OVERSEER® NUTRIENT BUDGETS

An unsung hero?

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Executive Summary

The OVERSEER® Nutrient Budget model (Overseer) has developed significantly since its inception in the early 1990's. The model has been widely accepted as an appropriate tool to aid fertiliser nutrient management decision making, the function that it was designed for.

Regional councils are starting to use Overseer as a regulatory tool, to meet the requirements of the National Policy Statement for Freshwater Management. Given this, the model has come under more scrutiny, particularly examining how the limitations of the model apply in a regulatory framework. This additional scrutiny has led to changes in the perceptions of Overseer by users.

The purpose of the report is to provide insights into the perceptions of Overseer, what influences these perceptions and why? This was achieved through the completion of 35 interviews. To enable the author to analyse a range of views, interview groups included dairy and drystock farmers from the Waikato, farmers facing nitrogen regulations, agricultural consultants and regional council staff.

The main findings of the survey were:

- Age and past exposure to the Overseer model are key influencers on farmer's current perceptions.
- The users of Overseer are key influencers of farmer perceptions, understanding and acceptance of the Overseer model.
- The accuracy of Overseer model output is viewed to be influenced by a number of factors, including accuracy of data supplied, consistency of file creation and the limitations of Overseer to model complex farm systems.
- There is a real concern across all sectors of the future use of Overseer in regulation, at its current perceived level of accuracy and credibility.
- The Overseer model is effective at completing the tasks that it was initially designed for, that being to aid on-farm nutrient management decision making.

Recommendations

The project highlights that there are measures that if implemented successfully, would significantly improve the perceptions and the level of confidence in Overseer. A number of these issues are already identified in the Overseer Strategic Plan and would be addressed through its implementation.

Through the investigations of the project the following recommendations should be considered for implementation:

- Significant investment in science to increase the credibility of the current model output and allow for the acknowledgement of future on-farm mitigation practice change.
- Increase the acceptance and understanding of Overseer with the users of the software through:
  - user friendly web site upgrade
  - timely communications
  - increases in pre-release testing to reduce bug fixes.
- Greater communication to the wider industry to promote investment, science and technology changes that have been made to improve Overseer.
- Greater incorporation of Overseer into farming system decision making processes, to increase the value of the software as "more than a regulatory tool". Suggested developments include:
  - More streamlined and automated data collection.
  - Links to other farm programmes such as FARMAX and Udder
  - Development of Overseer to create spatial representation of data, such as the MitAgator tool currently under development by Ballance.
  - A two tier nutrient budget model to inform on farm decision making for compliance and non-compliance activities.
  - The release of farmer tailored orientation workshops to improve farmer understanding of the Overseer model.

The wider industry can also contribute to improving the perceptions of Overseer by:

- Improved awareness by the farming community, facilitated by both regional councils and industry to highlight and gain acceptance to the causes, issues, contribution and solutions to regional water quality issues.
- The implementation of improved data collection processes nationally by initiatives such as data locker.
- Improved on-farm data collection to meet the requirements for the reporting of N loss and N use efficiency as part of the Sustainable Dairying: Water Accord obligations
- Clear guidance provided to farmers from regional councils, as to how Overseer will be used to inform regulation in their specific region, including future Overseer version changes and accounting for on-farm mitigations that are unable to be modelled in Overseer.

The Overseer owners are faced with the challenge of developing and gaining acceptance for the model that is now being used that for a purpose that it was not initially designed for. To achieve this, significant increases in-buy are required from the farmers that it will ultimately influence.

If this can be achieved, then this will enable the Overseer model to be seen as part of the solution rather than part the problem. In short, Overseer can be the unsung hero, if time and resource is made available to allow Overseer to meet the demands of a new regulatory era in nutrient management.

Contents.

1.0 Introduction.

OVERSEER® Nutrient Budgets (Overseer) is described by its owners [1] as a decision support tool that allows farmers, growers and their advisers to examine nutrient use and flows within a farm to optimise efficiency of nutrient use and reduce environmental impacts (emissions to soil, water and atmosphere). It also provides a means to investigate the effect of mitigation options or changes in management practice to help reduce the environmental impacts of farming.

