Farm Environmental Management Plan

Report for Southdown Holdings Limited

WHL Killermont Station

August 2009

Contents

Table Index

Figure Index

Appendices

1. Introduction

The Water Quality Study ('WQS') funded by Mackenzie Water Research Limited ('MWRL'), found that the additional irrigation proposed in the catchment could take place without significant adverse effects on the environment providing that nutrient reduction occurred on the farms.

The process that was advocated for ensuring this on-farm nutrient reduction was through Farm Environmental Management Planning. A clear process for building a Farm Environmental Management Plan (FEMP) was laid out in the WQS and has been followed here. An overview schematic of the process of building a FEMP is shown in Figure 1 below.

The responsibility of the implementation, monitoring and auditing of the plan lies with the farmer.

1.1 Purpose of a Farm Environmental Management Plan

This Farm Environmental Management Plan (FEMP) has been written to serve two purposes, to ensure the proposed farm system can meet the nutrient mitigation requirements set out by the Water Quality Study, and to identify and mitigate other farm specific environmental risks that arise from the inherent characteristics of the farm or from the proposed farm system and its management. These farm specific risks include uncontrolled discharges that are not identified in farm nutrient budget modelling but that may still have an environmental effect.

1.2 Why use a Farm Environmental Management Plan?

Farm management planning and the use of best management practices and mitigation methods are commonly used to reduce diffuse pollution from farms.

Diffuse pollution, as the name suggests, does not come from a single traceable source. In many cases the impacts are both temporally and spatially distanced from the source. This makes measurement from and traceability to an individual property difficult. For this reason, instead of measuring the losses, the emphasis is placed on the implementation of techniques that are known to reduce the contaminant.

1.3 Scope of a Farm Environmental Management Plan

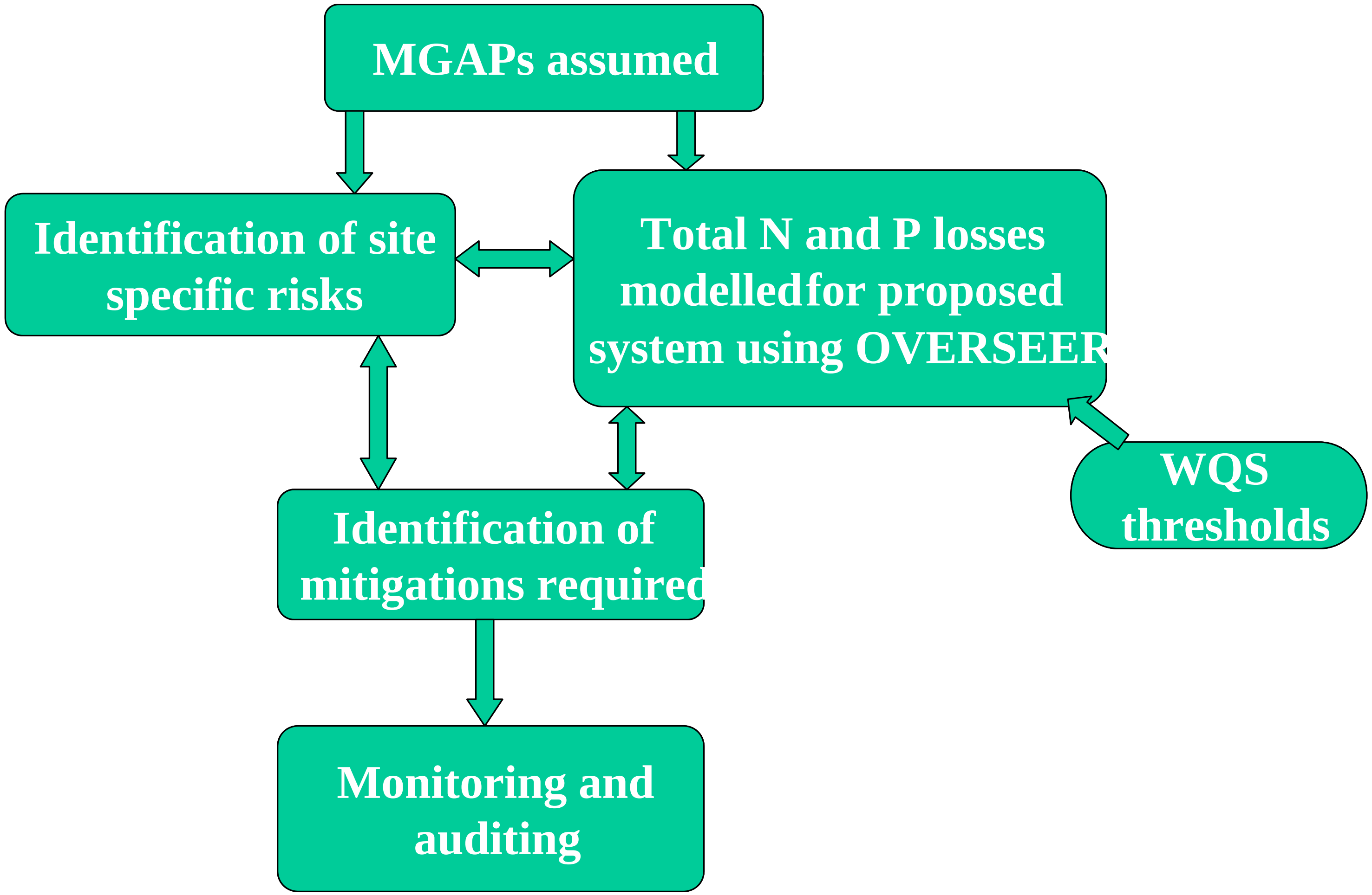
The development of a FEMP is divided into four sections:

- The first section describes Mandatory Good Agricultural Practices (MGAPs) that need to be implemented across the farm, and include the base assumptions of the OVERSEER model[1]. This helps to validate the use of the model on the property;
- The second section involves the construction of a representative farm model in OVERSEER and demonstrating the fulfilment of the nutrient mitigation required by the Water Quality Study; and
- The third section involves the identification and mitigation of site-specific environmental risks.
- The fourth section describes the proposed monitoring and auditing strategy.

---

[1] In the future, should an alternative model be used, the assumptions for that model would need to be specified in this good agricultural practice section.

Figure 1 **An overview schematic of the process of building a Farm Environmental Management Plan**



2. Farm Description

WHL Killermont station is situated approximately 5 km to the west of Omarama township (Figure 2). The station is generally flat and extends over two distinct terraces and is approximately 1,200ha. There is no irrigation currently and the very low dryland productivity of this area permits only occasional grazing by sheep. The land is currently unimproved (

Figure 3) with scattered exotic grasses, hawkweed, Sheep’s sorrel (Mitchell Partnerships, 2009) and an extensive *Heiracium* infestation. In addition there are large areas with little or no groundcover.

Figure 2 Location map for WHL Killermont

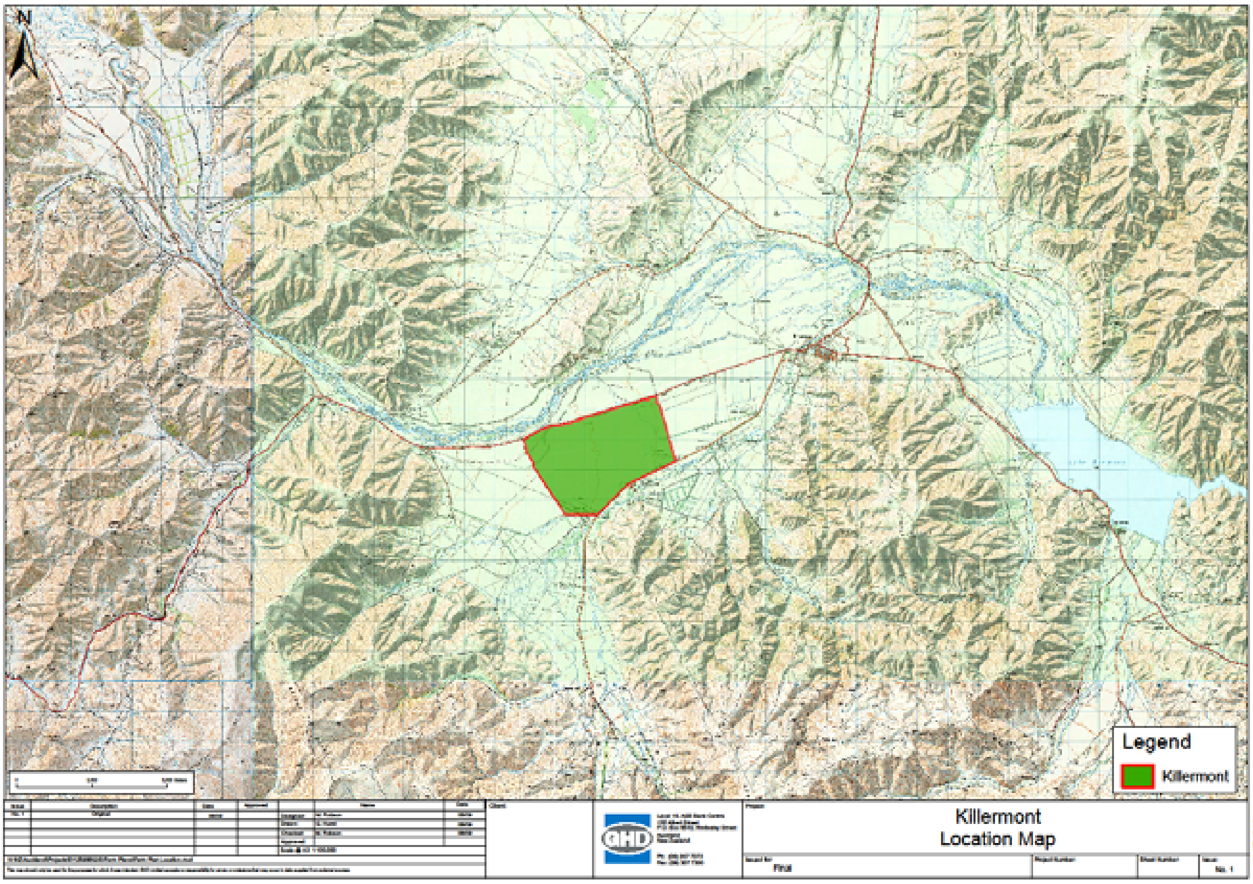


Figure 3 Current land use on WHL Killermont

2.1 Soils

The soils on WHL Killermont are Mackenzie series. They are predominantly shallow and stony and excessively to somewhat excessively well drained, and are characterized by sandy loam to very stony loamy sand top soils and B horizons over very stony sand C horizons below 30 cm (Webb, 1992). Most variations in soil properties are related to depth and stoniness (Webb, 1992). During the site visit soil pits revealed that the stones found at varying depths were smooth rounded river pebbles. A detailed soil survey was conducted by Webb (1992) on WHL Killermont and found six variations of Mackenzie soils in a 10 x 50 m plot, with over 90 % as shallow, shallow with stones or stony sandy loams.

