BEFORE THE TARANAKI REGIONAL COUNCIL

IN THE MATTER	of an application by Remediation (NZ) Limited for resource consents under Part 5 of the Resource Management Act 1991
AND	
IN THE MATTER	applications to obtain replacement consents for Consent Numbers 5838-2.2 and 5839-2 as summarised below: Consent 5838-2.2 – to discharge of a) waste material to land for composting; and b) treated stormwater and leachate, from composting operations; onto and into land in circumstances where contaminants may enter water in Haehanga Stream catchment and directly into an unnamed tributary of the Haehanga Stream at Grid Reference (NZTM) 1731656E-5686190N, 1733127E-5684809N, 1732277E-568510N, 1732658E-5684545N and 1732056E-5684927N Consent 5839-2 – to discharge emissions into the air, namely odour and dust, from composting operations between (NZTM) 1731704E-5685796N, 1733127E-5684809N, 1732277E-5685101N, 1732451E-5684624N and 1732056E-5684927N

STATEMENT OF EVIDENCE OF
Colin Kay
DATED 09 March 2021

Environmental Consultancy:

Landpro Limited
57 Vivian Street
New Plymouth 9342
Attention: Kathryn Hooper
Tel: 027 759 2044
Email: kathryn@landpro.co.nz

Counsel acting:

John Maassen
BARRISTER

john@johnmaassen.com
johnmaassen.com
04 914 1050
04 473 3179

Introduction

1. My name is Colin Kay. I am an Agricultural Consultant trading as Kay Consulting Ltd

2. I have the following relevant qualifications:

   a. Bachelor of Agricultural Science

   b. Advanced level Certificate in Sustainable Nutrient Management

   c. Certified Nutrient Management Advisor

   d. Certificate of Accreditation in Farm Dairy Effluent System Design

   e. Certified Farm Dairy Warrant of Fitness Assessor

   f. Quality System Auditor (ISO 9001:2008)

3. In the course of my work, I have obtained experience in:

   a. Irrigation design and management (Water and Farm Dairy Effluent)

   b. Nutrient Management

   c. Resource Management

   d. Integrated Management Systems (ISO 9001)

4. This evidence is given in support of the land use applications lodged by Remediation New Zealand Limited ("RNZ") Limited for consents to discharge contaminants to land, air and water at 1460 Mokau Road, Uruti.

5. I am authorised to give this evidence on behalf of RNZ.

6. I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note 2014, and I agree to comply with it as if this hearing was before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider

material facts known to me that might alter or detract from the opinions expressed.

Background and Role

7. I was engaged by Remediation (NZ) Ltd in March 2018 and my scope of work included:

    a. Development of an Integrated Management System which involved a review of existing and the development of new Management Plans in the ISO 14001 format for the operation and management of the Uruti site.

    b. Review the existing Irrigation System, develop an Irrigation Block Management Plan and Standard Operating Procedures.

    c. Develop an Environment Monitoring Plan to provide the methodology and procedures to ensure the monitoring of the environment of the Uruti site is accurate, carried out in a timely manner, and provides assurance that the site is operated within consent conditions

    d. Provide expert advice in response to requests for further information from the TRC.

8. I have visited the site on numerous occasions since March 2018, and also reviewed the material produced with the Applications, including the Revised AEE dated 26 June 2020.

Scope of Evidence

9. The purpose of my evidence is to:

    a. Provide details on the nutrient modelling I have undertaken for the site using OVERSEER®, including the assumptions in this modelling, and the limitations of the use of OVERSEER® in this context.

b. Describe the land treatment system and the assumptions made during the process of developing the Irrigation Block Management Plan

c. Describe the waste streams, environmental monitoring program, key analytes and results of monitoring;

d. Detail the changes to site management that have occurred and/or are proposed as a result of my review of the irrigation system, and the development of the overall integrated management system.

10. I also respond to the Officers Report from the Taranaki Regional Council (**TRC**) and the submissions.

11. My evidence is structured as follows:

(a) Describe the waste streams entering the composting area

(b) Describe the key analytes captured and contained in the irrigation pond as a result of the composting process

(c) Describe the land treatment process

(d) Describe the environmental monitoring program to monitor the effects of the land treatment process on the receiving environment, being soil, ground water and surface water

(e) Describe Overseer modelling including its limitations, why Overseer was selected to model nitrogen losses from the irrigation blocks, and review the modelling results

(f) Outline changes to management and operation of the Uruti site

(g) Outline future changes;

(h) Review the quality of ground water and surface water leaving the Uruti site;

(i) Response to Submissions;

(j) Response to Officer’s Report; and

(k) Proposed Conditions.

12. I have read the evidence prepared by the other witnesses presenting evidence on behalf of RNZ and have relied on such evidence in preparing this brief. I have also read the submissions lodged, and the Officers Report prepared by the TRC.

Summary of Evidence

13. The key issues related to the nutrient losses from this site, in my opinion are:

   a. Nitrogen and Chloride have been identified by the TRC as two nutrients that have the potential to contaminate the soils and water on the site.

   b. Site management plans have been developed and site practices have been improved or altered so to adequately manage the effects of the discharges of both Nitrogen and Chloride.

14. My evidence has assessed the relevant matters that I am aware of in relation to the Application and including the proposed modifications recommended in the application, I conclude that the site has been engineered to capture all the contaminants from the site and the land treatment system is capable of treating the site runoff to a standard where the effects on the environment, including N losses, are negligible. A review of monitoring data against current consent limits has shown that any breaches of consent can be attributed to ‘one-off’ management issues leading to discharge events, as opposed to systemic and long running discharges or leaching.

Waste streams entering the composting area

15. Waste products entering the site can be broadly categorised into three headings: organic waste, wastewater and drilling fluids from hydrocarbon exploration and green vegetative wastes.

16. The delivery of wastewater and drilling fluids from hydrocarbon exploration to the Uruti site ceased on 31st December 2020. These products have been incorporated into the composting pile and the stormwater runoff from the pile will need to be processed through the land treatment process until the compost has matured.

17. My evidence will be restricted to Pads 1 & 3, with Pad 2 receiving only paunch, and managed via vermiculture as opposed to composting.

18. I don't plan to describe the composting process as this is covered in other evidence except to say that a well-managed composting operation should produce little or no leachate and the only liquids leaving the composting pads should be stormwater runoff from the composting piles and the operating area including tracks and the truck wash.

19. Both Pads 1 & 3 and the operational areas are engineered so that all stormwater that falls on these areas is captured and diverted into the irrigation pond.

20. As described in the previous paragraph all the contaminated wastewater is contained in the irrigation pond. Once in the pond it is subjected to mechanical aeration to help reduce the nitrogen levels through volatilisation and evaporation. The remaining liquid is irrigated onto the irrigation blocks.

21. The irrigation process and management is covered in section 4.4 of the Leachate and Stormwater Management Plan which can be seen in Appendix F1 of the application, and is included as '**Attachment A'** of my evidence for ease of reference. In summary;

    a. The wastewater is pumped from the pond and discharged to land (the irrigation areas) via irrigators.

    b. The volume of wastewater irrigated is calculated to ensure that the soil is not over-irrigated. This is achieved by limiting the volume pumped and rotating irrigation areas.

    c. The soil in the different irrigation areas is well understood, and irrigation is managed accordingly.

d. Irrigation occurs at a frequency which ensures there is sufficient free-board (i.e. pond storage capacity) within the pond to ensure that the system can contain the volumes anticipated within the following weeks rainfall. See section 4.4.11 of Attachment A. At all times, sufficient freeboard is maintained within the pond to ensure there is capacity for a 60 minute long 1 in 10 year storm event. This is detailed in section 2.8.2 of the application for consent.

22. The nutrients from the irrigation process are absorbed into the soil and are subjected to a number of biological processes, including take up by plants. By ensuring the irrigation rate and volume is well managed, these processes ensure environmental effects are minimised.

23. The irrigation blocks could be better described as a land treatment system where the nutrients in the irrigation fluid are subjected to a number of biological (e.g. soil micro-organisms and uptake of nutrients by plants) and mechanical (e.g. pasture hay which is discussed further below in paragraph 24) processes designed to process the nutrients into forms that minimise or mitigate the effects on the receiving environment. The receiving environment in this case is the soil in the irrigation blocks, the underlying ground water and the surface water in the Haehanga Stream.

24. The key potential contaminants discharged to land that the TRC have identified as being a concern and which are subject to consent conditions are , chloride, and hydrocarbons. This is referred to in Table 4: Three Tier Framework for soil quality in the irrigation blocks in the '*Uruti Site Sampling Results Commentary'* a copy can be found in '**Attachment B**'.

25. The TRC requested further information on the fate of Nitrogen applied to the irrigation blocks as part of the application. In September 2019 AECOM produced a report entitled '*Uruti Composting Facility: Nitrogen Balance'* and in February 2020 Kay Consulting expanding upon the AECOM report in a report intitled *'Irrigation block Nitrogen Balance Analysis'*. In December 2020 the Kay Consulting report was rewritten to include Nitrogen balance across the total farm.

The findings of these reports are discussed below.

Soil Inorganic Nitrogen

26. Inorganic nitrogen could flow overland into surface water and in the form of nitrate can leach from the soil into ground water.

    a. Soil inorganic nitrogen in the form of nitrate and ammonium is readily absorbed by plants and through a process of denitrification is converted to nitrogen gas which is lost to the atmosphere. If there is excess nitrate in the soil (i.e. in greater quantities than the plant can uptake) it is likely to leach down the soil profile into ground water.

    b. Nitrogen is also removed from the irrigation blocks by harvesting the plants as pasture hay, thus removing Nitrogen from the localised Nitrogen cycle.

    c. Pasture can contain between 0.8% N for poor hay to 3.2% N for good quality hay and this can be removed off site through what is described as "cut and carry".

    d. The fate of nitrogen at this site has been modelled in OVERSEER® and the results of modelling and discussion of these results was provided in the Irrigation Block Nitrogen Analysis report provided as Appendix AA of the application. I have updated this report to include more detailed 'whole farm' analysis of N losses, and this updated version is provided as '**Attachment C'**. The OVERSEER® modelling is discussed further in paragraph 32..

Chloride

27. Chloride could flow overland into surface water and if present in the soil in sufficiently high concentrations result in contaminated soil and possibly leach into ground water.

    a. Plants take up chloride as Cl- ion from soil solution. It plays some important roles in plants, including in photosynthesis, osmotic adjustment and suppression of plant disease. However, in high concentrations,

b. chloride can cause toxicity problems in crops and reduce the yield.

c. High concentrations of chloride can also kill some microbes in soil.

d. The CI- anion is not adsorbed on soil particles at neutral and alkaline pH values, and therefore is easily leached.

28. Chloride soil sampling results are also assessed against the three-tier management framework detailed in the *"Uruti Composting Facility Site Management Plan",* provided as Appendix H of the consent application and prepared under the conditions of current consents. The sampling results show a flat trend with results in the lower levels of the framework. Because of the change in the laboratory test in June 2018 these results may not relate exactly to the figures in the three-tier framework. RNZ have formed the view that if Chloride sampling levels show an increasing trend, they will initiate further investigations. With the removal of hydrocarbons from the waste acceptance list I would expect to see a decline in soil chloride levels over time.

Hydrocarbons

29. Like Chloride, hydrocarbons could flow overland into surface water and if present in the soil in sufficiently high concentrations result in contaminated soil and possibly leach into ground water.

a. Hydrocarbon contamination in soils may be toxic to plants and soil microorganisms and act as a source of groundwater contamination.

b. At lower levels of soil contamination, soil microorganism will naturally degrade hydrocarbons.

30. Nitrogen concentrations in the irrigation fluid

The overseer modelling used a nitrogen concentration of 225 g/m3 which was the average concentration sampled between 2014 and 2019. The Officers report uses the 2019/2020 sampling concentration of 440 g/m3 and in paragraph 260 state: "Therefore the calculations provided by RNZ are extremely conservative, if not a completely unrealistic assessment of the effects of nitrogen". In the defence of using the 225 g/m3 concentration I make the following points:

A) The amount a nitrogen applied to the irrigation fields is a combination of the nitrogen concentration in the irrigation pond and the volume of fluid irrigated. In summer there is less rainfall and the evaporation from the pond is high leading to less volume pumped and a higher nitrogen concentration in the pond fluid. Conversely in winter the opposite applies. To show the dangers of using short term averages I have prepared a table shown below. I have selected two sampling dates in the 2018/2019 year, one in winter and one in summer to calculate the total nitrogen applied in the months of the sampling.

Sampling date	Ammoniacal nitrogen concentration g/m3	Volume of irrigation discharged in the month of the sampling	Total amount of nitrogen applied Kg
28/8/2018	200	2,775	555.0
22/2/2019	590	930	548.7
Average	395	1,852.5	731

By multiplying the nitrogen concentration by the volume irrigated the total nitrogen applied to the irrigation fields in both samples are similar. When the two samples are averaged the total nitrogen applied is calculated at 731 kg or a 33% increase.

B) The season (summer or winter) the samplings are collected can influence the concentrations recorded. The table shown below shows the number of summer and winter sampling dates:

Sampling year	Total number of sampling events	Number of Summer samplings	Number of winter samplings
2017/2018	4	3	1
2018/2019	4	3	1
2019/2020	3	2	1

By simply averaging the sampling results without accounting for the dilution effects of rainfall and evaporation is likely to distort the concentration figure.

C) The nitrogen concentration values have risen in part due to the decision to use the liquid pond to store the organic material before incorporating it into the compost pile. This had the unintended consequence of releasing nitrogen from the decomposing organic material. It is proposed that this practice will stop, and the material will be stored on pad 1. This change of site practice will likely reduce the amount of nitrogen entering the irrigation pond and therefore the nitrogen concentration is expected to reduce.

31. Monitoring of these potential contaminants, among others, has been undertaken at this site for a number of years and these results are discussed in paragraph 38 below.

32. Soil monitoring commenced in May 2014 for areas J, H and G (being the original irrigation areas). In June 2018 there was a change in the Laboratory analysing the samples which involved a new test for six of the analytes monitored. The graphs in the soil sampling sections (Item 5 in the Graphics and Data bundle) show sampling results from June 2018.

33. Total Hydrocarbon (TPH) soil sampling results are assessed against the three-tier framework as shown in Table 4 of the '*Uruti Site Sampling Results Commentary*' and a copy is provided in Attachment B. The framework states that when TPH levels reach 20,000mg/kg soil remediation measures (these are outlined in the *"Uruti Composting Facility Site Management Plan",* provided as Appendix H of the consent application and prepared under the conditions of current consents) are to be initiated.

34. TPH sampling results in areas L2 and L3 (E, J and H being the older irrigation blocks) range from 82mg/kg to 300mg/kg. This would indicate that TPH's in the irrigation fluid is not affecting the soil quality in the irrigation blocks.

Environmental monitoring Program

35. The Uruti site monitoring program uses monitoring data collected during regular sampling carried out by the TRC of surface water, ground water and soils of the irrigation blocks.

36. Surface water sampling results date back to 2011, ground water sampling 2011 and soil sampling results started in 2014.

37. The sampling data is entered onto spreadsheets. The results are graphed, and these were provided as Appendix X to the consent application. I have updated these recently to include data to August 2020, and the updated versions have been provided as Item 5 of the data and graphics bundle provided to the commissioners.

38. A report titled '*Uruti Site Sampling Results Commentary*' is produced for internal use, which provides commentary on the sampling results and explanations on any deviations from normal to keep site and company management informed on the environmental monitoring program. A copy of the latest report is provided in Attachment B and includes monitoring up to December 2020.

39. If any sampling results show a negative trend, then further monitoring is carried out by RNZ staff.

40. The commentary reporting, and the regular graphing of results enables any areas of concern to be identified, investigated and rectified. It also is the key source of information which informs the three tier management system that is in use at the site. To provide examples of how these results are used;

    a. A spike in Ammoniacal Nitrogen levels detected in the wetland discharge in August 2020 was unexpected. There were no obvious changes in operations that are thought to have led to the elevated levels, and potential further causes are currently being investigated.

    b. A spike in chloride, ammoniacal nitrogen and un-ionised ammonia detected in surface water on 22 February 2019. This was attributed to an issue with one of the pond bunds. It was the subject of an abatement notice issued by the TRC, remedied, and subsequent monitoring indicates that this remedial work has been effective.

OVERSEER® modelling

41. The TRC requested further information on the fate of nitrogen produced from the composting operation which was applied as irrigation and as a soil conditioner onto the irrigation blocks.

42. OVERSEER® was chosen as the most appropriate tool to model the fate of nitrogen as it is widely used throughout New Zealand and it would allow us to make broad comparisons to other farming operations.

