AFFCO Manawatu
Contract 303275

Land Application of Meatworks Process Wastewater at Byreburn Farm, Feilding Resource Consent Application and Assessment of Environmental Effects

February 2011

CPG New Zealand Ltd
A subsidiary of Downer EDI Limited

AFFCO Manawatu
Land Application of Meatworks Process Wastewater at Byreburn Farm, Feilding
Resource Consent Application and Assessment of Environmental Effects

Contract No 303275

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1.0 APPLICATION

Form 9

APPLICATION FOR RESOURCE CONSENT

UNDER SECTION 88 OF THE

RESOURCE MANAGEMENT ACT 1991

TO: Horizons Regional Council

AFFCO Manawatu, c/- CPG New Zealand Ltd, applies for the resource consent described below.

1. **THE NAMES AND ADDRESSES** of the owners and occupiers of any land to which the application relates are as follows:

a) Owner/occupier of Meat processing plant:

AFFCO Manawatu
P O Box 198
Feilding

b) Owner/occupier of application site:

Byreburn Limited
c/- Bryan R Guy
14 Highfield Road
Feilding

2. **THE LOCATION** to which this application relates is:

Byreburn Farm, Aorangi Road, Feilding, adjacent to and generally to the north of AFFCO Manawatu, Campbell Road, Feilding.

3. **LEGAL DESCRIPTIONS**:

- Lot 191, DP 100; 13.7947 ha;
- Pt Sec 3, Blk XIV, Oroua SD; 24.3665 ha;
- Lot 2, DP 89128; 39.9744 ha;
- Lot 1, DP 57560; 22.7125 ha;
- Lot 1, DP 89045; 19.2740 ha;
- Lot 2, DP 89045; 11.7475 ha;
- Lot 31, DP 2688; 0.6171 ha;
- Lot 30, DP 2688; 0.6171 ha;
- Pt Lot 29, DP 2688; 0.1675 ha;
- Pt Lot 29, DP 2688; 0.4490 ha;

- Lot 2, DP 73177; 23.1490 ha; and
- Sec 5, Blk XIV, Oroua SD; 32.2332 ha.

4. **THE TYPE** of resource consent sought from Horizons Regional Council:

- Discharge to land consent.

5. **A DESCRIPTION** of the activity to which the application relates is:

The discharge to land on Byreburn Farm, from a storage reservoir, by way of spray irrigation, of meat works process wastewater arising from the operation of AFFCO Manawatu's Feilding meat processing plant. A full description of the various activities is supplied in the balance of this document.

6. **ADDITIONAL RESOURCE CONSENTS:**

11 resource consents are required for the operation of the plant, all of which are under current application to Horizons Regional Council.

7. **THE DURATION** of consents sought is 25 years.

8. **AN ASSESSMENT** of any effects that the proposed activities may have on the environment in accordance with the fourth schedule to the Resource Management Act 1991 is attached.

9. **THE ATTACHED** assessment of environmental effects also contains any other such information required to be included in the application by the District or Regional Plan(s) or Act or Regulations.

____

Signed on behalf of applicant

Peter Hill
CPG New Zealand Ltd.

Dated this ………… day of February 2011.

ADDRESS FOR SERVICE of Applicant:

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2.0 EXECUTIVE SUMMARY

AFFCO Manawatu seeks a resource consent from Horizons Regional Council ("HRC") for the discharge of Meatworks Effluent (MWE) arising from the operation of its AFFCO Manawatu Meat Processing Plant ("AMP") at Campbell Road, Feilding, onto land on the adjoining Byreburn Farm. This consent will be to replace consent number 4226, which is due to expire on 14 May 2011. The current consent authorises the discharge of up to 2,000 m^3/day of MWE onto 75 ha of land on Byreburn Farm.

The AMP is situated on the south-east side of the Oroua River, accessed by Campbell Road off SH 54, on the Bunnythorpe side of Feilding. Byreburn Farm is located adjacent to AMP, directly bordering the plant to its north and east. It adjoins the south-east bank of the Oroua River, and includes land on both sides of Aorangi Road. The total farm area is 165.95 ha, and includes 12 titles comprising some 159 ha that may be considered for MWE application.

The data gathered as a result of the monitoring required by current consent number 4226 has enabled an evaluation of both the effects of, and appropriate limits on, the irrigation of MWE from AFFCO Manawatu's Feilding export meat processing plant onto land at the adjacent Byreburn Farm. A new irrigation regime is proposed that will have the ability to take more of AFFCO's effluent than previously, and apply it to a larger area of land.

Under the existing application scheme P accumulation has been identified as the parameter of most concern. In design of an application regime for the proposed activity P has been adopted as the limiting parameter. A summary of the proposed maximum land application parameters based on the existing MWE quality, with P as the limiting parameter are as follows:

Parameter	Existing application Area		Expanded application area	
Irrigation method	Existing	Low rate	Existing	Low rate
Irrigable area	75 ha		90 ha	
Limiting parameter	Phosphorus load			
Application Rates				
Maximum yearly application volume (m^3)	187,500		225,000	
Yearly application volume per unit area (m^3/ha)	2,500		2,500	
Yearly application depth (mm)	250		250	
Average daily over the 180 day season (mm/d)	1.4		1.4	
Maximum application per event (mm/application)	34	15	34	15
Number of applications per season (n)	7.4	16.7	7.4	16.7
Nutrients				
Yearly N applied (kg N/ha/y)	310	310	310	310
N applied per application (kg N/ha)	42	19	42	19
Yearly P applied (kg P/ha/y) – (@ 24 g/m^3)	60	60	60	60
P applied per application (kg P/ha)	8	4	8	4
Yearly K applied (kg K/ha/y)	110	110	110	110
K applied per application (kg K/ha)	15	7	15	7
Yearly Organic load applied (kg BOD/ha/y)	90	90	90	90
Organic load applied per application (kg BOD/ha)	12	5	12	5

It is proposed that a limit of 350 kg/ha/y of nitrogen from all sources be included for areas receiving MWE. This will enable the landowner more management options to ensure that farm production is maintained.

In the past gravelly Rangitikei soils close to the Oroua River have been used. These soils will no longer be used, with preference given to incorporating additional areas of Kairanga, Manawatu and/or Milson soils. This will enable AMP and Byreburn Farm to continue to operate the system of irrigation of MWE, over an expanded land area onto soils which are less likely to result in excessive leaching to the underlying shallow groundwater system. The additional area will also enable a significant increase to the maximum annual volume applied to land, but with specific loadings that will not lead to adverse environmental effects. Lower and more frequent applications, in line with plant uptake requirements, would be enabled by the use of a low rate application system.

The requirements of the Resource Management Act and the Regional Policy Statement are met. The activity complies with the Permitted Activity standards and objective and policy requirements of the operative Manawatu District Plan.

The activity has been assessed according to the One Plan Decisions Version, the Manawatu Catchment Water Quality Plan, and the Land and Water Regional Plan. While the activity qualifies as a Discretionary Activity under all three plans, the objectives, policies and rules are all able to be met by the application, assisted with the adoption of appropriate conditions on a consent for the proposed activity.

This Assessment of Environmental Effects concludes that there are no adverse environmental effects from the proposed discharge of MWE to land on Byreburn Farm that cannot be avoided, remedied or mitigated, and whose effects are greater than minor. It is therefore concluded that the resource consent under application here may safely be granted.

3.0 INTRODUCTION

3.1 Purpose of This Report

This report is to provide the Application and Assessment of Environmental Effects for AFFCO Manawatu to obtain resource consent from Horizons Regional Council (HRC) to authorise the discharge of Meatworks Effluent (MWE) from its AFFCO Manawatu Meat Processing Plant (AMP) onto land at the adjacent Byreburn Farm.

3.2 Background

The AMP has operated at its current Campbell Road site since May 1992. The site had previously been occupied by the larger Borthwick's meat processing plant for many decades, and was closed for re-building in September 1991. The current plant operated for a time under the name "Manawatu Beef Packers", which was a subsidiary of AFFCO.

The resource consents granted by HRC are scheduled to expire on 14 May 2011, and the grant of new consents to replace those expiring ("renewals") is now sought.

3.3 Existing Consents

There are eleven current consents granted by HRC for various water takes, discharges of water and wastewater, a river diversion, and the discharges to air. All consents except that for the groundwater take are scheduled to expire together on 14 May 2011.

There are also three further consents (numbers 105042, 105043 and 105045) for discharges to land and air of paunch material, which were granted on 12 February 2010 for a term expiring on 1 July 2029.

The following consent is currently held by the applicant with regard to the MWE discharge to land activity at this site:

Consent Number	Description	Type
4226	This consent authorises the discharge of up to 2,000 cubic metres per day of treated effluent on to no less than 75 hectares of land on Aorangi Road, Feilding, at or about map reference S21:304-051 shown on Plan C4226 attached to and forming part of this consent for a term expiring on **14 May 2011.**	Discharge

3.4 Report Scope

The scope of this report is to describe the activity of application of MWE to land at Byreburn Farm, to assess the effects of this activity on the environment, to evaluate these effects against the provisions of the relevant statutory and planning requirements, and to recommend conditions under which a resource consent for the activity may be granted.

4.0 RECEIVING ENVIRONMENT

4.1 Location

AFFCO Manawatu's Feilding Plant ("AMP") is situated on the south-east side of the Oroua River, accessed by Campbell Road off SH 54, on the Bunnythorpe side of Feilding. The plant is situated 1.5 km south-east of Feilding railway station, and some 500 m across the river from the nearest residential part of Feilding, as shown in Figure 1 (Appendix A).

Byreburn Farm is located adjacent to AMP, directly bordering the plant to its north and east. It adjoins the south-east bank of the Oroua River, and includes land on both sides of Aorangi Road. The total farm area is 165.95 ha, and includes 12 titles comprising some 159 ha that may be considered for MWE application. The farm is deployed about its main home and facilities on Aorangi Road at NZMG 2730845E – 6104755N, and its situation is shown in Figure 1 in Appendix A.

The MWE application area is identified in Figure 2 in Appendix A and comprises around 72 ha under current MWE irrigation, and around 90 ha of total proposed MWE irrigation area. It should be noted that the provision of 72 ha is within the required 75 ha area described in the existing consent. However, the actual applied volumes of MWE as described in Section 5 below are substantially less than allowed by the existing consent and so the effects from the discharge are correspondingly less than consented.

4.2 Topography

Byreburn Farm is flat, occupying three terrace levels to the south-east of the Oroua River, at altitudes between 73 and 81 m amsl. Adjacent to the site, the Oroua River runs in a south-westerly direction in a channel incised into its gravel terrace to a depth of about 5 m below the highest terrace. Some 3.2 km west of the farm is the start of the rolling downlands which lie west of Feilding, while rolling downlands to the east of Bunnythorpe lie 7 km to the east of the farm. The shortest distance from the farm to the coast is 30 km, to the west.

4.3 Site Details

The legal descriptions of the landholdings where the activity proposed are as follows;

- Lot 191, DP 100; 13.7947 ha;
- Pt Sec 3, Blk XIV, Oroua SD; 24.3665 ha;
- Lot 2, DP 89128; 39.9744 ha;
- Lot 1, DP 57560; 22.7125 ha;
- Lot 1, DP 89045; 19.2740 ha;
- Lot 2, DP 89045; 11.7475 ha;
- Lot 31, DP 2688; 0.6171 ha;
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- Pt Lot 29, DP 2688; 0.4490 ha;
- Lot 2, DP 73177; 23.1490 ha;
- Sec 5, Blk XIV, Oroua SD; 32.2332 ha.

All land titles are held in fee simple. The Byreburn Farm is located directly adjacent to AMP. The centre of the application area is located approximately 700 m from the AMP treatment pond outlet (Section 5.3) at map reference NZMS 260 S21:2370520E – 6105365N.

4.4 Neighbourhood

The land neighbouring the site of the proposed activity is in various rural, rural residential, and industrial uses. Besides the AMP plant to the south-west of the farm, and the adjoining Wallace Corp factory, all other directly adjoining land is in rural use, either as farms or as rural smallholdings. In the north-west, farm paddocks immediately adjacent to the Oroua River lie within 100 m of residential properties across the river in Seddon Street off Kimbolton Road. The town of Feilding, with a population of about 14,000, is centred to the west of the farm, separated from it by the Oroua River.

4.5 Climate

4.5.1 Rainfall & Evapotranspiration

The closest meteorological station with long term records for reported rainfall was Feilding at Sandon Road (NIWA Meteorological station number 3213, about 4 km west of the site). The closest meteorological station for monthly potential evapotranspiration (PET) was Palmerston North Ews (NIWA Meteorological station number 21963, about 10 km south of the site). Rainfall and PET records from 2000-2010 are referred to in this report. Table 1 below presents climate data provided by National Institute of Water and Atmospheric Research (NIWA). All data was collected from the database and averaged.

It is expected that the PET and rainfall at Palmerston North Ews and Feilding respectively will be close to those at Byreburn Farm, due to their physical proximity and the lack of significant topographical features separating them. A crop coefficient of 1.0 has been adopted because the site is usually covered in high-producing, short pasture grass.

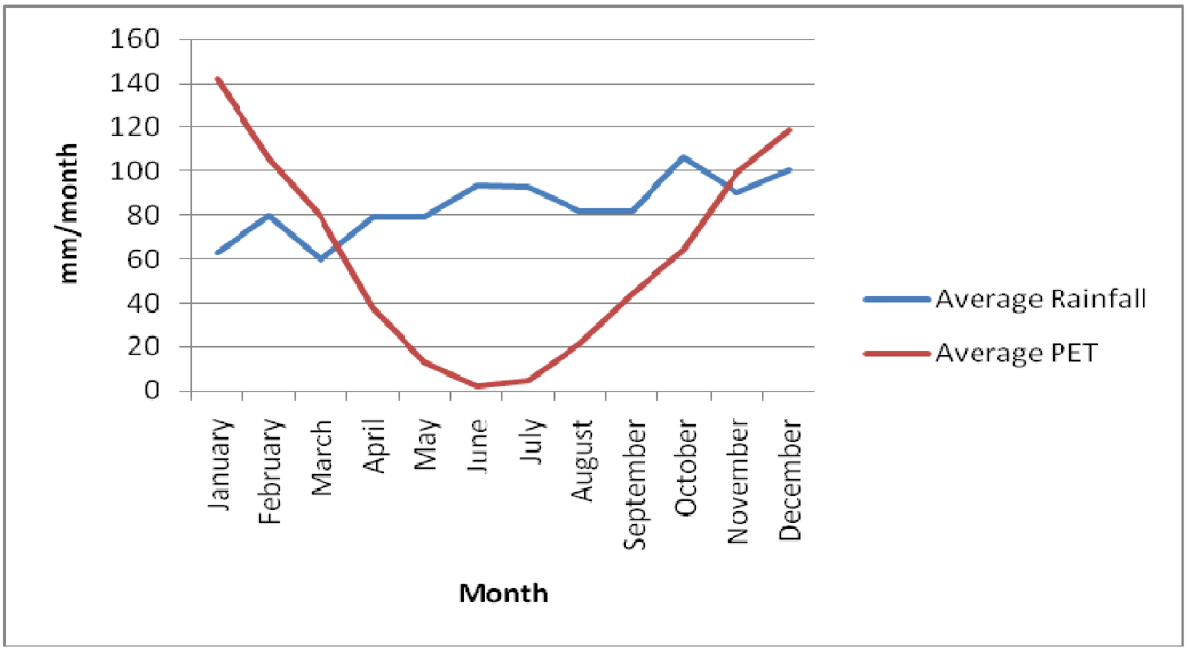
Table 1: Byreburn Farm – Assessed Mean Monthly Rainfall and Potential Evapotranspiration

Month	Rainfall (mm/month)	PET (mm/month)
January	63	142
February	80	106
March	59	79
April	79	37
May	79	13
June	93	2
July	93	5
August	82	21
September	81	44
October	106	64
November	90	99
December	100	119
Total	1,005	731
Site	NIWA Feilding	NIWA Palmerston North Ews
Years	2000-2010	2000 – 2010
Site No.	3213	21963

The data from Table 1 is illustrated in Figure 4.1 below.

The mean rainfall at Feilding is 1,005 mm/year. Rainfall is fairly evenly distributed throughout the year, peaking in October to December at 100 and 106 mm respectively. June and July are also wet months at 93 mm each, but at this time of year water loss due to evapotranspiration (represented by PET) is near 0. PET exceeds rainfall for the months November to March inclusive.

Figure 4.1: Mean Rainfall and PET, Palmerston North (2000-2010)



4.5.2 Wind

A windrose was sourced for the Palmerston North Aero meteorological station (Station ID 21963), which was considered to be the closest operating station to Byreburn Farm, at 10 km to the south-southeast. The data period was November 2001 - November 2008.

In addition a windrose was generated using historical data from Ohakea Air Force base which lies about 17 km to the north-east. The data period was January 1971- December 1990.

The Palmerston North windrose is considered to be fairly representative of conditions at Byreburn Farm, with unbroken flat land between the two localities. The Ohakea site records more northerly winds, reflecting its location alongside the Rangitikei River. The Palmerston North windrose indicates that the most frequent wind directions expected in the area of Byreburn Farm are from the south-east, north-west and north-east. Winds from the north and south-west are not common.

Winds from the north-east are characteristically light airs, seldom rising beyond 2.1 m/s. Those from the south-east are more frequent, and while light airs are typical, there are also some firmer breezes in the 3.6 to 5.7 m/s range. Winds from the north-west are the most frequent, with a significant incidence of winds in the 3.6 to over 10 m/s range. Light south-easterly breezes across Byreburn Farm would carry across the eastern parts of Feilding.

Both windroses are shown in Figure 3 (Appendix A).

4.6 Geology

The regional geology is fully described in Kingma (1962).

Holocene aged, greywacke-derived river gravels, sand and silt-sized alluvium deposited by the Oroua River underlie the surface in the general area of Byreburn Farm. Older Tertiary sediments lie several hundred metres below the surface, with a Mesozoic greywacke basement beneath this.

There are three terrace surfaces of deposited alluvium on Byreburn Farm, each with different soils present on them, as follows.

- The lowest and youngest is a frequently flooded floodplain (c. 73 mamsl), which is flat to undulating and mostly gravel.
- The low terrace level (c. 76 – 78 mamsl) is rarely flooded, and is flat to undulating and contains old levees, back-plains and back-basins.
- The high terrace (c. 79-81 mamsl) is a non-floodable, uplifted marine bench, which is flat, formed in weak sandstone, and covered with quartzo-feldspathic loess with tephra layers.

The Oroua River, running alongside Byreburn Farm, carries a bed load of Mesozoic greywacke cobbles, gravels and finer graded sediments derived by recent erosion from the Ruahine ranges.

4.7 Soils

The soils of Byreburn Farm are described and assessed in detail in Appendix H to this report.

Soils of the floodplain adjacent to the Oroua River are mapped as belonging to the Rangitikei Series, being recent, free-draining gravels with immature to poor profile development. These soils have high permeability and comparatively limited productive potential.

Due to the alluvial origin of the landform, the soils vary in texture across the low terrace. Kairanga soils occupy the majority of the low terrace. On the higher parts of the surface (levees) Manawatu soils are present.

The loess-covered high terrace is covered in Milson soil. This soil is more uniform on this surface than the soils are on the alluvial low terrace below it.

The Kairanga, Manawatu and Milson soils are highly productive and versatile soils.

Of particular relevance for this application is the hydraulic conductivity (K) of the soils, being the rate at which water can penetrate the surface and move through the soil. Measurement of K was undertaken on Byreburn Farm. Details and derivation of MWE application rates appropriate for the site are given in Appendix H. A summary of K for saturated flow (K_{sat}) are as follows:

- Kairanga Soils, 17 ± 10 mm/hr, 41 mm MWE/day;
- Manawatu soils, 33 ± 46 mm/hr, 80 mm MWE/day;
- Rangitikei soils, 95 ± 83 mm/hr, 228 mm MWE/day.

4.8 Hydrogeology

The site is located in the Manawatu Groundwater Management Zone (Horizons, 2008). The aquifer system from which bores extract groundwater, is built up of at least a 400 m thick sequence of Quaternary alluvial gravels, sands, silts and clays and contains occasional peat and wood layers. The Tertiary deposits underneath the Quaternary deposits (Section 4.6) are considered to be the lower boundary of the hydrogeological system.

The groundwater flow system is bounded by geological structures that run in south-western and north-eastern direction through the region, and flow is inferred to be towards the south-west. There are no clearly distinguishable aquifers and aquitards, the whole groundwater system being best regarded as a single, large, leaky aquifer.

Piezometers in the vicinity of the AMP ponds, to the west of the application site, indicate a depth to shallow groundwater of about 5 m, which is consistent with the depth of incision of the Oroua River locally as noted in Section 4.2 above. Groundwater flow direction under the site is yet to be confirmed definitively from recently installed piezometers, however the initial information is that flow is effectively parallel to the Oroua River.

Horizons lists 16 bores within 1 km of the AMP site. Where measured the bores identified have transmissivities of 67-570 m^2/d, with a median of 245 m^2/d. Depth to water ranges from 1.0 m to 10.2 m with no clear relationship between transmissivity and depth to water. Where listed the bore uses are for industrial, irrigation, farm use and domestic supply. The nearest bore is on the AMP site and has a transmissivity of 200 m^2/d and depth to water of 10.2 m

4.9 Hydrology

The main hydrological feature in the wider area is the Oroua River. A tributary of the Manawatu River, it flows south-westward from its catchment in the Ruahine ranges, joining the Manawatu River near Rangiotu, between Palmerston North and Shannon. The Kiwitea Stream is a major tributary that flows into the Oroua River just north of Feilding.

Water quality in the Oroua River is significantly affected by its phosphorus load. The median dissolved reactive phosphorus (DRP) level from 2002-2010 water quality monitoring upstream of the AFFCO river discharge is 0.11 g/m^3, higher than the 0.010 g/m^3 limit set in Horizons One Plan Decisions Version (2010). All sampling was carried out from May to November when river levels and therefore suspended sediment and DRP levels are typically high. However, the result still indicates that there are already high levels of DRP in the Oroua River above AFFCO and Byreburn Farm. Nitrate and nitrite levels in river water are normally well within guideline levels. Further specific detail of water quality in the Oroua River is given in the application and AEE for the discharge of wastewater by AMP to the Oroua River.

Hydrological data for the Oroua River in the vicinity of AMP is collected by HRC at the Kawa Wool site, which is a calculated monitoring site that combines the flow from the Almadale and the Kiwitea Stream monitoring sites upstream. The flow statistics for the Kawa Wool site have been compiled in the NIWA report – (Henderson and Diettrich 2007).The key parameters are shown below, with half median flow specifically confirmed with HRC hydrology staff:

- Mean – 11.376 m^3/s;
- MALF – 1.24 m^3/s;
- ½ median - 4.181 m^3/s;
- 3 x median - 20.913 m^3/s; and
- MAF - 204.83 m^3/s.

A key feature of these figures is the half median flow, which has been revised upwards since the current consent was granted.

Byreburn Farm is extensively artificially drained (moles and gravel-backfilled drainage pipe). Drainage flows into the main drain that meanders from its source near Byreburn Farm's ensilage pit south along Aorangi Road, through a piggery, southwest through Byreburn Farm and AFFCO land to the Oroua River. This drain has a catchment area of approximately 150 ha. It's outfall into the Oroua River is the same outfall AFFCO uses to discharge wastewater to the Oroua River. Maps of the drainage network are given in Appendix F.

4.10 River Ecology

The middle reaches of the Oroua River near Feilding are a significant conduit for trout moving between the Manawatu River and the Oroua headwaters. In the vicinity of Feilding, riverbed configuration provides ample fish passage but does not provide the diversity of pool and riffle habitats that would make it "good" trout habitat. A range of indigenous fish species inhabit the river, again using the middle reaches as a conduit to the more favoured habitats further upstream.

The river substrate provides habitat for macroinvertebrates, and there is some periphyton growth on the riverbed stones.

4.11 Vegetation

Forests originally dominated the terrace country in the Manawatu, with extensive wetlands in the lower Manawatu. Polynesian fires had converted considerable areas of forest to scrub, fern and native grasslands on drier terraces. Tall forest remained at the time of European settlement, especially in wetter areas. Land for Palmerston North had to be cleared of its podocarp forest and swamp vegetation. Harvesting of flax from natural wetlands was a major early industry in the lower Manawatu and Rangitikei areas.

Vegetation on the extensive flats extending many kilometres in all directions from Byreburn Farm is now almost exclusively high producing pasture and crops, with sporadic windbreaks and woodlots of trees. The river banks are dominated by willows, with a miscellany of woody weeds; no significant indigenous vegetation now occurs in the vicinity of Byreburn Farm or AMP.

4.12 Social Environment

Feilding township adjoins the Oroua River west of Byreburn Farm. Feilding has a population of approximately 14,000 people. The AFFCO plant is an integral part of the community, giving economic benefit as a major employer in the area.

The Oroua riverbed immediately upstream from AFFCO, and adjacent to Timona Park, is well used by Feilding residents, especially in summer. Uses include swimming, dog exercise, four-wheel driving and a limited amount of fishing. The Oroua River is in the Wellington Fish & Game region, and provides a brown trout angling opportunity, especially in the reaches upstream from Feilding.

The following iwi organisations are known to have an interest in the Oroua River and the area within which Byreburn Farm lies:

- Rangitane (Tanenuiarangi Manawatu);
- Ngati Raukawa Ki Te Tonga;
- Taiao Raukawa Environmental Trust; and
- Ngati Toa Rangatira.

It is acknowledged that the Oroua River is of cultural importance to tangata whenua.

4.13 Archaeological Environment

No archaeological sites or historic places are identified on Byreburn Farm by the Manawatu District Plan. Due to the long history of pastoral farming on the site it is expected that surficial sites, being the zone impacted by the proposed activity will have been identified and excluded from the site cultivation, or would have been modified by farming practices historically.

5.0 DESCRIPTION OF THE ACTIVITY

5.1 General

AMP is a modern, purpose-built beef processing facility, employing up to 320 people and processing up to 600 cattle per day. The supply of cattle is year round with a seasonal increase in numbers from October to April peaking in December through to February. The processing of the beef generates wastewater as a result primarily of effluent from stockyards and washdown procedures during processing. A summary of the wastewater collection and treatment system is as follows.

5.2 Wastewater Collection and Treatment

The wastewater and washdown water from the different areas of the AMP are deposited at different collection points around the plant, this is demonstrated in the wastewater cycle attached as Figure 4 in Appendix A.

The first collection point services the stockyards, the paunch receiving tank and the basement sump. The wastewater from this point contains animal excreta and paunch material (stomach contents). Solid material is removed to the paunch pit and wastewater is pumped from this collection point to the wastewater ponds.

For the rest of the wastewater from the plant, including the hardstand stormwater, it is collected at the main drain pump house. From the main drain pump house the wastewater is pumped up into the saveall. It flows through the saveall and into the wastewater ponds. The animal fat within the wastewater rises to surface and is scooped from the saveall.

The wastewater enters the settling pond where the small remaining amount of large-sized solid material settles out from the wastewater, or is biologically broken down. It is then piped into the second pond which is aerated with one aerator. Wastewater is circulated through the pond which has a retention time of around 30 days.

5.3 Wastewater Discharge Characterisation

AMP operates a combined land and water discharge system (CLAWD). This functions by utilising the land at times of the year when the soil and pasture can readily absorb the wastewater and the associated nutrients, and discharging to water when the land is saturated and unsuitable for the application of wastewater and when the river flow is at a sufficient level to minimise the impact of the MWE on the river water quality. The large size of the effluent ponds provides buffering storage for the times when neither the river discharge nor land irrigation is possible. There are two additional ponds which provide buffer storage.

The aerator pond has 1 metre of freeboard, which equates to 6,885 m^3 of available reserve storage. Additional storage in the two ponds on either side of the anaerobic pond provides a further 57,600 m^3. Thus an additional storage capacity of 64,485 m^3 in these ponds is available until a discharge to either land or water is allowable. This additional volume is equivalent to about 90 days storage under the current wastewater flow regime year round, or about 63 days during the irrigation season, due to higher production in the plant over this period.

The discharge of MWE to land occurs between November to March in most years, with the irrigation season extending where the weather conditions and the soil and pasture condition allow.

5.3.1 MWE Quality

The composition of the MWE near the outlet of the aeration lagoon is analysed as required by current consent conditions. This involves weekly sampling during the period that MWE is spray irrigated to land. Records have been used from 2007 to 2010 as described in Section 5.4.2.

Table 2 shows the measured concentrations of MWE constituents applied to Byreburn Farm. The MWE analysis reported has been undertaken during the application season.

Table 2: MWE Analysis Results, 2007-2010

Sample Parameter	MWE Median Monitoring Data 2007-2010
Suspended Solids (g/m^3)	120
Enterococci (cfu/100mL)	670
cBOD (g/m^3)	36
Nitrite/Nitrate N (g/m^3)	4
Ammoniacal N (g/m^3)	120
Total P (g/m^3)	24
Total K (g/m^3)	44

Table 2 shows the composition of the final wastewater quality over a period of three years. The BOD and the suspended solids have relatively low concentrations, while the ammonia, Enterococci and total phosphorus levels are high, but typical of meat processing wastewater.

Total N has not been historically measured since it was not a requirement of the current consent and so the amount of organically bound N is not known. This may lead to underestimation of N loading and so the likely contribution from an organic N fraction should be considered. Published information from NZ (van Oostrom, 1994) indicates that following anaerobic and aerobic pond treatment such as occurs at AMP, most of the organic N has been converted to ammoniacal N and so the reported ammoniacal N (Table 2) has been adopted for the design N loading.

5.3.2 MWE Quantity

Daily flows to the farm from the pond have been recorded over the term of the previous consent. Changes to the system and to the effluent flows and concentrations have occurred over time and following changes of site ownership. For the purpose of characterising the MWE, records from 2007 onwards have been used. The daily data is given in Appendix B. A summary of flows to the application area is given in Table 3.

Table 3: MWE Daily Flows

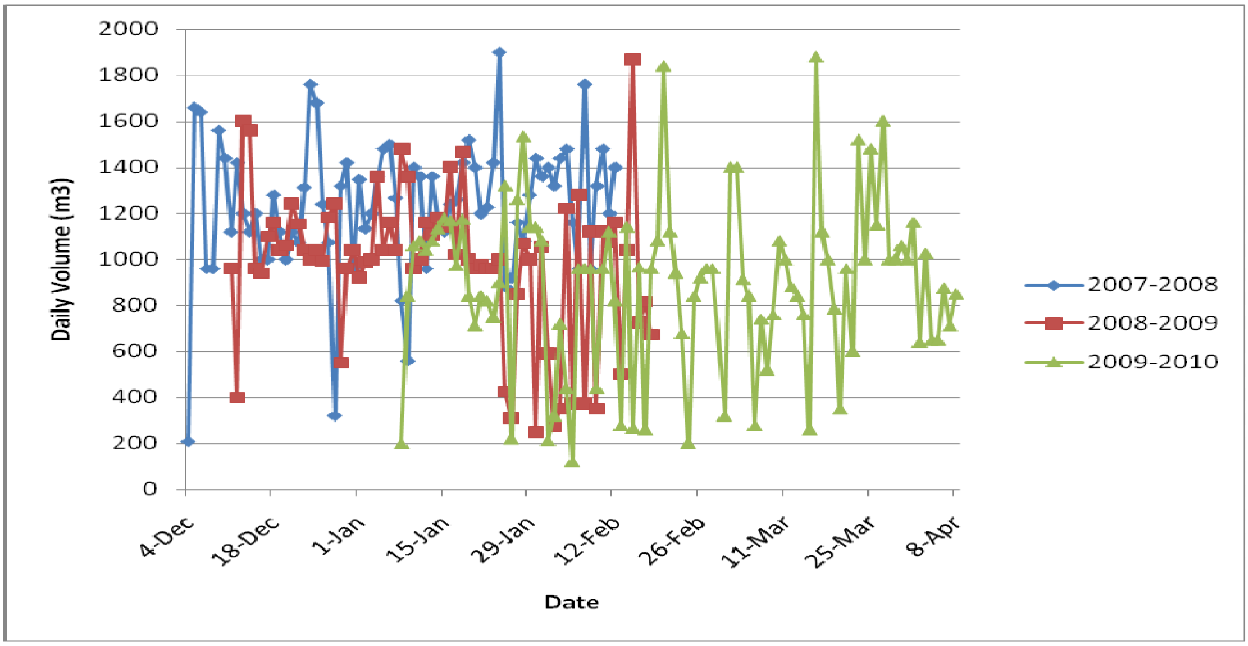
	Daily Volume (m^3/day)			
	2007-2008	**2008-2009**	**2009-2010**	**All years**
Median	1,260	1,030	960	1,030
Upper Quartile	1,420	1,158	1,080	1,223
Lower Quartile	1,100	945	717	921
Max	1,900	1,867	1,880	1,900

Total MWE flows from AMP onto Byreburn Farm over 2007-2008, 2008-2009 and 2009-2010 are shown in Figure 5.1 below, and total annual volumes irrigated are shown in Table 5 below.

While total annual volumes irrigated have ranged between 68,500 and 88,000 m^3 (average being 79,170 m^3), AMP has generated significantly larger total annual volumes of MWE, the remainder of which after irrigation has been, and is proposed to continue to be, discharged to the Oroua River under a separate resource consent. Total annual MWE production is currently estimated at 225,000 m^3, so about 39% of this has been irrigated to land.

Historically the amounts of effluent discharged to land have been constrained by the existing irrigation infrastructure and so do not represent the total effluent volume able to be received to the site. Volumes able to be received to the application site are discussed in Section 5.5 below.

Figure 5.1: Daily Volume of MWE Applied To Byreburn Farm



Total hourly flows have not exceeded the consented 100 m^3/hour during irrigation periods from 2007-2010 for which data is available, ranging from 50 m^3/hour to 80 m^3/hour. The limiting daily flow of 2,000 m^3 specified by Consent number 4226 has not been exceeded on any occasion over this period. The annual median daily application rate is 1,030 m^3/y. However the flows have at times been close to the consented limit, and thus provide a sound basis for planning future application rates.

5.4 Current Land Application System

MWE is pumped from the AMP ponds to a series of hydrants across the farm. On the low terrace a rotary boom irrigator ("Rotorainer") is set to begin from the middle of the block and either run down the slope towards Aorangi Road or up the slope to the west. A smaller travelling irrigator operates on the gravelly floodplain area towards the northwest of the property. Photos of the irrigators are provided in Appendix C.

The MWE land application block at Byreburn Farm mainly grows dairy pasture. It is common to have a small part of the milking platform in maize each year. At times this maize is grown on a paddock that receives MWE and irrigation of MWE to that paddock is restricted for the growing season (pers. comm. farm owner).

5.4.1 Existing Resource Consent 4226

Conditions of the existing resource consent (Appendix D) specify limiting parameters for the application of MWE. In addition the requirement for monitoring has provided a dataset to enable the assessment of the sustainability of those limiting parameters. Specific conditions controlling the application are as follows:

- Under Condition 1 of resource consent 4226 the maximum volume to be received to the site per day is 2,000 m^3 (hydraulic limitation);
- Under Condition 5 of resource consent 4226 a maximum of 400 kg N/ha/y should be applied to the site (nutrient limitation);
- Under Condition 6 of resource consent 4226 a resting period of 7 days should occur following application; and
- Under Condition 7 of resource consent 4226 the rate of application must not exceed 100 m^3/h.

In consideration of the conditions above and given a N concentration of MWE of 124 g/m^3 (Table 2) and an application season of 6 months a limiting parameter can be determined as shown in Table 4. The equivalent application rates allowed by the existing consent are given in Table 4 below. An analysis of actual loading rates is provided in Table 5 below.

Table 4: Equivalent* MWE Loading Rates.

Parameter	Hydraulic Limitation	Nutrient Limitation
Area	75	
Daily Volume (m^3/d)	2000	1294
Average daily application depth (mm/d)	2.8	1.8
With resting period (mm/application)	19.4	12.5
N load (kg N/ha/y)	618	400
P load (kg P/ha/y)	120	77

Red indicates the fixed parameter
* Equivalent MWE loading rates are derived from the conditions of Consent 4226.

5.4.2 System Operation 2007-2010

The application system has been in operation for the term of the previous consent. The previous three years of data have been used to describe the operation of the application system. The use of the most recent data is due to:

- Most complete data set; and
- Most representative of present and future flows to the site.

Daily MWE application rates onto the land treatment area over the period from 2007-2010 have been included in Appendix B.

5.4.3 Current Application Areas

The area currently receiving MWE application on the farm is shown in Figure 2 (Appendix A), and is 72.2 ha in extent. The application area can be broadly divided as indicated in Section 5.4 above, into the low terrace (~40 ha) and the flood plain (~35 ha). Within these broader units the land treatment area is divided into 32 zones. These zones and the actual irrigator runs traverse the edges of paddocks, races and other MWE hydrants. The 18 zones on the low terrace range between 2.6 and 3.8 ha. The 14 zones on the gravelly floodplain range between 0.8 and 1.4 ha.

The application to zones occurs in rotation to allow areas to be rested between irrigation cycles and to fit in with grazing rotations. The zones are numbered 1 to 32 and are shown in Figure 5 (Appendix A).

5.4.4 Current Application Rates

The management of the application of MWE to zones is at the discretion of the land owner within the constraints of the resource consent. An irrigation log is maintained as given in Appendix E. Records of the applications made between 2007 and 2010 are given in Appendix B. A summary of key parameters is given in Table 5.

Table 5: Application of MWE to Byreburn Farm

Parameter	2007/2008	2008/2009	2009/2010
Total area to which MWE applied (ha)	55.8	66.8	65.5
Total volume MWE (m^3)	87,802	68,727	80,989
Irrigation days	180	180	180
Average daily volume (m^3/d)	488	382	450
Average daily application over irrigation period (mm/d)	0.9	0.6	0.7
Average annual application depth (mm/y)	157	103	124
Average number of applications per year	2.5	2.7	2.1
Total N (kg/y)	10,887	8,522	10,390
Average N (kg/ha)	195	128	159
Total P (kg/y)	2,107	1,649	1,944
Average P (kg/ha)	38	25	30
Total K (kg/y)	3863	3024	3563
Average K (kg/ha)	69	45	54
Total BOD (kg/y)	3160	2474	2916
Average BOD (kg/ha)	57	37	45

The information given in Table 5 indicates that the actual operation of the application system is well within the consented limits for nutrient and hydraulic parameters. While the land area is less than the consented 75 ha, this is due to significantly less wastewater being applied than the consent allows. The average application depth received to the site for all years (0.6-0.9 mm/d) is within the consented limit (Table 4) for both hydraulic load (2.8 mm/d) and nitrogen load (1.8 mm/d) as calculated in Table 4 above.

In practice the MWE is not applied to the entire application area on every day of the application season. Instead the irrigated areas are rotated in accordance with the resource consent and in line with farm management. As a result of the rotation policy the MWE loading to individual zones may vary. The hydraulic loading per application varies, with a median of 38 mm/application up to a maximum over the monitoring period of 173 mm/application. Table 6 gives the nutrient loading by block for the period of monitoring.