A 100 m transects was sampled from 0-10 cm and below 10 cm. 10 cores were drilled at 10 m spacing along the transect and a representative bulked sample was taken. Figure 4 shows the location of the transect. Soil pits were dug and penetrometer readings taken along the transect and on two other sites to assess uniformity of the soils across the property.

In the analysed soils, the soils had reasonable pH at 5.7-5.8, good Olsen P and base saturation in the surface soils, however, low total carbon, total nitrogen and cation exchange capacity. Below 10 cm, while the pH remained similar, the soil had very low Olsen P and lower base saturation and lower carbon and nitrogen.

Figure 4 Location of soil transects and soil pits on WHL Killermont

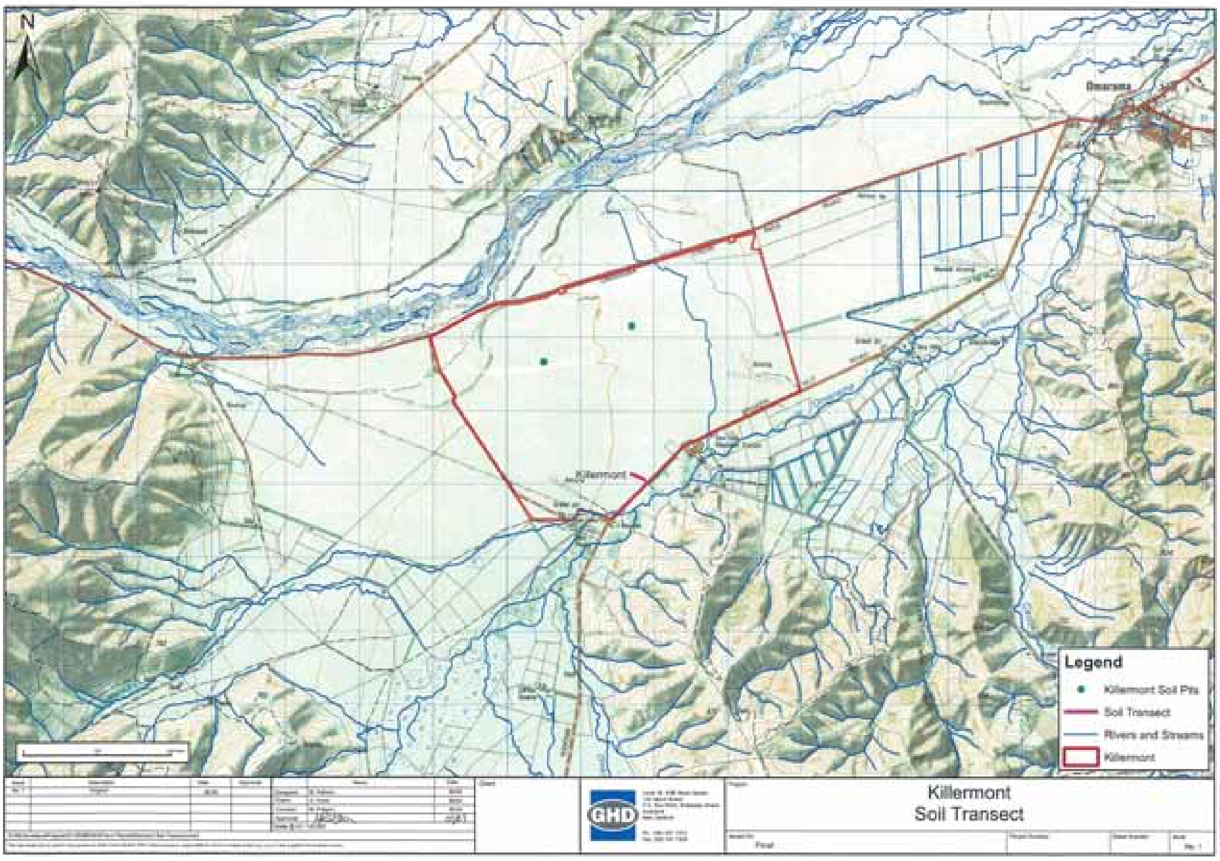
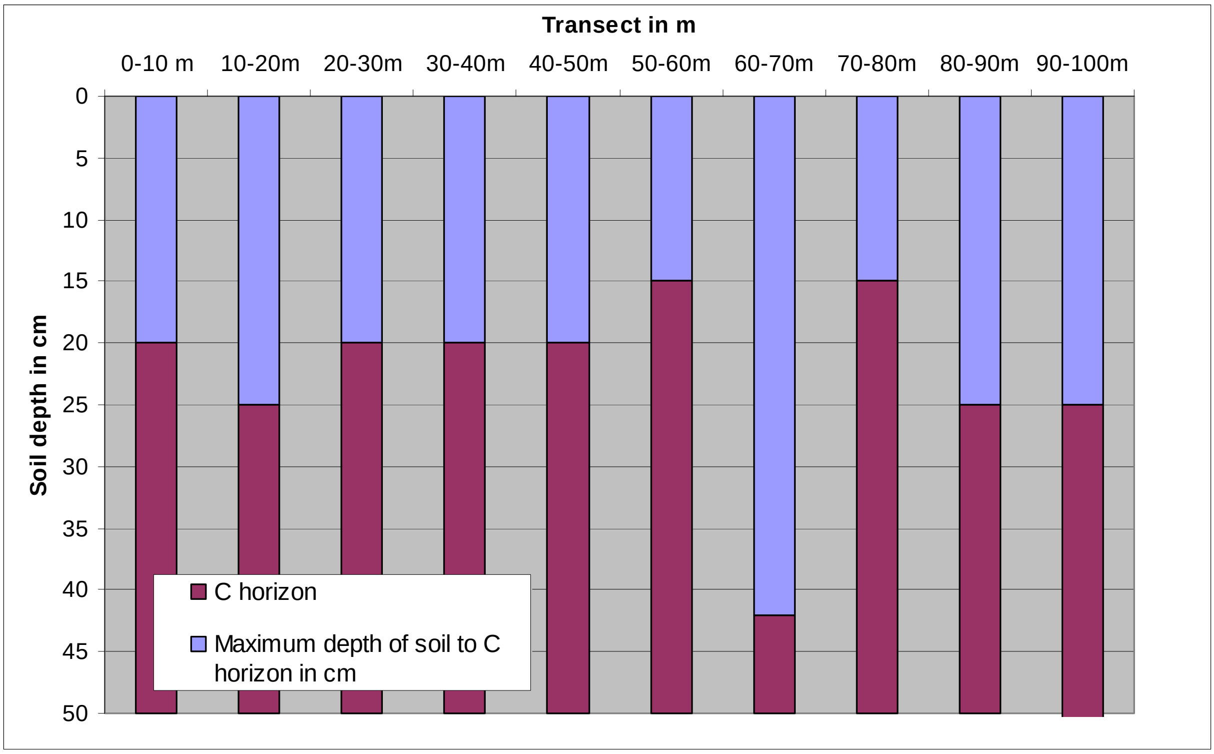


Figure 5 below shows the range of depths to C horizon in 10 m reaches along a 100 m transect. In each reach, the depth to the stones or C horizon was ascertained by probing the soil 20-30 times. A minimum and a maximum depth were recorded. No soil compaction issues were observed during site visit. The soils showed frost heave to approximately 5 cm. The soils are inherently vulnerable to erosion. The flat nature of the property reduces risk of water erosion, however soil loss due to wind erosion was evident.

Figure 5 Soil depth to stones over a 100 m transect on WHL Killermont



2.2 Climate

The climate in the Mackenzie Basin is characterized by dry summers and cold winters. Average annual rainfall on this station is 500 mm (Tait *et al*., 2006), and there is moderate variability in the monthly rainfall. Mean annual temperature is 10.3 degrees C, with a minimum winter temperature of < -2 degrees C (Snow and King, 2008).

