated to deactivate microorganisms. UV treatment provides a method to mitigate risks to human or animal health.

95. The effects of the project due to spray drift are able to be mitigated and in my view will be less than minor.

Summary of Effects due to Land Treatment

96. The proposed loading rate of the wastewater discharge to the MWWTP adjacent site (Stage 1) and to Pain Farm (Stage 2a and 2b) will enable soil remediation and plant uptake of applied contaminants including:

   a. Filtration and incorporation of TSS;

   b. Assimilation of BOD;

   c. Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;

   d. Filtration and attrition of pathogens; and

e. Water application to the MWWTP adjacent site or Pain Farm site will occur at such times and rates as to avoid ponding or run-off.

97. The discharge of municipal wastewater to land is expected to have effects on the receiving soil, shallow groundwater, the Ruamahanga River, and on water quality, habitat values, amenity, community, cultural and heritage values and air quality that are not more than minor. No adverse effect from the discharge has been identified that is more than minor.

RESPONSE TO COUNCIL REPORT

98. I have reviewed the staff report with particular reference to:

- Appendix 8 – Report for GWRC prepared by Dr Olivier Ausseil; and
- Appendix 9 – Report for GWRC prepared by Mr Rob Docherty

99. In general I agree with the report of Dr Ausseil with regard to the discharge regime proposed (Stages 1b and 2a), and the effects due to land treatment.

100. The report of Mr Docherty identifies several queries, comments or concerns to be addressed. A discussion of relevant matters is as follows.

101. Section 1, paragraph 4 states:

- *"The Section 92 response from LEI dated 2 June answers some of the questions, but PDP still has some concerns about the level of detail provided to support the consent application. These concerns can be addressed by taking a conservative approach to analysing the effects and by specifying certain conditions in the consent."*

102. As described in 39-42 above, the design of the discharge regime includes a high degree of conservatism in both the discharge to the river and to the land. My assessment of potential adverse effects has been

undertaken so that, where uncertainty exists in a parameter, the worst case scenario for that parameter has been assessed. As a result the conservative approach suggested by Mr Docherty has been adopted.

103. Section 3.1 discusses groundwater mounding from land application of wastewater during Stage 1b. Mr Docherty notes a discrepancy between PDP estimation and LEI estimation. Mr Docherty concludes groundwater mounding is not a concern for Stage 1b.

104. I agree that groundwater mounding is not likely to be a concern due to the Stage 1b discharge to land.

105. Section 3.2 paragraph 1 states "*The high irrigation rate will cause irrigated effluent to bypass the plant root zone without complete nitrate removal, with the remaining nitrate being then carried into the groundwater.*"

106. With regard to the risk of bypass flow due to irrigation rate, the rate of irrigation and the event irrigation depth have been determined as described in the AEE, Appendix 7, Section 8.5.5. The rate of application adopted, results in no saturation within the soil. Wastewater applied to the soil travels, not by gravity flow, but by matrix potential whereby water is held around the soil particles by surface tension. The result of this approach is that no rapid drainage occurs due to an application event and bypass flow is avoided. Due to the use of a deferred discharge regime as outlined in 48-50 above the wastewater discharge may cause the soils field capacity to be exceeded but does not cause the soil to become saturated, and therefore bypass flow does not occur.

107. This approach maximises the contact of the wastewater with the reactive surfaces of the soil and plant roots and therefore maximises the potential for nitrogen to be retained in the rooting zone of the soil.

108. Bypass flow and nitrate leaching occurs only where rainfall following irrigation causes the soil water to flow under gravity.

109. Section 3.2, paragraph 2 states *"…the specified N input is acceptable. However, due to the ambiguity of the discharged N load, it is recommended that a condition be added requiring preparation of a monitoring plan to ensure that N loads from groundwater discharges caused by land irrigation do not exceed this concentration (or exceed ANZECC limits) during MALF conditions."*

110. I consider that the conservatism used as discussed in 102 above provides sufficient certainty that nitrogen loads from groundwater discharges will be minor and diffuse, and that a net reduction from the current situation will occur, in particular during low flow conditions. I do not consider that groundwater monitoring is needed for Stage 1b.