43. The OVERSEER® modelling report titled *"Irrigation Block Nitrogen Balance Analysis"* was provided as Appendix AA of the original application and an updated version of this report is provided as Attachment B.

44. The changes made since the report submitted with the original application are;

    a. Modelling of the whole farm has been completed on a more detailed basis, rather than assumed.

    b. The number of input variables have been reduced and simplified. This allows the model to focus on the effects of changing a limited number of land use changes.

45. As confirmed in the report in Attachment B, before any compost is applied, the OVERSEER® modelling showed the total nitrogen leaching from the root zone as follows.

Total Nitrogen leached from the farm blocks		Kg N/ha/yr
Upper Irrigation Area	5.12 ha	77
Upper Irrigation Area	8.06 ha	79
Total farm	641 ha	7

46. The modelling showed the irrigation blocks leached from the root zone on average 78 Kg N/ha/yr and the whole farm which includes the cattle grazing, wetland and forest areas leached 7 KgN/ha/yr.

47. As a comparison, well managed dairy farms in Taranaki can leach between a range of 45 and 80 Kg N/ha/yr and this will depend on the amount of imported feed and the amount of nitrogen fertiliser used.

48. Two additional scenarios were also modelled to assess the potential impact of applying 1000 m^3 and 2000 m^3 compost over the irrigation areas as a soil conditioner. The results of this modelling are included in Table 22 in the report in Attachment C.

49. Also included in the report in Attachment C are the results of similar OVERSEER® modelling undertaken by AECOM for the 2018 actual scenario, the 2019 scenario and a best-case scenario. This modelling led to the management changes initiated on site to reduce N losses, and which have been incorporated into the modelling I have undertaken. The report by AECOM was provided with the application for consent (Appendix Z) and summarises that under their modelled scenarios the N losses from the site irrigation were 4,470 kg for the 2018 scenario, 3563kg for the 2019 scenario and 1269 kg for their 'best case' scenario. This equated to 1,397 kg/N/ha/year, 509 kg/N/ha/year and 120 kg/N/ha/year respectively. It should be noted that in scenario 2018, the irrigation block was 3.2 ha, scenario 2019 7.0 ha and scenario best case was 10.5 ha.

50. From this I make two observations: the first is that the scenarios I have modelled which include measures that respond to the concerns raised in the AECOM report, have resulted in N losses consistent with their best case modelling scenario. Secondly, the modelling of the 2018 'scenario' needs to be considered when reviewing the results of NH_3 and NH_4 monitoring that has occurred - i.e. up until 2018, the results were from a system that was, according to the modelling, leaching up to 1,397 N/ha/year into groundwater. Under a system that is modelled to be leaching 1/18th of this amount, it could be expected that results would be improved, however even under this scenario, the monitoring does not raise any significant concerns relating to ongoing, systemic leaching. The monitoring results are discussed in more detail by Mr Easton and Ms

Hooper in their evidence, and I touch on this briefly again from paragraph 51 below.

51. It is my opinion that the land application of the wastewater undertaken under the management controls that are in place is appropriate and able to occur without significant N losses. I also consider that application of compost to the irrigation areas will enhance the soil and improve plant growth and ultimately reduce the potential for N leaching. I therefore recommend applying compost to the irrigation areas. Modelling clearly shows that this will increase the potential (i.e. modelled) N losses from the irrigation blocks however ultimately there are a large number of variables that will dictate how much compost would be appropriate. Ms Hooper will discuss how flexibility for compost application could be incorporated within the consent within a planning context in her evidence, so that the benefits of compost application can be gained.

Limitations of the Overseer Model

52 OVERSEER® is a relative model in that it uses long-term annualised average data (climate, rainfall, pasture growth). Relative modelling will set-up a base farm and run different scenarios to compare different land use options or changes to the variables (i.e. irrigation block size, nitrogen concentration in the irrigation fluid) to the base farm.

53 OVERSEER® cannot be used to produce absolute outputs using specified inputs. For example, OVERSEER® cannot model the amount of nitrogen leached in a drought year verses a high rainfall year.

Outline changes to the operation of the Uruti site

54 the past three years I have observed a number of changes to the operation of the site. These include;

a. Increasing the size of the irrigation area from 5.3 ha in 2018 to 13.18 ha under irrigation today;

b. Increased understanding of the different soil types across the irrigation blocks and changing the irrigation plan to suit each soil type (i.e. high and low risk soils);

c. Purchase of a low application rate irrigator which allowed for an increase in the number of safe irrigation periods in winter and spring without causing surface runoff or soil drainage;

d. Changes to the way material is received at the site so that nutrients are not directly introduced to the irrigation pond if this is not necessary;

e. Introduction of the cut and carry of hay from the irrigation blocks. This removes significant amounts of nitrogen from the irrigation blocks and keeps the pasture in an optimum growing phase which allows the pasture to maximise the uptake of nutrients including nitrogen, and;

f. Replanting raupo plants in the wetland. This was in response to spikes in nitrogen in the wetland discharge identified in the regular sampling. After the plantings there were no spikes in the discharge for two years until the latest sampling results showed a spike which is unexplained. The site management are seeking advice from a wetland expert.

Outline future changes to the site operation

52. Site operations continue to evolve in response to concerns and consistent with the applicants desire to create a fully sustainable operation. These include;

a. Stopping the importation of the hydrocarbon waste onto the site. This will eliminate hydrocarbons and chloride entering the irrigation pond from the receiving pond and over time as the compost pile matures both hydrocarbons and chloride will reduce to little or negligible levels in the irrigation fluid;

b. Removing any provision for the receipt of biosolids from municipal sludge;

c. Completion of riparian fencing and planting, and;

d. Planting of the areas of the farm that are not used for the composting facility or already in native bush in a combination of indigenous or native forest.

53. In my opinion, these future site changes will further assist in the reduction of potential N losses, and overall improvement in soil and water quality.

Review the quality of the ground water and surface water leaving the Uruti site.

54. Results of monitoring of ground water leaving the site are discussed below.

55. Overseer calculates that 1,025 kg of nitrogen at a rate of 78 kgN/ha/year leaches from the root zone of the irrigation blocks. Overseer cannot model the fate of that nitrogen after it has left the root zone, and this is explained in section 4.11 of the '*Irrigation Block Nitrogen Balance Analysis'* attached in Attachment C. As discussed in paragraphs 49 and 50 above, modelling of the site under the 'current' scenario at 2018 indicated that up to 4,470 kg of nitrogen leached at a rate of 1,397 kg/N/ha/year was potentially being leached from the site up until this time.

56. Ground water leaving the Uruti site is monitored in monitoring bore GND 3007 which is located near state highway 3. A comparison of the ground water entering the site and ground water leaving the site is shown in table 12 of the '*Irrigation Block Nitrogen Balance Analysis'* attached as Attachment C. A general trend in a reduction of both NH_4 and NH_3 since 2018 can be observed.

57. Table 12 in Attachment B shows the differences in the levels of 6 analytes sampled in the monitoring bores representing groundwater entering and leaving the Uruti site. The monitoring results show that 5 of the 6 analytes improved and the sixth, ammoniacal nitrogen, decreased in quality as ground water left the site.

58. The commentary associated with Table 12 in Attachment B noted that the first sampling event occurred in April 2018 shortly after the bore GND 3007 was constructed. The first sampling event (April 2018) showed a high level

of Ammoniacal Nitrogen in ground water and the four subsequent samplings showed lower results. This could indicate that ground water around bore GND 3007 had been contaminated by the installation of the bore during that sampling event.

59. If the April 2018 sampling results are removed from the study, table 12 would show that based on the 6 analytes monitored, the operation of the site including the composting operation is not degrading/not having a detrimental effect on the ground water quality.

Surface water leaving the site

60. Surface water leaving the Uruti site is monitored at the monitoring site HHG 190 which is upstream stream of the State Highway 3 bridge. The monitoring programme records sampling results back to February 2011 and this monitoring site has been sampled 55 times.

61. Resource Consent 5838-2.2 contains two conditions that relate to surface water quality.

62. As well as complying to the conditions in the resource consent the surface water quality must also comply with the rules set out on the Regional Freshwater Plan for Taranaki (RFWP) and the National Objectives Framework (NOF).

63. A summary of those conditions and rules are out lined in Table 1 of the *Uruti site Sampling results commentary* attached in Attachment C.

64. As a general observation I can conclude that the surface water leaving the Uruti site is typical of a Taranaki hill country pastoral agricultural site and I agree with paragraph 114 of the TRC officers report that 'The topography and geology creates an erosive-type environment that naturally generates a sediment load within the watercourses, especially during heavy rainfall events'.65 However it is of concern that in the 55 sampling events there have been two events where chloride levels breached consent conditions and three events when ammoniacal nitrogen levels breached consent conditions. While these events can mostly be tracked back to an operational incident or a seasonal rise in nitrogen from the constructed wetland discharge, these events should not occur. The site

has been engineered to capture all the contaminants from the site and the land treatment system is capable of treating the site runoff to a standard where the effects on the environment are negligible.

Submissions

65. I have reviewed the submissions received and while I could comment on many, am aware that other experts addressing water quality and cultural effects will do so.

Proposed conditions of consent

66. I have reviewed the proposed conditions of consent and cannot find any scientific basis for a limit of 400kg applied nitrogen/ha/year.

67. I am aware of other similar consents in Taranaki authorising discharge to land, and permitted standards in other regions allowing 600kg. I therefore recommend that this condition be changed accordingly, and this is reflected by Ms Hooper in the conditions attached to her evidence.

Conclusion

68. My evidence has assessed the relevant matters that I am aware of in relation to the Application and when including the proposed modifications recommended in the application, I conclude that the site has been engineered to capture all the contaminants from the site and the land treatment system, is capable of treating the site runoff to a standard where the effects on the environment, including N losses, are negligible. A review of monitoring data against current consent limits has shown that any breaches of consent can be attributed to 'one-off' management issues leading to discharge events, as opposed to systemic and long running discharges or leaching.

Colin Kay

Kay Consulting Ltd

09 March 2021

Attachment A Leachate and Stormwater Management Plan

Remediation (NZ) Ltd.
Think of it as a State of the Art Fertiliser Production Facility

URUTI COMPOSTING & VERMICULTURE FACILITY

Leachate & Stormwater Management Plan

Document No:RU-650-0500-A

Revision No:1.5

Date: 5 June 2020

Version Control

Version	Date	Description	Prepared	Reviewed	Approved
V1.1	26-7-2018	Draft for review	C Kay		
V1.2	27-8-2018	Draft for review	C Kay		
V1.3	10-9-2018	Draft for review	C Kay		
V1.4	3-6-2020	Draft for review	C Kay		
V1.5	3-6-2020	Draft for review	C Kay		

Table of Content

0.0 Terms and Definitions

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1.0 Purpose of the Plan

The purpose of this document is to outline how the pond system that treats leachate generated from the compost pile and contaminated stormwater from pads 1 and 3 and the Truck Washdown area is managed.

2.0 General

The pad 1 and 3 pond system comprise of three separate ponds systems

- Pad 3 treatments ponds comprising:
  - Dewatering and settling pond
  - Silt collection pond
  - Skim pond
  - Settling ponds 1 & 2
  - Irrigation pond
- Duck pond
- Washdown settling pond

3.0 Resource consent conditions

Condition 14 Before 30 November 2015 the holder shall review and update the Uruti Composting Facility management Plan supplied in support of application 5838-2.2 and any changes shall be submitted for approval to the TRC. The plan shall be adhered to and reviewed on an annual basis (or as required) and any changes shall be submitted to the TRC. The plan shall include but not limited to;

a) Trigger limits for the three tier management system tiers set out in section 3.1 of the Uruti Composting Facility Management Plan
b) Monitoring frequencies of soil and groundwater in Tiers one, two, and three.
c) Remediation options for Tier three irrigation areas;
d) Riparian planting of irrigation areas;
e) Stormwater improvements at the site;
f) Water storage for dilution and remediation;
g) Soil and ground water analysis; and

Condition 20 The consent holder shall prepare a Pond Treatment System Management Plan which details management practices undertaken to maximise treatment capabilities of the system. The plan shall be submitted for approval to the TRC, within one month of the commencement date of this consent.

The Management Plan shall address but not necessarily be limited to, the following matters:

How the build-up of sediment and/or sludge will be managed within the entire system, how the level of build-up will be monitored including factors that will trigger management, and the frequency of undertaking the identified measures or procedures;

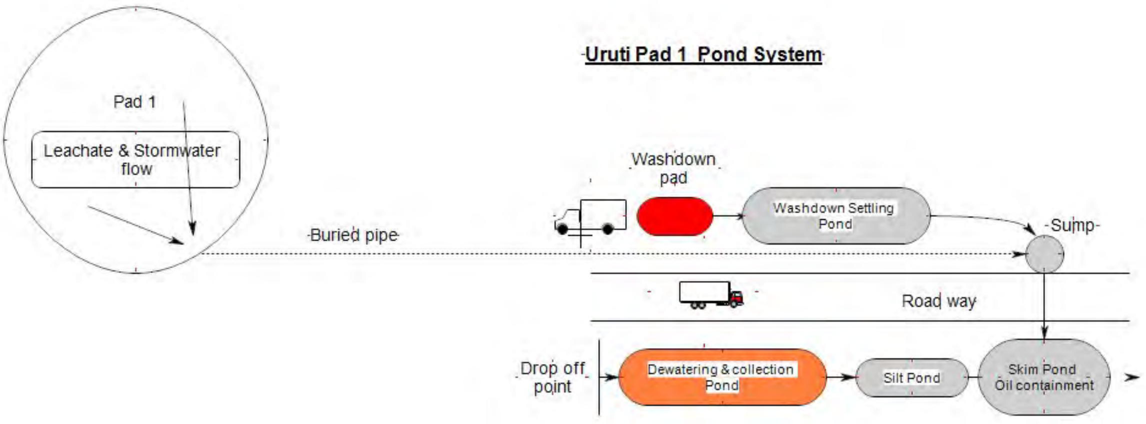
How overloading of the system will be prevented; and

How any offensive or objectionable odours at or beyond the boundary will be avoided in accordance with condition 13 of consent 5839-2

Condition 21 Operations on site shall be undertaken in accordance with the Pond Treatment System Management Plan, approved under condition 18 above, except in circumstances when the proposed Implementation Plan, approved under condition 9 of consent 5839-2, specifies otherwise.

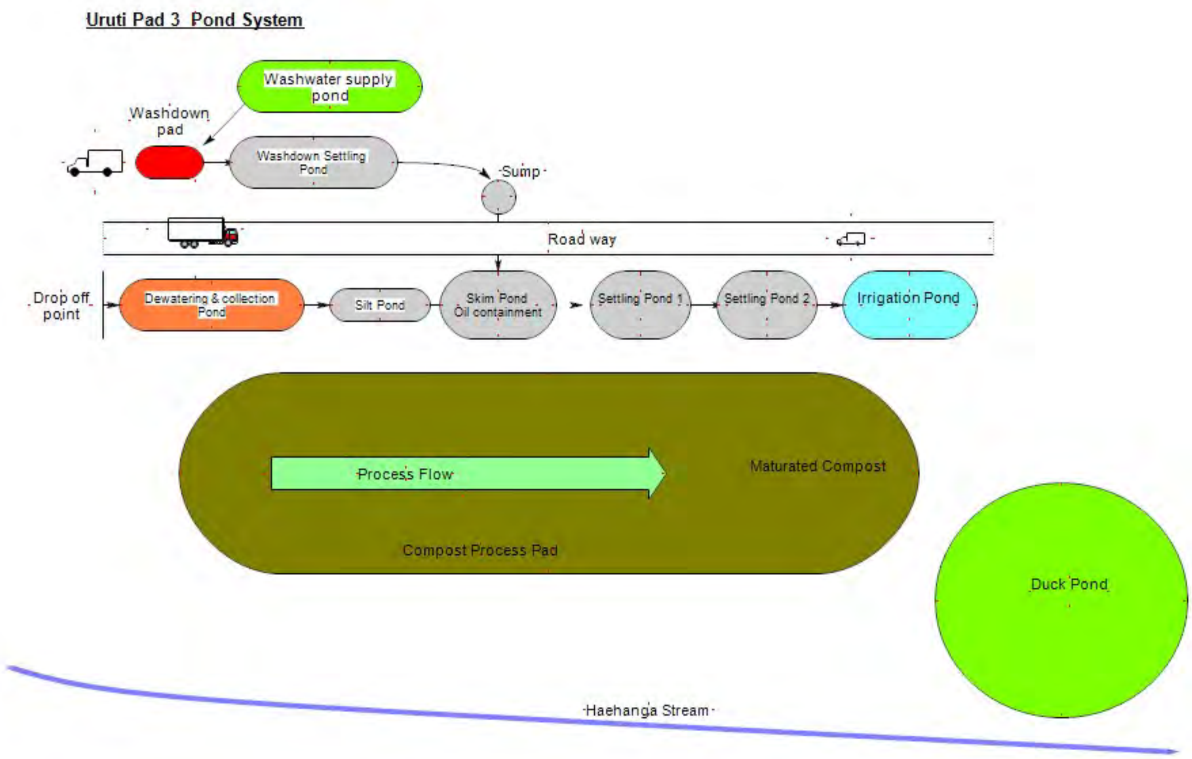
3.1 Pad 1

Figure 1: Pad 1



3.2 Pad 3

Figure 2: Pad 3



4.0 Pond Management Plan

4.1 Purpose of the Plan

This document describes the role of each pond system and provides instructions for the operation and maintenance for each system

4.2 Pond system inspection

Each pond is inspected daily to ensure the pond levels are maintained and there is no unplanned liquid overflow and the solids or sediment in each pond are below the planned maximum levels.