Table 6: MWE Nutrient Loading by Zone

Block ID	Land unit	Area * (ha)	2007/2008	2008/2009	2009/2010
			kg N/ha/y	kg N/ha/y	kg N/ha/y
1	Terrace	3.5	231	110	75
2	Terrace	3.8	198	103	122
3	Terrace	3.4	128	110	195
4	Terrace	3.0	143	143	189
5	Terrace	3.3	143	133	104
6	Terrace	3.2	131	187	156
7	Terrace	2.6	162	208	224
8	Terrace	3.3	248	142	212
9	Terrace	3.1	278	140	266
10	Terrace	3.3	119	135	199
11	Terrace	3.6	112	114	204
12	Terrace	3.2	221	122	219
13	Terrace	3.1	205	187	222
14	Terrace	3.0	203	194	218
15	Floodplain	NA	0	0	0
16	Floodplain	1.2	0	0	165
17	Floodplain	0.8	32	0	230
18	Floodplain	1.0	0	230	176
19	Floodplain	1.1	0	85	111
20	Floodplain	1.2	0	195	147
21	Floodplain	NA	0	0	0
22	Floodplain	NA	0	0	0
23	Floodplain	NA	0	0	0
24	Floodplain	NA	0	0	0
25	Floodplain	1.2	0	143	122
26	Floodplain	1.3	0	82	91
27	Floodplain	1.4	0	127	78
28	Floodplain	1.3	0	132	62
29	Terrace	3.4	115	37	0
30	Terrace	2.7	173	47	63
31	Terrace	3.0	301	109	101
32	Terrace	3.8	247	76	68

* Area rounded, not entire block irrigated on every occasion.

As indicated in Table 6 the N loading from MWE has on average, been consistently and substantially lower than the consented 400 kg N/ha/y.

It should be noted that additional sources of nutrients (chemical fertilisers and farm dairy effluent (FDE)) have been added to parts of the site that also receive MWE. These additions were made under the understanding that they were in compliance with the terms of Consent 4226 and/or complied with permitted activities. Conflicting records regarding the timing and quantities of additional nutrients have confounded attempts to assess the impact of the additions.

5.5 Proposed Land Application System

5.5.1 Consideration of Indicators for Change from Current System

Monitoring undertaken as required by Resource Consent 4226 has provided a set of process and environmental data. The extensive data set has been investigated to determine the effects of the existing application system parameters. A detailed discussion of the monitoring results is given in Appendix H. Based on the monitoring data an assessment has been made regarding the sustainability of the existing system and changes to be made. The following is a summary of the key findings of this investigation.

Key indicators of MWE application impact:

- Groundwater – results were unable to be distinguished from other effects and so groundwater concentrations were not able to be used to determine impacts from MWE application;
- Nutrient modelling using Overseer indicated N loss from the site at 16 kg N/ha/yr was well below POP limits;
- Soil hydraulic capacity – no clear trend has been demonstrated by ten years of monitoring indicating that irrigation of MWE has not impacted the infiltration capacity or drainage capacity of the site;
- Soil exchangeable P (Olsen P) – Soils receiving MWE have higher Olsen P results than unirrigated soils. The results are in the high to very high range indicating that the management of P accumulation in the soil should be considered in MWE receiving areas;
- Carbon to Nitrogen ratio (C:N) – In general no significant change in the C:N was measured. This indicates that organic matter turnover is not negatively impacted by MWE application; and
- Exchangeable Sodium Percentage (ESP) – No increase in the ESP of the soil indicates that sodium in MWE is not an issue for the site. This is expected due to high rainfall received causing flushing of the profile.

Under the existing application scheme long term P accumulation has been identified as the parameter of most concern. In design of an application regime for the proposed activity in the future P has been adopted as the limiting parameter. This means that if a limit is set for P and the other parameters (available land, hydraulic load, nitrogen load) are calculated based on the acceptable P load this will result in no exceedance of a recommended limit for any other parameter.

5.5.2 Phosphorus Loading

The objective for the development of a P load specification is to maximise the advantage to plant growth while avoiding saturation of soil sorption sites and leaching of P to groundwater. This is to be achieved by understanding the P storage capacity of the site's soil, and by applying P at a rate which can be taken up by plants or reasonably assimilated within the soil matrix over a period of time. The P load able to be received to the site is dependent on a number of factors including:

- P uptake and removal achieved on the site by plant uptake and removal;
- Soil P status;
- Soil capacity for sorption of P;
- Soil depth; and
- Percent fine material (< 2 mm) in soil.

The factors which relate to the soil, excluding the current soil test P levels are fixed and can be used to describe the soil's vulnerability to P leaching. Using the method of Webb et al. (2010)

the vulnerability to P leaching of the soils on the site is moderate to low (derived in Appendix H). Based on the current soil P status the risk of leaching will increase (McLeod and Condron, 2004) and is estimated to be in the moderate to high range.

It should be noted that the historic operation of the application area has resulted in uneven and occasionally excessive applications particularly prior to 2007. It is considered that this has resulted in P accumulation and high Olsen P values measured in some areas for some periods (Appendix H). In addition, the use of P fertiliser on the irrigation blocks has been indicated by the farmer to have occurred in the past. It is proposed that under the new regime nutrient additions from all sources will not exceed the recommended limits given below.

The dominant vegetation on the site is grazed, improved pasture. Maize crops are grown on parts of the site in some years. Table 7 gives the expected plant P uptake from pasture and maize, with kale included as an example of a crop that is grown and grazed *in-situ* since this is common practice in the wider farming community and so is considered as a potential use of the site.

Table 7: Crop Nutrient Uptake, Mixed Cropping and Grazing

Crop / Land use	Nitrogen uptake (kg/ha/y or rotation)	Phosphorus uptake (kg/ha/rotation)	Reference
Pasture – irrigated, cut and carry	500-600	130-160	Morton *et al.* (2000)
Animal excreta return	(300-360)	(78-96)	FLRC (2009), Williams and Haynes (1990)
Maize silage (20 t/ha)	220	40	FAR (2009)
Kale (18 t/ha)	380	50	Beare *et al.* (2010)

Brackets () indicate a net return of nutrients

It has been assessed that a P load of 60 kg P/ha/y can be sustainably applied to the site. At this rate plant uptake will account for most applied P with soil sorption accounting for any remainder, resulting in a minor rate of accumulation.

5.5.3 Nitrogen Loading

P loading is considered to be the key limiting parameter on this farm while using MWE. However, consideration should also be given to a maximum N loading. N may ultimately end up in the surface water (potentially within a relatively short travel distance) however it is seen as being less critical to water quality than P.

The dominant method of removal for N is by plant uptake. Soil microbe use and gaseous loss also account for the removal of some N. Table 7 above gives nitrogen uptake and return for a range of crops. Under a mixed cropping and pasture regime it has been assessed, including using Overseer™, that an N load of 350 kg N/ha/y can be sustainably applied to the site to ensure that POP N loss targets are not exceeded.

5.5.4 Design Parameters for Proposed Irrigation System

Table 8 below details a proposed application regime for the site. The focus is on capping the annual P loading at 60 kg P/ha/y. Also, as this operation is part of a combined land and water discharge system, consideration has been given to providing for a greater removal of water from the river by increasing the area irrigated to 90 ha from the current 75 ha.

The corresponding parameters are based on the existing MWE quality are given in Table 8.

Table 8: Proposed Land Application Parameters for MWE

Parameter	Existing application Area		Expanded application area	
Irrigation method	Existing	Low rate	Existing	Low rate
Irrigable area	75 ha		90 ha	
Limiting parameter	Phosphorus load			
Application Rates				
Max yearly application volume (m^3)	187,500		225,000	
Yearly application volume per unit area (m^3/ha)	2,500		2,500	
Yearly application depth (mm)	250		250	
Average daily over the 180 day season (mm/d)	1.4		1.4	
Maximum application per event (mm/application)	34	15	34	15
Number of applications per season (n)	7.4	16.7	7.4	16.7
Nutrients				
Yearly N applied (kg N/ha/y)	310	310	310	310
N applied per application (kg N/ha)	42	19	42	19
Yearly P applied (kg P/ha/y) – (@ 24 g/m^3)	60	60	60	60
P applied per application (kg P/ha)	8	4	8	4
Yearly K applied (kg K/ha/y)	110	110	110	110
K applied per application (kg K/ha)	15	7	15	7
Yearly Organic load applied (kg BOD/ha/y)	90	90	90	90
Organic load applied per application (kg BOD/ha)	12	5	12	5

Table 8 above, and comparison with Table 5, clearly show that more MWE can be applied to the land that what is currently being applied, as the current annual average volume applied is around 87,000 m^3/y, compared to 187,500 m^3/y which could be applied over the same land area. The current consent does allow a greater application volume than has actually been applied, but the greater application has not occurred for three reasons:

- Firstly, it is not current practice (while allowing for a wet weather contingency) to allow the accumulation of MWE to be irrigated when the soil conditions allow prior to the irrigation season. It is not intended to provide for additional storage, however it is proposed to better optimise the use of storage to allow more MWE to be carried over for irrigation rather than discharged to the river.
- Secondly, the irrigation infrastructure can limit the daily volume applied, and hence not as much is applied as could be potentially applied. Changes proposed to the irrigation area (discussed later) are intended to provide for a greater daily volume to be applied.
- Thirdly, the farmer has chosen not to, because of managing irrigation scheduling in with staff commitments (ie does not want staff shifting irrigators through the night) and the grazing rotation.

Consequently while a greater volume could be discharged, the likelihood is that a lesser rate will actually be used. Following discussions with the farmer, he has agreed to attempt to increase his loading rates and the land area irrigated to 90 ha, but the revised rates are unlikely to reach the maximum indicated in the table above. A likely maximum is estimated to be 150,000-180,000 m^3/y.

In addition, consideration is needed as to the implication and interaction of the combined loading of farm dairy effluent and other fertilisers. Based on a review of current fertiliser practices, it is possible that the use of phosphatic fertilisers has exacerbated the increase in soil P levels.

A pragmatic way to deal with the cumulative loading is to adopt an approach where the maximum loading of key nutrients of environmental concern are not exceeded. The proposal is to adopt a maximum P loading as identified in Section 5.5.2 of 60 kg/ha/y and a N loading of 350 kg N/ha/y. This N loading is greater than would be if the N was fully supplied by the N in the MWE up to the P limit, allowing for the strategic use of Urea to establish crops, provide pasture boosts at times of the year in between the MWE return period or apply nitrogen when the soils are drying, but still too wet for irrigation to start.

It should be noted that the application of MWE, Urea, FDE and other inputs may not be consistent across the farm, with some areas receiving more than others for varying reasons, including crop establishment. Consequently some areas will receive more MWE in areas than others. Based on this factor, and a proposed change in areas to be used for irrigation, including additional areas, a block loading schedule is recommended for inclusion in the Application Management Plan to be formulated in consultation with the land owner.

With regard to areas being used and their corresponding soil properties, it is proposed that irrigation of MWE is ceased on the gravelly Rangitikei land application area, and that an additional area of Kairanga, Manawatu and/or Milson soils is incorporated into the remaining land application area. This will enable AMP and Byreburn Farm to continue to operate the system of irrigation of MWE, over an expanded land area, with a significantly increased maximum annual volume, but with specific loadings that will not exceed what has been authorised, and which will not lead to adverse environmental effects.

In addition, the landowner has indicated a possible desire to move to a low rate application system of fixed or moveable sprinklers. This is considered to offer a greater degree of flexibility due to the greater degree of control over the application that can be achieved. The use of more frequent lower application depths will result in better matching the requirements for pasture uptake and more efficient use of applied water and nutrients. It is expected that the use of low rate application will promote the efficient use of a greater volume of MWE and is a favoured outcome. Resulting changes to parameters are indicated in Table 8.

6.0 CONSIDERATION OF ALTERNATIVES

The alternatives for the discharge of MWE to land at Byreburn Farm are not to discharge, to discharge to the Feilding municipal wastewater system, a river discharge, and various alternative land discharge arrangements.

The discharge of treated wastewater from AMP is an essential consequence of the operation of a meat processing plant. The consequence of not discharging would be the closure of the plant, which is an alternative that is not considered further.

A discharge to the Feilding municipal wastewater system would require a substantial and expensive upgrade to the Feilding municipal wastewater system, which does not currently have the capacity to receive AMP's staff wastewater, let alone its production waste stream. On the grounds of anticipated cost alone this alternative has not been given further serious consideration.

A river discharge was the original system deployed by Borthwick's (see Section 3.2 above) for the discharge of wastewater. It is still utilised as part of AMP's Combined Land and Water Discharge (CLAWD), at times and at river flow rates that minimise adverse environmental effects. However, to revert from the present CLAWD system to a straight river discharge would entail environmental consequences that would not meet plan requirements, so this alternative has not been considered further.

The land discharge seeks to optimise the opportunity to irrigate water and nutrients beneficially onto farm land. The existing system has operated for some 20 years so it is not a new proposal. Experience with its operation has shown that there are opportunities to improve its effectiveness and to reduce the potential for environmental effects, and these improvements are factored into this application with regard to the proposed revisions to the system.

There are practical limits to the nutrient reduction that can cost-effectively be achieved by enhancements to the wastewater treatment system, with the ultimate question being why take nutrients out of the wastewater when they can be beneficially utilised if applied to land. The real alternatives that are available relate to the size of the area to which irrigation is applied, and the rate at which it is applied. The revised area of 90 ha to be irrigated is the maximum that can practically be accommodated on Byreburn Farm. The rates of application have been the subject of detailed design consideration in this report and its several appendices, and have been calculated to balance optimum productive benefit to the farm with environmental effects that lie within accepted norms.

There is a further level of consideration of alternatives, which relates to the type of equipment used to apply the wastewater to land. This report does not specifically address the equipment, which is the means of achieving the specified environmental end; it has instead focussed on the environmental result to be achieved.

There may also be the need to consider striking a balance between the need for additional wastewater treatment to remove P and allowing some accumulation of P in the soils leading to leaching and ultimate release via groundwater into the river system. While not ideal, the latter approach may result in a reduction to the current P load to the river while avoiding expensive upgrades to remove P, avoid providing additional storage or increasing the irrigated land area beyond the proposed area (requiring a new property to be incorporated into the system).

7.0 STATUTORY PROVISIONS

In this Section of this report, the relevant national environmental standards and national, regional, and district statutory planning requirements are outlined in reference to the discharge of wastewater to land from the AMP.

Further evaluation and assessment of the effects of the discharges against the following is discussed in Section 11 of this report:

- The Resource Management Act;
- National Environmental Standards and National Policy Statements;
- Regional Policy Statements;
- Regional Plans;
- District Plans;
- Other Relevant Plans; and
- Consent Requirements.

7.1 The Resource Management Act

7.1.1 Part 2

The following Part 2 sections require consideration:

Section 5 Purpose and Principles
(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.
(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while—
(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Section 6 Matters of National Importance
In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:
(a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:
(b) The protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:
(c) The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:
(d) The maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:
(e) The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.
(f) The protection of historic heritage from inappropriate subdivision, use, and development.
(g) The protection of recognised customary activities.

Section 7 Other Matters

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to;

(a) Kaitiakitanga:
(aa) The ethic of stewardship:
(b) The efficient use and development of natural and physical resources:
(ba) the efficiency of the end use of energy:
(c) The maintenance and enhancement of amenity values:
(d) Intrinsic values of ecosystems:
(e) [Repealed]
(f) Maintenance and enhancement of the quality of the environment:
(g) Any finite characteristics of natural and physical resources:
(h) The protection of the habitat of trout and salmon:
(i) the effects of climate change:
(j) the benefits to be derived from the use and development of renewable energy.

Section 8 Treaty of Waitangi

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

7.1.2 Part 3

The following Part 3 sections require consideration:

Section 15 Discharge of contaminants into environment
Section 17 Duty to avoid, remedy, or mitigate adverse effects

7.1.3 Part 6

The following Part 6 sections require consideration:

Section 88 Making an application
Section 93 When public notification of consent applications is required
Section 94 When public notification of consent applications is not required
Section 94A Forming an opinion as to whether adverse effects are minor or more than minor
Section 94B Forming an opinion as to who may be adversely affected
Section 94C Public notification if applicant requests or if special circumstances exist
Section 104 Consideration of applications
Section 105 Matters relevant to certain applications

- *Nature of the discharge and sensitivity of receiving environment to adverse effects*
- *The applicants reasons for the proposed choice, and,*
- *Any possible alternative methods of discharge, including discharge into any other receiving environment.*

Section 107 Restrictions on grant of certain discharge permits
Section 108 Conditions of resource consents

7.2 National Policy Statements and National Environmental Standards

7.2.1 National Standard for Wastewater Discharge to Land

There is no relevant national standard for discharge of meat processing plant wastewater to land.

7.2.2 Other Statements and Standards

There are no other National Policy Statements or National Environmental Standards that apply to the discharge of MWE to land at Byreburn Farm.

7.3 Horizons Regional Policy Statement

Horizons Regional Council's (HRC's) One Plan Decisions Version (OPDV) contains objectives and policies that form the Regional Policy Statement (RPS).

The **Objective** of the RPS relating to the irrigation of MWE to land at Byreburn Farm is as follows:

"Objective 6-2: Water Quality.
(b) Groundwater quality is managed to ensure that existing groundwater quality is maintained, or enhanced where it is degraded."

The RPS also has provisions in Section 5 relating to land and soil management, but these address the issues of accelerated erosion and its prevention, and make no reference to issues relating to irrigation of soil with wastewater. The RPS also has provisions relating to the maintenance of surface water quality, but these are considered to be met by virtue of meeting the groundwater quality requirement.

The **Policy** of the RPS relating to the irrigation of MWE to land at Byreburn Farm is as follows:

*"**Policy 6-6: Maintenance of groundwater quality.***
- *(a) Discharges and land use activities must be managed in a manner which maintains the existing groundwater quality, or enhances it where it is degraded.*
- *(aa) An exception may be made under (a) where a discharge onto or into land better meets the purpose of the RMA than a discharge to water, provided that the best practicable option is adopted for the treatment and discharge system."*

7.4 Horizons Regional Plans

Horizons Regional Council has three Regional Plans which impact upon the irrigation of MWE to land at Byreburn Farm. Relevant objectives and policies of these are listed below. An assessment of the subject activity against Regional Plan objectives, policies, and assessment criteria is provided in Section 11 of this report.

7.4.1 One Plan Decisions Version (OPDV)

Horizons Regional Council's (HRC's) "One Plan Decisions Version" (OPDV) was released in August 2010; its provisions relevant to the irrigation of MWE to land at Byreburn Farm are as follows.

"Objective 13-1: Regulation of discharges to land and water.
The regulation of discharges into or onto land (including those that enter water) or directly into water in a manner that:

(a) Has regard to the values, management and objectives in Schedule AB;
(b) Has regard to the objectives and policies of Chapter 6 as they relate to surface water quality and groundwater quality, and;
(c) Where a discharge is onto or into land, avoids remedies or mitigates adverse effects on surface water or groundwater.

"Policy 13-2: Consent decision making for discharges to land
When making decisions on resource consent applications, and settling consent conditions, for discharges of contaminants onto or into land the Regional Council must have regard to:
(a) The objectives and policies of Chapter 6 regarding the management of groundwater quality and discharges.
(b) Where the discharge may enter surface water or have an adverse effect on surface water quality, the degree of compliance with the approach for managing surface water quality set out in Chapter 6.
(c) Avoiding as far as reasonably practicable any adverse effects on any sensitive receiving environment or potentially incompatible land uses, in particular any residential buildings, educational facilities, churches, marae, public areas, infrastructure and other physical resources of regional or national importance identified in Policy 3-1, wetlands, surface water bodies and coastal marine area.
(d) The appropriateness of adopting the best practicable option to prevent or minimise adverse effects in circumstances where:
(i) It is difficult to establish discharge parameters for a particular discharge that give effect to the management approaches for water quality and discharges set out in Chapter 6,
(ii) The potential adverse effects are likely to be minor, and the costs associated with adopting the best practicable option are small in comparison to the costs of investigating the likely effects on land and water,
(e) Avoiding discharges which contain any persistent contaminants that are likely to accumulate in the soil or groundwater, and
(f) The objectives and policies of Chapters 3,4,7,10,11A to the extent that they are relevant to the discharge.

Policy 13-2 B: Options for discharges to surface water and land
When applying for consents and making decisions on consent applications for discharges of contaminants into water or onto or into land, the opportunity to utilise alternative discharge options or a mix of discharge regimes, for the purpose of mitigating adverse effects where reasonably practicable, must be considered, including but not limited to:
(a) Discharging contaminants onto or into land as an alternative to discharging contaminants into water,
(b) Withholding from discharging contaminants into surface water at times of low flow, and
(c) Adopting different treatment and discharge options for different receiving environments or at different times (including different flow regimes or levels in surface water bodies)

The **Rule** in OPDV relevant to the irrigation of MWE to land at Byreburn Farm is as shown in Table 9 below.

Table 9: Rules of OPDV relevant to the irrigation of MWE to land at Byreburn Farm.

POP Rule	Activity	Classification	Conditions/Standards/Terms
13-27	The discharge of water or contaminants into surface water pursuant to s15(1)(a) RMA or discharge of contaminants onto or into land pursuant to ss15(1)(b), 15(1)(d) or 15(2A) RMA which are not	Discretionary	

	regulated by other rules in this Plan, or which do not comply with the permitted activity, controlled activity or restricted discretionary activity rules in this chapter.		

7.4.2 Manawatu Catchment Water Quality Plan (MCWQP)

This plan became operative on 6 October 1998. Its **Objective** in relation to the discharge of wastewater to land is as follows;

"To enhance surface water quality in the Manawatu catchment by the year 2009 to a level which meets the needs of all people and communities while safeguarding the life-supporting capacity of the water".

The plan does not have a **Policy** in direct relation to the irrigation of MWE to land at Byreburn Farm, and is more directly focused on the protection of surface water quality.

The **Rule** under this plan relevant to the irrigation of MWE to land at Byreburn Farm is as follows:

"MCWQ Rule 12: Discharges to land not meeting the standards of other rules.
Subject to MCWQ Rule 10, any discharge
(e). onto or into land from any industrial or trade premises,
*is a **Discretionary Activity"**.*

Further to MCWQ Rule 12, the plan specifies the following information requirements to accompany consent applications;

*"Pursuant to Section 88 (4) of the Act, applications for **Discretionary Activities** described in MCWQ Rule 12 shall include the following information:*

a. Description of the proposal and location of the proposed activity, including land area, soil types, distance to the nearest river and map references from NZMS map, scale 1:50,000.
b. Quantity of contaminants, or water, to be discharged to the environment, and how the applicant intends to monitor the discharge quantity.
c. Constituents of the discharge, including likely amounts or proportions of the constituents, and how the applicant intends to monitor the discharge quality.
d. An identification of those persons, including tangata whenua, interested in or affected by the proposal, and a statement as to the consultation undertaken (if any), the consultation undertaken, and any response to the views of those consulted.
e. An assessment of the actual or potential effects on the environment (including the sensitivity of the environment and effects on instream, recreational and cultural values) that would be caused by the proposed activity.
f. A description of mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce any actual or potential effects.
g. Possible alternative methods of disposal of the contaminants, or water, to be discharged that were considered and rejected by the applicant".

7.4.3 Land and Water Regional Plan (LWRP)

This plan became operative on 30 September 2003. Its **objectives** in respect of the irrigation of MWE to land at Byreburn Farm are as follows.

“DL Objective 1: Improving groundwater quality
To maintain groundwater quality in the Region, and to improve groundwater quality where it is locally degraded.
DL Objective 2: Improving groundwater quality
To reduce microbial contamination and nutrient leachate into groundwater”.

The **Policies** of the LWRP in respect of the irrigation of MWE to land at Byreburn Farm are as follows;

“DL Policy 1: Use of regional rules.
To manage discharges of contaminants to land by adopting regional rules that:
a. permit all activities that have minor effects on the environment provided specified conditions are met;
b. regulate those activities that have the potential to cause any adverse effect on the receiving environment that is more than minor, and where conditions to manage the activity need to be site-specific;
c. prohibit any activities that have an adverse effect on the environment and/or human health that cannot be adequately avoided, remedied or mitigated; and
d. contain measurable and enforceable conditions, standards and terms so that the community can undertake their activities with certainty.

DL Policy 2: Matters to be considered for resource consent applications.
The Council will have particular regard to the following matters when considering resource consent applications for discharges of contaminants onto or into land:
a. the effects of the discharge on:
i. groundwater quality and groundwater uses nearby, in particular any use for water supply;
ii. river water quality, in particular effects on rivers with existing high water quality and positive effects resulting from the cessation of existing discharges to water;
iii. any possible alternative receiving environment;
iv. lake and wetland water quality, in particular the contribution of the discharge to nutrient and sediment levels in lakes or wetlands by overland runoff or by groundwater flows to the lake or wetland;
v. soil quality;
vi. air quality, in particular adverse effects from the intrusion of odour and visual contaminants;
vii. human health and amenity values;
viii. any significant indigenous vegetation and significant habitats of indigenous fauna; and
ix. any specified value associated with any feature of regional significance identified in the Regional Policy Statement for Manawatu-Wanganui; and
b. the location of the proposed discharge in relation to any sensitive receiving environment or potentially incompatible land uses, in particular any neighbouring houses, schools, churches, marae, public areas, wetlands, lakes, springs, streams, the coastal marine area, or known areas of recharge to groundwater aquifers; and
c. the nature of the discharge with regard to tangata whenua concerns, and the effect of the discharge on mahinga kai, waahi tapu, marae and other resources or places of significance to tangata whenua; and
d. the proposed hydraulic loading, nutrient loading and biochemical oxygen demand loading, and the cumulative effect of these application rates with other discharges; and
e. the types and persistence of contaminants in the discharge; and
f. soil types between the ground surface and groundwater; and
g. existing groundwater quality, particularly levels of nitrate and microbial contamination; and
h. contingency measures available, such as storage ponds, to avoid the need to discharge during wet or windy periods; and
i. the proposed times and seasons of application, including method and rate of application; and

j. any relevant guidelines or standards, in particular the Public Health Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land; and
k. the outcome of consultation between the applicant and affected parties; and
l. the social and economic well being and the health and safety of people and communities; and
m. any relevant code of practice and any management and maintenance systems.

DL Policy 3: Restrictions on nitrogen loadings from wastewater discharges.
To ensure that the loading of nitrogen in discharges of wastewater to grazed pasture do not exceed 150 kgN/hectare in any 12 month period and do not exceed 50 kgN/hectare in any 24 hour period unless it can be demonstrated that:
a. greater amounts of nitrogen can be removed by crop management; or
b. groundwater is protected by overlying soils of low permeability; or
c. nitrogen will be removed by enhanced denitrification or by denitrification systems constructed and maintained for that purpose; or
d. groundwater would not be rendered unsuitable for domestic, stock, or industrial use; or
e. affected groundwater could not later contaminate any surface water body and result in any of the effects described in Section 107 of the Act".

The **Rule** in LWRP that addresses irrigation of MWE to land at Byreburn Farm is as follows:

"DL Rule 13: Discharge of industrial wastewater, sewage or sewage effluent.
13.1 Except as provided for in DL Rule 6, any discharge onto or into land of
a. wastewater from tanneries, fellmongeries, dairy processing industries, food manufacturing industries, textile industries, timber industries, rendering plants, and meat processing plants; or
b. sewage or sewage effluent, unless the discharge is specifically provided for and complies with all conditions of DL Rules 1, 2 or 3
*is a **Discretionary Activity"**.*

7.5 Manawatu District Plans

Byreburn Farm lies within the Manawatu District. The Manawatu District Plan was made operative on 1 December 2002.

7.5.1 Manawatu District Plan

Byreburn Farm lies within the Rural Zone, with three blocks in the east lying in the Rural 2 Zone, and the remaining (approximately) 80% of the property lying within the Rural 1 Zone.

At Section 4.3 the plan provides **Objectives and Policies** for Rural Zones, as follows;

"Objective LU 7: To promote sustainable use of the District's land and related resources, particularly by:
(a) Safeguarding the qualities of the District's soils which contribute to their life supporting capacity, including soil depth, soil structure, water holding capacity, organic matter and soil fauna."

Objective LU 8: To maintain and where appropriate enhance the rural character and amenity of the District's rural areas, which includes:
i) A predominance of primary production and other rural activities.
ii) A landscape within which the natural environment (including farming and forestry landscapes) predominates over the built one.
iii) The environmental contrast and clear distinction between town and country.
iv) The natural quality of the District's indigenous forest areas, rivers, lakes, wetlands and coastal strip.

v) A generally tidy appearance without the eyesores which can result from such things as unfinished or derelict buildings, piles of junk and car bodies being stored in the open.

Objective LU 9: To protect and where appropriate enhance the quality of the District's outstanding landscapes.

Objective LU 10: To ensure that rural dwellings and properties enjoy a level of rural amenity consistent with the presence of primary production and other rural activities in the zone.

Objective LU 11: To minimise conflict between potentially incompatible activities in the rural zone, for example between rural houses and activities such as primary production and rural industries.*"*

Policy *4.3.1 (a) To avoid damage to the soil resource from land uses which might result in chemical contamination, excavation, erosion or soil compaction.*

Policy *4.3.2 (a) To ensure that new and existing development does not adversely affect the existing character and amenity of the rural zones.*

Policy *4.3.2(b) To recognise that amenity values vary within the zone, and ensure that any nuisance generated by existing activities is mitigated.*

Further Objectives and Policies are not generally relevant to the discharge of MWE to land at Byreburn Farm.

Section B3.1 of the plan lists the activities which are Permitted Activities in the Rural Zones; this list includes "Farming", but makes no reference to irrigation, whether with wastewater or any other sort of water.

Section B3.3 of the plan provides standards for Permitted (and Controlled) Activities in the Rural Zones, as summarised in Table 10 below.

Table 10: Manawatu District Plan – Standards for Permitted Uses in Rural Zones

Condition No	Issue	Relevant to Pond Seepage Discharge to be Consented
3.3.1 A	Maximum building height.	No
3.3.1 B	Yards and separation distances.	No
3.3.1 C	Separation of dwellings along roads.	No
3.3.1 D	Separation of dwelling units in the Pohangina Valley.	No
3.3.1 E	Separation from pig farming operations.	No
3.3.1 F	Shelter belts and tree planting.	No
3.3.1 G	Fencing of Properties.	No
3.3.1 H	Roading impacts.	No
3.3.1 I	Effluent disposal and effluent ponds.	Yes
3.3.1 J	Sales Area.	No
3.3.1 K	Noise received in residential or village zones.	No
3.3.1 L	Noise received at rural dwellings.	No
3.3.1M	Exemptions and measurement of noise.	No
3.3.1N	Air noise control.	No
3.3.1O	Parking.	No
3.3.1P	Visibility at Railway Crossings.	No
3.3.1Q	Access to roads.	No
3.3.1R	Farm loading ramps.	No
3.3.1S	Glare.	No

7.6 Other Relevant Plans

Horizons Regional Council's "Oroua Catchment Water Allocation and River Flows Plan" (Oroua Allocation Plan) is currently operative, and applies to the geographical area within which the proposed activity is to take place. However, the plan addresses water quantity and takes, and does not address the groundwater quality issues that are potentially affected by the discharge of MWE to land at Byreburn Farm. Accordingly, this plan is not further considered in the context of this application.

There are no other plans known that are relevant to the proposed activity.

7.7 Consent Requirements

The discharge of MWE to land at Byreburn Farm qualifies as a Discretionary Activity under Rule 13-27 of OPDV, requiring a resource consent.

Under the MCWQP the discharge qualifies as a Discretionary Activity under MCWQ Rule 12, indicating that a resource consent is required.

Under the LWRP the discharge qualifies as a Discretionary Activity under DL Rule 13, indicating that a resource consent is required.

The resource consent application will need to be considered against the provisions of all three plans.

Under the Manawatu District Plan there is no resource consent requirement for the discharge of MWE to land at Byreburn Farm.

8.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

8.1 Receiving Environment

The receiving environment for the discharge of the treated MWE to land is the soil of Byreburn Farm, as described in Section 4 above. The potential secondary receiving environment is the shallow groundwater beneath the farm, and a potential tertiary receiving environment is the surface water of the Oroua River.

8.2 Sensitivity of Receiving Environment

Environmental risk depends on three major factors, these are:

- Source and type of contaminant;
- Migration pathways; and
- Receptors.

If one of these factors is absent, then the potential risk is greatly reduced. By removing the contaminant source, by containing the contaminant, or by the absence or removal of the receptor, the environmental risk is able to be significantly reduced.

The application of treated MWE to soil provides the source and type of contaminant. The irrigation and its timing, rate and placement are the primary migration pathway, with through-flow to groundwater providing a secondary migration pathway. The receptor is the soil in the first instance, groundwater in the second instance, and potentially the surface waters of the Oroua River in the third instance.

The soil, the groundwater, and the river water are all sensitive to the effects of the irrigation of MWE. The sensitivity of the soil relates to its potential loss of productivity and versatility if the hydraulic application rate is excessive. The sensitivity of the groundwater relates to the entry of contaminants through the soil, and phosphorus and nitrogen in particular, if irrigation rates are excessive and if nutrient loadings exceed the soil's capacity to adsorb or ameliorate them. The sensitivity of the river water relates to a further potential degradation of its water quality if contaminants from the irrigation pass through the soil, and by way of groundwater into the river.

These sensitivities can all be addressed at the soil application stage. If MWE is applied only at a rate that the soil can be shown to sustain, then water quality problems in the groundwater and the river will be avoided.

8.3 Summary of Effects

The activity that may produce actual or potential effects on the environment that need to be considered relates to:

- The discharge of treated Meat Works Effluent (MWE) to land on Byreburn Farm.

Actual or potential effects upon the environment are listed as:

- Effects of the discharge on the soil;
- Effects of the discharge on groundwater quality;
- Effects of the discharge on surface water quality;
- Effects on habitats;
- Effects on Amenity, Community, Cultural and Heritage values; and
- Effects of the discharge on air quality.

There will be no effects that are not capable of satisfactory avoidance, remediation or mitigation. The individual effects are all not more than minor.

8.4 Discharge of MWE to Land on Byreburn Farm

Irrigation of treated wastewater is planned to be at a sustainable rate and over an area such that the properties of the soil itself will be utilised to reduce the adverse effects of contaminants and nutrients, resulting in offsite effects being not more than minor.

The MWE to be irrigated onto the land application site on Byreburn Farm will have the following properties of potential environmental concern:

- Organic material, expressed as carbonaceous biochemical oxygen demand (BOD);
- Nitrogen (N as ammoniacal nitrogen (NH_4-N) and nitrite/nitrate nitrogen (NOx-N));
- Total phosphorus (P);
- Pathogens; and
- Water.

8.4.1 Effects of the Discharge on the Soil and Plants

The MWE will be applied at a rate equivalent to a maximum application depth per application event of 34 mm/application by the existing irrigation infrastructure or 15 mm/application if low rate application equipment is installed. The impact of the discharge on the soil and plant system relates the potential for a reduction in soil quality, and loss of productivity leading to poor performance of crops on the site. These are discussed below with regard to the properties identified in Section 5.4 above.

8.4.1.1 Effect of Water on Soil Structure

Soil structure refers to the size and distribution of soil particles and void spaces (pores) in the soil. It is important since it controls the rate at which water can be infiltrated into and drained from the soil, and the amount of water that can be retained in the soil. In addition, the distribution of pores influences the aeration of the soil. If the soil structure is degraded, drainage and root passage becomes impeded which leads to a loss of productivity and reduction in soil quality.

Irrigation has the potential to initiate soil structural degradation if not sustainably managed. If soil is allowed to remain at a high soil moisture content or saturation for a prolonged period damage to soil structure may occur by:

- Pugging due to animal traffic on wet soils;
- Mechanical damage by cultivation or vehicle traffic on wet soils; and
- Chemical and biological damage to structure by MWE constituents or microbial action in anoxic conditions due to saturated conditions.

In order to prevent prolonged wet conditions in the soil of the site a resting period not less than 7 days between applications will be maintained. To comply with the proposed parameters application to each area of the site will occur only 7.5 times in the 180 day season for the higher rate application or 16.7 times for the lower rate. This will ensure a long resting period between applications and sufficient time for the soil to dry out.

The depth of MWE to be applied in any event has been designed to meet industry best practice for wastewater irrigation as described in Appendix H. Application to land is halted during periods of wet weather to ensure that the additive effect of MWE plus rainfall does not cause prolonged soil wetness. It is considered that the effect of MWE applied water on the soil will be no more than minor.

8.4.1.2 Effect of Organic Material on Soil and Plants

Potential adverse effects of organic material, measured as BOD on soil and plants of the site include the generation of anaerobic conditions in the soil as oxygen is consumed. This important to the land treatment system; as if the system becomes anaerobic it will not function as the pore spaces of the receiving soil are blocked. This could cause production of surface slimes with the associated problems of:

- Plant die off;
- Degraded visual appearance;
- Production of odour;
- Degradation of soil structure; and
- Reduced soil infiltration capacity.

A healthy soil environment can assimilate up to 600 kg BOD/ha/day (NZLTC, 2000). The loading of BOD to be applied by the system is 5 (low rate) 12 (existing) kg BOD/ha/application event, and 90 kg BOD/ha/year. These rates are well within the capacity of a healthy soil, so the effects of BOD on soil and plants within the proposed application are expected to be less than minor.

8.4.1.3 Effect of Nitrogen on Soil and Plants

Potential adverse effects of high N loading on soil and plants may include:

- Oversupply of N in excess of plant requirements, leading to leaching to groundwater and drainage to surface water; and
- Plant damage due to high ammonia.

Much of the N will be removed by soil microbe use, plant uptake, short-term soil storage and gaseous losses (volatilisation and denitrification). Gaseous losses alone may remove 38 % of applied N for a high ammonia effluent (Laurenson, *et al.*, 2006)

The proposed N loading from MWE to the application area is 310 kg N/ha/y with a per application N load of 42 kg N/ha (existing) or 19 kg N/ha (low rate). A total loading rate of 350 kg N/ha/y is proposed for all sources of N. This loading rate is comparable to many agricultural fertiliser applications which are undertaken with permitted activity status. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated MWE. Soil transformation and plant uptake of the applied N is expected to match or exceed the rate of application. Adverse effects on soil and plant due to nitrogen from MWE application are considered be less than minor.

8.4.1.4 Effect of Phosphorus on Soil and Plants

The MWE contains P, which is an essential nutrient for plant growth and microbial activity (for maintenance of soil quality). The risk from P is predominantly due to the effects if it reaches surface water causing nuisance growth in streams and rivers.

The proposed P loading to the application area is 60 kg P/ha/y with a per application P load of 8 kg P/ha. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated MWE. Soil transformation and plant uptake of the applied P is expected to match or exceed the rate of application. Adverse effects on soil and plant due to phosphorus from MWE application are considered be less than minor.

The impact on ground and surface water is discussed in subsequent sections.

8.4.1.5 Effect of Pathogens on Soil and Plants

The MWE has the potential to contain pathogens as indicated by *E. coli*. The risk from pathogens in the soil occurs when they enter the food chain by consumption of raw crops.