111. Section 4.1 recommends a Condition should be required for a Management Plan for Stage 2 land application. I agree that this is necessary and note that a Land Discharge Management Plan is required by Schedule 1, Condition 6. An approval by GWRC is required by Schedule 1, Condition 7.

112. Section 4.2.1 paragraph 1 discusses groundwater mounding during Stage 2. The report states *"The deficit irrigation model is designed to minimise the amount of additional groundwater escaping from the irrigated area, but the scheme will cause saturation of the soil zone prior to rainfall events, potentially reducing the amount of rainfall which can be absorbed by the soil zone, increasing the input to groundwater."*

113. It is important to note that as described in 106 above, saturation of the soil will not occur due to the application of wastewater. Wastewater is applied at a rate which is less than or equivalent to the soils unsaturated

hydraulic conductivity at a matrix potential of -40 kPa. At this rate soil will not become saturated. Due to the use of a deficit irrigation regime, soil will not be irrigated if it is saturated due to preceding rainfall.

114. Additional drainage to that which occurs under the unirrigated site occurs because the irrigation of the site maintains the soil moisture at a higher level so that rainfall will cause the soil to reach field capacity more frequently and therefore drainage, or mounding on the soil pan will occur more frequently than occurs for the irrigated site.

115. The degree of mottling observed in the soil profile of Pain Farm suggests that periods of saturation occur, and that frequent and rapid changes in the depth to saturation occur. I consider this to indicate that the soil of Pain Farm is able to drain, most likely to the stream on the northwest boundary, thereby limiting the depth of a perched water mound on the site.

116. There are a number of sites in the Wairarapa currently receiving irrigation of clean water at rates similar to or higher than is proposed at Pain Farm, and with similar soil and climatic conditions. The success of these operations provide additional reassurance that the discharge regime proposed will not cause effects described in Section 4.2.1 paragraph 2.

117. Section 4.2.2 recommends monitoring of groundwater prior to the commencement of Stage 2a.

118. I agree that the collection of additional groundwater information is appropriate. I recommend that details of the monitoring are included in the Land Discharge Management Plan required by Schedule 1, Condition 6.

119. Section 4.2.3 recommends deep ripping of the Pain Farm soils and additional groundwater monitoring.

120. I consider that the soils of Pain Farm are unlikely to benefit from deep ripping due their texture and structural limitations. I note that Ms Arnesen advises in her report that GWRC's experience with deep ripping is that it is not always beneficial.

121. Section 4.2.4 discusses release of nitrate into groundwater during winter. The report suggests *"The release of N into groundwater can be controlled by preventing irrigation in the post-harvest/winter time period."*

122. I disagree that a limit should be set on irrigation by month or season. The use of a deficit system, relying on plant uptake to allow irrigation, provides a method to ensure discharge only occurs when plants are likely to use the applied water and nitrogen. Limiting the irrigation to seasons or months does not allow for the extension of irrigation during unseasonably dry years, or avoid irrigation during unseasonably wet years. For instance, if climatic conditions allow for more frequent irrigation in May 2012, compared to other May irrigation modelled then it may indicate higher evapotranspiration and lower rainfall, which are conducive to irrigation. It is likely under these conditions that the nitrogen excess which Section 4.2.4 refers to would not exist.

123. An additional mechanism for nitrogen removal is denitrification which can be expected to occur at low levels over the winter due to wet soil conditions (under which no irrigation would occur).

124. Section 4.3 discusses the storage volume required for Stage 2b. The report indicates confusion about the actual storage volume proposed compared to storage volumes given in scenario assessments.

125. For clarification, the volume of 37,400 m^3 as stated in the AEE is proposed for Stage 2b. This value represents the 90th percentile storage volume. To enable the adoption of a 90th percentile storage volume the AEE has proposed that where the storage facility is near capacity and the river conditions allow (flow greater than 3 x median) a discharge to river can occur. Other storage values identified in the report (63,000 m^3 for Pain Farm and MWWTP together, 98,000 m^3 for Pain Farm only) are the volumes required if no discharge to river were allowed i.e. the entire volume was discharged to land. This is not what has been applied for in the consent application and AEE.