4.3 Dewatering and settling pond system

4.3.1 General

Organic waste is deposited onto Pad 1 or the mixing area. This organic waste is mixed with sawdust and greenwaste and deposited onto the compost pile. Surplus liquids are collected in the dewatering and collection pond. Liquids overflow into a series of settling and treatment ponds and eventually flow into the Irrigation pond. The pond levels are maintained by a series of T weirs at the pond discharge.

4.3.2 Operational and Maintenance

1) Dewatering and Collection Pond

   Monthly - Scoop out sediment from the pond and deposit onto the compost pile

2) Silt Pond

   Monthly – scoop out and deposit into the dewatering and collection pond

3) Skim Pond

   Monthly – skim hydrocarbons from the pond and deposit into the hydrocarbon collection tank

   Annually – Scoop out sediment and deposit into dewatering and collection pond

4) Settling pond 1 & 2

   Annually – Scoop out sediment and deposit into dewatering and collection pond

5) Irrigation pond

   Annually – Scoop out sediment and deposit into dewatering and collection pond

4.3.3 Duck pond

4.3.3.1 General

The duck pond maintains its level by ground soakage. Water from the duck pond is pumped into the irrigation pond during dry conditions to maintain dilution levels in the irrigation liquid and to the washdown supply pond to maintain minimum pond levels to provide washdown water during dry conditions.

4.3.4 Washdown settling pond

4.3.4.1 General

The washdown pad is used to clean trucks after they have dumped their load of organic waste. Wash water is pumped from the washdown supply pond. Runoff liquids from the wash are collected in the washdown settling pond and the pond overflow flows to the collection sump and then into the skim pond

4.3.4.2 Operational and Maintenance

Six monthly – scoop out sediment and deposit into dewatering and collection pond.

4.4 Irrigation Block Management Plan

4.4.1 Purpose of the Plan

The purpose of this document is to provide the methodology and procedures to ensure the waste water from the Irrigation Pond is irrigated onto the irrigation block in compliance with consent conditions

4.4.2 Resource Consent Conditions

Condition 8 The consent holder shall record the following information in association with irrigating waste water to land:
a) The date, time and hours of irrigation;
b) The volume of waste water irrigated to land;
c) The conductivity of the irrigation fluid (measured in mS/m)
d) The source of the waste water [e.g. Pond or Wetland Treatment System]; and
e) The location and extent where the wastewater was irrigated.

Condition 9 There shall be no direct discharge to water as a result of irrigating wastewater to land. This includes, but not necessarily limited to, ensuring the following:

a) No irrigation shall occur closer than 25 m to any surface water body;
b) The discharge does not result in surface ponding;
c) No spray drift enters surface water;
d) The discharge does not occur at a rate at which it cannot be assimilated by the soil/pasture system; and
e) The pasture cover within irrigation areas is maintained at all times.

Condition 10 treated wastewater discharged by irrigation to land shall not have a hydrocarbon content exceeding 5% total petroleum hydrocarbon or a sodium adsorption ratio exceeding 18.

Condition 11 Discharges irrigated to land shall not give rise to any of the following adverse effects on the Haehanga Stream, after a mixing zone extending 30 m from the downstream extent of the irrigation areas;

a) A rise in filtered carbonaceous biochemical oxygen demand of more than 2.00 gm-3,
b) A level of unionised ammonia greater than 0.0025 gm-3,
c) An increase in total recoverable hydrocarbons;
d) Chloride levels greater than 150g/m3
e) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
f) Any conspicuous change in the colour visual clarity;

g) Any emissions of objectionable odour;
h) The rendering of fresh water unsuitable for consumption by farm animals; and
i) Any significant adverse effects on aquatic life.

4.4.3 Climate

NIWA virtual Climate Station -38.975, 174.525 Thirty years of rainfall and evaporation data is summarised in Table 1 below

Table 1: NIWA Virtual Climate Station 30-year data for a site near Uruti Site

Uruti	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Rainfall	120.0	107.0	119.2	151.2	181.2	189.5	181.8	178.0	175.4	188.4	149.4	149.0	1890.
Evaporation	134.5	108.0	88.6	52.7	31.1	21.4	25.4	39.0	57.5	85.1	109.3	126.0	878.6

4.4.4 Irrigation area

The Irrigation block consists of 8 areas as outlined in Appendix 22 as areas L1 to U3.

The area sizes are shown in Table 2 below

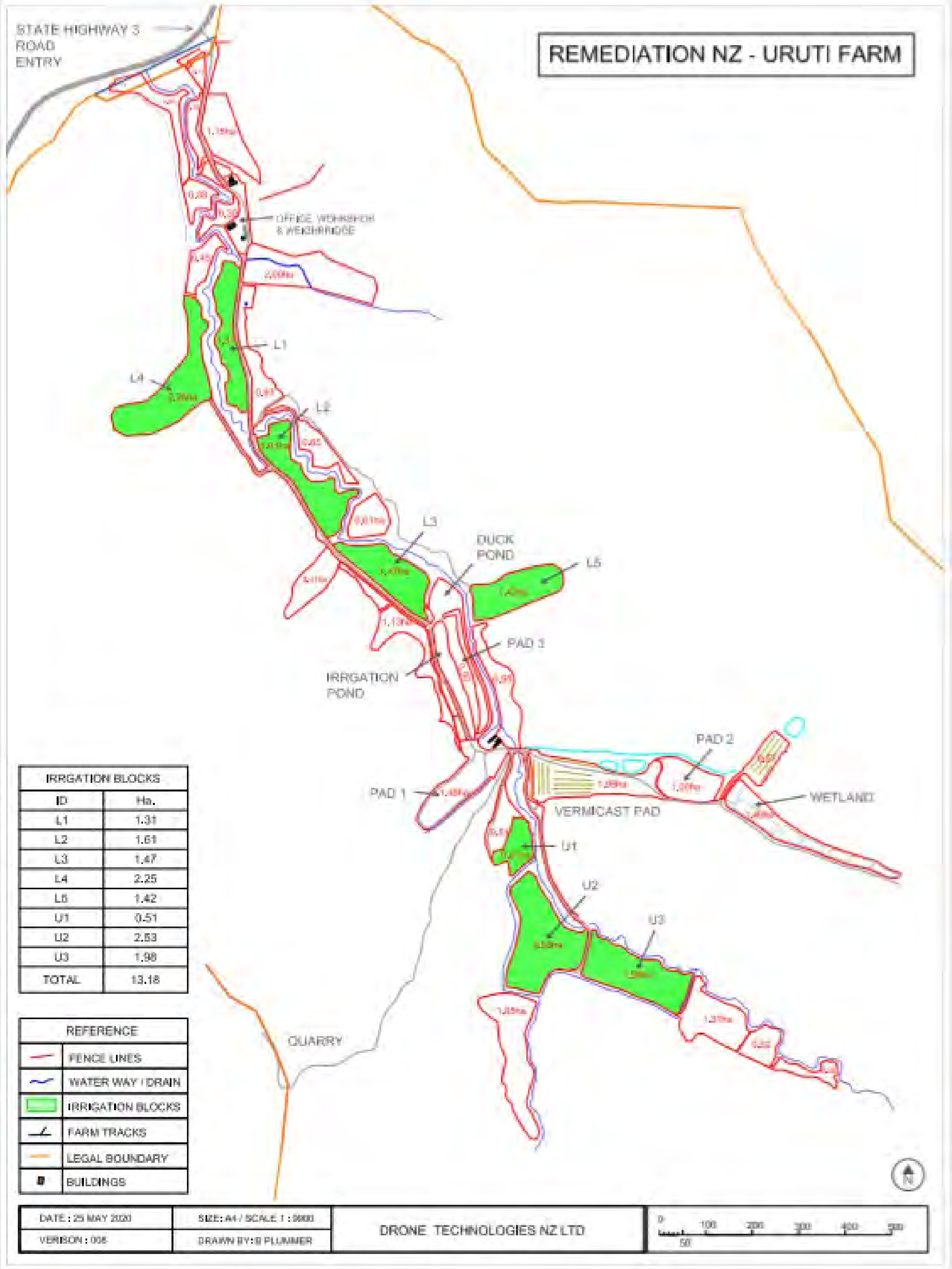
Table 2: Irrigation block areas

TRC	RNZ	Soil risk[1]	Ha
E	L1	Low risk	1.31
J	L2	Low risk	1.61
H	L3	Low risk	1.47
	L4	Low risk	2.25
	L5	Low risk	1.42
G	U1	High risk	0.61
	U2	High risk	2.53
F	U2	High risk	1.98
Total area			13.18

The locations of the 8 irrigation blocks are shown in figure 3 below

[1] Soil risk is discussed in “Irrigating High and Low risk Soils” refer to Appendix X

Figure 3: Irrigation areas



4.4.5 Soils

The soils in the effluent blocks were classified by BTW Company in the June 2015 report as Orthic brown soils from the Whangamomona Complex loams. A field survey by BTW Company using soil augers identified the top soil as Light brown grey silty clay and the subsoil as Light grey silty clay.

The soil texture was assessed by feel[2] during the KCL site visit as a silty loam as shown in Figure 1.

Figure 4: Photos showing test pit.

The assessment of the soils in the test pits indicated the top 300 mm of the soil profile consisted of 300 mm of a silty loam. The presence of mottles in the profile indicates that drainage is moderately drained.

4.4.6 Application Depth (Low risk soils)

It is important that the volume of effluent applied during each application does not exceed the water holding capacity of the soil in the plants root zone. The soil's Profile Available Water in the top 30 cm ($PAW_{30)}$ describes the maximum amount of water that can be held in the soil that is extractable by plants (i.e. plant available water).

The soils PAW_{30} was calculated using the methodology from the Farm Dairy Effluent Design Code of Practice FDEDCOP at 60 mm.

Industry good management practice is to restrict irrigation depth to less than 50% of PAW_{30}

Therefore, the maximum application depth is 30 mm.

As the irrigator does not distribute effluent evenly over the entire wetted area, in order to prevent over irrigating, the application depth is reduced by the distribution uniformity coefficient (DU). The FDEDCOP requires irrigators to achieve a DU of 1.25

Using a DU of 1.25 this gives an adjusted application depth **(Dt) of 25.0 mm.**

[2] Undertaken in general accordance with methodology described in 'Soil Description Handbook' Milne et al. (1995)

4.4.7 Application Rate (Low risk soils)

The FDE Design Code of Practice states that the maximum application rate must not exceed the soil infiltration rate. If effluent is applied at a rate greater than the soils infiltration capacity, effluent will pond on the soil surface and there is a risk of run off into surface water ways.

The soil infiltration rate was calculated using the methodology from the FDE Design Code of Practice at 15 mm/hr when using a watering time of 20 minutes.

Incorporating the losses gives a system design application rate **Ra = 15.00 mm/hr.**

4.4.8 Application Depth (High risk soils)

The principal applied to irrigation of high-risk soils is that it is important that the volume of effluent applied during each application does not exceed the soil water deficit.
The soil water deficit is calculated using a portable moisture probe.

The maximum application depth for high risk soils was calculated using the methodology from the FDE Design Code of Practice as:
The maximum application depth using a high rate irrigator (Travelling Irrigator) **(Dt) = 10 mm**
The maximum application depth using a low rate irrigator (Sprinkler pods) **(Dt) = 25 mm**

4.4.9 Application Rate (High risk soils)

The Farm Dairy Effluent (FDE) Design Code of Practice states that the maximum application rate must not exceed the soil infiltration rate. If effluent is applied at a rate greater than the soils infiltration capacity, effluent will pond on the soil surface and there is a risk of run off into surface water ways.

The soil infiltration rate for the subject site was calculated using the methodology from the FDE Design Code of Practice at 10 mm/hr.

The application depth for areas assessed as high risk should not exceed **Ra = 10.00 mm/hr**

4.4.10 Soil Chemistry

The BTW company report Uruti Composting Facility Management Plan (undated) developed a framework based on a three-tier decision tree which guides site operations in response to trigger levels of soil contaminants. The tiered response was developed because of its simplicity but also allows increased monitoring efforts and reviews of site performance to minimise risks from drainage to groundwater and accumulation of hydrocarbon constituents within the soil.

The three-tier framework is summarised in table 3 below.

Table 3: Three Tier response guidelines

Tier	Operation Status of irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

The trigger or threshold values and actions required are listed in the BTW company report in Appendix 23. The threshold values are summarised in table 4 below.

Table 4: Summary of the Three Tier threshold values for soil chemistry

Tier Level	Chloride	Total Petroleum Hydrocarbons (TPH)	SAR
	mg/kg	mg/kg	
One	0 – 700		0 – 6
Two	700 – 1,800	<20,000	6 – 18
Three	>1,800	>20,000	>18

4.4.11 Irrigation Model

The Irrigation Model is designed to proactively manage the pond levels. We receive predicted 14-day rainfall data from a Weather Forecaster on a weekly basis. We receive this data on Monday mornings and using the predicted rainfall data calculate the volume of stormwater that is predicted to arrive in the irrigation pond during the following week i.e. days 8 to 14. The irrigation plan is updated each Monday morning to account for this volume and the pond level is reduced during the week by irrigation to a level at the end of the week where the pond will have sufficient capacity to cope with the following weeks predicted rainfall.

We also receive a 3-monthly forecast which predicts the weather to be wetter than normal, normal or wetter than normal. The average rainfall data is entered into the model and multiplied by a correction factor to account for 3-month prediction e.g. normal = 0, wetter than normal + 10% and drier than normal = -10%.

The irrigation model is attached in Appendix 24

4.4.12 Standard Workplace Instruction

The Standard Workplace Instruction SWPI_RU-740-020-A provides instructions on how to operate the irrigation system so to achieve the design application depth and rate specific to the areas of high and low risk soil. Refer to Appendix 25

5.0

Attachment B Uruti Site Sampling Results Commentary

Uruti Composting & Vermiculture Facility

Uruti Site Sampling Results Commentary

Summary of monitoring on site since 2011 and provides commentary on the sampling results and explanations on any deviations from normal.

Prepared By	Colin Kay	Kay Consulting Ltd
Reviewed By	David Gibson	General Manager-Operations Remediation (NZ) Ltd

November 2020

Draft for client review

V2.2: 9 December 2020

Contents

1.0 Executive Summary

Surface water monitoring
Surface water sampling results from the routine sampling program carried out by the Taranaki Regional Council (TRC) 14th August 2020 show all sampling results from the monitoring sites are below the target or trigger analyte levels

Two events associated with earthen bund breaches on pad 3 in February 2018 and March 2019 resulted in spikes in chloride and ammonia levels above the accepted analyte levels. Subsequent earthworks to repair the bunds appear to have been successful and the April sampling results show levels returning to historical levels.

Soil quality monitoring
Soil quality sampling results from the routine sampling program carried out by the TRC 12th April 2019 show all sampling results from the monitoring are within tier one and tier two levels of the Three Tier Framework.

Ground water monitoring
Ground water sampling results from the routine sampling program carried out by the TRC 26th August 2020 show all sampling results from the monitoring are within tier one of the Three Tier Framework.

2.0 Introduction

2.1 Purpose of this report

The purpose of this report is to summarise monitoring on site since 2011 and provide commentary on the sampling results and explanations on any deviations from normal.

2.2 Scope of this report

The scope of this report covers monitoring results supplied by the TRC and is confined to reporting on the surface water, ground water and soil sampling carried out by the TRC on the Uruti site.

