LOWE Environmental Impact
[Sent by Email: ~~Post~~]
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Job No.10146

29 May 2015

The General Manager
Horizons Regional Council
Private Bag 11 025
PALMERSTON NORTH 4442

Attention: Jasmine Mitchell

Dear Jasmine

AFFCO FEILDING DISCHARGES – REVIEW OF APPLICATION

Thank you for your e-mail of 29 April 2015 in which you requested some clarification of issues relating to your review of the AFFCO consent applications. This letter is to provide a response to each the issues you have raised, in the order that you have raised them.

Several of the issues you have raised have been forwarded to Dr Olivier Ausseil for his response, which is provided as a memorandum dated 29 May 2015, appended *in toto* to this letter.

Issue 1: General
HRC Comment: *The proposal includes a 20% increase in production – why 20%?*

Applicant Response: The inclusion of an allowance for a 20% increase in MWE flows is noted in both Section 1 of the AEE (Executive Summary) and Section 5.3 (MWE Flow and Quality). In Section 5.3 there is reference to Appendix E, the Conceptual Design report. In Appendix E, Section 4.4 includes the following explanation:

"It is prudent to produce a conceptual design which can be operated for all flows over the term of the consent. There is potential that operations at the ANZ site could be expanded in the future. As the industry trends are often tied to factors outside of the plant's control it is not possible to predict with certainty what future MWE flows will be. As a result a generous increase in production has been adopted for development of the CLAWD system. This provides certainty that ANZ can operate within the system bounds, and enables the assessment the effects on the environment of a potential "worst case scenario". This approach minimises risk of non-compliance for the plant with future discharges.

An increase of 20 % of MWE flows has been adopted to estimate maximum MWE volumes for the term of the consent."

The 20% figure was adopted as a prudent and conservative contingency provision by the applicant.

Issue 2: General
HRC Comment: *This application seems to have a discharge preference of land, river and then storage whereas most combined land and water discharges seem to be land, storage and then river – is there a reason for this?*

Applicant Response: Management of storage to ensure there is available volume when it is needed is critical to the success of a CLAWD system. This is necessary to avoid a non-complying discharge to either water or land. This order of priority is considered to be appropriate for the AFFCO discharge application since extensive work has gone into the design of the water discharge regime to ensure that any discharge will have effects not more than those assessed in the resource consent application. As a result there is no environmental advantage gained by changing to a land-storage-water order of preference.

Issue 3: General
HRC Comment: *There is a slight difference between the application and proposed conditions eg the volume to be discharged and parameters to be monitored. It might be useful to tidy these things up.*

Applicant Response: In the event that there is a difference between the consent application and the proposed consent conditions, it is the consent conditions that should be considered. The proposed conditions reflect conditions that have been imposed for comparable discharge schemes, but whose consents were granted following the completion of the AFFCO main consent application document.

Issue 4: Water Discharge
HRC Comment: *There is a reference to the discharge being from the Wallace Corp factory – does the water discharge contain any heavy metals?*

Applicant Response: The Wallace Corp plant was formerly part of the Borthwicks meat processing plant, with its discharges part of the normal suite of wastewater produced by a comprehensive meat processing plant. When AFFCO rebuilt the plant in about 1991, the skin processing plant was on-sold to Wallace Corp, with agreement that its wastewater discharge would continue to be managed through the AFFCO waste system.

Wallace Corp's wastewater has continued to be discharged into the ANZ treatment ponds until recently. However, for various reasons Wallace Corp have chosen pursue other discharge options, and **no** Wallace Corp wastewater is discharged to the ANZ ponds. Wallace Corp's waste stream is now trucked to another facility for appropriate disposal.

Issue 5: Water Discharge
HRC Comment: *What are the cumulative effects on the Manawatu River as the Oroua catchment can be running at high flows while the Manawatu will still be low.*

Applicant Response: This question was referred to Dr Ausseil for consideration; his response is provided in Section 2 (headed Question 5) of his appended memorandum.

Issue 6: Water Discharge

HRC Comment: *This application refers to Phosphorus being the limiting nutrient in the Oroua River while the assessment from Dr Ausseil's assessment and different from the recent Feilding WWTP consent – what is the rationale for this? (Same issue raised in November.)*

Applicant Response: For the consent application the use of a limiting nutrient refers to the nutrient used for determination of a rate of discharge for the wastewater i.e. the amount of wastewater discharged is limited by the mass loading of phosphorus that results in a concentration change of x in the Oroua River. This is distinct from the limiting parameter for periphyton growth which is a water quality consideration rather than a design criteria consideration.

Issue 7: Water Discharge
HRC Comment: *What are the effects on the River between the Oroua River and 20th FEP? (Same issue raised in November.)*

Applicant Response: This question was referred to Dr Ausseil for consideration; his response is provided by Section 3 (headed Question 7) of his appended memorandum.

Issue 8: Water Discharge
HRC Comment: *The use of nutrient loadings for determining the discharge rate – its referred to both DRP and SIN levels however SIN is only referenced once.*

Applicant Response: Both DRP and SIN levels were considered when determining an acceptable rate of discharge to the Oroua River based on a concentration change of those analytes in the river. However, for the flow range in which discharge to river is proposed to occur, consideration of DRP always resulted in a lower volume of wastewater being discharged and so DRP was always the more limiting nutrient and was adopted for calculating the discharge rate/volume.

Issue 9: Water Discharge
HRC Comment: *The discharge is based on the dilution within the Oroua, however there are two references as to when the discharge rate is calculated. Is there any proposal to relate this into actual in-stream river flows? The Oroua is known to change during the day – does this affect the impact the assessment of effects?*

Applicant Response: Details of how the river flow will be used in practice to determine river discharge volume is given in the "reason" description for Condition 2 of the discharge to surface water proposed consent conditions (Appendix L).

With regard to the use of real-time monitoring to adjust discharge volumes in practice, there is no plan to use real-time adjustment as there is no significant environmental benefit, when assessed against One Plan targets, in doing so and a substantial time and cost associated with such a scheme.

Additional discussion of this point is given in the appended memorandum provided by Dr Ausseil, under Section 4, headed Question 9.

Issue 10: Pond Seepage
HRC Comment: *There is reference to the clay liner being able to absorb DRP due to the clays binding abilities – is this still the case if the ponds are 40 years old and does this affect the quality of the water discharge?*

Applicant Response: Section 8.5.2, in particular, page 49 discusses DRP leaching at length. As acknowledged on page 48 the DRP values in the bore immediately downgradient of the pond are elevated compared to the surrounding bores. If the source of the DRP is the ponds then this would suggest that DRP has come through the liner, indicating incomplete retention. However, as discussed on page 49, the concentration of DRP compared to other measured analytes when compared to the pond concentration is substantially lower. Given all analytes will be subject to the same dilution upon entering the groundwater, this indicates that some retention by the pond liner is occurring, but not 100 %. To determine if this is due to the capacity of the liner to retain P reducing over time would require monitoring over time which is proposed in the resource consent application. It should also be noted that P in the groundwater may be being influenced by other material buried in close proximity to the ponds, and as a result the P concentrations observed are not necessarily directly related to P leaking thought the pond liner.

Having acknowledged that DRP appears to be elevated in groundwater at the location downgradient of the pond, Section 8.5.2 goes on to assess the likely impact on water quality and concludes that, at MALF, the discharge would result in a change in the river concentration of less than 4 % of the DRP **detection limit**.

Issue 11: Water Discharge
HRC Comment: *The basis of the discharge relates to a very small increase in DRP being 0.005mg/l increase in DRP and this has been included as the value in the water modelling – why was this used? This is half of the One Plan target used and the increase will mean that the target will be exceeded? Is this the case?*

Applicant Response: The One Plan target is an annual average and so, no, the target will not be exceeded. This is explained in detail in the Report of Dr Ausseil, which is Appendix G of the resource consent application document. The report demonstrates that the One Plan target can be met, not only on an annual basis but also on a monthly basis.

Issue 12: Water Discharge
HRC Comment: *Are you able to provide a calculation of the nutrient loads that are contributed to the Manawatu River? The proposal seems to increase the overall load to the Oroua River and Manawatu River. How does this fit within the overall objective of maintain or enhancement of water quality?*

Applicant Response: This question was referred to Dr Ausseil for consideration; his response is provided by Section 5 (headed Question 12) of his appended memorandum.

Issue 13: Water Discharge
HRC Comment: *The proposal includes the discharge at flows above median flows and it is based on a dilution ration instream – how does this compare to the current situation at these flows instream? At flows below median there is an improvement in water quality downstream*

of the discharge. However, is this the case at flows between median and the 20th FEP or does the discharge result in a increased discharge volume at these flows and therefore an increase in the instream concentrations? If there is an increase in the concentrations between these flows could the applicant analysis the effects of this on the Feilding STP consent given that there discharge regime has them discharging to half median flow and below this at times. Periphyton accrual begins below the 20th FEP and any potential increase in nutrients upstream of the discharge may affect the ability of them to comply with any consent conditions.

Applicant Response: This question was referred to Dr Ausseil for consideration; his response is provided by Section 6 (headed Question 13) of his appended memorandum.

Issue 14: Ponds/Groundwater
HRC Comment: *The sludge has been removed by the digger, has this affected the clay lining?*

Applicant Response: The gravel which you have previously remarked on, on the floor of the pond, is understood to have been placed in line with good practice in the past to help protect the clay liner, so that when the pond is cleaned out the clay liner isn't damaged, i.e. the digger knows where to stop.

As you will know from the regulation of farm dairy effluent ponds, it is not possible to measure the permeability of clay liners *in situ* to the degree of accuracy required to meet the specified standard of 10^{-9} m/s. It is, however, possible to detect and measure gross leakage, and this has not been found to occur at the ANZ ponds. Accordingly, we do not consider that the clay lining of the ponds has been adversely affected by de-sludging activity. Further, in the absence of any detected leakage attributable to de-sludging in the past, we consider that the presence of the gravel in the bottom of the ponds will help to ensure that the clay lining remains intact in future.

Issue 15: Ponds/Groundwater
HRC Comment: *Can you provide a map of the groundwater monitoring points?*

Applicant Response: A map locating the bores and standpipes that have been used for plotting the groundwater surface is included as the third of three figures in Appendix A to the lodged AEE. That map shows groundwater surface contours and identifies bores and surface water level measurement sites with numbers running from 1 to 34. We omitted to include a reconciliation of depth to groundwater sites with registered bores in the lodged AEE, and this reconciliation is provided in Table 15.1 below.

Table 15.1: Reconciliation of Mapped Bore Sites with Bore Identifications

Bore Number on Groundwater Surface Contours Map	Bore Identification in Table 8.1 and Appendix I (Groundwater Composition Data)
1	325411
2	325016
3	325416B
13	325413
18	325273A
19	325257B
20	Standpipe, not sampled
21	325269C

31	Standpipe, not sampled
32	Standpipe, not sampled
33	Standpipe, not sampled
34	31 Matai

Sites from which groundwater samples have been taken for analysis and composition monitoring are identified in Table 8.1 in the AEE, and in Appendix I to the AEE (Groundwater Composition Data). These analytical sites include some from which depth measurements were made, but also include others from which depth measurements were not made. A map identifying the analytical sampling sites/ bore locations is attached to this letter at the end of Annex 16.

Issue 16: Ponds/Groundwater
HRC Comment: *The data is pretty limited and only provides a small snapshot of the water quality in the area and doesn't show any seasonal variations. Has any further monitoring been carried out since preparing the consent? I see that it is proposed to monitor quarterly?*

Applicant Response: As noted in Section 5.6 of the lodged AEE, there has been a large amount of information on groundwater gathered in the context of pond seepage at ANZ, both for this present application and previously. We consider that the data is considerably more comprehensive than could have been gained from the three piezometers that Hisham Zarour proposed for this purpose when investigations were initiated in 2010.

The AEE reports on analyses of groundwater samples taken in June 2013, April 2014 and May 2014. Further sampling and analysis was undertaken, but not included in the lodged AEE. All of the analyses that have been undertaken have now been compiled and reported as Annex 16 to this letter.

Issue 17: Ponds/Groundwater
HRC Comment: *From the limited data it is very hard to conclusively say that the effects are less than minor.*

Applicant Response: The data is not limited at all, and Sections 5.6 and 8.5 go to considerable lengths to reach the conclusion that the effects are no more than minor. The additional data provided will hopefully assist Council staff in reaching this same conclusion.

If there was a "more than minor" adverse effect from pond seepage, we consider that the investigations and results to date would have demonstrated that effect. We invite your further consideration of what has been provided, including that described in Annex 16, and perhaps an objective explanation of what further information could reasonably be provided as a basis for assessment as to whether the effect is more, or less, than minor.

Issue 18: Ponds/Groundwater
HRC Comment: *Are you proposing to install any additional monitoring bores?*

Applicant Response: Yes. Proposed Condition 11 in Section 2, Discharge to Groundwater (Appendix L: Proposed Conditions), identifies a program of groundwater composition monitoring. Section 10.3 of the AEE also refers to an ongoing monitoring program. While we believe that potentially an additional two bores should be installed, we will be pleased to discuss with you the number and location of monitoring bore sites that will be collectively acceptable for assessing pond leakage and land treatment.

Issue 19: Air Discharge
HRC Comment: *There seems to be no assessment of the application in terms of the air discharge. There is no assessment of the application of pond solids and paunch material in terms of the state of the material, where it will be placed and if there are any effects associated with this?*

Applicant Response: It had been anticipated that the two key air discharge conditions (no objectionable or offensive odours beyond the boundary, and keep a complaints register) would be applied as conditions to the land discharge consent, as they have been in the past. However, based on a recent Environment Court decision (Shannon municipal wastewater discharge consents) it was decided that a separate consent for the air discharge should be included.

Aspects of the air discharge are discussed in the following sections of the AEE:

- Section 5.8, (Description of the Proposed Activities), Discharge to Air.
- Section 6.3, Air Discharge Options.
- Section 8.2.2, Air Discharge Receptors and Sensitivities.
- Section 8.4, Discharge of MWE to Land by Irrigation. (Refers to Appendix F, AEE Land Discharge). Also refers to effects of odours and aerosols.
- Section 8.10, Effects on Air Quality.
- Section 9.4, (Mitigation), Effects on Air Quality.

The discharge to air of odours and aerosols from irrigation is fairly and correctly described in these sections of the AEE as having less than minor effects. The irrigated material is not particularly odorous, and aerosols will not carry to sensitive environments provided the proposed operational limitations are applied. Both farm dairy effluent and MWE have been irrigated onto Byreburn Farm for some years, and no odour complaint that can be attributed to wastewater irrigation has been received during that time. Section 13.3 of the AEE provides an account of a site inspection of the irrigation system with neighbours, where it was noted that "*It was clear that the effluent did not have an objectionable odour, which had been a main concern for neighbours.*"

The discharge to air arising from application of pond solids and paunch material to land has not been adequately addressed in the AEE, and Annex 19 to this letter provides information to correct this deficiency.

Issue 20: Air Discharge
HRC Comment: *Do you have any information on the existing travelling irrigator to determine the effects?*

Applicant Response: The only information on air quality effects arising from the use of the existing travelling irrigator is that there have been no complaints received arising from the activity. As noted in the response to Issue 19 above, Section 13.3 of the AEE accounts for a site inspection of the irrigation system with neighbours, where it was noted that "*It was clear that the effluent did not have an objectionable odour, which had been a main concern for neighbours.*"

The effluent referred to was in the process of being irrigated with the existing travelling irrigator. It clearly has operated, does operate, and will continue to operate in a manner that does not give rise to offensive or objectionable odours.

There may be the possibility of aerosols being propagated into sensitive environments. However, it is noted and proposed in several sections of the AEE to manage the risk of this happening by applying specified limits to both wind conditions during which irrigation will be allowable, and exclusion margins around the activity in line with other similar authorised discharges.

On the basis of the use of the travelling irrigator for this purpose over a period of some years, there is no reason to consider it in any way inadequate from the point of view of its ability to generate aerosols and odours.

Further, despite being used largely hassle free for more than 20 years, it is intended that the existing travelling irrigator will be phased out.

Issue 21: Air Discharge
HRC Comment: *Do you have an irrigation plan for the fixed irrigators in some areas? It would be useful to know the height above ground to determine whether there will be any spray drift.*

Applicant Response: No, there is not an irrigation plan for the fixed irrigators in some areas. Irrigators will be selected to meet consent conditions (we have proposed some) regarding spray drift. This will include specifications in tender documentation to ensure the DU (distribution uniformity co-efficient) and the application rate meet both the consent conditions and that expected with robust irrigation design.

Issue 22: Air Discharge
HRC Comment: *There is no assessment of the odour aspect other than saying it won't occur.*

Applicant Response: We have provided a description of the activity and the circumstances relating to potential air effects, as well as proposed measures to help ensure that air effects remain within acceptable limits.

In Annex 22 to this letter we have provided a FIDOL assessment of the air discharges expected to result from the irrigation of MES onto land.

Issue 23: Air Discharge
HRC Comment: *In order to ensure the irrigated wastewater doesn't become odorous, it may be that the DO level within the outlet needs to be managed, however there is no indication of how low the DO gets and what is done to correct it?*

Applicant Response: The wastewater in the main treatment facility at ANZ is constantly mechanically aerated, and as a result it is not particularly odorous. When this material is pumped to the irrigation area and irrigated by spray equipment it is also not particularly odorous. The organic nature of the material is also sufficiently low that when stored it does not go anaerobic.

The only way the irrigation can cause odours that are in any way different from their normal mild, rural background is if wastewater has been left in the pipeline from the storage pond to the irrigator for a significant period of time. In these circumstances wastewater left for the winter months when no irrigation is practicable, could well become anaerobic and release unpleasant odours when it is sprayed into the air when irrigation resumes in the spring.

This situation of unpleasant odours would only last as long as it takes for a pipe-full of anaerobic effluent to be discharged, a couple of minutes at the most. It could potentially smell unpleasant, but would dissipate quickly as the offending material was replaced in the pipeline and in the discharge from the irrigator by fresh, aerobic, acceptable-smelling wastewater.

The proposed management of this issue will be to specify a requirement for start-up from a shutdown period to be undertaken under conditions when any short term release of odours will not cause offense. We expect this matter to be covered in the Operational Management Plan that is proposed to be required as a condition of this consent.

It is not proposed to monitor DO levels within the treatment pond for the purposes of managing odours as a result of irrigation.

Issue 24: Air Discharge
HRC Comment: *Has there been any thought into odour monitoring around the edges of the irrigation area?*

Applicant Response: In the light of the field inspection of irrigation by the neighbours, and the agreement of those present that odour issues do not arise from wastewater irrigation, it is not proposed to institute any odour monitoring program around the edges of the irrigation area. If there was history of odour complaints attributable to the irrigation, or if the material to be irrigated was in fact unpleasantly smelly, then an odour monitoring program might be entertained. Instead, it is proposed that the neighbours to the irrigation area will comprise the odour monitors, as they have been for many years, and it will be in the interests of ANZ to ensure that these neighbours continue the established tradition of no odour complaints.

Issue 25: Air Discharge
HRC Comment: *There is some concern around the LMU2 area and the proximity to the residential properties and that some further controls may be needed in this area to manage the effects.*

Applicant Response: It is unclear what the concerns are and therefore it is difficult to comment whether the proposed use of buffer distances, wind speed cut-off and wind direction cut-off are insufficient. Owners and occupiers of the nearby residential properties have been consulted through the preparation of the consent application and so where issues have been expressed regarding odour and spray drift we have taken these into consideration when preparing the consent application.

We consider that the proposed conditions are suitable to protect the nearby properties from air quality effects, however the conditions include the recording of odour issues and the requirement to remedy any issues due to air quality effects of the spray irrigation. If there are other concerns please provide some further explanation so that we can better address them.

Conclusion
Your comments on the lodged AEE are appreciated, and as indicated above responses to each of your comments should be considered as additional to what has been provided in the final AEE where appropriate.

Yours sincerely

Lowe Environmental Impact

Hamish Lowe

ANNEXES

- Annex 16 – Further groundwater analyses and interpretation.
- Annex 19 – Paunch and Pond Solids, description of activity and AEE.
- Annex 22 – Effects of Odours from Irrigation of MES.
- Aquanet Response.

