

# EMSNM-004 – Matrix Methodology

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## 1 Introduction

The Matrix is a catchment nitrogen load calculation tool used by MHV Water and other Mid-Canterbury irrigations schemes to set and determine compliance with consented nitrogen load limits. The Matrix can also be used to calculate relative changes in catchment average nitrate concentrations in root zone drainage water.

Use of The Matrix is approved under the Canterbury Land and Water Regional Plan, as it was deemed “equivalent” to Overseer™ by the Canterbury Regional Council (ECan) Chief Executive on the 29<sup>th</sup> of April 2020, subject to a number of conditions.

This document describes how The Matrix is to be used in a way that will comply with the requirements of ECan’s “equivalence” approval as well as the requirements of MHV Water’s nutrient discharge resource consent CRC185857.

## 2 Purpose

The purpose of this document is to comply with the Canterbury Regional Council’s Matrix equivalence approval and satisfy conditions 12(g) of resource consent CRC185857, which states:

*Provide reproducible methodology on:*

- (i) How the nutrient load limits are calculated, and the rationale for that nutrient load calculation applied; and*
- (ii) How nutrients from all land subject to this resource consent will be accounted for*

Furthermore, condition 16(v) of resource consent CRC185857 requires any changes made which impact on how The Matrix is applied is subject to external peer review.

## 3 Conditions of Matrix Equivalence Approval

The Matrix is a modelling tool used by the mid-Canterbury irrigation schemes to calculate aggregated nitrogen loads. The Matrix was given formal approval as “equivalent” to Overseer by the Canterbury Regional Council Chief Executive, provided the following conditions are met:

1. Only to be used within the Mid-Canterbury plains, between the Rangitata and Rakaia Rivers, up to the foothills of the mountains, for groups of properties within a combined area of 2,500 ha
2. To be used only in the context of a resource consent to:
  - a. Generate an aggregated nitrogen baseline or nitrogen discharge allowance for groups of properties; and
  - b. Generate an aggregated nitrogen loss calculation to determine compliance with consented nitrogen loss limits.
3. Where the Matrix method is recalibrated against Overseer files every four years
4. The approval has effect until 30 April 2035.
5. Any proposed amendments to The Matrix method shall be submitted to Environment Canterbury for consideration before being implemented:
  - a. The amendments shall be considered by a panel made up of representatives of the Consents, Planning, Science and Compliance Monitoring sections of Environment Canterbury
  - b. Within 30 working days of receiving the proposed amendments the panel shall make a recommendation to the Chief Executive for consideration.

- c. Upon receiving the recommendation, the Chief Executive shall make a decision on the proposed amendments within 14 working days and notify all parties within 5 working days of making the decision.

## 4 Description of Matrix Method

The Matrix Method is a spatial tool that relies on the same key principles to calculate nitrogen load as the methodology used by ECan to calculate the nitrogen load for sub-regional catchments<sup>1</sup>. The Matrix uses representative Overseer scenarios<sup>2</sup> to provide nitrogen loss values for a nitrogen loss matrix.

The representative Overseer scenarios model nutrient losses from 8 different farm system types<sup>3</sup>, over four different soil types<sup>4</sup>, giving a total of 32 base scenarios. The farm systems are:

- Arable 1
- Arable 2
- Arable 4
- Dairy 1
- Dairy 2
- Dairy Support 1
- Dairy Support 2
- Sheep & Beef

Copies of the 32 base Overseer scenarios were taken and modified to account for various farm management level of practice, to provide a total of 192 scenarios. The management levels are:

- Base (reflective of typical 2009-13 practice)
- Hinds Plains Zone good management practice (HPZ-gmp)
- Schedule 28 Good Fertiliser Management Practice (GMP-Fert)
- Schedule 28 Good Irrigation Management Practice (GMP-Irr)
- Schedule 28 Good Management Practice (GMP)
- Advanced Mitigation (AM)<sup>5</sup>

To obtain nitrogen losses values for use in The Matrix, the Overseer block N losses were identified within each of the 32 Base files (Figure 1). Losses from blocks of each farm system with the same irrigation were grouped and the weighted average of the nitrogen losses calculated, creating a matrix of representative nitrogen losses by farm system, soil type and irrigation type. This process was repeated for each management practice standard to create a total of 6 matrices.

The representative scenarios are updated as necessary to remain consistent with Overseer input standards.

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<sup>1</sup> e.g. Mojsilovic, O, Duff, K., Shaw, H., Palmer, K., Steel, K., 2015. Generation of nitrogen and phosphorus loss estimates in the Waitaki Catchment. Environment Canterbury, Report No. R15/109.

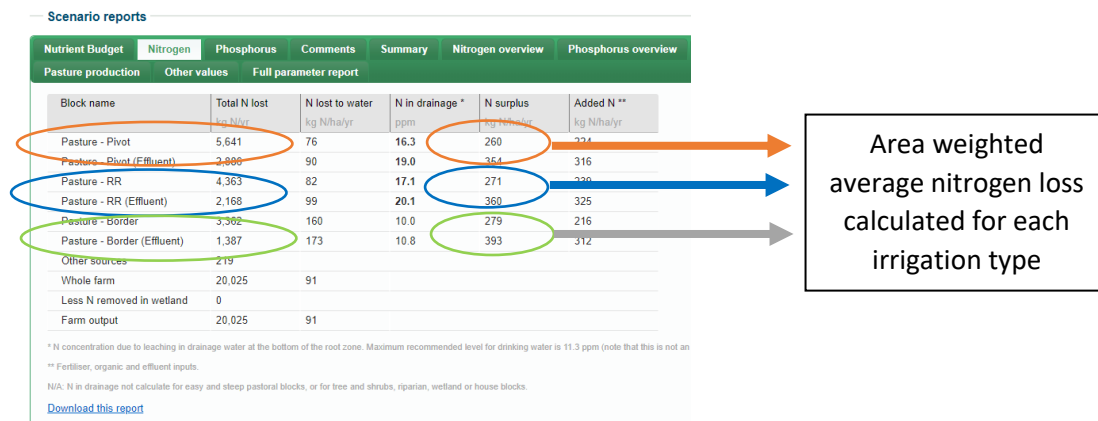
<sup>2</sup> The representative nutrient budgets were prepared by Macfarlane Rural Business and commissioned by Environment Canterbury for catchment accounting purposes in the Selwyn and Hinds Plains zones.