2.4 Description of the Uruti site catchment climate

The climate of the Uruti site catchment is described in the Assessment of Environmental Effects (AEE). The weather this summer is summarised as being dry with a series of short high intensity rainfall events. The flows in the streams have been recorded in weekly surveys are described as low, very low and no flow. The rainfall events have resulted in short duration floods with rainwater washing off the steeper land. Soil moistures have remained low with little rainfall soaking into soils

Refer to Appendix 1: Uruti site rainfall 1-1-2019 to 30-5-2019

3.0 Surface water sampling

3.1 Background

Sampling of the Haehanga Stream and a number of unnamed tributaries commenced 11-2-2011.
A number of sampling sites have been added since then as the operations on the Uruti site have changed.

The current surface water monitoring sites are:

HHG 090	Haehanga Stream above the new upper irrigation block
HHG 093	Haehanga stream at culvert above irrigation area G
HHG 097	Above the Wetland on the Wetland tributary
HHG 098	Dam tributary before the junction with the Wetland tributary
HHG 099	Southern tributary before junction with Haehanga stream
HHG 100	Up stream of the worm beds on the Haehanga Stream
HHG 103	Downstream of wetland discharge point on the Wetland tributary
HHG 106	Above Pad 3 (Mud pad) on the Pad1 tributary at the confluence with Haehanga Stream
HHG 109	Abeam the duck pond on Haehanga Stream
HHG 115	25 m downstream of the duck pond and swale collection area on Haehanga Stream
HHG 150	30 m downstream of RNZ irrigation area on Haehanga Stream (Twin culvert Crossing)
HHG 190	50 m upstream of SH3 bridge on Haehanga Stream
IND2044	Irrigation pond
IND3008	Wetland discharge

These sites are sampled by TRC on their regular sampling program.

3.2 Target or Trigger Analyte levels

Target or Trigger Analyte levels are referenced from the BTW Company Three Tier Framework and the Resource Consent 5838-2.2

3.2.1 Resource Consent 5838-2.2

Resource Consent 5838-2.2 contains two conditions that relate to surface water quality.
As well as complying the conditions in the resource consent the surface water quality must also comply with the rules set out on the Regional Freshwater Plan for Taranaki (RFWP) and the National Objectives Framework (NOF). A summary of those conditions and rules is out lined in table 1 below

Table 1: Conditions and rules relating to surface water quality at Uruti site

	Surface water *After mixing zone 30 metres downstream from the irrigation areas (GDN 2188, 2189, 2190)*		
NH4	Ammoniacal nitrogen	NOF - National Objectives Framework NOF lakes and rivers bottom line maximum - ANZEEC 2000 guidelines 80% species protection	<2.3 g/m^3
NH3	Un-ionised ammonia	RFWP Rule 23 Consent condition 11	<0.025 g/m^3

TPH	Total Petroleum Hydrocarbon	Consent condition 10	<5.0 %
SAR	Sodium adsorption ratio	Consent condition 10	<18.0
BODF	Biochemical Oxygen Demand filtered	RFWP Rule 23 Consent condition 11	<5.0 g/m^3 <2.00 g/m^3
Cl	Chloride	Consent condition 11	<150 g/m^3
pH	pH	RFWP Rule 23	6.0-9.0
SS	Suspended Solids	RFWP Rule 23	100 gm/m^3

Table 2: Conditions and rules relating to surface water quality at monitoring site HHG 103

Surface water ex Wetland Treatment System *after mixing zone of 40 metres*			HHG103
NH_4	Ammoniacal nitrogen	NOF - National Objectives Framework NOF lakes and rivers bottom line maximum - ANZEEC 2000 guidelines 80% species protection	<2.3 g/m^3
NH_3	Un-ionised ammonia	RFWP Rule 23	<0.025 g/m^3
BODCF	Biochemical Oxygen Demand filtered	RFWP Rule 23 Consent condition 24	<5.0 g/m^3 <2.00 g/m^3
Cl	Chloride	Consent condition 24	<150 g/m^3
SS	Suspended Soils	Consent condition 24	<100 g/m^3
pH		Consent condition 24	6.0 to 9.0

3.2.2 Three Tier Framework for fluid in the irrigation pond

BTW Company produced a report titled Uruti Composting Facility Management Plan in 2015. In the report BTW recommended a three tier alert system be adopted to monitor the levels of Chloride and Total Hydrocarbons in the fluid in the irrigation pond. The three Tier framework for irrigation fluid is shown below.

Tier	Operation Status of the irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

Table 3: Three Tier Framework for fluid in the irrigation pond

Tier	Receptor	Target or Trigger	Monitoring frequency	Timeline for change
One	Leachate Fluid (Irrigation pond)	Chloride – 0 to 2000 mg/l results in an Areal Loading of approximately up to 17,600mg/m^2/day	Weekly	N/A as standard operation phase
		TPH (Total Hydrocarbons) 0 – 2,500 mg/l (Half of 5% TPH consent limit)	Monthly	N/A as standard operation phase
Two	Leachate Fluid (Irrigation pond)	Chloride –2,000 to 10,000 mg/l	Monthly	If rainfall and soil moisture are expected to increase, irrigation can continue, however, if drier periods are forecast, irrigation
		TPH (Total Hydrocarbons) 2,500 - 3,000mg/l	Monthly	

				should cease especially over summer months.
Three				

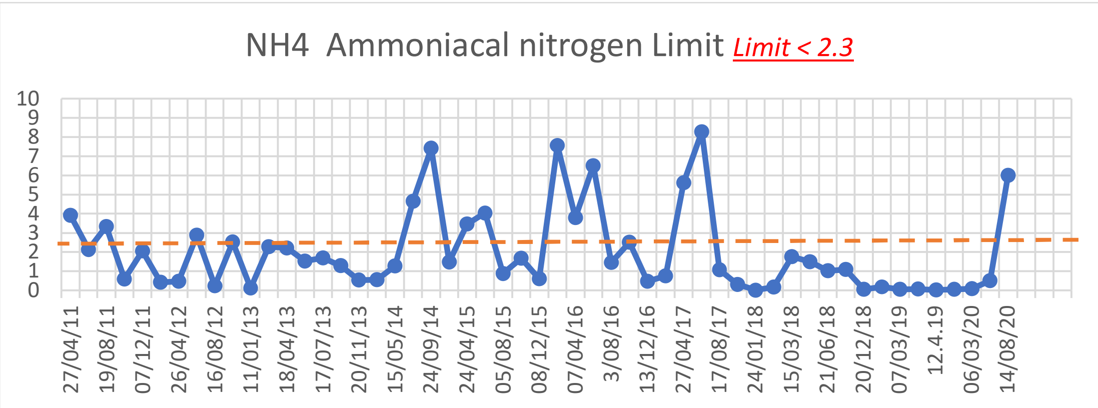
3.3 Commentary on surface water sampling results

3.3.1 TRC sampling 14/8/2020

Surface water sampling results from the routine sampling program carried out by the TRC on 14th August 2020 show all sampling results from the monitoring sites with the exception of the wetland discharge HHG 103 were below the target or trigger analyte levels.

The wetland discharge HHG 103 experienced a number of spikes in NH4 Ammoniacal nitrogen levels during monitoring between 2014 and 2017. Refer to Figure 1 below. RNZ undertook an investigation in 2018 which concluded that as the spikes tended to occur in autumn and winter and the probable cause to the spikes was plant dieback. This is accepted as a natural event in wetlands.
The investigation concluded that in some areas of the wetland plants needed to be replaced and new plants needed to be planted to fill the spaces caused by plant deaths. A replanting project commenced in 2018 which resulted in 1,200 Raupo plants planted in the wetland. NH4 monitoring results up to 6th April 2020 showed low or very low discharge results. The spike in the NH4 levels in the August 2020 monitoring was unexpected and would appear to be the result of plant dieback in the wetland. RNZ are undertaking a review and are seeking expert advice with the goal of identifying and remedying the problem.

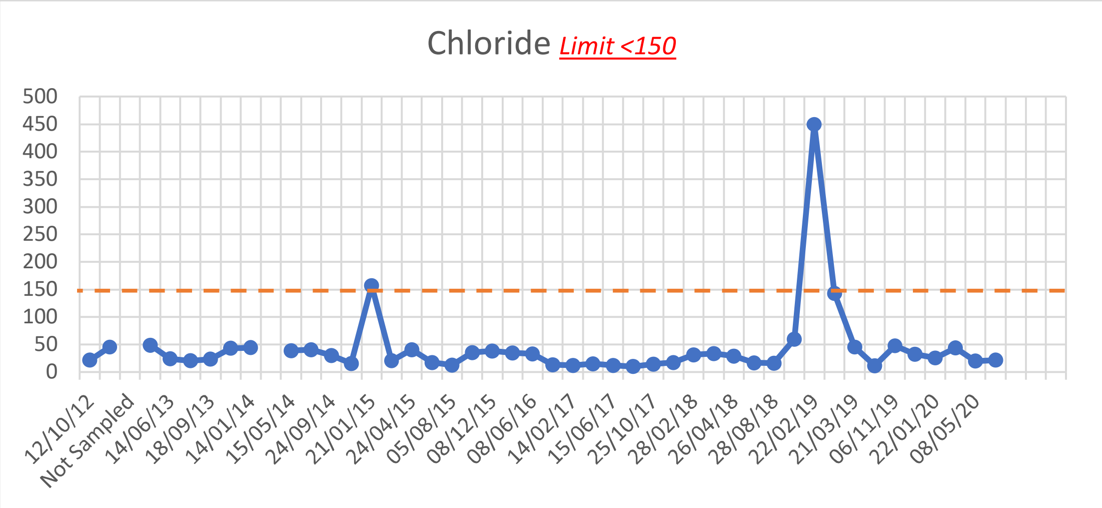
Figure 1: Surface water monitoring site HHG 103 - Wetland discharge.



3.3.2 Historical bund breach at monitoring site HHG 106

An event associated with earthen bund breaches on pad 3 in February 2019 resulted in spikes in chloride and ammonia levels above the consented analyte limits at monitoring site HHG 106. Refer to Figure 2 below. Subsequent earthworks to repair the bunds appear to have been successful and the subsequent sampling results show levels returning to historical levels.

Figure 2: Surface water monitoring site HHG 106



3.4 Surface water leaving the Uruti site at 14/8/2020

Monitoring results at HHG 190, Upstream of SH3, on 14/8/2020 indicated that surface water leaving the Uruti site complied with all consent conditions.

Refer to Appendix 1: Surface water sampling results to 14-8-2020

4.0 Soil sampling

4.1 Background

Soils in the irrigation blocks are monitored by taking soil core samples. Sampling of the two original irrigation blocks SOL 177 (Lower Irrigation Block) and SOL 176 (Upper Irrigation Block). Six new irrigation areas have been developed and are now included in the TRC regular sampling program.

4.2 Target or Trigger Analyte levels

Target or Trigger Analyte levels are referenced from the BTW Company Three Tier Framework and the Resource Consent 5838-2.2

4.2.1 Resource Consent 5838-2.2

Resource Consent 5838-2.2 contains three conditions that relate to soil quality.

Condition 12 states that soil samples be taken from the irrigation blocks every 6 months and analysed for petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylene.

Condition 13 states that soil samples be taken from the irrigation blocks and analysed for chloride, sodium, magnesium, calcium, potassium, total soluble salts and conductivity

Condition 14 states that the Uruti Composting Facility Management Plan shall include the Three Tier Framework.

4.2.2 Three Tier Framework for soil quality

BTW Company produced a report titled Uruti Composting Facility Management Plan in 2015. In the report BTW recommended a three Tier alert system be adopted to monitor the levels of Chloride and Total Hydrocarbons in the soil. The three Tier framework for soil is shown below.

Tier	Operation Status of the irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

Table 4: Three Tier Framework for soil quality in the irrigation blocks

Tier	Receptor	Target or Trigger	Monitoring frequency	Timeline for change
One	Soil	Chloride – 0 to 700 mg/l (based on the surrender criteria for NZ land farms criteria) Sodium Absorption Ratio 0 - 6	Monthly	N/A as standard operation phase
		TPH (Total Hydrocarbons) C7 – C9 <2700mg/kg C10 – C14 <58mg/kg C15 – C36 <4000mg/kg	3 Monthly	N/A as standard operation phase
Two	Soil	Chloride –700 to 1800 mg/kg Sodium Absorption Ratio 6 - 18	Monthly	If the Chlorides within the soil stay within this tier for 6 months, consider moving to Tier 3 Consider clean water irrigation to allow recovery from elevated SAR
		TPH (Total Hydrocarbons) TPH <20,000mg/kg	Monthly	Upper limit for bioremediation to be effective for hydrocarbons, leachate fluid to contain no TPH
Three	Soil	Chloride – >1800 mg/kg Sodium Absorption Ratio >18	Monthly	Initiate soil remediation measures (refer to section 5) of the BTW report) alongside clean water irrigation
		TPH (Total Hydrocarbons) >20,000mg/kg	Monthly	Initiate soil remediation measures (see section 5)

4.3 Commentary on soil sampling results

4.3.1 TRC sampling 26/6/2020

Monitoring results of soil samples carried out on 26/6/2020 indicated that all the soil analytes monitored in the irrigation areas at the Uruti site complied with all consent conditions.

Refer to Appendix 2: Soil sampling results to 26-6-2020

5.0 Groundwater sampling

5.1 Background

Groundwater is monitored on the Uruti site using 7 monitoring bores. The three original bores were installed in 2011, three bores were installed in 2018 and the seventh bore was installed above the new top irrigation block in 2019. The bores are sampled by the TRC on their regular sampling program.

5.2 Target or Trigger Analyte levels

Target or Trigger Analyte levels are referenced from the BTW Company Three Tier Framework and the Resource Consent 5838-2.2

5.2. Resource Consent 5838-2.2

Resource Consent 5838-2.2 contains three conditions that relate to groundwater quality.
Condition 18 states that groundwater samples be taken from the monitoring bores every 6 months and analysed for petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylene.
Condition 19 states that groundwater samples be taken from the monitoring bores and analysed for chloride, sodium, magnesium, calcium, potassium, total soluble salts and conductivity.

5.2.2 Target or Trigger Analyte levels

BTW Company produced a report titled Uruti Composting Facility Management Plan in 2015. In the report BTW recommended a three Tier alert system be adopted to monitor the levels of Chloride and Total Hydrocarbons in the groundwater. The three Tier framework for ground water is shown below.

Tier	Operation Status of the irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

Table 5: Three Tier Framework for ground water quality in the monitoring bores

Tier	Receptor	Target or Trigger	Monitoring frequency	Timeline for change
One	Groundwater	Chloride – 0 to 1000 mg/l and Conductivity – <350 uS/m	Bimonthly	N/A as standard operation phase
		TPH (Total Hydrocarbons) All fractions of hydrocarbons under detectable levels (essentially background level)	Biennially	N/A as standard operation phase
Two	Groundwater	Chloride –1000 to 2000 mg/l and Conductivity – 350 to 700 uS/m	Monthly	All irrigation to cease in this zone.
Three	Groundwater	Chloride – >2,000 mg/l and Conductivity – >700 uS/m	Monthly	Initiate groundwater remediation measures (refer to section 5 of the BTW report)

5.3 Commentary on groundwater sampling results

5.3.1 TRC sampling 26/8/2020

Monitoring results of ground water in the monitoring bores carried out on 26/8/2020 indicated that all the analytes monitored at the Uruti site complied with all consent conditions.
For drinking water, the New Zealand Drinking Water Standards (2008) set a Maximum Acceptable Value (MAV) of 50 mg/l for nitrate, which is the equivalent to 11.3 g/m^3 nitrate-nitrogen.

Groundwater leaving the Uruti site catchment is monitored at the monitoring well GND 3007 sited near State Highway 3. The sampling results for monitoring bore GND 3007 show the levels of nitrite/nitrate nitrogen ranged between 0.098 g/m^3 and less than 0.002 g/m^3 which are within the safe levels for drinking water.

5.3.2 Historical sampling results for monitoring bore GND 3009.
Monitoring bore GND 3009 was installed in 2018. Monitoring results of sampling between 28/8/2018 and 20/2/2020 show high levels of Chloride, Conductivity, NH4, NH3 and Total Dissolved Solids. Monitoring results of sampling carried out 5/6/2020 and 26/8/2020 show the levels of five analytes listed above have returned to levels consistent with the other monitoring bore results.