On the site, the main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. It is understood that 92 - 99.9 % of applied microbes are removed in the top 10 mm of the soil (Crane and Moore, 1984; Gunn, 1997). It is expected that the effect of pathogens from MWE on soil and plants will be less than minor.

8.4.2 Effects of the Discharge on Groundwater

Contaminants applied to the land have the potential to enter groundwater. On the land treatment site the discharge will be applied at the surface of the soil and there is the potential for it to leach into shallow groundwater. However results from the monitoring bores on the site do not give a clear indication of contamination from MWE in groundwater. It is likely that a significant amount of contaminant transported below the soil zone of treatment could be intercepted by subsurface drains that are extensive under the land application area and diverted directly to surface water. Therefore groundwater is expected to not be substantially influenced by MWE application.

8.4.2.1 Effect of Water on Groundwater

The potential effect of irrigation applied water on groundwater is predominantly due to the contaminants that are transported in the MWE applied water. These are dealt with in the following sections. The initiation of excessive drainage has the potential to cause localised groundwater mounding where groundwater is slow moving. Water applied to the soil surface by MWE application will be to a depth of 34 or 15 mm/ application with a long resting period between applications to the same site. This rate has been designed to avoid excessive drainage. Most applied water will not percolate through the soil to reach the groundwater; it will pass back out to the atmosphere by way of transpiration by plants or direct evaporation. The effects of water applied as MWE on groundwater is expected to be negligible.

8.4.2.2 Effect of Organic Material on Groundwater

Organic material (as BOD) in groundwater becomes a problem when the water reaches the surface, either through a bore for some productive use or to join surface water such as the Oroua River. High BOD causes a reduction in dissolved oxygen, leading to anaerobic conditions, mortality of river flora and fauna, and growth of undesirable flora and fauna.

BOD from MWE irrigation will be effectively intercepted in the soil, so that BOD entering groundwater will be negligible, and the effect of BOD on groundwater is expected to be less than minor.

8.4.2.3 Effect of Nitrogen on Groundwater

Potential adverse effects of N on groundwater in this situation would become apparent when groundwater enters surface water. The agronomic N application rate, predominantly applied during summer, ensures that a substantial proportion of applied N will be taken up by plants, sequestered by soil, or volatilised/denitrified.

The proposed annual average rate of application on Byreburn Farm will be approximately 310 kg N/ha/yr. This rate is comparable to many agriculture fertiliser application regimes.

The low rate application to the site will ensure that the N is utilised within the soil and not flushed through. Nutrient modelling using Overseer (included in Appendix H) indicates that expected N in drainage water under the proposed regime is 16 kg N/ha/y. This value is below the limits for the site required under the OPDV. Should N enter groundwater, the geology in the area is such that it would soon reach surface water, being the Oroua River.

Despite the geological aspect discussed above, N entering groundwater due to the discharge will be negligible. It is expected that effects of N on groundwater will be no more than minor and equivalent to the current or a reasonably expected land use.

8.4.2.4 Effect of Phosphorus on Groundwater

Potential adverse effects from P occur when groundwater enters surface water, under which conditions it can contribute to eutrophication. The design of the application rate for the site is based on P as a limiting parameter. A P loading rate of 60 kg P/ha/y has been adopted as a rate that can be managed to avoid P loss from the site in drainage water.

On the site the proposed hydraulic application rate of the wastewater will be sufficiently low to avoid a high rate of leaching through the soil profile to the underlying groundwater. Therefore the risk of P entering the groundwater is expected to be no more than minor.

8.4.3 Effects of the Discharge on Surface Water Quality

The Oroua River is the final receiving environment for the applied MWE. This river receives water from ephemeral streams that drain the present land treatment area, and also from the shallow groundwater in the area. MWE derived contaminants have the potential to enter the Oroua via either surface run-off, groundwater drainage or from the artificial drainage network on the site. The land application system is operated to ensure that no MWE enters surface water by direct run-off. As discussed above groundwater is not expected to be a significant source of MWE derived contaminants.

The most likely route for transport of MWE to surface water is by the drainage network on site. Design of the application regime has considered the limitation of drainage volume to ensure that the impact on surface water from the land treatment regime is minimal.

8.4.3.1 Effect of Organic Material on Surface Water Quality

The potential adverse effect of organic material (as BOD) on surface waters is a reduction in the dissolved oxygen content of the water. This leads to stress on the ecosystem and mortality of river flora and fauna. Reducing conditions may occur in the sediment of the bed of a waterway, leading to release of nutrients into the water.

As discussed in Section 8.4.1.2, the soil of the site has ample capacity to assimilate the applied organic material. The irrigation system involves the application of MWE to the surface to travel through the soil column. Applied organic material entering surface waters from groundwater will be negligible due to filtration. The potential for run-off of organic material from the site to surface water will be mitigated by avoiding the application to saturated soils near to surface water bodies.

The organic material to be discharged will not have an effect on the quality of surface water that is more than minor.

8.4.3.2 Effect of Nitrogen on Surface Water Quality

Potential adverse effects of N on surface waters may include:

- Excessive growth of nuisance aquatic plants;
- Reduction in dissolved oxygen;
- Alteration of river flow due to blockage by macrophytes;
- Change in biodiversity; and

- Reduction in recreational amenity.

The N applied to the application area is expected to be assimilated by the soil and growing plants. Nitrogen entering surface waters from the catchment via groundwater will be negligible. The application depth and lateral distance to surface water (greater than 20 m) will mitigate the risk of nitrogen entering surface water by run-off.

The N to be discharged will have an effect on the quality of surface waters that is less than minor.

8.4.3.3 Effect of Phosphorus on Surface Water Quality

Potential adverse effects of P on surface waters are similar to those described for nitrogen above. Phosphorus is identified in Section 5.5.1 above as the limiting parameter for MWE application to land on Byreburn Farm, and it has been assessed that a P load of 60 kg P/ha/y can be sustainably applied to the site. At this rate plant uptake will account for most applied P with soil sorption accounting for any remainder. Accordingly, it is anticipated that P entering surface waters from the land application system will be negligible.

8.4.4 Effects of the Discharge on Surface Water Habitats

Any effect that the application of MWE to land on Byreburn Farm may have on surface water habitats will be as a result of effects on surface water quality. As noted in Section 8.4.3 above, effects of the activity on surface water quality are expected to be minimal, and as a result effects on habitat values are also expected to be minimal.

In addition, the proposed increase in the volume of MWE discharged to land from the current situation will result in a reduction in MWE volume discharging directly to surface water. This is expected to result in a net improvement in the water quality and subsequently the surface water habitat of the Oroua River.

8.4.5 Effects of the Discharge on Amenity, Community, Cultural and Heritage Values

The mauri of Oroua River is of relevance and significance to Iwi. Application of MWE to land wherever possible ensures that the mauri of the river system is afforded the maximum protection that is practically possible.

As discussed above, the proposed MWE discharge to land at Byreburn Farm is unlikely to adversely affect the stream water quality or the stream habitat of the Oroua River. The effects on the instream values of the wastewater application are expected to be similar to the effects of the permitted farming land uses in the surrounding catchment. It is unlikely that the landscape of the receiving water will be affected by the discharge to the site. The application of the MWE to land will in fact enable the avoidance of the previous adverse effects of discharging the equivalent wastewater directly to the Oroua River.

Neither the contact nor the non-contact recreational users of the Oroua River are likely to be affected by the treated wastewater discharge to land, due to:

- No microbiologically contaminated water is expected to enter the river; and
- The contaminants in the wastewater are expected to be ameliorated by the soil to which they are applied, and to leach from there into the stream in only insignificant quantities.

It is considered that there will be minimal to no adverse effects on people or the community. Adherence to buffer distances and prescribed application rates will ensure that possible health effects from the discharge will be minimised.

The land treatment area is on private land. No public amenity values beyond the aesthetic value of the rural landscape currently exist on these sites. It is expected that the effects to amenity values on these sites will be no more than minor.

8.4.6 Summary of Effects of the Discharge

The proposed loading rate of the wastewater discharge to land will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of any suspended solids;
- Assimilation of organic material;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Cation adsorption; and
- Filtration and attrition of pathogens.

The amounts of wastewater-applied nutrients that are likely to enter surface or groundwater are negligible, and their effects are expected to be less than minor.

9.0 MITIGATION

Measures taken to reduce the potential adverse effects of the land application of MWE on Byreburn Farm are described as follows.

9.1 Identification of Limiting Parameter

Under the existing application scheme P accumulation has been identified as the parameter of most concern. In the design of an application regime for the proposed activity in the future P has been adopted as the limiting parameter. This means that if a limit is set for P and the other key parameters (available land, hydraulic load, and nitrogen load) are calculated based on the acceptable P load, then this will result in no exceedance of a recommended limit for any other parameter.

9.2 Determination of Maximum Application Rate of Limiting Parameter

It has been assessed that a P load of 60 kg P/ha/y can be sustainably applied to the site. At this rate plant uptake will account for most applied P with soil sorption accounting for any remainder.

9.3 Limitation of Additional Nutrient Sources

Limits are proposed for the total nutrient load to the site to avoid excessive application by sources other than MWE.

9.4 Avoidance of High Permeability Soils

It is proposed that irrigation of MWE is discontinued on the gravelly Rangitikei land application area, and that an additional area of Kairanga, Manawatu and/or Milson soils is incorporated into the land application area.

9.5 Avoidance of Run-off

The proposed land application system will ensure that there is no surface run-off of MWE, thus ensuring there is no direct discharge of contaminants into any waterway.

9.6 Land Application as Mitigation

The proposed land application system is itself the primary mitigation measure against adverse effects of the discharge of MWE directly to the Oroua River. The application of an increased proportion of AMP's total MWE production to land enables both an avoidance of discharge to the river in times of low flow, and a reduction of the total requirement for river discharge on an annual basis.

10.0 MONITORING

It is proposed to maintain the same monitoring regime that is currently employed at the site, which involves the following.

10.1 Irrigation Register

An Irrigation Register is kept, recording the following:

(a) the date when irrigation occurs and the times at which irrigation starts and ends each day.

(b) the spray irrigation locations used including spray area and spray block number, and the quantity of effluent applied to each spray block.

(c) the weather conditions and wind conditions during times of irrigation.

10.2 Effluent Monitoring

During the periods of land application, the effluent is sampled on a monthly basis and tested for the following parameters:

BOD_5, Suspended Solids, TKN, $N0_3$ and $N0_2$, Calcium, Sodium, Phosphorus, Potassium and Magnesium.

10.3 Groundwater Monitoring

One control and three shallow groundwater bores in the application area are monitored, with samples collected on the same days as effluent samples are taken, and tested for the following parameters:

BOD_5, Suspended Solids, TKN, $N0_3$ and $N0_2$, Calcium, Sodium, Phosphorus, Potassium and Magnesium. Sodium absorption ratio is calculated from these results.

10.4 Soil Monitoring

Soil samples are taken from three sampling sites located in each representative land discharge area during November each year. Samples are taken from 10 and 20 cm depths at each site and from a similar location each year, and are analysed for:

pH; Calcium; Phosphorus; Potassium; Sulphur Sulphate; Magnesium; Sodium; and Nitrogen.

Soil infiltration capacities and organic matter content at the same sites are also measured.

11.0 EVALUATION OF EFFECTS AGAINST STATUTORY PROVISIONS

In this part of the application report, the discharge by irrigation of MWE to land at Byreburn Farm is considered against the context of national, regional, and district statutory planning policies.

11.1 Resource Management Act

11.1.1 Part 2

Part 2 contains 4 sections that are of relevance to the discharge of MWE to land at Byreburn Farm. Only the section heading and a summary title is used below.

Section 5 Purpose and Principles

Sustainable Management

The purpose of the RMA is stated as being *"to promote the sustainable management of natural and physical resources"*. The elements of what is seen, by the legislation, to be sustainable management are considered below in relation to the proposed activities.

Managing Use, Development and Protection of Natural and Physical Resources

The discharge by irrigation of MWE to land at Byreburn Farm under this consent application is to enable the operation of a meat processing plant (the AMP) that is sustainable from social, environmental and economic perspectives.

Enable People and Communities to Provide for their Social, Economic and Cultural Wellbeing

The discharge by irrigation of MWE to land at Byreburn Farm arises unavoidably and inevitably from the operation of the AMP. The AMP sustains a market for farm produce, and generates employment both directly and indirectly, thus providing the Feilding and wider Manawatu community with clear social, economic, and consequent cultural benefits. The effects of the discharge are not shown to compromise any social, economic or cultural expectations, but rather enable a significant reduction in the discharge of wastewater to the Oroua River.

Safeguarding Life-Supporting Capacity

The discharge by irrigation of MWE to land at Byreburn Farm will be limited in such a way as to safeguard the life-supporting capacity of the Oroua River and adjacent land. This is achieved by limiting the nutrient and hydraulic application rates, and by directing a significant proportion of the wastewater stream from the river to land. The rates of application to the land are calculated to be within the capacity of that land to receive and beneficially utilise the water and the nutrients involved without adverse effects on productivity or life-supporting capacity.

Avoiding, Remedying or Mitigating Adverse Effects

The proposed discharge by irrigation of MWE to land at Byreburn Farm is managed to ensure that there are no adverse effects that are greater than minor and can be avoided, remedied or mitigated. The application to land significantly avoids the adverse effects of discharge to the Oroua River at times of low river flow.

Section 6 Matters of National Importance

Preservation of Natural Character

No aspect of natural character will be compromised by the discharge by irrigation of MWE to land at Byreburn Farm. The farm and its locality have been in intensively managed pastoral production for many decades, and most aspects of natural character have been changed during that time. Natural character will not be subject to adverse effects that are greater than minor.

Protection of Outstanding Features

No outstanding natural features or landscapes will be affected by the proposed discharge by irrigation of MWE to land at Byreburn Farm. The farm is situated in a thoroughly modified environment, in an area of intensively managed farm land. The natural aspects of the Oroua River flowing past Byreburn Farm are not expected to be compromised in any way by the discharge.

Protection of Significant Vegetation and Habitats

There is no significant indigenous vegetation in the immediate vicinity of Byreburn Farm.

The reach of the Oroua River adjacent to the farm has the potential to become part of a freshwater habitat to both indigenous and exotic species that will become progressively more significant as its water quality is improved. The realisation of this potential improvement to the habitat values of the Oroua River is not compromised in any way by the irrigation discharge, but is rather enhanced by the direction of a significant portion of the wastewater stream out of the river and onto land.

Public Access

Byreburn Farm is on private land held in fee simple title, with no requirement for any provision of public access. Public access is provided adjacent to the farm along Aorangi Road. The Oroua River forms the western boundary of the farm; there is a *de facto* availability of public access along the bed and banks of the river, which is used for a variety of informal outdoor activities by the wider community. No aspect of the proposed discharge to land will affect public access in any way.

The Relationship of Maori

The discharge by irrigation of MWE to land at Byreburn Farm is considered unlikely to have any effect on values of particular importance to Maori. The discharge is to land rather than to surface water, and its effects on the quality of groundwater and surface water are shown to be not greater than minor. The Oroua River is a site of significance to Rangitaane, the local Iwi, but the discharge will have no significant adverse effect on the river. The effect of the discharge to land in removing the need for discharges directly to the Oroua River at times of low flow is a clearly positive effect on river water quality. Accordingly, it is considered that the proposed discharges will not adversely affect the relationships of Maori with natural resources or Taonga.

Historic Heritage

There is no known historic heritage that would be adversely impacted by the proposed discharge by irrigation of MWE to land at Byreburn Farm.

Customary Activities

There are no known customary activities in the vicinity of Byreburn Farm that could be adversely affected by the discharge by irrigation of MWE to land at Byreburn Farm.

Section 7 Other Matters

Kaitiakitanga

In terms of s7(a) it is considered that the environmental performance of the discharge by irrigation of MWE to land at Byreburn Farm is managed to ensure that it generally meets reasonable neighbourhood entitlements. While Iwi have not been directly involved in guiding wastewater irrigation on the farm, it is considered that the environmental performance that Iwi and the rest of the community may expect will be delivered by the irrigation activity at the farm. Accordingly, while there has not been a process to engage Iwi in the irrigation management, that management has nevertheless achieved the results that Iwi and the wider community are entitled to expect. The duty of Kaitiakitanga may thus be considered to have been met.

Ethic of Stewardship

In terms of s7(aa), the applicant by meeting water quality standards is satisfying the consideration of the *'ethic of stewardship'* in protecting natural and physical resources.

Maintenance and Enhancement of Amenity Values

Amenity values in the neighbourhood are not adversely affected by the discharge by irrigation of MWE to land at Byreburn Farm. The irrigation may be considered to have positive effects on how green the involved area looks during dry summers. The off-site amenity effect of removing a significant portion of the wastewater stream from the Oroua River may be regarded as enhancing amenity values. It is considered that adverse effects on amenity values are not greater than minor.

Intrinsic Values of Ecosystems

The discharge by irrigation of MWE to land at Byreburn Farm has insignificant adverse effects on intrinsic ecosystem values. The discharge is expected to have no significant adverse effect on the nearby Oroua River or its associated ecosystems.

Maintenance and Enhancement of the Quality of the Environment

There are expected to be no significant adverse effects on the quality of the environment arising from the discharge.

Protection of the Habitat of Trout and Salmon

The discharge by irrigation of MWE to land at Byreburn Farm is expected to have a positive effect on the habitat of trout and other aquatic species, by retaining and consuming nutrients on the land that may otherwise be discharged to the Oroua River, whether by direct river discharge or by over-zealous land application. Salmon are not known to inhabit the Oroua River.

Effects of Climate Change

Climate change may involve increases in wind and rain, and this may be expected to have an effect on the receiving environment, with a possible rise in groundwater levels. It may in time reduce the requirement and opportunity for irrigation on the subject land. The size of the change during the expected term of the consent under application, however, is expected to be *de minimus,* as is the effect of any change in sea level.

Section 8 Treaty of Waitangi

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

The requirement to take the principles of the Treaty into account is a responsibility for the Regional Council to consider. Because the adverse effects of the discharge by irrigation of MWE to land at Byreburn Farm are not greater than minor, and because there is no cumulative aspect of the discharge that could compromise known Taonga, entitlements, or Iwi expectations, it is considered that there is no breach of any Treaty principle.

Conclusion with Respect to Part 2

The above discussion has considered all the relevant elements of Part 2 of the Act and the conclusion from this is that the proposal is not contrary to any of the provisions. Therefore it can be said that the proposal is in accordance with Part 2 of the Act.

11.1.2 Part 3

Section 15 Discharge of contaminants into the environment.

The proposed activity will involve the discharge of wastewater to land. Resource consent is sought to authorise this activity from the regional consent authority, where the discharge is classified as a discretionary activity under three plans.

Section 17 Duty to avoid, remedy, or mitigate adverse effects.

In reference to the discharge of wastewater to land for which consent is being applied, this application addresses how adverse effects will be avoided, remedied, or mitigated. This report proposes conditions for the consent for the proposed discharge that will achieve this.

11.1.3 Part 6

Section 88 Making an application.

This report with attachments forms part of an application for resource consent for the AMP under s88 and as described in the Form 9, Section 4 and elsewhere in this report.

Section 93 When public notification of consent applications is required.

This report contains information which assesses that the overall status of the discharge by irrigation of MWE to land at Byreburn Farm is a discretionary activity. This report with its attachments is an application for resource consent which considers that the actual or potential effects upon the environment will be not greater than minor.

Section 94 When public notification of consent applications is not required.
This report forms part of an application which assesses that public notification of the consent application for the discharges to land may not be required.

Section 94A Forming an opinion as to whether adverse effects are minor or more than minor.

This report and attachments provides information to assist the consent authority to determine that any actual or potential adverse effects upon the environment or persons from whom written approval has not been provided will be not more than minor.

Section 94B Forming an opinion as to who may be adversely affected.

This report as part of an application under s88 contains information in accordance with the 4th Schedule of the Act. It is concluded that the proposed discharge to land will have no adverse environmental effect on persons or parties and the wider community.

Section 94C Public notification if applicant requests or if special circumstances exist.

The applicant does not request public notification.

Section 104 Consideration of applications.

This report contains information relating to matters to be considered under S 104B (discretionary or non-complying activities). These are discussed in more detail in Section 8 of this report and attachments.

Section 105 Matters relevant to certain applications.

This report and attachments is for an application relating to a discharge contravening s15 of the Act. Accordingly information is provided for the consent authority to have regard to:

- Nature of the discharge and sensitivity of receiving environment to adverse effects;
- The applicant's reasons for the proposed choice; and
- Any possible alternative methods of discharge, including discharge into any other receiving environment.

Section 108 Conditions of resource consents.

This report and attachments contains information about the discharge of wastewater to land as to the actual or potential effects upon the environment and their avoidance, remediation and mitigation. For the discharge, certain conditions are proposed which are addressed in detail under Section 12 of this report.

11.2 National Policy Statements and National Environmental Standards

11.2.1 National Standard for Wastewater Discharge to Land

There is no relevant national standard for groundwater quality, or for wastewater discharge to land, or any other relevant aspect of this application.

11.3 Regional Policy Statement

Objective 6-2(b) of the RPS is for the maintenance of existing groundwater quality, and its enhancement where it is degraded. Irrigation of MWE onto land has continued seasonally for the last 20 years, and there is a case for the inclusion of its effect within what may be considered to be "existing groundwater quality." The effect of the discharge on groundwater quality under this application has in any event been shown to be not greater than minor, so this objective is generally met by the proposed discharge.

Policy 6-6(a) mirrors Objective 6-2(b) in requiring maintenance of existing groundwater quality, with enhancement if degraded. This policy is met by the discharge.

Policy 6-6(aa) introduces the prospect of an exception from the requirement of Policy 6-6(a) where the discharge to land better meets the purpose of the Act than would a discharge to water, provided treatment and discharge utilise best practicable options. In the present instance, the discharge will certainly have less adverse environmental effect than if an equivalent discharge were made directly to the river. The best practicable options for both pond treatment of wastewater at AMP and irrigation method are shown to be met, so this policy may be regarded as enabling of the authorisation of the discharge.

To the extent that the RPS sets environmental performance indicators for the MWE irrigation discharge, those provisions are met by the proposed discharge.

11.4 Regional Plans

Relevant objectives and policies of the Horizons Regional Plans applicable to the proposal are discussed below.

11.4.1 Horizons One Plan Decisions Version (OPDV)

The Objectives of the plan with respect to the MWE irrigation are that regard is had to the provisions of the RPS, and that a discharge to land avoids, remedies or mitigates adverse effects on groundwater. Discussion under Section 11.3 above shows that the plan's objectives are met by the proposed activity.

Policy 13-2 of the plan sets out a framework of matters against which the proposed activity is to be evaluated. For the discharge of wastewater to land by irrigation at Byreburn Farm, the assessment of environmental performance against those standards is as follows;

a) *The objectives and policies of Chapter 6 regarding the management of groundwater quality and discharges.*

These matters have been addressed under Section 11.3 (RPS) above; the proposed activity meets these requirements.

b) *Where the discharge may enter surface water or have an adverse effect on surface water quality, the degree of compliance with the approach for managing surface water quality set out in Chapter 6.*

The discharge is not expected to enter surface water, so the proposed activity is not in conflict with this requirement.

c) *Avoiding as far as reasonably practicable any adverse effects on any sensitive receiving environment or potentially incompatible land uses, in particular any residential buildings, educational facilities, churches, marae, public areas, infrastructure and other physical resources of regional or national importance identified in Policy 3-1, wetlands, surface water bodies and coastal marine area.*

There are no residential buildings, educational facilities, churches, marae, public areas, infrastructure, wetlands, surface water bodies or coastal marine areas close to the site of the discharge that may be considered to be affected by the discharge.

The St Dominic's property adjoining AMP is both a residential and an educational facility, and draws its domestic water supply from a bore on site, some 300 m down gradient from the nearest part of the application area. Before its present deployment, the facility was a residential school for the deaf. Over the 20 years that the facility and the MWE irrigation have co-existed, no groundwater quality issue at St Dominic's that might be attributed to the irrigation has been noted.

While AMP may be considered to be neither residential nor educational, it also draws up to 4,800 m^3/day of groundwater from a bore situated some 500 m from the nearest corner of the application area. While this abstracted groundwater is not put to potable use, no water quality issue that might be attributed to MWE irrigation to land on Byreburn Farm has been noted.

The Oroua River lies 60 m from the closest encroachment of the application area, although most of the application area is more than 250 m distant from the river, and some lies up to 1 km distant from the river. (See Figure 2 in Appendix A). There is no evidence of any adverse effect on the river that can be attributed to the MWE irrigation.

The adverse effects contemplated by Policy 13-2(c) may be considered to be avoided by the discharge.

d) The appropriateness of adopting the best practicable option to prevent or minimise adverse effects in circumstances where:

i) It is difficult to establish discharge parameters for a particular discharge that give effect to the management approaches for water quality and discharges set out in Chapter 6;

ii) The potential adverse effects are likely to be minor, and the costs associated with adopting the best practicable option are small in comparison to the costs of investigating the likely effects on land and water.

The focus of this policy is protection of the water quality in the river and groundwater quality. It is difficult to assess definitively the effect of the MWE irrigation on the quality of both the groundwater and the river, because of the likely masking of effects by background conditions. The irrigation of MWE to land on Byreburn Farm is by no means the only contributor of nutrients to the river or to groundwater in the Feilding locality. There has nevertheless been a long record of monitoring of groundwater quality on Byreburn Farm, see Appendix H.

In this situation, the adoption of best practicable option involves using an irrigation method which is calibrated and monitored to apply water, phosphorus and nitrogen only at rates which are within the capacity of the soil to receive, without run-off, through-flow, or nutrient passage to groundwater beyond levels normally expected from farm activities.

(e)Avoiding discharges which contain any persistent contaminants that are likely to accumulate in the soil or groundwater.

As by-products from the processing of livestock for human consumption, the constituents of the wastewater stream are mostly either water or derivatives of plant material consumed by the livestock. Only small additions of such materials as cleansers are expected to be included. There is scope for phosphorus to accumulate in the soil, and for a surplus beyond the soil's capacity to be leached into groundwater, which may be regarded as a contaminant when it reaches surface water. A key feature of the design of the irrigation system has been to limit phosphorus application so as to avoid its passage through the soil, so significant discharges of persistent contaminants may therefore be said to be avoided.

(f)The objectives and policies of Chapters 3,4,7,10,11A to the extent that they are relevant to the discharge.

Chapter 3 addresses infrastructure, energy, waste, hazardous substances, and contaminated land. In particular waste minimisation is addressed, with Policy 3-6 requiring that "*wastes…must be managed in accordance with the following hierarchy:*

(a) Reducing the amount of waste produced;
(b) Re-using waste;
(c) Recycling waste;
(d) Recovering resources from waste;
(e) Appropriately disposing of residual wastes."

In the context of this application, there is inevitable waste generated at a meat processing plant. AMP has commercial incentives to reduce waste; the water used costs to abstract and treat, and some of the waste generated has residual value that is capable of being realised. The land application of a portion of the wastewater enables the nutrients and water involved to be beneficially re-used for enhancing the growth of farm products. Paunch material and other floatable wastes are collected in the solids pond and the save-all, and beneficially re-applied to land. Blood, skins, bones, and other arisings are taken out of the waste stream and re-processed to produce marketable products. It may be considered that land application of the residual wastewater is the most appropriate of the possible methods of dealing with this material. The provisions of Chapter 3 may be considered to be met by the management of wastewater at AMP.

Chapter 4 addresses Te Ao Maori. Maori values in the Oroua River are acknowledged in this document, and it is considered that the proposed activity will have not greater than minor effect on Iwi and Hapu values as it is discharging to land rather than to water.

Chapter 7 addresses indigenous biological diversity, landscape and historic heritage. It is considered that the proposed activity will have no significant effect on these values.

Chapter 10 addresses natural hazards. While earthquakes and assorted other hazards will affect the site of the proposed activity from time to time, it is not considered that the proposed activity is rendered any less safe or sustainable by the existence of those hazards, and the hazards themselves are not made more severe by the proposed activity.

Chapter 11A addresses general objectives and policies, mostly on the mechanics of giving effect to policies. The provision here that is pertinent is the established common expiry dates for consents, which for the Oroua Water Management Zone is 2019.

Policy 13-2 B of the plan requires consideration of options for discharges.

"The opportunity to utilise alternative discharge options or a mix of discharge regimes, for the purpose of mitigating adverse effects where reasonably practicable, must be considered, including but not limited to:

(a) Discharging contaminants onto or into land as an alternative to discharging contaminants into water,
(b) Withholding from discharging contaminants into surface water at times of low flow, and
(c) Adopting different treatment and discharge options for different receiving environments or at different times (including different flow regimes or levels in surface water bodies)"

This discharge is to land, as part of an overall CLAWD discharge management system. The alternatives for the discharge are to the land, to another area of land, to Feilding's municipal wastewater system, or to the Oroua River.

Part of the discharge of wastewater from AMP is to the Oroua River, withheld at times of river low flow and during the summer. The discharge of the entire wastewater flow to the river is not considered environmentally acceptable, particularly at times of low river flow. Discharging to another area of land is not likely to have different environmental requirements from the system at Byreburn Farm, which has the added attractions of its immediate proximity to AMP (minimising piping and pumping costs) and its existing infrastructure for the irrigation.

The treatment option used at AMP is a large oxidation pond following solids removal; it is not considered to be cost effective to remove nutrients further than is currently achieved. While there are treatment systems available that could further reduce nutrient levels, the capital and operational costs could not be commercially sustained by AMP.

Notwithstanding that the activity of the MWE irrigation on Byreburn Farm clearly qualifies for consideration as a discretionary activity under OPDV, it is shown above that the effects of the activity meet the plan's objective and policy requirements.

11.4.2 Manawatu Catchment Water Quality Plan (MCWQP)

This plan addresses surface water quality, and only addresses groundwater quality to the extent that it may be shown to affect surface water quality. It nevertheless makes any discharge into land from an industrial premises a discretionary activity. In order to enable proper assessment of a consent application, this plan requires the following issues to be addressed.

a. *Description of the proposal and location of the proposed activity, including land area, soil types, distance to the nearest river and map references from NZMS map, scale 1:50,000.*

The proposal and its location are described in this document. The Oroua River lies 60 m from the closest encroachment of the application area, although most of the application area is more than 250 m distant from the river, and some lies up to 1 km distant from the river. Figure 2 in Appendix A provides the map, and map references are quoted in Section 4.1 above.

b. *Quantity of contaminants, or water, to be discharged to the environment, and how the applicant intends to monitor the discharge quantity.*

The quantity of wastewater that has been discharged to land at Byreburn Farm over the previous 3 years is accounted for in Section 5.3.2 above, and in Appendix B. The overall median daily flow of MWE during the 2007-08, 2008-09 and 2009-10 years was 1,030 m^3/day. Lower quartile flows were 1,100 m^3/day in 2007-08, 945 m^3/day in 2008-09, and 717 m^3/day in 2009-10. The maximum flow during this time was 1,900 m^3/day, within the consented limit of 2,000 m^3/day. The discharge quantity is metered.

The quantity of MWE that is to be discharged under this present application is described in Table 8 in Section 5.4.3.1 above. An annual volume of up to 225,000 m^3 is proposed to be discharged.

c. *Constituents of the discharge, including likely amounts or proportions of the constituents, and how the applicant intends to monitor the discharge quality.*

The constituents of the discharge are described in Table 2 in Section 5.1.1 above. Quality is monitored for the land discharge of wastewater as described in Section 10 above, and this will fairly reflect the quality of what is irrigated onto the land.

d. *An identification of those persons, including tangata whenua, interested in or affected by the proposal, and a statement as to the consultation undertaken (if any), the consultation undertaken, and any response to the views of those consulted.*

Because the effects of the land application of MWE are not greater than minor, there has been no consultation on the proposal, and no persons beyond the applicant and the regulatory authority are considered to be interested in, or affected by, the proposal.

e. *An assessment of the actual or potential effects on the environment (including the sensitivity of the environment and effects on instream, recreational and cultural values) that would be caused by the proposed activity.*

The AEE is provided in Section 8 above. Effects on instream, recreational and cultural values are considered to be less than minor.

f. *A description of mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce any actual or potential effects.*

Mitigation measures are described in Section 9 above. The focus is on operating the irrigation in such a way as to minimise surface ponding, run-off, or through-flow of wastewater, and to ensure that nutrients are utilised in the soil rather than discharged into the wider environment.

g. *Possible alternative methods of disposal of the contaminants, or water, to be discharged that were considered and rejected by the applicant".*

Alternatives are addressed in Section 6 above. The two options of no discharge and direct discharge to the Oroua River have been considered and rejected. The land application options relate to the size of the application area and aspects of the rate of application. The method of discharge selected is that which best meets the requirements of Byreburn Farm, AFFCO, and required environmental outcomes.

Notwithstanding that the activity of the discharge of MWE to land on Byreburn Farm clearly qualifies for consideration as a discretionary activity under MCWQP, it is shown above that the effects of the activity meet the plan's objective and policy requirements.

11.4.3 Land and Water Regional Plan (LWRP)

This plan addresses groundwater management more directly than the MCWQP. Its objectives in respect of the irrigation of MWE onto land at Byreburn Farm are considered as follows.

"DL Objective 1: Improving groundwater quality
To maintain groundwater quality in the Region, and to improve groundwater quality where it is locally degraded".

Groundwater quality in the vicinity of Byreburn Farm will be maintained by operating the irrigation in such a way as to minimise surface ponding, run-off, or through-flow of wastewater, to ensure that nutrients are utilised in the soil rather than discharged into the wider environment.

"DL Objective 2: Improving groundwater quality
To reduce microbial contamination and nutrient leachate into groundwater".

Microbial contamination and nutrient leachate will be minimised by operating the irrigation in such a way as to minimise surface ponding, run-off, or through-flow of wastewater, to ensure that nutrients are utilised in the soil rather than discharged into the wider environment.

The Policies of the LWRP in respect of irrigation of MWE to land on Byreburn Farm are considered as follows;

"DL Policy 1: Use of regional rules".

This policy addresses the manner in which rules are to be made and applied, and is not directly relevant to the information to be provided with this application.

"DL Policy 2: Matters to be considered for resource consent applications.
The Council will have particular regard to the following matters when considering resource consent applications for discharges of contaminants onto or into land:
a. the effects of the discharge on:
i. groundwater quality and groundwater uses nearby, in particular any use for water supply";

The effect of the discharge on groundwater quality is directly assessed in Section 8.4.2 above, and is shown to be not greater than minor. The two nearest groundwater abstractions are by AMP and by St Dominic's.

The St Dominic's property between AMP and SH 54 draws its domestic water supply from a bore on site, some 300 m down gradient from the nearest irrigated paddocks on Byreburn Farm. Before its present deployment, the facility was a residential school for the deaf. Over the 20 years that the facility and the irrigation of MWE on Byreburn Farm have co-existed, no groundwater quality issue at St Dominic's that might be attributed to MWE irrigation has been noted.

AMP draws up to 4,800 m^3/day of groundwater from a bore situated some 600 m from the nearest irrigated area. While this abstracted groundwater is not put to potable use, no water quality issue that might be attributed to MWE irrigation has been noted.

"ii. river water quality, in particular effects on rivers with existing high water quality and positive effects resulting from the cessation of existing discharges to water;"

The Oroua River lies 60 m from the closest encroachment of the application area, although most of the application area is more than 250 m distant from the river, and some lies up to 1 km distant from the river. (See Figure 2 in Appendix A). There is no evidence of any adverse effect on the river that can be attributed to the MWE irrigation.

"iii. any possible alternative receiving environment;"

The alternative receiving environments are the Oroua River, or other areas of land. The proposed area of land is preferred because of the current arrangements and existing infrastructure, as well as its immediate proximity to AMP and the source of the MWE.

"iv. lake and wetland water quality, in particular the contribution of the discharge to nutrient and sediment levels in lakes or wetlands by overland runoff or by groundwater flows to the lake or wetland;"

There are no lakes or wetlands near enough to Byreburn Farm to be influenced by the MWE irrigation activity.

" v. soil quality;"

The quality of the soil at the application site is to be protected from saturation and consequent pugging by the adoption of an irrigation regime described in Section 5.4.3 above. The application of water and nutrients as proposed is expected to provide a benefit to the soil's productive capability.

"vi. air quality, in particular adverse effects from the intrusion of odour and visual contaminants;"

There is not expected to be any significant intrusion of odour arising from the MWE irrigation on Byreburn Farm. Any odour is not expected to be offensive or objectionable beyond the property boundary. Visual contamination is not expected, as the wastewater application will in most respects resemble irrigation using fresh, clear water.

" vii. human health and amenity values;"

Human health issues could arise from pathogens in the MWE infecting members of the public or Byreburn Farm's personnel, either by the ingestion of spray drift or by the contamination of groundwater. Appropriate exclusion margins between the application areas and public roads or neighbouring properties are expected to continue to protect the public, as they have done for the last 20 years. The low application rate on highly productive farm soils is expected to minimise the risk of pathogens surviving beyond the top few millimetres of soil.

Amenity values in and associated with the Oroua River are protected by the irrigated MWE being applied to land rather than to the river, and are further protected by the attenuation of nutrients in the MWE by the soil. The rural amenity of the area will continue to be enhanced by the fresh, green productivity of the irrigated paddocks.

"viii. any significant indigenous vegetation and significant habitats of indigenous fauna;"

There is no significant indigenous vegetation or significant habitat of indigenous fauna in the vicinity of Byreburn Farm. The Oroua River provides a habitat for indigenous fish and invertebrate species, but the extent of groundwater contamination arising from the MWE irrigation (see Section 8.4.2 above) and leading to contamination of river water (see Section 8.4.3 above) is not expected to have any impact on the value of that habitat.

ix. any specified value associated with any feature of regional significance identified in the Regional Policy Statement for Manawatu-Wanganui;"

Irrigation of MWE onto land at Byreburn Farm not considered to have any adverse effect on either values or features, whether identified in the RPS or otherwise.

" b. the location of the proposed discharge in relation to any sensitive receiving environment or potentially incompatible land uses, in particular any neighbouring houses, schools, churches, marae, public areas, wetlands, lakes, springs, streams, the coastal marine area, or known areas of recharge to groundwater aquifers;"

These issues are mostly addressed in Section 11.4.1 (c) above. The only potentially sensitive environment in the vicinity of the MWE irrigation area on Byreburn Farm is the Oroua River, which is nowhere closer than 60 m from the irrigation area.

"c. the nature of the discharge with regard to tangata whenua concerns, and the effect of the discharge on mahinga kai, waahi tapu, marae and other resources or places of significance to tangata whenua;"

The discharge is not directly into the Oroua River, and its effect on tangata whenua values is accordingly considered to be not greater than minor.

"d. the proposed hydraulic loading, nutrient loading and biochemical oxygen demand loading, and the cumulative effect of these application rates with other discharges;"

The proposed hydraulic loading rate of up to 34 mm/application event, and up to 250 mm/year, and the parameter loadings as described in Table 8 in Section 5.4.3.1 above may be considered to have an insignificant cumulative effect with other discharges.

"e. the types and persistence of contaminants in the discharge;"

The contaminants in the discharge are detailed in Table 2 in Section 5.3.1 above.