ANNEX 16 – PONDS GROUNDWATER MONITORING

1.0 Introduction

AFFCO New Zealand ("ANZ") Manawatu meat processing plant at Feilding has lodged resource consent application with Horizons Regional Council ("HRC") to re-authorise discharges of meatworks effluent to groundwater by seepage from the wastewater treatment ponds. HRC has asked for further groundwater quality data, and preferably information on any seasonal variations.

Further groundwater monitoring was carried out since preparing the consent application; this annex is to provide the results of that monitoring and its interpretation.

2.0 Monitoring Program

The lodged AEE at Section 8.5.2 (Table 8.1) addressed the results of monitoring from 14 bores, on up to 3 occasions, with analysis for a list of 15 analytes. The dates of sampling were as follows:

- 17 June 2013;
- 14 April 2014; and
- 15 May 2014.

Following those sampling rounds, an increased circuit of up to 24 bores were sampled on up to a further 5 occasions, with the additional dates of sampling being as follows:

- 18 June 2014;
- 21 July 2014;
- 18 August 2014;
- 11 December 2014; and
- 21 April 2015.

Not all bores were sampled on all occasions; some standpipes were newly installed part way through the program for the purpose of widening the information base, while the owners of some private bores were reluctant to allow ongoing access for sampling. Some bores were dry when sampled, and another had been run over by a tractor and could no longer be sampled.

3.0 Results

Appended to this Annex is a spreadsheet tabulating the analysis results. Hill's Laboratory analysis certificates are available in every instance, but have been omitted from this annex in the interest of saving space; the certificates may be examined on request. A summary tabulation of the results is given in Table 16.1 below, which is an enlargement from Table 8.1 in the lodged AEE.

Of the 15 analytes, the key ones are considered to be Ammoniacal Nitrogen (NH_4-N), Total Nitrogen (TN), and Dissolved Reactive Phosphorus (DRP). Concentrations of these 3 key analytes in 19 shallow groundwater samples and 5 deep groundwater samples are tabulated in Table 16.1 below, with the bores arranged in an approximate up-gradient to down-gradient order. Mean values of the concentrations of each analyte at each bore are given, and colour coded as follows:

■ Narrow range; maximum is not more than **2** times the minimum;

■ Medium range; maximum lies between **2 and 10** times the minimum;

■ Wide range; maximum is more than **10** times the minimum.

Table 16.1: Concentrations of Key Shallow Groundwater Analytes, ANZ Locality

Bore	Sampling Date	[NH_4-N] (g/m^3)	[TN] (g/m^3)	[DRP] (g/m^3)
325413 (upgradient)	17/06/2013	0.010	22.	0.004
	14/04/2014	<0.010	0.23	<0.004
	15/05/2014	<0.010	1.1	<0.004
	18/06/2014	<0.010	8.2	<0.004
	21/07/2014	0.012	9.9	<0.004
	18/08/2014	<0.010	38.0	<0.004
	11/12/2014	<0.010	-	<0.004
	21/04/2015	<0.010	55	<0.004
	Mean	<0.010	19.2	<0.004
325416B (upgradient)	17/06/2013	4.4	31	0.006
	14/04/2014	5.2	21	0.004
	15/05/2014	2.904	-	0.063
	18/06/2014	6.9	21	0.004
	21/07/2014	7.8	20	<0.004
	18/08/2014	5.9	19.4	0.004
	11/12/2014	-	-	-
	21/04/2015	8.2	34	0.006
	Mean	5.9	24.4	0.013
325411 (upgradient)	17/06/2013	0.052	0.12	0.004
	14/04/2014	0.055	0.12	0.064
	15/05/2014	0.075	<0.30	0.075
	18/06/2014	0.062	0.31	<0.004
	21/07/2014	0.063	0.27	0.004
	18/08/2014	0.059	0.22	<0.004
	11/12/2014	0.060	<0.11	0.015
	21/04/2015	0.053	<0.11	<0.004
	Mean	0.060	0.195	0.022
325016 (upgradient)	17/06/2013	1.030	1.54	0.004
	14/04/2014	0.870	1.3	0.280
	15/05/2014	0.820	1.3	0.260
	18/06/2014	0.810	1.2	0.005
	21/07/2014	0.950	1.3	0.042
	18/08/2014	0.890	1.46	<0.004
	11/12/2014	2.80	9.7	6.0
	21/04/2015	2.30	5.1	5.5
	Mean	1.309	2.863	1.512
325275B (upgradient)	17/06/2013	0.017	0.40	0.004
	14/04/2014	0.033	0.60	0.004
	15/05/2014	<0.010	0.35	<0.004
	18/06/2014	0.052	0.30	<0.004
	21/07/2014	0.035	0.43	<0.004
	18/08/2014	<0.010	1.77	<0.004
	11/12/2014	<0.010	1.87	<0.004
	21/04/2015	<0.010	0.35	<0.004
	Mean	0.022	0.759	<0.004

Bore	Sampling Date	[NH_4-N] (g/m^3)	[TN] (g/m^3)	[DRP] (g/m^3)
325273A (upgradient)	17/06/2013	0.013	1.05	0.004
	14/04/2014	0.034	0.61	0.004
	15/05/2014	0.020	0.76	<0.004
	18/06/2014	0.018	2.8	<0.004
	21/07/2014	<0.010	4.4	0.006
	18/08/2014	<0.010	10	0.006
	11/12/2014	<0.010	-	0.008
	21/04/2015	<0.010	21	0.006
	Mean	0.016	5.803	0.005
325269C (downgradient)	17/06/2013	15.4	34	0.055
	14/04/2014	32	45	0.128
	15/05/2014	31	41	0.148
	18/06/2014	15	56	0.054
	21/07/2014	10.2	58	0.026
	18/08/2014	9.4	55	0.026
	11/12/2014	6.7	-	0.026
	21/04/2015	3.0	34	0.016
	Mean	15.34	46.14	0.059
31 Matai (downgradient)	17/06/2013	1.1	1.45	<0.004
	14/04/2014	-	-	-
	15/05/2014	1.4	1.6	<0.004
	18/06/2014	1.3	1.75	<0.004
	21/07/2014	1.4	1.63	<0.004
	18/08/2014	1.2	1.68	<0.004
	11/12/2014	1.6	1.88	<0.004
	21/04/2015	-	-	-
	Mean	1.33	1.665	<0.004
28 Aorangi (downgradient)	17/06/2013	0.3	0.56	0.113
	14/04/2014	0.28	0.48	0.260
	15/05/2014	-	-	-
	18/06/2014	-	-	-
	21/07/2014	-	-	-
	18/08/2014	-	-	-
	11/12/2014	-	-	-
	21/04/2015	-	-	-
	Mean	0.29	0.52	0.187
23 Matai (downgradient	17/06/2013	0.57	0.75	0.007
	14/04/2014	0.59	0.90	0.163
	15/05/2014	0.60	1.1	0.076
	18/06/2014	-	-	-
	21/07/2014	0.70	0.92	0.130
	18/08/2014	0.68	0.88	<0.004
	11/12/2014	0.74	0.90	<0.004
	21/04/2015	0.67	1.00	<0.004
	Mean	0.65	0.92	0.055
1415 Waugh downgradient	17/06/2013	0.40	0.60	<0.004
	14/04/2014	0.36	0.62	0.007
	15/05/2014	-	-	-
	18/06/2014	-	-	-
	21/07/2014	-	-	-
	18/08/2014	-	-	-
	11/12/2014	-	-	-
	21/04/2015	-	-	-

Bore	Sampling Date	[NH_4-N] (g/m³)	[TN] (g/m³)	[DRP] (g/m³)
	Mean	0.380	0.61	0.006
1447 Waugh downgradient	17/06/2013	0.113	0.31	0.057
	14/04/2014	0.118	0.20	0.018
	15/05/2014	0.133	0.30	<0.004
	18/06/2014	-	-	-
	21/07/2014	0.199	0.36	<0.004
	18/08/2014	0.174	0.32	<0.004
	11/12/2014	0.160	0.28	<0.004
	21/04/2015	-	-	-
	Mean	0.150	0.295	0.015
1427 Waugh downgradient	17/06/2013	0.370	0.54	0.009
	14/04/2014	0.350	0.66	<0.004
	15/05/2014	0.390	0.60	0.065
	18/06/2014	0.380	0.54	0.054
	21/07/2014	0.440	0.65	0.138
	18/08/2014	0.410	0.62	0.010
	11/12/2014	0.450	0.55	<0.004
	21/04/2015	0.430	0.70	0.008
	Mean	0.403	0.608	0.037
1459 Waugh downgradient	17/06/2013	0.016	0.84	<0.004
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	-	-	-
	21/07/2014	-	-	-
	18/08/2014	-	-	-
	11/12/2014	-	-	-
	21/04/2015	-	-	-
	Mean	0.016	0.84	<0.004
G Smith	17/06/2013	-	-	-
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	-	-	-
	21/07/2014	-	-	-
	18/08/2014	-	-	-
	02/10/2014	0.151	0.47	<0.004
	11/12/2014	0.166	-	<0.004
	21/04/2015	0.198	0.40	<0.004
	Mean	0.172	0.44	<0.004
SWP1 Pond Corner	17/06/2013	-	-	-
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	71	69	0.008
	21/07/2014	71	72	0.096
	18/08/2014	84	80	0.030
	11/12/2014	78	81	0.230
	21/04/2015	62	59	0.118
	Mean	73.2	72.2	0.096
SP2 Ratanui Rd Cnr	17/06/2013	-	-	-
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	0.470	24	<0.004
	21/07/2014	0.167	0.83	<0.004
	18/08/2014	0.157	0.89	<0.004

Bore	Sampling Date	[NH4-N] (g/m³)	[TN] (g/m³)	[DRP] (g/m³)
	11/12/2014	0.120	-	<0.004
	21/04/2015	<0.010	0.77	<0.004
	Mean	0.260	6.623	<0.004
SP3 Golf Course Pump Shed	17/06/2013	-	-	-
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	<0.010	39	<0.004
	21/07/2014	<0.010	4.1	<0.004
	18/08/2014	<0.010	0.77	<0.004
	11/12/2014	-	-	-
	21/04/2015	-	-	-
	Mean	<0.010	14.62	<0.004
SP4 Golf Course S Boundary	17/06/2013	-	-	-
	14/04/2014	-	-	-
	15/05/2014	-	-	-
	18/06/2014	1.00	4.9	<0.004
	21/07/2014	0.91	6.1	<0.004
	18/08/2014	0.56	1.12	<0.004
	11/12/2014	1.30	2.2	<0.004
	21/04/2015	-	-	-
	Mean	0.94	3.58	<0.004
Deep Bores				
Guy No 2, Milking Shed	15/05/2014	-	-	-
	18/06/2014	<0.010	0.94	0.005
	21/07/2014	<0.010	0.91	0.010
	18/08/2014	<0.010	0.95	0.014
	Mean	<0.010	0.93	0.010
325371, ANZ	15/05/2014	0.63	0.63	<0.004
	18/06/2014	-	-	-
	21/07/2014	-	-	-
	18/08/2014	0.65	0.95	<0.004
	Mean	0.64	0.79	<0.004
325125, ANZ	15/05/2014	0.43	0.36	0.006
	18/06/2014	0.47	0.43	0.004
	21/07/2014	-	-	-
	18/08/2014	0.45	0.52	0.004
	Mean	0.45	0.44	0.005
325321, St Dominics	15/05/2014	0.57	0.51	<0.004
	18/06/2014	0.51	0.51	<0.004
	21/07/2014	0.44	0.40	0.006
	18/08/2014	0.45	0.70	<0.004
	Mean	0.49	0.53	0.004
325047, Feilding Golf Course	15/05/2014	0.40	0.45	0.008
	18/06/2014	0.22	0.55	0.054
	21/07/2014	<0.010	0.74	0.090
	18/08/2014	<0.010	0.84	0.130
	Mean	0.205	0.65	0.071

4.0 Interpretation

4.1 Shallow Bores

The 19 shallow bores are located as shown on the map attached to this annex. Most bores are shown as having 8 sampling rounds, compared to the 3 rounds reported in the lodged AEE. While the specific analyte concentrations show a wider range of values than does Table 8.1 in the AEE, the comparison of the values within and between sites shows little variation from the findings reported in the AEE.

The crucial finding is that while the two bores close to and down-gradient from the ponds (325269C and SP1 Pond Corner) show elevated levels of contaminants, those elevated levels are not found to propagate further down-gradient. There are higher contaminant concentrations in bores away from the ponds, but as these occur up-gradient as well as down-gradient they cannot be unequivocally attributed to pond seepage.

Of the ammoniacal nitrogen readings, 11 of the mean values are within a "narrow" range, with the maximum less than twice the value of the minimum. These comparatively consistent readings are indicative of only modest changes in concentration at the site in question. However, at 5 sites the concentrations varied in a "medium" range with maxima between 2 and 10 times the minima, while a further 2 sites showed a "wide" range with maxima more than 10 times the minima. Finding these medium and wide ranges is indicative of loading shocks which are difficult to attribute to the more-or-less constant loading that could be expected from seepage from a 6 ha pond network. 4 of the "medium" range variabilities in ammoniacal nitrogen concentration are at sites up-gradient from the ponds, further supporting the view that such variability does not arise from pond seepage itself.

The Total Nitrogen ("TN") concentrations show a wide variation between sites, with mean values ranging between 0.2 g/m^3 and 72 g/m^3, a 360-fold difference. However, in Table 16.1, the seven sites between 28 Aorangi and G Smith are all down-gradient from the ANZ ponds, and all show mean TN concentrations of less than 1 g/m^3. By comparison the 6 sites up-gradient from the ANZ ponds show mean TN concentrations ranging between 0.2 g/m^3 and 24 g/m^3, with a mean (of means) of 8.76 g/m^3, well in excess of the down-gradient concentrations. Further, of these 6 up-gradient sites, only 1 shows a "narrow" range of values, with 3 medium range and 2 wide range spreads of concentration values, suggesting loading shocks and variability that cannot be attributed to ANZ pond seepage.

The Dissolved Reactive Phosphorus ("DRP") concentrations, like the ammoniacal nitrogen and total nitrogen, show elevated values at the two sites immediately down-gradient from the ANZ ponds. However, the highest mean value and highest individual values are found up-gradient from the ANZ ponds; suggesting the ponds are not the only, or the most intense, contributor of DRP to shallow groundwater. Of the 18 mean concentrations tabulated, 7 show "wide" ranges (maximum over 10 times minimum) with several of these means skewed by one or two notably high individual readings, suggesting loading shocks that are not necessarily attributable to pond seepage. Of the 11 bores down-gradient from the ponds and beyond their immediate vicinity, 6 show mean DRP concentrations at or below the detection limit of 0.004 g/m^3. The mean value for 28 Aorangi is anomalously high at 0.187 g/m^3, and this was a result from only two sampling rounds. At a concentration twice as high as that in the standpipe SP1 at the pond corner, this demonstrates that not all DRP concentration elevations are attributable to ANZ pond seepage.

4.2 Deep Bores

5 deep bores were sampled on up to 4 occasions between 15 May 2014 and 18 August 2014. Their locations in relation to the ANZ ponds are shown on the accompanying map.

Of the ammoniacal nitrogen mean values, those at the two ANZ bores and the St Dominics bore are consistent around 0.52 g/m^3. The down-gradient site at the golf course shows two readings of the same order as at ANZ, followed by two readings below the detection limit of 0.010 g/m^3. The up-gradient bore at Guy's milking shed stayed consistently below the detection limit.

The TN mean values at all 5 deep bore sites show a strong consistency around a value of 0.67 g/m^3 both up-gradient and down-gradient; there is no evidence of an influence from ANZ pond seepage.

The DRP values show a consistency at or about the detection limit in the two ANZ bores and at St Dominics, with slightly higher values at the up-gradient Guy milking shed site and significantly higher values at the down-gradient golf course site.

Like the shallow bores, the deep bores do not demonstrate a down-gradient increase in parameter concentrations away from the immediate vicinity of the ponds; therefore it is not apparent that seepage from the ponds is the direct and unequivocal cause of any down-gradient increase in contaminant concentrations.

5.0 Conclusions and Summary

Further groundwater sampling and analysis has been undertaken since the sections in the lodged AEE dealing with potential groundwater contamination by seepage from the ANZ ponds were prepared. These further data are summarised in this annex.

While there are more data points, collected from more sites and over a longer period of time, the general interpretation of the results does not differ from that presented in the lodged AEE, or from those presented in several previous investigation reports. There are comparatively high concentrations of ammoniacal nitrogen, total nitrogen and dissolved reactive phosphorus in the two sampling sites immediately down-gradient from the ponds, but this effect has not been found to propagate further down-gradient in either shallow bores or deep bores. It is reassuring that bores actually used by neighbours do not show signs of contamination. There is wide temporal and spatial variation in the concentrations of the parameters assessed, indicating that there are times and places where activities or issues that are not related to pond seepage give rise to groundwater quality effects.

While it is proposed that a groundwater quality monitoring program should continue to monitor any changes that may be attributed to pond seepage, it is nevertheless concluded that the demonstrated effects of pond seepage on groundwater quality beyond the immediate locality of the ponds is not greater than minor.

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325273A							
Lat.		40 14.028							
Long.		175 35.197							
Ground Level	m	73.7							
bore depth		5.33							
monitoring point height		0.47							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	2.16	3.26	2.32	2.29	2.35	2.22	2.18	1.25
mamsl		71.54	70.44	71.38	71.41	71.35	71.48	71.52	72.45
Temperature	oC	14.5	15.5	NA	14.7	13.3	12.8	14.5	16.1
pH	pH Units	6.5	6.6	6.6	6.6	6.6	6.7	6.8	7.4
Electrical Conductivity (EC)	mS/m	47.7	51.5	48.4	48.4	49.3	52.3	56.9	63.7
Chloride	g/m3	45.0	67	63	56	53	48	54	55
Total Nitrogen	g/m3	1.05	0.61	0.76	2.8	4.4	10	NA	21
Total Ammoniacal-N	g/m3	0.013	0.034	0.02	0.018	< 0.010	< 0.010	< 0.010	<0.010
Nitrite-N	g/m3	0.002	0.002	< 0.002	< 0.002	0.002	0.002	<0.10	<0.10
Nitrate-N	g/m3	0.420	0.002	0.149	1.91	3.4	8.8	NA	19.7
Nitrate-N + Nitrite-N	g/m3	0.420	0.002	0.15	1.91	3.5	8.8	10.1	19.7
Total Kjeldahl Nitrogen (TKN)	g/m3	0.63	0.61	0.61	0.9	0.94	1.24	1.31	1.48
Dissolved Reactive Phosphorus	g/m3	0.004	0.004	< 0.004	< 0.004	0.006	0.006	0.008	0.006
Total Phosphorus	g/m3	0.010	0.006	0.009	0.005	0.014	0.023	0.01	0.012
Total Sulphide	g/m3	0.004	0.002	0.002	0.006	< 0.002	0.002	<0.002	<0.002
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	< 2	< 2	< 2	< 2	< 2	<2
Escherichia coli	MPN / 100mL	1	8	3	< 1	< 1	< 1	< 1	10

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325275B							
Lat.		40 14.061							
Long.		175 35.385							
Ground Level	m	74.21							
bore depth		5.79							
monitoring point height		0.60							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	1.97	2.35	2.18	2.02	2.04	1.83	1.97	1.92
mamsl		72.24	71.86	72.03	72.19	72.17	72.38	72.24	72.29
Temperature	oC	14.5	15.0	NA	14.1	13.5	12.8	13.5	15.8
pH	pH Units	6.3	6.4	6.4	6.7	6.5	6.5	6.7	6.7
Electrical Conductivity (EC)	mS/m	43.7	40.1	40.3	40.7	40.7	40.7	41.2	41.1
Chloride	g/m3	40.0	41	41	42	39	37	39	43
Total Nitrogen	g/m3	0.40	0.6	0.35	0.3	0.43	1.77	1.87	0.35
Total Ammoniacal-N	g/m3	0.017	0.033	< 0.010	0.052	0.035	< 0.010	< 0.010	< 0.010
Nitrite-N	g/m3	0.002	0.012	0.006	< 0.002	0.005	0.03	0.022	0.005
Nitrate-N	g/m3	0.002	0.28	0.08	< 0.002	0.137	1.40	1.55	0.091
Nitrate-N + Nitrite-N	g/m3	0.003	0.29	0.086	0.003	0.141	1.43	1.57	0.096
Total Kjeldahl Nitrogen (TKN)	g/m3	0.40	0.32	0.26	0.3	0.29	0.34	0.30	0.26
Dissolved Reactive Phosphorus	g/m3	0.004	0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Total Phosphorus	g/m3	0.007	0.004	< 0.004	< 0.004	< 0.004	0.004	0.006	0.006
Total Sulphide	g/m3	0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	<0.002
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	< 2	< 2	< 2	< 2	< 2	<2
Escherichia coli	MPN / 100mL	4	13	1	1	< 1	< 1	< 1	<1