Figure 3: Monitoring bore 3009- Chloride

Figure 4: Monitoring bore 3009 - NH4

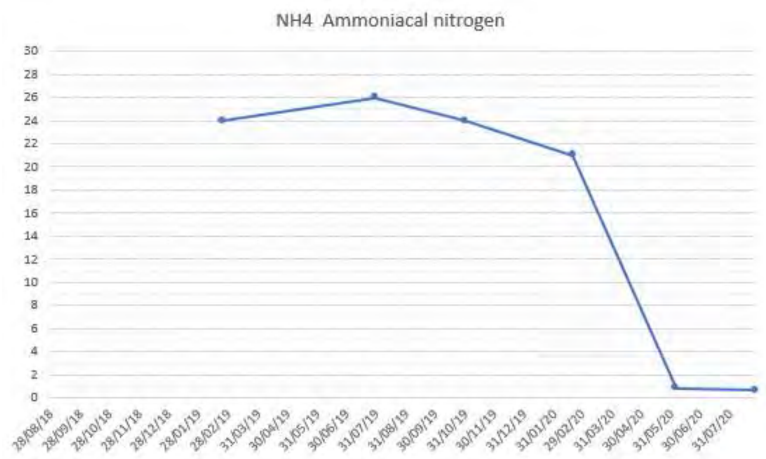
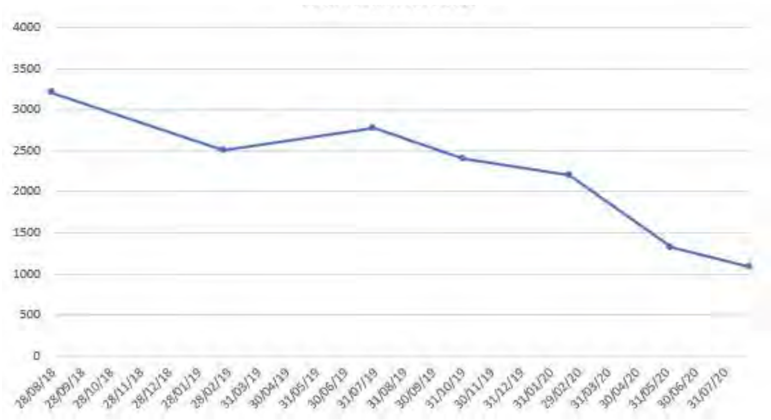


Figure 5: Monitoring bore 3009 - Total Dissolved Solids



One possible explanation for this result is that the bore was installed into an area that had been a natural depression and may have been subject to subject to higher concentrations of contaminants from the irrigation from the irrigation pond liquid. It is possible the soil surrounding the monitoring bore may have contaminated the ground water in the bore. Over time these contaminants have attenuated down to a level more representative of the general area.

5.4 Ground water leaving the Uruti site at 26/8/2020

Monitoring results at GND 3007, next to SH3, on 26/8/2020 indicated that ground water leaving the Uruti site complied with all consent conditions and complied with the New Zealand Drinking Water Standards for nitrite/nitrate nitrogen[1]. The sampling results for monitoring bore GND 3007 show the levels of nitrite/nitrate nitrogen ranged between 0.098 g/m^3 and less than 0.002 g/m^3 which are within the safe levels for drinking water.

Refer to Appendix 3: Groundwater sampling results to 26-8-2020

[1] For drinking water, the New Zealand Drinking Water Standards (2008) set a Maximum Acceptable Value (MAV) of 50 mg/l for nitrate, which is equivalent to 11.3 g/m^3 nitrate-nitrogen.

Appendices

Tables

Figures

Attachment C Updated Irrigation Block Nitrogen Analysis Report

Uruti Composting Facility

Irrigation Block Nitrogen Balance Analysis

KAY CONSULTING

Prepared for
Remediation (NZ) Ltd
PO Box 8045
New Plymouth 4342

Prepared By
Kay Consulting Ltd
PO Box 10,
New Plymouth 4340
P: 021 46 28 91
E: colin@kayconsulting.co.nz
W:www.kayconsulting.co.nz

18 November 2020

Version Control

Version	Date	Description	Prepared	Reviewed	Approved
V1.10	10-2-2020	Final draft for client review	C Kay		
V1.11_F	18-11-2020	Final	C Kay	D Gibson	K Hooper

Contents

1.0 Executive Summary

In September 2019 AECOM New Zealand Ltd prepared a report intitled "Uruti Composting Facility: Nitrogen Balance" for Remediation New Zealand (RNZ), in response to a request for further information in relation to consent renewal applications for the RNZ Uruti Composting Facility. The report used OVERSEER® to model nitrogen flows within the farm and compost operation. The report modelled a number of scenarios and made recommendations to reduce Nitrogen losses.

As a consequence of the report a number of changes to the operation of the compost process and the irrigation system were made by RNZ and this report reviews and models these changes. OVERSEER® and monitoring data were used to identify sources of nitrogen entering the system, leaving the system and quantify the effect on the receiving environment.

Using the OVERSEER® base file, two scenarios were modelled using different volumes of compost applied to the Irrigation Area.

The report has a number of conclusions including:

- The amount of nitrogen generated from the composting operation can be reduced using good management practices;
- Harvesting pasture and removing it off site as baleage removes significant amounts of nitrogen from the system;
- A review of six analytes sampled in monitoring bores showed that the ground water leaving the Uruti catchment is generally in better condition than groundwater entering the composting site;
- Nitrogen leached from the root zone on a whole farm basis varies only slightly between scenarios due to the large farm area and the significant area that is fallow/in bush and scrub.
- From the irrigation area only, nitrogen losses from the root zone ranged from 112 kg N/ha/yr under the scenario with no compost applied to 237 kg N/ha/yr when 2000 m^3 compost/year is applied to the irrigation areas.
- Monitoring of the groundwater leaving the Uruti catchment showed that the Nitrite-Nitrogen levels of groundwater is below the New Zealand Drinking Water Standards (2008) Maximum Acceptable Value (MAV), even under previous management conditions (i.e. with none of the measures to reduce nitrigen losses in place).
- The September 2019 AECOM report indicated that losses under this 2019 management sceneario were 3,574kg N/year. Compared to the 2019 scenario modelled by AECOM (which has led to the management changes and mitigation measures that are now presented in this report), N losses are significantly reduced.

2.0 Introduction

2.1 Background

Kay Consulting Ltd has been engaged by RNZ to review the AECOM OVERSEER® nitrogen modelling report dated 13 September 2019 and update the OVERSEER® file to take into account the changes in the site infrastructure and management since the report was published. Different options for application of compost have also been considered. The AECOM OVERSEER® budget for the current and projected 2019 year indicated total N losses from the irrigation areas were 3563 kg N/yr, or 992 kg N/ha/yr. (Based on 2019 irrigation areas).

2.2 Project Scope

The scope of this report is confined to the Uruti site which includes:

- The Regenerating native indigenous forest of 407 ha
- The Planting plan area (currently cattle grazing) of 191 ha
- The irrigation area of 13.18 ha
- The constructed wetland of 1.09 ha
- Pads, roads, ponds, and workshop areas of 29 ha

The report is prepared on the basis that drilling mud deliveries cease on 30 September 2020. The OVERSEER® file will use the status quo year of 2022.

2.3 Qualification of the Author

- B Ari Sc specialising in Agricultural Engineering
- Certificate in Advanced Sustainable Nutrient Management
- CNMA – Certified Nutrient Management Adviser

3.0 Description of the site activity

3.1 Site map

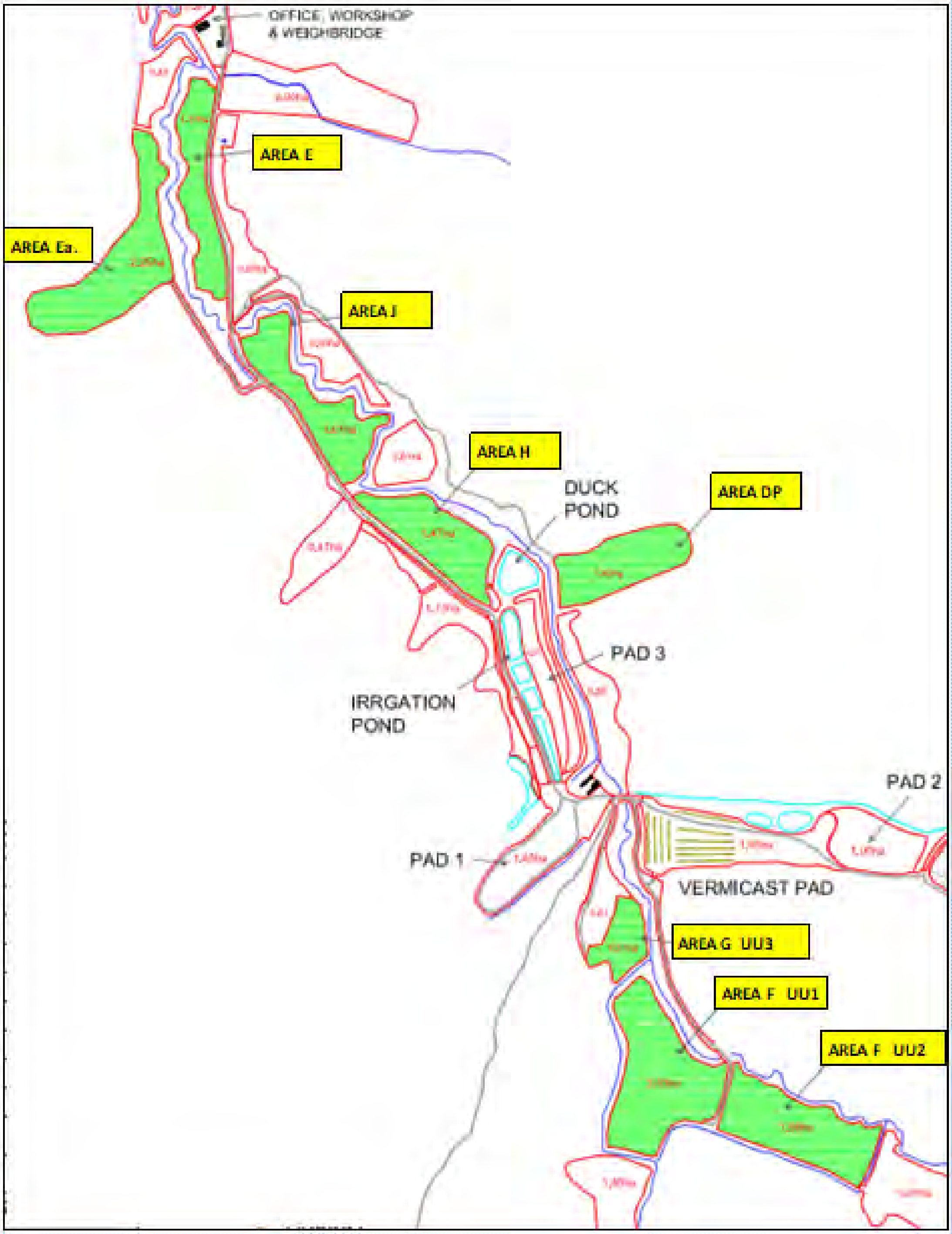


FIGURE 1: SITE OVERVIEW & IRRIGATION BLOCK LOCATIONS

Table 1: Irrigation Area Breakdown

Block			**Area (ha)**
Upper Irrigation	G	0.61	
	F UU1	2.53	
	F UU2	1.98	5.12
Lower Irrigation			
	E	1.31	
	Ea	2.25	
	J	1.61	
	H	1.47	
	DP	1.42	8.06
Total Area			13.18

3.2 Description of the site activity

The RNZ Pads 1 & 3 at Uruti processes organic waste and greenwaste.

The organic wastes are deposited into the receiving pad and the site operator then incorporates/mixes the organic waste with green waste and sawdust and incorporates the mixed material into the compost pile.

Leachate and stormwater runoff from the compost piles are collected and move through a series of the settlement ponds and then it is stored in the final pond.

3.3 Composting operation

The operation of the composting operation is controlled by the Site Practices Plan which specifies the methods used to generate and manage the compost windrows. A correctly constructed compost windrow will form a thatch that will shed stormwater. A well-managed compost windrow will create minimal leachate.

3.4 Aeration of pond liquid

The storage pond is aerated using the irrigation pump to recycle pond liquid through an aerator. The aeration of the pond liquid causes the reduction of ammonium (NH_4) to ammonia (NH_3) and the subsequent loss of ammonia gas to the atmosphere (volatisation process).

3.5 Irrigation of pond liquid

When climatic conditions and soil conditions are suitable the irrigation pond liquid is pumped through a buried mainline to the irrigator which discharges the liquid onto land.

The operation of the irrigation system is controlled by the Irrigation Block Management Plan – refer to Appendix 1.

3.6 Cut and carry of the harvested pasture

Pasture from the irrigation block is harvested between September and April and transported off site or used in the composting process. When the pasture has reached a suitable height, it is cut and allowed to wilt before being processed into baleage. Each bale weighs approximately 800 kg and would contain approximately 320 kg of dry matter.

For the purposes of this report (and associated OVERSEER® model) it has been predicted that 4 cuts of hay/baleage will be taken each year in the months of October, November, January and April. It is predicted that 561 bales will be made and removed off site.

The removal of harvested pasture from the irrigation areas will remove significant amounts of nutrients from the soil. While the aim of the cut and carry operation is to remove excess nitrogen, this practice will also remove other nutrients essential for pasture health and growth. Regular soil tests will identify any essential nutrient deficits, and these should be replaced in a customised fertiliser dressing. Nitrogen fertiliser will not be required.

4.0 Nutrient Balance of status quo nutrient budget

4.1 OverseerFM Software Overview

OVERSEER® is a software programme used to model nutrient cycling on-farm. OVERSEER® takes nutrients that are present or introduced to the farm, models how they are used by plants and animals on the farm and estimates how they leave the farm and in what form.

OVERSEER® can be used to model different farm management practices in an attempt optimise the efficient use of nutrients and reduce their losses from the farm.

It was determined that OVERSEER® is an appropriate tool to provide an estimate of nitrogen loading and losses across the irrigation areas.

4.2 Nutrients entering and leaving the irrigation Area

OVERSEER® calculates the addition and removal of 7 nutrients being nitrogen, phosphorus, potassium, sulphur, calcium, magnesium and sodium. This report focuses on the nitrogen loading and losses from the site.

Nitrogen enters the Irrigation Area through the irrigated liquid, rainfall and clover fixation.

Nitrogen leaves the Irrigation Area by being leached below the root zone, by volatilisation and denitrification to the atmosphere and in the harvested pasture in the form of baleage.

Nitrogen moves between the organic and inorganic pools within the soil. Generally, nitrogen in the organic form is held in the soil and is not available for plant uptake and does not leach from the root zone. Nitrogen in the Inorganic form are plant available and in certain circumstances can leach through the soil*.

**Refer to Appendix 2 - Nitrogen cycle.*

4.3 Nitrogen entering the irrigation Area

Nitrogen concentrations in the irrigation pond have been monitored on a regular basis since 2014. The major form of nitrogen recorded in the pond is Ammoniacal nitrogen (NH_4) with levels ranging between 17.6 to 590 g/m^3 with the average concentration being 226.7 g/m^3.

The concentration levels of nitrogen in the irrigation pond (and ultimately the irrigated fluid) will vary depending upon climate (rainfall dilution) and site activities (type and quantities of waste products entering the site). For the purposes of this report a concentration of 225 g/m^3 has been used (being the average concentration rounded to the nearest 5g). It is acknowledged that the nitrogen concentration is likely to be higher in the drier summers and lower in the wetter winters. It is also considered likely that the concentration of nitrogen in the irrigation pond will decline as a result of improved management practices which will prevent organic matter directly entering the pond system.

Nitrogen also enters the Irrigation Area with rain and clover fixation.

4.4 Total volume of irrigation liquid irrigated onto the Irrigation Blocks

The irrigation liquid is pumped from the pond to the irrigator through a buried pipeline. The pumping flow rate was measured by BTW company in 2015 as 30 m^3/hr[1].

The pumping hours are recorded in the irrigation log and for the purposes of this report the actual pumping hours for the 12 months ending 31 July 2019 were used.

The irrigation log recording the pumping hours and the calculated volume pumped in shown in Table 2 below:

TABLE 2: IRRIGATION LOG FOR YEAR ENDING 31 JULY 2019

[1] *Uruti Composting Facility Management Plan, BTW Company Limited, 2015. (provided as Appendix J of the Application for Consent Renewal)*

	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6		Hours pumping	Total volume pumped m3
Aug-18	23.5	27	26	16	0	0		92.5	2,775
Sep-18	8	17	25	4.5	0	0		54.5	1,635
Oct-18	14.5	10	6	3	1	0		34.5	1,035
Nov-18	17	6	6	8	8	0		45	1,350
Dec-18	6	10	6	8.5	5.5	0		36	1,080
Jan-19	8.5	2	3	5	5	0		23.5	705
Feb-19	4.5	7	10.5	4	5	0		31	930
Mar-19	7	20.5	18.5	2	6			54	1,620
Apr-19	7	19.5	11.5	5.5	9	7		59.5	1,785
May-19	8.5	4	4	2	21	15.5		55	1,650
Jun-19	4	2	2	7	15	7		37	1,110
Jul-19	15.5	15	2	10.5	26	27.5		96.5	2,895
								619	18,570
							Total	m3	18,570

These figures are considered to be representative of irrigation volumes that would be expected to occur in the future and have been used to inform the rate of application of the irrigation fluid in OVERSEER®.

