Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®

Incorporating:

Part A: Recalculation of nitrogen (N) leaching maximums by LUC class using OVERSEER® versions 5.2.6 (2007) and 6.2.3 (2017)

Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version of OVERSEER® (v6.2.3)

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Introduction

Horizons Regional Council commissioned the Fertilizer and Lime Research Centre (Massey University) to investigate the extent to which cumulative N leaching maximums, by Land Use Capability (LUC) Class in Table 14.2, of their One Plan, are affected by a change in the version of OVERSEER®. The Year 1 numbers in Table 14.2 appear to have been derived directly from values calculated using OVERSEER® version 5.2.6 (2007 version) or earlier (Carran *et al.,* 2007). The first step to re-calibrating the Table 14.2 values is to assess the impact that the current version of OVERSEER® (v6.2.3) has on the N leaching losses by LUC class for Year 1 (Table 1).

Table 1: One Plan Table 14.2 Cumulative N Leaching Maximums for Year 1 (kg N/ha)

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	30	27	24	18	16	15	8	2

This report has two objectives. Firstly, to approximately replicate the data for each LUC class for Year 1 (One Plan Table 14.2) by identifying input parameter data (known and assumed) for a base farm for use in OVERSEER® (v5.2.6). Secondly, the input parameter data is used in the current version of OVERSEER® (v6.2.3) to determine the new cumulative N leaching maximums for each LUC class.

Methods

The main initial assumptions used to develop the base farm file for use in OVERSEER® (v5.2.6) include the following:

- a legume based pasture receiving no N fertiliser,
- seasonal supply dairy farm, not carrying any replacements,
- 1200 mm annual average rainfall,
- soil orders used: Class I = Recent Soil, Class II = Brown soil, Class III - VII Pallic soil.
- the appropriate slope class and erosion potential solely dictate the choice of topography, and
- distance from the coast of 50 km
- A total of 9% of the farm area is used for spray application of farm dairy effluent (Holding ponds are used to store effluent, which is 'sprayed at optimum times').

Full details of the input parameters for the base farm file are provided in Appendix 1. The approach used to develop the base farm file was to first set up the farm for LUC I. To do this, the 'attainable physical potential' grazing carrying capacity was obtained from the NZLRI Land Use Capability Extended Legend for the Manawatu/Taranaki Region. For LUC I, the

'attainable physical potential' is 30 stock units (SU)/ha, while the 'present average' value provided is 20 SU/ha. Cow stocking rate and milksolids production were increased in OVERSEER® v5.2.6 until a pasture intake corresponding to a stocking rate of approximately 30 SU/ha (16,500 kg DM/ha; assumes 550 kg DM/SU) was achieved. The milksolids (MS) production was maintained at 370 kg MS/cow, which was the average value provided in Clothier *et al.,* (2007).

To derive the stocking rate values for the other LUC classes (LUC II-VII), the stocking rate and milksolids production were decreased until the N loss to water values were the same as those provided in the One Plan Table 14.2 for Year 1 (Table 1). The pasture intakes for each LUC class, as estimated by OVERSEER® v5.2.6, were then compared with the 'attainable physical potential' grazing carrying capacity, provided in the NZLRI Land Use Capability Extended Legend. This was done to ensure that the values obtained using OVERSEER® v5.2.6 for each LUC class were within the expected range provided in the LUC Extended Legend. The stocking rates, milk solids production, soil order and topography used in OVERSEER® v5.2.6 for each LUC class are provided in Table 2. Although LUC VII is classified as having 'Steep' topography, 'Easy' was used instead because a N loss to water below 9 kg N/ha could not be achieved with OVERSEER® v5.2.6 when 'Steep' topography was used.

Table 2: Summary of main input parameter changes for each LUC class

LUC	Stock Units (SU/ha)	Stocking rate (cows/ha)	Milksolids (kg/ha)	Soil Order	Topography
I	29.9	3.4	1275	Recent	Flat
II	27.1	3.1	1150	Brown	Flat
III	23.8	2.7	1020	Pallic	Rolling
IV	16.6	1.9	700	Pallic	Rolling
V	14.0	1.6	590	Pallic	Easy
VI	13.1	1.5	555	Pallic	Easy
VII	4.4	0.5	185	Pallic	Easy**
VIII	Trees	-	-	-	

*Assumes 550 kg DM/SU intake. **Used Easy rather than Steep.