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	**325269C**							
Lat.		**40 14.208**							
Long.		**175 35.196**							
Ground Level	**m**	**73.54**							
bore depth		**6.92**							
monitoring point height		**0.58**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	5.78	6.25	6.18	6.04	5.98	5.90	5.81	5.90
mamsl		-5.78	-6.25	67.36	67.50	67.56	67.64	67.73	67.64
Temperature	oC	15.0	15.5	NA	15.6	15.3	15.6	16.8	18.00
pH	pH Units	6.5	6.6	6.7	6.5	6.5	6.5	6.5	6.40
Electrical Conductivity (EC)	mS/m	147.0	195.5	199.1	165.6	132.6	116.7	100.6	88.7
Chloride	g/m3	188.0	340	350	230	137	100	119	118
Total Nitrogen	g/m3	34.00	45	41	56	58	55	NA	34
Total Ammoniacal-N	g/m3	15.400	32	31	15	10.2	9.4	6.7	3.0
Nitrite-N	g/m3	0.008	0.008	0.024	0.023	0.008	0.015	< 0.10	<0.10
Nitrate-N	g/m3	18.200	4.1	11	45	49	44	NA	26
Nitrate-N + Nitrite-N	g/m3	18.200	4.1	11.1	45	49	44	25	26
Total Kjeldahl Nitrogen (TKN)	g/m3	15.70	41	30	11.5	9.5	10.5	6.9	8
Dissolved Reactive Phosphorus	g/m3	0.055	0.128	0.148	0.054	0.026	0.026	0.026	0.016
Total Phosphorus	g/m3	0.085	0.8	0.92	1.14	0.52	1.69	2.4	5.7
Total Sulphide	g/m3	0.006	0.023	0.005	0.004	< 0.002	0.004	< 0.002	0.004
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	< 2	< 2	< 2	< 2	< 2	<2
Escherichia coli	MPN / 100mL	1	25	< 1	< 1	< 1	< 1	3	50

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325413							
Lat.		**40 13.278**							
Long.		**175 35.089**							
Ground Level	**m**	**84**							
bore depth		**6.38**							
monitoring point height		**0.86**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	3.86	3.93	4.06	3.83	3.86	3.56	3.60	3.65
mamsl		80.14	80.07	79.94	80.17	80.14	80.44	80.40	80.35
Temperature	oC	14.5	14.5	14.4	13.9	13.3	12.7	13.3	14.8
pH	pH Units	6.2	6.3	6.5	6.2	6.3	6.0	6.8	7.5
Electrical Conductivity (EC)	mS/m	48.3	27.4	30.2	40.1	41.1	73.4	36.6	89.0
Chloride	g/m3	43.0	34	39	53	51	78	48	91
Total Nitrogen	g/m3	22.00	0.23	1.1	8.2	9.9	38.0	NA	55.0
Total Ammoniacal-N	g/m3	0.010	< 0.01	< 0.010	< 0.010	0.012	< 0.010	< 0.010	<0.010
Nitrite-N	g/m3	0.041	0.014	0.032	0.047	0.044	0.005	<0.10	<0.10
Nitrate-N	g/m3	22.000	0.124	0.94	7.9	9.6	38.0	NA	55
Nitrate-N + Nitrite-N	g/m3	22.000	0.138	0.97	8	9.7	38.0	3.2	55
Total Kjeldahl Nitrogen (TKN)	g/m3	0.10	< 0.1	0.13	0.19	0.17	< 0.10	0.18	<0.10
Dissolved Reactive Phosphorus	g/m3	0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	<0.004
Total Phosphorus	g/m3	0.004	< 0.004	0.004	< 0.004	0.095	< 0.004	< 0.004	0.008
Total Sulphide	g/m3	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	<0.002
Carbonaceous Biochemical Oxygen	g O2/m3	2	< 2	< 2	< 2	< 2	< 2	< 2	<2
Escherichia coli	MPN / 100mL	110	5,800	490	26	5	7	<1	17

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325016							
Lat.		**40 13.841**							
Long.		**175 35.579**							
Ground Level	**m**	**78**							
bore depth		**7.09**							
monitoring point height		**0.0 causing some debris to enter**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	2.31	2.63	2.53	2.39	2.39	2.25	2.31	2.27
mamsl		75.69	75.37	75.47	75.61	75.61	75.75	75.69	75.73
Temperature	oC	14.5	14.0	14.7	14.5	13.5	13.8	13.3	14.7
pH	pH Units	6.4	6.4	6.5	6.6	6.5	6.4	7.3	6.8
Electrical Conductivity (EC)	mS/m	75.8	71.4	72.9	72.2	72.6	73.4	39.1	53.6
Chloride	g/m3	98.0	102	101	99	102	102	41	48
Total Nitrogen	g/m3	1.54	1.3	1.3	1.2	1.3	1.46	9.7	5.1
Total Ammoniacal-N	g/m3	1.030	0.87	0.82	0.81	0.95	0.89	2.8	2.3
Nitrite-N	g/m3	0.020	0.2	**< 0.2**	< 0.2	**< 0.2**	< 0.02	< 0.02	< 0.02
Nitrate-N	g/m3	0.020	0.2	< 0.2	< 0.2	< 0.2	< 0.02	< 0.02	< 0.02
Nitrate-N + Nitrite-N	g/m3	0.020	**0.2**	**< 0.2**	**< 0.2**	**< 0.2**	**< 0.02**	**< 0.02**	**< 0.02**
Total Kjeldahl Nitrogen (TKN)	g/m3	1.53	1.34	1.22	1.18	1.34	1.46	9.5	5.1
Dissolved Reactive Phosphorus	g/m3	0.004	0.28	0.26	0.005	0.042	< 0.004	6.0	5.5
Total Phosphorus	g/m3	1.620	1.14	1.37	0.86	1.3	1.33	0.134	9.6
Total Sulphide	g/m3	0.075	0.053	0.042	0.026	0.026	0.023	0.002	0.03
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	< 2	3	3	< 2	< 2	< 2
Escherichia coli	MPN / 100mL	3	5	6	< 1	< 1	< 1	< 1	>2,400

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325411							
Lat.		**40 13.801**							
Long.		**175 35.996**							
Ground Level	**m**	**80**							
bore depth		**6.07**							
monitoring point height		**0.76**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	1.80	1.85	1.78	1.81	1.83	1.72	1.59	1.77
mamsl		78.20	78.15	78.22	78.19	78.17	78.28	78.41	78.23
Temperature	oC	14.5	14.0	14.8	14.2	13.4	13.3	13.3	14.9
pH	pH Units	6.5	6.6	6.7	6.9	6.7	6.6	6.6	6.4
Electrical Conductivity (EC)	mS/m	28.7	27.5	28.7	28.8	28.7	27.7	28.6	28.5
Chloride	g/m3	17.4	16.5	16.2	16.6	15.8	15.5	15	15.9
Total Nitrogen	g/m3	0.12	0.12	< 0.3	0.31	0.27	0.22	<0.11	<0.11
Total Ammoniacal-N	g/m3	0.052	0.055	0.075	0.062	0.063	0.059	0.06	0.053
Nitrite-N	g/m3	0.020	0.02	**< 0.2**	< 0.02	< 0.002	< 0.02	< 0.02	<0.02
Nitrate-N	g/m3	0.020	0.02	< 0.2	< 0.02	< 0.002	< 0.02	< 0.02	< 0.02
Nitrate-N + Nitrite-N	g/m3	0.020	**0.02**	**< 0.2**	< 0.02	< 0.002	**< 0.02**	**< 0.02**	**< 0.02**
Total Kjeldahl Nitrogen (TKN)	g/m3	0.11	0.12	< 0.10	0.3	0.27	0.22	<0.10	0.1
Dissolved Reactive Phosphorus	g/m3	0.004	0.064	0.075	< 0.004	0.004	< 0.004	0.015	<0.004
Total Phosphorus	g/m3	0.099	0.23	0.23	1.12	1.62	0.31	0.134	0.112
Total Sulphide	g/m3	0.007	0.004	0.002	0.004	0.004	0.003	0.002	<0.002
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	< 2	< 2	< 2	< 2	<2	<2
Escherichia coli	MPN / 100mL	10	1	< 1	< 1	< 1	< 1	<1	<1

AFFCO Manawatu - AFFCO & Byreburn Farm bores sampled 2013-

	Sample Name:	325416B							
Lat.		40 13.695							
Long.		175 34.962							
Ground Level	m	73							
bore depth		6.37							
monitoring point height		0.85							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	3.83	3.83	NA	3.67	3.83	3.47	NA	3.6
mamsl		69.17	69.17	NA	69.33	69.17	69.53	NA	69.40
Temperature	oC	14.0	15.0	NA	13.5	11.2	12.7	NA	15.8
pH	pH Units	6.0	6.1	NA	6.2	6.1	6.1	NA	6.6
Electrical Conductivity (EC)	mS/m	54.2	49.9	NA	47.2	47.1	47.2	NA	56.6
Chloride	g/m3	36.0	39	NA	40	40	41	NA	41
Total Nitrogen	g/m3	31.00	21	NA	21	20	19.4	NA	34
Total Ammoniacal-N	g/m3	4.400	5.2	NA	6.9	7.8	5.9	NA	8.2
Nitrite-N	g/m3	0.010	0.009	NA	0.003	0.012	< 0.002	NA	<0.10
Nitrate-N	g/m3	28.00	16.3	NA	15.3	12.2	13.2	NA	26
Nitrate-N + Nitrite-N	g/m3	28.00	16.4	NA	15.3	12.2	13.2	NA	26
Total Kjeldahl Nitrogen (TKN)	g/m3	2.40	4.9	NA	5.4	8.1	6.2	NA	8
Dissolved Reactive Phosphorus	g/m3	0.006	0.004	NA	0.004	< 0.004	0.004	NA	0.006
Total Phosphorus	g/m3	0.026	0.008	NA	0.008	0.157	0.096	NA	0.008
Total Sulphide	g/m3	0.002	0.002	NA	< 0.002	< 0.002	< 0.002	NA	<0.002
Carbonaceous Biochemical Oxygen	g O2/m3	2	2	NA	< 2	< 2	< 2	NA	<2
Escherichia coli	MPN / 100mL	1	51	NA	3	< 1	< 1	NA	<1

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	31 Matai							
Lat.		**40 14.429**							
Long.		**175 35.226**							
Ground Level	**m**	**68**							
bore depth	**m**	**9.02**							
monitoring point heigh	**m**	**0.40**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	3.88	NA	NA	4.41	4.07	3.93	3.84	NA
mamsl		64.12	NA	NA	63.59	63.93	64.07	64.16	NA
Temperature	oC	15.0	NA	NA	15.0	14.1	14.1	14.3	NA
pH	pH Units	6.6	NA	6.7	6.8	6.8	6.7	7	NA
Electrical Conductivity (EC	mS/m	69.3	NA	75	76.5	80	72.1	72.9	NA
Chloride	g/m3	86.0	NA	99	96	95	85	88	NA
Total Nitrogen	g/m3	1.45	NA	1.6	1.75	1.63	1.68	1.88	NA
Total Ammoniacal-N	g/m3	1.100	NA	1.4	1.3	1.4	1.2	1.6	NA
Nitrite-N	g/m3	0.012	NA	< 0.2	< 0.02	< 0.02	< 0.02	0.03	NA
Nitrate-N	g/m3	<0.002	NA	< 0.2	0.06	< 0.02	< 0.02	< 0.02	NA
Nitrate-N + Nitrite-N	g/m3	0.008	NA	< 0.2	0.07	< 0.02	**< 0.02**	**< 0.02**	NA
Total Kjeldahl Nitrogen (T	g/m3	1.44	NA	1.64	1.68	1.63	1.68	1.88	NA
Dissolved Reactive Phosph	g/m3	<0.004	NA	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	NA
Total Phosphorus	g/m3	0.450	NA	0.36	0.26	0.41	0.44	0.45	NA
Total Sulphide	g/m3	0.260	NA	0.23	0.175	0.048	0.153	0.011	NA
Carbonaceous Biochemica	g O2/m3	3	NA	4	< 2	3	3	< 2	NA
Escherichia coli	MPN / 100mL	<1	NA	< 1	< 1	< 1	< 1	< 1	NA

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	**23 Matai**							
Lat.		**40 14.487**							
Long.		**175 35.207**							
Ground Level	**m**	**68**							
bore depth	**m**	**5.27**							
monitoring point heigh	**m**	**0.39**							
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	3.19	3.45	4.89	NA	3.35	3.23	3.13	3.38
mamsl		-3.19	-3.45	-4.89	NA	-3.35	-3.23	-3.13	-3.38
Temperature	oC	13.0	14.5		NA	8.6	13.6	14.4	15.9
pH	pH Units	6.5	6.5	6.6	NA	6.7	6.6	6.8	6.6
Electrical Conductivity (EC	mS/m	54.2	59.5	58.3	NA	65.2	64.8	59.9	64
Chloride	g/m3	64.0	80	84	NA	93	86	77	84
Total Nitrogen	g/m3	0.75	0.9	1.1	NA	0.92	0.88	0.9	1
Total Ammoniacal-N	g/m3	0.570	0.590	0.6	NA	0.7	0.68	0.74	0.67
Nitrite-N	g/m3	0.009	<0.2	< 0.2	NA	< 0.02	< 0.02	< 0.02	<0.2
Nitrate-N	g/m3	0.007	<0.2	< 0.2	NA	< 0.02	< 0.02	< 0.02	<0.2
Nitrate-N + Nitrite-N	g/m3	0.015	**<0.2**	0.2	NA	< 0.02	**< 0.02**	**< 0.02**	**<0.2**
Total Kjeldahl Nitrogen (T	g/m3	0.73	0.88	0.85	NA	0.9	0.88	0.86	0.99
Dissolved Reactive Phosph	g/m3	0.007	0.163	0.076	NA	0.13	< 0.004	< 0.004	<0.004
Total Phosphorus	g/m3	0.550	0.530	0.56	NA	0.5	0.58	0.55	0.61
Total Sulphide	g/m3	0.028	0.013	0.005	NA	0.011	< 0.002	0.019	0.008
Carbonaceous Biochemica	g O2/m3	<2	<2	< 2	NA	< 2	< 2	< 2	<2
Escherichia coli	MPN / 100mL	<1	7	12	NA	1	< 1	9	1

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	28 Aorangi		
Lat.		**40 14.566**		
Long.		**175 35.365**		
Ground Level	**m**	**68.71**		
bore depth	**m**	**7.31**		
monitoring point heigh	**m**	**0.25**		
Date		17/06/2013	14/04/2014	15/05/2014
swl	m	2.76	2.90	NA
mamsl		65.95	65.81	o further sampling
Temperature	oC	14.5	15.5	
pH	pH Units	6.4	6.5	
Electrical Conductivity (EC	mS/m	36.9	33.4	
Chloride	g/m3	27.0	27.0	
Total Nitrogen	g/m3	0.56	0.48	
Total Ammoniacal-N	g/m3	0.300	0.280	
Nitrite-N	g/m3	<0.02	<0.01	
Nitrate-N	g/m3	0.040	<0.01	
Nitrate-N + Nitrite-N	g/m3	0.050	**<0.01**	
Total Kjeldahl Nitrogen (T	g/m3	0.52	0.47	
Dissolved Reactive Phosph	g/m3	0.113	0.260	
Total Phosphorus	g/m3	0.690	0.560	
Total Sulphide	g/m3	0.021	0.081	
Carbonaceous Biochemica	g O2/m3	<2	<2	
Escherichia coli	MPN / 100mL	1	<1	

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	1459 Waugh		
Lat.		**40 14.495**		
Long.		**175 34.902**		
Ground Level	**m**	**66**		
bore depth	**m**			
monitoring point heigh	**m**			
Date		17/06/2013	14/04/2014	15/05/2014
swl	m	NA	no water	no water
mamsl		NA	no further sampling	
Temperature	oC	14.6		
pH	pH Units	6.6		
Electrical Conductivity (EC	mS/m	83.9		
Chloride	g/m3	138.0		
Total Nitrogen	g/m3	0.84		
Total Ammoniacal-N	g/m3	0.016		
Nitrite-N	g/m3	0.012		
Nitrate-N	g/m3	0.620		
Nitrate-N + Nitrite-N	g/m3	0.630		
Total Kjeldahl Nitrogen (T	g/m3	0.21		
Dissolved Reactive Phosph	g/m3	<0.004		
Total Phosphorus	g/m3	<0.004		
Total Sulphide	g/m3	<0.002		
Carbonaceous Biochemica	g O2/m3	<2		
Escherichia coli	MPN / 100mL	<1		

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	**1447 Waugh**							
Lat.		**40 14.594**							
Long.		**175 34.902**							
Ground Level	**m**	**66**							
bore depth	**m**								
monitoring point heigh	**m**								
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	NA	NA	NA	NA	NA	NA	NA	NA
mamsl		NA	NA	NA	NA	NA	NA	NA	NA
Temperature	oC	14.5	14.5	NA	NA	9.3	11.6	16.5	NA
pH	pH Units	6.5	6.5	6.6	NA	6.6	6.6	6.8	NA
Electrical Conductivity (EC	mS/m	69.8	68.9	71.5	NA	69.8	71.1	66.8	NA
Chloride	g/m3	112.0	115	117	NA	116	114	100	NA
Total Nitrogen	g/m3	0.31	0.2	0.3	NA	0.36	0.32	0.28	NA
Total Ammoniacal-N	g/m3	0.113	0.118	0.133	NA	0.199	0.174	0.16	NA
Nitrite-N	g/m3	<0.02	<0.2	**< 0.2**	NA	< 0.002	0.004	< 0.02	NA
Nitrate-N	g/m3	0.040	<0.2	< 0.2	NA	0.003	< 0.002	< 0.02	NA
Nitrate-N + Nitrite-N	g/m3	0.050	**<0.2**	**< 0.2**	NA	0.003	0.004	**< 0.2**	NA
Total Kjeldahl Nitrogen (T	g/m3	0.26	0.23	0.27	NA	0.36	0.32	0.27	NA
Dissolved Reactive Phosph	g/m3	0.057	0.018	< 0.004	NA	< 0.004	< 0.004	< 0.004	NA
Total Phosphorus	g/m3	0.153	0.13	0.34	NA	0.42	0.1	0.109	NA
Total Sulphide	g/m3	0.041	0.034	0.006	NA	0.005	0.003	< 0.002	NA
Carbonaceous Biochemica	g O2/m3	<2	<2	< 2	NA	< 2	< 2	< 2	NA
Escherichia coli	MPN / 100mL	<1	<1	< 1	NA	< 1	< 1	7	NA

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	1427 Waugh							
Lat.		**40 14.632**							
Long.		**175 35.023**							
Ground Level	**m**	**66**							
bore depth	**m**								
monitoring point heigh	**m**								
Date		17/06/2013	14/04/2014	15/05/2014	18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	NA	NA	NA	NA	NA	NA	NA	NA
mamsl		NA	NA	NA	NA	NA	NA	NA	NA
Temperature	oC	14.5	14.5	NA	13.6	6.7	13.5	14.7	16.5
pH	pH Units	6.4	6.5	6.6	6.5	6.6	6.4	6.5	6.5
Electrical Conductivity (EC	mS/m	42.3	42.4	43.4	44	45.2	45.9	45.6	46.4
Chloride	g/m3	46.0	54	53	55	58	56	57	59
Total Nitrogen	g/m3	0.54	0.66	0.6	0.54	0.65	0.62	0.55	0.7
Total Ammoniacal-N	g/m3	0.370	0.35	0.39	0.38	0.44	0.41	0.45	0.43
Nitrite-N	g/m3	0.013	0.003	< 0.2	< 0.02	0.02	< 0.02	< 0.02	< 0.2
Nitrate-N	g/m3	0.004	0.027	< 0.2	0.03	< 0.02	< 0.02	< 0.02	< 0.2
Nitrate-N + Nitrite-N	g/m3	0.017	0.029	< 0.2	0.04	0.03	**< 0.02**	**< 0.02**	**< 0.2**
Total Kjeldahl Nitrogen (T	g/m3	0.53	0.63	0.59	0.5	0.62	0.62	0.55	0.66
Dissolved Reactive Phosph	g/m3	0.009	<0.004	0.065	0.054	0.138	0.01	< 0.004	0.008
Total Phosphorus	g/m3	0.320	0.127	0.28	0.21	0.36	0.37	0.25	0.32
Total Sulphide	g/m3	<0.002	0.002	< 0.002	< 0.002	0.002	0.002	< 0.002	< 0.002
Carbonaceous Biochemica	g O2/m3	<2	<2	< 2	< 2	< 2	< 2	< 2	< 2
Escherichia coli	MPN / 100mL	<1	2	< 1	< 1	< 1	< 1	< 1	< 1