RESPONSE TO SUBMISSIONS

126. Submission 2 from Nalini and Colin Baruch, Submission 15 from Patrick and Mary Desbonnets and Submission 16 from Eileen Dawn Procter indicate concern about odour from the wastewater irrigation impacting on their property.

127. A description of the mitigation measures adopted to avoid odour issues is given in 88-91 above. I consider that the risk of odour effects to neighbours, including Mrs and Mr Baruch can be adequately mitigated.

128. Mrs and Mr Baruch also raise a concern about the risk to their (bore) water supply due to leaching from the land discharge area.

129. Mrs and Mr Baruch's property is noted to be in an upgradient location from the site. This means that flow of groundwater from the Pain Farm site is away from the Mrs and Baruch's property. In addition, as described in 79 above water percolating from the site is expected to be intercepted by a soil pan which will prevent most leached material from reaching groundwater.

130. It is also noted that bores in the vicinity of Mrs and Mr Baruch's property are screened at 28-30 m, 21-22 m and 19-20 m suggesting that

groundwater is drawn from depth which is substantially separated from the land surface that will receive the wastewater discharge. I consider that the risk to Mrs and Mr Baruch's water supply from the land discharge is less than minor.

131. Submission 4 from Beverly Joan Clark states a preference for in ground drippers to be used to discharge the wastewater, for the purpose of mitigating air quality.

132. As discussed in 127 above I consider that air quality effects can be adequately mitigated. There are a number of other reasons that sub-surface driplines are not favoured for this situation, including:

- They are more prone to blockage than other methods;
- They are easily damaged by machinery on a cut and carry site;
- Wastewater is discharged near the bottom of the rooting zone resulting in less opportunity for plant uptake and soil remediation of applied wastewater.

133. Submission 7 from Kahungunu ki Wairarapa states that land treatment should not occur on crops intended from human consumption.

134. As indicted in 53 above the planned crop is cut and carry pasture for baleage. In addition, the New Zealand Guidelines for the Utilisation of Sewage Effluent on Land provide guideance as to the accepted practice for discharge. The wastewater produced by MWWTP is not suitable for discharge to crops intended for human consumption and it will not be used for this purpose.

135. Kahungunu ki Wairarapa has sought assurance that technically advanced spray dispensers will be used to avoid spray drift effects.

136. While it is beyond the scope of my evidence to offer any assurance, 92-95 describe the mitigation measures for avoidance of adverse effects due

to spray drift. I consider that if these mitigation measures are adopted effects due to spray will be no more than minor.

137. Submission 8 from Mahaki Trustees Ltd and Hikinui Trustees express concern that run-off and groundwater contamination will occur as a consequence of Stage 2.

138. The avoidance of run-off and groundwater contamination is a key criteria for the irrigation regime design. 78 above discusses the avoidance of run-off. 71-79 outline how groundwater contamination is avoided and further technical discussion is given in 106 and 113 above. I consider that run-off and groundwater leaching at Pain Farm can be adequately avoided or mitigated.

139. Submission 11 from Regional Public Health indicates that they are satisfied the effluent irrigation setback distances are sufficient to manage cross boundary aerosol effects.

140. The support of Regional Public Health with regard to setback distances is acknowledged.

SUITABILITY OF CONDITIONS

141. In general I agree with the conditions proposed for operation of Consent WAR120258. My comments are as follows.

142. Schedule 2, Condition 3 gives performance standards for the wastewater quality. It is noted the proposed values correspond to median values achieved by SWDC. However, the condition wording suggests they are 75th percentile values. The assessment of effects has relied on these values as median values. I recommend the condition wording is amended to reflect these values should not be exceeded in more than 6 out of 12 samples.

143. Schedule 4, Condition 1 includes limits to the daily discharge volumes. The daily limits are intended to reflect the daily application depths. These are given in Condition 2 and it is recommended that Condition 1 is removed. If Condition 1 is retained then it should be adjusted as follows. b) corresponds to the pumping limit of the discharge to the river. However the capacity for discharge to land for Stage 2 is 4,770 m3/day (9 mm/day). I recommend that b) is changed to 4,770 m^3 to reflect the capability of the receiving environment, rather than the limitation of existing infrastructure.