4.5 Total Kg of Nitrogen irrigated onto the Irrigation Blocks

The total kgs of nitrogen applied to the irrigation blocks is calculated by multiplying the pond nitrogen concentration (g/m^3) x irrigation volume (m^3).

Based on the irrigation volumes in Table 2, the total kg of nitrogen that would be applied using different nitrogen concentrations in the irrigation fluid is shown in table 4 below. This shows the effect of a change in nitrogen concentration on the overall total kgs of N applied.

TABLE 3:TOTAL KG OF NITROGEN APPLIED USING DIFFERENT N CONCENTRATIONS BASED ON IRRIGATION VOLUMES IN TABLE 2.

		N concentration of irrigation fluid g/m3										
		100	150	200	225	250	275	300	325	350	375	400
Kgs of Nirogen applied in the irrigated liquid	Aug-18	278	416	555	624	694	763	833	902	971	1,041	1,110
	Sep-18	164	245	327	368	409	450	491	531	572	613	654
	Oct-18	104	155	207	233	259	285	311	336	362	388	414
	Nov-18	135	203	270	304	338	371	405	439	473	506	540
	Dec-18	108	162	216	243	270	297	324	351	378	405	432
	Jan-19	71	106	141	159	176	194	212	229	247	264	282
	Feb-19	93	140	186	209	233	256	279	302	326	349	372
	Mar-19	162	243	324	365	405	446	486	527	567	608	648
	Apr-19	179	268	357	402	446	491	536	580	625	669	714
	May-19	165	248	330	371	413	454	495	536	578	619	660
	Jun-19	111	167	222	250	278	305	333	361	389	416	444
	Jul-19	290	434	579	651	724	796	869	941	1,013	1,086	1,158
Totals kg N/yr		1,857	2,786	3,714	4,178	4,643	5,107	5,571	6,035	6,500	6,964	7,428

The scenario modelled in OVERSEER® (concentration of 225 g/m^3) results in 4,178 kg N/year in total being applied to the 12 ha irrigation area. A reduction in concentration from 225 g/m^3 to 200 g/m^3 (25 g/m^3) would reduce total nitrogen application by 464 kg N/year.

4.6 Kg of Nitrogen applied per ha

The nitrogen application rates in kg/ha was calculated using the nitrogen concentration table above and is shown in Table 4 below:

TABLE 4: NITROGEN APPLICATION RATES KG/HA/YR USING DIFFERENT N CONCENTRATIONS

	Area ha	12									
g/m3	100.00	150.00	200.00	225.00	250.00	275.00	300.00	325.00	350.00	375.00	400.00
Aug-18	23	35	46	52	58	64	69	75	81	87	93
Sep-18	14	20	27	31	34	37	41	44	48	51	55
Oct-18	9	13	17	19	22	24	26	28	30	32	55
Nov-18	11	17	23	25	28	31	34	37	39	42	45
Dec-18	9	14	18	20	23	25	27	29	32	34	36
Jan-19	6	9	12	13	15	16	18	19	21	22	24
Feb-19	8	12	16	17	19	21	23	25	27	29	31
Mar-19	14	20	27	30	34	37	41	44	47	51	54
Apr-19	15	22	30	33	37	41	45	48	52	56	60
May-19	14	21	28	31	34	38	41	45	48	52	55
Jun-19	9	14	19	21	23	25	28	30	32	35	37
Jul-19	24	36	48	54	60	66	72	78	84	90	97
KgN/ha/yr	154.8	232.1	309.5	348.2	386.9	425.6	464.3	502.9	541.6	580.3	639.0

The scenario modelled (concentration of 225 g/m^3) results in application of 348 kg N/ha/year. A reduction in concentration of 25 g/m^3 would reduce nitrogen application by 38 kg N/ha/year.

4.7 Overseer data input

Data was entered into the OVERSEER® model as outlined in Table 5 show below:

TABLE 5: OVERSEER DATA INPUT

Overseer Section	Scenario Modelled (Scenarios 1 and 2 are identical except for compost application rate)
Blocks	Blocks were drawn according to maps, notes from site visit. Upper Irrigation Block – 5.12 ha Lower Irrigation Block – 8.06 ha
Climate	Overseer defaults according to latitude and longitude
Soil	
Farm Soils	No S-Map data for the area was available (Overseer's default source for soil classification). Soil data was input as: order = Brown, soil group = sedimentary (as per BTW, 2015, section 2.3.1). Model sensitivity to soil drainage class and topsoil texture was investigated. Soil drainage class = poor. Topsoil texture = silt loam. Stoney = no. No root barrier depth assumed. Drainage impeded layer assumed at 20cm for lower area and 100cm for upper area (BTW, 2015).

<table>
<tr><td>Soil tests</td><td colspan="2">Soils test data from 12-04-2019 (RNZ, 2019)</td></tr>
<tr><td>Drainage</td><td colspan="2">No drainage method assumed for the irrigation areas.</td></tr>
<tr><td>Pasture/crops</td><td colspan="2">Irrigation areas assumed; ‘flat topography’, ‘grass only’, cultivated in the last 5 years, no animals present.</td></tr>
<tr><td>Animals</td><td colspan="2">No animals present.</td></tr>
<tr><td>Structure/effluent</td><td colspan="2">No dairy effluent system.</td></tr>
<tr><td>Supplements</td><td colspan="2">Baleage harvested from the irrigation areas. All distributed offsite.
Bale sizing assumed round (15 bale equivalents), 800 kg wet wt. 320 kg DM/bale. Harvested assumed in October (187 bales), November (173), January (115) and April (86).</td></tr>
<tr><td>Fertiliser</td><td colspan="2">Irrigation pond nutrients modelled as ‘custom soluble fertiliser’.
Custom Soluble Fertiliser details:
- N = 225g/m^3
- Application rate determined in accordance with Table 4
Compost; modelled as ‘custom organic fertiliser’, ‘compost/mulches’, 60% dry matter, 0.61% N, 0.19% P, 0.27% K– data from Uruti compost analysis (Hill Laboratories compost testing results 16 January 2020).</td></tr>
<tr><td rowspan="2">Compost application</td><td>Scenario 1 – 1000 m3 (500 tonnes) compost applied per year (‘2022+compost 1000’)</td><td>Scenario 2 – 2000 m3 compost applied per year (1000 tonnes) (‘2022+compost 2000’)</td></tr>
<tr><td>1,000 m^3 of compost converts to 500 tonnes which when applied to 12 ha at a rate of 14 tonne/ha.</td><td>2,000 m^3 of compost converts to 1,000 tonnes which when applied to 12 ha at a rate of 28 tonne/ha.</td></tr>
<tr><td>GHG</td><td colspan="2">Defaults not overridden.</td></tr>
</table>

4.8 Total Nitrogen` entering the Irrigation Area in irrigation fluid

The total amount of nitrogen entering the system as a result of irrigation fluid application is calculated by OVERSEER® and shown in Table 6 below:

TABLE 6: NITROGEN ENTERING THE IRRIGATION AREA (2022 + GRAZING)

Nitrogen entering the system	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
In irrigation fluid	346	346	4,560
In rainfall and clover fixation	29	26	358
Total	375	372	4,918

4.9 Total Nitrogen leaving the Irrigation area from irrigation fluid

The total amount of nitrogen removed from the Irrigation Area calculated by OVERSEER® is shown in Table 7 below:

TABLE 7: NITROGEN REMOVED FROM THE IRRIGATION AREA (2022 + GRAZING)

Nitrogen removed from the system	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
Leached from the root zone	79	77	1,025
To atmosphere	33	33	435
As baleage	265	262	3,468
Added to the organic Nitrogen pool	-2	0	-10
Total	375	372	4,918

4.10 Nitrogen leaving the whole farm

OVERSEER® calculates the amount of Nitrogen leached from the root zone from the Irrigation Area and it is shown in Table 8 below:

TABLE 8: TOTAL NITROGEN LEACHED FROM THE ROOT ZONE FROM THE IRRIGATION AREA (2022 + GRAZING)

Total Nitrogen leached from the farm blocks		Kg/yr	Kg/ha/yr
Upper Irrigation Area	5.12 ha	404	77
Lower Irrigation Area	8.06 ha	621	79
Cattle grazing	191 ha	1,857	10
Wetland	1.09 ha	3	3
Regenerating forest	407 ha	1,220	3
Roads, pads, ponds, workshop	29 ha	162	6
Other sources	-	20	-
Total Nitrogen leached from the root zone		4,285	7.0

Overseer calculates that a total of 1,025 kg N/yr is leached from the root zone of the Irrigation Area under this scenario. The irrigation blocks are one component of total nitrogen loss from the farm. Nitrogen loss represented on a whole farm basis, modelling the remainder of the land as unproductive/ungrazed pasture or trees and scrub is shown in Table 9 below:

TABLE 9: TOTAL NITROGEN LEACHED FROM THE IRRIGATION AREA ON A WHOLE FARM BASIS (2022 + GRAZING)

Total Nitrogen leached from the Irrigation Area on a whole farm basis		
Total Nitrogen leached from the root zone	Kg	4,285
Whole farm area	Ha	641
Nitrogen leached on a whole farm basis	Kg N/ha/yr	7

4.11 Fate of Nitrogen leached from the root zone

Nitrogen can be attenuated (reduced) by different biogeochemical processes on its journey after leaching from the root zone till it reaches the sampling point at the catchment outlet.

In low oxygen subsurface environments, nitrate can be reduced and emitted as a nitrogen gas, via a biogeochemical process of denitrification in the subsurface environment. As a result, nitrogen losses are said to be attenuated before entering and effecting the receiving water body.

Groundwater leaving the Uruti site catchment is monitored at the monitoring well GND 3007 sited near State Highway 3. Monitoring of this well started in April 2018 and the sampling results are shown in Table 10 below:

Table 10: Monitoring results of sampling the monitoring well GND 3007 sited near State Highway 3 records the groundwater leaving the Uruti catchment

New monitoring bore GND 3007 Beside SHW 3		Chloride	Conductivity	NH4 Ammoniacal nitrogen	NNN Nitrite/ Nitrate	PH	LEVEL	Temperature	NH3 Un-ionised ammonia	Total Disolved Solids
	Tier One	0 - 1,000	< 350							
	Tier Two	1,00 - 2,000	350 - 700							
	Tier Three	> 2,000	> 700							
Site	Collected	g/m3	mS/m@20C	g/m3 N	g/m3 N	pH	m	Deg.C	g/m3	g/m3
GND3007	26/04/18	20.6	32.1	2.98	0.03	6.2	2.702	17.1	0.00182	248.4
	28/08/18	37	23.7			6		14.8		156
	30/07/19	19.4	14.4	0.135	<0.002	5.9		13	0.000032	90
	31/10/19	27	17.7	0.023	<0.002	5.6		14.4	<0.000010	112
	5/06/20	8.6	19.7	0.022	0.085	6.7		14	0.000032	124
	26/08/20	13.1	18	<0.01	0.098	6.6		13.3	<000013	111
Average		20.95	20.93	0.79	0.07	6.17	2.70	14.43	0.000628	140.23

For drinking water, the New Zealand Drinking Water Standards (2008) set a Maximum Acceptable Value (MAV) of 50 mg/l for nitrate, which is the equivalent to 11.3 g/m^3 nitrate-nitrogen.

The sampling results for monitoring bore GND 3007 show the levels of nitrite/nitrate nitrogen ranged between 0.003 g/m^3 and less than 0.002 g/m^3

A monitoring bore GND 2188 is located upstream of the upper Irrigation Area and monitors the groundwater before it enters the Irrigation and composting areas. Monitoring of this well started in February 2011 and the sampling results are shown in Table 11 below:

TABLE 11: MONITORING RESULTS OF SAMPLING THE MONITORING BORE GND 2011 SITED ABOVE THE UPPER IRRIGATION AREA RECORDS THE GROUNDWATER ENTERING THE URUTI COMPOSTING AREA.

Control monitoring bore GND 2188		Chloride	Conductivity	NH4 Ammoniacal nitrogen	NNN Nitrite/ Nitrate nitrogen	PH	LEVEL	Temperature	NH3 Un-ionised ammonia	Total Disolved Solids
	Tier One	0 - 1,000	< 350							
	Tier Two	1,000 - 2,000	350 - 700							
	Tier Three	> 2,000	> 700							
Site	Collected	g/m3	mS/m@20C	g/m3 N	g/m3 N	pH	m	Deg.C	g/m3	g/m3
GND2188	4/02/11	50.4	64.4	0.106	2	7.1	0.89	18.3	0.00056	498.3
GND2188	11/02/11	53.1	64.1			7.1	0.88	18.1		495.9
GND2188	19/08/11	40.2	52.7	1.14	0.01	7.3	0.76	12.9	0.0064	407.7
GND2188	26/04/12	63	70.2	1.16	0.02	6.9	1.4	16.4	0.00337	543.1
GND2188	21/11/12	58.4	65.2	0.91	0.34	6.8	1.27	15.4	0.00195	504.5
GND2188	14/06/13	71.3	46.7	0.023	7.76	6.3	0.83	14.5	0.00001	361.3
GND2188	14/01/14	63.5	52.5	0.325	1.29	6.6	1	17.7	0.00052	406.2
GND2188	15/05/14	90.5	57	0.048	8.52	6.2		16.2	0.00003	441
GND2188	20/06/14	75.2	47.3	0.64	1.87	6.6		13.7	0.00076	366
GND2188	21/01/15	70.2	66.3	0.512	<0.01	6.7		15.9	0.0009	513
GND2188	30/04/15	92.2	58.8	0.171	<0.01	6.4	0.703	15.7	0.00015	454.9
GND2188	16/03/16	70.4	71.2	0.676	<0.01	6.8	1.43	18.1	0.00177	550.9
GND2188	8/06/16	159	66.7	0.03	7.47	5.9	0.675	14.2	0.00001	516.1
GND2188	3/08/16	238	95.6	0.12	1.64	5.9	0.28	13	0.00003	739.7
GND2188	14/12/16	333	132	0.182	0.02	5.8	0.998	14.5	0.00004	1021.3
GND2188	17/08/17	102	65.5	0.253	<0.01	5.9	0.33	12.6	0.00006	506.8
GND2188	28/02/18	89.9	76.7	1.91	<0.01	6.6	0.954	18.2	0.00318	593.4
GND2188	26/04/18	71.9	51.5	0.006	7.46	5.4	0.671	17	<0.00001	398.5
GND2189	28/08/18	82	76.6			6.6		13.7		480
GND2190	22/02/19	81	77.5	1.15	0.4	6.9		17.7	0.0036	470
GND2191	30/07/19	111	74.4	2.1	0.009	6.7		14.2	0.0031	470
Average		98.4	68.2	0.6	2.8	6.5	0.9	15.6	0.00147	511.4

Results of monitoring bores sampling of groundwater entering and leaving the site is summarised in Table 12 shown below. Six analytes were compared, and the results showed that 5 analytes improved (decreased) and one analyte worsened (increased) in the groundwater leaving the catchment when compared with the groundwater entering the composting site.

TABLE 12: COMPARING THE MONITORING RESULTS OF THE GROUNDWATER ENTERING AND LEAVING THE URUTI COMPOSTING SITE USING AVERAGED SAMPLING RESULTS FROM TABLE 10 AND TABLE 11.

		Chloride	Conductivity	Ammoniacal Nitrogen NH_4	NNN Nitrite/Nitrate Nitrogen	Un-ionised ammonia NH_3	Total Disolved Solids
		g/m^3	mS/m@20C	g/m^3 N	g/m^3 N	g/m^3	g/m^3
Groundwater entering the site	GND2188	98.39	68.23	0.60	2.77	0.00147	511.36
Groundwater leaving the catchment	GND3007	20.95	20.93	0.79	0.07	0.000628	140.23
Difference		-77.44	-47.3	0.19	-2.7	-0.00084	-371.13
% Difference		-79%	-69%	32%*	-97%	-57%	-73%

*Sampling of Ammoniacal Nitrogen in a bore representative of groundwater leaving the catchment has occurred on five occasions. The first sampling event occurred in April 2018 shortly after the bore was constructed. The first sampling event (April 2018) showed a high level of Ammoniacal Nitrogen in ground water and the four subsequent samplings showed lower results. Further sampling of this bore is required to establish a representative trend.

The potential for groundwater/surface water connectivity has been considered. Analysis of surface water monitoring results is more complex given the other potential inputs to the system, however indicates that the levels in surface water are generally compliant, and that spikes in NH_4 in surface water leaving the site are linked to specific management events/incidents, as opposed to ongoing irrigation activities. This is discussed in section 5 of the AEE for the renewal of consents at the site and other management changes will address these issues.