<sup>3</sup> Dairy 1 (higher intensity), Dairy 2 (lower intensity), Arable 1 (seeds), Arable 2 (process), Arable 4 (dryland), Dairy Support 1 (wintering dominant), Dairy Support 2 (replacements grazing dominant) and Sheep and Beef

<sup>4</sup> Deep, Poorly Drained (DPD), Medium Heavy (MH), Light (L) and Very Light (VL)

<sup>5</sup> The Advanced Mitigation files represent practices beyond that expected of GMP and were developed by Environment Canterbury as part of the Plan Change 2 process

Figure 1: Example of how nitrogen loss values for specific irrigation types were taken from MRB Overseer files.



The representative nitrogen loss values are then spatially applied to an individual property by identifying the specific number of hectares of each activity within the matrix, calculated using a GIS mapping tool (**Error! Reference source not found.**). Nitrogen loads for each property are then aggregated to calculate the nitrogen load for a catchment or irrigation scheme.

#### 4.1 Application of The Matrix

Following the process above, a Matrix was created to identify representative N losses by soil type, farm system, irrigation type, and farm management standard, which are then applied to a particular parcel of land within a property. The representative N losses calculated are based on a particular version of Overseer and need to be updated to reflect current Overseer N loss estimates at the time of reporting.

Four farm-specific criteria are used to create each Matrix assessment. Those criteria are:

- Farm system
- Irrigation type
- Soil type
- FEP audit-derived management practice

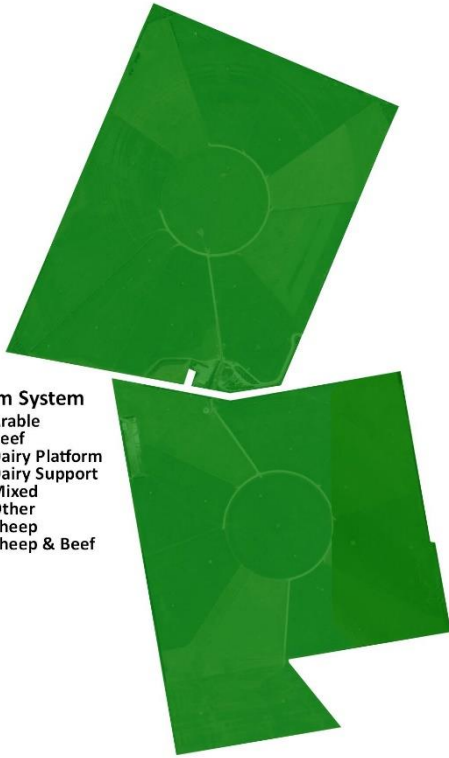
Figure 2: Summary of Layers Used to Calculate Nitrogen Losses



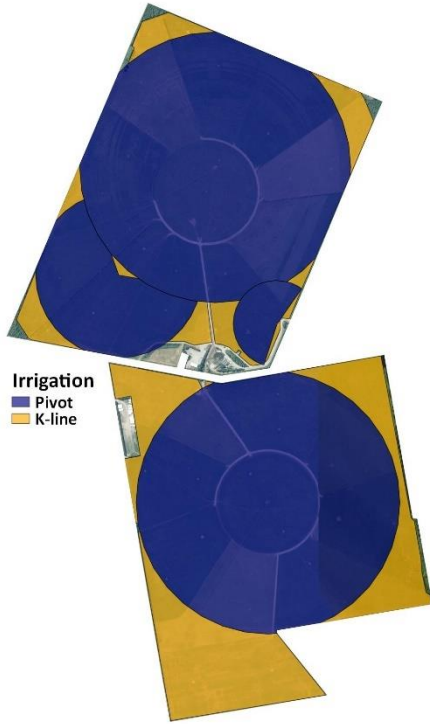
#### 4.2 Case Study – Property NDA

A hypothetical 167 ha Dairy farm has centre-pivot and K-line irrigation, with some dryland. The farm has Heavy, Light, and Poorly Drained soil, and achieved an 'A' audit grade, meaning Good Management Practices were implemented.

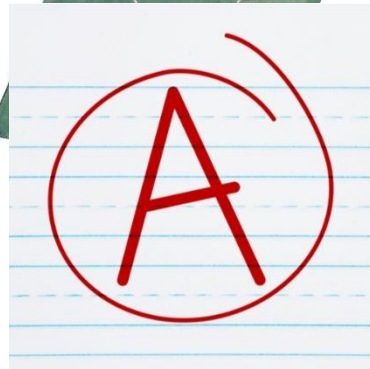
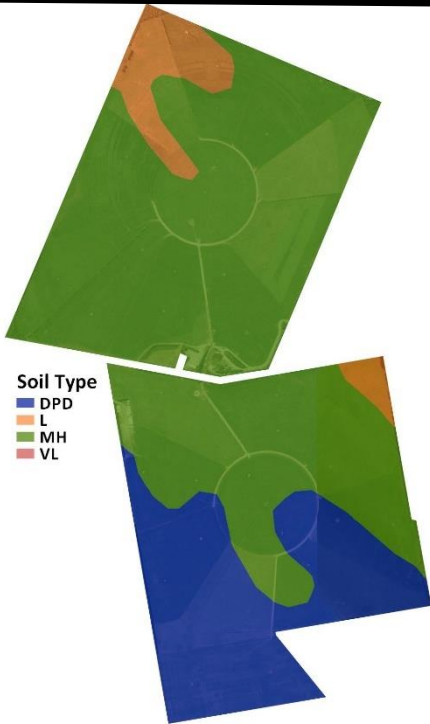
- Farm System**
- Arable
  - Beef
  - Dairy Platform
  - Dairy Support
  - Mixed
  - Other
  - Sheep
  - Sheep & Beef



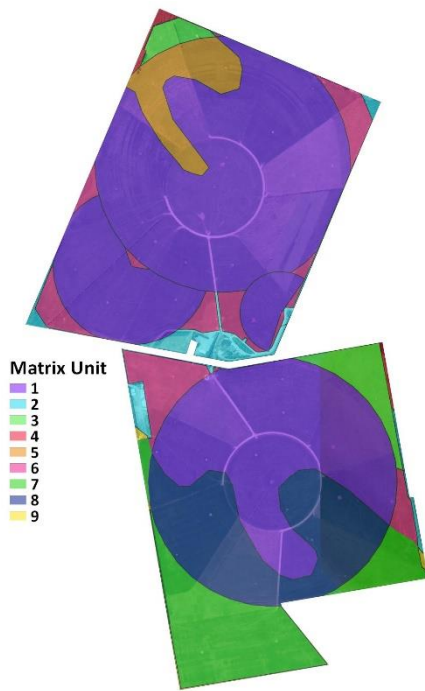
- Irrigation**
- Pivot
  - K-line



- Soil Type**
- DPD
  - L
  - MH
  - VL







Overlaying the four Matrix components (farm system, irrigation, soil type, and management practice) gave nine different nitrogen loss Matrix parcels for the property. These parcels have a weighted average nitrogen loss of 35.7 kg N/ha, with an average nitrogen leaching concentration of 13.9 ppm (Table 1) using a Matrix based on Overseer v6.4.1.

