

N-Loss limits for the Johnston Farm Strategy following the reclassification of irrigated sand country

1 Summary and conclusions

Reclassifying the irrigated LUC units found on the Johnston property have an affect on the N-loss limits for the property. Currently the property is permitted to leach 16.5 kg N/ha/year in year one under the proposed One Plan. Reclassifying the irrigated areas increases this to 17.2 kg N/ha/year in year one. As expected, similar patterns are observed for years 5, 10 and 20 N-loss limits. Despite increasing the permitted N-loss limits following reclassification, the property is still leaking in excess of its permitted levels.

2 Purpose and Objectives

The purpose of this report is to assess the impact of reclassification of land on the Johnston property, Foxton, as a result of the installation of permanent irrigation.

3 Background information

AgResearch recently prepared a Farm Strategy for the Johnston Property near Foxton. The outcomes of this are outlined below.

3.1 Existing Farm Strategy

A comprehensive Farm Strategy was prepared for the Johnston property by AgResearch (2009). The property is a 257 ha irrigated seasonal supply dairy unit located in the sand belt near Foxton. AgResearch estimated that the current N-loss via leaching was 25.0 kg N/ha/year. LandVision Ltd originally LUC mapped the property at 1:7,000 for AgResearch and the calculated permitted One-Plan N leaching limits are shown in the following table.

LUC	Area (ha)	One Plan N-limits by period (kg/ha)				Farm N-limits by unit (kg N/unit)			
		Year 1	Year 5	Year 10	Year 20	Year 1	Year 5	Year 10	Year 20
3	117	22	21	19	18	2574	2457	2223	2106
4	54	16	16	14	13	864	864	756	702
6	72	10	10	10	10	720	720	720	720
7	11	6	6	6	6	66	66	66	66
8	3	2	2	2	2	6	6	6	6
Total	257					4230	4113	3771	3600
Permissible N-loss limits for the Johnston Farm (kg N/ha/yr)						16.5	16.0	14.7	14.0

Under the current management system and LUC classification, the property fails to meet the year one N-leaching limits by 8.5 kg/N/ha.

3.2 Re-classification of sand country under irrigation

There is a sound argument for re-classification of sand country under permanent irrigation as the physical limitations can be significantly reduced. Appendix Two contains a discussion paper on this issue.

4 Re-classification of LUC

Using the rules outlined in the discussion document on reclassification of sand country under irrigation (Appendix Two) the property was reclassified. The following table shows the LUC unit distribution on the property for before and after the reclassification. Appendix one shows the 'reclassified LUC map' for the property.

LUC Unit	Original classification	Reclassified classification
IIIw4	117.0 ha	117.0 ha
IVe10	53.8 ha	82.1 ha
Ve	-	7.2 ha
Vle24	18.7 ha	11.6 ha
VIs4	52.6 ha	24.4 ha
VIIe15	11.4 ha	11.3 ha
VIIIw2	3.4 ha	3.4 ha