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	1415 Waugh		
Lat.		**40 14.668**		
Long.		**175 35.082**		
Ground Level	**m**	**66**		
bore depth	**m**	**4.65**		
monitoring point heigh	**m**	**0.00**		
Date		17/06/2013	14/04/2014	NA
swl	m	4.01	NA	o further sampling
mamsl		61.99	NA	
Temperature	oC	14.5	14.5	
pH	pH Units	6.5	6.6	
Electrical Conductivity (EC	mS/m	37.9	34.5	
Chloride	g/m3	35.0	37	
Total Nitrogen	g/m3	0.60	0.62	
Total Ammoniacal-N	g/m3	0.400	0.36	
Nitrite-N	g/m3	0.011	0.008	
Nitrate-N	g/m3	0.005	0.006	
Nitrate-N + Nitrite-N	g/m3	0.016	0.014	
Total Kjeldahl Nitrogen (T	g/m3	0.58	0.6	
Dissolved Reactive Phosph	g/m3	<0.004	0.007	
Total Phosphorus	g/m3	1.140	0.66	
Total Sulphide	g/m3	0.044	0.017	
Carbonaceous Biochemica	g O2/m3	<2	<2	
Escherichia coli	MPN / 100mL	<1	6	

AFFCO Manawatu - Private Bores sampled 2013-

	Sample Name:	G Smith Flower Grower		
Lat.				
Long.				
Ground Level	**m**	**68.86**		
bore depth	**m**	**11.70**		
monitoring point heigh	**m**	**0.56**		
Date		2/10/2014	11/12/2014	21/04/2015
swl	m	3.84	2.60	4.33
mamsl		65.02	66.26	64.53
Temperature	oC	14.2	14.6	15.8
pH	pH Units	6.7	6.7	7.2
Electrical Conductivity (EC	mS/m	77.6	74.5	69.7
Chloride	g/m3	93	83	75
Total Nitrogen	g/m3	0.47	NA	0.4
Total Ammoniacal-N	g/m3	0.151	0.166	0.198
Nitrite-N	g/m3	< 0.02	< 0.10	<0.2
Nitrate-N	g/m3	< 0.02	NA	<0.2
Nitrate-N + Nitrite-N	g/m3	< 0.02	< 0.10	<0.2
Total Kjeldahl Nitrogen (T	g/m3	0.47	0.45	0.37
Dissolved Reactive Phosph	g/m3	< 0.004	< 0.004	<0.004
Total Phosphorus	g/m3	0.24	0.31	0.26
Total Sulphide	g/m3	2.9	1.32	0.67
Carbonaceous Biochemica	g O2/m3	14	12	3
Escherichia coli	MPN / 100mL	< 1	88	<1
Dissolved Sodium	g/m3	105		
Heavy metals, totals, screen As,Cd,Cr,Cu,Ni,Pb,Zn				
Total Arsenic	g/m3		< 0.021	
Total Cadmium	g/m3		< 0.0011	
Total Chromium	g/m3		0.018	
Total Copper	g/m3		< 0.011	
Total Lead	g/m3		< 0.0021	
Total Nickel	g/m3		< 0.011	
Total Zinc	g/m3		< 0.021	
Total Boron	g/m3		0.83	

AFFCO Manawatu - Deep Bores samples 2014

	Sample Name:	325047			
Description		**Feilding Golf Course**			
GPS					
Lat.					
Long.					
Ground Level	**m**				
bore depth	**m**	**111.60**			
monitoring point height					
Date		15/05/2014	18/06/2014	21/07/2014	18/08/2014
swl	m	NA	NA	NA	NA
mamsl		NA	NA	NA	NA
Temperature	oC	NA	11.40	8.9	9.6
pH	pH Units	7.3	7.6	8	8.1
Electrical Conductivity (EC	mS/m	30.3	31.1	31.6	32.7
Chloride	g/m3	23	23	23	23
Total Nitrogen	g/m3	0.45	0.55	0.74	0.84
Total Ammoniacal-N	g/m3	0.4	0.22	< 0.010	< 0.010
Nitrite-N	g/m3	0.005	0.009	< 0.002	< 0.002
Nitrate-N	g/m3	0.052	0.3	0.66	0.72
Nitrate-N + Nitrite-N	g/m3	0.057	0.31	0.66	0.73
Total Kjeldahl Nitrogen (T	g/m3	0.39	0.24	< 0.10	0.12
Dissolved Reactive Phosph	g/m3	0.008	0.054	0.09	0.13
Total Phosphorus	g/m3	0.28	0.068	0.1	0.146
Total Sulphide	g/m3	< 0.002	< 0.002	< 0.002	< 0.002
Carbonaceous Biochemica	g O2/m3	< 2	< 2	< 2	< 2
Escherichia coli	MPN / 100mL	10	10	1	< 1

AFFCO Manawatu - Deep Bores samples 2014

	Sample Name:	325125			
Description		AFFCO steel & tube condenser cooling by engineering workshop			
GPS					
Lat.					
Long.					
Ground Level	m				
bore depth	m	86.50			
monitoring point height					
Date		15/05/2014	18/06/2014	21/07/2014	18/08/2014
swl	m	NA	NA	NA	NA
mamsl		NA	NA	NA	NA
Temperature	oC	NA	12.1	NA	11.20
pH	pH Units	7.4	7.4	NA	7.4
Electrical Conductivity (EC	mS/m	30.9	31	NA	31.7
Chloride	g/m3	23	23	NA	24
Total Nitrogen	g/m3	0.36	0.43	NA	0.52
Total Ammoniacal-N	g/m3	0.43	0.47	NA	0.45
Nitrite-N	g/m3	< 0.002	< 0.002	NA	< 0.002
Nitrate-N	g/m3	< 0.002	< 0.002	NA	< 0.002
Nitrate-N + Nitrite-N	g/m3	< 0.002	< 0.002	NA	< 0.002
Total Kjeldahl Nitrogen (T	g/m3	0.35	0.43	NA	0.52
Dissolved Reactive Phosph	g/m3	0.006	0.004	NA	0.004
Total Phosphorus	g/m3	0.33	0.184	NA	0.38
Total Sulphide	g/m3	< 0.002	< 0.002	NA	< 0.002
Carbonaceous Biochemica	g O2/m3	< 2	< 3	NA	< 2
Escherichia coli	MPN / 100mL	< 1	< 1	NA	< 1

AFFCO Manawatu - Deep Bores samples 2014

	Sample Name:	325371			
Description		**as of 325125**			
GPS		**708**			
Lat.					
Long.					
Ground Level	**m**				
bore depth	**m**	**73.20**			
monitoring point height					
Date		15/05/2014	18/06/2014	21/07/2014	18/08/2014
swl	m	NA	did not sample		NA
mamsl		NA	NA	NA	NA
Temperature	oC	NA	NA	NA	12.3
pH	pH Units	7.5	NA	NA	8
Electrical Conductivity (EC	mS/m	29.9	NA	NA	32.6
Chloride	g/m3	25	NA	NA	24
Total Nitrogen	g/m3	0.63	NA	NA	0.95
Total Ammoniacal-N	g/m3	0.63	NA	NA	0.65
Nitrite-N	g/m3	< 0.002	NA	NA	< 0.002
Nitrate-N	g/m3	< 0.002	NA	NA	< 0.002
Nitrate-N + Nitrite-N	g/m3	< 0.002	NA	NA	< 0.002
Total Kjeldahl Nitrogen (T	g/m3	0.63	NA	NA	0.95
Dissolved Reactive Phosph	g/m3	< 0.004	NA	NA	< 0.004
Total Phosphorus	g/m3	0.26	NA	NA	0.096
Total Sulphide	g/m3	< 0.002	NA	NA	< 0.002
Carbonaceous Biochemica	g O2/m3	< 2	NA	NA	< 2
Escherichia coli	MPN / 100mL	< 1	NA	NA	< 1

AFFCO Manawatu - Deep Bores samples 2014

	Sample Name:	St Dominics			
Description		**325321**			
GPS					
Lat.					
Long.					
Ground Level	**m**				
bore depth	**m**	**>50.8**			
monitoring point height					
Date		18/06/2014	21/07/2014	18/08/2014	11/12/2014
swl	m	27.23	24.96	24.58	26.77
mamsl		NA	NA	NA	NA
Temperature	oC	13.2	9.60	12.5	11.8
pH	pH Units	7.8	8.2	8.4	7.3
Electrical Conductivity (EC	mS/m	28.4	27.2	26.9	30.7
Chloride	g/m3	25	24	25	24
Total Nitrogen	g/m3	0.51	0.51	0.4	0.7
Total Ammoniacal-N	g/m3	0.57	0.51	0.44	0.45
Nitrite-N	g/m3	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m3	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	g/m3	< 0.002	< 0.002	< 0.002	< 0.002
Total Kjeldahl Nitrogen (T	g/m3	0.51	0.51	0.4	0.7
Dissolved Reactive Phosph	g/m3	< 0.004	< 0.004	0.006	< 0.004
Total Phosphorus	g/m3	0.23	0.064	0.108	2.2
Total Sulphide	g/m3	< 0.002	< 0.002	< 0.002	< 0.002
Carbonaceous Biochemica	g O2/m3	< 2	< 2	< 2	< 2
Escherichia coli	MPN / 100mL	< 1	< 1	< 1	< 1

AFFCO Manawatu - Deep Bores samples 2014

	Sample Name:	Guy No2			
Description		**Byreburn Farm for milking shed & troughs**			
GPS		**724**			
Lat.					
Long.					
Ground Level	**m**				
bore depth	**m**	**NA**			
monitoring point height					
Date		15/05/2014	18/06/2014	21/07/2014	18/08/2014
swl	m	did not sample	NA	NA	NA
mamsl		NA	NA	NA	NA
Temperature	oC	NA	14	3.3	13.9
pH	pH Units	NA	6.5	6.7	6.6
Electrical Conductivity (EC	mS/m	NA	14.4	14.2	14.3
Chloride	g/m3	NA	6.2	5.7	6.3
Total Nitrogen	g/m3	NA	0.94	0.91	0.95
Total Ammoniacal-N	g/m3	NA	< 0.010	< 0.010	< 0.010
Nitrite-N	g/m3	NA	< 0.002	< 0.002	0.002
Nitrate-N	g/m3	NA	0.89	0.86	0.88
Nitrate-N + Nitrite-N	g/m3	NA	0.89	0.86	0.88
Total Kjeldahl Nitrogen (T	g/m3	NA	< 0.10	< 0.10	< 0.10
Dissolved Reactive Phosph	g/m3	NA	0.005	0.01	0.014
Total Phosphorus	g/m3	NA	0.016	0.016	0.012
Total Sulphide	g/m3	NA	0.007	< 0.002	< 0.002
Carbonaceous Biochemica	g O2/m3	NA	< 2	< 2	< 2
Escherichia coli	MPN / 100mL	NA	< 1	< 1	< 1

AFFCO Manawatu Standpipes sampled 2014 -

note more data in Wallace Corporation Analysis for October 2014

	Sample Name:	SP 1				
Description		**SE Cnr Treatment Pond**				
GPS		**719**				
Lat.						
Long.						
Ground Level	**m**	**72.19**				
bore depth	**m**	**4.29**				
monitoring point height		**0.21**				
Date		18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	2.61	NA	2.32	2.61	2.77
mamsl		69.58	NA	69.87	69.58	69.42
Temperature	oC	14.30	NA	11.60	15.10	20.20
pH	pH Units	8.1	8.4	8.2	8.1	7.9
Electrical Conductivity (EC)	mS/m	189.1	155.9	173.6	159.6	127.8
Chloride	g/m3	280	196	200	154	120
Total Nitrogen	g/m3	69	72	80	81	59
Total Ammoniacal-N	g/m3	71	71	84	78	62
Nitrite-N	g/m3	< 0.002	< 0.002	< 0.002	< 0.002	0.088
Nitrate-N	g/m3	0.005	0.007	0.035	0.011	0.25
Nitrate-N + Nitrite-N	g/m3	0.005	0.008	0.036	0.012	0.33
Total Kjeldahl Nitrogen (TK	g/m3	69	72	80	81	59
Dissolved Reactive Phospho	g/m3	0.008	0.096	0.03	0.23	0.118
Total Phosphorus	g/m3	2.6	3.8	0.65	3.3	4.9
Total Sulphide	g/m3	0.032	0.04	0.016	0.054	0.06
Carbonaceous Biochemical	g O2/m3	5	6	4	3	<2
Escherichia coli	MPN / 100mL	< 1	< 1	< 1	23	<1

AFFCO Manawatu Standpipes sampled 2014 -

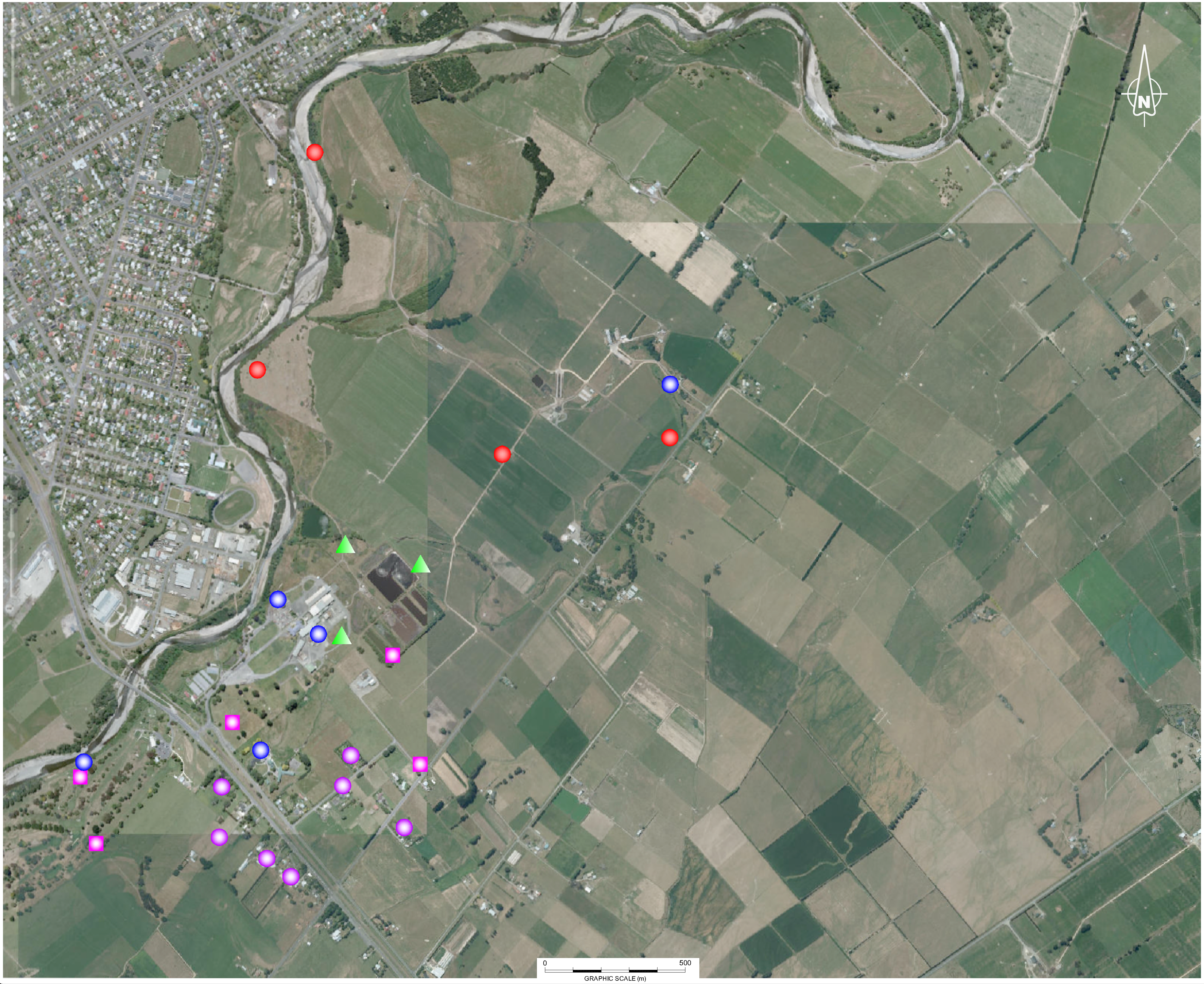
	Sample Name:	SP 2				
Description		**cnr Ratanui Road**				
GPS		**720**				
Lat.						
Long.						
Ground Level	**m**	**69.31**				
bore depth	**m**	**5.08**				
monitoring point height		**0.26**				
Date		18/06/2014	21/07/2014	18/08/2014	11/12/2014	21/04/2015
swl	m	2.14	NA	2.83	2.75	3.06
mamsl		-2.14	NA	-2.83	-2.75	-3.06
Temperature	oC	13.60	NA	11.90	18.80	19.20
pH	pH Units	7.3	8.8	7.9	NA	7
Electrical Conductivity (EC)	mS/m	37	24.3	33.8	NA	32.1
Chloride	g/m3	28	18.6	26	NA	23
Total Nitrogen	g/m3	24	0.83	0.89	NA	0.77
Total Ammoniacal-N	g/m3	0.47	0.167	0.157	0.12	<0.010
Nitrite-N	g/m3	< 0.002	< 0.002	< 0.002	< 0.002	<0.002
Nitrate-N	g/m3	0.004	0.015	0.003	NA	0.005
Nitrate-N + Nitrite-N	g/m3	0.006	0.015	0.004	0.006	0.005
Total Kjeldahl Nitrogen (TK	g/m3	24	0.82	0.88	NA	0.76
Dissolved Reactive Phospho	g/m3	< 0.004	< 0.004	< 0.004	< 0.004	<0.004
Total Phosphorus	g/m3	21	0.29	0.3	NA	0.183
Total Sulphide	g/m3	0.152	0.021	0.013	NA	0.198
Carbonaceous Biochemical	g O2/m3	13	13	16	10	49
Escherichia coli	MPN / 100mL	< 1	< 1	< 1	< 1	<1

AFFCO Manawatu Standpipes sampled 2014 -

	Sample Name:	SP 3			
Description		**Golf Course by pump shed**			
GPS		**721**			
Lat.					
Long.					
Ground Level	**m**	**65.09**			
bore depth	**m**	**5.51**			
monitoring point height		**0.27**			
Date		18/06/2014	21/07/2014	18/08/2014	11/12/2014
swl	m	2.86	2.99	2.70	damaged
mamsl		62.23	62.10	62.39	
Temperature	oC	14.70	13.70	NA	
pH	pH Units	7.1	7.4	7.3	
Electrical Conductivity (EC)	mS/m	43.3	44.5	35.2	
Chloride	g/m3	40	46	40	
Total Nitrogen	g/m3	39	4.1	0.77	
Total Ammoniacal-N	g/m3	< 0.010	< 0.010	< 0.010	
Nitrite-N	g/m3	< 0.002	< 0.002	< 0.002	
Nitrate-N	g/m3	0.003	< 0.002	< 0.002	
Nitrate-N + Nitrite-N	g/m3	0.003	< 0.002	< 0.002	
Total Kjeldahl Nitrogen (TK	g/m3	39	4.1	0.77	
Dissolved Reactive Phospho	g/m3	< 0.004	< 0.004	< 0.004	
Total Phosphorus	g/m3	28	2.7	0.39	
Total Sulphide	g/m3	0.64	0.5	0.22	
Carbonaceous Biochemical	g O2/m3	10	6	4	
Escherichia coli	MPN / 100mL	9	< 1	< 1	

AFFCO Manawatu Standpipes sampled 2014 -

	Sample Name:	SP 4			
Description		**Golf Course by boundary fence**			
GPS		**722**			
Lat.					
Long.					
Ground Level	**m**	**65.89**			
bore depth	**m**	**6.34**			
monitoring point height		**0.29**			
Date		18/06/2014	21/07/2014	18/08/2014	11/12/2014
swl	m	4.03	4.06	3.85	4.1
mamsl		-4.03	-4.06	-3.85	-4.10
Temperature	oC	14.60	13.7	12.80	12.8
pH	pH Units	7.5	7.6	7.3	6.6
Electrical Conductivity (EC)	mS/m	53.3	52.1	44.1	53.3
Chloride	g/m3	48	53	45	62
Total Nitrogen	g/m3	4.9	6.1	1.12	2.2
Total Ammoniacal-N	g/m3	1	0.91	0.56	1.3
Nitrite-N	g/m3	0.013	< 0.002	< 0.002	< 0.02
Nitrate-N	g/m3	0.096	0.003	0.007	< 0.02
Nitrate-N + Nitrite-N	g/m3	0.109	0.005	0.008	< 0.02
Total Kjeldahl Nitrogen (TK	g/m3	4.8	6.1	1.11	2.2
Dissolved Reactive Phospho	g/m3	< 0.004	< 0.004	< 0.004	< 0.004
Total Phosphorus	g/m3	2.7	3.9	0.2	1.25
Total Sulphide	g/m3	0.052	0.033	0.01	0.019
Carbonaceous Biochemical	g O2/m3	< 2	5	< 3	< 2
Escherichia coli	MPN / 100mL	2	< 1	< 1	< 1



NOTES

LEGEND

- PRIVATE BORES
- AFFCO BORES
- DEEP BORES
- STANDPIPE
- AFFCO PIEZOMETERS

REV.	DESCRIPTION	DATE
–	–	–

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APPROVED	HL	28.03.14
CHECKED	–	–
DESIGNED	SC	28.03.14
DRAWN	PMJS	28.03.14

CLIENT

AFFCO Manawatu Limited

PROJECT

Groundwater Analysis

DRAWING TITLE

Groundwater Sampling Locations

DRAWING STATUS

Consenting

DATE	DRAWING No.
24 Jul 2014	10146
SCALE	**REVISION**
1:12,500 (A3)	-

ANNEX 19 – AIR DISCHARGE ASSESSMENT OF EFFECTS

1.0 Introduction

AFFCO New Zealand ("ANZ") Manawatu meat processing plant at Feilding has lodged resource consent application with Horizons Regional Council ("HRC") to re-authorise discharges of meatworks effluent, effluent sludge and paunch material to land, and to authorise air discharges arising from the land discharge. HRC has asked for an assessment of the effects of the air discharges, which had been inadvertently omitted from the lodged Assessment of Environmental Effects ("AEE"). This annex is to provide that assessment of effects.