Overseer was initially designed as a tool to aid fertiliser nutrient management decision making, but it is increasingly being used to support compliance and regulation. An example of this is its use to meet Sustainable Dairy: Water accord commitments. Regional councils (such as Horizons, Environment Canterbury, Otago and Waikato) are also looking to use Overseer to inform compliance processes to meet the National Policy Statement on Freshwater Management requirements to set and manage within water quality limits.

As the scope and importance of Overseers use increases, so does the scrutiny of the model in its suitability for specific uses, particular for compliance.

With change comes uncertainty, particularly where change is rapid and drivers are external. Commentary on the suitability of Overseer's expanding use has been both positive and negative. Anecdotes reported frequently include:

- "Farmers have a poor understanding and perception of the model"

- "Consultant confidence in output values is low"

- "The tool is being used for what it was not designed for"

- "It is not applicable across all sectors due to complex systems and input limitations"

The purpose of this report is to gain a deeper understanding of the perceptions of farmers and a range of other stakeholders of Overseer. This process was supported through the completion of a perception survey. A range of stakeholders were interviewed to assess the influence of farm type, regional compliance regimes and user experience on their

perception of Overseer. It will highlight the key drivers of interviewee's current perception and provide guidance on appropriate communication and support programmes to positively influence perceptions around the changing use of Overseer.

[1]Overseer is owned jointly by AgResearch, the Fertiliser Association of New Zealand and the Ministry of Primary Industries.

2.0 Requirement for nutrient management budgeting.

New Zealand agriculture now works in an environment where maximum output is not the only consideration and measure of success. As demand increases for resources, the effective management of these is becoming a priority for both farmers and regional authorities. There are many factors that influence the increasing requirement to manage resources more effectively, these will be discussed in the following section.

2.1 Productivity.

New Zealand's favourable climate, soils and a relative low population distribution has resulted in an economy where agricultural is a major land use and economic contributor. In 2012, primary industries that depend on fresh water such as livestock farming, horticulture and forestry – delivered more than 12 per cent of our GDP and over 52 per cent of overall exports and 70 per cent of merchandise exports (Ministry for the Environment. 2013). Increasing world populations continues to provide an export market for agricultural products, through increasing demand for more high quality food products, especially animal proteins.

Over recent years, improved returns for the dairy industry has led to increasing dairy cow numbers and decreasing beef and sheep national herds. This has led to agricultural land use changes and increased intensification. This change is demonstrated in figure 1. Increases in the dairy production area has been just under 2.8% per year since 2003 with an increase in stocking rate of 0.5% per year and increases in Milk solids/cow of 1.0% per year. This has resulted in an average increase in production of 4.2% per year between 2003 and 2013(DairyNZ, 2014)

Source: Beef + Lamb New Zealand Economic Service
Statistics New Zealand
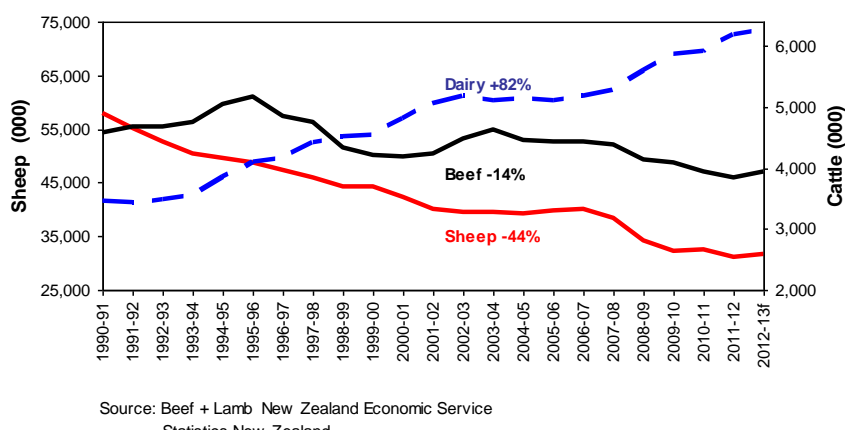
Figure 1: Changing New Zealand stock population since 1990.