For each LUC class, the equivalent input data to that was used in OVERSEER® v5.2.6 was then entered into OVERSEER® v6.2.3. There were two main considerations that needed to be addressed when changing versions. The first consideration was that some of the default values

used in OVERSEER® v5.2.6 varied from OVERSEER® v6.2.3. Therefore, two sets of results from OVERSEER® v6.2.3 are provided; one using the v5.2.6 default values (Appendix 2) and the other using the v6.2.3 default values (Appendix 3). The other consideration was that v6.2.3 has more options for entering input data than v5.2.6. Therefore, in most cases where additional input information was required by v6.2.3, then either the default value was used or the OVERSEER®Best Practice Data Input Standards (v6.2.3) were used for guidance.

Results

The N leaching maximums obtained with OVERSEER® v6.2.3, using the v5.2.6 defaults, were 32.5 - 66.0% higher than the original One Plan Table 14.2 values (Table 2). Using the v6.2.3 defaults instead of the v5.2.6 defaults made minimal difference to the N leaching maximums obtained (Table 3).

Table 2: Original and revised (v 6.2.3 using v5.2.6 defaults) N leaching maximums

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v 5.2.6)	30	27	24	18	16	15	8	2
Revised (v 6.2.3) ***v5.2.6 defaults***	49.8	44.4	35.7	26.2	22.7	21.6	10.6	3.3*
Increase	66.0%	64.4%	48.8%	45.6%	41.9%	44.0%	32.5%	65.0%

*Native trees (pines are 2.7 kg N/ha loss to water)

Table 3: Original and revised (v6.2.3 using v6.2.3 defaults) N leaching maximums

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v 5.2.6)	30	27	24	18	16	15	8	2
Revised (v 6.2.3) ***v6.2.3 defaults***	49.4	44.0	35.5	26.0	22.6	21.5	10.6	3.3*
Increase	64.7%	63.0%	47.9%	44.4%	41.3%	43.3%	32.5%	65.0%

*Native trees (pines are 2.7 kg N/ha loss to water)

The pasture intakes provided for each LUC class by OVERSEER® v6.2.3, using the v5.2.6 defaults, were close to those obtained with v5.2.6 (Table 4). When the v6.2.3 default values were used instead, the difference in pasture intakes between v6.2.3 and v5.2.6 increased. Therefore, it is recommended that comparisons of the N losses to water between the two OVERSEER® versions are best made using the v5.2.6 defaults for both versions.

Table 4: Stock units and OVERSEER® pasture intakes* for each LUC class

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Stock units** (SU/ha)	29.9	27.1	23.8	16.6	14	13.1	4.4	-
v5.2.6 Pasture Intake (kg DM/ha)	16,448	14,930	13,108	9,123	7,683	7,216	2,406	-
v6.2.3 Pasture Intake *v5.2.6 defaults* (kg DM/ha)	16,265	14,742	13,179	9,144	7,784	7,319	2,440	-
v6.2.3 Pasture Intake *v6.2.3 defaults* (kg DM/ha)	16,977	15,395	13,748	9,543	8,130	7,636	2,545	-

*Assumes that pasture intake is 85% of pasture production. **Based on an intake of 550 kg DM/SU

References

Carran A, Clothier B, Mackay, Parfitt R (2007). A*ppendix 6: Defining nutrient (nitrogen) loss limits within a water management zone on the basis of the natural capital of soil in Farm Strategies for Contaminant Management*. A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Clothier B, Mackay A Carran A, Gray R, Parfitt R, Francis G, Manning Maitland, Duerer M, Green S (2007). *Farm Strategies for Contaminant Management.* A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Appendix 1

Case study farm - LUC I (base)

Overseer 5.2.6 file: '*LUC I(v5.2.6)*'

Current

Farm

- Region: East Coast North Island

Block setup

- Block areas: 100 ha Non-effluent, 10 ha Effluent (spray effluent)
- Relative productivity: No difference between blocks

Dairy animals

- Dairy cows (/ha): 3.4 cows
- Breed: Friesian
- Milk solids (kg/ha): 1275 kg MS/ha
- Replacements grazed off: Weaning
- Effluent disposal system: Holding pond
- Pond treatment method: Spray at optimum times
- Block (solid) effluent distrib: Effluent block (pond sludge)

Non-effluent block

Block general

- Topography: Flat
- Distance from coast: 50 km
- Rainfall: 1200 mm

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: Recent
- Soil texture: Silt loam
- Soil tests: "Click if missing soil test data"

Fertiliser

Effluent block

Block general

- Topography: Flat
- Distance from coast: 50 km
- Rainfall: 1200 mm
- Effluent application rate: Medium

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: Recent
- Soil texture: Silt loam
- Soil tests: "Click if missing soil test data"