Table 1: Method used to assign nitrogen loss matrix values to parcels of land.

Unit	Area (ha)	Farm system type	Soil category	Irrigation type	Management Practice	Matrix code	N Loss (kg N/ha) <sup>6</sup>	ppm	
1	98.0	Dairy (<3.7 cow/ha)	Heavy	Pivot	GMP	D2_Piv_MH_GMP	36.6	13.5	
2	5.6	Dairy (<3.7 cow/ha)	Heavy	Dryland	GMP	D2_Dry_MH_GMP	29.9	12.9	
3	3.2	Dairy (<3.7 cow/ha)	Light	K-line	GMP	D2_RR_L_GMP	51	17	
4	0.8	Dairy (<3.7 cow/ha)	Light	Dryland	GMP	D2_Dry_L_GMP	38.9	15.6	
5	7.3	Dairy (<3.7 cow/ha)	Light	Pivot	GMP	D2_Piv_L_GMP	49.4	16.6	
6	14.3	Dairy (<3.7 cow/ha)	Heavy	K-line	GMP	D2_RR_MH_GMP	36.6	13.4	
7	17.2	Dairy (<3.7 cow/ha)	Poorly Drained	K-line	GMP	D2_RR_DPD_GMP	30.6	14.4	
8	21.7	Dairy (<3.7 cow/ha)	Poorly Drained	Pivot	GMP	D2_Piv_DPD_GMP	29.5	15.2	
9	0.6	Dairy (<3.7 cow/ha)	Poorly Drained	Dryland	GMP	D2_Dry_DPD_GMP	21.7	11.2	
<b>Total</b>	168.6	<b>Weighted Average</b>						35.7	13.9

<sup>6</sup> Overseer V6.4.1

### 4.3 Winter Grazing Activities

Winter grazing of cattle is a common secondary activity on some farm systems. To account for the secondary activity, a Winter Grazing matrix was created using the area weighted average nitrogen loss of the wintering crops modelled in the Dairy Support representative scenarios.

To incorporate winter grazing, we identified the area of winter grazing<sup>7</sup> activities on properties not classified as dairy support and used the weighted average nitrogen load between the primary land use and the winter grazing area.

For example, if a 100 ha Arable farm also winters dairy cattle on 15 ha, the nitrogen loss for that property would be comprised of 15% dairy wintering and 85% Arable.

## 5 Application of Matrix for Nitrogen Discharge Allowance Calculations

The Nitrogen Discharge Allowance (NDA) is the limit set by resource consent CRC185857, in accordance with Rule 13.5.22 of the Canterbury Land and Water Regional Plan. The NDA is updated when land joins and leaves MHV Water and reported in the most recent version of Overseer.

### 5.1 Source Data – Soils

The layer "Environment Canterbury Soil Types" was used which was accessed via Canterbury Maps at this address:

<https://ecan.maps.arcgis.com/home/item.html?id=73dcd5b8021b4d8e97a2330440f5d496>

### 5.2 Source Data – Farm System and Irrigation

The farm system, winter grazing area and irrigation type mapped for all land managed within MHV Resource consent CRC185857 as at 13<sup>th</sup> May 2021<sup>8</sup> has been subject to review by the owner of the land at that date.

Any changes to the winter grazing, farm system or irrigation maps used to estimate the consented nitrogen load limit are subject to condition 7(b) of resource consent CRC185857, which states:

*b. for land listed within Schedule CRC185857A at the Commencement Date, may be updated within the 12 months following, provided that:*

*(i) the update is consistent with the assessment methodology described for the Matrix Method;*

*(ii) information on the changes (including information on the actual land use and irrigation system) is recorded to support each change, including confirmation that the change remains consistent with Condition 4.*

Each change made to the maps was recorded, including a record of the supporting information used to justify the change in the MHV shareholder folder for that land. No changes will be made to the 2009-2013 farm maps for land managed under CRC185857 at 13<sup>th</sup> May 2021 after 13<sup>th</sup> May 2022.

### 5.3 NDA N Load Allocation

The Matrix NDA is calculated using a four-year rolling average to align with the definition of nitrogen baseline and lawful irrigation set by Plan Change 2 of the Canterbury Land and Water Regional Plan (LWRP).

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<sup>7</sup> Winter grazing is defined as the grazing of cattle within the period of 1 May to 30 September, where the cattle are contained for break-feeding of in-situ brassica and root vegetable forage crops.

<sup>8</sup> Commencement date of resource consent CRC185857.



In the Hekeao/Hinds Plains Zone, operative Policy 13.4.15(e)(iii) states how a load limit for an irrigation scheme is calculated. The calculation for land irrigation under is detailed as follows:

*(e) requiring that the total aggregated nitrogen losses from properties where the nitrogen losses are managed by an irrigation scheme or principal water supplier be limited as follows:*

...

*(iii) land first irrigated with water lawfully supplied by an irrigation scheme or principal water supplier for irrigation authorised and established under and prior to the expiry of resource consent CRC121664 or CRC162882 is limited to a nitrogen loss calculation of 27 kgN (Calculated using Overseer version 6.0.3) per hectare per year;*

Subsequent version changes to Overseer has meant the 27 kg N/ha/year stated in the LWRP varies and needs to be recalculated at each update of The Matrix.