Improved performance in drystock farming (lambing %, lamb weights and beef carcass weights) has also resulted in increases in output for beef enterprises and sheep enterprise (Beef and Lamb, 2013).

The intensification of land under dairy and sheep and beef systems has increased these industries impact on the environment for nitrogen loss through leaching, increased phosphate loss through run-off and the contamination of waterways by faecal matter and sediment run-off.

2.2 Impacts of the environment.

New Zealanders enjoy good quality freshwater which, by international standards is abundant and clean. Water is essential to sustain human, plant and animal life. It provides pleasure and recreation as well as supporting much of New Zealand's economic growth and development. (Ministry for the Environment. 2013)

There are a number of areas throughout the country where water quality is degraded beyond what is acceptable for ecosystems to function normally, for people to meet their recreational and cultural needs, and for sustainable economic development.

It is accepted that agriculture through both increased intensification and land use change has contributed to the increases in nutrient loads in waterways.

A concern of the impacts of increasing nutrient losses from agricultural production systems is not limited to New Zealand. Dunbier et al (2013) summarised examples for around the world.

2.3 Managing environmental effects.

To help guide farmers in their efforts to reduce their impacts on the environment industry and regional councils have created rules, guidelines and milk supply requirements to set minimum expectations. To date, most of these initiatives have been voluntary, but increasing environmental pressures see more expectations being written into rules.

2.31 Sustainable Dairying: Water Accord

The signing of the Dairying and Clean Streams Accord in 2003 (now termed the Sustainable Dairying: Water Accord), saw the adoption of a voluntary targets to achieve effective nutrient management on all dairy farms by 2007. The fertiliser industry stepped up to meet this challenge and worked with industry to have nutrient management plans in place on the majority of farms by the end of 2012. The use of a nutrient budget and its interpretation is central to the creation of an effective nutrient management plan (DairyNZ, 2013a). The Sustainable Dairying: Water Accord also set targets for the industry around the fencing and riparian planting along waterways, to minimise direct stock access and mitigate against sediment and faecal run off.

The Water accord also states that for nutrient management reporting, farms must supply their dairy company with information that will allow for the modelling of nitrogen loss and nitrogen conversion efficiency. Companies will report comparative performance back to farmers to drive continuous improvement in nutrient management. (DairyNZ,2013b).

2.32 Regional Councils.

Some regional councils have introduced requirements for the completion of nutrient management plans as part of permitted activity requirements. An example of this is in the Waikato where "You must prepare and implement a nutrient management plan if you are applying fertiliser 1). at a rate that exceeds 60kg of nitrogen per hectare per year or 2). to land that has had stock effluent applied to it in the past 12 months (Waikato Regional Council, 2014a).

Also in the Waikato, the Regional Council has implemented Variation 5 rules to protect water quality in Lake Taupo by managing land use and nutrient discharges. This means there is a cap on nutrient leaching for farmers in the Taupo catchment (Waikato Regional Council, 2012b). This cap is monitored by annual Overseer nutrient budgets, essentially providing the farmers in the region with a license to operate.

2.33 National Policy Statement for Freshwater Management.

Central government's response to the concerns about the management of water quantity and declining water quality trends was to provide guidance to Regional Councils through the release of the National Policy Statement for Freshwater Management in 2011. This sets objectives and policies for Regional Councils to help them to develop regional plans with the aim of managing water quantity and maintaining or improving water quality for all ground and surface water bodies within their region by December 2030. Many regional councils have indicated that they intend to use Overseer as a tool to measure and monitor farmer's performance. This has raised concerns among many quarters, as Overseer was not specifically designed for compliance. It has also been documented that there are limitations to the use of Overseer in the compliance space, these will be discussed further.