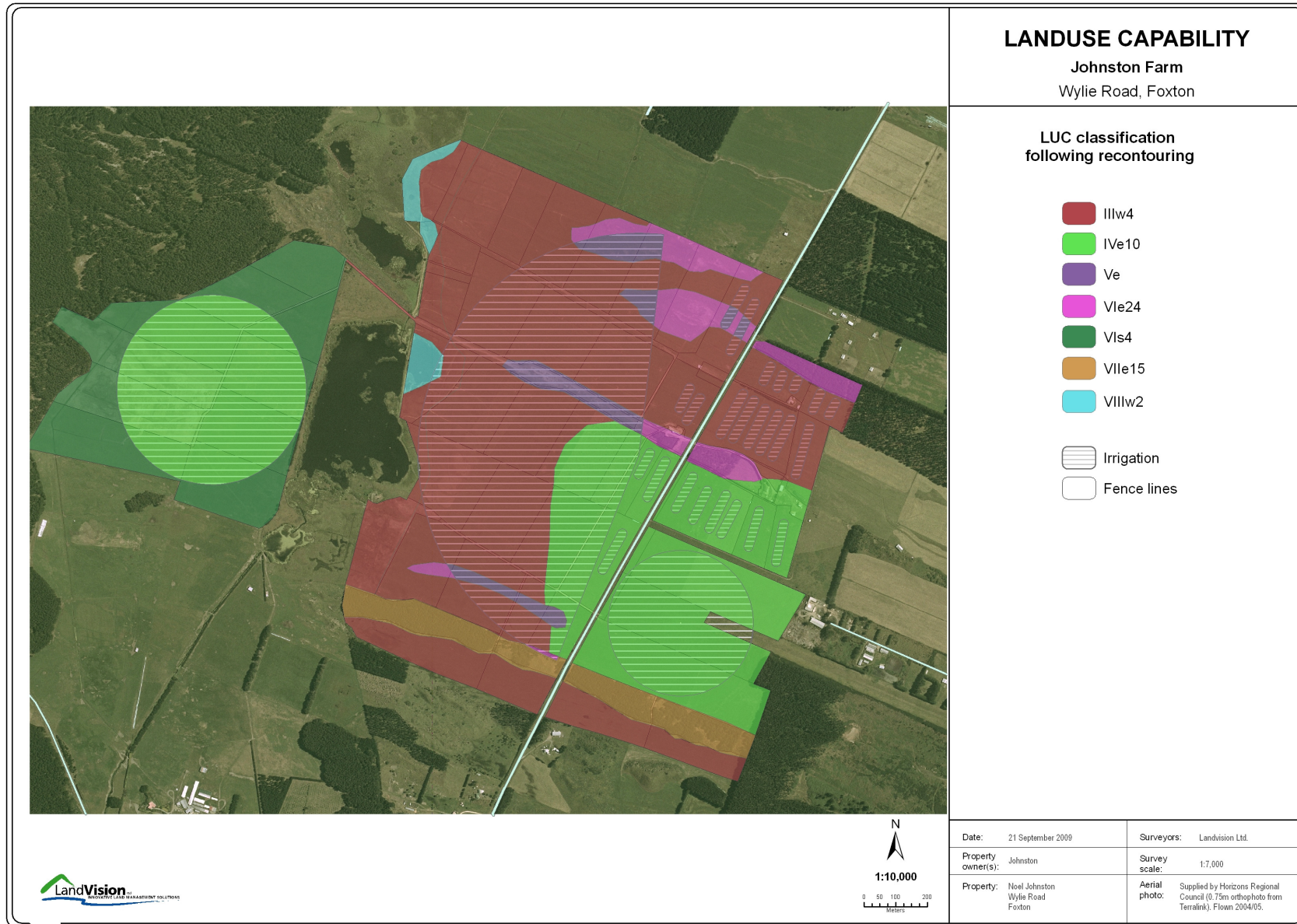
5 Calculation of One-Plan N Loss Limits under reclassification

The following table shows the N-leaching limits following reclassification of the land under permanent irrigation.

LUC	Area (ha)	One Plan N-limits by period (kg/ha)				Farm N-limits by unit (kg N/unit)			
		Year 1	Year 5	Year 10	Year 20	Year 1	Year 5	Year 10	Year 20
3	117.0	22	21	19	18	2574.0	2457	2223.0	2106.0
4	82.1	16	16	14	13	1313.6	1313.6	1149.4	1067.3
5	7.2	13	13	13	12	93.6	93.6	93.6	86.4
6	36.0	10	10	10	10	360.0	360.0	360.0	360.0
7	11.3	6	6	6	6	67.8	67.8	67.8	67.8
8	3.4	2	2	2	2	6.8	6.8	6.8	6.8
Total	257					4415.8	4298.8	3900.6	3694.3
	Permissible N-loss limits for the Johnston Farm (kg N/ha/yr)					17.2	16.7	15.2	14.4

This table shows that the N-leaching limit for year one is 17.2 kg N/ha/year under reclassification compared to 16.5 kg N/ha/year. This is approximately 7.8 kg N/ha/year below the current N-loss (25 kg N/ha/year).