2.0 Activities Involved

The three activities that are capable of generating odours are as follows:

- The irrigation of treated wastewater onto land;
- The application of paunch material to land; and
- The application of pond solids to land.

These activities are not new, but the sites where they are proposed to take place are more extensive than are currently authorised.

3.0 Irrigation of Treated Wastewater

As described in the AEE, treated wastewater is to be irrigated onto farm land under the ownership of Byreburn Farm, ANZ and Dalcam, as shown on the plan titled "Block Identification" appended to this Annex. The irrigation will be by spray infrastructure in the same manner that farm dairy effluent is applied to land throughout Horizons region and indeed throughout New Zealand.

Spray irrigation has the potential to release odours and aerosols into the air, which have the potential to be offensive and objectionable if they carry into a sensitive environment. An effect requires a source material, a vector to allow transport and a receptor to receive or intercept the material.

The source of the odours and/or aerosols will be the wastewater in the process of being irrigated. In the case of the ANZ wastewater, it is not normally odorous, so with the source essentially neutralised there will be no significant effect.

The vector for the propagation of odours and/or aerosols will be the wind at the time irrigation is taking place. If the wind is strong, and/or in such a direction as to carry the effect into a sensitive environment or towards the receptor, and the irrigation activity is in close proximity to the sensitive environment or receptor, then an effect has the potential to occur.

The receptor for odours and aerosols will be people who have a sensitivity to the odour or the aerosols involved. If the odour is not odorous at source, and/or if the vector is not towards a sensitive receptor, then a significant effect may be understood to be unlikely to occur. Conversely, if the material is odorous, and the wind is blowing it towards a sensitive environment, and the sensitive environment is close at hand, then a significant effect can be expected.

The wastewater to be irrigated has been found to be not particularly odorous, and neighbours who visited the irrigation activity while it was being undertaken on 18 March 2015 expressed pleasant surprise at how little odour was in fact generated by this activity. This being the case, factors influencing the delivery vector and proximity of sensitive environments/receptors become less relevant; simply as the stuff doesn't smell.

However, in the unlikely event that the wastewater should develop an odour, its development into a greater than minor effect would be mitigated by the management practices proposed, which include the following:

- Buffer exclusion margins to separate the irrigation activity from nearby sensitive environments, as shown in the Proposed Consent Conditions in Appendix L to the lodged AEE; and
- The use of a purpose-installed meteorological station to stop irrigation when wind speeds and directions contravene pre-determined limits.

Aerosols are potentially generated by the irrigation spray units, putting fine droplets of wastewater into air suspension and able to be transferred downwind for considerable distances. If the aerosols contained harmful pathogens, or corrosive chemicals, or had the capacity to change the colour of surfaces upon which the aerosol might alight, then there could be considered the possibility of an unacceptable effect. The wastewater is, however, benign. Its long residence in the treatment ponds before irrigation ensures that ultraviolet radiation has neutralised pathogens. It does not contain inedible chemicals, and is relatively colourless.

There are several management factors which assist with mitigating odour and aerosol effects. These include:

- Irrigation is seasonal and will only be irrigated for the months where there is a soil moisture deficit, meaning that irrigation will not occur for in some cases more than 5 consecutive days;
- The land area available is extensive and while there are sensitive receptors in some locations, there is considerably more land than is needed to allow irrigation to occur elsewhere on the properties so that the sensitive receptors are either up wind or sufficiently downwind not to be affected; and
- Irrigation will not have to occur on any one day as there is considerable storage capacity, meaning that irrigation can be suspended within any day, and if need be multiple full days.

It is considered that the effect of the proposed irrigation activity in propagating odours and aerosols is not greater than minor, or alternatively can be managed to ensure that the effect of the activity is not greater than minor.

4.0 The Application of Paunch Material to Land

As described in the AEE, it is proposed to apply paunch material to land, within the same area identified for wastewater irrigation, and shown on the accompanying plan. Paunch material consists of rumen contents from slaughtered cattle, and may be considered to be grass fodder in a state of transition towards becoming faeces. Its character is more like that of grass than of faeces, but some digestion has occurred and the material has a slightly more strident odour than does, say, freshly mown hay. By the time the material is matured and ready for application to land its odour is substantially more pleasant than the fully-digested faeces that all dairy farms must deal with on a daily basis. The physical condition of the paunch material to be applied to land is a moist, fibrous mass that readily breaks apart under mechanical disturbance, lending itself to land application with a muck spreader.

It is intended that the paunch material will continue to be excavated from the surface of the solids pond and stored for at least two years in the designated paunch pit at ANZ, as already authorised. However, whereas the current consents authorise the application of matured paunch material to a designated area of land within the ANZ landholding, it is now proposed to extend the area to which it may be applied to include all of the land to which meatworks effluent is to be applied.

As with the irrigation, the area to which application of paunch material is proposed is very much larger than the minimum that is required to keep nitrogen loading within normal limits, and this is to give the farmer full operational flexibility in deciding where he would prefer the material to be placed on any particular occasion. As explained in Section 5.3 of the lodged AEE, annual production of paunch material will be up to 627 m^3/y, so the annual applications to land will vary according to circumstances but will average 627 m^3/y over the long term. The composition of the paunch material is tabulated in Table 4.3 of the Conceptual Design report, which is Appendix E to the lodged AEE, and which is reproduced below.

Table 4.3: Composted Paunch Pit Solids

Sample	Units	Concentration
pH		6.85
Electrical Conductivity	(mS/cm)	1.45
Phosphorus	(mg/L)	2
Phosphorus	(mg/kg)	2,435
Sulphur	(mg/L)	92
Sulphur	(mg/kg)	3,080
Potassium	(mg/L)	19.5
Potassium	(mg/kg)	1210
Calcium	(mg/L)	193.5
Calcium	(mg/kg)	23,600
Magnesium	(mg/L)	13
Magnesium	(mg/kg)	2,340
Sodium	(mg/L)	87
Sodium	(mg/kg)	610.5
Carbon	(%)	15.1
Nitrate-N	(mg/L)	98
Ammonium-N	(mg/L)	1
Nitrogen	(%)	1.355
Nitrogen	(mg/L)	13,550
Plant available nitrogen (PAN)	(kg N/tonne)	2.08
C/N	Ratio	11
Organic Matter	(%)	26.1

Dry Matter	(%)	50.55
Iron	(mg/kg)	13,050
Manganese	(mg/kg)	964.5
Zinc	(mg/kg)	164.5
Copper	(mg/kg)	18.5
Boron	(mg/kg)	10.5

As shown in Table 4.3 the nitrogen loading of the paunch material has been analysed as 13,550 mg/L or 13.55 kg/m^3. Average annual production of 627 m^3 of paunch material would therefore contain 8,496 kg N. Applying this quantity of material to land at a rate that would not exceed a nitrogen loading rate of 200 kg N/ha/y would require the annual use of a land area of 42.5 ha. If it is accepted that only one third of the total nitrogen content of the material is plant available in any given year, then the land area requirement for paunch material application reduces to 14 ha. The lodged AEE notes in Section 5.5.1 that a total area of 132.8 ha is suitable and available. However, it should be noted that this assumes all the material is applied to the properties being consented here, when in fact other properties also receive some of the material.

The paunch material is to be applied to land with a muck spreader or similar technology, and the land is to be cultivated and/or sown within a few days of application. Any odour emitted will therefore be short-lived, and as noted above is not expected to be unpleasant, much less offensive or objectionable. The moist but solid nature of the material makes it unlikely that any aerosols will be generated either by the spreading activity or while the material lies on the ground.

Mitigation of potential odours from this source is provided by the following:

- The material is not offensively odorous in the first place;
- The comparatively small 14 ha average area required in any given year is able to be located where potential nuisance (sensitive receptors) can largely be avoided;
- The material is to be cultivated into the soil within a short time of having been applied;
- Buffer margins will separate the activity from neighbours and other sensitive receptors; and
- Wind velocity and direction are to be used as limits on application activity to reduce the likelihood of adverse odour issues propagating beyond the property boundary.

The effect of the discharge of paunch material to land on air quality is therefore expected to be no greater than minor.

5.0 The Application of Pond Solids to Land

As described in the AEE, the Pond Solids material is the precipitated solids that need to be removed occasionally from the treatment ponds, with an expected annual production rate of 200 m^3/y, and a composition expected to be similar to that of the paunch material as described above. The material comprises mostly the remains of the algae and bacteria that have been decomposing the wastewater in the anaerobic pond; noting that the majority of gross solids have been removed by screening and by both flotation and sedimentation in the solids pond.

The material has the consistency of a mushy and viscous sludge with between 5% and 10% water content; and it comes in varying shades of black. The odour of the pond solids being applied to land is normally sweet, full, earthy and fuscous. However, as the anaerobic material oxidises it can release ammonia, sulphides and mercaptans which can involve unpleasant odours.

It is proposed to apply pond solids to land, within the same area identified for wastewater irrigation, and shown on the accompanying plan. Pond solids are dredged from the bottoms of both the solids pond and the anaerobic pond at ANZ, with a frequency ranging between once per year and once in five years, depending on the efficiency of functioning of those respective ponds. From being dredged, the pond solids are either applied directly to land using a spreader wagon, or transferred to the paunch pit for drying, oxidation and storage. Land application of pond solids may happen as frequently as one time per year, but may not happen at all for periods of up to 5 years.

As with the paunch material, the area to which application of pond solids is proposed is very much larger than the minimum that is required to keep nitrogen loading within normal limits, and this is to give the farmer full operational flexibility in deciding where he would prefer the material to be placed on any particular occasion. As explained in Section 5.3 of the lodged AEE, annual production of paunch material will be up to 200 m^3/y, so the annual applications to land will vary according to circumstances but will average 200 m^3/y over the long term.

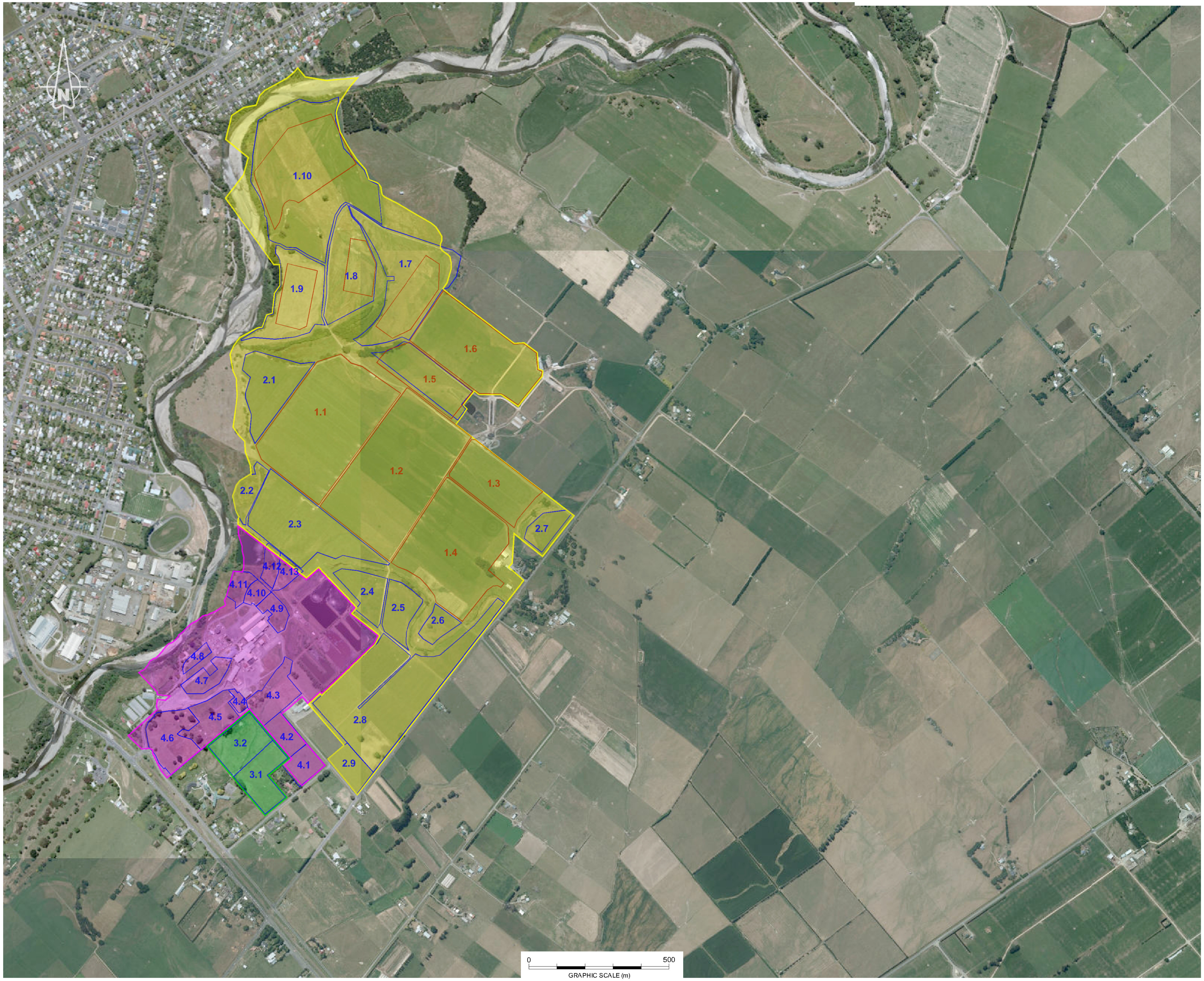
With a total nitrogen content in the order of 13 kg N/m^3, the 200 m^3 annual production will contain some 2,600 kg N, of which about one third (870 kg N) is expected to be plant available in the year of application. With the material applied at any one time at a rate not exceeding 200 kg N/ha/y, an average annual land area requirement will be 4.35 ha every year.

The pond solids material is to be applied to land with a muck spreader or similar technology, and the land is to be cultivated and/or sown as soon as practically possible after application and once the entire paddock has received material i.e. it is likely that application to any one paddock may take several days and it is unlikely that only parts of a paddock will be cultivated in a day. Any odour emitted will therefore be short-lived, and is not expected to be offensive or objectionable beyond the property boundary. The mushy, sludgy nature of the material makes it unlikely that any aerosols will be generated either by the spreading activity or while the material lies on the ground.

Mitigation of potential odours from this source is provided by the following:

- The comparatively small 4 ha average area required in any given year is able to be located where potential nuisance (sensitive receptors) can largely be avoided;
- The material is to be cultivated into the soil within a short time of having been applied;
- Buffer margins will separate the activity from neighbours and other sensitive receptors;
- There will be no compulsion to apply material and as a result suitable days can be identified that cause the least nuisance; and
- Wind velocity and direction are to be used as limits on application activity to reduce the likelihood of adverse odour issues propagating beyond the property boundary.

The effect of the discharge of pond solids material to land on air quality is therefore expected to be no greater than minor.



NOTES

LEGEND

- BYREBURN FARM (IRRIGATED)
- AFFCO
- ST DOMINICS
- CURRENTLY IRRIGATED BLOCKS
- NEW IRRIGATION BLOCKS

REV.	DESCRIPTION	DATE
–	–	–

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APPROVED	HL	28.03.14
CHECKED	–	–
DESIGNED	SC	28.03.14
DRAWN	PMJS	28.03.14

CLIENT

AFFCO Manawatu Limited

PROJECT

AFFCO Manawatu

DRAWING TITLE

Block Identification

DRAWING STATUS

Conceptual Design

DATE	DRAWING No.
04 Jul 2014	10146-05
SCALE	REVISION
1:12,500 (A3)	-

ANNEX 22 – ODOUR ASSESSMENT

1.0 Introduction

AFFCO New Zealand ("ANZ") Manawatu meat processing plant at Feilding has lodged resource consent application with Horizons Regional Council ("HRC") to re-authorise discharges of meatworks effluent, effluent sludge and paunch material to land, and to authorise air discharges arising from the land discharge. HRC has asked for an odour assessment of the air discharges, which had been inadvertently omitted from the lodged Assessment of Environmental Effects. This annex is to provide that this odour assessment by way of a FIDOL Assessment (Frequency Intensity Duration Offensiveness and Location).

2.0 Activities Involved

The three activities that are capable of generating odours are as follows:

- The irrigation of treated wastewater onto land;
- The application of paunch material to land; and
- The application of pond solids to land.

These activities are not new, but the sites where they are proposed to take place are more extensive than are currently authorised.

Treated wastewater has been irrigated to land on Byreburn Farm for some 20 years; the present consent application proposes to extend the area to include a larger part of Byreburn Farm, as well as land on ANZ and DALCAM properties which has not previously been irrigated in this manner. The area of land onto which it is proposed to apply treated wastewater is shown on the plan titled "Block Identification" appended to this Annex.

Paunch material is currently authorised to be applied to land within the ANZ property by consents 105042, 105043 and 105045, scheduled to expire on 1 July 2019. This present consent application seeks to extend the area to which application of this material is authorised to include all the land to which meatworks effluent irrigation is proposed.

Pond solids comprise the sludge that accumulates in the anaerobic treatment pond, typically comprising the organic remains of the algae and bacteria that have been decomposing the wastewater. At present the pond solids are "de-sludged" occasionally from the anaerobic pond, and deposited in the paunch pit for composting with the paunch material. This is proposed to continue, but on occasion the sludge may alternatively be directly applied to land throughout the area of land to which meatworks effluent irrigation is proposed.

3.0 FIDOL Assessments

3.1 Irrigation of Treated Wastewater to Land

3.1.1 Frequency. Spray irrigation of wastewater onto pasture is undertaken when soil conditions are sufficiently dry to receive the wastewater without environmental problems (no ponding or run-off). It can occur on any day over the summer, from late November through to early April depending on the character of the season. Irrigation may take place for up to 24 hours per day.