Case study farm - LUC II (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC II (v5.2.6)*'
Current
Dairy animals
- Dairy cows (/ha): 3.1 cows
- Milk solids (kg/ha): 1150 kg MS/ha

Non-effluent block
Soil
- Soil order: Brown

Effluent block
Soil
- Soil order: Brown

Case study farm - LUC III (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC III (v5.2.6)*'
Current
Dairy animals
- Dairy cows (/ha): 2.7 cows
- Milk solids (kg/ha): 1020 kg MS/ha

Non-effluent block
Block general
- Topography: Rolling

Soil
- Soil order: Pallic

Fertiliser
Effluent block
Block general
- Topography: Rolling

Soil
- Soil order: Pallic

Case study farm - LUC IV (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC IV (v5.2.6)*'

Current

Dairy animals

- Dairy cows (/ha): 1.9 cows
- Milk solids (kg/ha): 700 kg MS/ha

Non-effluent block

Block general

- Topography: Rolling

Soil

- Soil order: Pallic

Effluent block

Block general

- Topography: Rolling

Soil

- Soil order: Pallic

Case study farm - LUC V (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC V (v5.2.6)*'

Current

Dairy animals

- Dairy cows (/ha): 1.6 cows
- Milk solids (kg/ha): 590 kg MS/ha

Non-effluent block

Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

Effluent block

Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

Case study farm - LUC VI (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC VI (v5.2.6)'*

Current

Dairy animals

- Dairy cows (/ha): 1.5 cows
- Milk solids (kg/ha): 555 kg MS/ha

Non-effluent block

Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

Effluent block

Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

Case study farm - LUC VII (differences from LUC I – base):
Overseer 5.2.6 file: '*LUC VII(v5.2.6)'*

Current

Dairy animals

- Dairy cows (/ha): 0.5 cows
- Milk solids (kg/ha): 185 kg MS/ha

Non-effluent block

Block general

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

Effluent block

Block general

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

Case study farm - LUC VIII:

Overseer 5.2.6 file: '*LUC VII(v5.2.6)*'

Current

Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Other animals

- SU/ha beef: 1

Trees block

Block general

- Distance from coast: 50 km
- Rainfall: 1200 mm

Pasture block

Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

Appendix 2 – Overseer 6.2.3 using v5.2.6 defaults

Case study farm - LUC I (base): Bold denotes additional input information required by v6.2.3

Overseer 6.2.3 file: '*LUC I (v6.2.3) – v5 defaults*'

Farm scenario

Farm

- Location — By Region - East Coast North Island

Block setup

- Block areas: — **Total 110 ha:** 100 ha Non-effluent, 10 ha Effluent
- Relative productivity: — No difference between blocks

Dairy animals

- **Peak cow numbers:** — 374 cows **(breeding numbers NOT constant)**
- Breed: — Friesian
- **Average weight:** — 534 kg/animal (default for 5.2.6)
- **Replacement rate:** — 25% (default for 5.2.6)
- Milk solids (kg/ha): — 1275 kg MS/ha
- **Lactation length:** — 271 (default for 5.2.6)
- Replacements grazed off: — Weaning
- Effluent disposal system: — Holding pond;
- **Pond solids:** — **Solids spread on selected blocks; ponds empty every 1 year**
- **Liquid effluent:** — **Spray regularly**

Non-effluent block

General

- Topography: — Flat
- Distance from coast: — 50 km

Climate

- **Daily rainfall pattern:** — **731-1450 mm, low**
- Rainfall: — 1200 mm
- **Temperature:** — 12.6 ^{o}C (default for 5.2.6)
- **PET:** — **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** — **Moderate**

Pasture

- Development status: — **No input for development status**
- Pasture type: — Ryegrass/white clover
- Specify pasture quality: — default from v5.2.6, see table below

	Digestibility (%)	ME (MJ ME/kg DM)
January	75	11.1
February-April	73	10.8
May-August	74	10.9
September	77	11.4
October	79	11.7
November	78	11.5
December	77	11.4

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 80 tonnes (dry weight basis) (automatic in v5.2.6)
- Destination: Non-effluent block

Effluent block

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern:** **731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** 12.6 ^{o}C (default for v5.2.6)
- **PET:** **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** **Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Default from v5.2.6

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 8 tonnes (dry weight basis) (default from 5.2.6)
- Destination: Effluent block

Effluent

- Effluent application rate: **12-24 mm**
- Solids effluent application: Pond solids/sludge **(December)**

Case study farm - LUC II (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC II (v6.2.3) - v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 341 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1150 kg MS/ha