" f. soil types between the ground surface and groundwater;"

The soil type between the ground surface and groundwater is described in Section 4.7 above, and in closer detail in Appendix H.

"g. existing groundwater quality, particularly levels of nitrate and microbial contamination;"

Existing groundwater quality is reported in Appendix H, which details the results of ongoing monitoring of the quality of shallow groundwater in the irrigation area on Byreburn Farm.

" h. contingency measures available, such as storage ponds, to avoid the need to discharge during wet or windy periods;"

The MWE for irrigation on Byreburn Farm is drawn from storage ponds at AMP, and is only applied when soil moisture and climatic conditions are suitable.

" i. the proposed times and seasons of application, including method and rate of application;"

The irrigation is undertaken during late spring, summer, and early autumn each year, varying according to seasonal climate variations. It is proposed that the irrigation continue to be authorised for up to 24 hours per day. The method and rate of application are described in Section 5.4 above.

" j. any relevant guidelines or standards, in particular the Public Health Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land;"

The discharge is of MWE, and not of sewage effluent or sewage sludge.

" k. the outcome of consultation between the applicant and affected parties;"

Because of the assessment of minor environmental effect, it is considered that there are no affected parties, and accordingly there has been no consultation beyond the applicant and the consent authority.

" l. the social and economic well being and the health and safety of people and communities;"

The operation of AMP provides employment for up to 330 people in the vicinity of Feilding, and provides a market for beef cattle producers from a wide area of the lower North Island. The health and safety of people and communities are protected by the low application rates, and the effective prevention of direct access of the MWE to the waters of the Oroua River.

"m. any relevant code of practice and any management and maintenance systems".

There is no code of practice as such, although it is considered that the irrigation system to be used represents industry best practice.

"DL Policy 3: Restrictions on nitrogen loadings from wastewater discharges.

To ensure that the loading of nitrogen in discharges of wastewater to grazed pasture do not exceed 150 kg N/hectare in any 12 month period and do not exceed 50 kg N/hectare in any 24 hour period unless it can be demonstrated that:

a. greater amounts of nitrogen can be removed by crop management; or

b. groundwater is protected by overlying soils of low permeability; or

c. nitrogen will be removed by enhanced denitrification or by denitrification systems constructed and maintained for that purpose; or

d. groundwater would not be rendered unsuitable for domestic, stock, or industrial use; or

e. affected groundwater could not later contaminate any surface water body and result in any of the effects described in Section 107 of the Act".

The discharge involved in this application is of meat works effluent to grazed pasture, with a nitrogen loading not exceeding 310 kg N/ha/yr, and 42 kg N/ha/application event. Overseer modelling demonstrates that this application regime results in nitrogen leaching to groundwater at rates well within the range of those achieved by normal farming systems. As shown in Section 8.4.2.3 above and Appendix G, a nitrogen leaching rate of the order of 16 kg N/ha/yr is modelled. The groundwater is protected by overlying soils of low permeability. Nitrogen is removed from the wastewater in the soil, and nearby groundwater has been shown not to be unsuitable for both domestic and industrial use. Only an insignificant contribution of contaminants is considered to be made to the flow of the Oroua River, and this is not known to have led to any oil or grease films, scums, foams, floatable or suspended materials, change in colour or clarity, odour, or other s107 effects.

The Rule in LWRP that addresses pond seepage at AMP is as follows:

"DL Rule 13: Discharge of industrial wastewater, sewage or sewage effluent.
13.1 Except as provided for in DL Rule 6, any discharge onto or into land of…wastewater from… meat processing plants…is a ***Discretionary Activity".***

Notwithstanding that the activity of land application of MWE clearly qualifies for consideration as a discretionary activity under this rule of LWRP, it is shown above that the effects of the activity meet the plan's objective and policy requirements.

11.5 Manawatu District Plan

The planned activity will take place within the Rural 1 and 2 Zones under this plan. The plan does not make specific provision for, and nor does it exclude, the discharge of wastewater to land by irrigation. Its only pertinent rules is 3.3.1I (see Table 22, Section 7.5.1 above), which requires that;

"*Adequate provision shall be made for disposal of any solid or liquid effluent (including effluent ponds if necessary), and for the hygienic storage of waste matter."*

It is shown that adequate provision has been made for the discharge of MWE to land on Byreburn Farm; the activity may therefore be regarded as a permitted activity under this plan, with no requirement for a resource consent from the Manawatu District Council.

11.6 Summary of Evaluation of Effects against Statutory Provisions

The requirements of the Resource Management Act, National Policy Statements, National Environmental Standards, the Regional Policy Statement, and the operative Manawatu District Plan are shown to be met by the proposal, without a requirement for specific consenting under those provisions.

The proposed activity has been evaluated against the provisions of the three regional plans with a bearing on the activity. Each plan makes it clear that the activity is a discretionary activity, but the evaluation of the activity's effects against the objectives and policies of the plans show that the requirements specified are met.

12.0 PROPOSED CONDITIONS

1. This consent authorises the discharge of up to 225,000 cubic metres per year of treated meat works effluent on to 90 hectares of land on Aorangi Road, Feilding, at or about map reference NZMG 2370520E – 6105365N shown on Figure 2 attached to and forming part of this consent for a term expiring on **14 May 2036.**

2. Charges, set in accordance with Section 36(1)c of the Resource Management Act 1991, and Section 690 A of the Local Government Act 1974, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring and supervision of this resource consent and for the carrying out of its functions under Section 35 (duty to gather information, monitor, and keep records) of the Act.

   [Note: Section 36(1)c of the Act provides that Council may from time to time fix charges payable by holders of resource consents. The procedure for setting administrative charges is governed by Section 36(2) of the Act and is currently carried out as part of the formulation of the Council's Annual Plan.]

3. Rates of application of meat works effluent to land are not to exceed 34 mm per irrigation event, or 250 mm per year, irrespective of the actual area irrigated in any given year.

4. The Consent Holder shall carry out the following monitoring program;

   a. i. The keeping of an Irrigation Register in which the following shall be recorded:

      (a) the date when irrigation occurs and the times at which irrigation starts and ends each day.

      (b) the spray irrigation locations used including spray area and spray block number, and the quantity of effluent applied to each spray block.

      (c) the weather conditions and wind conditions during times of irrigation.

      ii. A copy of the irrigation register shall be sent to the Regional Council's Resource Monitoring Manager by the end of September each year.

   b. i. The Consent Holder shall undertake the following Effluent Monitoring program:

      (a) During the periods of land application, the effluent shall be sampled on a monthly basis and tested for the following parameters:

      BOD_5, Suspended Solids, TKN, $N0_3$ and $N0_2$, Calcium, Sodium, Phosphorus, Potassium and Magnesium.

      i. The results of the sample analyses are to be sent to the Regional Council's Resource Monitoring Manager by the end of September each year.

   c. i. The Consent Holder shall undertake the following Groundwater Monitoring program:

(a) Bore water shall be collected from one control and at least 3 shallow groundwater bores on the same day as effluent samples are taken, and tested for the following parameters:

- BOD_5, Suspended Solids, TKN, $N0_3$ and $N0_2$, Calcium, Sodium, Phosphorus, Potassium and Magnesium.

iii. The results of the sample analyses and the calculations are to be sent to the Regional Council's Resource Monitoring Manager by the end of September each year.

d. i. The Consent Holder shall undertake the following Soil Monitoring programme:

(a) The Consent Holder shall take soil samples from three sampling sites located in each of the effluent discharge areas during the month of November each year. A sample shall be taken from 10 and 20 cm depths at each site and from a similar location each year.

(b) The samples shall be analysed for:

- pH; Calcium; Phosphorus; Potassium; Sulphur Sulphate; Magnesium; Sodium; and Nitrogen.

(c) Soil infiltration capacities and organic matter content at the sites referred to in Condition 4(d)(i)(a) shall be measured.

ii. The results of the above analyses shall be sent to the Regional Council's Resource Monitoring Manager by the end of September each year.

5. The maximum nitrogen application rate shall not exceed 400 kg per hectare per year.

6. Each irrigation block shall receive no more than 35 mm applied in 7 days, and shall not be grazed for a period of 7 days following cessation of irrigation.

7. The discharge shall cease or the rate of application shall be reduced when necessary to ensure compliance with other consent conditions.

8. No irrigation shall occur during periods of heavy rainfall or where excessive surface ponding or runoff is occurring.

9. Irrigation shall not take place within 20 metres of any natural waterway, dwelling, property boundary or public road.

10. Vehicular and animal traffic on the irrigation areas shall be minimised when the pasture is wet in order to reduce soil compaction.

11. The Manawatu-Wanganui Regional Council may serve notice of a review of the conditions of this consent in April 2016 and/or April 2021. These reviews may be necessary to:

a. assess the adequacy of the monitoring programmes provided for in Condition 4 of this consent; and

b. assess the effectiveness of Conditions 5, 6 and 7 of this consent, in avoiding, remedying or mitigating any adverse effects on the soil and groundwater.

The review of conditions shall allow for the:

c. modification of the monitoring programme provided for in Condition 4 of this consent; and

d. deletion or amendment of Conditions 5, 6 and 7 of this consent; and addition of new conditions as necessary, to avoid, remedy or mitigate any adverse effects on the soil and groundwater.

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13.0 CONSULTATION

There has been no consultation in respect of this application, because it is considered that the lack of contaminants in the discharge to land, and the lack of significant adverse effect beyond the land, mean that there are no affected or interested parties beyond AFFCO, Byreburn Farm, and the consent authority.

14.0 CONCLUSIONS

The data gathered as a result of the monitoring required by current consent number 4226 has enabled an objective evaluation of both the effects of, and appropriate limits on, the irrigation of meat works effluent from AFFCO Manawatu's Feilding export meat processing plant onto land at the adjacent Byreburn Farm. A new irrigation regime is proposed that will take more of AFFCO's effluent than previously, and apply it to a larger area of land.

The requirements of the Resource Management Act and the Regional Policy Statement are met, and the activity complies with the Permitted Activity standards and objective and policy requirements of the operative Manawatu District Plan.

The activity has been assessed according to the One Plan Decisions Version, the Manawatu Catchment Water Quality Plan, and the Land and Water Regional Plan. While the activity qualifies as a Discretionary Activity under all three plans, the objectives, policies and rules are all able to be met by the application of appropriate conditions on a consent for the proposed activity.

This Assessment of Environmental Effects concludes that there are no adverse environmental effects from the proposed discharge of meat works effluent to land on Byreburn Farm that cannot be avoided, remedied or mitigated, and whose effects are greater than minor. It is therefore concluded that the resource consent under application here may safely be granted.

15.0 REFERENCES

Crane, S.R. and Moore, J.A. (1984): *Bacterial Population of Groundwater: A Review.* Water Air & Soil Pollution, Vol 22 No1, Springer, Netherlands.

Crites and Tchobanoglous (1998). *'Small and Decentralized Wastewater Management Systems.'* McGraw-Hill, New York.

Horizons 1997: *Oroua Catchment Water Allocation and River Flows Regional Plan*, Change 1, May 1997.

Horizons Regional Council. 2008. *Groundwater Resources in the Manawatu–Wanganui Region, Technical Report to Support Policy Development*. Report No: 2008/EXT/948.

Gunn, I. (1997): *On-site wastewater and bacterial reduction in subsoil disposal areas – a review*. On-site NewZ Special Report – 97/2 a CaRE for the environment project.

Kingma, J.T. 1962. *Geological Map of New Zealand*. 1:250,000. Sheet 11 - Dannevirke. New Zealand Geological Survey. Department of Scientific and Industrial Research, Wellington.

Laurenson, J.N.S, Bolan, N.S., Cartwright, G., Wheeler, D.M., and Redding, M.R. (2006): *The transformation and loss of major nutrients following the application of piggery effluent,* submitted for: The New Zealand Sustainable Farming Fund.

Longhurst, B., Mercer, G. 2009. FARM Strategy – Farm 3: Intensive dairy – Feilding. AgResearch. New Zealand. Report prepared for Horizons Regional Council.

NZLTC (2000): *New Zealand Guidelines for Utilisation of Sewage Effluent on Land.* New Zealand Land Treatment Collective and Forest Research. Rotorua, New Zealand. 180 pp.

Webb, T., Hewitt, A., Lilburne, L., McLeod, M. and Close, M. 2010. *Mapping of vulnerability of nitrate and phosphorus leaching, microbial bypass flow, and soil runoff potential for two areas of Canterbury*. Environment Canterbury Report R10/125.

Beare, M., White, S., Wilson, D. *Managing winter forage crops sustainably*. Crop and Food Research, Private Bag 4704, Christchurch

Fertiliser and Lime Research Centre (FLRC). 2009. *Sustainable nutrient management in New Zealand Agriculture*. Course Notes, 2009.

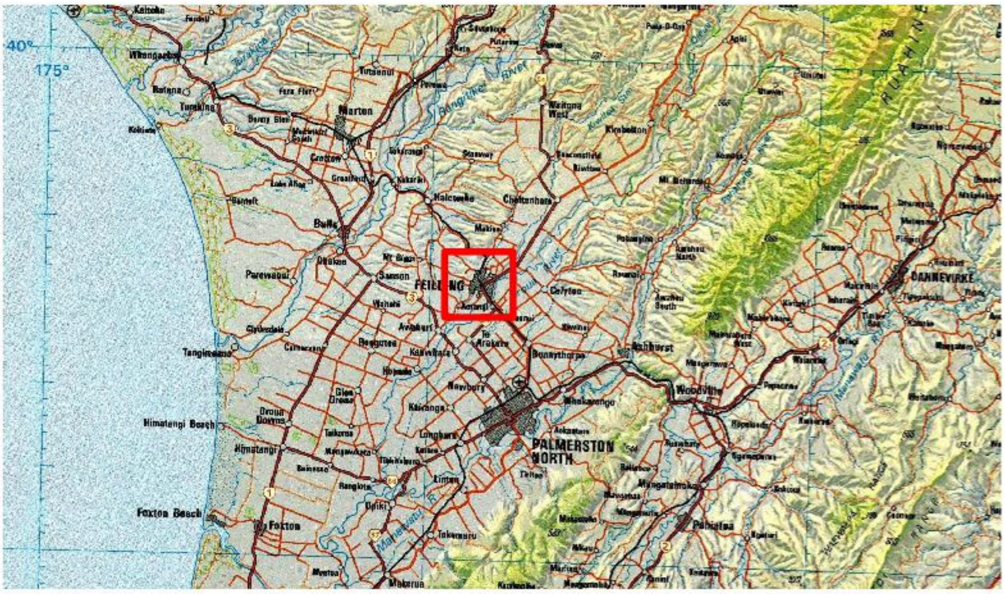
HortResearch. 1995. *Fertiliser Recommendations for Horticultural Crops – Nutrient Requirements and Specific Deficiency Symptoms of Vegetable Species*. http://www.hortnet.co.nz/publications/guides/fertmanual/vege2.htm

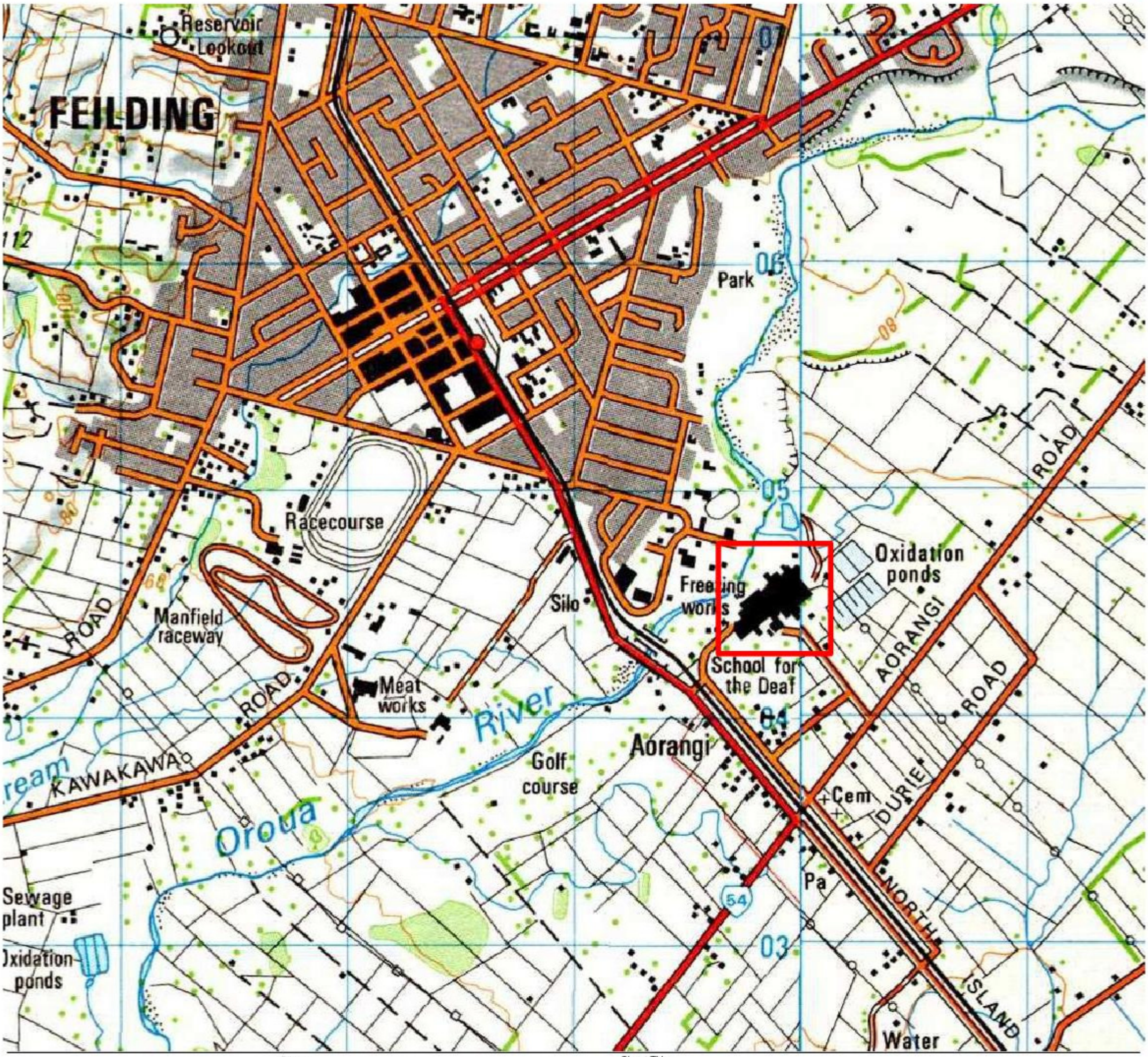
Morton, J., O'Connor, M., Carnus, J. M. and Wang, H. *Crop Selection and Management, Chapter Six in New Zealand Guidelines for Utilisation of Sewage Effluent on Land. Part 2: Issues for Design and Management.* (Edited by L.J. Whitehouse, H.Wang and M. Tomer). Pp. 120. Joint publication of the New Zealand Land Treatment Collective and Forest Research. Rotorua, New Zealand.

Williams, P. H., and Haynes, R. J. 1990. *Influence of improved pastures and grazing animals on nutrient cycling within New Zealand Soils*. New Zealand Journal of Ecology. 14:49-57.

APPENDIX A

Figures





Revision	By	Date
Designed		
Approved		

Client
AFFCO New Zealand Ltd
Manawatu

MAP Ref 303275 Sheet Fig1 Rev A
Scale (A4 Original) Not to Scale

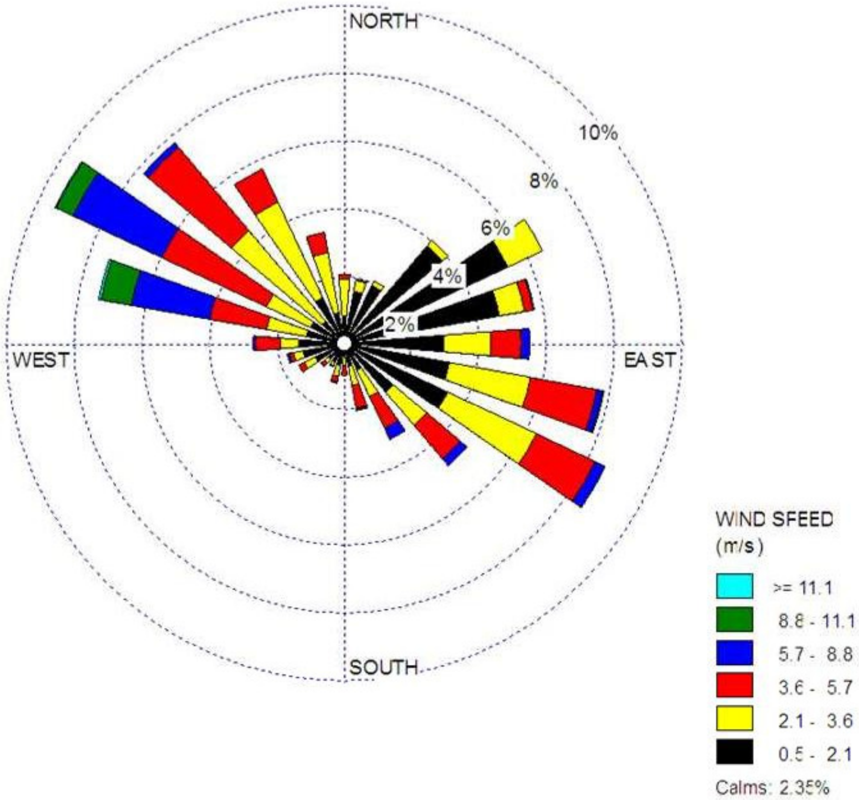
Sheet Title
Figure 1
Location Map

Project Title
Consents Application

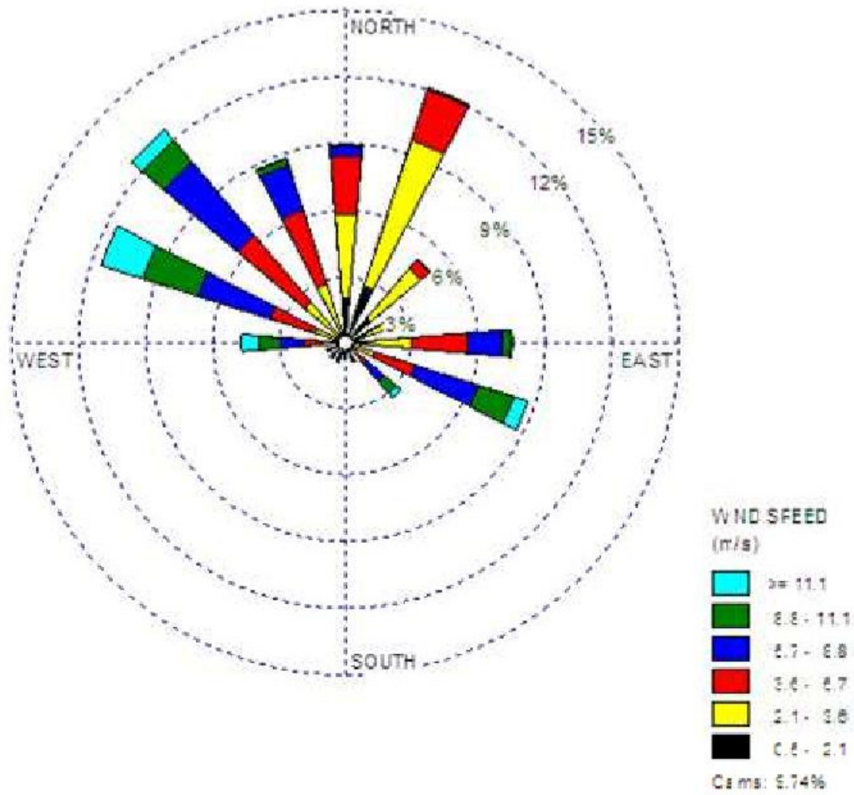
CPG New Zealand Ltd
Level 3, Rangitikei House
89-93 Rangitikei Street
PO Box 562
Palmerston North
Phone 06 354 4501
Fax 06 354 4516

CPG Land Application Appendix A

Figure 2 303275-176A Current and Potential Irrigation Areas is no longer accessible



Wind rose derived from Palmerston North Airport

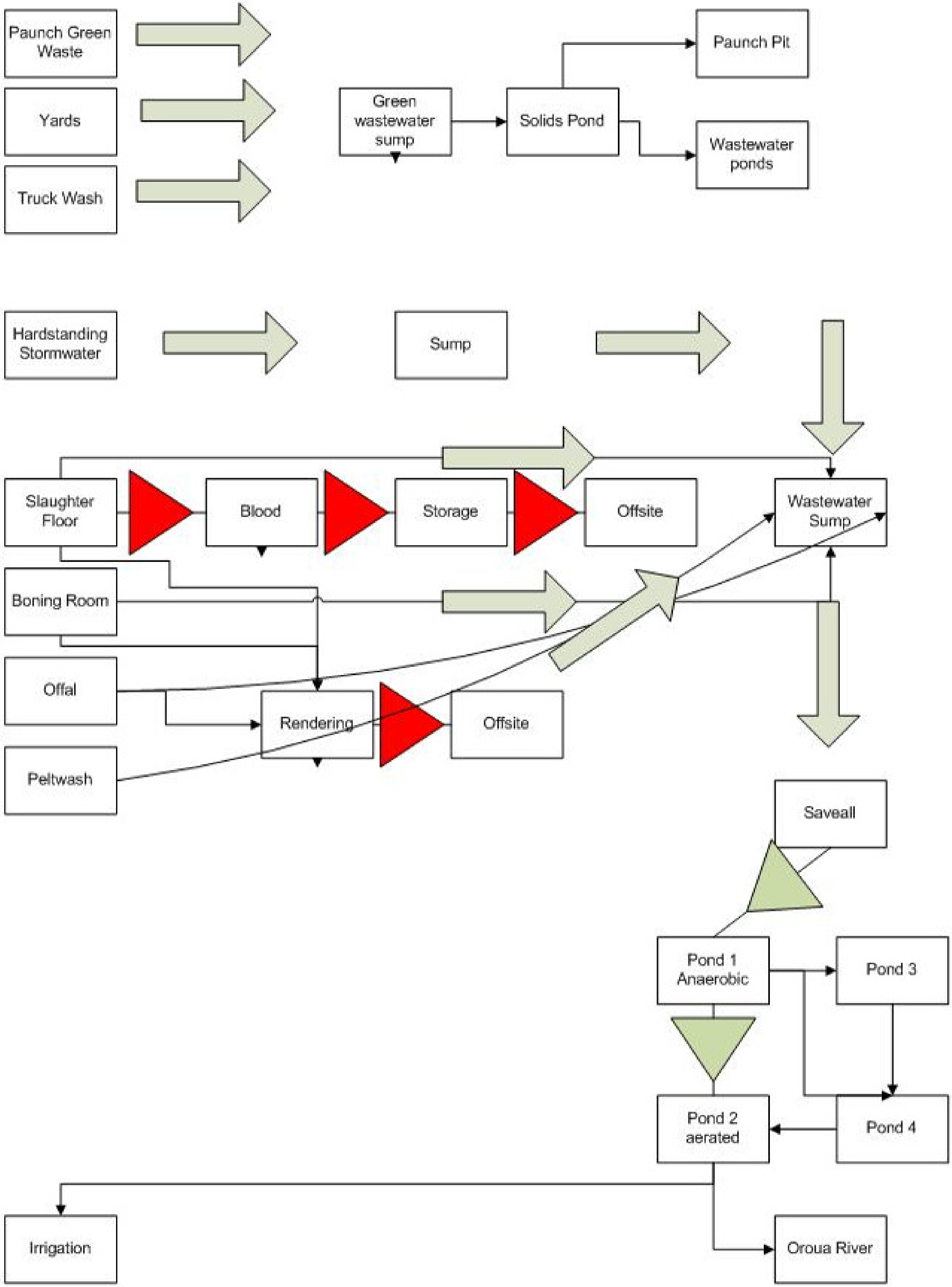


Wind rose derived from Ohakea Aerodrome

Date: July 2010	**Figure 3: Prevailing Winds around Campbell Road Application Area (Palmerston North and Ohakea Data)**
Drawing No: Fig3 Sheet No. of Sheets	

89-93 Rangitikei St, PO Box 562
Palmerston North 4440, New Zealand
Ph (06) 354-4501 Fax (06)354-4516
Email:palmerstonnorth@nz.cpg-global.com

CPG



Date: January 2011

Drawing No: Fig4

Figure 4
Schematic Wastewater Cycle

CPG
89-93 Rangitikei St, PO Box 582
Palmerston North 4440, New Zealand

Date: January 2011

Drawing No: Fig5

Figure 5: Irrigation Zone IDs @ January 2011

89-93 Rangitikei St, PO Box 562
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Ph (06) 354-4501 Fax (06)354-4516
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CPG

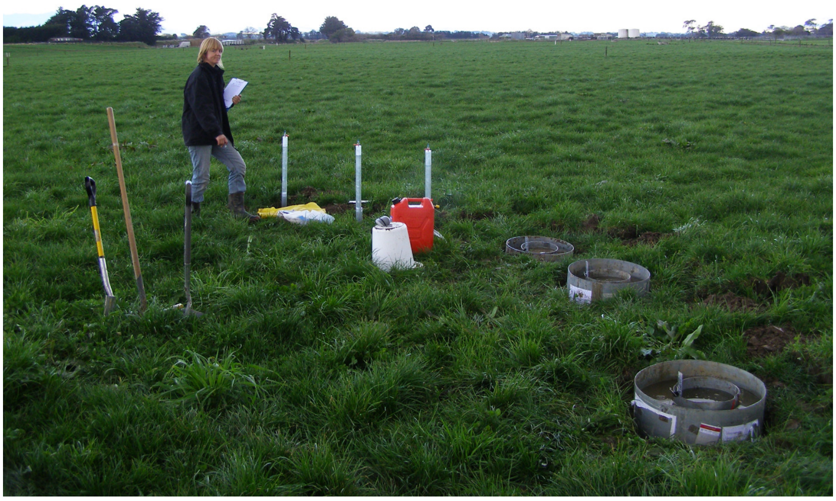
Appendix C
Site Photos

Looking South Across Soil Site 3, Irrigation Block 8, Paddock 51

Looking North-East, Irrigation Block 3, Paddock 33

Looking South-South-West Across Irrigation Block 30, Paddock 23

Soil Hydraulic Testing, Irrigation Block 30, Paddock 23



Irrigator Used On Kairanga And Manawatu Soils

Irrigator Used On Rangitikei Soils

Looking Along Aorangi Road From Near Monitoring Bore 1

Looking West From Near Bore 1 To Paddocks 15-17

Monitoring Bore 1

6w1. Source Of Stream And Location of 6m Deep Byreburn Bore.

Typical Example Of Pugging Near Gates Into Dairy Races

Location Of Monitoring Bore 2

Looking West Across Paddocks 53 And 54 Towards Old Levee

Looking North-West Towards Levee In Paddock 51

Relict Channel On Lower Terrace – 8w2

Looking North-West Along Paddock 61: Gravelly Rangitikei Soils

Looking East Into Paddock 63: Rangitikei Soils

Bore 3 In Paddock 63 Adjacent To (North-East of) The Oroua River

Appendix D
Horizons Regional Council
Resource Consent 4226

6.7 **The Hearing Committee pursuant to delegated authority under Section 34 of the Act, resolved to grant, pursuant to Section 105, Discharge Permit 4226 to Manawatu Beef Packers Limited, subject to the following conditions:**

1 This consent authorises the discharge of up to 2000 cubic metres per day of treated effluent on to no less than 75 hectares of land on Aorangi Road, Feilding, at or about map reference S2-1-304-051 shown on Plan C4226 attached to and forming part of this consent for a term expiring on **14 May 2011.**

2. Charges, set in accordance with Section 36(1)c of the Resource Management Act 1991, and Section 690 A of the Local Government Act 1974, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring and supervision of this resource consent and for the carrying out of its functions under Section 35 (duty to gather information, monitor, and keep records) of the Act.

[Note: Section 36(1)c of the Act provides that Council may from time to time fix charges payable by holders of resource consents. The procedure for setting administrative charges is governed by Section 36(2) of the Act and is currently carried out as part of the formulation of the Council's Annual Plan.]

3. Prior to any irrigation commencing the Consent Holder shall forward to the Regional Council's Resource Monitoring Manager, a map of the irrigation area showing:

a. The general soil types mapped at 1:5,000.

b. The total water holding capacity (TWHC) for each of the main soil types in the area.

4. The Consent Holder shall carry out the following self-monitoring programme.

a. i. The keeping of an Irrigation Register in which the following shall be recorded:

(a) the date when irrigation occurs and the times at which irrigation starts and ends each day.

(b) the spray irrigation locations used including spray area and spray block number, and the quantity of effluent applied to each spray block.

(c) the weather conditions and wind conditions during times of irrigation.

(d) any changes in pasture conditions - proportion and species of weeds compared to the proportion of clover.

(e) any farming activity of relevance taking place on pasture areas being irrigated.

ii. A copy of the irrigation register shall be sent to the Regional Council's Resource Monitoring Manager monthly within 10 days of the end of each months irrigation.

b. i. The Consent Holder shall undertake the following effluent and bore (one control and at least 3 shallow groundwater bores) monitoring programme:

(a) During the periods of land application, the effluent shall be sampled on a monthly basis and tested for the following parameters: BOD5, Suspended Solids, TKN, N03 and N02, Calcium, Sodium, Phosphorous, Potassium and Magnesium.

(b) Borewater shall be collected on the same day as effluent samples are taken, and tested for the following parameters: BOD5, Suspended Solids, TKN, N03 and N02, Calcium, Sodium, Phosphorous, Potassium and Magnesium.

(c) Sodium absorption ratio, and cation exchange capacity shall be calculated.

ii. The position of the monitoring sites shall be determined in consultation with the Regional Council's Resource Monitoring Manager.

iii. The results of the testing and the calculations are to be sent to the Regional Council's Resource Monitoring Manager within two weeks of the testing.

C. i. The Consent Holder shall undertake the following effluent soil monitoring programme:

(a) The Consent Holder shall take soil samples from three sampling sites located in each of the effluent disposal areas during the month of November each year. A sample shall be taken from 10 and 20cm depths at each site and from a similar location each year.

(b) The samples shall be analysed for:

pH; Calcium; Phosphorous; Potassium; Sulphur Sulphate; Magnesium; Sodium; and Nitrogen.

(c) Soil infiltration capacities and organic matter content at the sites referred to in Condition 4(c)(i)(a) shall be measured.

ii. The results of the above analyses shall be sent to the Regional Council's Resource Monitoring Manager within two weeks of completion of these analyses.

5. The maximum nitrogen application rate shall not exceed 400 kg per hectare per year.

6. Each pasture block in the existing disposal area shall consist of an area of pasture approximately 400m long x 80m wide. Each block shall receive one day's effluent and then be rested for a period of at least 7 days during which time the block shall not receive any more effluent, nor be grazed.

7. Hydraulic application on each spray block shall be limited to a maximum rate of 100 cubic metres per hour, for 24 hours per day. Nevertheless, the discharge shall cease or the volume be reduced when necessary to ensure compliance with other consent conditions.

No irrigation shall occur during periods of heavy rainfall or where excessive surface ponding or runoff is occurring.

9. Irrigation shall not take place within 20 metres of any natural waterway, dwelling, property boundary or public road.

10. Vehicular and animal traffic on the irrigation areas shall be minimised when the pasture is wet in order to reduce soil compaction.

11. The Manawatu-Wanganui Regional Council may serve notice of a review of the conditions of this consent in April 2001 and, or April 2006. These reviews may be necessary to:

    a. assess the adequacy of the monitoring programmes provided for in Condition 4 of this consent; and

    b. assess the effectiveness of Conditions 5, 6 and 7 of this consent, in avoiding, remedying or mitigating any adverse effects on the soil and groundwater. The review of conditions shall allow for the:

    c. modification of the monitoring programme provided for in Conditions 14 of this consent; and

    d. deletion or amendment of Conditions 5, 6 and 7 of this consent; and

    e. addition of new conditions as necessary,

to avoid, remedy or mitigate any adverse effects on the soil and groundwater.

6.8 The Hearing Committee pursuant to delegated authority under Section 34 of the Act, resolved to grant, pursuant to Section 105, Discharge Permit 6191 to Manawatu Beef Packers Limited, subject to the following conditions:

1. This consent authorises the discharge into ground by seepage of effluent from the anaerobic, aerobic and solids ponds on the Manawatu Beef Packers Limited Campbell Road, Feilding site for a term expiring on **14 May 2011.**

2. Charges, set in accordance with Section 36(1)c of the Resource Management Act 1991, and Section 690 A of the Local Government Act 1974, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring

and supervision of this resource consent and for the carrying out of its functions under Section 35 (duty to gather information, monitor, and keep records) of the Act.

[Note: Section 36(1)c of the Act provides that Council may from time to time fix charges payable by holders of resource consents. The procedure for setting administrative charges is governed by Section 36(2) of the Act and is currently carried out as part of the formulation of the Council's Annual Plan.]

6.9 The Hearing Committee pursuant to delegated authority under Section 34 of the Act, resolved to grant, pursuant to Section 105, Discharge Permit 4224 to Manawatu Beef Packers Limited, subject to the following conditions:

1. This Consent authorises the discharge of extended aeration treatment plant effluent into subsurface trenches at a rate not more than 35nim per day on the Manawatu Beef Packers Limited Campbell Road, Feilding site at approximate map reference T23:302-045 for a period expiring on **14 May 2011.**

2. Charges, set in accordance with Section 36(1)c of the Resource Management Act 1991, and Section 690 A of the Local Government Act 1974, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring and supervision of this resource consent and for the carrying out of its functions under Section 35 (duty to gather information, monitor, and keep records) of the Act.

   [Note: Section 336(1)c of the Act provides that Council may from time to time fix charges payable by holders of resource consents. The procedure for setting administrative charges is governed by Section 36(2) of the Act and is currently carried out as part of the formulation of the Council's Annual Plan.]

3. The Consent Holder shall not allow stormwater into the system and shall make adequate provision to direct stormwater runoff away from the disposal area.

4. The bottom of the trenches shall be no deeper than 400 mm below the ground surface, no wider than 500 mm and spaced at no closer than 2 metre centres. The trenches shall be lined with washed gravel and the top of the trenches lined with filter fabric.

5. The Consent Holder shall ensure effluent is pressure distributed to provide even application throughout the soakage area.

6. The disposal field shall be installed on-site as described on the site plan C4224 attached to and forming part of this consent.

7. The Consent Holder shall make available a reserve disposal area of equivalent size on-site, as shown on the site plan C4224 attached to and forming part of this consent.

8. The Consent Holder shall ensure that all parts of the disposal area are more than 3 metres from any property boundary.

9. There shall be no surface ponding of effluent.

6.10 The Hearing Committee, pursuant to delegated authority under Section 34 of the Act resolved the Consent Holder shall pay to the Regional Council costs of 56373.13.