3.1.2 Intensity. The intensity of the odour from the irrigation of wastewater onto land is assessed to range from E (for weak) to F (for very weak).

3.1.3 Duration. Irrigation and any attendant odour can occur for up to 24 hours per day over the summer months. It will not occur year round and there will be significant continuous periods where there is no irrigation.

3.1.4 Offensiveness/Character. The hedonic character of the odour of the irrigated wastewater is the same mildly meaty smell that emanates from the aerator pond. The odour is identifiably that from an abattoir, but it falls well short of being offensive. Its character is considered to be directly comparable with that of farm dairy effluent, but with a markedly lesser intensity.

3.1.5 Location. The wastewater irrigation takes place on Byreburn Farm, ANZ land, and Dalcam land to the north and east of the ANZ treatment ponds, as shown on the accompanying plan. The irrigated area extends from within 60 m of the Oroua River in the north, to within 20 m of Aorangi Road in the south.

3.1.6 Management. Management of the irrigation to avoid odours is undertaken within the treatment plant, where correct routing of flows and exclusion of putrescibles and excess blood have been shown to provide a quality of effluent, the odour of which has been found not to have an effect which is objectionable or offensive. This was confirmed with a site visit to inspect the irrigation with neighbours on 18 March 2015, when the spray was not found to be significantly odorous.

3.2 Application of Paunch Material to Land

3.2.1 Frequency. Paunch material is to be applied to land occasionally, involving one or two applications in some years and no applications in other years. Odour emissions arising from the land application of this material may occur on a few (typically less than 7) days per year. The frequency and need for land application can be limited by ambient conditions that exist at the time.

3.2.2 Intensity. The odour from land application of paunch material is assessed as having an intensity of D (for distinct).

3.2.3 Duration. The distinct odour that is generated by the mechanical disturbance of paunch material during land application lasts as long as the application activity, which is normally two days at the most, on each occasion.

3.2.4 Offensiveness/Character. The odour of the paunch material being applied to land is green, grassy, with notes of asparagus and capsicum. With short exposure the odour is not entirely unpleasant, although protracted exposure could see its attraction wearing rather thin. The odour of the mechanically disturbed paunch material is soft and organic rather than pungent and offensive; it smells like the healthy compost that it has effectively become.

3.2.5 Location. The land to which the paunch material is to be applied is the same land to which meatworks effluent is proposed to be applied, comprising parts of Byreburn Farm, ANZ land and Dalcam land, as shown on the accompanying plan.

3.2.6 Management. Paunch material is matured in the open air in a designated pit for up to several years, during which time it loses much of its bulk by volatilisation. Due to the aerobic state of the compost, the volatilisation does not lead to the generation of offensive odours. The material is transported by truck for application onto land which is about to be cultivated, either for crop (maize) or pasture renewal. Movement of the material is covered by a management plan required by the existing consents, which will be applied to the area of land under application here. It should be noted that authorisation is sought for paunch material application over a much larger area of land than the minimum required in any one year, in order to maximise the farm management flexibility for the farm operation.

3.3 Application of Pond Solids to Land

3.3.1 Frequency. Pond solids are dredged from the bottoms of both the solids pond and the anaerobic pond at ANZ, with a frequency ranging between once per year and once in five years, depending on the efficiency of functioning of those respective ponds. From being dredged, the pond solids are either applied directly to land using a spreader wagon, or transferred to the paunch pit for drying, oxidation or storage. Land application of pond solids may happen as frequently as one time per year, but may not happen at all for periods of up to 5 years. The timing of the application is sensitive to ambient conditions, with application able to be delayed to suit weather conditions.

3.3.2 Intensity. The odour from land application of pond solids is assessed as having an intensity of D (for distinct); it may be directly compared with the effect of the land spreading activity that follows the annual de-sludging of a farm dairy effluent pond.

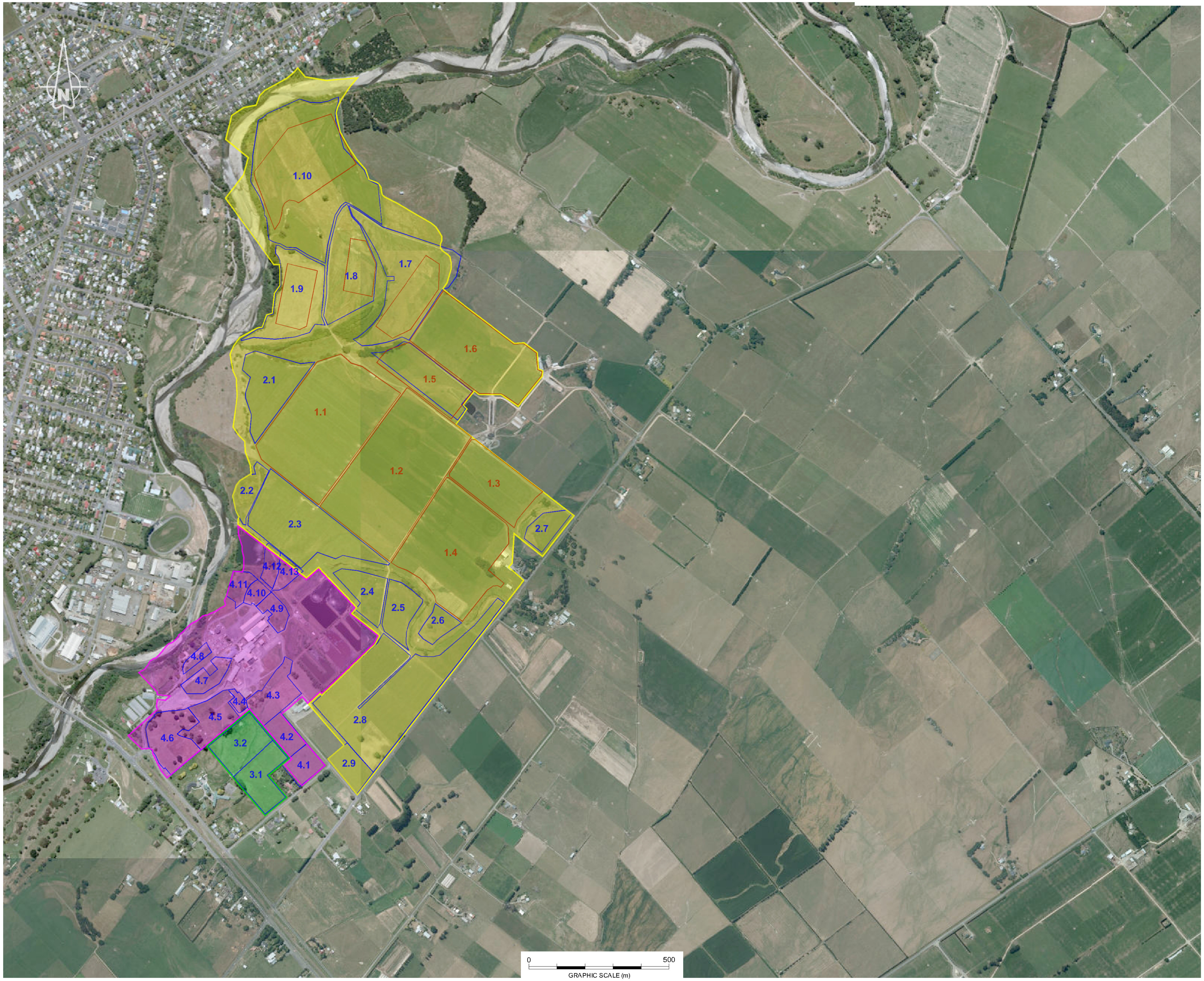
3.3.3 Duration. The distinct odour that is generated by the land application of pond solids lasts as long as the application activity, which is normally two days at the most, on each occasion. The odour normally dissipates quickly, being un-detectable within 2 days. Ensuring a thin application depth helps to minimise any lingering odours.

3.3.4 Offensiveness/Character. The odour of the pond solids being applied to land is normally sweet, full, earthy and fuscous. However, as the material oxidises it can release ammonia, sulphides and mercaptans which can involve unpleasant odours, so it is important that the management of the application is focused on getting the material cultivated in at the earliest opportunity.

3.3.5 Location. The land to which the pond solids are to be applied is the same land to which meatworks effluent is proposed to be applied, comprising parts of Byreburn Farm, ANZ land and Dalcam land, as shown on the accompanying plan.

3.3.6 Management. If pond solids are to be placed in the paunch pit, they will be buried with maturing paunch material in order to prevent the escape of unpleasant odours. After resting with the paunch material for a couple of years the pond solids will have been oxidised and its odour will have become benign.

If the pond solids are to be applied directly to land, then their application method will depend on their consistency on the day. If the material is in the form of a thin slurry it will be spread in the same manner as farm dairy effluent from a spreader wagon. If it has a stodgier consistency, it will be applied using a solids spreader. In either case, where the material has the potential to release worrisome odours, it will be applied onto land that either has been, or is immediately about to be, cultivated for crop establishment or pasture renewal. The cultivation of the land directly after pond solids application is expected to reduce both the intensity and the duration of any odour effect.



NOTES

LEGEND

- BYREBURN FARM (IRRIGATED)
- AFFCO
- ST DOMINICS
- CURRENTLY IRRIGATED BLOCKS
- NEW IRRIGATION BLOCKS

REV.	DESCRIPTION	DATE
–	–	–

L O W E Environmental Impact
|T| [+64] 6 359 3099
|E| office@lei.co.nz
|W| www.lei.co.nz
|A| PO BOX 4667, PALMERSTON NORTH, 4442, NEW ZEALAND.

APPROVED	HL	28.03.14
CHECKED	–	–
DESIGNED	SC	28.03.14
DRAWN	PMJS	28.03.14

CLIENT
AFFCO Manawatu Limited

PROJECT
AFFCO Manawatu

DRAWING TITLE
Block Identification

DRAWING STATUS
Conceptual Design

DATE	DRAWING No.
04 Jul 2014	10146-05
SCALE	**REVISION**
1:12,500 (A3)	-

2nd June 2015

To: Peter Hill
Lowe Environmental Impact

AFFCO Feilding discharge to the Oroua River

Response to points raised by Horizons Regional Council (effects on water quality)

This memo sets out my response to points raised by Horizons Regional Council in a letter dated 18 May 2015 in relation to the AFFCO Feilding treated wastewater discharge to the Oroua River.

1 Methods and data

The numerical outputs presented in this memo have been generated utilising the daily time step mass conservation balance model described in the September 2014 Aquanet technical report forming part of the application[1]. The input data, assumptions, model structure and calibration used in this memo are as per the September 2014 Aquanet technical report.

The cumulative effects of the AFFCO and the MDC Feilding WWTP discharge have been considered in this memo. The input data, assumptions, model structure and calibration are as per my evidence to the Feilding WWTP Hearing Panel[2] and an earlier technical report[3].

[1] Aquanet (2014a) AFFCO (Feilding Meat Processing Plant) discharge to the Oroua River: Water Quality modelling and assessment of effects of proposed discharge regimes. Report prepared for AFFCO NZ Ltd by Aquanet Consulting Ltd. September 2014.

[2] In the Matter of an application by the Manawatu District Council (Infrastructure Group) for resource consents for discharges, bed disturbance and earthworks associated with the Feilding Wastewater Treatment Plant and a Notice of Requirement by the Manawatu District Council (Infrastructure Group) for amendments to and extension of an existing designation, Statement of Evidence of Dr Olivier Ausseil. Dated 22 July 2014.

[3] Aquanet (2014b). Feilding WWTP discharge to the Oroua River - Water Quality modelling and assessment of effects of the proposed discharge regime. Report prepared for Manawatu District Council by Aquanet Consulting Ltd. March 2014.

2 Question 5: What are the cumulative effects on the Manawatu River as the Oroua catchment can be running at high flows while the Manawatu will still be low?

The potential effects of the AFFCO discharge on nutrient concentrations in the Manawatu River were modelled using the same methodology as for the Oroua River.

It is noted that this approach ignores any nutrient attenuation between the discharge point and the Manawatu River, i.e. will overestimate the actual effects of the AFFCO discharge on nutrient concentrations in the Manawatu River.

The modelling outputs are summarised in the tables below.

The potential contribution of the AFFCO discharge to nutrient concentrations at flows below the 20th FEP in the lower Manawatu River is predicted to:

- Reduce from 0.0007 g/m^3 (5% of the One Plan target) to 0.0002 g/m^3 (1% of the One Plan target) for DRP; and
- Reduce from 0.004 g/m^3 (1% of the One Plan target) to 0.001 g/m^3 (0.3% of the One Plan target) for DRP

Although the proposed discharge regime does not include any discharges to the Oroua River when it is under median flows, the differences in hydrological regimes between the Oroua and the Manawatu Rivers mean that, on occasions, discharges are predicted to occur when the Manawatu River is below its median flow. This is predicted to occur approximately 10% of the time under the current scenario, reducing to 2.5% of the time under the proposed regime. The predicted effects on average nutrient concentrations when the Manawatu River is below median flows are predicted to be negligible (0.05 parts per billion for DRP and 0.3 parts per billion for SIN).

Table 1: Predicted potential DRP concentration increase in the Manawatu River downstream of the confluence with the Oroua River as a result of the current and proposed AFFCO Feilding discharge.

	Current		Proposed	
	Δ [DRP] (g/m^3)	% of OP Target	Δ [DRP] (g/m^3)	% of OP Target
All river flows	0.0006	4%	0.0003	2%
River flows below 20th FEP	0.0007	5%	0.0002	1%
River flows median to 20th FEP	0.0008	5%	0.0005	3%
River flows below median	0.0006	4%	0.00005	0.4%

Table 2: Predicted potential SIN concentration increase in the Manawatu River downstream of the confluence with the Oroua River as a result of the current and proposed AFFCO Feilding discharge.

	Current		Proposed	
	Δ [SIN] (g/m^3)	% of OP Target	Δ [SIN] (g/m^3)	% of OP Target
All river flows	0.004	1%	0.002	0.5%
River flows below 20th FEP	0.004	1%	0.001	0.3%
River flows median to 20th FEP	0.005	1%	0.003	0.7%
River flows below median	0.003	0.7%	0.0003	0.08%

3 Question 7: What are the effects on the River on the Oroua River between median flow and the 20th FEP?

The DRP and SIN loads discharged to the Oroua River in different river flow ranges are presented in Figures 5 and 10 (absolute numbers in Tonnes per year) and Figures 6 and 11 (as a proportion of the total load) of the September 2014 Aquanet report. The graphs show that the proposed discharge regime results in a significant reduction (approximately 67%, i.e. a two-thirds reduction) of the loads of both DRP and SIN discharged to the Oroua River at river flows between the median flow and the 20th FEP. It is understood that this meets the information requirements with regards to contaminant loads.

With regards to nutrient concentrations, the following figures are updated versions of Figures 7, 8 and 9 (for DRP) and 12, 13 and 14 (for SIN), now specifically incorporating the predicted changes in concentrations in the median to 20th FEP flow range.

It is apparent from these figures that the proposed discharge regime results in significant reduction in the predicted effects of the discharge on in-river average DRP and SIN concentrations under all flow ranges modelled, including median to 20th FEP, when compared with the current scenario. This conclusion is valid when considering both annual and monthly time-scales.

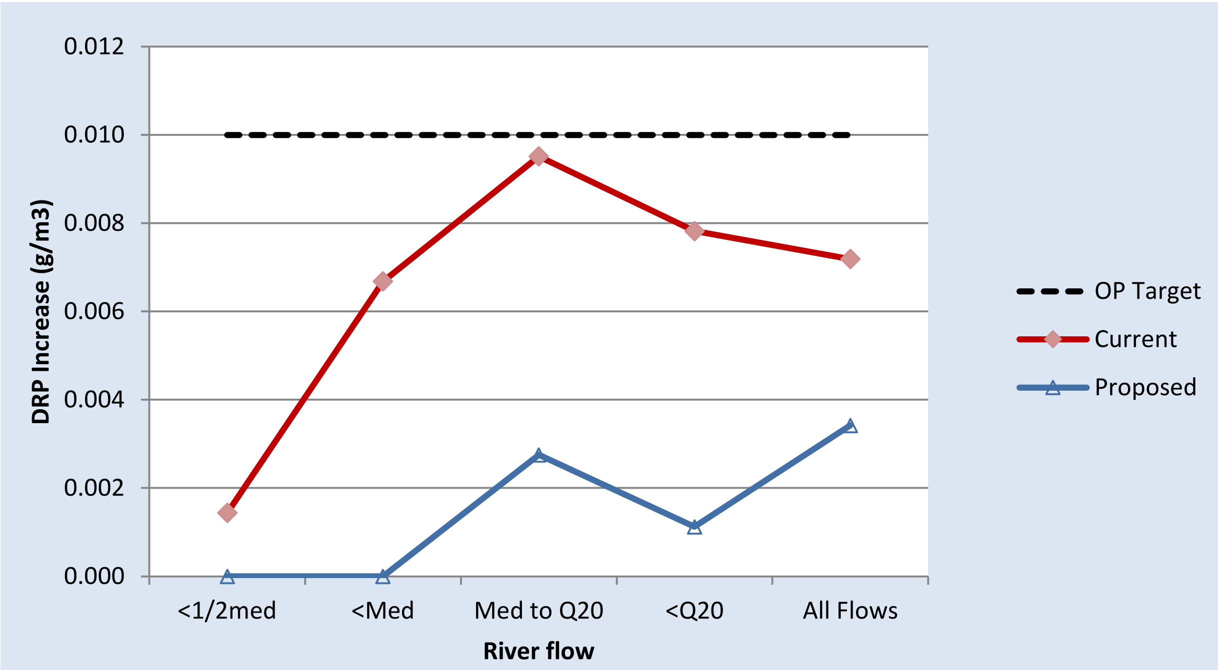


Figure 1: (updated Figure 7 from Sept 2014 Aquanet report). Predicted annual average DRP concentration <u>increase</u> in the Oroua River due to the AFFCO discharge at different flows under current and proposed discharge scenarios.

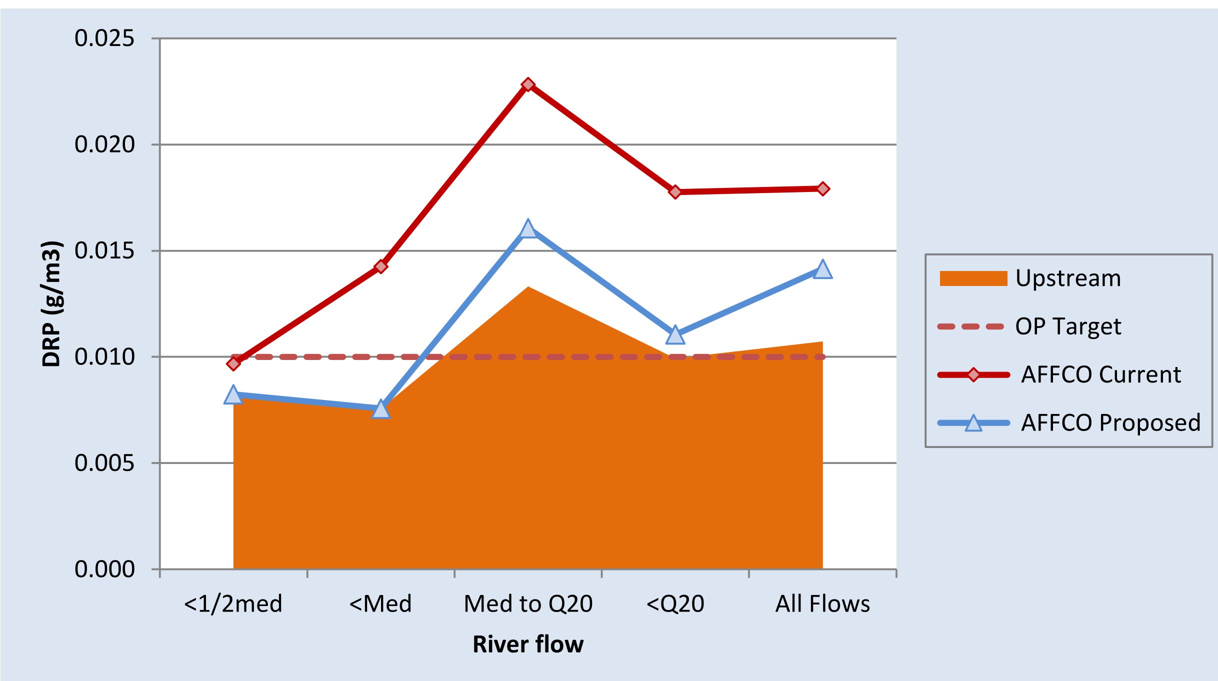


Figure 2: (updated Figure 8 from Sept 2014 Aquanet report). Predicted annual average DRP concentration in the Oroua River upstream and downstream of the AFFCO discharge at different flows under current and proposed discharge scenarios.