In accordance with policy 13.4.15(e)(iii) of the LWRP, resource consent CRC185857 defines land as follows:

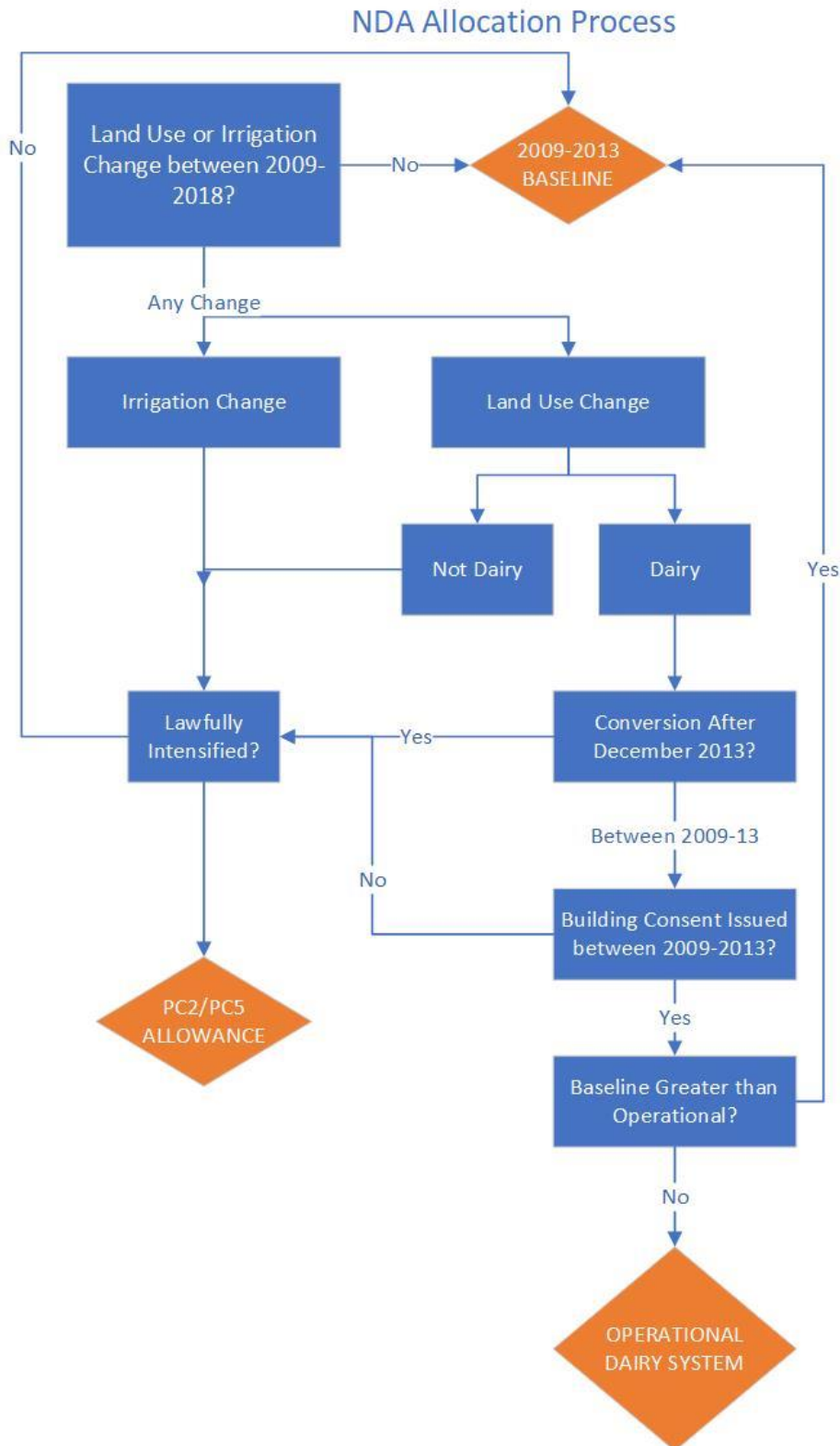
Term	Definition	Allocated Load
<b>Dry Land</b>	Land that is not irrigated, but where nitrogen losses are managed under this consent	2009-13 Baseline <sup>9</sup> , adjusted to HPZ gmp + reductions
<b>Existing Scheme Irrigated Land</b>	Land lawfully supplied with irrigation water by an irrigation scheme or principal water supplier prior to 26 May 2014.	2009-13 Baseline, adjusted to HPZ gmp + reductions
<b>Lawfully Irrigated PC2 Land</b>	Land that was previously not irrigated and which was first supplied with irrigation water by an irrigation scheme or principal water supplier under the authorisation of resource consent(s) CRC121664 or CRC162882 (or replacements or subsequent variations).	27 kg N/ha/year <sup>10</sup>
<b>Other Irrigated Land</b>	Land that is irrigated from any source and which is not Existing Scheme Irrigated Land or Lawfully Irrigated PC2 Land and which is on a Property that receives irrigation water from the MHV Water irrigation scheme.	2009-13 Baseline, adjusted to HPZ gmp + reductions

A summary of the decision-making process to allocate the correct load for land within the MHV Water command area in accordance with the conditions of resource consent CRC185857 is detailed in Figure 3.

<sup>9</sup> Nitrogen baseline means: (a) the discharge of nitrogen below the root zone, as modelled with OVERSEER<sup>®</sup>, (where the required data is inputted into the model in accordance with OVERSEER<sup>®</sup> Best Practice Data Input Standards), or an equivalent model approved by the Chief Executive of Environment Canterbury, averaged over a 48 month consecutive period within the period 1 January 2009 to 31 December 2013, and expressed in kg per hectare per annum, except in relation to Rules 5.46, 5.56, 5.58A and 5.62, where it is expressed as a total kg per annum from the identified area of land; and (b) in the case where a building consent and effluent discharge consent have been granted for a new or upgraded dairy milking shed in the period 01 January 2009 to 31 December 2013, the calculation under (a) will be on the basis that the dairy farming activity is operational; and (c) if OVERSEER<sup>®</sup> is updated, the most recent version is to be used to recalculate the nitrogen baseline using the same input data for the same period as used in (a) above.

<sup>10</sup> Or equivalent in reporting version of Overseer.