CR B C BEETRAM, QSO
<u>COMMITEE CHAIRMAN</u>

Appendix E
Irrigation Register

Irrigation Register

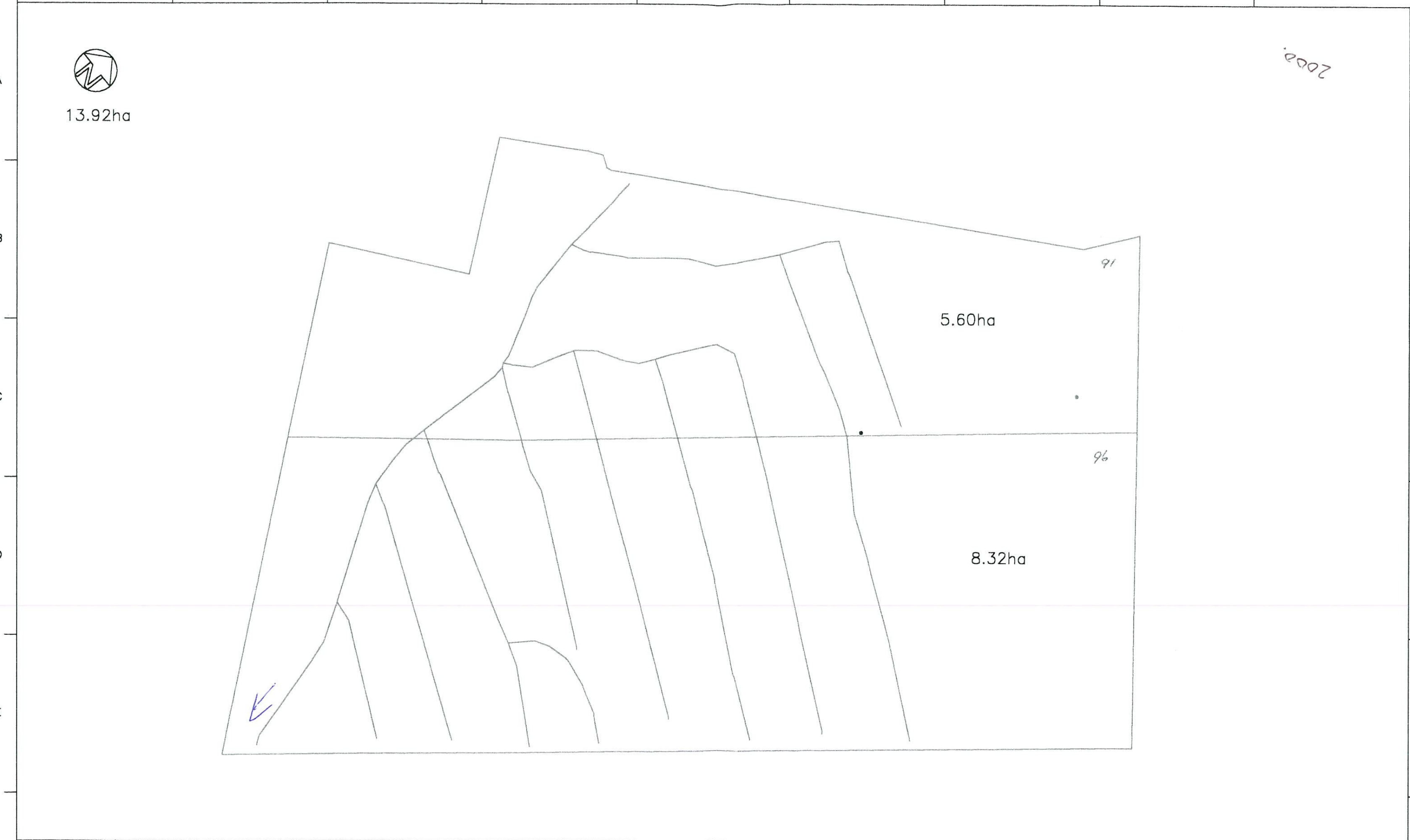
Irrigation Turned on:		Irrigation Turned off:		Block No	% Area Sprayed	Weather & Wind Conditions	Last Grazed
Date	Time	Date	Time				

Consent Conditions:-

Irrigation for each block limited to 24 hours per day.
After receiving one days effluent, block must not be grazed for 7 days and no effluent added applied during this period.
DO NOT irrigate during period of heavy rainfall or where excessive surface ponding or runoff is occurring.
DO NOT irrigate within 20m of any natural waterway, dwelling, property, boundary or public road.

Appendix F
Map Of Subsurface Drains On Byreburn Farm

Byreburn Farm



IPLEX Pipelines

IPLEX PIPELINES NZ LIMITED
67 MALDEN STREET
PRIVATE BAG 11019
PALMERSTON NORTH
NEW ZEALAND
TELEPHONE: (06) 358 2004
FACSIMILE: (06) 356 2906

LEGEND

- • WATER TROUGH
- FENCE LINE
- HYDRANTS
- IPLEX NEXUS/NOVAFLO

BRIAN GUY
AORANGI ROAD
FEILDING
PLANS SUPPLIED BY FARMWORKS
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SCALE: 1:2000	
SURVEYED	C.McFADZEAN
DRAWN	C.McFADZEAN
CONTRACTOR	BLACKLEY
MERCHANT	HYNDS
PRECISION FARMING SYSTEMS	FILE: 239

Appendix G
Revised Overseer™ Nutrient Budget

Report from OVERSEER nutrient budgets 2009, version 5.4.6 on 21/09/2010 12:03 p.m.

Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

Sharn Hainsworth
CPG New Zealand

Current scenario.ovp

Nutrient Budget

Farm Budget for: Current farm

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser and lime	167	38	30	66	51	5	0	0.0
House block imports	0	0	0	0	0	0	0	0.0
Atmospheric/clover N	69	0	2	4	3	6	25	0.0
Irrigation	7	0	5	7	28	7	28	0.0
Slow release	0	3	22	0	3	4	5	0.0
Supplements imported	31	6	25	3	5	3	4	-1.1
Outputs								
Product	68	11	17	4	14	1	5	0.0
Effluent removed	0	0	0	0	0	0	0	0.0
Supplements removed	0	0	0	0	0	0	0	0.0
Atmospheric	90	0	0	0	0	0	0	0.0
Leaching/runoff	34	1	64	75	71	7	31	-2.1
Net immobilisation/absorption	83	23	0	3	0	0	0	-0.1
Change in inorganic soil pool	0	12	4	0	3	17	26	1.2

* Acidity - kg H+/ha

Surplus P means that soil inorganic P is accumulating and soil P test will increase. See nutrient budgets to identify block(s) where P fertiliser rate should be reviewed.

Report from OVERSEER nutrient budgets 2009, version 5.4.6 on 21/09/2010 12:03 p.m.

Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

Sharn Hainsworth
CPG New Zealand

Current scenario.ovp

Block nitrogen report

For: Current farm

Block name	N in drainage * (ppm)	N leached (kg N/ha/yr)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)	% reduction in wetland
MWE Kairanga	4.9	103	512	508	0
MWE & FDE Rangitikei	22.5	151	1296	1335	0
Milking Platform	4.1	14	124	92	0
Dry stock	4.3	17	122	92	0
Overall farm	4.8	34	207		

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

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Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

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Current scenario.ovp

Block phosphorus report

For: Current farm

Block name	P loss factors				P lost	% P
	Soil	Fertiliser	Effluent	Overall	(kg P/ha/yr)	removed by filter strip
MWE Kairanga	High	High**	n/a	High	2.3	n/a
MWE & FDE Rangitikei	Medium	High**	High	High	2.1	n/a
Milking Platform	Low	Low	n/a	Low	0.7	n/a
Dry stock	Low	Low	n/a	Low	0.5	n/a
Overall farm	Medium	Medium	Low	Low*	0.9 *	

* Includes P loss from ponds to waterways
** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Report from OVERSEER nutrient budgets 2009, version 5.4.6 on 21/09/2010 12:02 p.m.

Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

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Current scenario.ovp

Nutrient Budget

Block Budget for: Current farm Block: MWE Kairanga

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser and lime	508	82	159	62	11	6	0	0.0
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/clover N	15	0	2	5	3	6	28	0.0
Irrigation	46	2	30	46	172	41	176	0.0
Slow release	0	3	5	0	3	4	5	0.0
Supplements imported	0	0	0	0	0	0	0	0.0
Outputs								
Product	72	12	18	4	15	2	5	0.0
Net transfer by animals	26	1	38	2	5	3	0	-0.5
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	190	0	0	0	0	0	0	0.0
Leaching/runoff	103	2	73	112	134	34	119	-6.8
Net immobilisation/absorption	178	29	0	-5	0	0	0	0.0
Change in inorganic soil pool	0	43	68	0	34	18	84	7.3

* Acidity - kg H+/ha

Total P inputs of fertiliser and effluent (82 kg P/ha/yr) should be lower than maintenance P (34 kg P/ha/yr) when Olsen P (54) is above that required for near maximum pasture production (30). Note that on high producing dairy farms, target Olsen P levels are higher.
Soil P loss status is high. Check Olsen P levels are within economic optimum levels.
Fertiliser P loss is greater than 10% of total P loss - this is outside the range of data available for New Zealand and P loss data should be used with caution. Potential P loss from fertiliser is high. Check fertiliser rates are not too high. If P is applied in high risk months consider alternative months of application or changing the form of P.

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Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

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CPG New Zealand

Current scenario.ovp

Nutrient Budget

Block Budget for: Current farm Block: MWE & FDE Rangitikei

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser and lime	566	77	159	0	0	0	0	0.0
Effluent added	769	124	1238	86	204	125	75	-32.4
Atmospheric/clover N	7	0	2	5	3	6	26	0.0
Irrigation	11	0	7	11	41	10	42	0.0
Slow release	0	3	4	0	3	4	5	0.0
Supplements imported	0	0	0	0	0	0	0	0.0
Outputs								
Product	72	12	18	4	15	2	5	0.0
Net transfer by animals	26	1	38	2	5	3	0	-0.5
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	354	0	0	0	0	0	0	-1.9
Leaching/runoff	151	2	672	75	123	10	54	-9.2
Net immobilisation/absorption	750	31	0	21	0	0	0	-2.0
Change in inorganic soil pool	0	158	682	0	107	130	90	-18.7

* Acidity - kg H+/ha

* Maintenance nutrient requirements for this block take account of nutrients added in effluent.

You are already applying in excess of 150 kg N/ha/yr in the effluent. Consider increasing area for effluent application or removing supplements. Also consider stopping N applications to the effluent block.Note that effluent application rates for N may be higher than is allowed by some regional council plans. Please check with the relevant council.

Excess P being applied as fertiliser and imported effluent. Consider reducing fertiliser P applications to the effluent blocks.
Potential P loss from effluent is high. Check effluent area is large enough. Consider reducing the rate at

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Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

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Current scenario.ovp

Nutrient Budget

Block Budget for: Current farm Block: Milking Platform

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser and lime	92	30	0	76	66	6	0	0.0
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/clover N	89	0	2	5	3	6	26	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	22	0	3	4	5	0.0
Supplements imported	0	0	0	0	0	0	0	0.0
Outputs								
Product	72	12	18	4	15	2	5	0.0
Net transfer by animals	26	1	38	2	5	3	0	-0.5
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	48	0	0	0	0	0	0	0.0
Leaching/runoff	14	1	54	80	67	1	14	-0.8
Net immobilisation/absorption	21	28	0	-5	0	0	0	0.0
Change in inorganic soil pool	0	-8	-86	0	-16	10	13	1.4

* Acidity - kg H+/ha

Olsen P (54) is above that required for near maximum pasture production (30). See a consultant about reducing fertiliser P inputs. Note that on high producing dairy farms, target Olsen P levels are higher.

Estimated change in soil P, K and Mg test is -1, -1.0 and 1 respectively. Negative value = depletion and need for additional inputs. Positive value = surplus and potential for reducing inputs if soil test is at or above optimum.

Soil is slowly acidifying and would be neutralised by a maintenance lime application of 70 kg/ha/yr pure lime.

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Affco Manawatu
Byreburn Limited Farm
Aorangi Road
Feilding

Sharn Hainsworth
CPG New Zealand

Current scenario.ovp

Nutrient Budget

Block Budget for: Current farm   Block: Dry stock

	N	P	K	S	Ca	Mg	Na	H+
	(kg/ha/yr)							
Inputs								
Fertiliser and lime	92	30	0	76	66	6	0	0.0
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric/clover N	88	0	2	5	3	6	26	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	32	0	3	4	5	0.0
Supplements imported	0	0	0	0	0	0	0	0.0
Outputs								
Product	72	12	18	4	15	2	5	0.0
Net transfer by animals	26	1	38	2	5	3	0	-0.5
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	43	0	0	0	0	0	0	0.0
Leaching/runoff	17	1	27	68	59	1	14	-1.0
Net immobilisation/absorption	22	18	0	7	0	0	0	0.0
Change in inorganic soil pool	0	2	-48	0	-8	10	13	1.6

* Acidity - kg H+/ha

Estimated change in soil P, K and Mg test is 1, -0.6 and 1 respectively. Negative value = depletion and need for additional inputs. Positive value = surplus and potential for reducing inputs if soil test is at or above optimum.

Soil is slowly acidifying and would be neutralised by a maintenance lime application of 80 kg/ha/yr pure lime. Review soil pH and lime requirement.

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Affco Manawatu
Byreburn Limited Farm
Aorangi Road
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Current scenario.ovp

Block maintenance fertiliser nutrient recommendations

For: Current farm

Maintenance fertiliser nutrient recommendations to maintain soil tests at current levels

Block name	P	K	S	Ca	Mg	Na	Lime	Relative yield (%)
	(kg/ha/yr)							
MWE Kairanga	34	45	0	0	0	0	380	99
MWE & FDE Rangitikei	0	0	0	0	0	0	0	97
Milking Platform	36	75	9	80	0	0	70	94
Dry stock	26	46	19	72	0	0	80	90

It is recommended that a fertiliser company representative or farm consultant with experience in nutrient management is consulted for advice on the types of fertiliser and on the timing of application of fertilisers.

These rates are to maintain soil test values only. If soil test values are above optimum, then less than maintenance can be applied to allow soil test values to fall. Conversely, if soil tests are below those required to maintain target pasture production levels, then capital dressings may be required. In both cases, it is recommended that a fertiliser company representative is consulted.

Also note that experienced fertiliser company representatives may advise rates that differ from these results based on local experience.

Appendix B
Land Application Data from 2007-2010

Amounts Of MWE Applied In
2007/08, 2008/09 & 2009/10

Date	Daily Volume (m3/day)		
	2007-2008	**2008-2009**	**2009-2010**
4-Dec	208		
5-Dec	1660		
6-Dec	1640		
7-Dec	960		
8-Dec	960		
9-Dec	1560		
10-Dec	1440		
11-Dec	1120	960	
12-Dec	1420	400	
13-Dec	1200	1600	
14-Dec	1120	1560	
15-Dec	1200	960	
16-Dec	1000	940	
17-Dec	1000	1100	
18-Dec	1280	1160	
19-Dec	1120	1040	
20-Dec	1000	1060	
21-Dec	1120	1240	
22-Dec	1073	1153	
23-Dec	1313	1040	
24-Dec	1760	1000	
25-Dec	1680	1040	
26-Dec	1240	993	
27-Dec	1073	1180	
28-Dec	320	1240	
29-Dec	1320	550	
30-Dec	1420	960	
31-Dec	960	1040	
1-Jan	1347	920	
2-Jan	1133	987	
3-Jan	1200	1000	
4-Jan	1360	1360	
5-Jan	1480	1040	
6-Jan	1500	1160	
7-Jan	1267	1040	
8-Jan	820	1480	200
9-Jan	560	1360	840
10-Jan	1400	960	1060
11-Jan	1360	1000	1080
12-Jan	960	1160	1040
13-Jan	1360	1107	1080

Date	Daily Volume (m3/day)		
	2007-2008	**2008-2009**	**2009-2010**
14-Jan	1180	1180	1133
15-Jan	1120	1140	1180
16-Jan	1240	1400	1167
17-Jan	1260	1020	973
18-Jan	1420	1467	1173
19-Jan	1520	1000	840
20-Jan	1400	960	713
21-Jan	1200	973	840
22-Jan	1227	960	820
23-Jan	1420	960	747
24-Jan	1900	1000	900
25-Jan	880	425	1320
26-Jan	920	312	220
27-Jan	1160	850	1260
28-Jan	1080	1071	1533
29-Jan	1280	1000	1140
30-Jan	1440	250	1140
31-Jan	1360	1053	1080
1-Feb	1400	592	213
2-Feb	1320	275	320
3-Feb	1440	350	720
4-Feb	1480	1220	440
5-Feb	1160	375	120
6-Feb	960	1280	960
7-Feb	1760	375	960
8-Feb	960	1120	960
9-Feb	1320	350	440
10-Feb	1480	1120	960
11-Feb	1200	1075	1120
12-Feb	1400	1160	820
13-Feb		500	280
14-Feb		1040	1140
15-Feb		1867	267
16-Feb		725	967
17-Feb		817	260
18-Feb		675	960
19-Feb			1080
20-Feb			1840
21-Feb			1120
22-Feb			940

Date	Daily Volume (m3/day)		
	2007-2008	**2008-2009**	**2009-2010**
23-Feb			680
24-Feb			200
25-Feb			840
26-Feb			920
27-Feb			960
28-Feb			960
1-Mar			320
2-Mar			1400
3-Mar			1400
4-Mar			913
5-Mar			840
6-Mar			280
7-Mar			740
8-Mar			520
9-Mar			760
10-Mar			1080
11-Mar			1000
12-Mar			880
13-Mar			840
14-Mar			760
15-Mar			260
16-Mar			1880
17-Mar			1120
18-Mar			1000
19-Mar			787
20-Mar			350
21-Mar			960
22-Mar			600
23-Mar			1520
24-Mar			1000
25-Mar			1480
26-Mar			1150
27-Mar			1600
28-Mar			1000
29-Mar			1000
30-Mar			1060
31-Mar			1000
1-Apr			1160
2-Apr			640
3-Apr			1025

Date	Daily Volume (m3/day)		
	2007-2008	**2008-2009**	**2009-2010**
4-Apr			650
5-Apr			650
6-Apr			875
7-Apr			713
8-Apr			850
Median	1260	1030	960
Upper Quartile	1420	1158	1080
Lower Quartile	1100	945	717
Max	1900	1867	1880
Overall Median	1030		
Overall Max	1900		

AFFCO Manawatu
Contract 303275

Land Application of Meatworks Effluent at Byreburn Farm, Feilding

Appendix H
Soil and Groundwater Resource Assessment

November 2010

CPG New Zealand Ltd
A subsidiary of Downer EDI Limited

AFFCO Manawatu
Land Application of Meatworks Effluent at Byreburn Farm, Feilding
Soil and Groundwater Resource Assessment

Contract No 303275

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Ref: 303275 Soil and Groundwater Resource Assessment 101118

AFFCO Manawatu
Land Application of Meatworks Effluent at Byreburn Farm, Feilding
Soil and Groundwater Resource Assessment

Contract No 303275

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

AFFCO Manawatu seeks a resource consent from Horizons Regional Council ("HRC") for the discharge of Meatworks Effluent (MWE) arising from the operation of its AFFCO Manawatu Meat Processing Plant ("AMP") at Campbell Road, Feilding, onto land on the adjoining Byreburn Farm. This consent will be to replace consent number 4226, which is due to expire on 14 May 2011.

The current consent authorises the discharge of up to 2,000 m^3/day of MWE onto 75 ha of land on Byreburn Farm for a term expiring 14 May 2011.

A resource consent application and Assessment of Environmental Effects (AEE) has been prepared in respect of this consent "renewal"; this Appendix to the AEE provides full details of the soil resource investigation on Byreburn Farm, the findings of which have been incorporated into the AEE.

2 INTRODUCTION

2.1. Background

A flow of wastewater arises from the operation of the AFFCO Manawatu Meat Processing Plant (AMP) at Campbell Road, Feilding. This wastewater is discharged from the site by means of a Combined Land and Water Discharge system (CLAWD). Under this system, some of the wastewater is irrigated onto land at the adjacent Byreburn Farm when soil moisture conditions allow this to occur safely. The balance of the wastewater is discharged to the Oroua River during times of high river flow, when adverse environmental effects of the discharge are minimised. Substantial pond storage capacity is available as a buffer against times when neither river flow nor soil moisture conditions enable the safe discharge of wastewater.

For at least 20 years, a portion of AMP's wastewater has been irrigated onto pasture at Byreburn Farm. Since 1996 this irrigation has been authorised by resource consent number 4226, which is due to expire on 14 May 2011. A resource consent application and Assessment of Environmental Effects (AEE) has been prepared to enable the replacement of the expiring consent, to enable the continuation of the activity.

As part of the AEE, a detailed assessment of the soils to be irrigated, and of the effects of the irrigation on groundwater quality, has been carried out; this report is to describe the detail of the investigation and its findings.

2.2. Scope

This report investigates the soils of part of Byreburn Farm where it is intended to continue the beneficial land application of Meat Works Effluent (MWE). It describes the types of soils found on the land treatment site and their characteristics with regard to distribution, fertility and hydraulics. It describes the results of shallow groundwater quality monitoring as they relate to the irrigation. The report is intended to provide the detailed basis for the more summarised soils and groundwater information provided in the AEE itself.

2.3. Limitations

CPG's responsibility for this report is limited to AFFCO Manawatu and to that client only. CPG disclaims all responsibility and will accept no liability to any other person unless that party has obtained the written consent of CPG New Zealand Limited (CPG). CPG reserves the right to qualify or amend any opinion expressed in this report in dealing with any other party. This report is not to be relied upon for any other purpose without reference to CPG.

Recommendations and opinions in this report are based on data obtained from the investigations as detailed in this report. The nature and continuity of receiving environment conditions at all locations are inferred and it should be appreciated that actual conditions could vary from the assumed model.

3 MAPPING AND SOIL/LAND ASSESSMENT

3.1. Method

An investigation of the soils of identified blocks on Byreburn Farm was undertaken to characterize the top 1 m of soil on the site. The purpose of the soil assessment was to characterize the current versatility and productivity and to evaluate the soils' ability to accept and treat or attenuate applied wastewater.

The soil was intensively mapped at a scale of 1:5,000 using a combination of soil auger observations and typical profile analysis. The resultant soil map and soil profile information are recorded in Appendix B.

A 1:5,000 scale Land Resource Inventory (LRI) map of the site has also been produced using the method of Lynn *et al* (2009). Land Use Capability (LUC) units have been assigned to each of the LRI map units. A 1:5,000 scale LRI and LUC map has been provided in Appendix B. An LUC map was recently prepared for the site by AgResearch (Longhurst and Mercer, 2009). These maps are shown in Figure 2 in Appendix A.

3.2. Results

There are three terrace surfaces of deposited alluvium on Byreburn Farm, each with different soils present on them, as follows.

The lowest and youngest is a frequently flooded floodplain (c. 73 mamsl), which is flat to undulating and mostly gravel.

The low terrace level (c. 76 – 78 mamsl) is rarely flooded, and is flat to undulating and contains old levees, back-plains and back-basins.

The high terrace (c. 79-81 mamsl) is a non-floodable, uplifted marine bench, which is flat, formed in weak sandstone, and covered with quartzo-feldspathic loess with tephra layers.

There are Fluvial Recent soils on the floodplain and low terrace and Perched-Gley Pallic soils on the uplifted marine bench. The Recent soils on the floodplain are gravelly Rangitikei soils. Kairanga soils occupy the majority of the low terrace, on the back plain and back basin. Due to the alluvial origin of the landform, the soils vary in texture across it. On the highest parts of the levees on this surface Manawatu soils are present. The loess-covered uplifted marine bench is covered in Milson soil. This soil is more uniform on this surface than the soils are on the alluvial low terrace below it.

The Milson soil has an LUC of 2s2. This silty loam textured soil has a slightly firm, moderately slowly to slowly permeable subsoil layer (in places a fragipan) which perches drainage water above it. The wetness of the soils in winter leads to the risk of pugging and surface ponding. These soils are artificially sub-surface drained. The soil is summer-dry and winter-wet. Macropores gape open when the soils are dry, leading to a high potential for bypass flow and leaching to shallow groundwater. Plant roots can only grow along ped faces when the soil contracts. This significantly reduces the amount of soil moisture available for plants to exploit in the profile. Milson soils are fertile soils with a moderately high cation exchange capacity (CEC) but a moderately low anion retention capacity (ASC) (around 30%). The subsoil contains appreciable amounts of vermiculite which provides a natural source of plant available potassium. The Milson soils on this site have an ASNZ 1547:2000 Soil Category of 4.

Manawatu and Kairanga soils typically have an LUC of 2w2 (Lynn *et al*, 2009). They are affected by a rising water table, although the area has now been extensively artificially drained. Manawatu soils are imperfectly drained and on Byreburn Farm tend to have a silt loam texture. The Kairanga soils are poorly drained and predominantly have a silt loam texture. However, being composed of alluvium, the texture of Kairanga soils varies considerably across the site. The most common soil on the site contains 20 cm of silt loam topsoil over another 40 cm of silt loam, over at least 40 cm of sand. There are also locations containing 100 cm of silt loam and others where the soils are more of a sandy loam. Typically the Manawatu soils tend to have a higher base saturation than the Kairanga soils. They are both fertile soils, with high available water holding capacities (TAWHC and RAWHC) and moderate CEC. Neither soil has a very high ASC.

Given that the Kairanga soils on Byreburn Farm are artificially drained, that the Manawatu soils are imperfectly drained and are silt loam textured like the Kairanga soils, they are essentially equivalent to the Kairanga soils for the purposes of land application of MWE. The silt loam Manawatu and Kairanga soils have a Soil Category of 4. The sandy loam soils have a Soil Category of 3.

The Rangitikei loamy sand soils have an LUC of 4s2. They are very stony. These soils have very low TAWHC, RAWHC, base saturation, CEC and ASC values but they are well to excessively well drained and have a Soil Category of 1.

4 SOIL HYDRAULICS

Field investigations have been undertaken on the site to characterise the soil physical properties. The detailed results from the hydraulic conductivity testing from both the period of Resource Consent 4226 and CPG investigations in 2010 are located in Appendix F. A summary of these results will be discussed below.

4.1. Theory

Saturated hydraulic conductivity (K_{sat}) is the rate that water infiltrates the soil under saturated conditions.

Using a double-ring infiltrometer falling head method, measurements were taken to determine the saturated hydraulic conductivity (K_{sat}) of the soil. This test provides an indication as to the rate at which water will enter the soil under saturated conditions. These conditions typically represent flow through all of the soil pores, including soil macro-pores, draining under gravity.

This method seeks to establish K_{sat} near the soil horizon where irrigation will occur. This is an upper-limit indication as to the maximum amount of water a soil can drain in a given period of time under saturated conditions. The double-ring method measures vertical flow only, eliminating possible overestimation of the infiltration due to lateral flow in the soil.

CPG notes that the falling water levels within then double-ring infiltrometer does result in a variation of head conditions over time which can affect the rate of conductivity measured in the soil. Additionally, the operator is unable to determine if preferential flow is occurring through cracks in the soil or the extent to which macropores impact on the infiltration rates. As a result of the above, the results from the Double-Ring Infiltrometers should be used as a guide along with other analyses to determine infiltrations capacities and the suitability to accept wastewater.

4.2. Method

In July 2010, 2-dimensional saturated hydraulic conductivity (K_{sat}) was measured on the following combinations of soil type and management regime:

- Kairanga silty loam over sand, irrigated;
- Kairanga silty loam over sand, unirrigated;
- Kairanga silty loam, irrigated;
- Manawatu mottled silty loam; irrigated.

The rings are seated level in the soil, to a depth of several centimetres, then filled with water. Timed recording then measures the rate of water level fall in the inner ring over time. Changes in water levels were recorded on a regular basis for up to 120 minutes, or until such time as the infiltration rate stabilised.

3 replicate tests were completed at each site using double ring Infiltrometers. The internal ring was 60 cm in diameter, equivalent or greater than the diameter single large ring infiltrometer.

For the duration of the period of Resource Consent 4226, 2-dimensional saturated hydraulic conductivity (K_{sat}) has been measured in the laboratory. This process has involved using repacked cores (10 cm diameter) that are ponded. The results of this testing procedure were compared with 2010 data from CPG derived from the large double ring infiltrometer method and results were similar.

Testing locations are shown in Appendix B.

4.3. Results

The hydraulic tests carried out repeatedly at 3 permanent sites from 1997 to 2009 found that the K_{sat} values at each of the sites was markedly different. The amount of variability of results at each site also differed with soil type. The results are shown in Table 1 below and in the Appendix F:

Table 1: Laboratory Based K_{sat} Values, Annual Tests From 1997-2009

Soil Site	Soil Type	Median (mm/hr)	Mean (mm/hr)	Standard Deviation (mm/hr)
1	Kairanga	14	16.9	9.9
3	Manawatu	24	33.2	46.1
4	Rangitikei	70	95.2	82.8

The K_{sat} results from long term monitoring differ due to soil type.

Rangitikei stony loamy sand soils have a median K_{sat} of 70 mm/hr. These soils have a rapid permeability and have high infiltration rates because of the presence of greater than 70% stones in the soil profile, less than 5 cm of topsoil development and a loamy sandy matrix. The results on this soil type were highly variable (standard deviation of 82.8 mm/hr), most likely because of the complicating factor of the presence of stones, which makes accurate testing difficult.

Manawatu mottled silty loam soils with stones have a median K_{sat} of 24 mm/hr. These soils are moderately permeable and have moderate infiltration rates because of the silty loam texture of the soil, the moderately well developed topsoil and a lack of stones near the surface. The results on this soil type were moderately variable (standard deviation of 46.1 mm/hr), most likely because Soil Site 3 is located on the edge of a small map unit of this soil, where there are pockets of both Manawatu and Kairanga soils. The area is also dominated by bar and swale microrelief which indicates that the area will have considerable variation in grain size distribution of parent material and therefore permeability.

Kairanga silty loam soils have a median K_{sat} of 14 mm/hr. These soils have moderately low permeability and have moderately infiltration rates because of the heavier silt loam texture of the soil. The results on this soil type were much more uniform (standard deviation of 9.9 mm/hr), most likely because Soil Site 1 is located in the middle of a large back plain, containing only Kairanga soil.

No significant downwards trends were evident in the results from long term K_{sat} testing.

Table 2 shows the mean K_{sat} results for the CPG tests completed in July 2010 (Appendix F).

Table 2: K_{sat} Values Using Double Ring Infiltrometer

Landform	Soil Type	Irrigated?	K_{sat} (mm/hr)
Back basin	Kairanga silty loam	Y	18.2
Back plain	Kairanga silty loam over sand	Y	13.1
Back plain	Kairanga silty loam over sand	N	14.6
Levee	Manawatu mottled silt loam with stones	Y	19.7

Results from the CPG testing do not differ significantly across the Manawatu and Kairanga soils on Byreburn Farm. While the Manawatu soil showed a K_{sat} value of 19.7 mm/hr, the Kairanga soils varied from 13.1 – 18.2 mm/hr, with the soil with heaviest texture and lowest physiographic position showing the highest K_{sat} value out of the 3 test sites.

The results using the laboratory-based method are used in further calculations.

Because the Manawatu and Kairanga soils occur on the same surface and cannot easily be managed differently, the lower of the 2 values (336 mm/day) has been used in calculations in this report.

5 SOIL FERTILITY

5.1. General

Field investigations have been undertaken on the site to characterise the chemical properties of the soil. The results from the fertility testing from both the period of Resource Consent 4226 and CPG investigations in 2010 are located in Appendix D. A summary of these results will be discussed below.

5.2. Method

From 1997 – 2009, randomly selected soil transects have been used to select composite samples from 0-10 cm and 10-20 cm depths within the paddocks containing Soil Sites 1, 3 and 4 (the same sites as the K_{sat} measurements).

CPG took composite samples of the top 0-7 cm of soil from GPS located transects in the following soil units/irrigation regimes:

- Kairanga silty loam, irrigated with MWE;
- Kairanga silty loam over sand, irrigated with MWE;
- Kairanga silty loam over sand, unirrigated with MWE;
- Manawatu mottled silt loam with stones, irrigated with MWE;
- Rangitikei stony loamy sand, irrigated with MWE; and
- Milson silt loam, unirrigated with MWE.

5.3. Results

Soil fertility has been measured at 3 sites on Byreburn Farm from 1997 to 2010. Sites 1, 3 and 4 are located on Kairanga, Manawatu and Rangitikei soils respectively. Together these represent the soil types present on the area that been irrigated with MWE during this period. The location of these sample sites is shown on the map in Figure 4, Appendix B. Data from the July 2010 soil fertility tests are in Appendix D.

The results of the annual Olsen P measurements at Soil Sites 1, 3 and 4 are shown in Table 3 below:

Table 3: Olsen P in 0-10 cm and 10-20 cm Soil Samples – Over Time

Date	Olsen P (µg/g)					
	Site 1: Kairanga Soil		Site 2: Manawatu Soil		Site 4: Rangitikei Soil	
	0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm
Feb-97	53.3	30	50.5	30	48.6	29.5
Dec-97	40.5	17.1	37.6	16.7	45.7	21.6
Dec-98	58.1	25.2	54.8	22.9	45	21.4
Dec-99	55	20.4	70.6	41.2	37.9	30.3
Dec-00	56.3	18	55.8	21.7	48.2	41.1
Dec-01	57.1	19.8	70.3	38.2	49.5	41.5
Dec-02	65.1	24.4	90.9	42.1	51.2	48.3
Dec-03	59.1	27	64.3	27.4	73.8	64.8
Dec-04	37.2	70.1	52.7	33.9	30.1	43.8

Date	Olsen P (µg/g)					
	Site 1: Kairanga Soil		Site 2: Manawatu Soil		Site 4: Rangitikei Soil	
	0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm
Dec-05	40.9	31.5	73.9	30.1	60.7	48
Dec-06	62.9	40.1	34.9	45.3	54.8	60.9
Dec-07	41.8	41.3	48.5	58.9	76.5	66
Dec-08	52.3	43.3	76.5	80	66.8	61.5
Dec-09	43.4	33	73.6	78.8	59	37.7

These results are shown in graph form in Figures 3, 4 and 5 below:

Figure 3: Trends in Olsen P at Site 1: Kairanga Soil

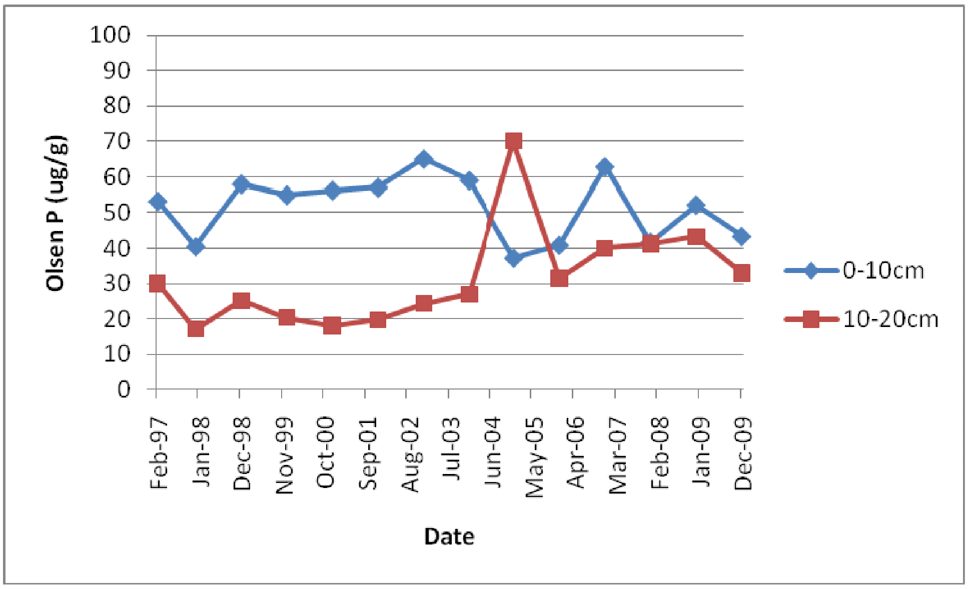


Figure 4: Trends in Olsen P at Site 3: Manawatu Soil

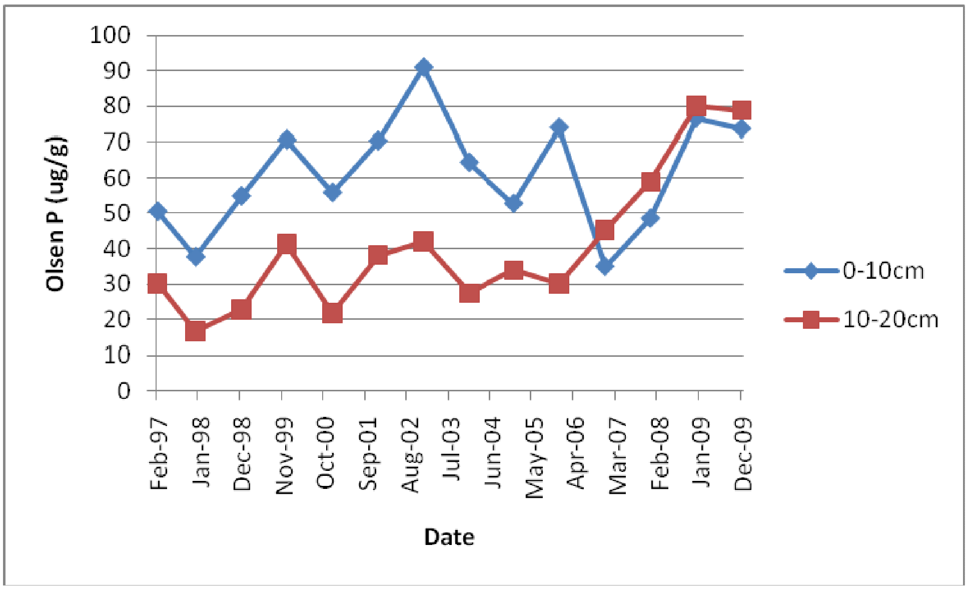
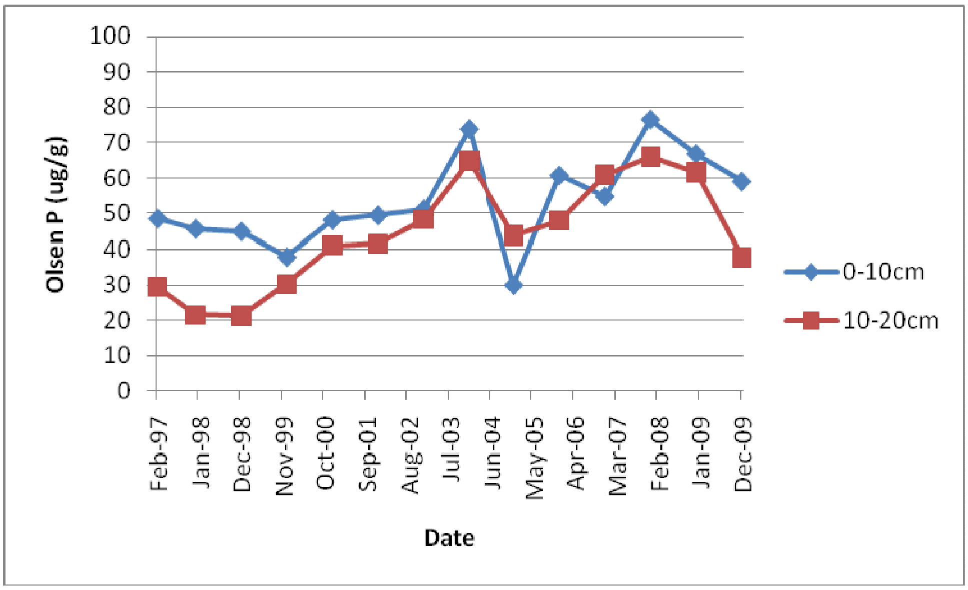


Figure 5: Trends in Olsen P at Site 4: Rangitikei Soil



5.3.1 Olsen P Trends over Time on Kairanga Soils

Where MWE was discharged onto the Kairanga soil at Soil Site 1, Olsen P levels trended upwards from the December 1997 level of 40.5 µg/g in the 0-10 cm zone, to a peak of 65.1 in December 2002 (a drought year). Throughout this time period, the Olsen P value in the 10-20 cm zone was significantly lower but also trended upwards. The Olsen P levels in the 10-20 cm zone in December 1997 were 17.1 µg/g and by December of 2002 were 24.4 µg/g.