6 Appendix 1 – Reclassified LUC map



7 Appendix two – LUC reclassification of sand country discussion Document

Sand country land re-classification under irrigation

1 Summary and conclusions

The sand country land development within the Horizons region from extensive pastoral farming to intensive dairying with the use of irrigation is unique. Production levels are being tripled as a result. Land being developed is typically Class VI land.

The sand country contains five LUC units and these are differentiated on sand plains and sand dunes. There are two sand plain units and these are divided on drainage. One of these units is poorly drained (IIIw4) and has a wetness limitation whilst the other (IVe10) is well drained and has an erosion limitation under arable use. The sand dunes have three LUC units and these are divided on contour and topsoil development. Two of these are LUC class VI units, VIe4 and VIe24. Production on the LUC unit VIe4 is limited firstly by poor moisture holding capability and LUC Class VIe24 has a moderate erosion limitation under pastoral farming. The most fragile sand country unit is VIIe15. This unit has limited topsoil development and the dunes are generally steeper than VIe24.

Questions of sand country classification have come about as a result of the development and the resulting production levels that have been achieved. Reclassification of some units in the sand country is warranted under permanent irrigation. For reclassification to occur there needs to be significant change in the physical limitations or hazards present as a result of the irrigation.

The only opportunities for reclassification are with LUC Class VIe4 to class 4 and VIe24 to either class IV or V depending on contour and soil type. Reclassification of LUC Class VIIe15, IVe10 and IIIw4 can not be justified. For reclassification to be considered there needs to be permanent irrigation.

The LUC units of re-contoured land could be re-classified however this would be dependent on the physical limitations or risk to arable and pastoral use. This would be determined using the current LUC classification for the sand country following the re-contouring and it would need to be done on a 'case by case' basis.

2 Purpose

Under the proposed One Plan, the sand country poses a unique set of problems for Horizons Regional Council for setting nutrient limits. Large areas of sand country within the Horizons region particularly on the west coast, have been converted to dairying due to the introduction of irrigation. Prior to this the landuse was predominantly extensive sheep and beef, or forestry, and struggled to grow more than 4-5 tonne of dry matter per hectare per annum. Under irrigation, yields in excess of 15-16 tonnes of dry matter per hectare per annum can be achieved. Typically this is Class VI land is out performing Class I land on the alluvial plains.

The purpose of this report is two fold: firstly to discuss the merits of considering reclassification of some of the sand country LUC units under irrigation, and if the irrigation reduces the hazard for which the original LUC classification was defined for; and secondly, if reclassification is justified – to what level should it be adjusted to.

3 Background information

3.1 The land use classification system

The land use capability system (LUC) is a classification system that differentiates land according to physical limitation or hazard. It comprises of eight different classes of land and each is described below. The LUC

classification system does not account for productivity levels between LUC Classes as there is huge variation of productivity within each Class.

Class 1 land is the most versatile multiple-use land, with minimal physical limitations to arable use. It is flat or undulating, has deep resilient and easily worked soils and there is minimal risk of erosion. The soils are characterised as being fine textured, well drained, not seriously affected by drought, well supplied with plant nutrients and responsive to fertilisers. Climate is favourable for the growth of a wide range of cultivated crops, pasture or forest.

Land which has a slight limiting physical characteristic such as wetness, risk of flooding, or drought can be included in Class 1 where the limitation can be removed by permanent works. The extent of Class 1 land is limited, and is confined almost entirely to areas of deep, well drained alluvial soils located mostly on the flood plans of the larger rivers, or tephric and recent loess soils on terraces, or inland in frost free localities where climatic conditions are favourable for good crop growth. In the North Island, Class 1 land normally occurs below 350 m and 200 m in the South Island. Rainfall is normally between 650 and 1500 ml annually.

Class 2 land has only slight physical limitations to arable use, which is readily controlled by management and soil conservation practices. Most Class 2 land is flat or undulating. When cultivated, there may be a slight susceptibility to wind erosion and surface wash on more undulating land. Slight streambank erosion may be present around waterways. Unfavourable soil characteristics include loamy sand and clay-textured soils. The soils are generally developed from alluvium and recent loess, although some in the North Island may be developed on fine-textured, andesitic and basaltic ash. Class 2 land normally occurs below 400 m (South Island) and 500 m (North Island), and where the annual rainfall is between 800 and 2,000 mm in the North Island and less than 1,500 mm in the South Island.