Non-effluent block

Soil

- Soil order: *Brown*

Supplements made

- Category: Silage
- Weight: 73 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 7 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC III (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC III (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 297 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1120 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 64 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC IV (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC IV (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 209 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 700 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 45 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC V (differences from LUC I – base)
Overseer 6.2.3 file: '*LUC V (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 176 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 590 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 38 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VI (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC VI (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 165 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 555 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 36 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VII (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC VII (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 5 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 185 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 12 tonnes (dry weight basis) ((automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 1 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VIII:

Overseer 6.2.3 file: '*LUC VIII (v6.2.3) – v5 defaults'*

Farm scenario

Beef/dairy grazers

- Block areas: 1 RSU

Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Trees

General

- Bush type Native

Pasture

Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

Appendix 3 - Overseer 6.2.3 using v6.2.3 defaults

Case study farm - LUC I (base): Bold denotes additional input information required by v6.2.3

Overseer 6.2.3 file: '*LUC I (v6.2.3) – v6 defaults*'

Farm scenario

Farm

- Location: By Region - East Coast North Island

Block setup

- Block areas: **Total 110 ha:** 100 ha Non-effluent, 10 ha Effluent
- Relative productivity: No difference between blocks

Dairy animals

- **Peak cow numbers:** 374 cows **(breeding numbers NOT constant)**
- Breed: Friesian
- **Average weight:** Default reading falsely as 462 kg/animal, actual 525 kg/animal (default for 6.2.3**)**
- **Replacement rate:** Default 23% (default for 6.2.3)
- Milk solids (kg/ha): 1275 kg MS/ha
- **Lactation length:** 270 (default for 6.2.3)
- Replacements grazed off: Weaning
- Effluent disposal system: Holding pond;
- **Pond solids:** **Solids spread on selected blocks; ponds empty every 1 year**
- **Liquid effluent:** **Spray regularly**

Non-effluent block

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern:** **731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** Default 12.3 ^{o}C (default for 6.2.3)
- **PET:** **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** **Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Not specified (defaults for 6.2.3 are different to defaults for v5.2.6, but are not shown)

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 80 tonnes (dry weight basis) (automatic in v5.2.6)

- Destination: Non-effluent block

Effluent block

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern: 731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** Default 12.3 ^{o}C (default for 6.2.3)
- **PET: Use default PET (801-950 mm/yr)**
- **PET seasonal variation: Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Not specified (defaults for 6.2.3 are different to defaults for v5.2.6, but are not shown)
- *Soil*
- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile: Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging: Occasional**

Supplements made

- Category: Silage
- Weight: 8 tonnes (dry weight basis) (automatic in v5.2.6)
- Destination: Effluent block

Effluent

- Effluent application rate: **12-24 mm**
- Solids effluent application: Pond solids/sludge **(December)**

Case study farm - LUC II (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC II (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 341 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1150 kg MS/ha

Non-effluent block

Soil

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 73 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 7 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC III (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC III (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 297 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1120 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 64 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC IV (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC IV (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 209 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 700 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 45 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC V (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC V (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 176 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 590 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 38 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

-

Case study farm - LUC VI (differences from LUC I – base): *Italics denotes changes from the previous LUC value file*

Overseer 6.2.3 file: '*LUC VI (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 165 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 555 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 36 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VII (differences from LUC I – base):

Overseer 6.2.3 file: '*LUC VII (v6.2.3) – v6 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 5 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 185 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 12 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 1 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VIII:

Overseer 6.2.3 file: *LUC VIII '(v6.2.3) – v6 defaults'*

Farm scenario

Beef/dairy grazers

- Block areas: 1 RSU

Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Trees

General

- Bush type Native

Pasture

Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

MASSEY UNIVERSITY

FERTILIZER & LIME RESEARCH CENTRE

Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®

Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version of OVERSEER®(v6.2.3)

horizons regional council

February 2018

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Horizons Regional Council February 2018

Palmerston North

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Introduction

Horizons Regional Council commissioned the Fertilizer and Lime Research Centre (Massey University) to investigate the extent to which cumulative N leaching maximums in Table 14.2 of their One Plan are affected by OVERSEER® version changes. The results of that analysis, reported in Hanly *et al.,* (2018), showed that the N leaching maximums obtained with OVERSEER® (v6.2.3) were 32.5 - 66.0% higher than the original One Plan Table 14.2 values (Table 1).

Table 1: Original and revised (OVERSEER® v 6.2.3 using v5.2.6 defaults) cumulative N leaching maximums (Hanly *et al.*, 2018).