2.3 Topography

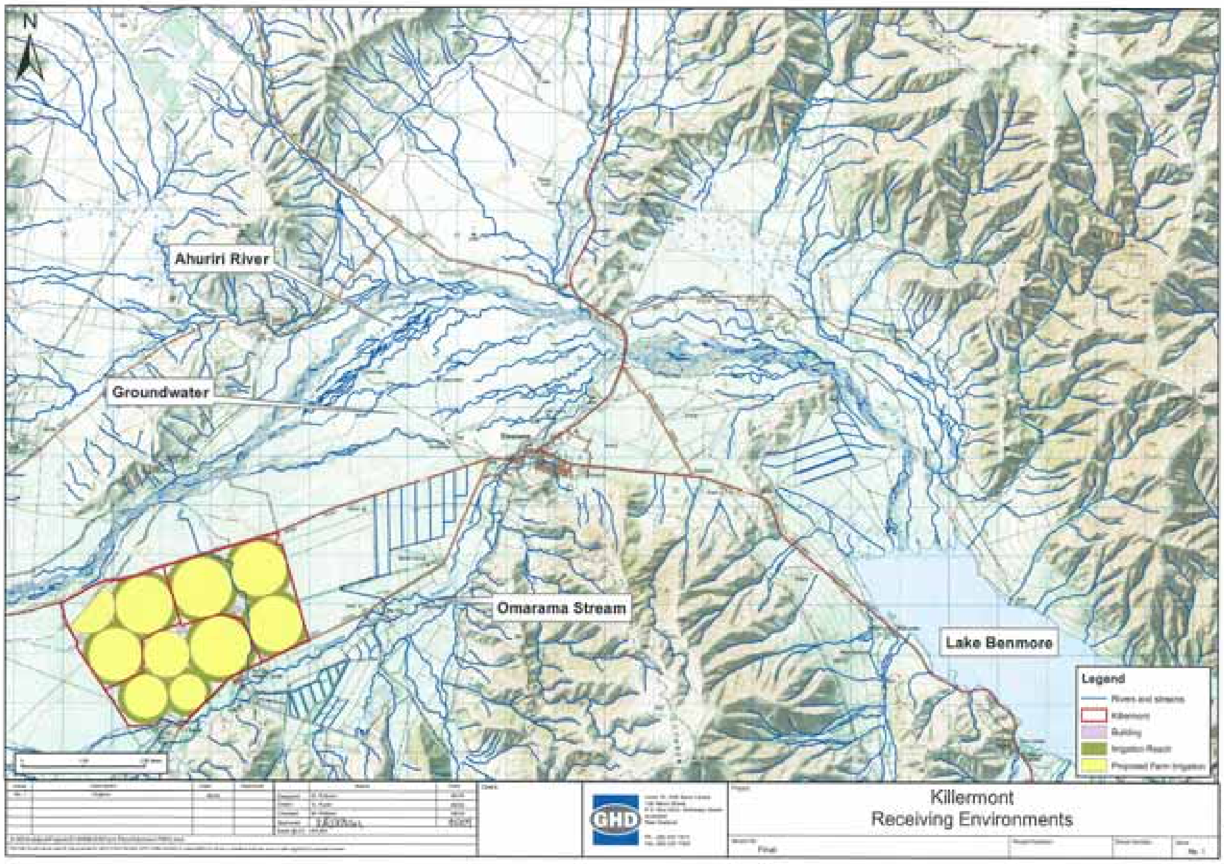
The property slopes evenly from west to east with an average gradient of 0.01m/m. The surface topography is generally flat and consists of part of the glacial outwash surface created by the Ahuriri River during the last 'Aviemore' glacial period forming the basin floor plains (Mitchell Partnerships, 2009a). An old scarp formed by the river during its transition from the outwash plain to the more recent alluvial plains cuts across the northwest corner of the property.

3. Environmental context

The environmental context of the farm is a reference both to local and wider receiving environments. Figure 6 shows the receiving environments of WHL Killermont. Due to the permeability of the soils no surface runoff is expected to occur.

The ecological value of this area is extremely low (Mitchell Partnerships, 2009). The ecological impact of proposed practices on WHL Killermont and the required mitigation for protection are discussed in full by Mitchell Partnerships (2009) and Ryder Consulting (2009) in their respective reports on ecology and aquatic ecology.

Figure 6 Map showing the receiving environments for WHL Killermont (available as an A3 in Appendix F)



3.1 Water Quality Study mitigation requirement

WHL Killermont Station, according to the WQS (GHD, 2009), lies in Ahuriri and Omarama groundwater and surface water catchments (Appendix A). More detailed investigations have confirmed the direction of groundwater movement (Appendix B).

Table 1a and Table 1b show the calculated nutrient mitigation requirement of the receiving environments determined in the WQS and the resulting thresholds for N and P for WHL Killermont.

For this farm, the Lake Benmore - Ahuriri Arm mitigation requirements are the most stringent. These mitigation requirements cap WHL Killermont's nutrient discharges at 35,262g N per annum and 551 kg P per annum. However, 1,500 kg N has been reallocated to the remainder of Killermont Station thereby reducing the N threshold to 33,762 kg N.

3.2 Local receiving environments

Due to very permeable nature of the soils and the low likelihood of overland flow or shallow interflow, the closest receiving environment are the Omarama Stream and Ahuriri River, beyond the property boundary. These two receiving environments are already considered as a part of the WQS and therefore no additional mitigation is required for other receiving environments.

The Tara Hills irrigation race traverses the property, however, there is no groundwater connectivity with this race, therefore drainage losses from the farm will not be seen in the race. The flat topography and very well drained nature of the soils precludes the possibility of surface runoff. The only sources of contamination into the race, and consequently into the Omarama sub-catchment, are direct deposition from stock or effluent irrigation and runoff from the one centre pivot track that crosses the race. Mitigation measures have been adopted to prevent these discharges.

The Manuka Creek runs across the southern corner of the farm. In terms of the groundwater direction the Manuka Creek is 'upstream' of the farm therefore drainage losses from the farm will not be seen in the creek. The very well drained nature of the soils precludes the possibility of surface runoff. The only sources of contamination into the creek, and therefore into the Omarama sub-catchment, are direct deposition from stock or effluent irrigation. Mitigation measures have been adopted to prevent these discharges.

Table 1a Water Quality Study mitigation requirements for WHL Killermont. Yellow highlights indicate receiving enviroment most restrictive mitigation (GHD, 2009)

Farm	Surface water sub-catchment	Secondary surface water subcatchment	Groundwater sub catchment	Lake Sub-catchment	Proposed whole farm N loss from WQS	Proposed whole farm P loss/ha from WQS	Stream mitigation required for periphyton kg/ha irrigated land		Secondary stream mitigation required for periphyton kg/ha irrigated land		Stream mitigation required for ANZECC kg/ha irrigated land		Secondary stream mitigation required for ANZECC kg/ha irrigated land		Groundwater mitigation required kg/ha irrigated land		Lake mitigation required kg/ha irrigated land	
							N	P	N	P	N	P	N	P	N	P	N	P
Killermont	Ahuriri	na	Ahuriri	Ahuriri Arm	46486	1669	1.1	-1.0	0	0	0	0	0	0	0	0	-10.7	-1.1
Killermont	Omarama	Omarama	Ahuriri	Ahuriri Arm	46486	1669	-3.3	0.3	1.1	-1.0	0.1	-0.1	0	0	0	0	-10.7	-1.1

Table 1b Water Quality Study mitigation requirements for WHL Killermont continued

Stream mitigation required for periphyton kg/farm		Secondary stream mitigation required for periphyton kg/farm		Stream mitigation required for ANZECC kg/farm		Secondary stream mitigation required ANZECC kg/farm		GWR mitigation required kg/farm		Lake mitigation required kg/farm		Stream mitigation threshold for periphyton kg/year		Secondary stream mitigation threshold for periphyton kg/year		Stream mitigation threshold for ANZECC kg/year		Secondary stream mitigation threshold for ANZECC kg/year		Groundwater mitigation required threshold kg/year		Lake mitigation required threshold kg/year		Overall Farm thresholds for WQS mitigation kg/year	
N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P
1153.9	-1049	0	0	0	0	0	0	0	0	-11224	-1154	47640	620	46486	1669	46486	1669	46486	1669	46486	1669	35262	515	35262	515
-3461.7	314.7	1153.9	-1049	105	-105	0	0	0	0	-11224	-1154	43024	1984	47640	620	46591	1574	46486	1669	46486	1669	35262	515	35262	515

4. FEMP development

4.1 Stage 1 – Mandatory good agricultural practices

Table 2 below shows the mandatory good agricultural practices that will be adopted. These include the base assumptions of OVERSEER and therefore help validate the use of the model on the farm.

Table 2 Mandatory good agricultural practices

Mandatory good agricultural practices	What these practices mean on farm
Fertilisers applied according to code of practice for fertiliser use (NZFRMA, 2002)	The fertiliser users' code of practice aims to ensure that where fertilisers are used that they are used safely, responsibly and effectively and in a way that avoids, remedies or mitigates any adverse environmental effects. The code of practice includes guidance on fertiliser use, application, storage, transport, handling and disposal.
Use a fertiliser recommendation system and account for all sources of nutrients including applied effluents and soil reservoirs accounted for	Planning fertiliser applications to all crops, determining crop requirement and accounting for soil nutrients and organic nutrient supplies, all reduce the risks of applying excessive fertiliser above the crop requirem ent. This maximises the economic return from the use of fertilisers and reduces the risk of causing nutrient pollution of the environment Accounting for all sources of nutrients including imported sources and soil reservoirs is an important management measure in all farming systems and become especially important on farms where manure is produced and applied to the land. The re-application of organic manures to land is often thought of as a disposal of a waste product, and the available nutrients within the organic manures are not accounted for. The use of an integrated nutrient budgeting tool such as OVERSEER automatically accounts for nutrients supplied in organic manures.
Fertiliser application applied evenly	The even application of fertiliser is an assumption of the OVERSEER model as included in the fertiliser code of practice. Fertiliser spreaders should be tested and calibrated in-house at least annually and every 5 years by an independent auditor.
Irrigation and effluent applied evenly	The even application of water and or effluent is an assumption of the OVERSEER model. Irrigators should be tested and calibrated in-house at least annually and every 5 years by an independent auditor.
Crop, cultivation, nutrient inputs and yield records kept per farm management unit	Maintaining good crop input records is important for: ◗ The calculation of cumulative annual organic fertiliser applications and also their contribution to long term nutrient supply; ◗ The prediction of realistic crop yields that are used to determine crop requirements;

	◗ Providing accurate inputs to the OVERSEER nutrient budgeting model that is being used here as a proxy for measuring diffuse nutrient losses.
Good design of irrigation systems	Design will match soil properties and low application amounts on shallower soil to prevent summer drainage.
Robust irrigation scheduling	Good irrigation scheduling to prevent summer drainage.
Supplement and feeding out management	Proper storage of supplements and responsible methods of feeding out that do not result in accumulations of excreta on small proportions of the farm. Where large amounts of supplements are fed out, a feed pad should used.
Winter grazing management	Winter management of stock to prevent pugging and high densities of stock in one area for long times.