Class 3 land has moderate physical limitations to arable use. These limitations restrict the choice of crops and intensity of cultivation, and/or require special soil conservation practices. Some common limitations include; moderate susceptibility to erosion under cultivation, rolling slopes, shallow or stony soils, wetness or water-logging after drainage, low moisture holding capacity, moderate structural impediments to cultivation, low natural fertility, and moderate climatic limitations. Class 3 land occurs on undulating to rolling country, flat pumice country, slow draining soils, and across extensive areas of shallow and stony plains. Distribution is generally confined to below 650 m (South Island) or 750 m (North Island), and where annual rainfall is between 800 and 2,500 mm in the North Island or below 2,400 in the South Island.

Class 4 land has severe physical limitations to arable use. These limitations substantially reduce the range of crops which can be grown, and/or make intensive soil conservation and management necessary. In general, Class 4 land is suitable for occasional cropping (eg once in five years or less frequently) and is most suitable for pasture, tree crops or production forestry. The most common limitations which may occur in Class 4 land are; moderate to high susceptibility to erosion under cultivation, strongly sloping, very shallow soils and/or stony or very stony soils, excessive wetness after drainage, frequent flooding, very low moisture holding capacity, severe structural impediments to cultivation, low fertility difficult to correct, and severe climatic limitations.

Class 4 land ranges from flat to strongly rolling. When cultivated there may be severe susceptibility to wind erosion, and to sheet, rill and gully erosion. Unfavourable soil characteristics include clay, loamy sand and sand textures, and very stony soils on terraces. Distribution normally occurs below 800 m (South Island) or 1000 m (North Island) or where rainfall is between 800 and 3,000 mm in the North Island or below 3,000 mm in the South Island.

Class 5 land is high producing pasture with physical limitations that make it unsuitable for arable cropping, but only negligible to slight limitations or hazards to pastoral, tree crop or production forestry.

Class 6 land is defined as land which is not suitable for arable use, and has slight to moderate physical limitations and hazards under a perennial vegetative cover. Some Class 6 land may be suitable for cultivation but for pasture renewal only (ie less than once in ten years).

Class 7 land is defined as land that is unsuitable for arable use and has the potential for severe physical limitations or hazards under perennial vegetation.





Class 8 land has the potential for very severe to extreme physical limitations which make it unsuitable for arable, pastoral, or commercial forestry use. In the sand country Class 8 land occurs within 400 m of the coast and is generally restricted to the coastal foredune. It is not suitable for productive use.


In summary, the limitations or hazards for land use increase and the versatility of uses decreases as you move from Class 1 to Class 8 land. This is shown in the following table.

LUC Class	Arable cropping suitability	Pastoral grazing suitability	Production forestry suitability	General suitability
1	High	High	High	Multiple land use
2	↓	↓	↓	
3	↓	↓	↓	
4	Low	↓	↓	
5	Unsuitable	↓	↓	Pastoral or forestry land
6		↓	↓	
7		Low	Low	
8		Unsuitable	Unsuitable	Conservation land

3.2 Sand country classification

The sand country LUC units can be split into two groups – those on sand dunes and those on sand flats. The sand flats are further differentiated according to depth of water table (which effectively determines soil type). The sand dunes are further differentiated according to the depth of topsoil (which effectively determines the risk to wind erosion if this topsoil is disturbed). The LUC units found in the sand country are described in the following table:

Luc unit	Resources information	Parent material	Slope (degrees)	Erosion degree & severity		Strengths	• Limitations	Landuse suitability	Conditions of use
	IIIw4 Flat, wet sand plains with gleyed yellow-brown sands and gley soils. High water table in winter and spring limits cropping versatility.	Wind blown sand. Peat.	0-7	Nil.	Slight wind erosion when cultivated.	<ul style="list-style-type: none"> Stable sand country. Good moisture holding capabilities. Summer safe. 	<ul style="list-style-type: none"> Small areas of swamp. Difficult to drain without affecting adjacent units. Persistence of rushes. High water table in winter and spring limits cropping versatility. Pugs when wet with heavy cattle. 	Intensive pastoral farming	<ul style="list-style-type: none"> Management of this unit should always be related to adjacent areas. Fence off this unit from surrounding dune ridges if significant enough to allow differential grazing management and realize full production of this unit without causing severe overgrazing of the dunes. Care with grazing when wet.
	Ive10 Sand plains with yellow-brown sand soils which are of low to moderate natural fertility and subject to periods of soil moisture deficiency. Potential for severe wind erosion when cultivated.	Wind blown sands.	0-7	Nil.	Nil to slight wind erosion. Severe wind erosion when cultivated.	<ul style="list-style-type: none"> Good contour. Good winter grazing country. Excellent drainage. 	<ul style="list-style-type: none"> Subject to long periods of summer drought. Slight wind erosion potential. Potential for severe wind erosion if cultivated. Low natural fertility. 	Seasonal intensive pastoral farming.	<ul style="list-style-type: none"> Avoid overgrazing during seasonal droughts to avoid wind erosion. Subdivide this unit from other associated sand dunes to allow differential grazing. If cultivated, use minimum tillage techniques such as direct drilling. Establish shelter belts.
	Vle24 Undulating to moderately steep stabilized sand dunes with weakly developed yellow-brown sand soils. Soils are free draining with frequent periods of soil moisture deficiency. Potential for moderate wind erosion.	Wind blown sands.	3-25	Slight to moderate wind erosion.	Moderate wind erosion.	<ul style="list-style-type: none"> Good winter country for stock. Very good drainage. Suitable for forestry. Good all year round access. 	<ul style="list-style-type: none"> Moderate to severe wind erosion. Severe drainage and poor water holding capacity. Careful stock management required. May require de stocking in summer. Drought prone. 	Extensive pastoral farming.	<ul style="list-style-type: none"> Ensure that blow outs are revegetated. Practice good stock management. Avoid overgrazing during seasonal droughts to avoid wind erosion. Subdivide this unit from other associated sand dunes to allow differential grazing. Siting of fences important to minimize wind erosion.
	Vis4 Flat sand plans with yellow-brown sand soils that are free draining, of low to medium natural fertility and have frequent periods of soil moisture deficit. Potential for slight wind erosion.	Wind blown sands.	0-3	Nil to slight wind erosion.	Slight wind erosion.	<ul style="list-style-type: none"> Contour. Access. 	<ul style="list-style-type: none"> Potential for slight to moderate wind erosion if the surface is broken. Has the tendency to dry out during the summer period. Very free-draining. 	Pastoral production.	<ul style="list-style-type: none"> Use minimum tillage techniques when cultivating. Avoid overgrazing during seasonal droughts to avoid wind erosion. Subdivide this unit from other associated sand dunes to allow differential grazing. Siting of fences important to minimize wind erosion. Establish windbreaks.

	<p>Vile15 Rolling to moderately steep sand dunes with a potential for extreme wind erosion under grassland.</p>	<p>Wind blown sand.</p>	<p>7-25</p>	<p>Moderate to extreme wind erosion.</p>	<p>Severe to extreme wind erosion.</p>	<ul style="list-style-type: none"> • Good winter country for stock. • Suitable for forestry. • Good all year round access. 	<ul style="list-style-type: none"> • Potential for extreme wind erosion. • Extreme drainage. • Pasture production limited. • Bare areas of sand. • Difficult to re-establish pasture species. • Limited topsoil. 	<p>Extensive pastoral grazing. Erosion control forestry. Marram planting on bare areas of sand.</p>	<ul style="list-style-type: none"> • Subdivide this unit from adjacent units. • Maintenance of a complete vegetation cover is essential. • Establish erosion control forestry. • Extensive grazing only. • Ensure blow outs are revegetated. • Prevent over grazing.
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3.3 Past re-classification of LUC units

In the past, LUC units of parcels of land could be reclassified if there was a system or management change that resulted in a significant reduction in the hazard or limitation present. The system or management implemented needed to be permanent and involve more than one property. An example of this; was land irrigated under a community border dyke scheme in Canterbury. Land that was irrigated had a reduced erosion risk and as a consequence the versatility of the land improved significantly. Re-classification of irrigated land on just one property would not be considered.