2.4 The Overseer model.

The role of Overseer has changed significantly since the initial development back in 1990. At the time, it was described by one of the lead developers as a "decision support system to assist farm consultants to make decisions around fertiliser use. It is a farm management tool to make comparisons between different fertiliser scenarios" (Edmeades, 2011). Its initial focus was to estimate nutrient efficiency and fertiliser nutrient requirements (Ledgard 2009).

Accounting systems are not a new tool to be used, European countries have developed 50 programmes that support nutrient management decision making (Oborn, 2003). These mechanisms can be classified into 3 groups, those being farm gate budgets, soil surface budgets and soils systems budgets (Cherry et al, 2008). In this classification Overseer is a soil system budget and is the most comprehensive of the 3, as it takes into account 1) Nutrients brought and sold, imported and exported (fertiliser and feed and milk, meat and grain respectively. 2) Movements of nutrients through soil process and interaction (such as denitrification and volatilisation 3) Movements within a soil system and losses not solely from the soil surface (immobilisation and leaching and run-off respectively) (Cherry et al, 2008).

The method that Overseer uses to calculate nutrient transfers in a pastoral system is through the estimation of dry matter intake by the metabolic model which is a sub-model within Overseer. This takes into account input parameters such as production, stock numbers and management practices employed, to calculate the total energy requirement to meet the production output. The model then takes into account the energy inputs provided from imported supplements, seasonal and regional variation of pasture quality and growth, plus the influence of farm practices to estimate pasture intake.

Overseer then allows movements, surpluses and losses of nutrient within a farming system to be identified taking into account additional farm information and assumptions provided. As with all complex natural systems models, a certain number of assumptions need to be applied as set out below (Wheeler and Shepard, 2013)

Underlying assumptions within Overseer

- Is an annual average model, it is not designed to predict the outcomes for a particular year or resulting from extreme events.
- Assumes the system is in quasi-equilibrium – that is, that the farm is in a 'steady state' without significant variability occurring within any year, this then means that the model doesn't determine the impacts of transition during a change from one practice to another.
- Assumes actual and reasonable inputs - the model provides a balanced estimate of inputs and outputs based on the complex processes that effect nutrient flows and this relies on the farm specific information (such as fertiliser use, production values, stock numbers) being as close to actual as possible to model estimates of nutrient use efficiency and potential losses of nutrients from the system.
- Calculates nutrient losses to 'edge of farm', that is, Overseer models nutrient loss to the bottom of the root zone or across the surface to the farm boundary, it does not provide any analysis of nutrient movement into a receiving water body.
- Assumes any management implemented on the farm is according to 'Best Practice'. E.g. fertiliser is applied according to the Fertmark and Spreadmark codes of practice.

The development of Overseer has been summarised by Dunbier et al 2013 in Appendix 1. In 2012, the current version of Overseer was released (Version 6) and was described as step change in the model development; complete redesign of the software, the addition of new features and a review of the science underpinning key parts of the model. All of the changes made were to keep the tool relevant and useful for end-users, particularly in response to evolving farm management systems (e.g. fodder crops, supplement management, mitigation of nutrient losses) (Shepard and Wheeler, 2013). These changes have been summarised in Appendix 2.

To summarise, Overseer is a mathematical model with attempts to describe complex biological processes, which vary over time and space (Edmeades, 2013). As a result there will always be a level of uncertainty in estimating nutrient losses. This has been highlighted as an area for concern with the use of Overseer, with a number of factors potentially contributing to error.

2.5 Influences on Overseer output values

It is well documented that Overseer estimates have a margin of error of +/- 20% for N loss (Dunbier et al 2013 and Edmeades 2011). In terms of Overseer, error generally refers to the difference between the modelled representation of a system, and the reality of the system (Shepherd et al, 2013).

Sources of error can be split into two types 1) Model error, due to errors in understanding, or deliberate simplification of the system being modelled; or errors in measured data from experiments used to calibrate and validate the model. 2) Input error, where any inaccuracy in data collection, data entry and interpretation by the user will lead to potential inaccuracies versus the expected output (Shepherd et al, 2013).