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original	30	27	24	18	16	15	8	2
Revised (v 6.2.3)	49.8	44.4	35.7	26.2	22.7	21.6	10.6	3.3*
Increase	66.0%	64.4%	48.8%	45.6%	41.9%	44.0%	32.5%	65.0%

*Native trees (pines are 2.7 kg N/ha loss to water)

The increase in the quantity of estimated N leaching from the soil root zone, using the current version of OVERSEER® (v6.2.3), has implications for the original N transmission coefficient derived by Clothier *et al.,* (2007) and used in Carran *et al.,* (2007). The transmission coefficient is defined as the proportion of N leached from the soil root zone, as estimated by OVERSEER®, that is measured in the river. Using OVERSEER® (v5), Clothier *et al.*, (2007) estimated that the N transmission coefficient for a 'typical' dairying and 'typical' sheep/beef farms was ~0.5 in two sub-catchments (Weber and Hopelands) of the Upper Manawatu River Catchment. In other words, approximately 50% of the N estimated by OVERSEER® to be lost from the root zone was measured in the river.

With the OVERSEER® estimates of N leaching from the root zone increasing with the current version (v6.2.3, Table 1), then the N transmission coefficient will also be lower than previously estimated because the river N load is a measured value. Therefore, the N transmission coefficient should be varied with changes in OVERSEER® N leaching estimates, to provide a consistent approach for predicting the impact of changing N leaching maximums on river N loads.

The aim of the analysis presented in this report was to determine the effect of the OVERSEER® version change, from v5.2.6 to v6.2.3, on the derived N transmission coefficient. In addition,

this exercise explored the relationship between the revised N leaching maximum values for each LUC class (Table 1), and the revised N transmission coefficients and the implications for river N loads using the same approach as presented in Carran *et al*., (2007).

Methods

Farm input parameters for the 'typical' dairy farm and 'typical' sheep/beef farm were obtained from Clothier *et al.,* (2007). For input parameters that were not provided by Clothier *et al.,* (2007), then default or assumed values were used to complete the farm files in OVERSEER® (v5.2.6). The OVERSEER® (v5.2.6) N leaching values were then compared with those reported for the two farm systems in Clothier *et al.,* (2007).

The equivalent input data, to that used in OVERSEER® (v5.2.6), was then entered into OVERSEER® (v6.2.3). As reported in Hanly *et al.*, 2018, there were two main considerations that needed to be addressed when changing versions. The first consideration was that some of the default values used in OVERSEER® v6.2.3 varied from those in OVERSEER® v5.2.6. In such cases, the v5.2.6 default values were used (as indicated in Appendix 2). The other consideration was that v6.2.3 has more options for entering input information compared to v5.2.6. Therefore, in most cases where additional input information was required by v6.2.3, then either the default value was used or the OVERSEER® Best Practice Data Input Standards (v6.2.3) were used for guidance. Full details of the OVERSEER® input parameters used for the farm files are provided in Appendices 1 and 2.

Results

The estimated OVERSEER® N leaching values obtained in the current analysis for the 'typical' dairy farm and 'typical' sheep/beef farm using v5.2.6 were 31 and 7 kg N/ha/yr, respectively, which were the same values report in Clothier *et al.,* (2007) (Table 2).

Table 2: The river-based farm fluxes *q*, the median of OVERSEER® (v5) calculations *q**, and the derived transmission coefficient estimates for dairying and sheep/beef (adapted from Table 3 in Clothier *et al.*, 2007).

	q (Eq5) kg N/ha/yr	*q** (Eq5) kg N/ha/yr	Transmission coefficient
Dairying	15.4	31	~0.5
Sheep/beef	3.9	7	~0.5

Changing from v5.2.6 to v6.2.3 increased the 'typical' dairying farm N leaching value by 22.6%, from 31 kg to 38 kg N/ha/yr (Table 3). This percentage increase is smaller than the 32.5-66.0% increase range obtained for the farm files when OVERSEER® (v6.2.3) was used to revise the One Plan Table 14.2 (Hanly *et al.,* 2018). The reasons for this discrepancy relates to differences in the predictions of N leaching by the two versions of OVERSEER® when nitrogen fertiliser is used. When the OVERSEER® versions are compared when no N fertiliser is used (i.e. as was the case with the farm files used to derive the One Plan Table 14.2 values) then the 'typical' dairy farm N leaching loss value increased by 45.8%, from 24 to 35 kg N/ha/yr. However, the 'typical' dairying farm in Clothier *et al.,* (2007) used urea fertiliser at a rate of 100 kg N/ha/yr. For some reason, v6.2.3 predicts a smaller increase in estimated N leaching from the use of N fertiliser than v5.2.6. Accordingly, there is a larger difference in N leaching losses between the two versions of the farm scenarios that use no N fertiliser.