4.2 Stage 2 – OVERSEER and meeting WQS mitigation requirements

The WQS thresholds set for WHL Killermont, using the most stringent nutrient mitigation requirement, are 33,762[2] kg N/year and 551 kg P/year. Table 3 below shows the output from OVERSEER for the modelled proposed farming system at WHL Killermont. The results illustrate that the farm system mitigations proposed meet the P thresholds set out in the WQS and surpass the requirements set out in the WQS for N.

It is important to note at this points that the proposed cubicle stable system at Killermont whereby stock are housed completely for 8 months of the year goes a long way towards ensuring that the WQS mitigation requirements are met.

A list of OVERSEER model inputs and outputs are given in Appendices D and E.

Table 3 Total N and P losses modelled by OVERSEER for the proposed farming system on WHL Killermont and WQS thresholds

	OVERSEER modelling outputs kg/year	WQS threshold kg/year
Total N leaching/runoff	17,857	33,762[3]
Total P leaching/runoff	442	515

At a highly developed setting, the modelled N losses increase to 21,496 kg N. As this is still within the WQS threshold, no further mitigation will be required when soils have reached highly developed.

[2] This new threshold includes 1500 kg N reallocated to the remainder of Killermont Station

[3] This new threshold includes 1500 kg N reallocated to the remainder of Killermont Station

4.3 Stage 3 – Identification and mitigation of site specific environmental risks

The Farm Environmental Risk Assessment (FERA) has been conducted on the proposed farming system (pre-mitigation), and has highlighted that there are potentially soil, effluent, stock, chemical, track and fertiliser site-specific environmental risks on the proposed farm. These risks are described below and are colour coded to indicate severity of risk or sensitivity of environment to risk[4]. All risks will need to be addressed in the Farm Environmental Management Plan (FEMP). The full FERA is attached as Appendix C.

4.3.1 Soil risks

The current soil risks identified are vulnerability to, and evidence of, wind erosion, and poor extent of ground cover for protection, The soil risks associated with the proposed farming system are; trafficking when wet and stock grazing over winter.

4.3.2 Effluent risks

The effluent risks associated with the proposed farming system are, clean and dirty water are not separated on the yard, close to 200 kg N from organic manures will be applied, Silage liquor is not to be collected and spread to land and that direct discharges may occur from the silage pits.

4.3.3 Fertiliser risks

The fertiliser risks associated with the proposed farming system are that more than 50 kg fertiliser N is to be applied in a single application, and applications are not to be excluded in winter and autumn, Olsen P levels may exceed 30, fertiliser spreaders are not calibrated, and a suitable storage and filling area has not been identified.

4.3.4 Stock risks

The stock risks associated with the proposed farming system are that stock are not to be excluded from the watercourses, there is no provision to control dietary N and P levels, stock will spend some time grazing over winter, and there are no provisions for further reducing winter stock nutrient losses.

4.3.5 Water risks

The water risks associated with the proposed farming system are that stock are not to be excluded from the watercourses.

4.3.6 Runoff risks

There are no runoff risks associated with the current or proposed farming system.

4.3.7 Track risks

The track risks associated with the proposed farming system are from pivot tracks where these run over a watercourse.

---

[4] High risk, medium risk low risk

4.3.8 Biodiversity risks

The ecological value of this area us extremely low as almost all of the indigenous vegetation cover has been removed. Irrigation on the flat land would have a positive impact on the ecology of the property by creating a vegetative cover to help bind the remaining soil (Mitchell Partnerships, 2009). The biodiversity values and risk from the water intake and the proposed farming system are discussed in full in Mitchell Partnerships (2009).

The aquatic and avifauna ecological value of area is discussed in full in Ryder Consulting (2009). In brief, good aquatic health has been found in the Manuka Creek which passes over a corner of the WHL Killermont property. The Tara Hills water race, which runs through the proposed irrigation area does not flow continuously and only minor aquatic values.

Most of the bird species found on the property are predominantly associated with wetland or farmland habitat, with the exception of three endemic and two native species that prefer native bush. Given the sparsity of woody vegetation within the proposed irrigation area it would appear that any direct effects caused by irrigation would not adversely affect the habitat of the majority of bird species. The main species that currently utilise the proposed irrigation area are likely to be introduced finches and skylarks *(Alauda arvensis)*, and the endemic paradise shelducks (*Tadorna variegata)*. Any irrigation and subsequent pasture and crop production is likely to be beneficial to these species (Ryder Consulting, 2009).

4.3.9 Chemical risks

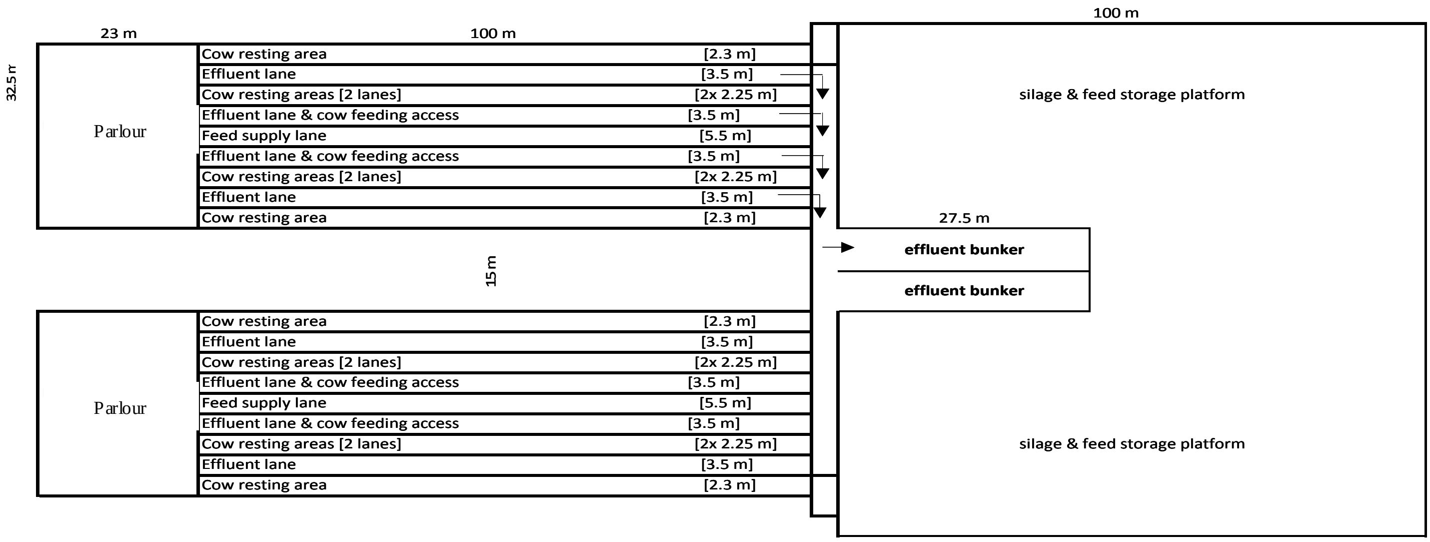
The chemical risks associated with the proposed farming system are that no provision for the safe storage, handling, using and disposing of chemicals has been made.

5. Proposed farm system with mitigations

The proposed farming system is an irrigated dairy farm with stock wintered on the farm using a cubicle stable system. The stock are planned to be housed full time for 8 months of the year and housed partially (12 hrs/day) for the remaining four months of the year. However, this system allows housing up to 365 days per year. The farm will primarily operate a cut and carry system to bring pasture to the herd in the barns. Pasture will be cut, conserved and fed to the herd throughout the year along with imported supplement (Englebrecht, 2009).

The layout of the cubicle stable is shown below in Figure 8. The plan view shows the milking sheds on the left and the layout of the cubicles in the centre interspersed with alternative effluent lanes and feeding lanes. Effluent is scraped along the effluent lanes and into the effluent bunker to be separated and then stored, also draining to the effluent bunker are the silage clamps, on the right. The whole unit is covered by a roof.