When determining the total level error between what is modelled in Overseer, and the actual losses in the field. The accuracy around actual losses measured in water samples also comes with a level error, due to typical variability in the sampling and analysis process. With there being multiple contributors to the total error, it has been suggested by Shepherd et al (2014) that the term, model uncertainty is a more appropriate term to use. Some of the contributors to the level of uncertainty are discussed in more detail below.

Overseer predicts N leaching for a pastoral system primarily by the amount of urine that is excreted from the production system. The information required to provide this estimate is summarised in Figure 2.
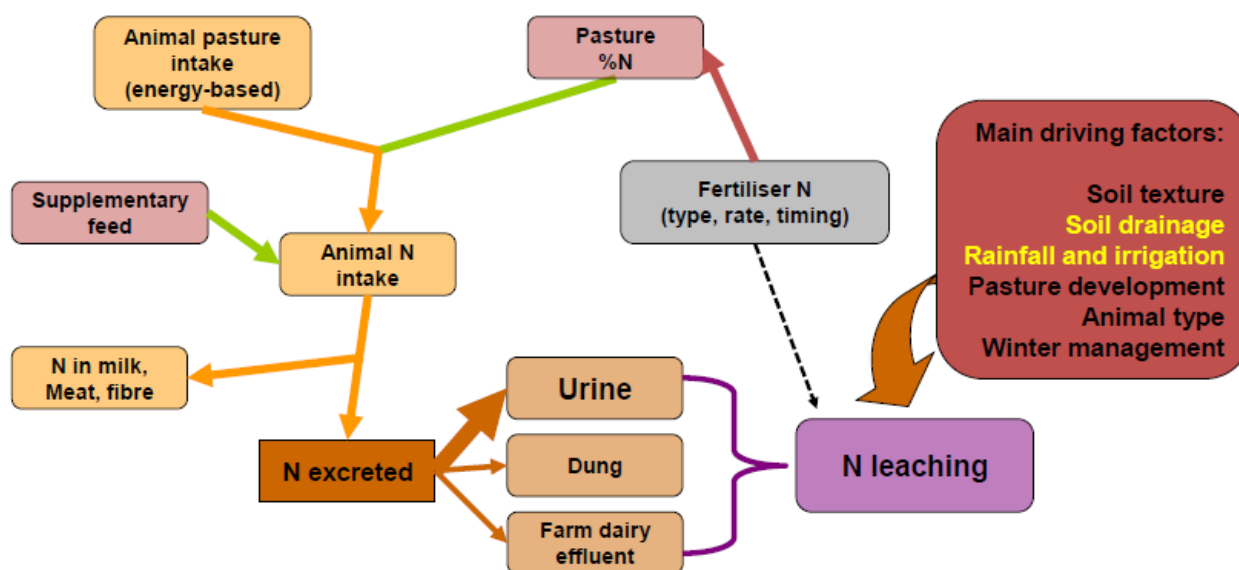
Figure 2: How Overseer calculates N loss.   (Ledgard, 2009)

2.51 Accuracy of input data and farmer records.

To date, farmers have been able to farm with relatively little paper work requirements. As a result, they have been able to concentrate on what they do well, produce milk, meat and crops. As we move into an era of compliance, so comes the requirement for robust processes, quality control and audits. Through my own discussions with farmers, improved record keeping has been highlighted by farmers as a concern. Edmeades (2011) has also noted, unless the farmer sees the benefit through (less duplication, data sharing), they will not change their practices around record keeping.

With the use of Overseer to inform compliance, there will be a need for accurate data to be supplied to meet the requirements of a regulatory process through the creation of an Overseer nutrient budget. The quality of data supplied will need to be of a standard that is auditable, to provide Regional Council with the confidence that the monitoring process can be used as a mechanism to help meet environmental outcomes. Examples where poor data collection can result in the difference between actual and recorded can be significant are: stock movements, crop yields and the timing and quantity of fertiliser applied. There is very limited information available to assess the cumulative effect of the impact of varying quality input data on Overseer output values. A much better understanding of the level of

uncertainty will be needed if farmers are being consented "to a number" or are required work with a cap, such as in Taupo to meet Variation 5 policy.