It is noted that the monitoring results discussed reflect historic management practices at the site, while the OVERSEER® modelling projects forwards and is based on the activities on the site in 2022. It is therefore not appropriate to directly correlate the OVERSEER® predictions in this report with the historic monitoring data. The purpose of including this information is to show that even under current practices, the groundwater quality leaving the site is acceptable.

Significant changes have been, and will continue to be implemented to mitigate effects (these mitigation measures are also detailed in the AEE for renewal of consents at the site) and are anticipated to further improve discharge quality and further reduce potential and actual effects on the environment.

5.0 Compost Applications

5.1 Background

Mature compost from pads 1 and 3 is applied to the irrigation areas as a soil conditioner.

Two scenarios are modelled in Overseer to show the effect of the compost applications at different application rates.

5.2 Compost Application

It is proposed to apply compost to the 12-ha irrigation area in 3 equal applications in November, January and March of each year. The report assumes the compost has a bulk density of 500 kg/m^3.

Scenario 1

1,000 m^3 of compost converts to 500 tonnes which when applied to 12 ha at a rate of 14 tonne/ha.

Scenario 2

2,000 m^3 of compost converts to 1,000 tonnes which when applied to 12 ha at a rate of 28 tonne/ha.

5.3 Compost Nutrient Analysis

A compost nutrient analysis is contained in a Hill Laboratories analysis dated 16 January 2020. The nutrient analysis is shown in Table 13 below:

TABLE 13: NUTRIENT ANALYSIS OF COMPOST DATED 16 JANUARY 2020 ON A WET WEIGHT BASIS

	DM	Nitrogen	Phosphorus	Potassium	Sulphur	Calcium	Magnesium	Sodium
	%	%	%	%	%	%	%	%
Dry wgt		0.61	0.19	0.27	0	0	0	0
Wet wgt	60	0.336	0.114	0.162	0	0	0	0

5.4 Scenario 1 - Nutrient Budget Nitrogen analysis of compost application - (1000 m^3)

The compost application rate shown in 5.2, Scenario 1 and the nutrient analysis listed in table 11 were entered into OVERSEER scenario 2022 + compost c. The total nutrients entering and leaving the Irrigation Area from the irrigation fluid and the compost was calculated by OVERSEER and the amounts of Nitrogen entering and leaving the Irrigation Area are shown in tables 15, 16, 17 and 18 below.

5.5 Total Nitrogen entering the Irrigation Area with the addition of compost applications

The total amount of nitrogen entering the Irrigation Area calculated by OVERSEER® is shown in Table 14 below:

TABLE 14: NITROGEN ENTERING THE IRRIGATION AREA WITH THE ADDITION OF COMPOST APPLICATIONS - SCENARIO 1 (2022 + 1000 GRAZED)

Nitrogen entering the Irrigation Areas	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
In irrigation fluid	346	346	4,560
In compost	114	114	1,502
In rainfall and clover fixation	11	23	241
Total	471	483	6,304

5.6 Total Nitrogen leaving the Irrigation Area with the addition of compost application

The total amount of nitrogen removed from the Irrigation Area calculated by OVERSEER® is shown in Table 15 below:

TABLE 15: NITROGEN REMOVED FROM THE IRRIGATION AREA WITH THE ADDITION OF COMPOST APPLICATIONS - SCENARIO 1 (2022 + 1000 GRAZED)

Nitrogen removed from the Irrigation Areas	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
Leached from the root zone	129	177	2,087
To atmosphere	46	30	477
As baleage	274	267	3,554
Added to the organic Nitrogen pool	22	9	185
Total	471	483	6304

5.7 Nitrogen leaving the whole farm with the addition of compost applications

OVERSEER® calculates the amount of Nitrogen leached from the root zone from the Irrigation Area and it is shown in Table 16 below:

TABLE 16: TOTAL NITROGEN LEACHED FROM THE ROOT ZONE FROM THE IRRIGATION AREA WITH THE ADDITION OF COMPOST APPLICATIONS – SCENARIO 1 (2022 + 1000 GRAZED)

Total Nitrogen leached from the Irrigation Area		Kg/yr
Leached from the Upper Irrigation Area	5.12 ha	660
Leached from the Lower Irrigation Area	8.06 ha	1,427
Total Nitrogen leached from the root zone		2,087

Overseer calculates that 2,087 kg N/yr is leached from the root zone of the Irrigation Area when irrigation fluid plus 1000m^3/ha/year compost is applied.

The irrigation blocks are one component of total nitrogen loss from the farm. Nitrogen loss represented on a whole farm basis, modelling the remainder of the land as unproductive/ungrazed pasture or trees and scrub is shown in Table 17 below:

TABLE 17: TOTAL NITROGEN LEACHED ON A WHOLE FARM BASIS AS CALCULATED BY OVERSEER - SCENARIO 1 (2022 + 1000 GRAZED)

Total Nitrogen leached from the farm blocks		Kg/yr	Kg/ha/yr
Upper Irrigation Area	5.12 ha	658	129
Lower Irrigation Area	8.06 ha	1,435	177
Cattle grazing	191 ha	2,385	13
Wetland	1.09 ha	3	3
Regenerating forest	407 ha	1,222	3
Roads, pads, ponds, workshop	29 ha	163	6
Other sources	-	21	-
Total Nitrogen leached from the root zone		5,887	9

OVERSEER® calculates that the compost applications (1,000 m3/yr) added 114 kg N/ha/yr to the irrigation Area and the total nitrogen leached from the Irrigation Area increased by 1,065 kg N/yr from 1,025 to 2,087 kg N.

When modelled on a whole farm basis, nitrogen leached over the whole farm increased from 7 to 9 kg N/ha/yr as a result of the application of 1000m3/yr.

5.8 Scenario 2 - Nutrient Budget Nitrogen analysis of compost application - (2000 m^3)

The compost application rate shown in 5.2, Scenario 2 and the nutrient analysis listed in table 11 were entered into OVERSEER scenario 2022 + 2,000 m3 compost. The total nutrients entering and leaving the Irrigation Area from the irrigation fluid and the compost was calculated by OVERSEER and the amounts of Nitrogen entering and leaving the Irrigation Area are shown in tables 16, 17, 18 and 19 below.

5.9 Total Nitrogen entering the Irrigation Area with the addition of compost applications

The total amount of nitrogen entering the Irrigation Area calculated by OVERSEER® is shown in Table 18 below:

TABLE 18: NITROGEN ENTERING THE IRRIGATION AREAS WITH THE ADDITION OF COMPOST APPLICATIONS - SCENARIO 2 (2022 + 2000 GRAZED)

Nitrogen entering the system	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
In irrigation fluid	346	346	4,560
In compost	227	227	2,991
In rainfall and clover fixation	4	16	149
Total	577	589	7,700

5.10 Total Nitrogen leaving the Irrigation Area with the addition of compost applications

The total amount of nitrogen removed from the Irrigation Area calculated by OVERSEER® is shown in Table 19 below:

TABLE 19: NITROGEN REMOVED FROM THE IRRIGATION AREAS WITH THE ADDITION OF COMPOST APPLICATIONS - SCENARIO 2 (2022 + 2000 GRAZED)

Nitrogen removed from the system	Upper Irrigation Block 5.12 ha	Lower Irrigation Block 8.06 ha	Total Irrigation Blocks 13.18 ha
	Kg/ha/yr	Kg/ha/yr	Kg/yr
Leached from the root zone	198	257	3,085
To atmosphere	64	37	625
As baleage	282	274	3,652
Added to the organic Nitrogen pool	34	21	343
Total	578	589	7,706

5.11 Nitrogen leaving the whole farm with the addition of compost applications

OVERSEER® calculates the amount of Nitrogen leached from the root zone from the Irrigation Area and it is shown in Table 20 below:

TABLE 20: TOTAL NITROGEN LEACHED FROM THE ROOT ZONE FROM THE IRRIGATION AREA WITH THE ADDITION OF COMPOST APPLICATIONS – SCENARIO 2 (2000 M^3)

Total Nitrogen leached from the Irrigation Area		Kg/yr
Leached from the Upper Irrigation Area	5.12 ha	1,013
Leached from the Lower Irrigation Area	8.06 ha	2,071
Total Nitrogen leached from the root zone		3,085

Overseer calculates that 2,854 kg N/yr is leached from the root zone of the Irrigation Area under this scenario. The impacts of this on nitrogen loss over the whole farm is shown in Table 21 below:

TABLE 21: TOTAL NITROGEN LEACHED FROM THE IRRIGATION AREA WITH THE ADDITION OF COMPOST APPLICATIONS ON A WHOLE FARM BASIS - SCENARIO 2 (2000 M^3)

Total Nitrogen leached from the farm blocks		Kg/yr	Kg/ha/yr
Upper Irrigation Area	5.12 ha	1,009	198
Lower Irrigation Area	8.06 ha	2,079	257
Cattle grazing	191 ha	2,676	14
Wetland	1.09 ha	3	3
Regenerating forest	407 ha	1,222	3
Roads, pads, ponds, workshop	29 ha	163	6
Other sources	-	27	-
Total Nitrogen leached from the root zone		7,179	11

OVERSEER® calculates that the compost applications (2,000 m3/yr) added 227 kg N/ha/yr to the irrigation Area and the total nitrogen leached from the Irrigation Area increased by 2,060 kg N/yr from 1,025 to 3,085 kg N.

Nitrogen leached on a whole farm increased due to the compost application (2000m^3/yr) from 7 to 11 kg N/ha/yr.

6.0 Conclusion

- The amount of nitrogen applied to the irrigation areas is dependent on the nitrogen concentration in the Irrigation pond.
- The amount of nitrogen entering the irrigation pond is dependent on the type and volume of products received on the receiving and mixing pads.
- The amount of nitrogen entering the irrigation pond from rainfall runoff and leachate from the compost windrows is minimised by using good management practices in the construction and maintenance of the windrows.
- Operating the aerator at the Irrigation pond will remove nitrogen from the pond through volatisation.
- Significant amounts of nitrogen are removed from the soil in the irrigation areas with the cut and carry of harvested pasture.
- The cut and carry operation will also remove other nutrients essential for plant health and growth which will need to be replaced with a customised fertiliser dressing.
- An analysis of the total Nitrogen leached form the root zone of the Irrigation Area is shown in table 29 below:

TABLE 22: ANALYSIS OF NITROGEN LEACHED FROM THE ROOT ZONE – ALL SCENARIOS

		No compost	Scenario 1 (1,000 m^3)	Scenario 2 (2,000 m^3)	AECOM 2019 Scenario
Total Nitrogen leached from the root zone – irrigation area	Kg/yr	1,025	2,087	3,085	3563
Nitrogen leached from the root zone – irrigation area	Kg N/ha/yr	77	158	234	992
Nitrogen leached over whole farm	Kg N/ha/yr	7	9	11	11

- Under past site management practices, results of monitoring bores sampling shows groundwater leaving the site is below the NZ drinking water level guideline for Nitrate. The AECOM 2019 scenario shown in Table 22 would be indicative of the OVERSEER® modelled losses under the management practices occurring at the time of the recent samples.
- Compared to the 2019 scenario modelled by AECOM (which has led to the management changes and mitigation measures that are now presented in this report), N losses are significantly reduced.
- It is recommended that compost application be capped at 1000m^3/year at this stage, however over time the volume may be able to be increased as the nitrogen levels in irrigation water respond to the mitigation measures that have been put in place. The appropriateness of this could be demonstrated by modelling updated actual nitrogen concentrations in the irrigation water with increased compost application. The applicant may also investigate options for non-irrigation areas to apply compost to.

Appendix 1 – Irrigation Block Management Plan

(4.4 Leachate and Stormwater Management Plan)

URUTI COMPOSTING & VERMICULTURE FACILITY

Leachate & Stormwater Management Plan

Document No:RU-650-0500-A

Revision No:1.5

Date: 5 June 2020

Version Control

Version	Date	Description	Prepared	Reviewed	Approved
V1.1	26-7-2018	Draft for review	C Kay		
V1.2	27-8-2018	Draft for review	C Kay		
V1.3	10-9-2018	Draft for review	C Kay		
V1.4	3-6-2020	Draft for review	C Kay		
V1.5	3-6-2020	Draft for review	C Kay		

Table of Content

0.0 Terms and Definitions

xxx	yyy

1.0 Purpose of the Plan

The purpose of this document is to outline how the pond system that treats leachate generated from the compost pile and contaminated stormwater from pads 1 and 3 and the Truck Washdown area is managed.

2.0 General

The pad 1 and 3 pond system comprise of three separate ponds systems

- Pad 3 treatments ponds comprising:
    - Dewatering and settling pond
    - Silt collection pond
    - Skim pond
    - Settling ponds 1 & 2
    - Irrigation pond
- Duck pond
- Washdown settling pond

3.0 Resource consent conditions

Condition 14 Before 30 November 2015 the holder shall review and update the Uruti Composting Facility management Plan supplied in support of application 5838-2.2 and any changes shall be submitted for approval to the TRC. The plan shall be adhered to and reviewed on an annual basis (or as required) and any changes shall be submitted to the TRC. The plan shall include but not limited to;

a) Trigger limits for the three tier management system tiers set out in section 3.1 of the Uruti Composting Facility Management Plan
b) Monitoring frequencies of soil and groundwater in Tiers one, two, and three.
c) Remediation options for Tier three irrigation areas;
d) Riparian planting of irrigation areas;
e) Stormwater improvements at the site;
f) Water storage for dilution and remediation;
g) Soil and ground water analysis; and

Condition 20 The consent holder shall prepare a Pond Treatment System Management Plan which details management practices undertaken to maximise treatment capabilities of the system. The plan shall be submitted for approval to the TRC, within one month of the commencement date of this consent.

The Management Plan shall address but not necessarily be limited to, the following matters:

How the build-up of sediment and/or sludge will be managed within the entire system, how the level of build-up will be monitored including factors that will trigger management, and the frequency of undertaking the identified measures or procedures;

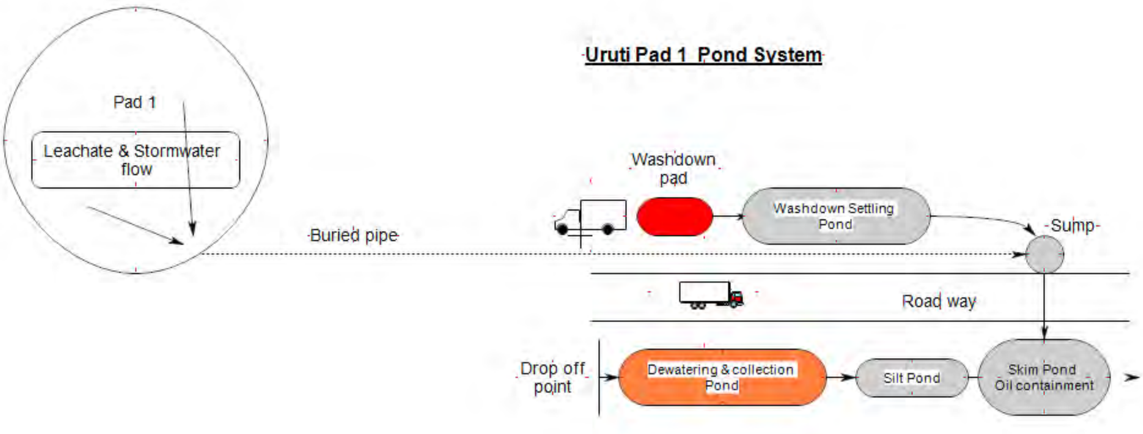
How overloading of the system will be prevented; and

How any offensive or objectionable odours at or beyond the boundary will be avoided in accordance with condition 13 of consent 5839-2

Condition 21 Operations on site shall be undertaken in accordance with the Pond Treatment System Management Plan, approved under condition 18 above, except in circumstances when the proposed Implementation Plan, approved under condition 9 of consent 5839-2, specifies otherwise.