Figure 3: Decision Diagram to allocate appropriate load to calculate Nitrogen Discharge Allowance



## 5.4 NDA Schedule

Condition 3 of resource consent CRC185857 states:

*Schedule CRC185857A attached to and forming part of this consent, shall specify:*

- a. *The Nutrient Allocation Zone(s) within which each Property is located; and*
- b. *The load that has been calculated for each property in accordance with Conditions 4 to 7; and*
- c. *A total aggregated NDA for each Nutrient Allocation Zone, being the sum of the assessed nitrogen losses from all properties provided for in Conditions 4(a) and (b) and identified in the relevant part of Schedule CRC185857A.*

Schedule CRC185857A is required to complete the following table as a minimum:

	NDA (kg/yr)	
Property number	Nutrient allocation zone A	Nutrient allocation zone B
<b>Total</b>		

Properties which are less than 5 ha or have a nitrogen loss less than 15 kg N/ha/year are defined as an “authorised property” under resource consent CRC185857 and report a N loss of “0” within the N loss schedule.

**5.5 NDA Calculation for New Land**

Any new land joining MHV Water is defined as “Dry Land” or “Other Irrigated Land” and sufficient information must be provided to allow GIS mapping of the farm system and irrigation type to calculate nitrogen losses for land to be added to The Schedule, which includes the following as a minimum:

- 1. 2009-13 Overseer baseline nutrient budget<sup>11</sup>
- 2. Irrigation system maps for each year within the 2009-13 baseline period
- 3. Farm system and winter grazing maps for each year within the 2009-13 baseline period
- 4. Supporting farm data if required

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<sup>11</sup> Except where land was previously managed by either Barrhill Chertsey Irrigation or Ashburton Lyndhurst Irrigation Schemes

The NDA for the land is then allocated according to the flow diagram above and added to the N load schedule and provided to Environment Canterbury that reporting year.

## 6 Application of Matrix for Calculating Nitrogen Load

The nitrogen load calculation estimates the catchment nitrogen losses from land managed under resource consent CRC185857 at any point in time. The nitrogen losses are compared against the NDA for reporting compliance against resource consent condition 6, which states:

*The maximum annual amount of nitrogen that is lost to water from the Properties described in Condition 4(a) and (b) and listed in Schedule CRC185857A shall not exceed the combined and aggregated NDA of those Properties for each Nutrient Allocation Zone.*

### 6.1 Source Data – Farm System

Farm system information is reviewed with the Farm Environment Plan (FEP) implementer during the annual FEP updates and verified during FEP audits. Farm systems are mapped in the QGIS mapping system as follows:

QGIS Farm System	Description	Measured By	Matrix Farm System
<b>Dairy Platform</b>	Where the majority use of land is used to graze lactating dairy cows	Annual feed demand on land dominated by lactating dairy cows.	Dairy 1 (> 3.7 cows/ha) Dairy 2 (<3.7 cows/ha)
<b>Dairy Support</b>	Where the majority of land is used to graze animals which are farmed for milk production but are not lactating. For avoidance of doubt this classification includes bulls farmed for mating a dairy herd.	Area of land (ha) predominantly used to feed non-lactating dairy animals exceeds other land uses (e.g. arable); or Annual feed demand on land dominated by non-lactating dairy animals	Dairy Support
<b>Wintering<sup>12</sup></b>	Area of land used to break-feed cattle on brassica or root crops between 1 <sup>st</sup> May and 30 <sup>th</sup> September.	Area (ha) of land planted in brassica or root crop to winter graze cattle.	Wintering
<b>Arable/Cropping</b>	<i>Where the majority of the land is in a crop rotation for seed crops or process crops (see section 217B of the RMA). Arable may include the grazing of livestock, but this activity is secondary to the growing of seed and process crops.</i>	Area of land (ha) used for arable crops exceeds area of land dedicated to other uses.	Arable
<b>Beef</b>	Where the majority use of land is for the grazing of beef cattle.	Annual feed demand on land dominated by beef cattle.	Sheep and Beef
<b>Sheep</b>	Where the majority use of land is for the grazing of sheep.	Annual feed demand on land dominated by sheep.	Sheep and Beef

<sup>12</sup> Note Wintering is the only farm system classification which can be applied on the same area of land as another farm system classification, excluding dairy support.

QGIS Farm System	Description	Measured By	Matrix Farm System
<b>Deer/goats</b>	Where the majority use of land is for the grazing of deer or goats.	Annual feed demand on land dominated by deer or goats.	Sheep and Beef
<b>Pig</b>	Where the majority use of land is for the grazing of pigs.	Annual feed demand on land dominated by pigs.	Sheep and Beef
<b>Lifestyle</b>	Where the majority use of land is residential.	Area of land used to support residence.	Sheep and Beef
<b>Mixed</b>	Where use of land is a mixed	As defined by stock class which dominated annual feed demand.	Sheep and Beef
<b>Sheep &amp; Beef</b>	Where the majority use of land is for either sheep or beef, dependent on market demand.	As defined by stock class which dominated annual feed demand.	Sheep and Beef
<b>Other</b>	Where majority use of land is not otherwise classified, such as forestry, bulbs, and permanent horticultural crops <sup>13</sup> .	As defined by majority area of land (ha) not otherwise classified above.	Sheep and Beef

A FEP may include multiple farm system classifications where land use is distinctly different within a property. For instance, where a dairy farm always uses the same paddocks for dairy support activities or where deer are only grazed in a particular area. Where multiple land uses are in rotation, then the dominant farm system classification applies to the whole area of land within the rotation.

Changes in farm system are subject to approval from MHV Water in accordance with the Authorised Land Use policy, however reporting of the farm system is as it occurred during the reporting period, irrespective of whether approval was provided by the scheme.

## 6.2 Source Data - Irrigation

Irrigation systems are reviewed with the FEP implementer during the annual FEP updates and verified during FEP audits. Irrigation systems are mapped using as built design plans and verified with aerial maps, if available, and limited to the area where installed infrastructure can deliver water in accordance with the design specifications<sup>14</sup>. For clarity, irrigation only applies to systems designed for the distribution of freshwater and exclude irrigation systems designed to distribute collected animal effluent.

QGIS Irrigation System	Description	Matrix Irrigation System
<b>Pivot</b>	Low application depth spray irrigation system, centred at a singular point, including an arm or gun to extend coverage.	Pivot
<b>Lateral</b>	Low application depth spray irrigation system, not centred at a singular point, including an arm or gun to extend coverage.	Pivot

<sup>13</sup> E.g., berries or tree fruit

<sup>14</sup> For instance, irrigated area includes land, which is not irrigated in a particular season, but has the infrastructure to do so at any time and excludes land where infrastructure cannot deliver water.