In December of 2003 the Olsen P value in the 0-10 cm zone went down to 59.1 µg/g while the level in the 10-20 cm zone continued its steady upwards trend to 27 µg/g. It is possible that this was due to a difference in sampling rather than a statistically significant change.

There was however a significant change in Olsen P values in December 2004, after the February 2004 storm and other storms of July of the same year. The Olsen P value in the 0-10 cm zone dropped sharply from 59.1 µg/g to 37.2 µg/g while in the 10-20 cm zone the value increased sharply from 27 µg/g to 70.1 µg/g. This is evidence that phosphorus was leached from the 0-10 cm zone to the 10-20 cm zone in the Kairanga soil during 2004.

Since 2004 Olsen P values in the 0-10 cm zone have risen to peaks of 62.9 µg/g and 52.3 µg/g in December of 2006 and 2008 respectively, but in the in the intervening periods the values have fluctuated between 40.9 µg/g and 43.4 µg/g.

Unlike the 0-10 cm zone in the 10-20 cm zone the Olsen P value dropped in December 2005 back to 31.5. This indicates that phosphorus was leached out of the 10-20 cm zone of the Kairanga soil into the subsoil beneath it during 2005. The Olsen P value in the 10-20 cm zone has then steadily climbed to 43.3 µg/g by December 2008. In December 2009 the value again dropped, this time to 33 µg/g.

Overall these results indicate that phosphorus is leaching through the topsoil and into the subsoil in the Kairanga soils over time. The leaching tends to occur during years of high intensity storms, or prolonged wet periods. This is in keeping with the following characteristics of the Kairanga soils on the site:

- High Olsen P values, particularly in the 0-10 cm zone;

- Low anion cation exchange capacity;
- Moderate permeability; and
- Naturally high water tables.

5.3.2 Olsen P Trends over Time on Manawatu Soils

Between 1997 and 2006 where MWE was discharged onto the Manawatu soil on the old levee at Soil Site 3, Olsen P levels in the 0-10 cm zone have stayed much higher than the 10-20 cm zone. In December 1997 the levels were 37.6 µg/g in the 0-10cm zone and 16.7 µg/g in the 10-20 cm zone respectively and these increased to 70.6 µg/g and 41.2 µg/g in December 1999. From this point on the Olsen P level in the 0-10 cm zone stayed above 70 µg/g for all years except 2000, 2003, 2004, 2006 and 2007, with a peak of 90.9 and 42.1 in December 2002. The most significant drop in Olsen P in the 0-10 cm zone was between 2005 and 2006, with a change from 73.9 µg/g to 34.9 µg/g.

Unlike the Kairanga soil, the values in the 0-10 cm zone did not drop with a corresponding increase in the 10-20 cm zone in 2004, or at any other time during the testing period. However from December 2007 to December of 2009, the Olsen P values in the 10-20 cm zone have remained 3.5 to 10.4 µg/g higher than in the 0-10 cm zone.

In this location this soil has reached its limit with respect to the application of phosphorus and that break-through and leaching from the 0-10 cm zone to the 10-20 cm consistently occurs with the continued application of phosphorus. This is likely to continue to occur until the phosphorus level in the top 0-10 cm is significantly reduced, for example by cut and carry maize cropping.

Overall, the Olsen P levels in the 10-20 cm zone of the Manawatu soil at Soil Site 3 have increased from 16.7 µg/g in December 1997 to 45.3 µg/g in December 2006. They then increased dramatically to 58.9 µg/g in December 2007, peaking at 80 µg/g in December 2008 then dropping to 78.8 in December 2009 (probably of no statistical significance).

In both 2000 (41.2 µg/g to 21.7 µg/g) and 2003 (42.1 µg/g to 27.4 µg/g) abrupt decreases in Olsen P levels in the 10-20 cm zone were recorded. Similar drops were also recorded in the 0-10 cm zone during these times. The difference between Olsen P levels in 2 zones didn’t alter dramatically. It is possible that these decreases could be as equally due to maize cropping (which did happen on the farm until a management change in 2010) or leaching.

Overall these results correspond well with the results for the Kairanga soil, when soil characteristics and wastewater irrigation management regime are taken into account. Important factors at play include:

- Very high Olsen P values;
- Low anion cation exchange capacity;
- Moderate to moderately high permeability;
- Naturally moderately high water tables; and
- Problems with the current irrigation infrastructure which are leading to lower pressure in this area (pers. comm. Bryan Guy).

5.3.3 Olsen P Trends over Time on Rangitikei Soils

Some irrigation blocks on the Rangitikei soil receives both MWE and FDE. This soil is very gravelly, with a loamy sand matrix. This soil has no topsoil of significance. It is a rapidly draining soil with very low anion storage capacity or available water holding capacity.

Results for Olsen P at Soil Site 4 show the same general trends as for the Manawatu and Kairanga soils. Although the curve for Olsen P over time is different because of the different soil and management, there are a number of other factors/trends that are similar. Olsen P is still moderately high to high, with medians of 50.4 µg/g and 42.7 µg/g with maxima of 76.5 µg/g and 66.0 µg/g for 0-10 cm and 10-20 cm zones respectively. Because of the permeable nature of the soil and the low anion sorption capacity, Olsen P levels have abruptly dropped in the 0-10 cm zone in 1999 (45.0 µg/g to 37.9 µg/g) and 2004 (73.8 µg/g to 30.1 µg/g). There is a clear upwards trend in Olsen P levels.

5.3.4 Soil Sampling across Different Soil Types and Management Regimes

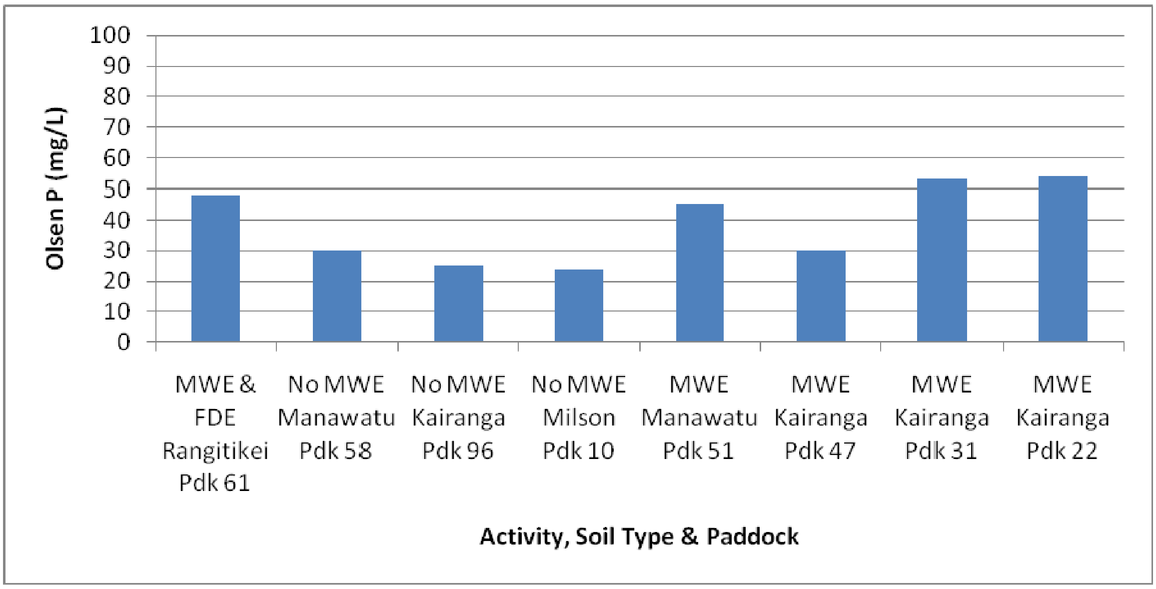
In July 2010 CPG took samples from within 0-7 cm of the soil surface within the various soil units on the farm. The blocks that are managed differently were also tested, including areas considered to be the most likely candidates for extension of the existing land treatment area. The results of the Olsen P measurements at these sites are shown in Table 4 below:

Table 4: Olsen P in 0-7 cm in Soil Samples – Across the Farm

Activity	Soil Type	Paddock	Olsen P (mg/L)
MWE & FDE	Rangitikei	61	48
No MWE	Manawatu	58	30
No MWE	Kairanga	96	25
No MWE	Milson	10	24
MWE	Manawatu	51	45
MWE	Kairanga	47	30
MWE	Kairanga	31	53
MWE	Kairanga	22	54

These results are shown in graph form in Figure 6 below:

Figure 6: Trends in Olsen P in 0-7 cm Soil Samples – Across the Farm



Where no MWE or FDE has been applied, Olsen P ranges from 24 to 30 mg/L, despite these areas receiving 485 kg/ha/year of phosphate fertiliser (30 kg P/ha/year). These values are near or at the optimum for maximum yield for the amount of phosphorus applied (FLRC, 2009).

Where MWE or MWE and FDE has been applied, Olsen P levels range between 45 mg/L and 54 mg/L, except in Paddock 47 where it was only 30 mg/L.

5.3.5 Carbon to Nitrogen Ratios over Time

The results of the annual Total Carbon, Total Nitrogen measurements and calculated Carbon : Nitrogen (C:N) ratios at Soil Sites 1, 3 and 4 are shown in Table 5 below:

Table 5: C:N Ratios in 0-10 cm Soil Samples – Over Time

Date	C:N Ratio		
	Site 1: Kairanga Soil	Site 2: Manawatu Soil	Site 4: Rangitikei Soil
Feb-97	12.1	12.5	12.9
Dec-97	17.4	10.7	10.7
Dec-98			
Dec-99	17.9	10.7	10.5
Dec-00	19.4	11	10.4
Dec-01	18.4	10	10
Dec-02	18.3	6.4	10.9
Dec-03	15	9.1	9.7
Dec-04	9.6	11.2	10.7
Dec-05	11.9	10.7	10.7
Dec-06	11.3	10.5	11.5
Dec-07	12.3	11.3	15.7
Dec-08	11.8	10.5	11
Dec-09	13.2	10.4	10.6

These results are shown in graph form in Figures 7-9 below:

Figure 7: Trends in C:N Ratios at Site 1: Kairanga Soil

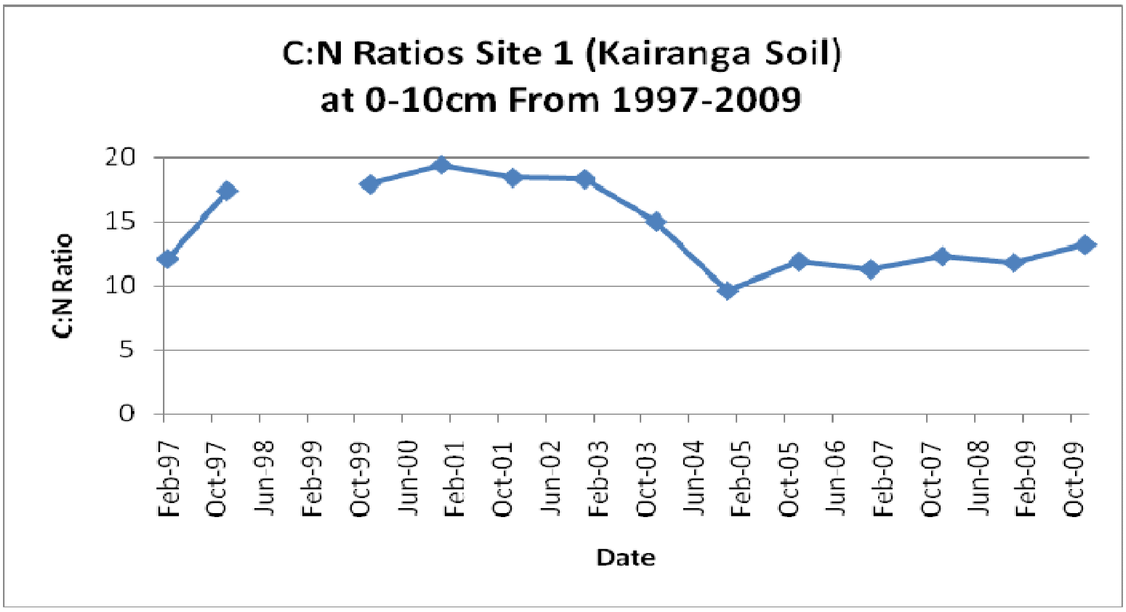


Figure 8: Trends in C:N Ratios at Site 3: Manawatu Soil

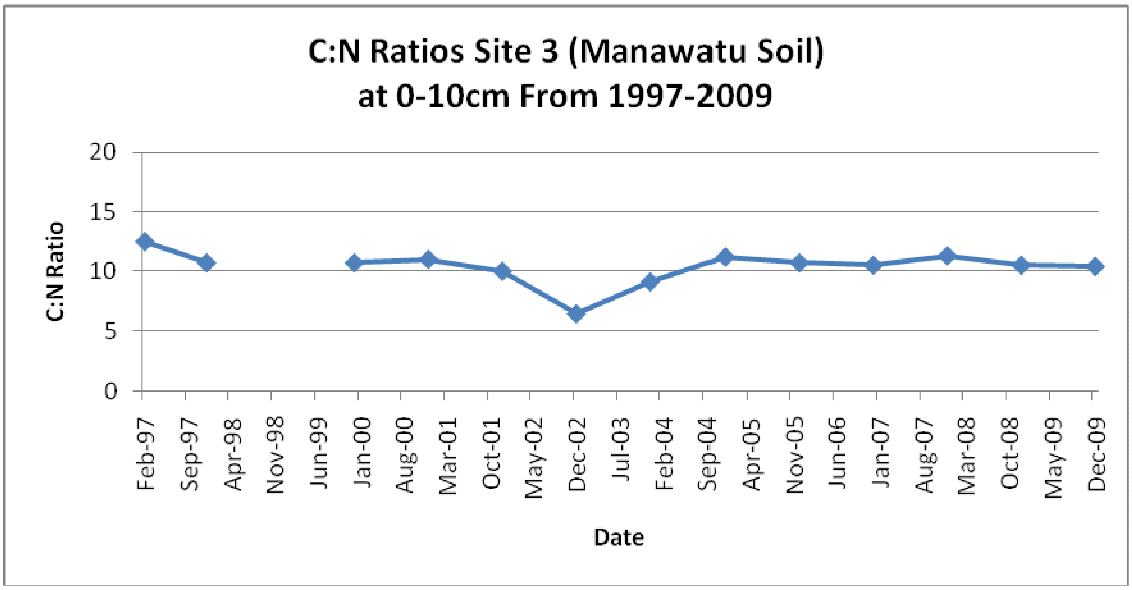
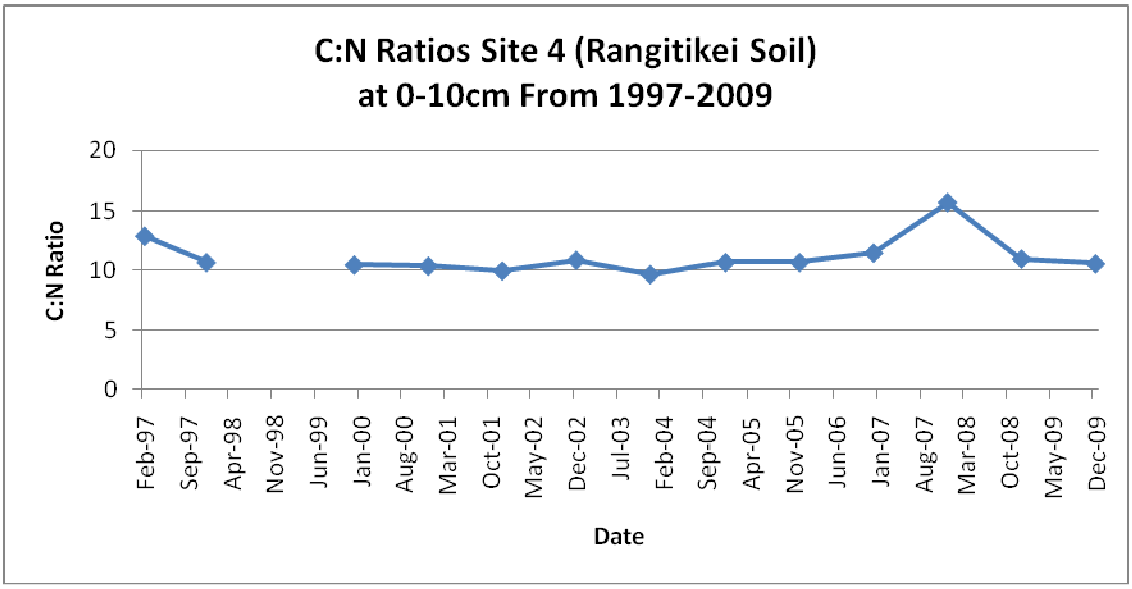


Figure 9: Trends in C:N Ratios at Site 4: Rangitikei Soil



C: N ratios for the Kairanga, Manawatu and Rangitikei soils have ranged from 9.6 to 19.4, 6.2 to 11.3 and 9.7 to 15.7 respectively over the period from December 1997 to December 2009. These results all show that the top 0-7 cm of these soils are in a state of net mineralisation, although it is more usual to have rates around 8-12 than 18-20.

5.3.6 Carbon to Nitrogen Ratios across Soil Types and Management Regimes

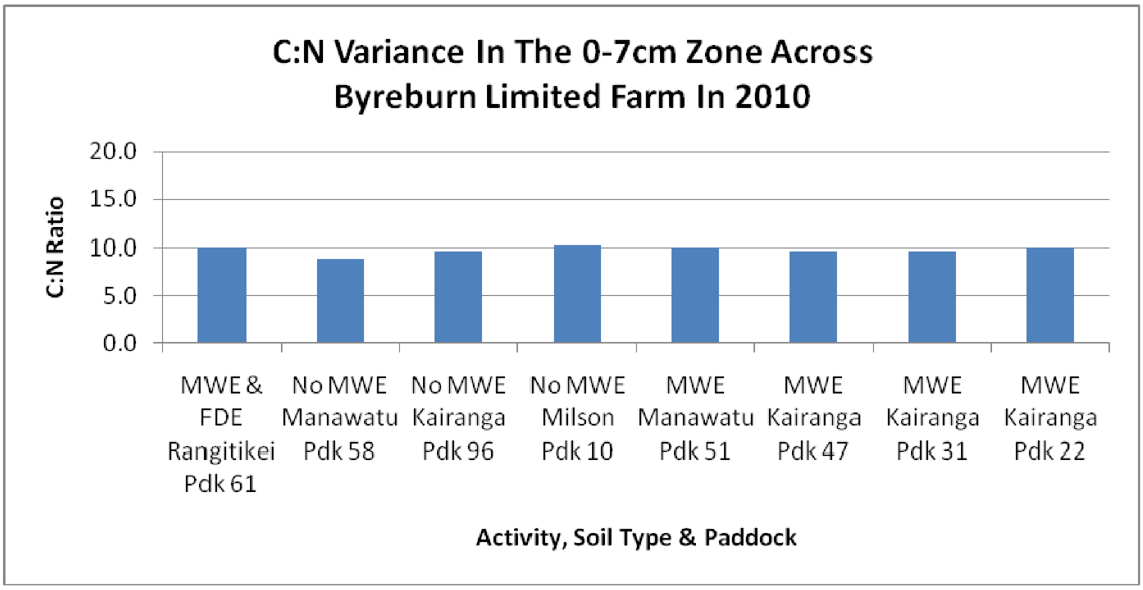
The 2010 CPG testing of blocks that are managed differently, including areas considered to be the most likely candidates for extension of the existing land treatment area. The results of the Total Carbon percentage, Total Nitrogen Percentage and C:N Ratios at these sites are shown in Table 6 below:

Table 6: C:N Ratios in 0-7 cm in Soil Samples – Across the Farm

Activity	Soil Type	Paddock	C (%)	N (%)	C:N Ratio
MWE & FDE	Rangitikei	61	5	0.5	10.0
No MWE	Manawatu	58	4.1	0.46	8.9
No MWE	Kairanga	96	3.4	0.35	9.7
No MWE	Milson	10	3.1	0.31	10.3
MWE	Manawatu	51	2.9	0.3	10.0
MWE	Kairanga	47	3.3	0.34	9.7
MWE	Kairanga	31	5.1	0.51	9.7
MWE	Kairanga	22	3.4	0.33	10.0

These results are shown in graph form in Figure 10 below:

Figure 10: Trends in C:N Ratios in 0-7 cm Soil Samples – Across the Farm



These results reflect a state of net mineralisation across all soil types and management regimes. In this case the results were within the 8-12 zone which is within the range where soil organic matter becomes stabilised (McLaren and Cameron, 1996).

5.3.7 ESP over Time in Kairanga, Manawatu and Rangitikei Soils

The results of the annual Potassium (K), Calcium (Ca), Magnesium (Mg) and Sodium (Na) measurements and calculated Exchangeable Sodium Percentage (ESP) at Soil Sites 1, 3 and 4 are shown in Table 7 below:

Table 7: ESP in 0-10 cm Soil Samples – Over Time

Date	Exchangeable Sodium Percentage (ESP %)		
	Site 1: Kairanga Soil	Site 2: Manawatu Soil	Site 4: Rangitikei Soil
Feb-97	6.4	5.9	5.3
Dec-97	5.4	4.3	1.4
Dec-98	3.5	4.6	1
Dec-99	1.8	2.5	5.1
Dec-00	2.8	4	3.1
Dec-01	3.5	3.9	1.3
Dec-02	1	2.6	1.8
Dec-03	3.8	2.6	2.6
Dec-04	1.4	1.8	3.5
Dec-05	3	4.9	2.3
Dec-06	2	2.7	1.2
Dec-07	2.2	4.2	1.5
Dec-08	2.6	3.8	0.4
Dec-09	1.7	2	1

These results are shown in graph form in Figures 11-13 below:

Figure 11: Trends in ESP at Site 1: Kairanga Soil

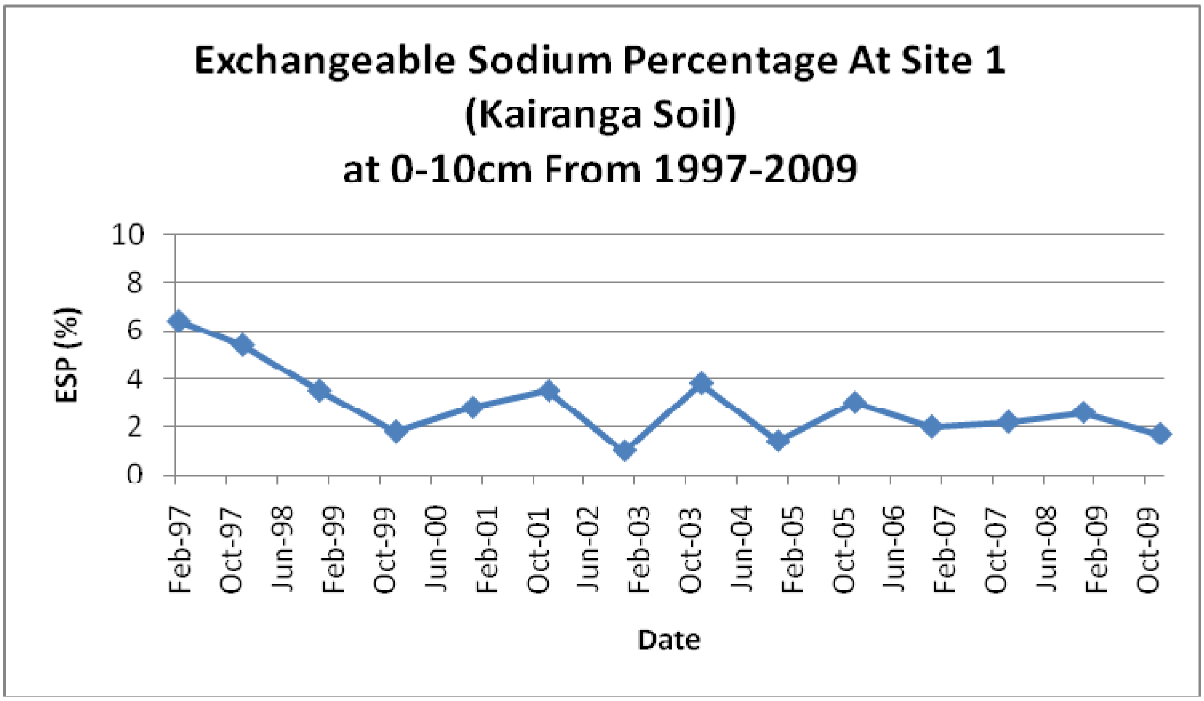


Figure 12: Trends in ESP at Site 3: Manawatu Soil

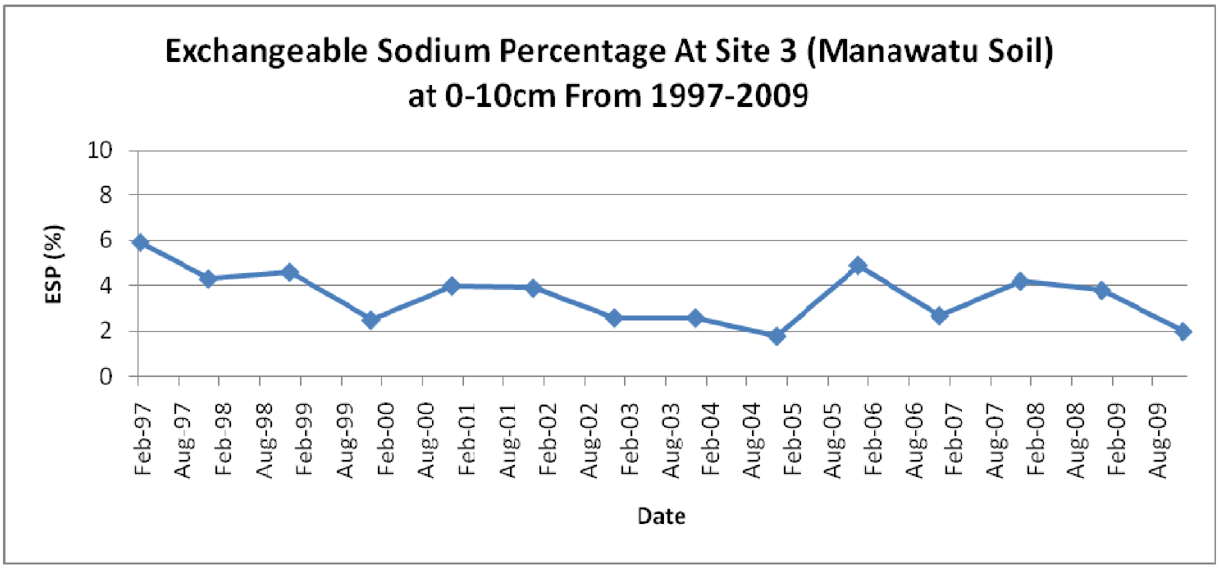
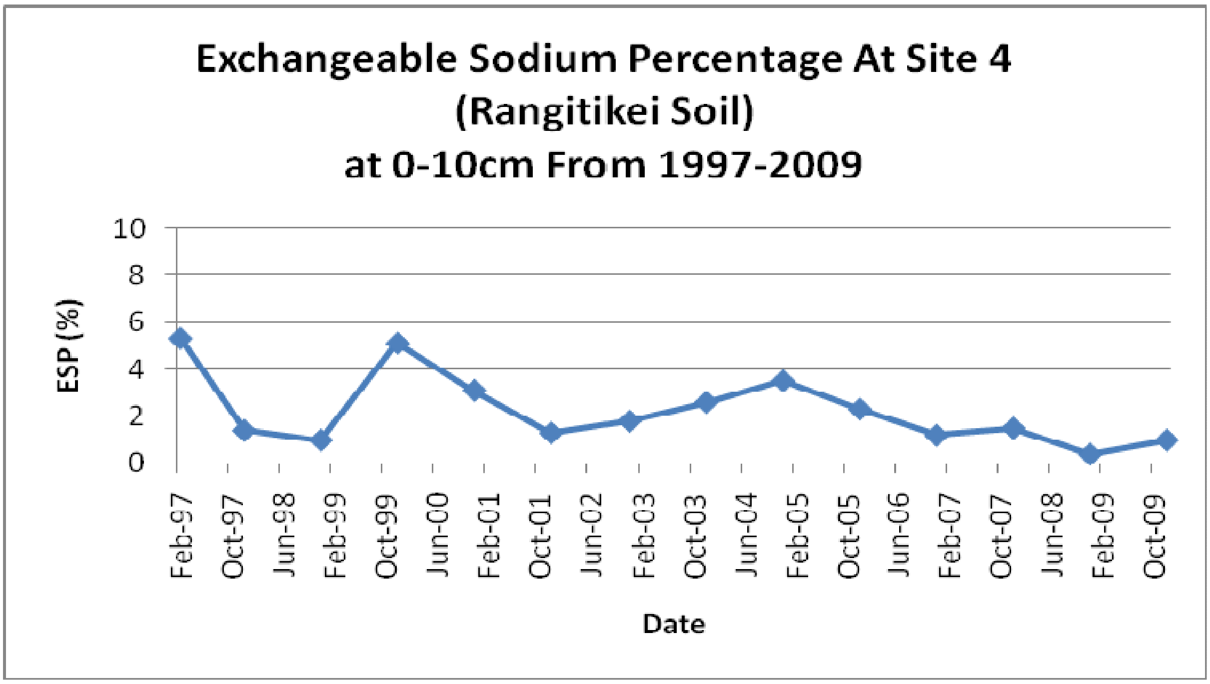


Figure 13: Trends in ESP at Site 4: Rangitikei Soil



ESP ratios for these the Kairanga, Manawatu and Rangitikei soils at Soil Sites 1, 3 and 4 have generally declined over time. Although some small spikes in ESP have occurred over time (different years for each site), ESP values have stayed well below the critical threshold of 13%, meaning there is little chance of permanent structure damage occurring due to the sodium levels in the soil.

5.3.8 ESP across Soil Types and Management Regimes

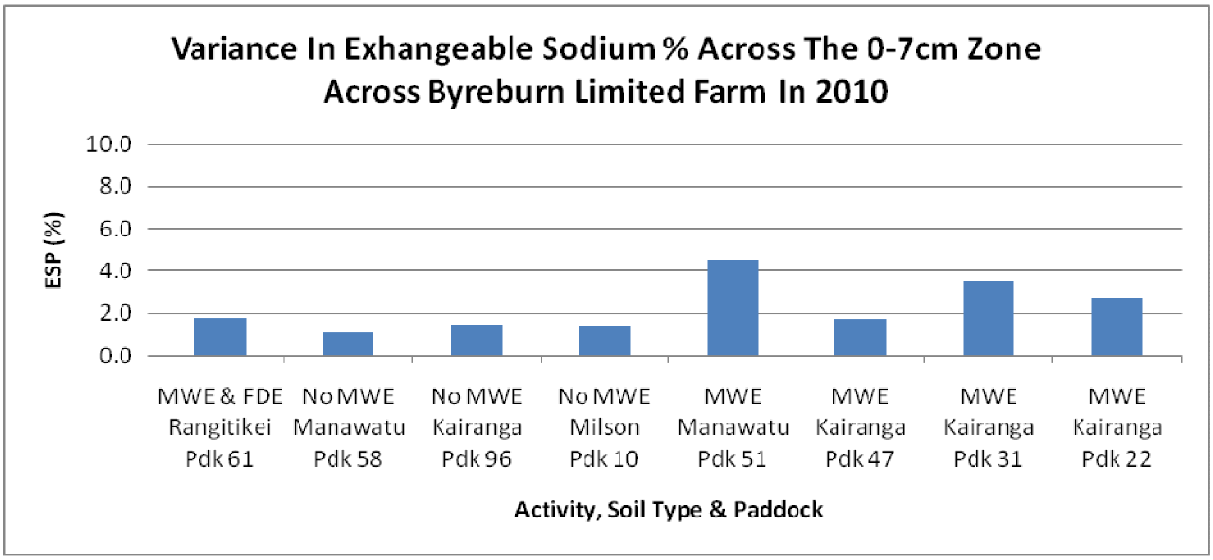
The 2010 CPG testing of blocks that are managed differently, including areas considered to be the most likely candidates for extension of the existing land treatment area. The results of the ESP Ratios at these sites are shown in Table 8 below:

Table 8: ESP in 0-7 cm in Soil Samples – Across the Farm

Activity	Soil Type	Paddock	K	Ca	Mg	Na	ESP (%)
MWE & FDE	Rangitikei	61	1.84	6.6	2.74	0.2	1.8
No MWE	Manawatu	58	0.55	13.5	2.33	0.18	1.1
No MWE	Kairanga	96	0.52	9.5	1.43	0.17	1.5
No MWE	Milson	10	0.4	4.4	1.12	0.28	4.5
MWE	Manawatu	51	0.54	8.6	2.74	0.2	1.7
MWE	Kairanga	47	1.16	9	1.63	0.43	3.5
MWE	Kairanga	31	1.21	13.4	3.59	0.5	2.7
MWE	Kairanga	22	0.65	10.9	2.16	0.2	1.4

These results are shown in graph form in Figure 14 below:

Figure 14: Trends in ESP in 0-7 cm Soil Samples – Across the Farm



These results show that ESP is significantly lower than the threshold of 13%, meaning there is little chance of permanent structure damage occurring due to the sodium levels in the soil. At the time of testing in July 2010, ESP levels were significantly lower in the non-irrigated Manawatu and Kairanga soils than in the Manawatu and Kairanga soils irrigated with MWE. ESP was also low in the Rangitikei soil where MWE and FDE are applied. This is possibly due to the very low cation exchange capacity, low available water holding capacity and high permeability of Rangitikei soils leading to leaching of soluble cations out of the top 0-7 cm of this soil.

6 GROUNDWATER QUALITY

6.1 Hydrogeological Setting

The site is located in the Manawatu Groundwater Management Zone. The aquifer system from which local bores extract groundwater, is built up of at least a 400 m thick sequence of quaternary alluvial gravels, sands, silts and clays and contains occasional peat and wood layers. The top of the Tertiary sedimentary rocks beneath the Quaternary deposits is considered to be the boundary of the hydrogeological system. The groundwater flow system is bounded by geological structures that run in a south-western to north-eastern direction through the region. There are no clearly distinguishable aquifers and aquitards (Horizons Regional Council, 2008).

The aquifer system is recharged by rainfall (about 1369 mm/year in the Manawatu Groundwater Management Zone) and the main recharge zone is understood to be the foothills north-east from Feilding and Palmerston North. The aquifer system is drained by the rivers and creeks that cut through the region and flow through in a south-westerly direction. The regional groundwater flow is also in a south-westerly direction towards the lower plains and eventually the Tasman Sea, though it is locally diverted towards local groundwater-fed creeks and rivers or groundwater bores for water supply (e.g. farming, industry, etc.). The lower plains and the river valleys can generally be perceived as discharge areas for groundwater. The groundwater levels around Feilding vary from 80 to 60 masl and the flow direction is SSW (Horizons Regional Council, 2008).

6.2 Water Quality in Monitoring Bores

Water quality has been measured in 3 shallow (6-8 m deep) monitoring bores on Byreburn Farm from 1999 to 2009. The location of these bores is shown on the map in Figure 4, Appendix B. A full list of results is included in Appendix E.

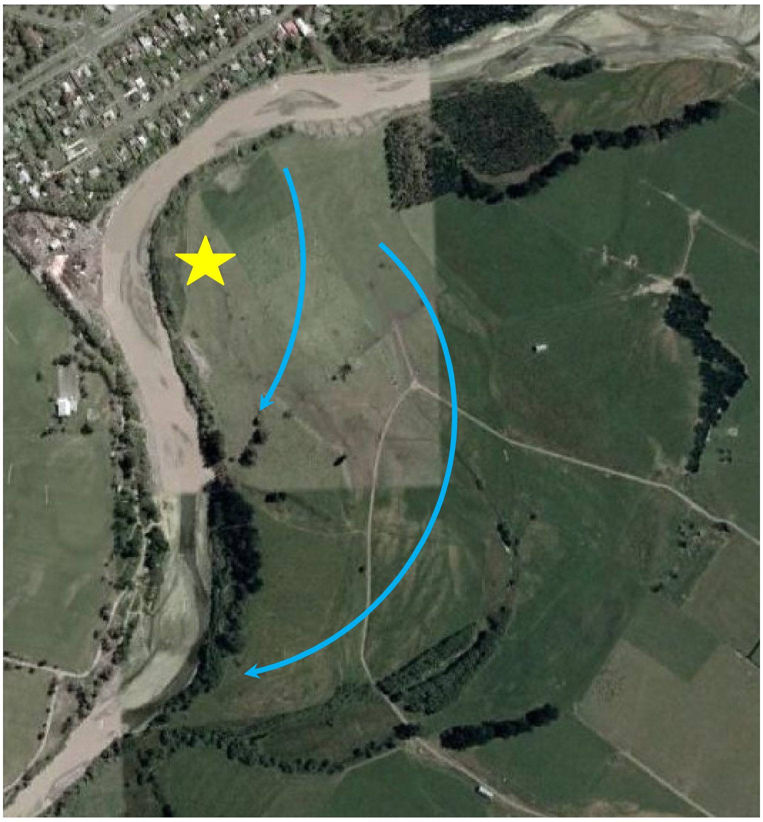
6.3 Bore Sites and Aspects of Data Interpretation

Before analysing these results it is important to note that the information from the monitoring bores may be impacted by a number of variables other than just the impact of the land based application of MWE on Byreburn Farm.

Bore 4 is located on Unoccupied Crown Land on the Rangitikei surface adjacent to the Oroua River, 300 m from the areas where MWE or FDE are discharged. The area is not developed dairy farm and is located immediately north of an old fill site.