Changing from v5.2.6 to 6.2.3 increases the 'typical' sheep/beef farm N leaching loss value by 85.7%, from 7 to 13 kg N/ha/yr. This farm uses urea N fertiliser at a low rate of 7 kg N/ha/yr.

Table 3: The river-based farm fluxes *q*, the median of OVERSEER® (v6.2.3) calculations *q**, and the derived transmission coefficient estimates for dairying and sheep/beef.

	q (Eq5) kg N/ha/yr	*q** (Eq5) kg N/ha/yr	Transmission coefficient
Dairying	15.4	38	~0.4
Sheep/beef	3.9	13	~0.3

The N transmission coefficient of ~0.5 was used by Carran *et al.,* (2007) to estimate the total N loading in the river (kg N/yr) for the Upper Manawatu River Catchment, which was 767,541 kg N/yr (Table 4). This estimated value is close to the measured load of 744,000 kg N/yr (Clothier *et al.* 2007). Carran *et al.,* (2007) found that "*when the fraction of potential production is limited to 75% on all LUC classes, the N at farm scale and the resulting N loading in the river are very close to the present loading".* They go on to say that "*if the short-term goal was to prevent any further increase in the N loading in the river the N loss values in column 5 provide an N loss limit, before requiring the introduction of a mitigation practice."*

Table 4: Area of each LUC class in the Upper Manawatu River Catchment, calculated N loss associated with the potential productivity of the soil in each LUC class (using OVERSEER® v5) and the contribution of the soils in each LUC to the N loading of the Upper Manawatu river when each LUC is farmed at 75% of potential (values from Carran *et al.,* 2007).

LUC Class	Area (ha)	N loss based on potential production (kg N/ha/yr)	Fraction of potential	N loss limit (kg N/ha/yr)	Transmission coefficient	Total N loading in the River (kg N/yr)
II	12424	27	0.75	20.6	0.5	127790
III	20257	23	0.75	17.6	0.5	178315
IV	11508	18	0.75	13.1	0.5	75608
V	907	16	0.75	12.3	0.5	5555
VI	57254	15	0.75	10.9	0.5	311580
VII	22108	8	0.75	6.2	0.5	68693
VIII	5180	0	0.75	0	0.5	0
Total	**129638**					**767541**

A simplified approach was used to allocate the revised dairy N transmission coefficient and the revised sheep/beef N transmission coefficient to the different LUC classes. The dairy coefficient of ~0.4 was applied to the lowest LUC classes based on the area of land in dairying, and then the sheep/beef coefficient of ~0.3 was applied to the remaining LUC classes. Clothier *et al.*, (2007) estimated that approximately 16% of the catchment was in dairy farming at that time. Therefore, 0.4 was used for all of the LUC Class II land and half of the LUC Class III land, which resulted in transmission coefficient of 0.35 for LUC Class III. When the N leaching losses, based on potential production for each LUC class, and the N transmission coefficient were revised using OVERSEER® (v6.2.3), the N river load is estimated to be 758,775 kg N/yr (Table 5). This revised value is close to the value estimated using the earlier version of OVERSEER® (Table 4).

Table 5: Area of each LUC class in the Upper Manawatu River Catchment, calculated N loss associated with the potential productivity of the soil in each LUC class (using OVERSEER® v6.2.3) and the contribution of the soils in each LUC to the N loading of the Upper Manawatu river when each LUC is farmed at 75% of potential.

LUC Class	Area (ha)	N loss based on potential production (kg N/ha/yr)	Fraction of potential	N loss limit (kg N/ha/yr)	Transmission coefficient	Total N loading in the River (kg N/yr)
II	12424	44.4	0.75	33.3	0.4	165488
III	20257	35.7	0.75	26.8	0.35	189833
IV	11508	26.2	0.75	19.7	0.3	67840
V	907	22.7	0.75	17.0	0.3	4633
VI	57254	21.6	0.75	16.2	0.3	278254
VII	22108	10.6	0.75	8.0	0.3	52728
VIII	5180	0*	0.75	0.0	0.3	0
Total	**129638**					**758775**

*A value of zero was used for LUC VIII to be consistent with the approach by Carren *et al.,* 2007.