4 Discussion

Sand country throughout the Horizons region is being developed from extensive store farming or forestry, to dairying with the introduction of large scale irrigation. Dry matter production levels have increased from less than 4-5 tonnes dry matter per hectare to in excess of 15-16 tonnes of dry matter per hectare per annum with irrigation.

Natural fertility is generally very low due to minimal topsoil development, particle size, low water holding capacity, and limited weathering of the parent material. With irrigation, fertiliser can be more targeted by practicing fertigation. Irrigation can produce higher leaching also.

4.1 Reclassification of land under irrigation

This section details any possible reclassification of sand country LUC units when permanent irrigation is applied.

Class IIIw4

The biggest limitation of this unit is poor drainage and irrigation will not reduce the moderate physical limitations to arable use. Hence any reclassification under irrigation can not be justified.

Class IVe10

Without irrigation this unit has severe limitations to arable use. Permanent irrigation could possibly lower the erosion limitation to moderate however the limiting soil physical properties would still be severe and may become the dominant limitation. This would restrict arable use. Re-classification of IVe10 under irrigation could not be justified.

Class VI s4

The biggest limitation to use of LUC Class VI s4 land is the ability for the soil to hold moisture in the summer period. Irrigation on this land class would significantly enhance productivity, and lower the erosion potential. With permanent irrigation this unit could be cultivated due to contour and used for arable farming. However, it would have a severe physical limitation to arable cropping. Any irrigation would need to be of quantity throughout the spring-summer-autumn to minimise wind erosion.

Reclassification of VI s4 to IVe10 under irrigation could be justified. The land could be suitable for arable use but the physical limitations would be severe. Cultivation on this land type could only be undertaken infrequently and generally only for pasture renewal. Direct drilling would likely be the preferred method of pasture renewal.

VIe24

VIe24 occurs on undulating to moderately steep stabilised dunes. The soil development is dependent on the age of the dunes. Under permanent irrigation reclassification should be dependent on a combination of contour and soil type.

Undulating contoured dunes with yellow brown sand soils (Motuiti, Mosston, Foxton or Patea) could be reclassified as Class IVe land. The limitation to arable use would still be severe.

Dunes with either recent soils (Waitarere, Castlecliff or Hokio soils) present or have a slope greater than 15 degrees could be reclassified as Class Ve land. These dunes would have very severe or extreme limitations to arable use, hence reclassification to anything better than Class Ve could not be justified. A new LUC Class V unit would be required. There are currently no LUC Class V units for the sand country and under the recent update of the Landuse Capability Handbook there is the opportunity to do this.

Reclassification of dunes with characteristics outside these parameters (ie recent soils and over 15 degrees) could not be justified, as even with irrigation it is considered that the physical limitations for pasture will remain moderate.

VIIe15

The contour and recent soils found on Class VIIe15 means that the physical limitations to pastoral farming are likely to remain severe even under irrigation. Hence any reclassification of Class VIIe15 under irrigation could not be justified.

4.2 Reclassification of re-contoured dunes

In the short to medium term any re-contoured dunes would have too greater limitation for arable use. Consequently they could not be reclassified as anything better than class V land. With irrigation the LUC unit of any re-contoured land would be determined by the depth of topsoil present or degree of soil development. This affects the erosion risk or hazard. This would need to be done on a case by case basis. If there is only limited or no topsoil or soil development present at the surface following re-contouring, then there is still a moderate to severe risk for erosion under pastoral farming. Therefore, with irrigation, classification would still be VIe24 or VIIe15. Increased topsoil or soil development depth would mean a classification of class V, VIe4 or VIe24. In the long term with greater soil development it could be classified as IVe10 if it has suitable soil depth for arable use to reduce the erosion limitation.