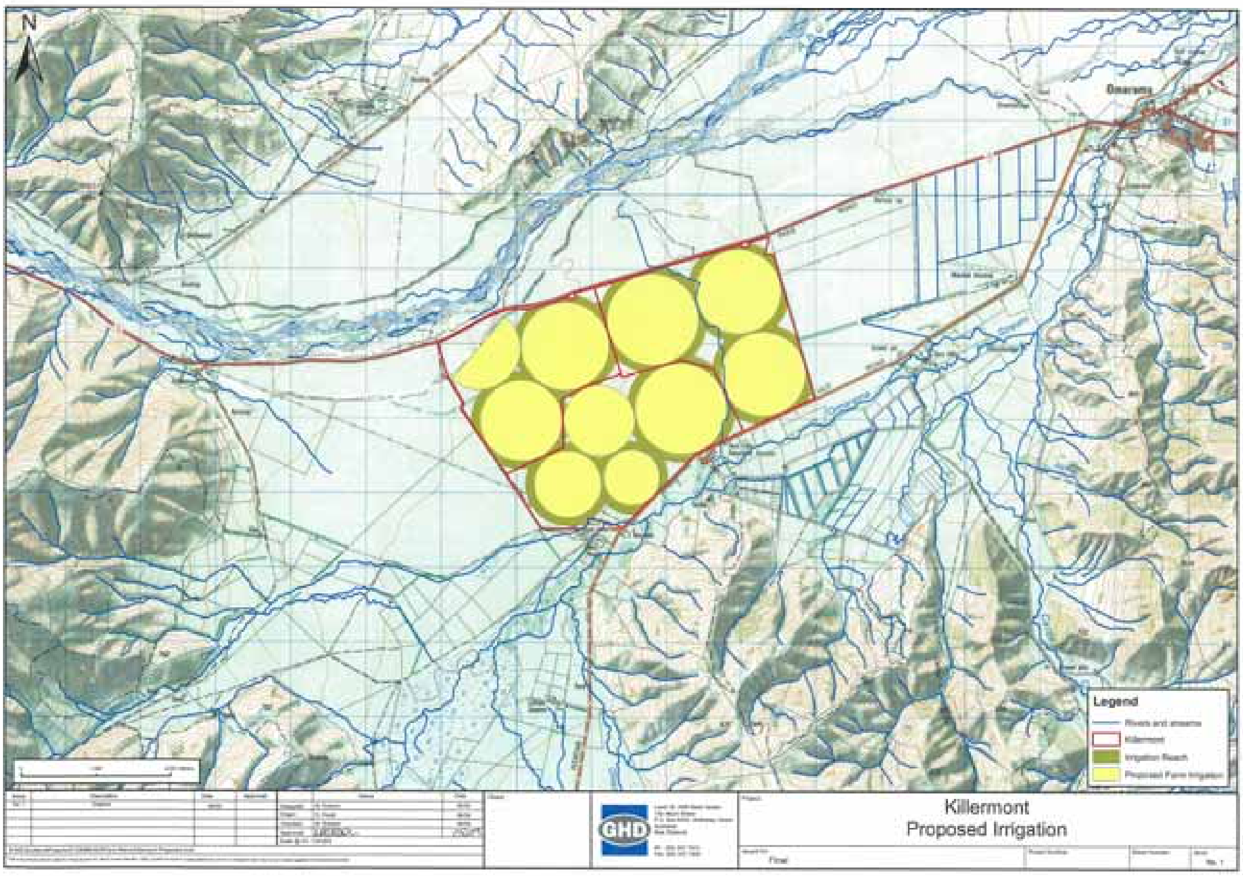
Figure 7 Proposed layout of the cubicle stables including silage clamp and effluent collection facility



5.1 Blocks

Three independent management units are proposed on the property (Figure 8), each comprising approximately 366 ha and carrying approximately 1280 milking cows.

Figure 8 **Map showing proposed irrigation layout and farm management blocks on WHL Killermont (available as an A3 in Appendix F)**



5.2 Soils

The FERA highlighted potential soil issues arising from the vulnerable nature of the soils to erosion, the grazing of stock over winter and the possibility of trafficking soils when wet. The proposed mitigation measures are;

Irrigation and consequent full ground cover to protect the soil from erosion;

The housing of stock over the winter period to remove potential for soil damage from grazing stock in adverse conditions; and,

No trafficking of soils when wet, and as this is not always possible, the annual monitoring and identification of soil compaction in hydrologically connected areas and documented remedial actions taken.

5.3 Stock

The dairy herds will consist of both Holstein crosses and Holstein cows, making in total a herd size of 3850 cows and at a stocking rate of 3.5 SU/ha. Young stock will be grazed off farm from weaning as will dry stock. Only milking cows will be present on the farm and milking cow numbers will be maintained throughout the year, (B. Englebrecht, *Pers Comm*, 2009).

The FERA highlighted potential stock issues arising from the non-exclusion of stock from watercourses, the non-control of dietary N and P, and the grazing of stock over winter with no further provision for reducing these losses. The proposed mitigation measures are;

The exclusion of stock from watercourses by planting and fencing riparian margins. A minimum distance of 3 m from the outside bank of the watercourse has been agreed;

The closer management of the herd due to housing allows the feeding of animals according to their requirements (phase feeding); and,

The housing of stock over the winter period will mitigate winter stock nutrient losses.

5.4 Production

The irrigated area will be under ryegrass /white clover, fescues and chicory, however clover levels may be depressed by the even and substantial return of organic manures. Pasture production is expected to be approximately 13 t dry matter/ha on irrigated and fertilised land. An 85 % pasture utilisation rate has been assumed as the mechanical harvesting and feeding of silage in the cubicle stables will result in greater utilisation rates, and the lack of pasture damage from stock will enhance pasture production (Engelbrecht, 2009). Milk Solids production is expected to be approximately 350 kg MS/cow[5]. The close management possible with housed herds will permit all year round calving and milking, taking advantage of the winter milk premium (Engelbrecht, 2009).

5.5 Manure, effluent and silage storage

5.5.1 Manure production

3,850 cows housed for 365 days will produce approximately 75, 600 m^3 of undiluted excreta. This will receive some dilution from dairy washings[6], and any yard draining to the collection area. The stock are expected to be housed full time for 8 months and for 12 hours per day for 4 months.

5.5.2 Manure handling

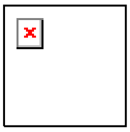
In the cubicle stables, alleys and other stocked areas will be regularly scraped down to deliver effluent to a sump at one end of the stables (Figure 7). From the sump, the effluent will be pumped to an effluent press and separated into liquid and solid fractions. Any leachate from around the effluent press area will drain into the liquid effluent collection system.

The FERA highlighted potential effluent issues arising from no clean and dirty water separation on the yards. The proposed management measure is:

Clean water will be separated in the yard and roof water either diverted and discharged to ground or collected and used.

[5] 400 kg MS/cow is reported to be achievable with this system (B. Englebrecht. Pers Comm). This would increase modelled losses to 18,952 kg N and 450 kg P.

[6] Milking will be done using either a rotary bale or robotic milkers. Both will be undercover and minimal water used in cleaning.



5.5.3 Manure storage

There will be seven months storage, 26,600 m^3 in lined facilities for the liquid fraction. A freeboard of at least 750 mm will be maintained at all times. The solid fraction will have 12 months storage availability and it will be stored on covered concrete pads and will drain to the effluent storage facility.

5.5.4 Manure application

Effluent will be applied through the centre pivots and the solid fraction will be spread using a calibrated muck spreader or exported. Effluent will be injected to irrigation water prior to being irrigated. Effluent will be applied at the most appropriate times for crop uptake, during active pasture growth in the spring and summer. Effluent application depth will be determined by soil moisture deficit and a minimum of 5.9 mm of soil moisture deficit will be maintained.

No effluent will be applied within 20 m of the watercourse. All applications will be recorded and accounted for when determining fertiliser requirements.

All applications will be recorded and accounted for when determining fertiliser requirements.

The FERA highlighted potential effluent issues arising from close to 200 kg /ha /year of organic manure N being applied. However, improved storage and prolonged housing may increase the effluent to be recycled to land. A total effluent loading rate of less than 200 kg/N/year permits this activity to maintain a consented activity status under Environment Canterbury's dairy effluent rules. This threshold is in compliance with the consent for effluent application lodged for this property.

The proposed management measures are:

To test effluent nutrient concentrations during spreading season, and record cumulative applications;

If applications indicate that more than 200 kg N of organic manure will be added should all the remaining effluent and solid manure be applied, the solid fraction will be exported; and,

A farm map showing no spread areas should be clearly displayed in the farm office and if effluent is spread by tractor, these should be carried in tractor cabs.

5.5.5 Silage

The FERA highlighted potential effluent issues arising from silage liquor not being collected and spread to land and that direct discharges are made from the silage pits. The proposed management option is that silage is stored on a concrete pad and drains to the effluent collection facility (Figure 7). The silage liquor will be recycled to land along with effluent[7]. Due to the unknown nutrient concentrations in the liquor, the effluent will be regularly tested during spreading and cumulative applications recorded.

5.6 Anticipated fertiliser use

Specific fertiliser recommendations will be produced on an annual basis using a recommended system. Plant nutrient supply will be estimated from both organic and inorganic fertilisers as well as N fixation using a nutrient budgeting system. The effluent and solid manure collected from the sheds will provide an important part of the nutrient requirement.

[7] The concrete will need to be an appropriate specification for containing silage as the liquor is highly corrosive.

Nitrogen losses may occur during collection, storage and application and also when solid manure is applied, not all of the nutrients, especially the N will be immediately available. However these quantities would be sufficient to meet over half of the P and K requirements of a silage field with four cuts taken (MAFF, 2000).

Although a significant amount of N will be recycled, inorganic fertiliser will also be required. The P fertilisation strategy will be to build soil P concentrations to between 20 and 25 Olsen P, and to maintain them in this range. Full account will be taken of the organic fertiliser inputs of phosphorus through the use of a nutrient budget. The FERA highlighted potential fertiliser issues arising from more than 50 kg fertiliser N being applied in a single application, N applications occurring in autumn and winter, fertiliser spreaders not being calibrated and no suitable storage and filling area having been identified. The proposed mitigation measures are:

No N fertiliser to be applied in autumn and winter;

N fertiliser applications to be split to less than 50 kg N/ application;

Soil Olsen P levels to be maintained below 25;

Fertiliser spreaders to be on-farm calibrated annually and optimised;

Fertiliser will be stored in a covered area;

The identified fertiliser filling area will be at least 50 m from a watercourse of spring or bore and will have no drains that discharge to clean water or that can discharge straight to ground; and,

If liquid fertiliser used, fertiliser will be stored in a bunded tank and also protected from vehicle movements.