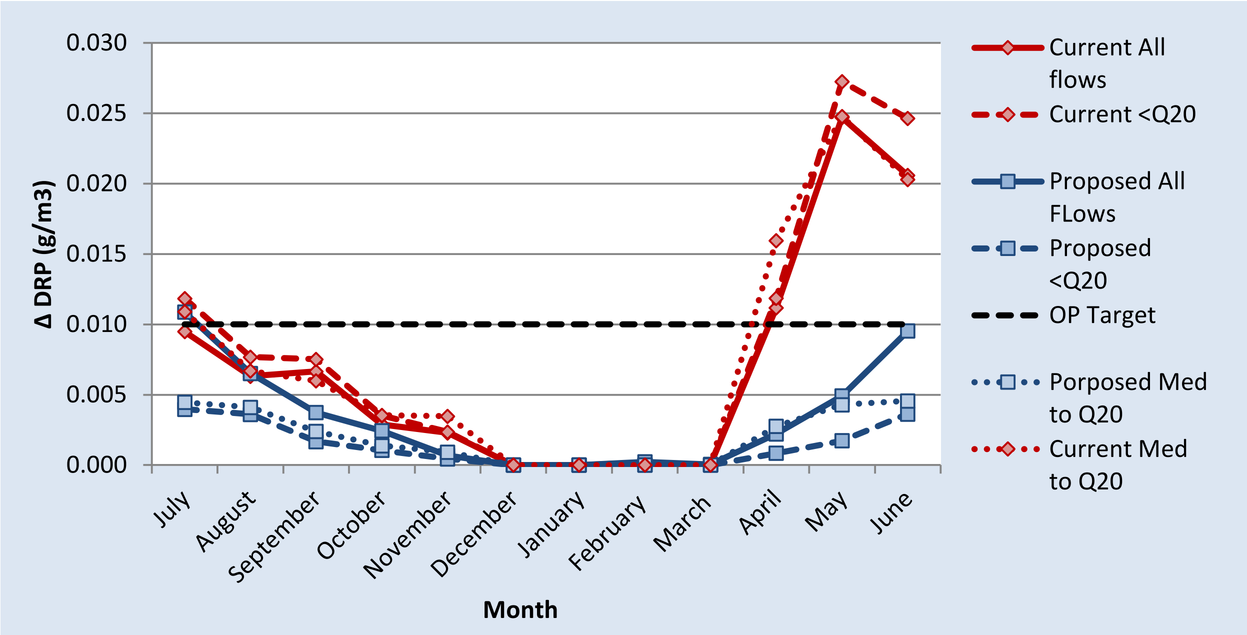


Figure 3: (updated Figure 9 from Sept 2014 Aquanet report). Predicted annual average DRP concentration <u>increase</u> in the Oroua River due to the AFFCO discharge at different flows under current and proposed discharge scenarios.

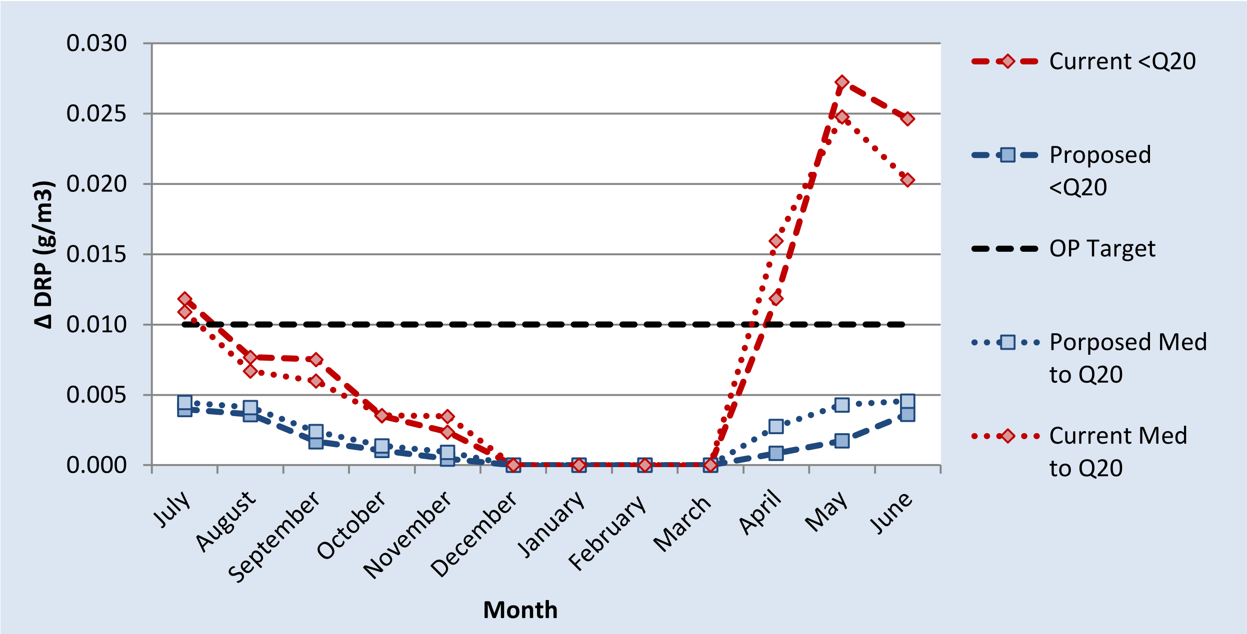


Figure 4: Same as Figure 3 above, but with predictions at "all flows" removed for ease of reading.

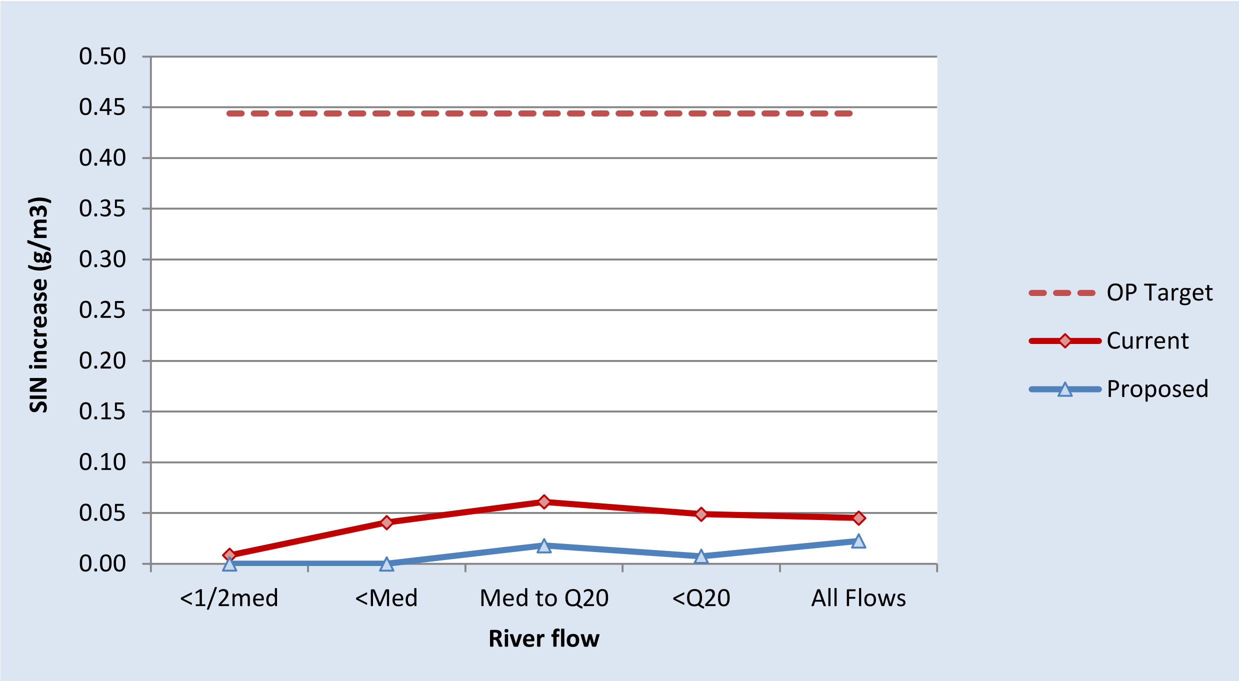


Figure 5: (updated Figure 12 from Sept 2014 Aquanet report). Predicted annual average SIN concentration <u>increase</u> in the Oroua River due to the AFFCO discharge at different flows under current and proposed discharge scenarios.

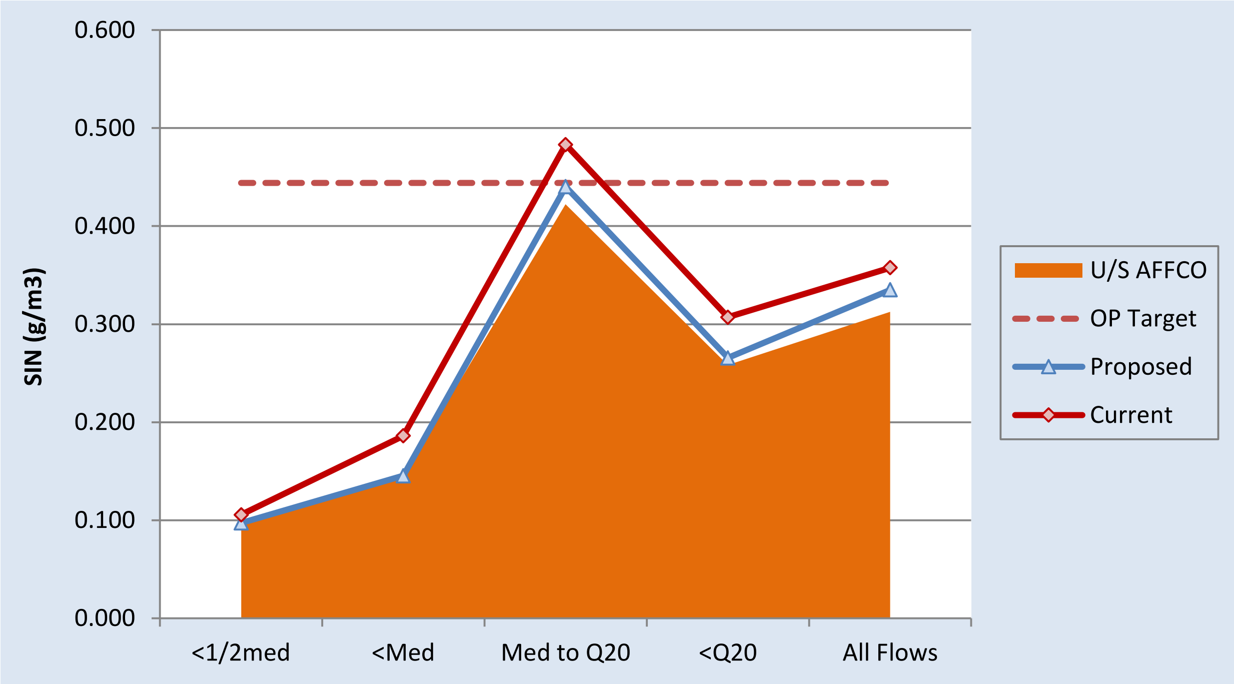


Figure 6: (updated Figure 13 from Sept 2014 Aquanet report). Predicted annual average SIN concentration in the Oroua River upstream and downstream of the AFFCO discharge at different flows under current and proposed discharge scenarios.

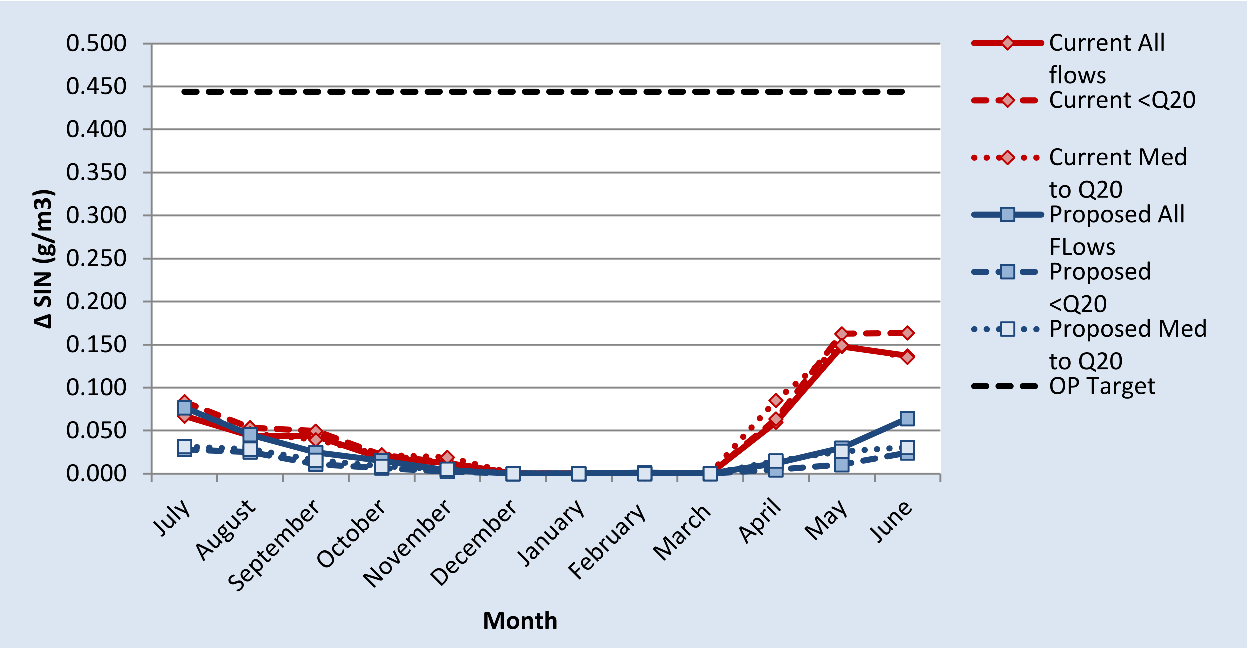


Figure 7: (updated Figure 14 from Sept 2014 Aquanet report). Predicted annual average SIN concentration <u>increase</u> in the Oroua River due to the AFFCO discharge at different flows under current and proposed discharge scenarios.

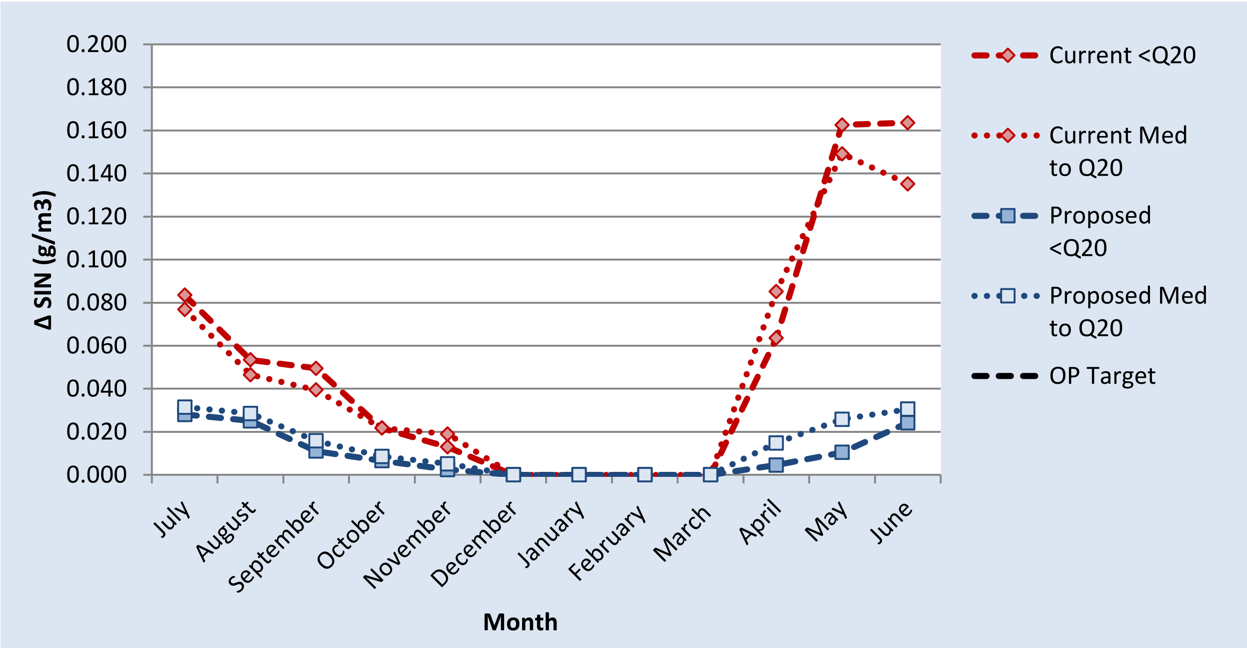


Figure 8: Same as Figure 7 above, but with predictions at "all flows" removed and expanded on vertical scale for ease of reading.

4 Question 9: The discharge is based on the dilution within the Oroua, however there are two references as to when the discharge rate is calculated. Is there any proposal to relate this into actual in-stream river flows? The Oroua is known to change during the day – does this affect the impact the assessment of effects?

It is my understanding that LEI will respond to the part of the question relative to the operative management of the discharge.

All predictions presented in the September 2014 Aquanet report and this memo are based on daily average flows in the Oroua River.

With regards to potential effects on contaminant concentrations in the river, assuming that the discharge rate to the river is calculated on the basis of river flow conditions at 9 am each morning, then it is likely that on a falling or rising river, the contaminant concentration increases caused by the discharge will be somewhat higher (on a falling river) or lower (on a rising river) than those predicted by modelling based on daily average river flow. The law of averages means that overall, there will be as many days when the concentration is somewhat higher (i.e. falling river) as it is somewhat lower (i.e. rising river), than I have predicted.

With regards to nutrient concentrations, it is generally accepted that dissolved nutrient concentrations over sustained periods of time (weeks to months) are more likely to influence periphyton growth than short-term variations in concentrations. This is the reason why the One Plan nutrient targets are expressed as an average concentration over a period of 12 months. It is accepted that nutrient concentrations over shorter (than annual) timeframes can affect periphyton growth, and I have provided monthly average concentration predictions for this reason. On the basis that there will be as many "overs" than "unders" compared with the modelling predictions and that these unders and overs will be of short duration (less than a day each) I do not consider that monthly average nutrient concentrations, or that the predictions relative to periphyton growth will be materially affected.

With regards to toxicants, in particular ammonia, unpredicted short-term elevated concentrations would potentially be of concern if they were sufficient to cause short-term (acute) toxic effects. As detailed in section 4.4 of the September 2014 Aquanet report, the highest daily total ammonia-N concentration predicted under the "proposed" scenario is 0.227 g/m^3, which is approximately 10 times lower than the One Plan target for acute ammonia toxicity (2.1 g/m^3). It seems unlikely that daily river flow variations (particularly on a falling limb) would be of such a scale that the One Plan acute ammonia target concentration would be exceeded. I note however that I have not been able to access instantaneous river flow data (as opposed to daily average flow data) in order to verify this conclusion.

5 Question 12: Are you able to provide a calculation of the nutrient loads that are contributed to the Manawatu River

The following tables were provided to the hearing Panel for the Feilding WWTP Hearing in August 2014, as part of the water quality experts' joint witness statement[4]. The loads for the Manawatu River at Shannon (upstream of the Shannon WWTP discharge) were calculated using a similar modelling methodology. The data, assumptions and methods are summarised in an earlier Aquanet technical report[5].

Columns shaded in grey were added in this memo in relation to the AFFCO Feilding discharge.

It is noted that the estimated contributions to the nutrient loads in the Manawatu River at Shannon do not account for any attenuation of nutrient loads between Feilding and Shannon, and are therefore overestimations of the *actual* contribution to nutrient loads in the lower Manawatu River.