It is likely that water quality in Bore 3 is significantly affected by the quality of the water in the Oroua River rather than just the land based application of MWE and FDE on the terrace itself. Bore 3 is located within 50 m of the Oroua River on the low, gravelly Rangitikei soils. This terrace is only some 3 m above normal river level and the bore is some 6-8 m deep. The gravels and sands in the point bar where Bore 3 is located also appear to be oriented in a direction that will lead to significant interaction between the river water and water infiltrated from the surface. Figure 9 shows the sedimentation patterns in photographic form, providing evidence of bands/lenses of gravels and alluvium sweeping east from the upstream side of the current river channel and curving back towards the south in parallel with the old river channel in the back basin south and east of Paddock 61. If in fact water from the Oroua River is infiltrating through the area from which groundwater samples are taken, the water quality may be considerably influenced.

Figure 15: Pattern of Sedimentation And Presumed Direction of Shallow Groundwater Flow



Bore 2 is located in the middle of the older irrigation block on Kairanga soils, but it is within 1 m of a raceway in the swale on the side of the race, where stormwater and effluent from the race runs into. The casing has been removed, so the bore cap is approximately 10 cm below the soil surface, leading to a risk of contamination of the bore with runoff from the race. This was confirmed by Brian Curry (pers. comm.) who does the bore sampling. He explained that unlike the other bores (which take about 2 minutes), he has to pump water out for about 10 minutes, some time before it becomes clear, at which point he samples from the bore.

Bore 1 is considered the control bore. Bore 1 is located in a very low part of the landscape – a back basin. The area is so low that the water table measured in this bore is considerably higher than in Bore 2. Adjacent to the site is a wetland in an old river channel that now forms the source of a stream that winds its way in and out of the farm on its way down Aorangi Road to the Oroua River. This site is part of the Byreburn Farm milking platform and it receives a higher amount of fertiliser to make up for not being irrigated with MWE or FDE. 30 kgP/ha/year is applied. Although Bore 1 is several hundred meters away from areas irrigated with MWE, the whole terrace surface slopes back towards this area and it is possible that shallow groundwater from under this low terrace flows towards this bore. It is likely that Bore 1 is the only Bore that may provide meaningful data about water quality relating the irrigation of MWE on Byreburn Farm.

6.4 Groundwater Quality Monitoring Results

The results for dissolved reactive phosphorus (DRP) levels at each monitoring bore are shown in graph form in Figures 16-17 below:

Figure 16: Trends in DRP Levels in Monitoring Bores On Byreburn Farm

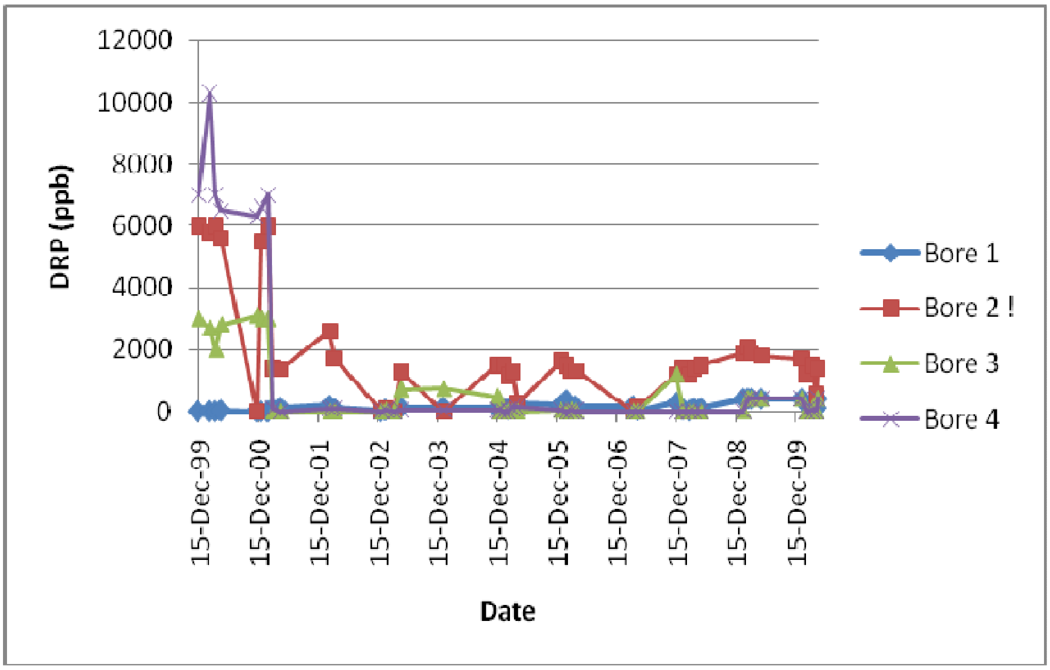
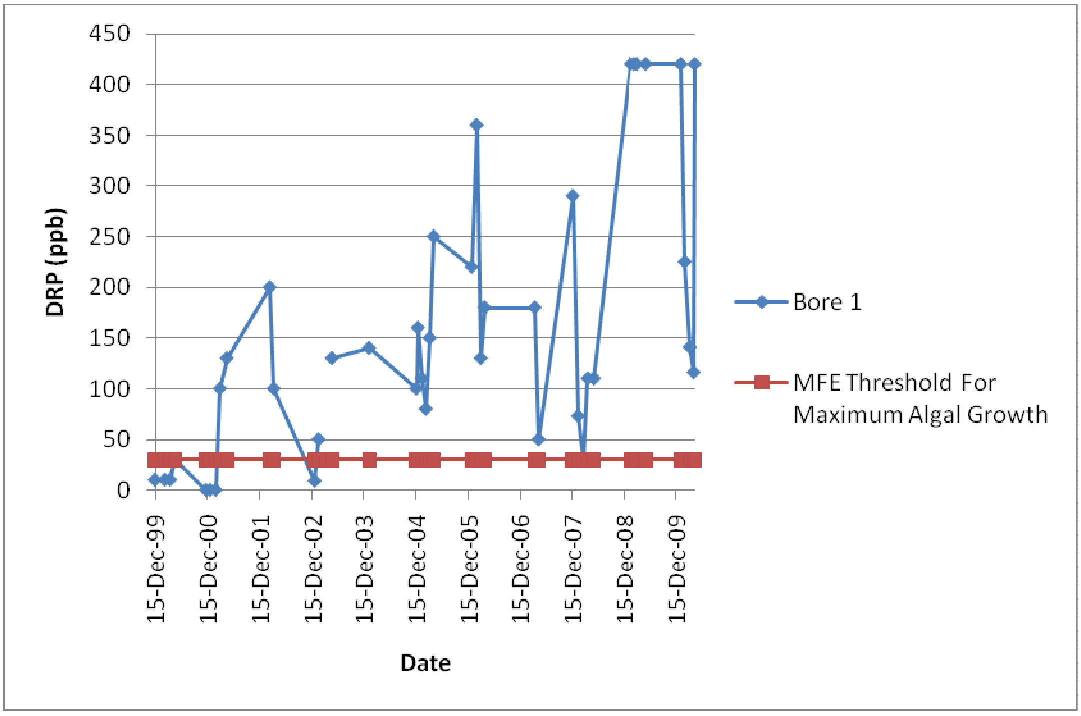


Figure 17: DRP in Monitoring Bore 1 (For Clarity)



6.4.1 Dissolved Reactive Phosphorus

Bore 1 had the lowest median of 130 ppb, with a lower quartile of 50 ppb. It is possible that dissolved reactive phosphorus that has leached into groundwater from the irrigation area is flowing through the gravels and alluvium underlying the site towards the natural back basin, where the water table is naturally located at or near the surface. The information from this bore is likely to be the most relevant in terms of assessing the potential effects on shallow groundwater quality due to the irrigation of MWE on Byreburn Farm. The results from this bore are further discussed below.

Bore 2 (the potentially contaminated bore) had a median of 1,400 ppb with a lower quartile of 1,200 ppb. Levels peaked in December 1999 and March 2000 at 6,000 ppb. These dissolved reactive phosphorus levels are extreme when compared against the MFE threshold of 15-30 ppb, and unlike results for other bores, the high levels occur for sustained periods. This indicates that there has indeed been contamination of this bore. The bore either needs a bund around the top of it or new casing.

Bore 3 had a median of 19.5 ppb and a lower quartile of 9 ppb. These dissolved reactive phosphorus levels are medium to high compared with the MFE (1992) threshold, but much lower than those of the values from Bore 1. Given the activity occurring on this landform, the nature of the soils and underlying lithology and the evidence of leaching through the upper horizons of this soil, it is likely that this bore is indeed reflecting river water quality, rather than the impact of land use from Byreburn Farm. In saying this, levels did peak at extreme levels early on in the duration of consent period - 3,000 ppb in December 1999, 3,100 ppb in December 2000 and 3,000 ppb in January and February of 2001. After this point there was a significant, sustained decrease in dissolved reactive phosphorus levels at this location.

The characteristics of the trend in dissolved reactive phosphorus levels in Bore 4 are similar to Bore 3. Initial dissolved reactive phosphorus levels at this location were excessive – around 6,000-7,000 ppb from December 1999 to February 2001, with a spike of 10,300 in February 2000. After February 2001 the dissolved reactive phosphorus levels settled down to medium to high levels of 10-130 ppb until the end of January 2009. The median for this bore is 50 ppb and the lower quartile is 10 ppb. Like Bore 3 this bore is more likely to be influenced by the water quality in the Oroua River, than by the irrigation of MWE on Byreburn Farm.

The results for Bore 1 are much higher than the 1-30 ppb threshold for maximum periphyton growth in waterways (MFE, 1992). The levels are also significantly higher than the levels found in the bores in river gravels adjacent to and near the water level of the Oroua River (Bores 3 and 4). This suggests that there has been a detrimental impact on groundwater quality from some sort of activity in the recharge area of this groundwater. Given the nature of the surface microrelief around this bore, and the relationship of the water table with that microrelief, it is possible that at least a part of these higher than normal dissolved reactive phosphorus levels is attributable to the irrigation of MWE on Byreburn Farm, although no direct cause and effect relationship can be established with the available data.

Dissolved reactive phosphorus levels in Bore 1 ranged between 100-200 ppb between March 2001 and March 2002 then they dropped down to 9 ppb in January 2003, followed by 50 ppb in February the same year. 2003 had a dry summer/autumn with only 189 mm of rainfall between January and May and 820 mm from January to December that year. No measurements of groundwater quality occurred after the February 2004 storm because irrigation stopped, therefore so did the monitoring. It is recommended that monitoring continues throughout the year to ensure a more comprehensive picture can be constructed in the future. From March 2005 until March 2007 levels ranged from 130-360 ppb, then dropped to 50 ppb in April 2007, the year of a very significant drought. In 2007 both spring, summer and autumn were very dry, with an annual rainfall of only 765 mm.

6.4.2 Dissolved Nitrite and Nitrate

The results for nitrate/nitrite levels at each monitoring bore are shown in graph form in Figures 18-19 below:

Figure 18-19: Trends in Nitrite/Nitrate Levels in Monitoring Bores On Byreburn Farm

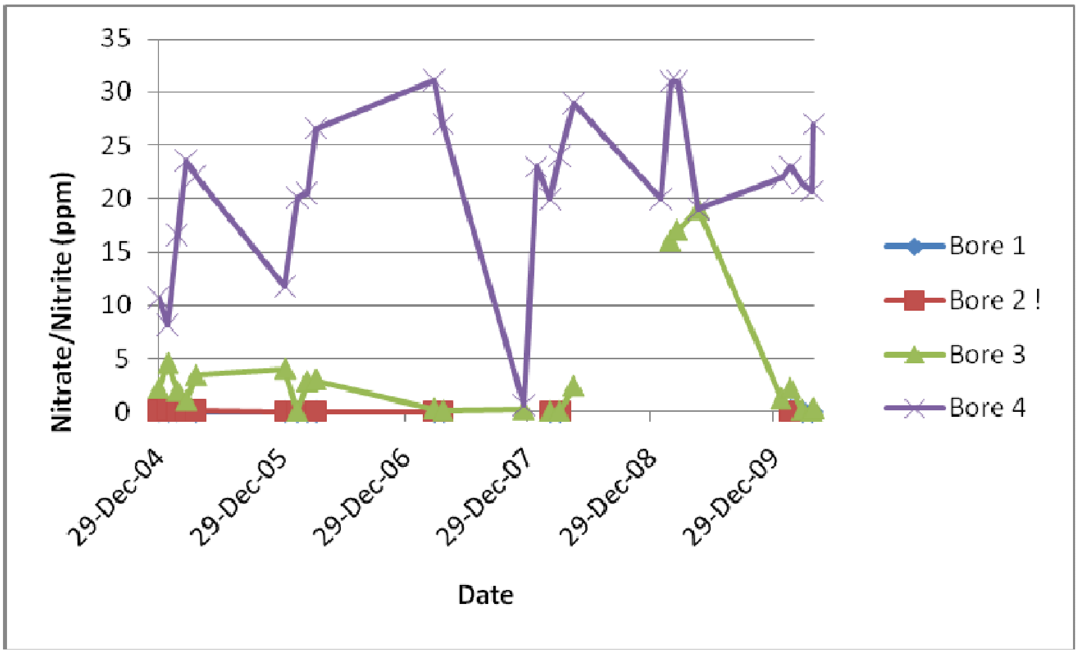
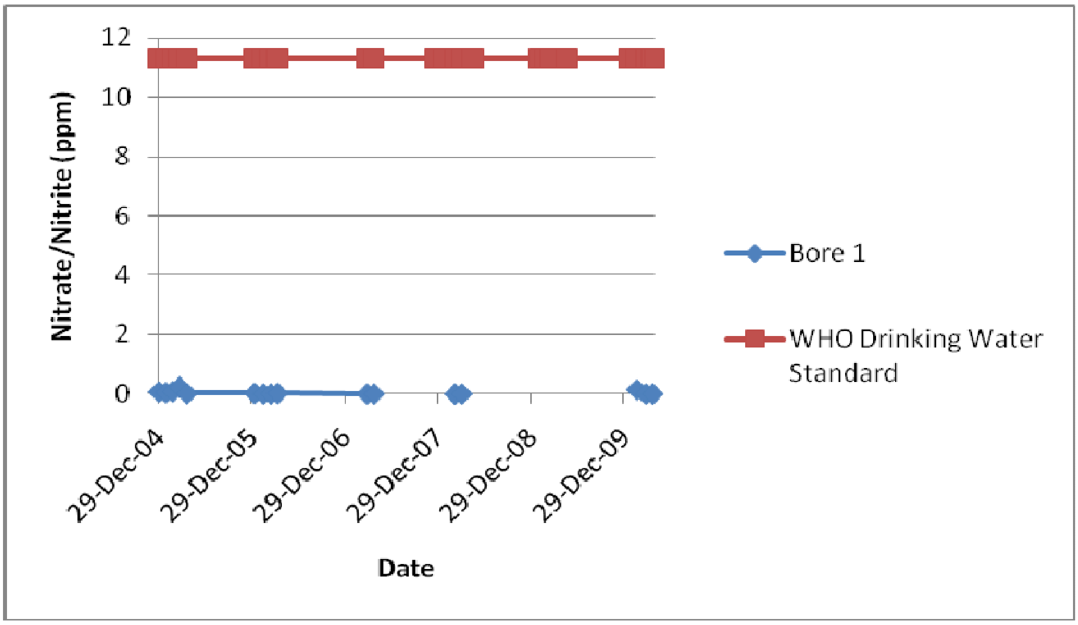


Figure 19: Trends in Nitrite/Nitrate Levels in Bore 1 (For Clarity)



In terms of nitrate/nitrite levels in Bores 1 to 4, results for bores 1 and 2 are very low (XX ppm) compared to World Health Organisation (WHO) drinking water standards (11.3 ppm).

Levels in bore 3 where irrigation of both MWE and FDE occurs on rapidly permeable, gravelly Rangitikei soils are also below 5 ppm from when measurements began in December 2004 until

May 2008. The level then spiked at between 16 and 19 ppm in February and May of 2009, at a level above the WHO limit. Land use history does not explain this change. The irrigation management and fertiliser regimes did not suddenly change on Byreburn Farm at this time. Although the area was put into fodder crop and break-fed, that happened in 2010 and would have involved direct drilling as the area is too stony to cultivate. It is possible that the spike was due to changes in nitrogen levels in the surface water of Oroua River itself.

Unlike in the situation with phosphorus, the results for nitrate/nitrite for Bore 4 were considerably different to the results for Bore 3, indicating a nitrogen source derived from a source other than the river. It is likely that the nitrogen source is not the MWE irrigation on Byreburn Farm. This is because the bore is distant from the irrigated land area, on a much lower terrace, and adjacent to the Oroua River on gravels and alluvium. Additionally similar results were not found in any of the other bores, and the results were not paralleled by those for phosphorus.

7 REFERENCES

Horizons Regional Council. 2008. *Groundwater Resources in the Manawatu–Wanganui Region, Technical Report to Support Policy Development*. Report No: 2008/EXT/948.

Longhurst, B., Mercer, G. 2009. FARM Strategy – Farm 3: Intensive dairy – Feilding. AgResearch. New Zealand; report prepared for Horizons Regional Council.

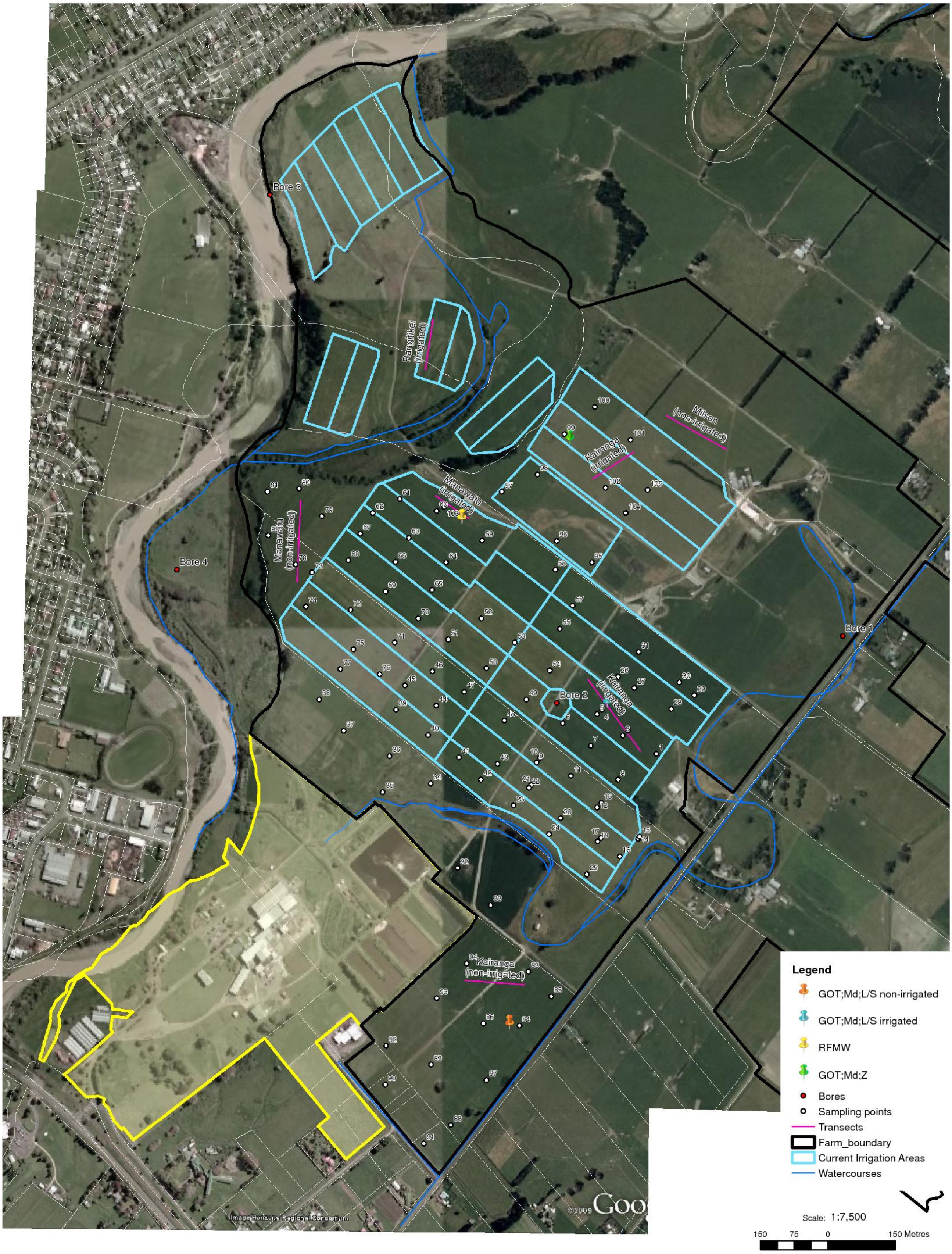
Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF, 2009. *Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land*. 3rd ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163pp.

McLaren, R.G., Cameron, K.C. 1996. *Soil Science. Sustainable Production And Environmental Protection.* Oxford University Press. Auckland, New Zealand.

APPENDIX A
FIGURES

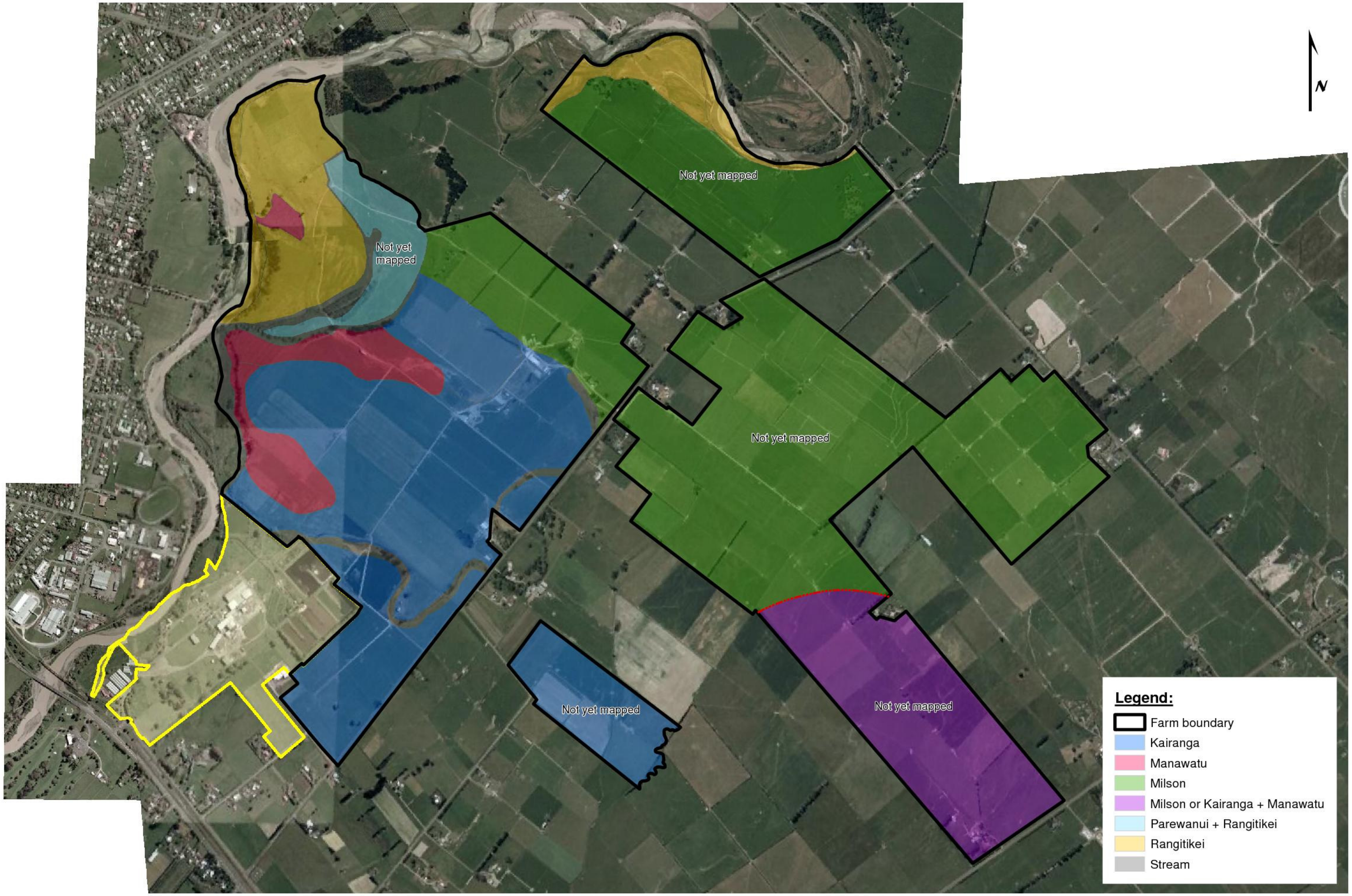
(Removed to AEE document)

APPENDIX B
SOIL MAPS



Revision Designed Approved	By	Date	CPG New Zealand Ltd Level 3, Rangitikei House 89-93 Rangitikei Street PO Box 562 Palmerston North Phone 06 354 4501 Fax 06 354 4516	Sheet Title Soil Sample and Monitoring Bore Locations Byreburn Ltd Farm Project Title Consents Application	Client AFFCO New Zealand Ltd Manawatu Accurate to: 1:5,000 Project Ref 303275 Rev A

Figure 4: Locations of Soil And Water Quality Samples



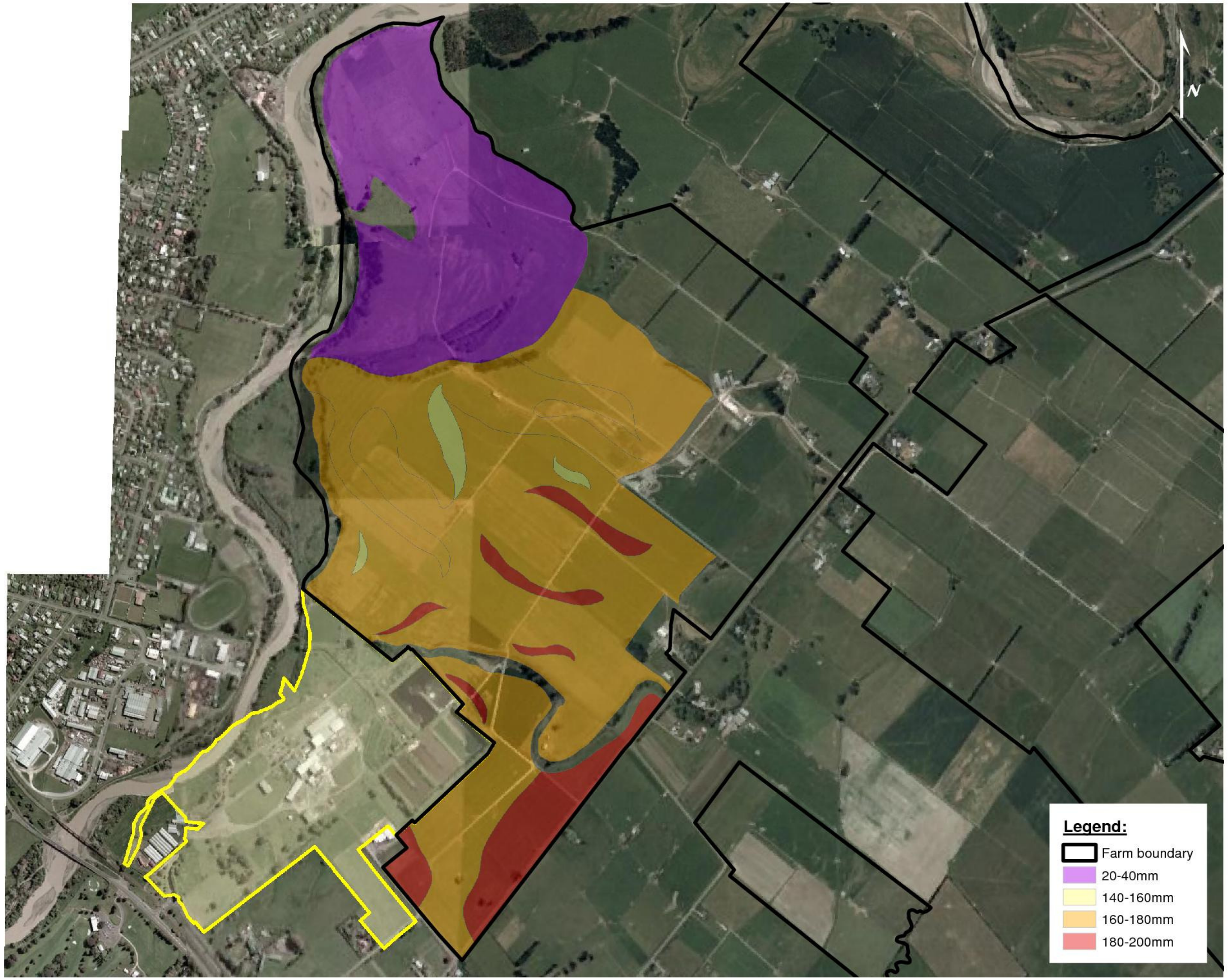
Revision Designed Approved	By	Date	CPG New Zealand Ltd Level 3, Rangitikei House 89-93 Rangitikei Street PO Box 562 Palmerston North Phone 06 354 4501 Fax 06 354 4516	Sheet Title Map of Soils, Byreburn Ltd Farm, Aorangi Road, Feilding	Project Title Consents Application	Client AFFCO New Zealand Ltd Manawatu

Accurate to: 1:5,000
Scale: 1:12,500
250 125 0 250 Metres
Project Ref 303275 Rev A

Figure 5: 1:5,000 Soil Map

Revision Designed Approved	By	Date	CPG New Zealand Ltd Level 3, Rangitikei House 89-93 Rangitikei Street PO Box 562 Palmerston North Phone 06 354 4501 Fax 06 354 4516	Sheet Title Land Use Capability Byreburn Ltd Farm, Aorangi Road, Feilding	Project Title Consents Application	Client AFFCO New Zealand Ltd Manawatu	Scale: 1:12,500 250 125 0 250 Metres Accurate to: 1:5,000 Project Ref: 303275 Rev A

Figure 6: 1:5,000 Land Use Capability



Revision Designed Approved	By	Date	CPG New Zealand Ltd Level 3, Rangitikei House 89-93 Rangitikei Street PO Box 562 Palmerston North Phone 06 354 4501 Fax 06 354 4516	Sheet Title Available Water Holding Capacity Byreburn Ltd Farm Aorangi Road, Feilding	Project Title Consents Application	Client AFFCO New Zealand Ltd Manawatu

Scale: 1:10,000

210 105 0 210 Metres

Accurate to: 1:5,000

Project Ref: 303275 Rev A

Figure 7: 1:5,000 Available Water Holding Capacity Map

APPENDIX C
SOIL PROFILE DESCRIPTIONS

Soil Profile

Soil	Kairanga silt loam over sand	***Profile Number***	1
Client	Affco	***Job Number***	702203
Soil	Typic Orthic Gley	***Parent Material***	Alluvium
Land Use Capability Class	2w2	***Soil Category ****	4
Survey Date	26/07/2010	***Soil Surveyor***	Sharn Hainsworth
Site Address	Aorangi Road, Feilding	***Vegetation***	High producing pasture
Site Map Reference (NZMS 260)	6187125N 2611869E	***Slope (°)***	0-3°
Survey Purpose	Wastewater Irrigation		
Land Use	Intensive dairy farming and land treatment of wastewater.		
Drainage	Poorly drained	***Average Annual Rainfall (mm)***	1,005 mm
Topography	Low river terrace.	***Elevation (m amsl)***	78 m

** Draft ASNZ 1547:2007*

Base Depth (cm)	Horizon	Horizon description
20	Apg	Grey-brown (10 YR 5/2) silty loam. Slightly sticky, slightly plastic, 22% clay. Abundant fine roots. Many earthworms. Moderately pedal (75%). Fine polyhedral structure. Weak ped strength. Weak soil strength.
70	Bg	Grey (5 Y 7/2) matrix with 20% 2-4 mm reddish-orange (7.5 YR 5/8) redox mottles. Silty loam. Slightly sticky, slightly plastic, 22% clay. Common fine roots. Moderately pedal (75%). Medium to coarse prismatic breaking to medium polyhedral structure. Weak ped strength. Weak soil strength.
100+	2Cg	Dark grey (5 Y 6/2) matrix with 15% 6-10 mm reddish (5 YR 4/6) redox mottles. Loamy sand. Non sticky, non plastic. Apedal single grain. Loose.

<u>**Soil Profile**</u>

Soil	Manawatu mottled silt loam over loamy sand	***Profile Number***	2
Client	Affco	***Job Number***	702203
Soil	Weathered Mottled Fluvial Recent soil	***Parent Material***	Alluvium
Land Use Capability Class	2w2	***Soil Category ****	4
Survey Date	26/07/2010	***Soil Surveyor***	Sharn Hainsworth
Site Address	Aorangi Road, Feilding	***Vegetation***	High producing pasture
***Site Map Reference* (NZMS 260)**	6187125N 2611869E	***Slope (°)***	0-3°
Survey Purpose	Wastewater Irrigation		
Land Use	Intensive dairy farming and land treatment of wastewater.		
Drainage	Poorly drained	***Average Annual Rainfall (mm)***	1,005 mm
Topography	Low river terrace.	***Elevation (m amsl)***	79 m

** Draft ASNZ 1547:2007*

Base Depth (cm)	Horizon	Horizon description
20	Ap	Brown (10 YR 4/2) silty loam. Slightly sticky, slightly plastic, 20% clay. Abundant fine roots. Many earthworms. Moderately pedal (75%). Fine polyhedral structure. Weak ped strength. Weak soil strength.
80	Bw(g)	Yellow brown (7.5 YR 5/4) matrix with 10% 2-4 mm grey (5 Y 7/2) gley mottles. Silty loam. Slightly sticky, slightly plastic, 20% clay. Common fine roots. Weakly pedal (75%). Medium polyhedral structure. Weak ped strength. Weak soil strength.
100+	2Cg	Dark grey (5 Y 6/2) matrix with 15% 6-10 mm reddish (5 YR 4/6) redox mottles. Loamy sand. Non sticky, non plastic. Apedal single grain. Loose. 20% 20-50 mm slightly weathered, sub-rounded, sub-angular greywacke gravels.

Soil Profile

Soil	Kairanga silt loam	***Profile Number***	4
Client	Affco	***Job Number***	702203
Soil	Typic Orthic Gley	***Parent Material***	Alluvium
Land Use Capability Class	2w2	***Soil Category****	4
Survey Date	26/07/2010	***Soil Surveyor***	Sharn Hainsworth
Site Address	Aorangi Road, Feilding	***Vegetation***	High producing pasture
Site Map Reference (NZMS 260)	6187125N 2611869E	***Slope (°)***	0-3°
Survey Purpose	Wastewater irrigation	***Land Use***	Intensive dairy farming and land treatment of wastewater.
Drainage	Poorly drained	***Average Annual Rainfall (mm)***	1,005 mm
Topography	Low river terrace.	***Elevation (m amsl)***	76 m

** Draft ASNZ 1547:2007*

Base Depth (cm)	Horizon	Horizon description
20	Apg	Grey-brown (10 YR 5/2) silty loam. Slightly sticky, slightly plastic, 22% clay. Abundant fine roots. Many earthworms. Moderately pedal (75%). Fine polyhedral structure. Weak ped strength. Weak soil strength.
70	Bg1	Grey (5 Y 7/2) matrix with 20% 2-4 mm reddish-orange (7.5 YR 5/8) redox mottles. Silty loam. Slightly sticky, slightly plastic, 22% clay. Common fine roots. Moderately pedal (75%). Medium to coarse prismatic breaking to medium polyhedral structure. Weak ped strength. Weak soil strength.
85	Bg2	Grey (5 Y 7/2) matrix with 35% 2-4 mm reddish-orange (7.5 YR 5/8) redox mottles. Silty loam. Slightly sticky, slightly plastic, 22% clay. Common fine roots. Weakly pedal (30%). Medium prismatic structure. Weak ped strength. Weak to slightly firm soil strength.
100+	Cg	Grey (5 Y 7/2) matrix with 20% 2-4 mm reddish-orange (7.5 YR 5/8) redox mottles. Silty loam. Slightly sticky, slightly plastic, 22% clay. Few fine roots. Apedal massive. Weak soil strength.

APPENDIX D
SOIL FERTILITY TEST RESULTS

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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ANALYSIS REPORT

Client:	CPG New Zealand Ltd	**Lab No:**	811922 svgpv1
Address:	PO Box 562	**Date Registered:**	27-Jul-2010
	PALMERSTON NORTH 4440	**Date Reported:**	04-Aug-2010
		Quote No:	41622
		Order No:	
		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

Soil Analysis Results

Sample Name:		125- Got Other Side- C. Shed	122- Other Block- River End	120- Other Block Roadside	Block Past Feed Pad PPJ	Gravel Block	Main Block Got, Md, L
Lab Number:		811922.1	811922.2	811922.3	811922.4	811922.5	811922.6
Sample Type:		SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture
Sample Type Code:		S1	S1	S1	S1	S1	S1
pH	pH Units	6.2	6.6	6.3	5.7	6.3	6.4
Olsen Phosphorus	mg/L	54	30	25	24	48	30
Anion Storage Capacity (estimated)*	%	33	32	38	42	26	28
Potassium	me/100g	1.21	0.55	0.52	0.65	1.84	0.54
Potassium	%BS	5.1	2.8	3.5	3.2	12.0	3.7
Potassium	MAF units	19	11	10	12	33	10
Calcium	me/100g	13.4	13.5	9.5	10.9	6.6	8.6
Calcium	%BS	56	68	64	53	43	60
Calcium	MAF units	13	16	11	12	7	10
Magnesium	me/100g	3.59	2.33	1.43	2.16	2.74	1.62
Magnesium	%BS	15.1	11.8	9.6	10.5	17.8	11.2
Magnesium	MAF units	63	49	29	44	55	33
Sodium	me/100g	0.50	0.18	0.17	0.20	0.20	0.37
Sodium	%BS	2.1	0.9	1.1	1.0	1.3	2.6
Sodium	MAF units	18	8	7	8	8	16
CEC	me/100g	24	20	15	21	15	14
Total Base Saturation	%	78	84	78	68	74	77
Volume Weight	g/mL	0.78	0.93	0.91	0.90	0.89	0.91
Sulphate Sulphur	mg/kg	5	6	10	13	3	12
Organic Sulphur	mg/kg	11	9	7	6	7	8
Available Nitrogen (15cm Depth)*	kg/ha	256	222	171	147	288	139
Anaerobically Mineralisable N*	µg/g	219	158	125	110	217	102
Organic Matter*	%	8.8	7.1	5.8	5.9	8.5	5.0
Total Carbon*	%	5.1	4.1	3.4	3.4	5.0	2.9
Total Nitrogen*	%	0.51	0.46	0.35	0.33	0.50	0.30
C/N Ratio*		10.1	9.0	9.6	10.3	9.9	9.6

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		Quote No:	41622
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		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

Soil Analysis Results

Sample Name:	125- Got Other Side- C. Shed	122- Other Block- River End	120- Other Block Roadside	Block Past Feed Pad PPJ	Gravel Block	Main Block Got, Md, L
Lab Number:	811922.1	811922.2	811922.3	811922.4	811922.5	811922.6
Sample Type:	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture	SOIL Mixed Pasture
Sample Type Code:	S1	S1	S1	S1	S1	S1
Anaerobically Mineralisable N/Total% N Ratio*	4.3	3.5	3.5	3.3	4.3	3.4

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		Quote No:	41622
		Order No:	
		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

Soil Analysis Results

Sample Name:		Main Block Got Md, L/S	Main Block RFMW				
Lab Number:		811922.7	811922.8				
Sample Type:		SOIL Mixed Pasture	SOIL Mixed Pasture				
Sample Type Code:		S1	S1				
pH	pH Units	6.5	5.4	-	-	-	-
Olsen Phosphorus	mg/L	53	45	-	-	-	-
Anion Storage Capacity (estimated)*	%	31	36	-	-	-	-
Potassium	me/100g	1.16	0.40	-	-	-	-
Potassium	%BS	7.7	3.0	-	-	-	-
Potassium	MAF units	22	8	-	-	-	-
Calcium	me/100g	9.0	4.4	-	-	-	-
Calcium	%BS	61	33	-	-	-	-
Calcium	MAF units	11	5	-	-	-	-
Magnesium	me/100g	1.63	1.12	-	-	-	-
Magnesium	%BS	10.9	8.4	-	-	-	-
Magnesium	MAF units	34	23	-	-	-	-
Sodium	me/100g	0.43	0.28	-	-	-	-
Sodium	%BS	2.9	2.1	-	-	-	-
Sodium	MAF units	19	12	-	-	-	-
CEC	me/100g	15	13	-	-	-	-
Total Base Saturation	%	82	46	-	-	-	-
Volume Weight	g/mL	0.94	0.91	-	-	-	-
Sulphate Sulphur	mg/kg	11	15	-	-	-	-
Organic Sulphur	mg/kg	6	6	-	-	-	-
Available Nitrogen (15cm Depth)*	kg/ha	143	81	-	-	-	-
Anaerobically Mineralisable N*	µg/g	102	59	-	-	-	-
Organic Matter*	%	5.7	5.4	-	-	-	-
Total Carbon	%	3.3	3.1	-	-	-	-
Total Nitrogen	%	0.34	0.31	-	-	-	-
C/N Ratio*		9.7	10.1	-	-	-	-
Anaerobically Mineralisable N/Total N Ratio*	%	3.0	1.9	-	-	-	-

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		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

Analyst's Comments

The AN (kg/ha) test above assumes the sample is taken to a 15 cm depth. If the depth is 7.5 cm, then the level above should be divided by two.