5.7 Chemical storage and management

The FERA highlighted that no chemical management strategy was in place. To satisfy the issues raised, the proposed management strategies are:

Where chemicals are used on farm, these will be stored in a secure shed. Containers and foil caps will be disposed of as hazardous waste, or triple rinsed and disposed of as non-hazardous;

The services of a professional crop adviser or other suitably qualified person will be used to advise on pesticide options, doses and tank mixes;

Sprayers will either be filled on a concrete yard draining to a sealed tank or a biobed or in the field. When filling, a portable bund will be placed beneath the induction hopper;

Back siphoning prevention measures will be used when filling sprayers, through the use of bowsers;

Tank washings will be resprayed to same fields ensuring no exceedance of dose;

Sprayer washdown area will drain to sealed tank or biobed and sprayers should be stored under cover; and,

'No spray' areas will be clearly marked on a map and displayed in the farm office and in the sprayer cabs. An emergency 'in case of a spillage' procedure should be clearly displayed in office, chemical store and sprayer filling area. A bucket of sand will be available in the sprayer filling area to be used on any spills.

5.8 Cultivations and trafficking

After initial cultivation for the establishment of permanent pasture, little cultivation is expected. Re-establishment of pastures is not expected to involve inversion tillage.

The FERA highlighted potential soil risks arising from trafficking soil when wet and consequent runoff to a watercourse.

The proposed mitigation measure is:

Compaction in hydrologically connected areas caused by machinery movement will need to be identified on an annual basis between late autumn and mid spring, excluding times when land is frozen. Compaction is identified both through visual inspection (of the soil surface and plant stress indicators) and through testing for compaction using a soil penetrometer and digging verification pits. Identified compaction should be removed at the earliest opportunity with an appropriate technique for the depth of compaction.

5.9 Water and runoff

1,100 ha of the farm is planned to be irrigated at a rate of 600 mm/year, the proposed farm irrigation layout is shown in Figure 8. The source of the irrigation water is from Ahuriri River. In total, 9 centre pivots are proposed (8 full circle and 1 half circle). Final pivot design has avoided crossing watercourses as much as possible. In the one case where this is not possible, bridges will be constructed at wheel crossing points. Full details of the irrigation water take, transport and application can be found in the Williamson Holdings Project Summary (Aqualinc Memorandum, 3 June 2009).

The FERA highlighted potential water and runoff risks arising from stock having access to watercourses and pivot tracks going over watercourses.

The proposed mitigation measures are:

Riparian fencing and planting will prevent stock encroachment of waterways;

Runoff from pivot tracks will be prevented from entering watercourse; and

Stock water facilities will need to be provided, however, due to the very restricted grazing system proposed, soils are not expected to be seriously damaged around troughs. Where damage does occur, this will be assessed during the annual soil compaction assessment.

5.10 Biodiversity

Mitigation measures to protect ecology are discussed in full in Ryder Consulting (2009) and Mitchell Partnerships (2009). In brief, riparian planting and fencing is proposed to prevent stock access, shade waterways, provide cover and habitat for fish and invertebrates and stabilise banks. Measures to protect avifauna include controlling pest species and predators.

A densely planted 3 m set back is proposed for Tara Hills Irrigation race and a densely planted 5 m set back is proposed for Manuka Creek.

6. Farm Environmental Management Plan for WHL Killermont

Table 4 below shows the all the mitigation and management tools that are proposed to be undertaken on WHL Killermont. Measures indicated as FEMP stage 1 are those identified as Mandatory Good Agricultural Practice, measures identified as FEMP stage 2 are those changes that have been modelled in OVERSEER to meet the WQS mitigation requirement, and those indicated as FEMP stage 3 are mitigation measures chosen to ameliorate site specific environmental risks on the farm and that are not modelled within OVERSEER. The table indicates in brief how the measures are to be monitored and audited, and a map showing the locations of the proposed mitigation measures is shown in Figure 9.

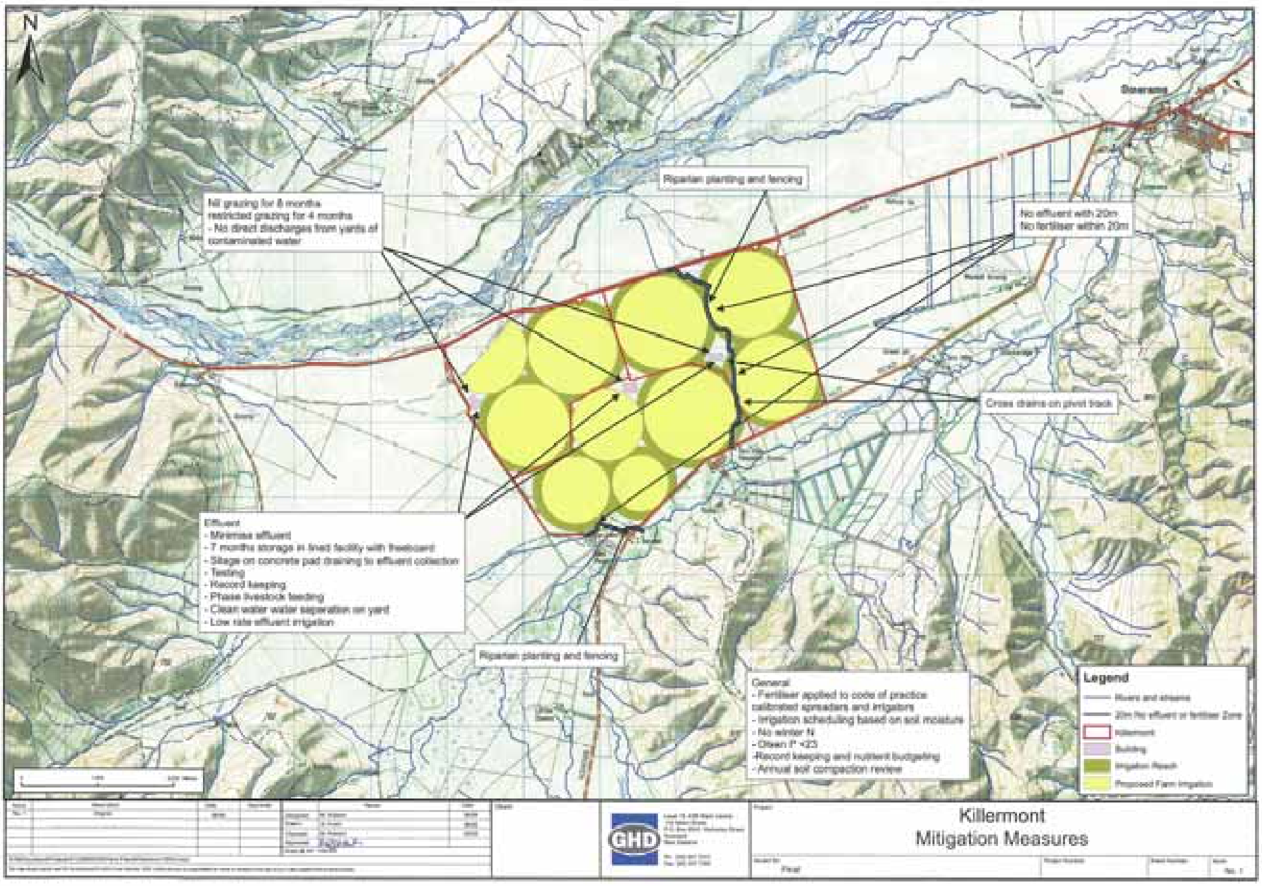
Table 4 Table of mitigation options, monitoring and auditing for WHL Killermont

FEMP stage	Measure	Monitoring	Auditing
1	Fertilisers applied according to code of practice for fertiliser use		Self certification
1	Accounting for all sources of nutrients including applied effluents and soil reservoirs	Soil and effluent testing and cumulative effluent inputs per management unit	Reconciliation of fertiliser, effluent and soil records with nutrient budget for example blocks. Submission of examples soil and effluent tests
1	Even fertiliser application	Calibrate and optimise fertiliser spreaders annually and every 5 years by an external auditor	Submission of testing and calibration
1	Even irrigation and effluent application	Calibrate and optimise irrigators annually in house and every 5 years by an external auditor	Submission of testing and calibration
1	Record crop, cultivation, nutrient inputs and yields per farm management unit	Upkeep of records	Submission of example block records
1	Good design of irrigation systems	Design of irrigation system by a certified professional	Irrigation system audited by a certified auditor every 5 years
1	Robust irrigation scheduling	Calculation of annual % effective water use	Submission of annual % effective water use

FEMP stage	Measure	Monitoring	Auditing
1	Supplement and feeding out management	Not applicable as stock are wintered indoors	
1	Winter grazing management	Not applicable as stock are wintered indoors	
2	Nil grazing for 8 months	Field records showing when restricted grazing starts and ends	Signed field records
2	Restricted grazing for 4 months	Field records showing when restricted grazing starts and ends	Signed field records
2	Minimisation of effluent produced		Annual auditing visit. Photographic evidence of extent of roofing, diversion on any open yards and robotic milkers.
2	Fencing stock out of waterways through riparian fencing and planting	Surface water testing of race as it enters and exits the property	Annual auditing visit.
2	No winter application of fertiliser	Field records	Signed field records
2	N fertiliser applications split to under 50 kg N/application	Field records	Signed field records
2	Effective separation of liquid and solid fraction of effluents and part removal of solid fraction	Effluent testing including dry matter and cumulative application records, see Figure 11.	Submission of test results. Annual audit visit. Submission of proof of solid fraction export
3	Effluent Storage		Storage volume calculation and plans submitted. Annual audit visit.
3	Low rate irrigation of dilute effluent	Irrigation scheduling and cumulative application records	Submission of example irrigation schedules and cumulative application records
3	Improved ground cover to protect from wind erosion	Annual quadrat testing for % cover in all blocks and photographs	Submission of testing results and photographs
3	Identify and remove soil compaction and consolidation	Annual soil compaction assessment in hydrologically connected areas.	Submission of assessment and remedials

FEMP stage	Measure	Monitoring	Auditing
3	Phase feeding of livestock	Feed ration monitoring	Submission of example of feed rations.
3	Silage stored on a concrete pad and draining to effluent collection facility		Submission of silage clamp plans. Annual audit visit.
3	Silage liquor and effluent regularly tested for nutrient content in spreading season	Implicit within mitigation – accounting for all nutrient sources	Implicit within mitigation – accounting for all nutrient sources
3	Olsen P of below 25 maintained	Regular soil testing (every 3 years)	Submission of soil tests
3	Fertiliser stored in covered area		Photograph of storage area. Annual audit visit.
3	Identified fertiliser filling area will be at least 50 m from a waterway and will have no drains of direct discharges to ground		Photograph of filling area, and map showing drains and watercourses. Annual audit visit.
3	If liquid fertiliser is used, fertiliser will be stored in a bunded tank		Photograph of storage area. Annual audit visit.
3	Chemical storage and management		Submission of proof of 'approved handler' status
3	Prevention of runoff from pivot track entering waterway through series of mini cross drains approaching the waterway	Annual wet weather survey to assess whether there is runoff.	Photographic evidence of cross drains. Submission of wet weather survey results and remedials

Figure 9 Annotated map with key mitigation options and locations on WHL Killermont (available as an A3 in Appendix F)



6.1 Monitoring and Auditing

Monitoring and auditing of the FEMP are as important as the plan itself.