The original cumulative N leaching maximums by LUC Class from Table 14.2 of Horizons Regional Council's One Plan for Years 1, 5, 10 and 20 are presented in Table 6. The percentage decreases in values in each of the subsequent years after Year 1, in Table 6, were identified. These percentage decreases were then applied to the revised Year 1 values (using OVERSEER v 6.2.3) to obtain revised values for Years 5, 10 and 20 for comparative purposes (Table 7).

Table 6: Original cumulative N leaching maximums (kg N/ha/yr) by LUC Class from Table 14.2 of Horizons Regional Council's One Plan.

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	30	27	24	18	16	15	8	2
Year 5	27	25	21	16	13	10	6	2
Year 10	26	22	19	14	13	10	6	2
Year 20	25	21	18	13	12	10	6	2

Table 7: Revised cumulative N leaching maximums (kg N/ha/yr) by LUC Class, revised using OVERSEER® v6.2.3.

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	50	44	36	26	23	22	11	3
Year 5	45	41	32	23	19	15	8	3
Year 10	43	36	29	20	19	15	8	3
Year 20	42	34	27	19	17	15	8	3

References

Carran A, Clothier B, Mackay, Parfitt R (2007). A*ppendix 6: Defining nutrient (nitrogen) loss limits within a water management zone on the basis of the natural capital of soil in Farm Strategies for Contaminant Management*. A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Clothier B, Mackay A, Carran A, Gray R, Parfitt R, Francis G, Manning Maitland, Duerer M, Green S (2007). *Farm Strategies for Contaminant Management.* A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Hanly J, Hedley M, Horne D (2018). Sensitivity of One Plan Table 14.2 values to OVERSEER version change. Part A: Recalculation of nitrogen (N) leaching maximums by LUC class using OVERSEER versions 5.2.6 (2007) and 6.2.3 (2017). A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.

Appendix 1 - Overseer 5.2.6

'Typical' dairy farm (Bold denotes assumed input parameters)

Overseer 5.2.6 file: 'Typical dairy *(v5.2.6)'*

Current

Farm

- Region: East Coast North Island

Block setup

- Block areas: 99 ha Non-effluent, 11 ha Effluent (spray effluent)
- Relative productivity: **No difference between blocks**

Dairy animals

- Dairy cows (/ha): 2.5 cows
- Breed: **Friesian x Jersey**
- Milk solids (kg/ha): 1000 kg MS/ha
- Average weight: **478 kg/animal**
- Replacements grazed off: **Weaning**
- Effluent disposal system: **Holding pond**
- Pond treatment method: **Spray at optimum times**
- Block (solid) effluent distrib: **Effluent block (pond sludge)**

Supplements added

- Quantity: Total 110 T DM (70% silage); **Good quality pasture silage 77 T DM**, **Good quality pasture hay 33 T DM**
- Destination: **Paddocks**

Non-effluent block

Block general

- Topography: **Flat**
- Distance from coast: **50 km**
- Rainfall: 1200 mm

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: **Recent**
- Soil texture: **Silt loam**
- Soil tests: Olsen P = 30, **Organic S = 8**, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3

Fertiliser

- Fertiliser rates: 217 kg urea/ha; 322 kg SSP/ha (Maintenance P)

Effluent block

Block general

- Topography: **Flat**
- Distance from coast: **50 km**
- Rainfall: 1200 mm
- Effluent application rate: **Medium**

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: **Recent**
- Soil texture: **Silt loam**

- Soil tests: Olsen P = 30, **Organic S = 8**, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3

Fertiliser

- Fertiliser rates **No fertiliser**

'Typical' sheep & beef farm (Bold denotes assumed input parameters)

Overseer 5.2.6 file: 'Typical sheep & beef *(v5.2.6)*'

Current

Farm

- Region: East Coast North Island

Block setup

- Block areas: 400 ha Pasture

Other animals

- Sheep (SU/ha): 7
- Beef (SU/ha): 3
- Wool (kg/ha): 38.5
- % beef as males 33

Pasture block

Block general

- Topography: **Rolling**
- Distance from coast: **50 km**
- Rainfall: 1200 mm

Animals and pasture

- Development status: Developing (not default)
- Pasture type: Browntop

Soil

- Soil order: **Pallic**
- Soil texture: Silt loam
- Soil tests: Olsen P = 14, **Organic S = 8**, QT K = 10, QT Ca = 12, QT Mg = 20, QT Na = 5

Fertiliser

- Fertiliser rates 15 kg urea/ha; 180 kg SSP/ha

Appendix 2 – Overseer 6.2.3 using v5.2.6 defaults

'Typical' dairy farm (Bold shows additional input parameters compared to v5.2.6)