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Client:	CPG New Zealand Ltd	**Lab No:**	811922 svgpv1
Address:	PO Box 562	**Date Registered:**	27-Jul-2010
	PALMERSTON NORTH 4440	**Date Reported:**	04-Aug-2010
		Quote No:	41622
		Order No:	
		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Samples
Sample Registration*	Samples were registered according to instructions received.	-	1-8
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-8
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-8
Olsen Phosphorus	Olsen extraction followed by Molybdenum Blue colorimetry.	1 mg/L	1-8
Anion Storage Capacity (estimated)*	Equilibration with 0.02M potassium phosphate solution followed by ICP-OES. The standard sulphur extract is utilised, where the extraction conditions differ from the reference method. An in-house conversion formula is used to convert this result to the reference method equivalent.	7 %	1-8
Sulphate Sulphur	0.02M Potassium phosphate extraction followed by Ion Chromatography.	1 mg/kg	1-8
Potassium (MAF)	1M Neutral ammonium acetate extraction followed by ICP-OES.	2 MAF units	1-8
Calcium (MAF)	1M Neutral ammonium acetate extraction followed by ICP-OES.	2 MAF units	1-8
Magnesium (MAF)	1M Neutral ammonium acetate extraction followed by ICP-OES.	2 MAF units	1-8
Sodium (MAF)	1M Neutral ammonium acetate extraction followed by ICP-OES.	2 MAF units	1-8
Organic Sulphur	0.02M Potassium phosphate extraction. Total extractable S is determined by ICP-OES from which the sulphate-S is subtracted.	2 mg/kg	1-8
Available Nitrogen	Anaerobic incubation followed by extraction using 2M KCl followed by Berthelot colorimetry. (Calculation based on 15cm depth sample).	1 mg/L	5
Available Nitrogen*	Determined by NIR, calibration based on Available N by Anaerobic incubation followed by extraction using 2M KCl followed by Berthelot colorimetry. (Calculation based on 15cm depth sample).	1 mg/L	1-4, 6-8
Anaerobically Mineralisable N*	As for Available Nitrogen but reported as µg/g.	5 µg/g	1-8
Organic Matter*	Organic Matter is 1.72 x Total Carbon.	0.2 %	1-8
Total Carbon	Dumas combustion.	0.1 %	2, 5, 7-8
Total Nitrogen	Dumas combustion.	0.04 %	2, 5, 7-8
Total Carbon*	Determined by NIR, calibration based on Total Carbon by Dumas combustion.	0.1 %	1, 3-4, 6
Total Nitrogen*	Determined by NIR, calibration based on Total N by Dumas combustion.	0.04 %	1, 3-4, 6
Potassium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.01 me/100g	1-8
Calcium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.5 me/100g	1-8
Magnesium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.04 me/100g	1-8
Sodium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.05 me/100g	1-8
Potassium (Sat)	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.1 %BS	1-8
Calcium (Sat)	1M Neutral ammonium acetate extraction followed by ICP-OES.	1 %BS	1-8

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	CPG New Zealand Ltd	**Lab No:**	811922 svgpv1
Address:	PO Box 562	**Date Registered:**	27-Jul-2010
	PALMERSTON NORTH 4440	**Date Reported:**	04-Aug-2010
		Quote No:	41622
		Order No:	
		Client Reference:	
Phone:	06 354 4501	**Submitted By:**	Sharn Hainsworth

Sample Type: Soil

Test	Method Description	Default Detection Limit	Samples
Magnesium (Sat)	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.2 %BS	1-8
Sodium (Sat)	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.1 %BS	1-8
CEC	Summation of extractable cations (K, Ca, Mg, Na) and extractable acidity.	2 me/100g	1-8
Total Base Saturation	Calculated from Extractable Cations and Cation Exchange Capacity.	5 %	1-8
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-8

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

FMCalvert

Fiona Calvert NZCS
Client Services Manager - Agriculture Division

APPENDIX E
MONITORING BORE WATER QUALITY TEST RESULTS

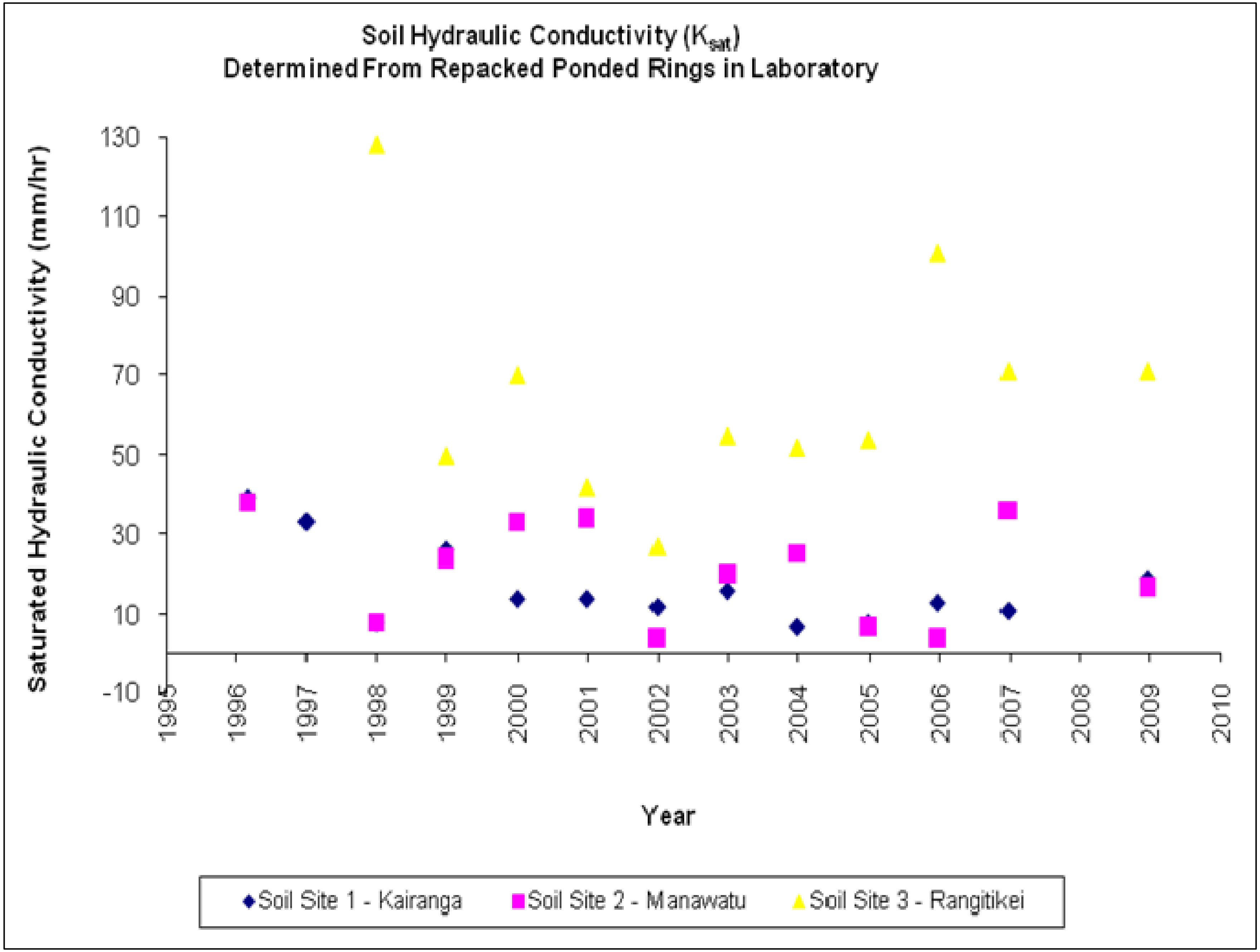
Date	Bore		
	1	**3**	**4**
15/12/1999	0.01	3	7
22/02/2000	0.01	2.7	10.3
30/03/2000	0.01	2	7
3/05/2000	0.03	2.8	6.5
6/12/2000	0	3.1	6.3
4/01/2001	0	3	6.6
12/02/2001	0	3	7
14/03/2001	0.1	0.01	0.1
1/05/2001	0.13	0.003	0.01
26/02/2002	0.2	0.003	0.1
25/03/2002	0.1	0.003	0.1
7/01/2003	0.009	0.01	0.003
3/02/2003	0.05	0.05	0.06
26/03/2003			
7/05/2003	0.13	0.73	0.06
18/12/2004	0.1	0.5	0.05
22/01/2004	0.14	0.74	0.05
29/12/2004	0.16	0.01	0.03
26/01/2005	0.11	0.01	0.01
22/02/2005	0.08	0.03	0.02
21/03/2005	0.15	0.01	0.13
18/04/2005	0.25	0.01	0.13
9/01/2006	0.22	0.04	0.05
13/02/2006	0.36	0.01	0.01
14/03/2006	0.13	0.06	0.3
10/04/2006	0.18	0.02	0.02
27/03/2007	0.18	0.01	0.01
23/04/2007	0.05	0.01	0.01
18/12/2007	0.29	1.2	0.008
24/01/2008	0.073		0.013
6/03/2008	0.029	0.0098	0.004
2/04/2008	0.11	0.004	0.004
14/05/2008	0.11	0.004	0.004
29/01/2009	0.42	0.019	0.004
25/02/2009	0.42	0.42	0.42
18/03/2009	0.42	0.42	0.42
28/04/2010	0.42	0.42	0.42
20/05/2009	0.42	0.42	0.42
21/01/2010	0.42	0.42	0.42
18/02/2010	0.225	0.007	0.023
25/03/2010	0.141	0.007	0.029
21/04/2010	0.116	0.007	0.03

Table 1: Phosphate Levels (g/m^3).

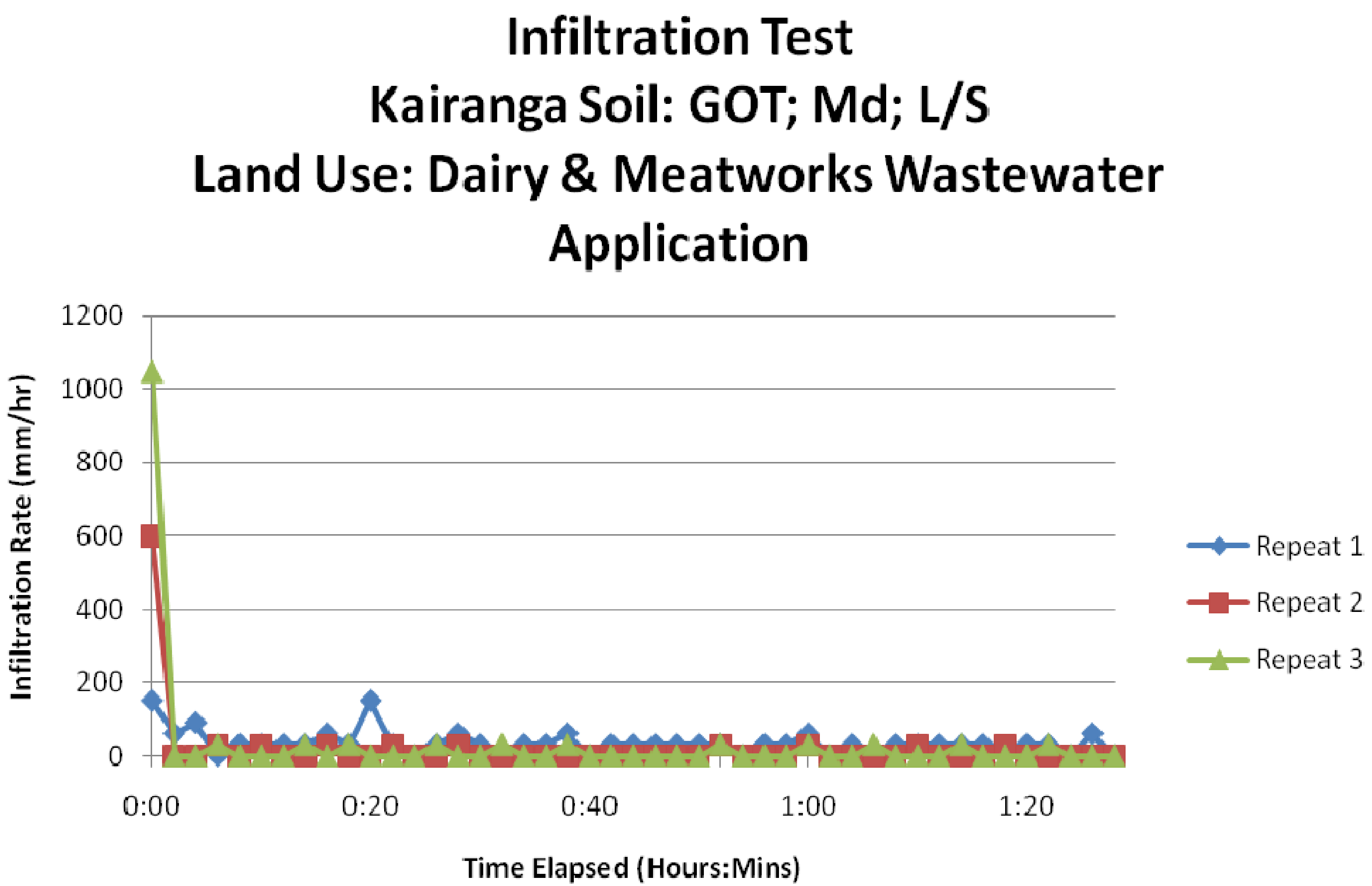
	Bore		
Date	**Bore 1**	**Bore 3**	**Bore 4**
29/12/2004	0.071	2.16	10.7
26/01/2005	0.049	4.53	8.17
22/02/2005	0.079	1.94	16.6
21/03/2005	0.218	1.03	23.6
18/04/2005	0.016	3.4	22.1
9/01/2006	0.025	4.01	11.8
13/02/2006	0.005	0.006	20.1
14/03/2006	0.05	2.83	20.5
10/04/2006	0.024	2.98	26.6
27/03/2007	0.05	0.282	31.1
23/04/2007	0.005	0.05	27
18/12/2007	0.1	0.2	0.6
24/01/2008	0.1	0.1	23
6/03/2008		0.0074	20
2/04/2008	0.0051	0.002	24
14/05/2008	0.1	2.4	29
29/01/2009	0.1	0.1	20
25/02/2009	0.1	16	31
18/03/2009	0.1	17	31
28/04/2010	0.1	0.3	27
20/05/2009	0.1	19	19
21/01/2010	0.1	1.2	22
18/02/2010	0.144	2.19	23
25/03/2010	0.005	0.129	21.4
21/04/2010	0.005	0.019	20.7

Table 2: Nitrite/Nitrate Levels (g/m^3).

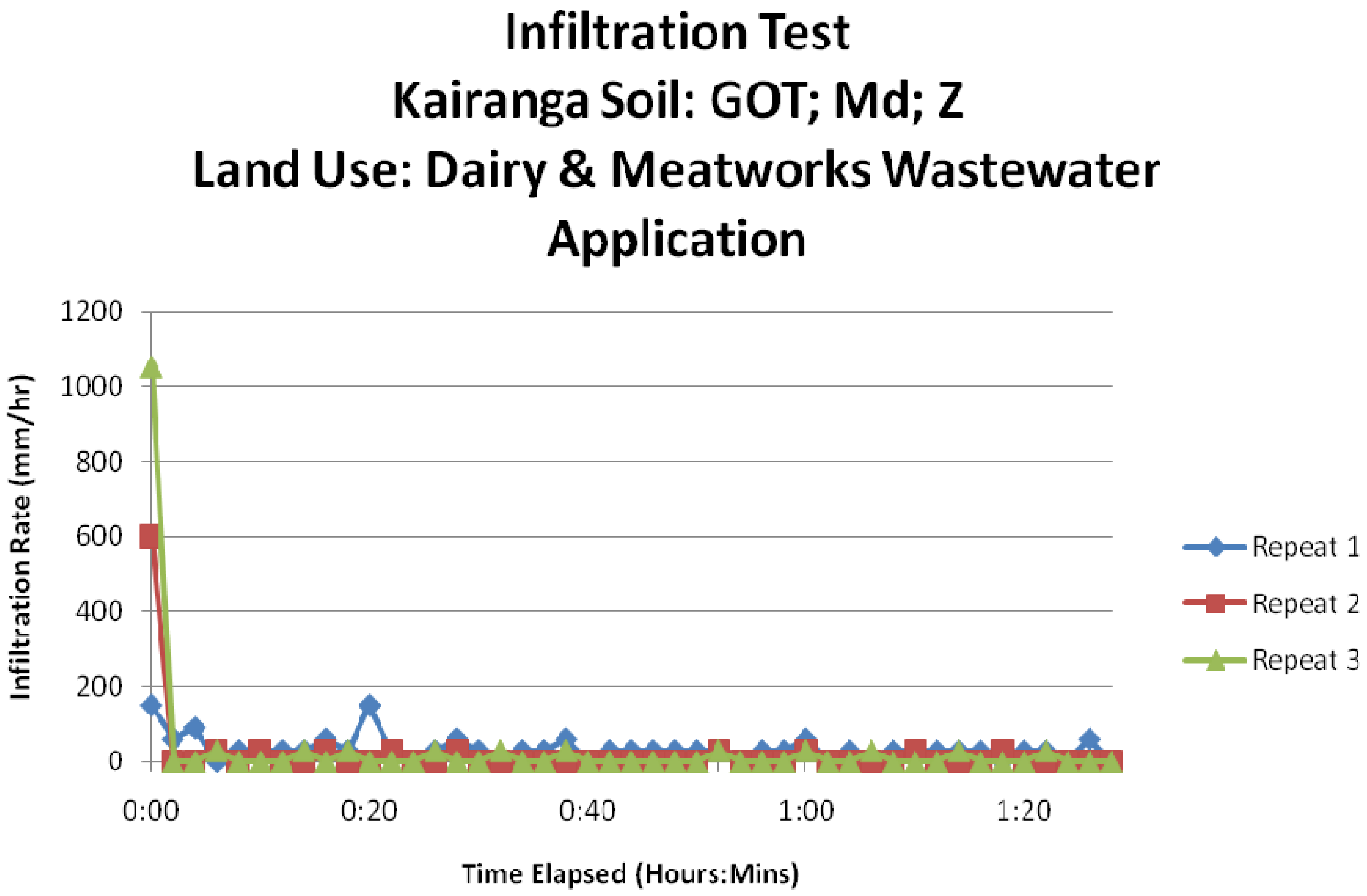
APPENDIX F
SOIL HYDRAULICS GRAPHS

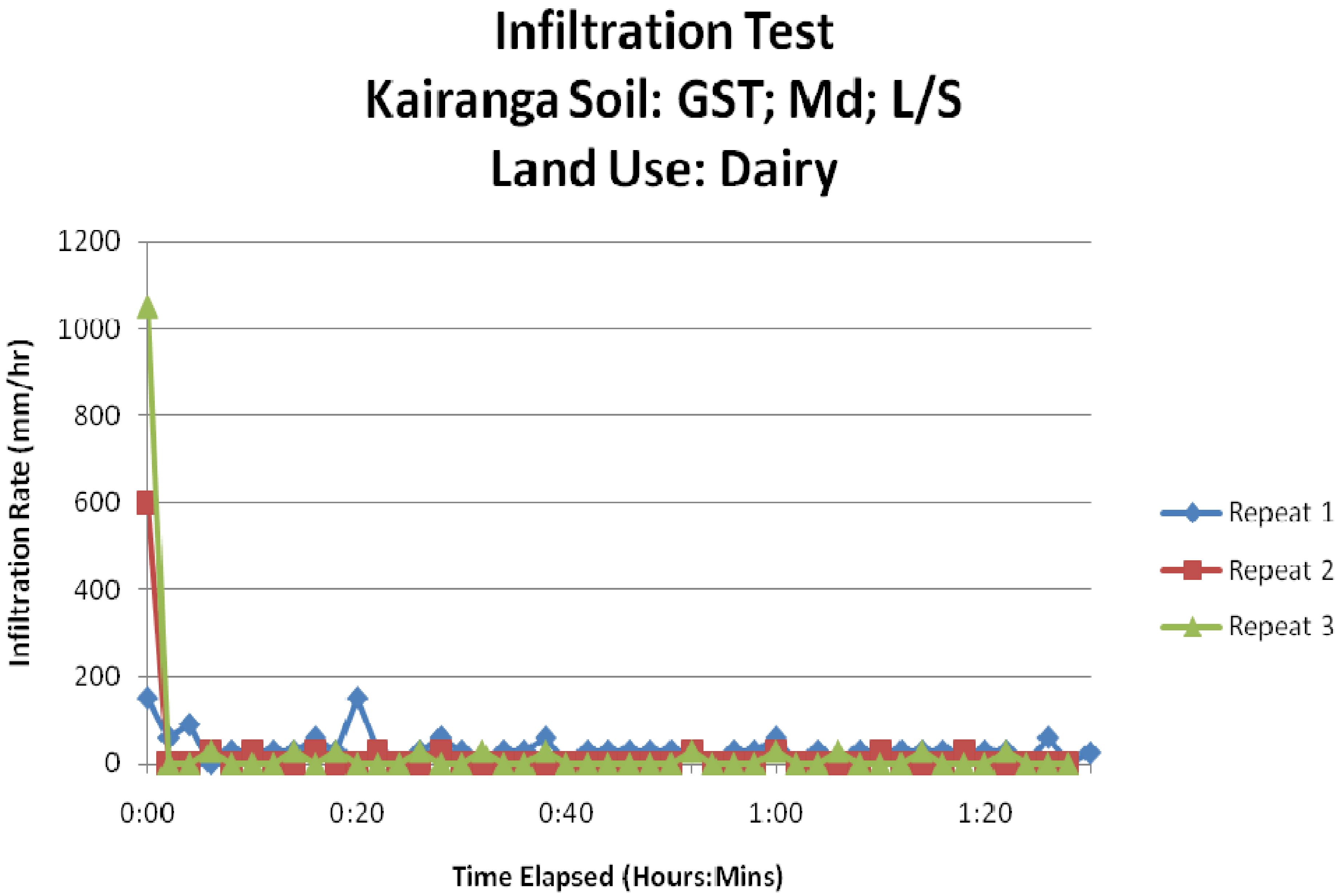


Soil Hydraulic Conductivity (Ksat)
Determined From Repacked Ponded Rings in Laboratory
Saturated Hydraulic Conductivity (mm/hr)
130
110
90
70
50
30
10
-10
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
Soil Site 1 - Kairanga
Soil Site 2 - Manawatu
Soil Site 3 - Rangitikei

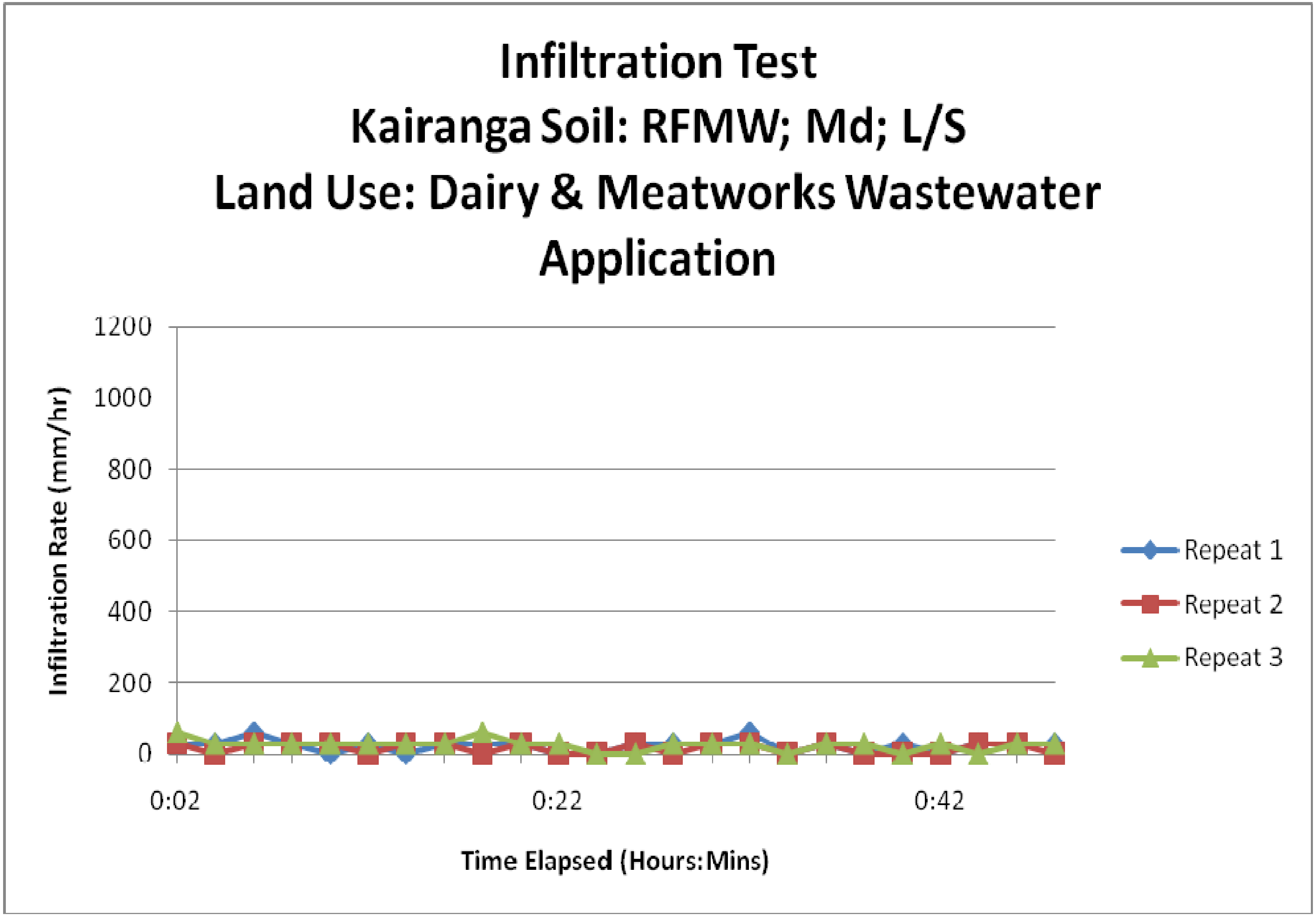


Infiltration Test
Kairanga Soil: GOT; Md; L/S
Land Use: Dairy & Meatworks Wastewater Application
Infiltration Rate (mm/hr)
1200
1000
800
600
400
200
0
0:00
0:20
0:40
1:00
1:20
Time Elapsed (Hours:Mins)
Repeat 1
Repeat 2
Repeat 3


Infiltration Test
Kairanga Soil: GOT; Md; Z
Land Use: Dairy & Meatworks Wastewater Application
Infiltration Rate (mm/hr)
1200
1000
800
600
400
200
0
0:00
0:20
0:40
1:00
1:20
Time Elapsed (Hours:Mins)
Repeat 1
Repeat 2
Repeat 3



Infiltration Test
Kairanga Soil: GST; Md; L/S
Land Use: Dairy
1200
1000
800
600
400
200
0
Infiltration Rate (mm/hr)
0:00
0:20
0:40
1:00
1:20
Time Elapsed (Hours:Mins)
Repeat 1
Repeat 2
Repeat 3


Infiltration Test
Kairanga Soil: RFMW; Md; L/S
Land Use: Dairy & Meatworks Wastewater Application
Infiltration Rate (mm/hr)
1200
1000
800
600
400
200
0
0:02
0:22
0:42
Time Elapsed (Hours:Mins)
Repeat 1
Repeat 2
Repeat 3

APPENDIX G
AVAILABLE WATER HOLDING CAPACITY RESULTS

Soil Physics Laboratory Analytical Report

Landcare Research
Manaaki Whenua

Private Bag 11052
Palmerston North 4442

phone: +64 6 353 4911
fax: +64 6 353 4801

Job Number: PJ10002

Customer: Sharn Hainsworth,
CPG Palmerston North

Reference: 303275

Date Received: 29/07/2010

Date Reported: 30/08/2010

Core no.	CPG site name	Sample ID	Particle density	Bulk density	Porosity	Gravimetric water content		Volumetric water content		AWC
						@ 10 kPa	1500 kPa	@ 10 kPa	1500 kPa	
			($g\ cm^{-3}$)	($g\ cm^{-3}$)	(%)	(%w/w)	(%w/w)	(%v/v)	(%v/v)	(%)
822	GOT;Md;L/S – Apg 1	PP10-0001	2.61	1.21	54	34	15	41	19	23
828	GOT;Md;L/S – Apg 2	PP10-0002	2.63	1.34	49	26	14	35	19	16
863	GOT;Md;L/S – Apg 3	PP10-0003	2.62	1.27	52	32	15	41	20	22
909	GOT;Md;L/S – Bg 1	PP10-0004	2.60	1.27	51	29	17	37	22	15
702	GOT;Md;L/S – Bg 2	PP10-0005	2.61	1.33	49	24	17	32	22	10
826	GOT;Md;L/S – Bg 3	PP10-0006	2.61	1.25	52	34	18	42	23	19
747	GOT;Md;L/S – 2Cg 1	PP10-0007	2.70	1.40	48	20	6	28	8	20
898	GOT;Md;L/S – 2Cg 2	PP10-0008	2.70	1.42	47	17	5	24	7	17
730	GOT;Md;L/S – 2Cg 3	PP10-0009	2.71	1.43	47	18	5	26	7	19
745	GOT;Md;Z – Apg 1	PP10-0010	2.65	1.20	55	36	21	44	25	19
950	GOT;Md;Z – Apg 2	PP10-0011	2.63	1.22	53	36	20	44	24	19
908	GOT;Md;Z – Apg 3	PP10-0012	2.62	1.18	55	40	21	47	24	22

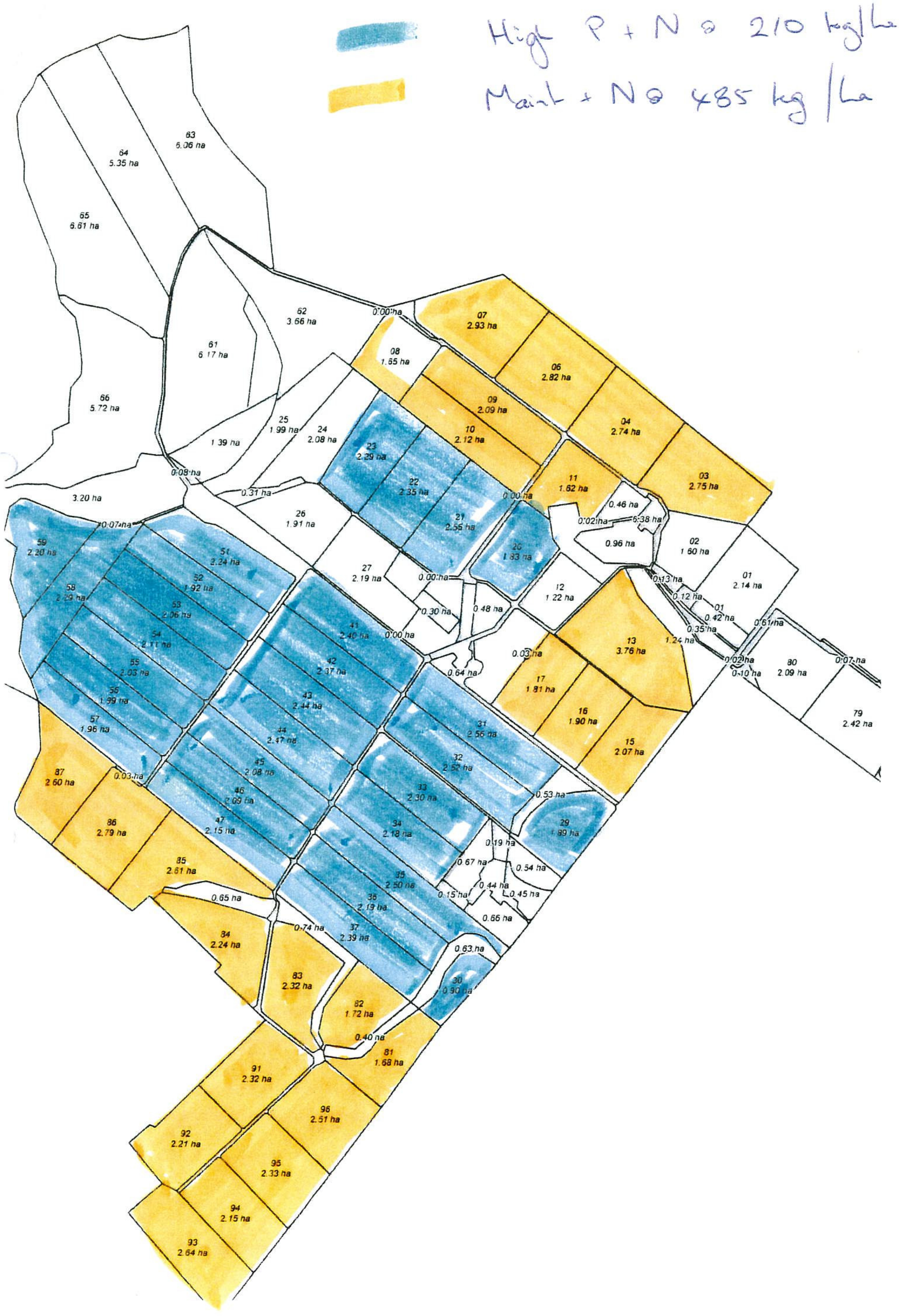
959	GOT;Md;Z – Bg 1	PP10-0013	2.71	1.33	51	31	18	42	24	18
927	GOT;Md;Z – Bg 2	PP10-0014	2.69	1.33	51	32	19	43	26	18
904	GOT;Md;Z – Bg 3	PP10-0015	2.71	1.34	51	32	19	43	25	17
878	GOT;Md;Z – 2Cg 1	PP10-0016	2.73	1.36	50	27	17	37	23	14
817	GOT;Md;Z – 2Cg 2	PP10-0017	2.71	1.39	49	27	15	38	20	18
819	GOT;Md;Z – 2Cg 3	PP10-0018	2.73	1.35	51	28	18	38	25	13
876	RFMW – Ap 1	PP10-0019	2.60	1.25	52	29	13	36	16	20
806	RFMW – Ap 2	PP10-0020	2.59	1.25	52	31	14	39	18	21
753	RFMW – Ap 3	PP10-0021	2.62	1.24	52	30	13	37	16	21
807	RFMW – Bw(g) 1	PP10-0022	2.69	1.37	49	26	11	35	15	21
835	RFMW – Bw(g) 2	PP10-0023	2.67	1.36	49	25	10	35	14	21
831	RFMW – Bw(g) 3	PP10-0024	2.68	1.34	50	25	10	33	14	19
995	RFMW – 2Cg 1	PP10-0025	2.68	1.45	46	16	5	23	8	15
941	RFMW – 2Cg 2	PP10-0026	2.69	1.42	47	15	4	22	6	16
896	RFMW – 2Cg 3	PP10-0027	2.67	1.42	47	17	4	24	6	18

Note: all sampled by client.

JL Dando

Laboratory manager

APPENDIX H
FERTILISER MANAGEMENT UNITS



High P + N @ 210 kg/ha
Maint + N @ 485 kg/ha
63 6.06 ha
64 5.35 ha
65 6.61 ha
66 5.72 ha
61 6.17 ha
62 3.66 ha
1.39 ha
3.20 ha
07 2.93 ha
08 1.65 ha
06 2.82 ha
09 2.09 ha
10 2.12 ha
04 2.74 ha
03 2.75 ha
11 1.62 ha
25 1.99 ha
24 2.08 ha
23 2.29 ha
22 2.35 ha
21 2.55 ha
20 1.83 ha
26 1.91 ha
27 2.19 ha
02 1.60 ha
01 2.14 ha
0.96 ha
12 1.22 ha
13 3.76 ha
59 2.20 ha
58 2.29 ha
51 2.24 ha
52 1.92 ha
53 2.06 ha
54 2.11 ha
55 2.03 ha
56 1.99 ha
57 1.96 ha
41 2.40 ha
42 2.37 ha
43 2.44 ha
44 2.47 ha
45 2.08 ha
46 2.09 ha
47 2.15 ha
17 1.81 ha
16 1.90 ha
15 2.07 ha
80 2.09 ha
79 2.42 ha
31 2.56 ha
32 2.52 ha
33 2.30 ha
34 2.18 ha
35 2.50 ha
36 2.19 ha
37 2.39 ha
29 1.89 ha
30 0.90 ha
87 2.60 ha
86 2.79 ha
85 2.61 ha
84 2.24 ha
83 2.32 ha
82 1.72 ha
81 1.68 ha
91 2.32 ha
96 2.51 ha
92 2.21 ha
95 2.33 ha
94 2.15 ha
93 2.64 ha