Table 4 above shows the monitoring suggested for the mitigation and management options chosen for WHL Killermont. Table 5 below shows the frequency and parameters for the monitoring, and Figure 10 shows these monitoring points on a map of the property.

Additional monitoring will be carried out in conjunction with other farmers in the sub-catchment by Mackenzie Irrigation Company, on a sub-catchment basis on the Omarama Stream and the Ahuriri River and also in the Ahuriri Arm of Lake Benmore.

Detailed groundwater modelling has been conducted for the farm and the modelled nitrate contribution from WHL Killermont to groundwater concentrations have been modelled for 5, 15 and 25 years. These outputs are shown in Appendix B. The modelled contribution to groundwater quickly reaches steady state and the maximum modelled contribution from WHL Killermont to groundwater nitrate concentrations after 5, 15 and 25 years, is 0.16 mg/l nitrate-N. This concentration is seen immediately 'downstream' of WHL Killermont.

Table 5 Location, frequency and parameters for monitoring on WHL Killermont

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Soil	Soil nutrient testing	All blocks in rotation	1 in 3 years	Standard suite of soil nutrients, pH C, N and organic matter	Olsen P of 25	Reduce or stop addition of P fertiliser to area and monitor
Soil	Soil compaction survey	All hydro-logically connected blocks	Annually	Surface and subsoil compaction	Compaction, surface capping	Remove compaction with appropriate tool
Soil	Wet weather survey	All blocks	Annually	Runoff from tracks and centre pivot tracks	Runoff occurring	Immediately review current runoff mitigation options for pivot tracks. Introduce further runoff removal infrastructure
Effluent	Irrigated effluent nutrient testing	All blocks receiving effluent	Regularly throughout spreading season	Total N, nitrate, ammonia, dissolved reactive phosphorus, BOD	NA	
Effluent	Cumulative effluent application	All blocks receiving effluent	Record each time effluent is applied	Application depth	200 kg/ha effluent N including solid fraction	Store solid fraction until exportation can be arranged. Export enough of solid fraction to maintain application at less than 200 kg
Water	Groundwater quality	Two identified bores, H39/0914 and H39/0045	2 x per year at mid depth of aquifer	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus.	> 1 mg/l nitrate-N	If comparative groundwater analysis from upstream and downstream indicates an excedence of 1 mg/l due to on farm activities, the N application to land should be reduced or stock withheld for longer until a root cause analysis can be conducted
Water	Surface water quality	Entry and exit of Tara Hills race on property boundaries	Monthly for first couple of years to establish patterns	Total Nitrogen, nitrate, ammonia, total Kjeldahl nitrogen, total phosphorus, dissolved reactive phosphorus, suspended solids.	No significant decrease in water quality	If comparative surface water analysis indicates a decrease in surface water quality, the degraded determinands should be identified as these will indicate the likely cause of the contamination, while a full root cause analysis is undertaken. If the determinands suggest effluent, then effluent irrigation should cease on the implicated pivots. If the analyses indicate stock encroachment, the stock should be withheld from the connected paddocks.

		Location	Frequency	Measured parameters to include	Triggers	Contingency plan if triggers are exceeded
Water	Irrigation application		Annually in house and 1 in 5 years by an independent	Application uniformity	>80 %	Optimisation of the irrigator performance will be performed at the time of testing
Fertiliser	Fertiliser application		Annually in house and 1 in 5 years by an independent	Application uniformity		Optimisation of the spreader performance will be performed at the time of testing
Pasture	Ground cover	All blocks	2 x per year	% Ground cover	> 80 %	Soil nutrient and compaction testing should be performed to identify possible causes

Figure 10 Map showing location of monitoring points on WHL Killermont (available as an A3 in Appendix F)

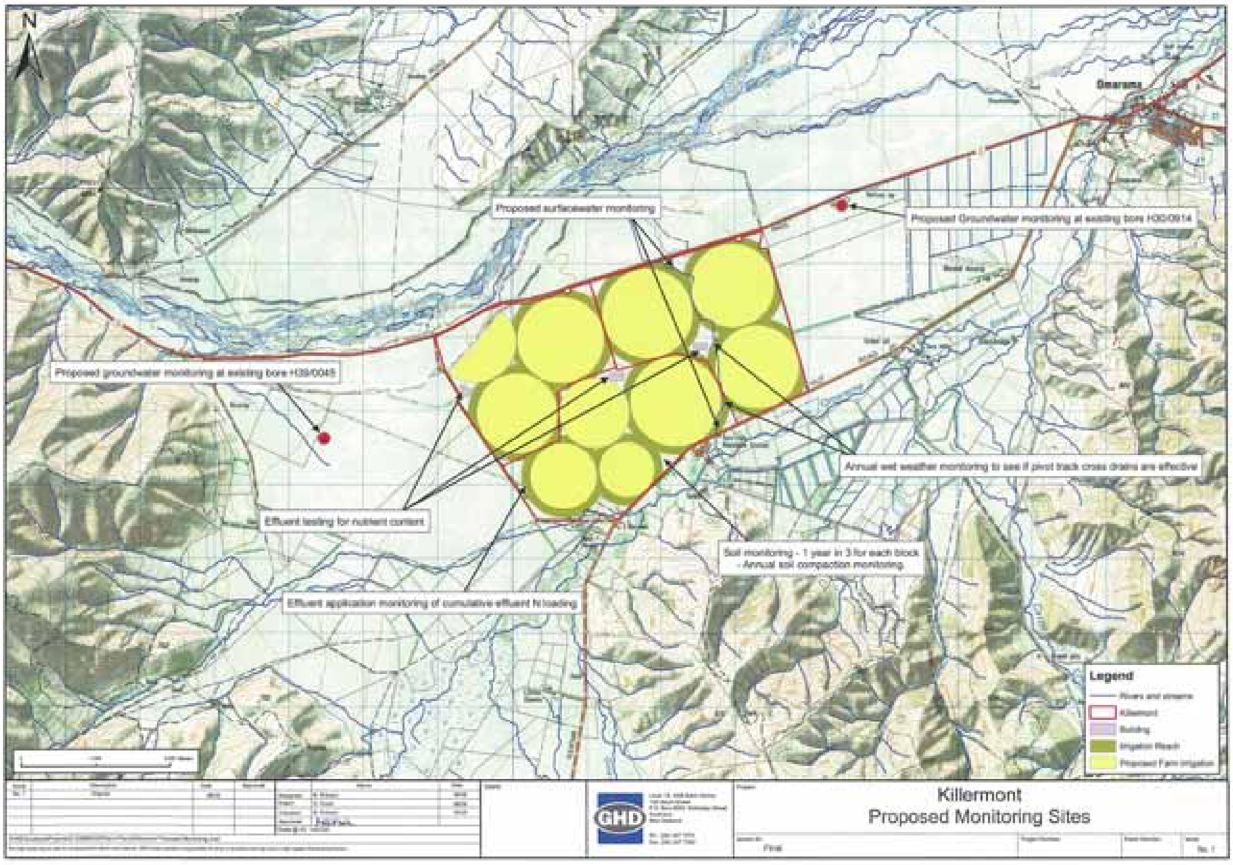
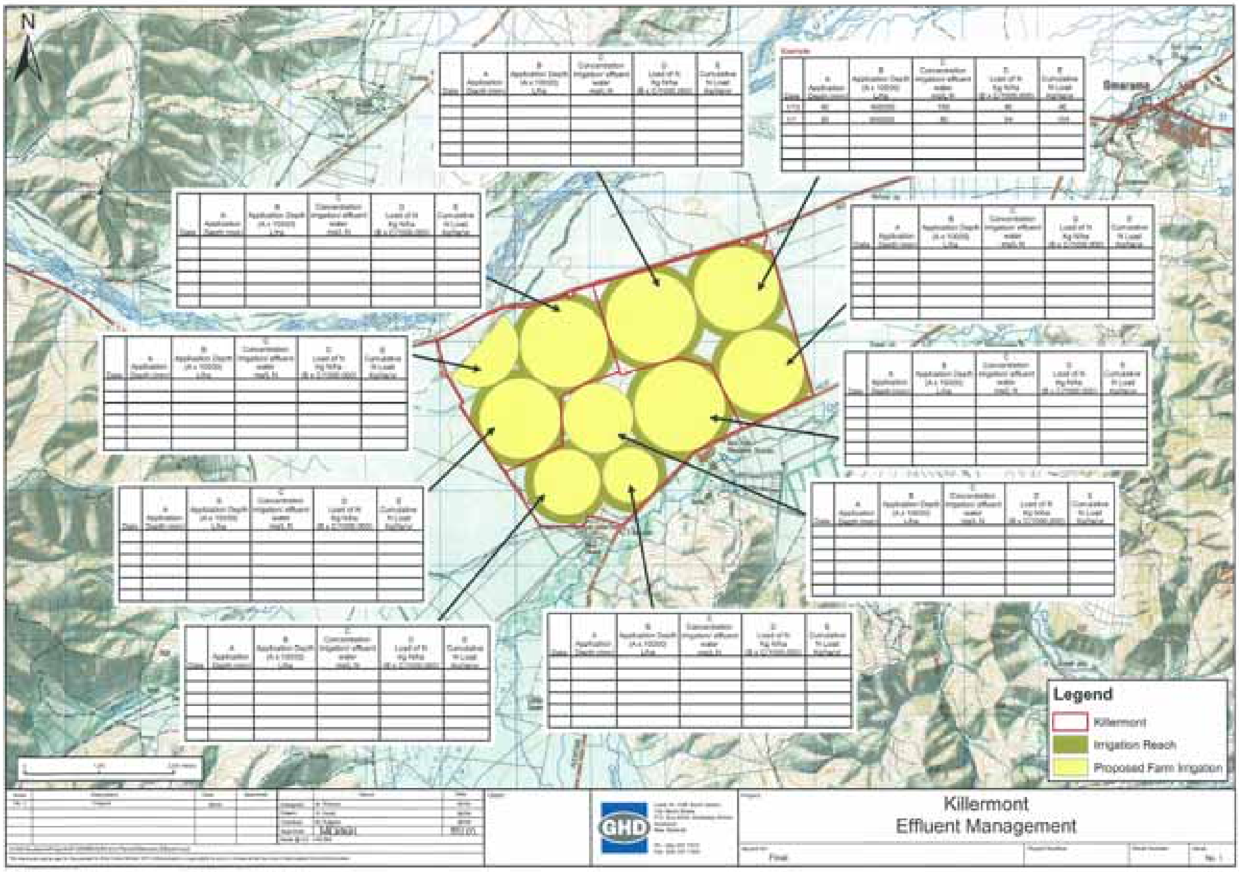