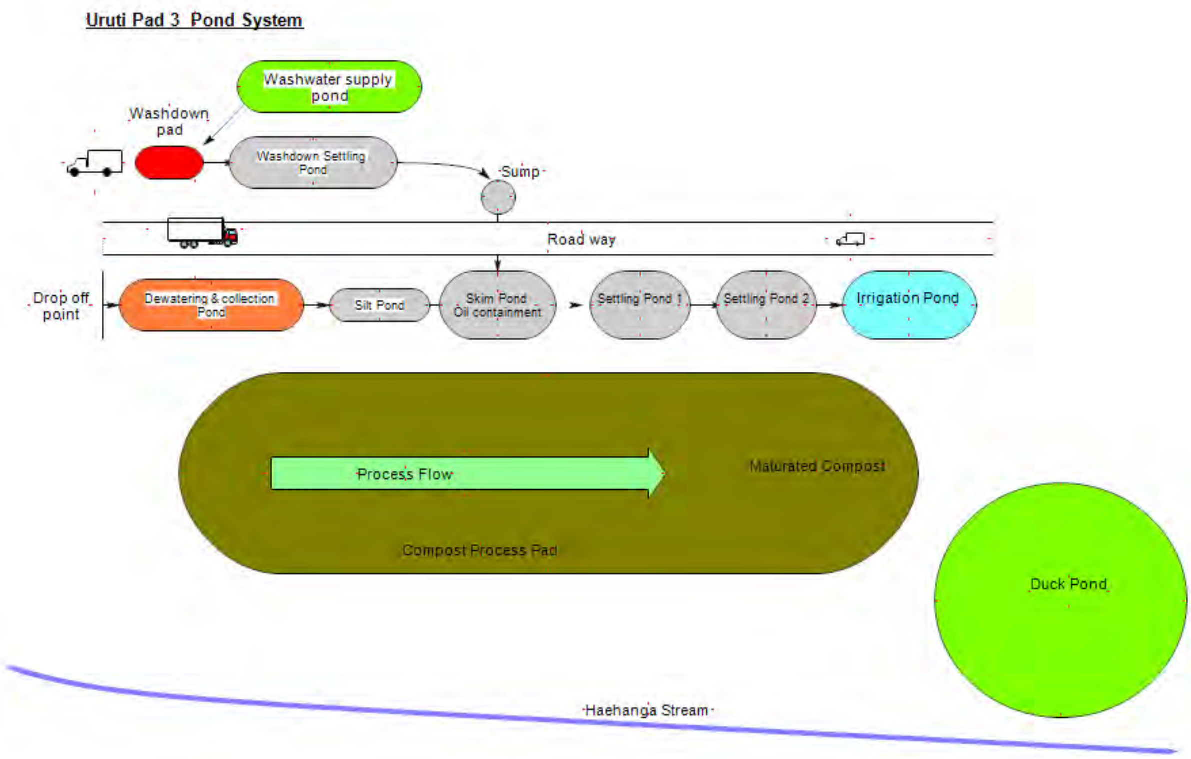
3.1 Pad 1

Figure 1: Pad 1



3.2 Pad 3

Figure 2: Pad 3



4.0 Pond Management Plan

4.1 Purpose of the Plan

This document describes the role of each pond system and provides instructions for the operation and maintenance for each system

4.2 Pond system inspection

Each pond is inspected daily to ensure the pond levels are maintained and there is no unplanned liquid overflow and the solids or sediment in each pond are below the planned maximum levels.

4.3 Dewatering and settling pond system

4.3.1 General

Organic waste is deposited onto Pad 1 or the mixing area. This organic waste is mixed with sawdust and greenwaste and deposited onto the compost pile. Surplus liquids are collected in the dewatering and collection pond. Liquids overflow into a series of settling and treatment ponds and eventually flow into the Irrigation pond. The pond levels are maintained by a series of T weirs at the pond discharge.

4.3.2 Operational and Maintenance

1) Dewatering and Collection Pond

   Monthly - Scoop out sediment from the pond and deposit onto the compost pile

2) Silt Pond

   Monthly – scoop out and deposit into the dewatering and collection pond

3) Skim Pond

   Monthly – skim hydrocarbons from the pond and deposit into the hydrocarbon collection tank

   Annually – Scoop out sediment and deposit into dewatering and collection pond

4) Settling pond 1 & 2

   Annually – Scoop out sediment and deposit into dewatering and collection pond

5) Irrigation pond

   Annually – Scoop out sediment and deposit into dewatering and collection pond

4.3.3 Duck pond

4.3.3.1 General

The duck pond maintains its level by ground soakage. Water from the duck pond is pumped into the irrigation pond during dry conditions to maintain dilution levels in the irrigation liquid and to the washdown supply pond to maintain minimum pond levels to provide washdown water during dry conditions.

4.3.4 Washdown settling pond

4.3.4.1 General

The washdown pad is used to clean trucks after they have dumped their load of organic waste. Wash water is pumped from the washdown supply pond. Runoff liquids from the wash are collected in the washdown settling pond and the pond overflow flows to the collection sump and then into the skim pond

4.3.4.2 Operational and Maintenance

Six monthly – scoop out sediment and deposit into dewatering and collection pond.

4.4 Irrigation Block Management Plan

4.4.1 Purpose of the Plan

The purpose of this document is to provide the methodology and procedures to ensure the waste water from the Irrigation Pond is irrigated onto the irrigation block in compliance with consent conditions

4.4.2 Resource Consent Conditions

Condition 8 The consent holder shall record the following information in association with irrigating waste water to land:
a) The date, time and hours of irrigation;
b) The volume of waste water irrigated to land;
c) The conductivity of the irrigation fluid (measured in mS/m)
d) The source of the waste water [e.g. Pond or Wetland Treatment System]; and
e) The location and extent where the wastewater was irrigated.

Condition 9 There shall be no direct discharge to water as a result of irrigating wastewater to land. This includes, but not necessarily limited to, ensuring the following:

a) No irrigation shall occur closer than 25 m to any surface water body;
b) The discharge does not result in surface ponding;
c) No spray drift enters surface water;
d) The discharge does not occur at a rate at which it cannot be assimilated by the soil/pasture system; and
e) The pasture cover within irrigation areas is maintained at all times.

Condition 10 treated wastewater discharged by irrigation to land shall not have a hydrocarbon content exceeding 5% total petroleum hydrocarbon or a sodium adsorption ratio exceeding 18.

Condition 11 Discharges irrigated to land shall not give rise to any of the following adverse effects on the Haehanga Stream, after a mixing zone extending 30 m from the downstream extent of the irrigation areas;

a) A rise in filtered carbonaceous biochemical oxygen demand of more than 2.00 gm-3,
b) A level of unionised ammonia greater than 0.0025 gm-3,
c) An increase in total recoverable hydrocarbons;
d) Chloride levels greater than 150g/m3
e) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
f) Any conspicuous change in the colour visual clarity;

g) Any emissions of objectionable odour;
h) The rendering of fresh water unsuitable for consumption by farm animals; and
i) Any significant adverse effects on aquatic life.

4.4.3 Climate

NIWA virtual Climate Station -38.975, 174.525 Thirty years of rainfall and evaporation data is summarised in Table 1 below

Table 1: NIWA Virtual Climate Station 30-year data for a site near Uruti Site

Uruti	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Rainfall	120.0	107.0	119.2	151.2	181.2	189.5	181.8	178.0	175.4	188.4	149.4	149.0	1890.
Evaporation	134.5	108.0	88.6	52.7	31.1	21.4	25.4	39.0	57.5	85.1	109.3	126.0	878.6

4.4.4 Irrigation area

The Irrigation block consists of 8 areas as outlined in Appendix 22 as areas L1 to U3.

The area sizes are shown in Table 2 below

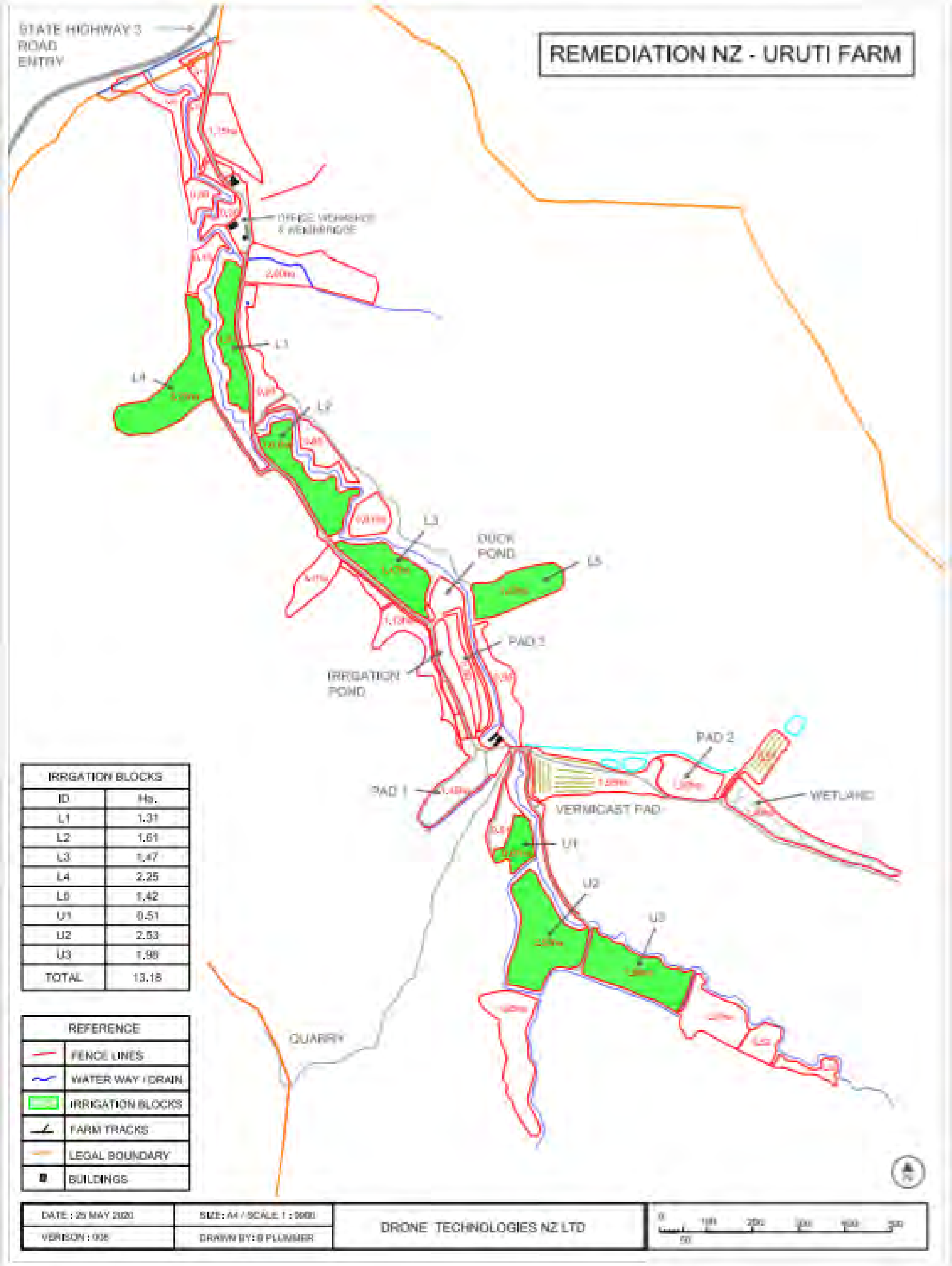
Table 2: Irrigation block areas

TRC	RNZ	Soil risk[1]	Ha
E	L1	Low risk	1.31
J	L2	Low risk	1.61
H	L3	Low risk	1.47
	L4	Low risk	2.25
	L5	Low risk	1.42
G	U1	High risk	0.61
	U2	High risk	2.53
F	U2	High risk	1.98
Total area			13.18

The locations of the 8 irrigation blocks are shown in figure 3 below

[1] Soil risk is discussed in “Irrigating High and Low risk Soils” refer to Appendix X

Figure 3: Irrigation areas



4.4.5 Soils

The soils in the effluent blocks were classified by BTW Company in the June 2015 report as Orthic brown soils from the Whangamomona Complex loams. A field survey by BTW Company using soil augers identified the top soil as Light brown grey silty clay and the subsoil as Light grey silty clay.

The soil texture was assessed by feel[2] during the KCL site visit as a silty loam as shown in Figure 1.

Figure 4: Photos showing test pit.

The assessment of the soils in the test pits indicated the top 300 mm of the soil profile consisted of 300 mm of a silty loam. The presence of mottles in the profile indicates that drainage is moderately drained.

4.4.6 Application Depth (Low risk soils)

It is important that the volume of effluent applied during each application does not exceed the water holding capacity of the soil in the plants root zone. The soil's Profile Available Water in the top 30 cm ($PAW_{30)}$ describes the maximum amount of water that can be held in the soil that is extractable by plants (i.e. plant available water).

The soils PAW_{30} was calculated using the methodology from the Farm Dairy Effluent Design Code of Practice FDEDCOP at 60 mm.

Industry good management practice is to restrict irrigation depth to less than 50% of PAW_{30}

Therefore, the maximum application depth is 30 mm.

As the irrigator does not distribute effluent evenly over the entire wetted area, in order to prevent over irrigating, the application depth is reduced by the distribution uniformity coefficient (DU). The FDEDCOP requires irrigators to achieve a DU of 1.25

Using a DU of 1.25 this gives an adjusted application depth **(Dt) of 25.0 mm.**

[2] Undertaken in general accordance with methodology described in 'Soil Description Handbook' Milne et al. (1995)

4.4.7 Application Rate (Low risk soils)

The FDE Design Code of Practice states that the maximum application rate must not exceed the soil infiltration rate. If effluent is applied at a rate greater than the soils infiltration capacity, effluent will pond on the soil surface and there is a risk of run off into surface water ways.

The soil infiltration rate was calculated using the methodology from the FDE Design Code of Practice at 15 mm/hr when using a watering time of 20 minutes.

Incorporating the losses gives a system design application rate **Ra = 15.00 mm/hr.**

4.4.8 Application Depth (High risk soils)

The principal applied to irrigation of high-risk soils is that it is important that the volume of effluent applied during each application does not exceed the soil water deficit.
The soil water deficit is calculated using a portable moisture probe.

The maximum application depth for high risk soils was calculated using the methodology from the FDE Design Code of Practice as:
The maximum application depth using a high rate irrigator (Travelling Irrigator) **(Dt) = 10 mm**
The maximum application depth using a low rate irrigator (Sprinkler pods) **(Dt) = 25 mm**

4.4.9 Application Rate (High risk soils)

The Farm Dairy Effluent (FDE) Design Code of Practice states that the maximum application rate must not exceed the soil infiltration rate. If effluent is applied at a rate greater than the soils infiltration capacity, effluent will pond on the soil surface and there is a risk of run off into surface water ways.

The soil infiltration rate for the subject site was calculated using the methodology from the FDE Design Code of Practice at 10 mm/hr.

The application depth for areas assessed as high risk should not exceed **Ra = 10.00 mm/hr**

4.4.10 Soil Chemistry

The BTW company report Uruti Composting Facility Management Plan (undated) developed a framework based on a three-tier decision tree which guides site operations in response to trigger levels of soil contaminants. The tiered response was developed because of its simplicity but also allows increased monitoring efforts and reviews of site performance to minimise risks from drainage to groundwater and accumulation of hydrocarbon constituents within the soil.

The three-tier framework is summarised in table 3 below.

Table 3: Three Tier response guidelines

Tier	Operation Status of irrigated area
One	Surveillance or normal operation of site
Two	Alert or increased level of monitoring with deferred irrigation
Three	Action or remediation options initiated and irrigation ceases

The trigger or threshold values and actions required are listed in the BTW company report in Appendix 23. The threshold values are summarised in table 4 below.

Table 4: Summary of the Three Tier threshold values for soil chemistry

Tier Level	Chloride	Total Petroleum Hydrocarbons (TPH)	SAR
	mg/kg	mg/kg	
One	0 – 700		0 – 6
Two	700 – 1,800	<20,000	6 – 18
Three	>1,800	>20,000	>18

4.4.11 Irrigation Model

The Irrigation Model is designed to proactively manage the pond levels. We receive predicted 14-day rainfall data from a Weather Forecaster on a weekly basis. We receive this data on Monday mornings and using the predicted rainfall data calculate the volume of stormwater that is predicted to arrive in the irrigation pond during the following week i.e. days 8 to 14. The irrigation plan is updated each Monday morning to account for this volume and the pond level is reduced during the week by irrigation to a level at the end of the week where the pond will have sufficient capacity to cope with the following weeks predicted rainfall.

We also receive a 3-monthly forecast which predicts the weather to be wetter than normal, normal or wetter than normal. The average rainfall data is entered into the model and multiplied by a correction factor to account for 3-month prediction e.g. normal = 0, wetter than normal + 10% and drier than normal = -10%.

The irrigation model is attached in Appendix 24

4.4.12 Standard Workplace Instruction

The Standard Workplace Instruction SWPI_RU-740-020-A provides instructions on how to operate the irrigation system so to achieve the design application depth and rate specific to the areas of high and low risk soil. Refer to Appendix 25

5.0

Appendix 2 – Nitrogen Cycle

Figure 1. Inputs, outputs and transformations of nitrogen in farming systems