Overseer 6.2.3 file: 'Typical dairy *(v6.2.3) – v5 defaults'*

Farm scenario

Farm

- Location — By Region - East Coast North Island

Block setup

- Block areas: — Total 110 ha**:** 99 ha Non-effluent, 11 ha Effluent
- Relative productivity: — No difference between blocks

Dairy animals

- Peak cow numbers: — 275 cows **(breeding numbers NOT constant)**
- Breed: — Friesian x Jersey
- Milk solids (kg/ha): — 1000 kg MS/ha
- Average weight: — 478 kg/animal (default for 5.2.6)
- Replacement rate: — 25% (default for 5.2.6)
- Milk solids (kg/ha): — 1000 kg MS/ha
- Lactation length: — 271 (default for 5.2.6)
- Replacements grazed off: — Weaning
- Effluent disposal system: — Holding pond
- **Pond solids:** — **Solids spread on selected blocks; ponds empty every 1 year**
- **Liquid effluent:** — **Spray regularly**

Supplements imported

- Quantity — Total 110 T DM (70% silage); Good quality pasture silage 77 T DM, Good quality pasture hay 33 T DM
- Destination — Paddocks
- Utilisation — **Average**

Non-effluent block

General

- Topography: — Flat
- Distance from coast: — 50 km

Climate

- **Daily rainfall pattern:** — **731-1450 mm, low**
- Rainfall: — 1200 mm
- Temperature: — 12.6 ^{o}C (default for 5.2.6)
- **PET:** — **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** — **Moderate**

Pasture

- Development status: — **No input for development status**
- Pasture type: — Ryegrass/white clover
- Specify pasture quality: — Default from v5.2.6, see table below

	Digestibility (%)	ME (MJ ME/kg DM)
January	75	11.1
February-April	73	10.8
May-August	74	10.9
September	77	11.4
October	79	11.7
November	78	11.5
December	77	11.4

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: Olsen P = 30, Organic S = 8, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 58 tonnes (dry weight basis) (automatic in 5.2.6)
- Destination: Non-effluent block

Fertiliser

- Fertiliser rates: 217 kg urea/ha (**Split Aug, Sep, Oct**); 322 kg SSP/ha (Maintenance P) (**Mar**)

<u>Effluent block</u>

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern:** **731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** 12.6 ^{o}C (default for 5.2.6)
- **PET:** **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** **Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Default from v5.2.6

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: Olsen P = 30, Organic S = 8, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in 5.2.6)
- Destination: Effluent block

Effluent

- Effluent application rate: **12-24 mm**
- Solids effluent application: Pond solids/sludge **(December)**

'Typical' sheep & beef farm (Bold shows additional input parameters compared to v5.2.6)
Overseer 6.2.3 file: 'Typical sheep & beef *(v6.2.3) – v5 defaults'*

Farm scenario

Farm

- Location: By Region - East Coast North Island

Block setup

- Block areas: **Total 400 ha:** 400 ha Pasture

Other animals

- Sheep (RSU): 2486 (7 SU/ha x 400 ha x 88.8%*)
  *(5775 SU/6500 RSU = 88.8%; convert from SU to RSU)
- Beef (RSU): 1066 (3 SU/ha x 400 ha x 88.8%*)
- Wool (kg): 15400 kg (38.5 kg/ha)
- % beef as males: 33

Non-effluent block

General

- Topography: Rolling
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern: 731-1450 mm, low**
- Rainfall: 1200 mm
- Temperature: 12.6 ^{o}C (default for 5.2.6)
- **PET: Use default PET (801-950 mm/yr)**
- **PET seasonal variation: Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Browntop
- Specify pasture quality: Default from v5.2.6, see table below

	Digestibility (%)	ME (MJ ME/kg DM)
January	***61***	***9.1***
February-March	***57***	***8.4***
April	***60***	***8.9***
May	***66***	***9.8***
June-July	***71***	***10.4***
August	***74***	***10.9***
September-Oct	***75***	***11.1***
November	***71***	***10.5***
December	***66***	***9.8***

Soil

- Soil order: Pallic
- Top soil texture: Silt loam
- Soil tests: Olsen P = 14, Organic S = 8, QT K = 10, QT Ca = 12, QT Mg = 20, QT Na = 5
- **Susceptibility to pugging: Occasional**

Supplements made

- Category: Silage
- Weight: 38 tonnes (dry weight basis) (default from 5.2.6)
- Destination: Pasture block

Fertiliser

- Fertiliser rates 15 kg urea/ha (**Sep**); 180 kg SSP/ha (**Mar**)

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