Figure 11 Map showing block effluent applications and cumulative loading on WHL Killermont (available as an A3 in Appendix F)



Where triggers are exceeded, the immediate contingency plans in Table 5 should be implemented while a ‘root cause’ analysis is carried out. Any further mitigation measures to be adopted as a result of monitoring should be added to Tables 5, 6 and 7.

1) Is the current mitigation option implemented correctly?

No – Implement and monitor

Yes – to 2)

2) Has anything changed in the farm system?

Yes – remodel and monitor

No – to 3)

3) Have there been abnormal conditions at the time of trigger breach?

Yes – continue monitoring to see if trigger breach continues

No – Seek advice of suitably qualified person to further investigate root cause and suggest appropriate further mitigation.

If emergency conditions occur that risk a pollution event, such as severe flooding event that puts the effluent storage system at risk or a catastrophic failure of the effluent system, seek immediate guidance from you regional council:

Environment Canterbury 0800 76 55 88

6.1.1 Auditing

The auditing process allows both the farm operator to illustrate, and other interested parties to have confidence that the management practices and mitigations planned for the farm are being implemented. In addition, the audit shows that there is a mechanism for the adaptive management of the property should the chosen mitigation or management not perform to expectations.

An annual audit is proposed, and requires both external and in-house input. The annual audit should be completed and submitted to Environment Canterbury by end of July each year.

Table 6 below shows the proposed contents of an annual report for WHL Killermont.

Table 6 Table showing proposed contents of an annual audit report for WHL Killermont

Audit measures	Action in the case of non-compliance
Additional auditing that must be done externally	
Check the clean and dirty water separation methods in and around the cubicle stables, parlour and yards, plus photographs	If any contamination of clean water is found all water should be directed to effluent store until problem is found and effective separation is verified
Check for evidence of direct discharges from the cubicle stables, parlour and yard area	Any direct discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check riparian planting and fencing is present where it should be and that it is intact, plus photographs	Any failure in the integrity of the fencing should be repaired immediately or a barrier placed around gap to prevent stock access until repair is made
Check the effluent press and liquid and solid fractions and also the destination of any liquid from the press area.	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of liquid fraction for visible signs of discharge and maintenance of freeboard. When empty, the integrity of the lining should be checked and repairs made if necessary.	Any uncontrolled discharge of effluent must be stopped immediately. If a failure of the lining is suspected, the store must be pumped out and the lining inspected and repaired if necessary The freeboard should be maintained at all times.
Check the storage of solid fraction and destination of seepage if occurs	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check the storage of silage for visible signs of discharge and destination of silage liquor	All liquid should drain into effluent storage. Any discharge must be stopped immediately. Temporary barriers such as straw bales may be used to take up any discharges until permanent structures are in place
Check fertiliser storage and filling area.	There should be no possibility of loss of fertiliser to drains or direct discharge to ground. Any drains should be covered, or the filling area moved to where no discharges will occur.
Annual audit of OVERSEER nutrient budget and report based on previous 3 years. Submission of compliance with thresholds	Should the OVERSEER report show losses exceeding the threshold, further mitigations should be adopted to effect a reduction in nutrient loss to below thresholds.
Fertiliser spreader and irrigation testing and calibration 1 in 5 years by independent auditor	Spreaders and irrigators not performing should be recalibrated
Additional auditing that can be done either externally or internally	

Audit measures	Action in the case of non-compliance
Reconciliation of fertiliser, effluent and soil records with nutrient budget and fertiliser recommendations	Where reconciliation is not possible and an over application has occurred, this should be rectified in the following year
Submission and brief interpretation of soil, effluent, water quality, supplement and machinery calibration tests	Where triggers have been exceeded, immediate contingency plans should have been effected and a root cause analysis conducted. The results of which should be presented here.
Submission of field records demonstrating fertiliser and effluent practice and nil and restricted grazing periods	Where field records show variation from proposed nil and restricted grazing, changes must be justified and the farm shown to remain within threshold limits, or the practice must revert to the proposed system
Submission of proof removal of solid manure fraction if required	If calculation indicate that a part of the solid fraction will have to be removed and no removal has occurred, spreading should cease and solids stored until a suitable recipient can be found.
Submission of silage clamp and effluent storage design plans	Once approved, the plans need only to be submitted once
Submission of example irrigation schedules and calculated water use efficiency	Where calculated water use efficiency is such that the trigger is exceeded, remedial action of how the system is to be optimised should be submitted, and followed up in the next audit
Annual quadrat testing for % ground cover, submission broad findings	Where poor groundcover is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual soil compaction survey, submission broad findings and remedials	Where poor soil structure is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual wet weather survey, submission broad findings and remedials	Where runoff is found and cause assessed, the remedials should be implemented and followed up in the next audit
Annual fertiliser spreader and irrigation testing and calibration	Spreaders and irrigators not performing should be recalibrated
Auditing that must be done internally	
Self certification for application of fertiliser according to code of practice	Any failures in observing the code of practice for applying fertiliser should be rectified and followed up in the next audit
Submission of proof of 'approved handler' status	Inappropriate handling of chemicals should cease until an approved handler is in place

7. Summary

This FEMP has been written to serve two purposes, to ensure the proposed farm system can meet the nutrient mitigation requirements set out by the Water Quality Study, and to identify and mitigate other farm specific environmental risks that arise from the inherent characteristics of the farm or from the proposed farm system and its management. These farm specific risks include uncontrolled discharges that are not identified in farm nutrient budget modelling but that may still have an environmental effect.

The mitigation and management measures detailed in Table 4 lay out the techniques that have been adopted to fulfil these two objectives. The WQS thresholds and modelling outputs from OVERSEER detailed in Table 3 illustrate that the proposed farming system meets the WQS thresholds, and the risk assessment and mitigation measures proposed in Sections 4 and 5 illustrate how site specific environmental issues, including uncontrolled discharges, have been identified and are mitigated.

The monitoring and auditing of this plan, addressed in Sections 5 and 6 allow the performance of the measures chosen to be monitored and where they are performing sub-optimally, these can be addressed through the root cause analysis process.

8. References

Aqualinc (2009). Killermont Station Project Summary. Memorandum to Ryder Consulting.

Englebrecht, B. (2009). Report for Southdown Holdings limited and Five Rivers Limited. Prepared for meeting at RMV, 23rd June 2009.

GHD (2009). Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Basin – Summary Report.

Mitchell Partnerships (2009). Ecological Assessment of Ohau Downs, Glen Eyrie Downs and Killermont Station. A report prepared for Southdown Holdings Limited, Five Rivers Limited and Williamson Holdings Limited.

Mitchell Partnerships (2009a). Killermont Station effluent discharge application. Memorandum to Ryder Consulting

NZFMRA (2002). Code of Practice for Fertiliser Use. Providing practical and specific guidance for safe, responsible and effective nutrient management.

Ryder Consulting (2009). Aquatic and Avifauna Ecology Assessment of Ohau Downs, Glen Eyrie Downs and Killermont Station. A report prepared for Southdown Holdings Limited, Five Rivers Limited and Williamson Holdings Limited.

Snow, V., King, W. (2008). Upper Waitaki Farm Systems and Nutrient Assessment. Stage 2: Pasture and Ryecorn Growth Modelling. Report prepared for GHD by AgResearch

Webb, T. H. (1992). Soils of the Upper Waitaki Basin, South Island, New Zealand, DSIR.

Appendix A

WQS ground and surface water sub-catchments for WHL Killermont

Appendix B

Detailed groundwater modelling for WHL Killermont

Appendix C

Farm Environmental Risk Assessment

Appendix D

OVERSEER Input Parameters

Appendix E

OVERSEER Output Data

Appendix F

A3 Maps

GHD Limited

Level 1, Merial Building
Putney Way, Manukau City
T: 64 9 261 1400   F: 64 9 262 8340   E: auckmail@ghd.co.nz

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
	Melissa Robson	Jeff Matthews		John Male		