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[4] Manawatu District Council –Permits associated with the Feilding WWTP. Water Quality Conferencing Notes from the 30th June 2014, 1st and 3rd July 2014. Dated 4th July 2014.

[5] Shannon WWTP discharge to the Manawatu River – Water quality modelling and assessment of effects of the proposed future discharge regime. 31 October 2013. Report prepared for the Horowhenua District Council by Aquanet Consulting Ltd.

Table 3: Estimated annual DRP loads (in T/Yr) under different flow conditions. Numbers in brackets are the contribution to the loads in the Manawatu at Shannon for the same flow range.

	Manawatu River at Shannon	Oroua River upstream of Feilding WWTP	Feilding WWTP discharge (historical)	Feilding WWTP discharge (current)	Feilding WWTP discharge (after implementation of land discharge)	AFFCO Feilding Current	AFFCO Feilding Proposed	AFFCO + MDC Current	AFFCO + MDC proposed
At all river flows	90 (100%)	6.8 (7.5%)	26.8 (30%)	0.70 (0.8%)	0.57 (0.6%)	2.21 (2.5%)	2.37 (2.6%)	2.91 (3.2%)	2.94 (3.3%)
Under 20th FEP	41	4.0 (9.8%)	20.2 (49%)	0.53 (1.3%)	0.39 (0.9%)	1.48 (3.6%)	0.33 (0.8%)	1.87 (4.9%)	0.72 (1.7%)
Under Median flow	13	1.3 (9.8%)	11.3 (87%)	0.30 (2.3%)	0.16 (1.2%)	0.48 (3.7%)	0 (0%)	0.64 (6.0%)	0.16 (1.2%)
Under half median flow	3.3	0.26 (7.8%)	5.1 *(>100%)*	0.14 (4.2%)	0.008 (0.2%)	0.03 (1.0%	0 (0%)	0.17 (5.3%)	0.008 (0.2%)

Table 4: Estimated annual SIN loads (in T/Yr) under different flow conditions. Numbers in brackets are the contribution to the loads in the Manawatu at Shannon for the same flow range.

	Manawatu River at Shannon	Oroua River upstream of Feilding WWTP	Feilding WWTP discharge (historical)	Feilding WWTP discharge (current)	Feilding WWTP discharge (after implementation of land discharge)	AFFCO Feilding Current	AFFCO Feilding Proposed	AFFCO + MDC Current	AFFCO + MDC proposed
At all river flows	2,900	157 (5.4%)	77 (2.7%)	51.1 (1.8%)	42.1 (1.4%)	14.1 (0.5%)	15.7 (0.5%)	65.2 (2.2%)	57.8 (2.0%)
Under 20th FEP	1,206	80 (6.6%)	58 (4.8%)	38.6 (3.2%)	28.9 (2.3%)	9.4 (0.8%)	2.15 (0.2%)	48.0 (4.0%)	31.0 (2.6%)
Under Median flow	359	15.4 (4.2%)	32 (8.9%)	21.5 (6.0%)	11.3 (3.1%)	2.9 (0.8%)	0 (0%)	24.4 (6.8%)	11.3 (3.1%)
Under half median flow	79	1.4 (1.8%)	14 (18%)	9.5 (12%)	0.46 (0.6%)	0.2 (0.3%)	0 (0%)	9.7 (12.3%)	0.5 (0.6%)

6 Question 13: The proposal includes the discharge at flows above median flows and it is based on a dilution ration instream – how does this compare to the current situation at these flows instream? At flows below median there is an improvement in water quality downstream of the discharge. However, is this the case at flows between median and the 20th FEP or does the discharge result in an increased discharge volume at these flows and therefore an increase in the instream concentrations? If there is an increase in the concentrations between these flows could the applicant analysis the effects of this on the Feilding STP consent given that there discharge regime has them discharging to half median flow and below this at times. Periphyton accrual begins below the 20th FEP and any potential increase in nutrients upstream of the discharge may affect the ability of them to comply with any consent conditions.

As indicated in to Section 3 of this memo, the proposed discharge regime results in:

- A two-thirds (67%) reduction in the annual SIN and DRP loads discharged to the Oroua River at river flows between median and 20th FEP; and
- Reductions in annual and monthly average concentrations downstream of the discharge (when compared with the current situation) under all flow ranges modelled.

Qualitatively, this means that the proposed discharge regime is likely to:

- Cause less periphyton growth downstream of the AFFCO discharge as compared to the current situation;
- Increase the likeliness of the MDC Feilding being able to meet the One Plan periphyton biomass and cover targets more often, again as compared with the current situation, and all other things being equal (i.e. without considering the proposed changes to the MDC discharge).

Cumulative effects of the AFFCO Feilding and the MDC Feilding WWTP[6] discharges on the Oroua River.

Given the proposed changes to the discharge regimes for both discharges and their proximity, the cumulative effects of the AFFCO Feilding and the MDC Feilding WWTP discharges were modelled on a daily basis by adding the effects of the MDC discharge to the "downstream of AFFCO" predicted nutrient concentrations, both under "current" and "proposed" scenarios.

It is noted that this approach does not account for any attenuation, or any additional inputs from external sources, of nutrients between the AFFCO discharge and downstream of the Feilding discharge.

Annual and monthly average concentration predictions are presented in the series of graphs below.

Historically, most the of the exceedances of the One Plan periphyton targets upstream or downstream of the MDC Feilding WWTP discharge have occurred in the February to May (inclusive) period. These months therefore represent the highest risk period for nuisance periphyton growth in the Oroua River.

The AFFCO discharge is not proposed to operate at flows below 20th FEP (in fact below 3 times median flow which is a higher threshold) during the months December to March inclusive, and is therefore not likely to cause any more than minor effects on periphyton growth during these months.

In April and May, the proposed AFFCO discharge regime results in significant reductions in monthly DRP and SIN average concentrations downstream of the AFFCO discharge, when compared with the current situation, under all flow ranges tested. Similarly the discharge regime proposed for the MDC Feilding discharge also results in reductions in the effects of that discharge on monthly average SIN and DRP concentrations.

[6] Manawatu District Council Feilding Wastewater Treatment Plant.

Cumulatively, the combined effect of the two discharges on monthly average SIN and DRP concentrations at flows below 20th FEP are predicted to be reduced by

- 74% (in May) and 77% (in April) for DRP
- 62% (in May) and 77% (in April) for SIN

The conclusion is that the proposed changes to the AFFCO discharge regime are predicted to result in a reduction in both DIN and DRP concentrations under all timescales (annual and monthly) and flow ranges considered downstream of the AFFCO discharge, i.e. upstream of the MDC Feilding WWTP discharge. This in itself is expected to increase, rather than decrease, the likeliness of the One Plan periphyton targets being met both upstream and downstream of the MDC Feilding WWTP discharge.

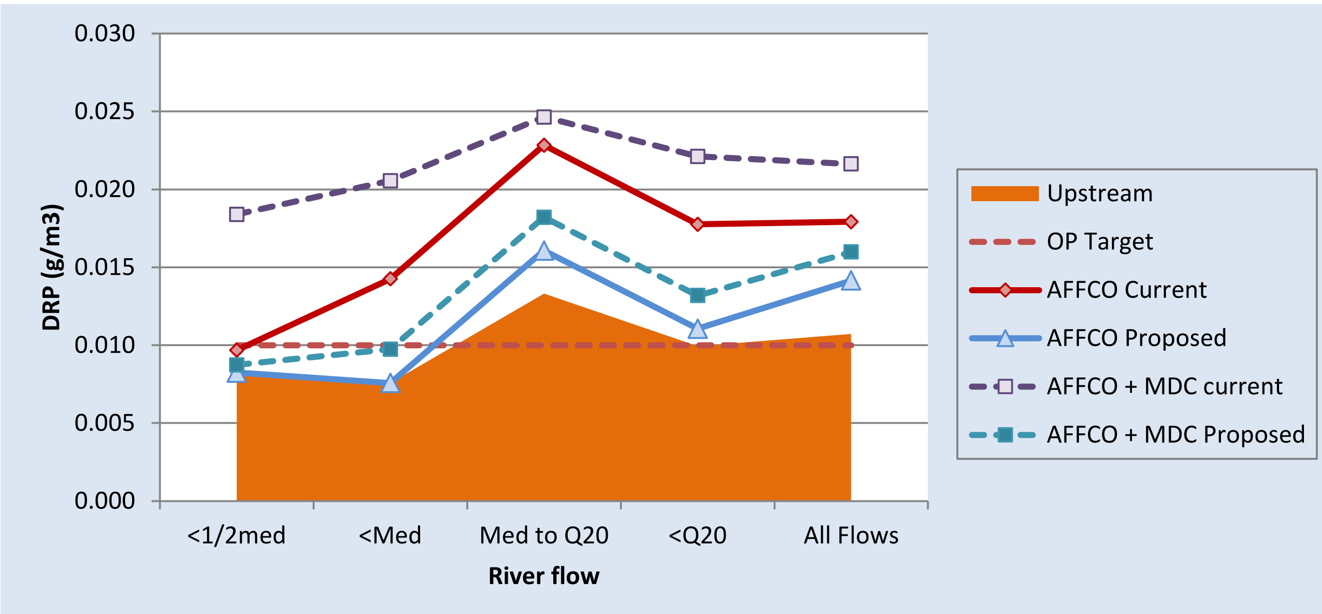


Figure 9: Predicted annual average DRP concentration in the Oroua River upstream and downstream of the AFFCO and Feilding MDC discharge at different flows under current and proposed discharge scenarios.

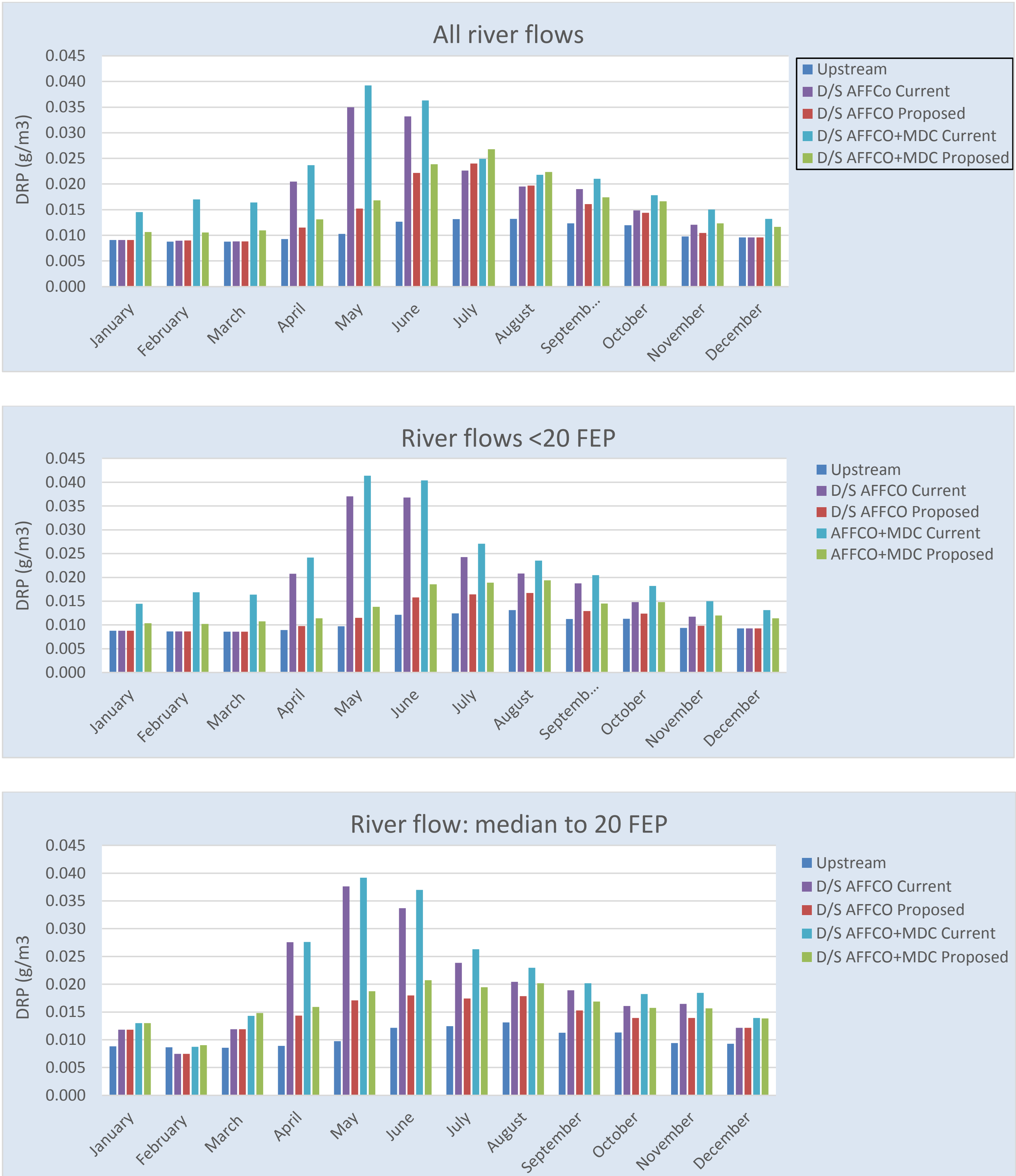
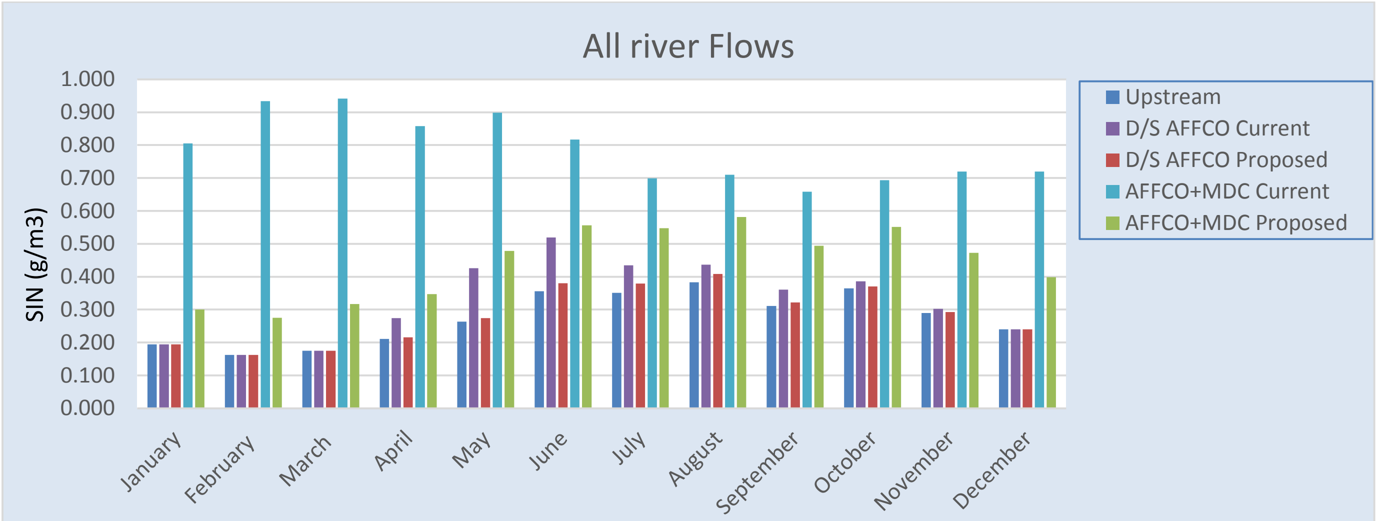
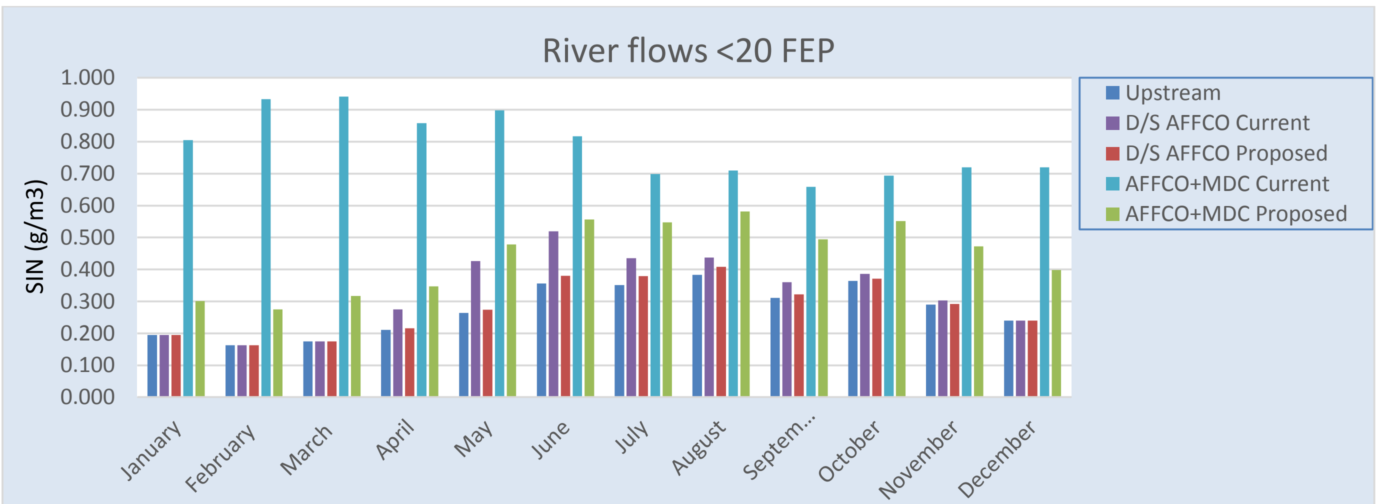


Figure 10: Predicted monthly average DRP concentration in the Oroua River upstream and downstream of the AFFCO and Feilding MDC discharge at different river flows under current and proposed discharge scenarios.





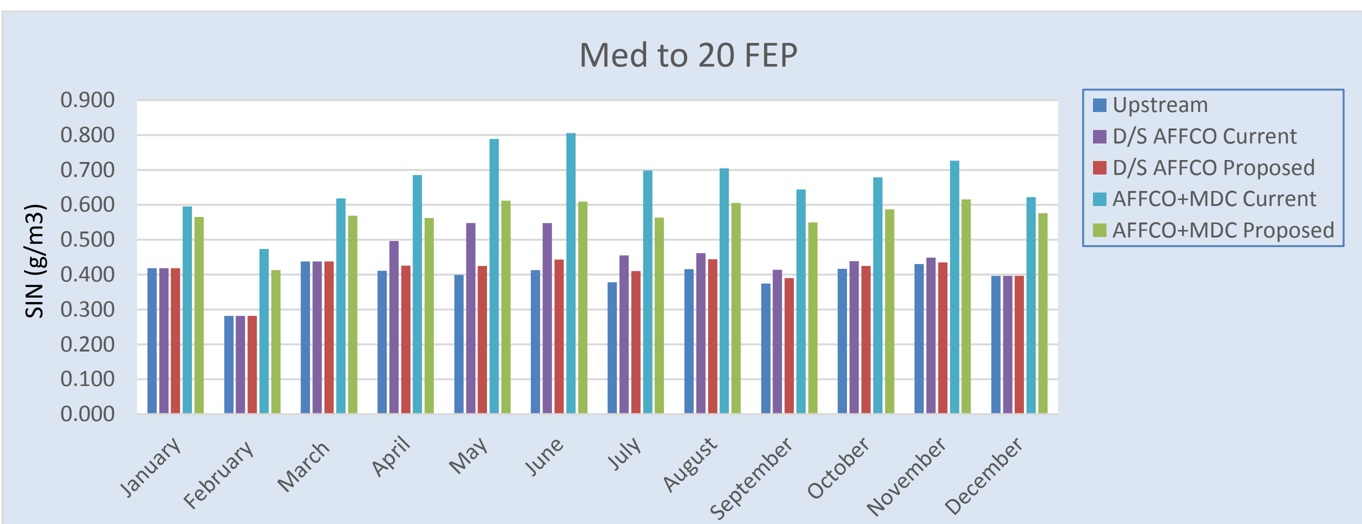


Figure 11: Predicted monthly average DRP concentration in the Oroua River upstream and downstream of the AFFCO and Feilding MDC discharge at different river flows under current and proposed discharge scenarios.

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