QGIS Irrigation System	Description	Matrix Irrigation System
<b>Solid Set</b>	Fixed low application depth sprinkler system.	Pivot
<b>Rotorainer</b>	High application depth spray irrigation system from a rotating boom, characterised by a long return period.	Rotorainer
<b>Linear Boom/ Turborainer</b>	High application depth spray irrigation system from a fixed boom, characterised by a long return period.	Rotorainer
<b>Gun</b>	High application depth spray irrigation system from a gun, characterised by a long return period.	Rotorainer
<b>K-line/Long Lateral</b>	High application depth sprinkler system, characterised by a long return period.	Rotorainer
<b>Borderdyke</b>	High application depth surface	Borderdyke
<b>Drip/Mirco</b>	Low application depth sub-surface irrigation system.	Pivot
<b>Dryland</b>	No irrigation or infrastructure to deliver irrigation.	Dryland
<b>Other</b>	System not otherwise defined.	As best represented by one of the 4 systems above

Changes in irrigation system are subject to approval from MHV Water in accordance with the Authorised Land Use policy, however reporting of irrigated is as it occurred during the reporting period, irrespective of whether approval was provided by the scheme.

### 6.3 Source Data – Management Standard

All properties which are not defined as “Authorised” under condition 9 of CRC185857 are regularly audited against the targets and objectives specified in Schedule CRC185857C at the frequency determined by condition 19(a).

At any point in time, these properties will have a standing audit grade, termed the “Compliance Management Standard” (CMS) grade. The CMS grade is updated when a property is audited and used to allocate the management standard in The Matrix as follows:

Audit Grade	Matrix CMS
C or D Grade	Baseline
B Grade, M or L LOC for Irrigation Target 3 and Nutrient Target 3	Baseline
B Grade, H LOC for Nutrient Target 3, M or L LOC for Irrigation Target 3	GMP-Fertiliser
B Grade, H LOC for Irrigation Target 3, M or Low LOC for Nutrient Target 3	GMP-Irrigation
B Grade, H LOC for both Irrigation Target 3 AND Nutrient Target 3	GMP
A Grade	GMP
A Grade and can demonstrate advanced mitigation practices are implemented <sup>15</sup>	AM1
<i>Irrigation Target 3: The timing and depth of irrigation water applied takes account of crop requirements and is justified through soil moisture monitoring or soil water budgets and climatic information.</i> <i>Nutrient Target 3: Manage the amount, timing and application of fertiliser inputs to match the predicted plant requirements and minimise nutrient losses.</i>	

<sup>15</sup> As identified by an Accredited FEP auditor in accordance with the Advanced Mitigation auditor guidance notes.



## 7 Reporting N loss Calculation

To report nitrogen losses, the NDA is updated into the most recent version of Overseer and compared against the nitrogen losses calculating using The Matrix using the farm system, irrigation type and CMS audit grades for the previous 1 July to 30 June.

The updated NDA schedule (including revision number), the current N load calculations for the property, and an updated consent wide map showing all properties management under the consent<sup>16</sup> shall be included in the Annual Compliance Report provided to Te Rūnanga o Arowhenua and Canterbury Regional Council by 1<sup>st</sup> December each year.

## 8 Validation of The Matrix

The Matrix is required to be revalidated once every 4 years. The process to validate the model is detailed in the application to approve The Matrix as equivalent to Overseer.

### 8.1 Validation

The validation of The Matrix shall be completed once every four (4) years using a sample of properties. The minimum sample size will ensure 95% confidence of a result within 10% of the true value. As of 2020, this would equate to 90 properties located between the MHV Water, Barrhill Chertsey Irrigation Limited and Ashburton Lyndhurst Irrigation Scheme consented command areas. The first validation exercise will be completed in 2024.

The properties selected will be representative of farming activities within the Mid Canterbury area. A representative sample will have approximately the same distribution of farm system, soil type and rainfall as the collective schemes. Each selected property will complete a Year-End Overseer nutrient budget, using a suitably qualified professional in accordance with the most recent OverseerFM User Guide, or equivalent document. All nitrogen losses will be aggregated using the same version of Overseer.

A Matrix assessment will be completed for the same sample properties using the land use and irrigation maps and FEP Audit results applicable to the Year-End nutrient budget. The Matrix load will be calculated with the same version of Overseer as the representative sample of nutrient budgets.

An acceptable threshold of aggregated nitrogen losses (calculated as kg N/year) as calculated using The Matrix shall be within +/- 10% of the aggregated nitrogen losses as calculated using OverseerFM.

### 8.2 Recalibration Process

Where the validation of The Matrix demonstrates a variation greater than 10%, the user of The Matrix can choose one of two options:

Option A: Expand Validation Sample Size

Option B: Update Matrix files and Recalibrate

#### 8.2.1 Option A: Increase Sample Size

Option A would be suitable where the variation from the nutrient budgets was caused by the randomised samples not being representative of the catchment.

Where Option A is chosen, additional Overseer nutrient budgets would be prepared, ensuring the sample properties are representative of the farming activities occurring within the catchment. The additional nutrient

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<sup>16</sup> Provided as a map and in commonly used GIS format.

budgets are added to the existing validation and compared to The Matrix. If this resolves the issue, the regular validation process can continue.

### 8.2.2 Option B: Update Matrix and Recalibrate

Option B would be the most suitable option where the deviation was caused by radical changes in land use activities and/or location within the catchment. Overseer will also need to be capable of modelling these changes.

Where Option B is chosen, a full investigation of the cause of the deviation will need to be completed and a proposal prepared for consideration by Environment Canterbury.

The proposal shall include:

- Detailed report on the probable cause of the changes resulting in the deviation of The Matrix from the aggregated Overseer Nutrient budgets
- A detailed proposal on the amendments required to The Matrix required to maintain equivalence.

An example where this process would be needed could be where climate has been identified as the reason for a difference of >10% between The Matrix and year-end Overseer nutrient budgets. In this situation, the proposal would consider methods to take climate into account in the model to re-calibrate the model to within +/- 10%.

Once a proposal is accepted by the Environment Canterbury, a suitably qualified person would then update The Matrix files and re-run the model. The updated Matrix is then re-calibrated against the Overseer nutrient budget samples and the process repeated until The Matrix is calibrated.

As the Matrix is based on the Overseer model, further granularity in the Matrix could be developed to ensure equivalence is maintained at all times.