144. Schedule 4, Condition 2 b) includes the phrase *"when there is a corresponding soil moisture deficit"*. I consider that this phrase is ambiguous. I recommend that additional text such as "to be determined in accordance with the Land Discharge Management Plan" is added or that this condition is superseded by the Management Plan.

145. Schedule 4, Condition 6 b) states:

"b) Avoid the discharge of wastewater to land within 125m of the property boundary, except that wastewater may be discharged to land within 25m from the property boundary where:

(i) median E.coli. concentrations are less than 100cfu/100ml; and

(ii) irrigation is at low pressure (less than 1.4 bar); and,

(iii) the irrigation boom does not exceed 1.52m from ground level <u>and</u> does not incorporate an "end gun";

(iv) *wind speed does not exceed 12m/s (or 4m/s sustained for a period of 15 minutes or more) in a direction toward an existing dwelling (at the time of commencement of this consent) on an adjoining site within 300m of the irrigation area"*

146. These parameters are dealt with in the Wairarapa Combined District Plan Rule 4.5.2 (m) and can be controlled by this rule. I consider there is no need for these parameters to be included in Schedule 4.

147. Schedule 4 includes monitoring related to the discharge to land. I recommend the inclusion of a requirement to collect monitoring data for

the unnamed stream at Pain Farm. A condition may include "No later than 12 months prior to commencing the discharge to Pain Farm Stage 2A, the permit holder must undertake surface water monitoring of the unnamed stream identified on [Plan to be determined] in accordance with the Environmental Monitoring Plan".

CONCLUSIONS

148. A robust, technically based land treatment system has been developed to acknowledge site limitations and minimise offsite effects for each of the Stages 1b and 2a/2b.

149. Where uncertainty over a parameter exists the adoption of worst case scenario for that parameter assists to provide certainty that the effects identified can be achieved.

150. Subject to the amended conditions of consent that have been proposed, I consider that overall, there are no effects from the land treatment of wastewater from MWWTP at Stages 1b, 2a or 2b which are more than minor.

Date: 17 April 2015

Signed:

ANNEX A: Summary of Water Balance Inputs and Outputs

Parameter	Average Year*			
	Stage 1A – No Land Application	**Stage 1B – MWWTP Adjacent**	**Stage 2A – Pain Farm no storage**	**Stage 2B – Pain farm with storage**
Land Application				
Design Criteria:				
Irrigable area (ha)	0	5.3	53	53
Limiting parameter		Nutrient to Groundwater	Hydraulic	Hydraulic
Soil moisture trigger to allow application		5mm above FC after application	1mm below FC after application	1mm below FC after application
Average daily application rate over the year (mm/d)		2.7	0.4	1.0
Maximum application per event (mm/d)		15	9	9
Maximum application per event – June, July, August (mm/d)		0	9	9
Outputs:				
Yearly application depth (mm/y)		995	155	370
Yearly application volume (m3/y)		52,731	93,208	222,374
Natural Drainage (mm/y)		497	459	459
Drainage in excess of natural (mm/y)		840	76	272
Average yearly # application passes (#/y)		66	17	42
N applied (kg N/ha/y)		267	48	113
P applied (kg P/ha/y)		61	11	26
Plant uptake N/P (kg N/ha/yr)			300/40	
Soil retention N/P (kg N/ha/y)			0/108	
Na applied (kg Na/ha/y)		995	155	370
Additional Storage				
Storage volume 90th%ile (m^3)		N/A	3,700	37,400
River Discharge				
Design Criteria:				
River Cut-off	All Flows	HMF**	HMF	FRE3†
Nutrient Loading Limit		DRP Detection Limit – 0.002mg/L		NH_4-N toxicity
Outputs:				
Volume to river, HMF – 20FEP (m^3/y)		131,194	120,797	0
Volume to river, >20FEP (m^3/y)		37,977	8,374	Only when required to manage pond storage
Total Volume to river (m^3/y)	221,920	169,171	129,171	0
Days of river discharge (#/y)	365	247	212	0
N load (kg/y)	6,009	4,580	3,497	0
P load (kg/y)	1,359	1,036	791	0

*Average year for the period that data was available

** HMF = half median flow

† FRE3 = 3 times median flow