The Matrix is validated on a 4-yearly basis using the following process described in Figure 5.

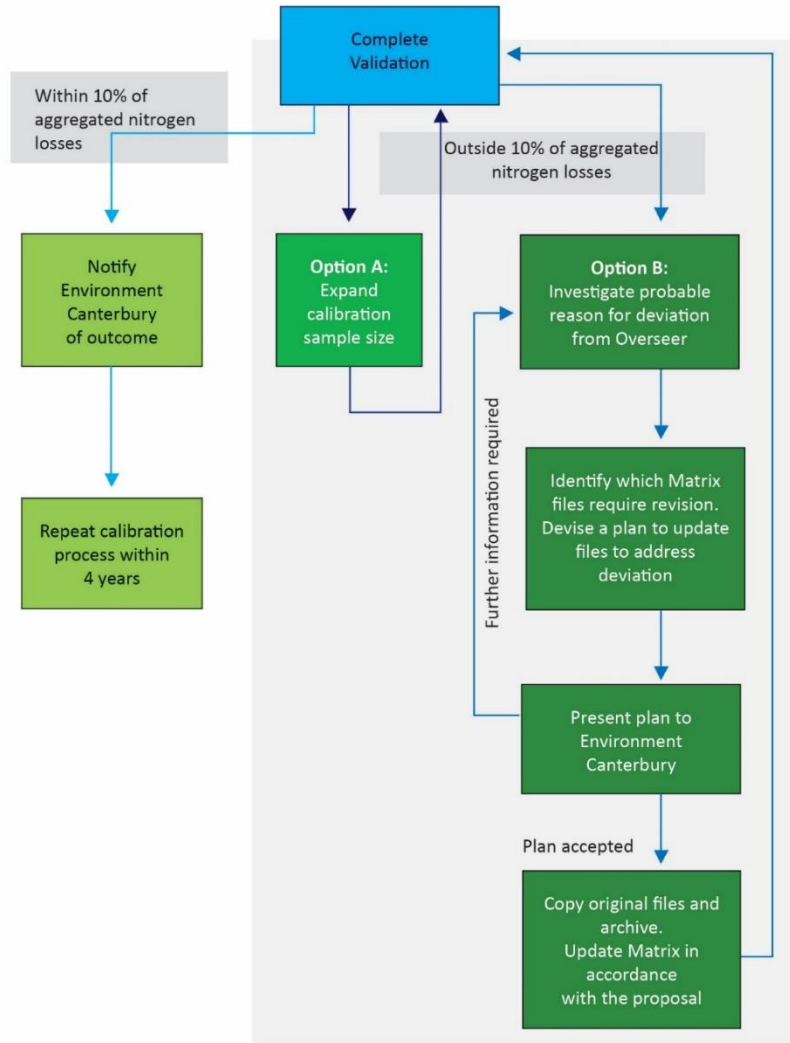


Figure 4: Proposed validation process for The Matrix

## 9 Overseer Updates of The Matrix

All Overseer updates to the representative nutrient budgets used in The Matrix are subject to peer review under condition 16 (v)(B) of resource consent CRC185857.

The 192 representative nutrient budgets used to calculate nitrogen losses in The Matrix are stored in the Irrigo OverseerSci account, which automatically updates the nutrient budgets with each version release of the Overseer model.

The process to update The Matrix into a later version of Overseer is detailed in the application to approve The Matrix as equivalent to Overseer.

While Overseer automatically re-runs a nutrient budget in the most recent version, it is possible these updates will require new or modified inputs in order to re-calculate nitrogen losses in that particular version. Examples of where this has occurred in the past has been the grazing inputs on crops and the introduction of a new irrigation model.

Environment Canterbury may also identify minor issues with the Matrix files and request changes, provided the change is unlikely to require additional validation of the model and mutual agreement is achieved.

If issues arise when updating The Matrix in a later version, the process described in Figure 6 will be followed.

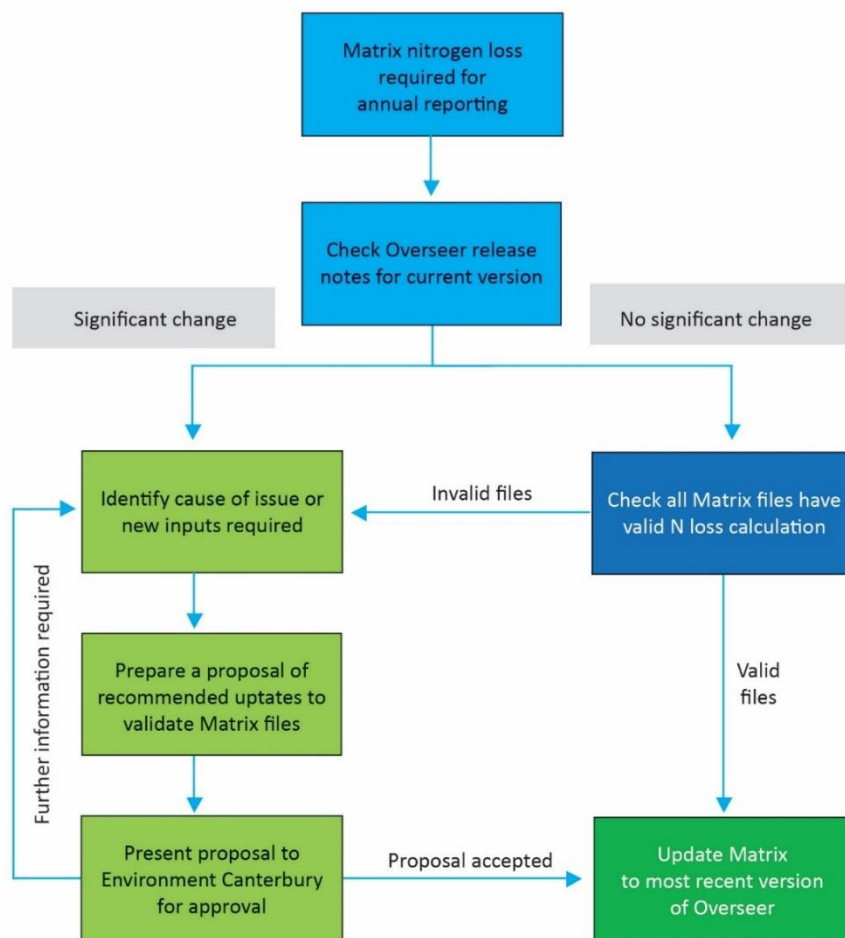


Figure 5: Proposed process for updating The Matrix into most recent version of Overseer

## 10 Overseer Updates to the Lawful Irrigation Loss Rates

The nitrogen loss rate of 27 kg N/ha/yr was originally prepared with Leo Fietje from Environment Canterbury (ECan) to be consistent of the requirements of the Land and Water Regional Plan at the time, and is documented in an email from Leo Fietje to Angela Fenemor on 18 February 2014, as detailed below:

*The future area was assumed to be 60% dairy, 20% dairy support and 20% cropping. Nitrogen leaching data was obtained by work carried out by Macfarlane Rural Business (MRB) for the Hinds Nutrient Project. The following MRB representative farms were used to model the 19,486 ha of future irrigated land:*

- *Dairy 1 (D1) on very light soils – Advanced Mitigations Level 1 (AM1)*
- *Dairy Support 1 (DS1) on very light soils – Advanced Mitigations Level 1 (AM1)*
- *Arable 2 (A2) on very light soils – Advanced Mitigations Level 1 (AM1)*

*The calculation is included below:*

*0.2 ha of cropping @ 23 kg N/ha = 4.6*

*0.6 ha of dairy platform @ 26 kg N/ha = 15.6*

*0.2 ha of dairy support @ 33 kg N/ha = 6.6*

***Total 26.8 (27)***

The Overseer nutrient budget files used to calculate the lawful irrigation load are stored in Irrigo's OverseerSci account and automatically updated into the most recent version of Overseer. The updated N losses for each file are extracted to repeat the above calculation to work out the lawful irrigated load in a particular version of Overseer. This value is then applied to the NDA calculation, prepared in the same version of Overseer.

All updates to the lawful irrigated load are subject to peer review under condition 16 (v)(B) of resource consent CRC185857.

## 11 Changes to The Matrix Representative Files

Farm systems may evolve over time, and it could be necessary to incorporate new or update the representative farm system files used to feed into The Matrix to maintain the model's validity. The process to incorporate new files or update existing files into The Matrix is detailed in the application to approve The Matrix as equivalent to Overseer.

To update The Matrix, a detailed proposal needs to be prepared and submitted to Environment Canterbury for consideration by a panel made up of representatives of the Consents, Planning, Science and Compliance Monitoring sections, who will provide a recommendation for approval of the change to the Chief Executive within 30 working days of receipt of the proposal.

Once a proposal is accepted by the Environment Canterbury, a suitably qualified person would then update The Matrix files and re-run the model. The updated Matrix is then re-calibrated against the Overseer nutrient budget samples. Further amendments to the initial proposal may be required if calibration of the new files is not within +/- 10% of the aggregated Overseer nutrient budgets in accordance with the process detailed as "Option B" above.

## 12 Peer Review of The Matrix

Condition 16 of resource consent CRC185857 requires an annual peer review of the preparation of the NDA and N load calculation to ensure processes detailed in this document are followed.

The peer review is to be included in the annual compliance report for discharge consent CRC185857, due to be provided to Environment Canterbury by 1<sup>st</sup> December each year.

Reviews are to be completed by a suitably qualified and independent expert to assess:

- A. *A review of any change made to the use of the property irrigation, land use and management standards as applied through the Matrix Method when calculate the scheme nitrogen losses; and*
- B. *A review of the process undertaken to update any change made to the nutrient budget reference files used to calculate scheme nitrogen load limits and losses into the most recent version of Overseer.*

It is noted Overseer often updates the model in October. It is therefore possible the version of Overseer used to calculate the NDA and compliance losses for the reporting period (1<sup>st</sup> July -30<sup>th</sup> June) could differ to the version in place at the date of reporting (1<sup>st</sup> December). Therefore, PDF downloads of the information used to calculate N losses will be kept to enable a peer reviewer to assess the process to calculate the N losses in the instance where Overseer updates after the NDA and N load is calculated for that reporting year.

## 13 Data Storage

### 13.1 Overseer nutrient budgets

The Matrix consists of 192 Overseer nutrient budget files (8 farm system x 4 soil types x 6 management standards) which are stored in the OverseerSci tool in Irrigo's account. The Advanced Mitigation files used for the AM1 Matrix are also used to re-calculate the lawful irrigated loads allocated under CRC162882 and CRC183851 in later versions of Overseer, forming the value applied to new irrigated land in the scheme consented NDAs.

Access to the Irrigo OverseerSci account is strictly limited to those who need to view the full Overseer nutrient budget details for the period of time they require it. Examples of personnel who require access include:

- Suitably qualified professionals needing access to nutrient budgets to update Matrix to a later version of Overseer or prepare additional representative nutrient budgets
- Third party auditors to verify the updates made to Matrix nutrient budgets
- Environment Canterbury to verify compliance with a resource consent
- Irrigo Environmental Team to manage OverseerSci account

The original nutrients budgets used to form The Matrix are stored in Overseer version 6.3.0 in .xml format here: C:\Users\Dropbox (BCI Water) \MRB files v6.3.0 – ECan

The original files do not include any updates made in OverseerSci as part of the consenting process or to validate files in a later version of Overseer.

### 13.2 QGIS Files and Matrix Calculations

All shape files and spreadsheets used to update the NDA and calculate N losses in a particular year are copied and archived for future reference.



## 14 Relevant Documents

Document
Resource Consent CRC185857
Authorised Land Use Policy
EMSNM - 002
Assessment of Environmental Effects: Application to Discharge Nutrients for MHV Water Limited (October 2019) (prepared by PDP Limited)
MHV Water – Nitrogen Discharge Allowance v6 (October 2019) (prepared by Dr. Glen Treweek)
Summary of The Matrix Methodology for Calculating Nitrogen Losses (v4) (April 2020) (prepared by Eva Harris)
Recommendation to Approve The Matrix Method a Equivalent to Overseer (April 2020) (prepared by Andrew Parrish and Tania Harris)
MHV Water Environmental Management Strategy

## 15 Document Management Control

Version	Date Reviewed	Purpose / Amendments	Section Reviewed	Reviewer	Status
1.0	May 2022	Development of EMSNM - 004	All	Eva Harris and Glen Treweek	FINAL DRAFT
1.0	May 2022		All	Mel Brooks	Approved