2.52 Consistency of Overseer files creation.

Overseer is designed to allow users to select different parameters and settings that best represent the farming system being modelled. As farms and farm systems can be very different from each other in terms of inputs, scale and geography, a high number of inputs fields need to be populated in the creation of an Overseer file. What comes with this is the risk of opportunities to put in wrong or poor quality information and to miss important fields, all of which will impact on the accuracy of the output compared to the expected output.

Until 2009, the collection and inputting of data was determined by the user. There was no industry standard. However the Fertilizer and Lime Research Centre (FLRC) at Massey University in conjunction with FertResearch and AgResearch had developed certificated courses in Sustainable Nutrient Management (Intermediate and Advanced levels) that provided rural professionals with skills and training in the operation of nutrient budgeting software.

The Nutrient Management Advisors Certification Programme (NMACP) provides a formal accreditation for nutrient management advisers. This provides a level of certainty to those seeking an Overseer budget that it has been created by an appropriately qualified and experienced practitioner. . The certification programme defines standards for people to meet, to be able to provide advice to a certified nutrient management level. Once this standard is achieved, then continuing professional development is promoted, this is defined as "educational and professional activities aimed at ensuring a nutrient management adviser's continuing competence to practise, including keeping up to date , with new developments in nutrient management science and practice" (NMACP, 2014).

In 2010, DairyNZ and Fonterra identified a number of gaps in the existing approach to nutrient management that were constraining the effectiveness of Overseer to deliver on-farm change. As a result, the Audited Nutrient Management (ANM) Project was initiated early in 2011 to address these issues through the development of an industry protocol for the use of Overseer. This was a joint Primary Growth Partnership (PGP)/DairyNZ

programme funded by the Ministry of Primary Industries (MPI) and dairy levy payers. This protocol would standardise the data input processes, define auditing procedures and provide improved methods for reporting data to farmers.

The protocol is jointly owned by DairyNZ and Fonterra and is freely available to any milk supply company to adopt. The aim was to provide a framework for N loss and efficiency reporting to meet the requirements of the Sustainable Dairying: Water Accord.

In 2013, the OVERSEER® Best Practice Data Input Standards were developed by a group of seven technical expert users, who drew on their personal knowledge plus that contained in the DairyNZ Input Protocol, the AgResearch Expert User Group Guidelines and the Waikato Regional Council's Protocol for Variation 5 (West Taupo catchment). The Standards are a consensus of the views of the seven technical expert users and are endorsed by a stakeholder group of industry, regional council and government representatives. (Overseer, 2014). With the incorporation of dairy protocol into the data input standards, users now have a consistent approach.

The Standards are a set of guidelines to assist expert users to define data inputs into Overseer that consistently achieve the most accurate nutrient budget of a farm for nutrient management purposes (Overseer, 2014).

Consistency of Overseer file creation was highlighted as a potential source of variability during submissions in the One Plan process (Ledgard 2012). Even with users trained through the Massey University Intermediate and Advanced Sustainable nutrient management course, it was accepted that variability would still exist.

2.53 Science to underpin the model.

Where the science and trail work is available, the Overseer model will have been tested and calibrated. But there are limitations in both cost and time to be able calibrate the model for all possible scenarios such as different soil types, climates and farm systems. As farm systems become even more diverse and complex, the number of possible different scenarios that Overseer will be required to model is set to increase. To enable Overseer to be used where actual trails have not taken place, the Overseer team has extrapolated and

interpolated the available information based on robust scientific principles. The Overseer owners have recognised that more calibration and/or validation is required, in particular for:

- Cropping farms

- Beef & sheep

- All farm-types with rainfall >1200 mm /yr

- Clay soils, shallow soils

(Agresearch, 2013)

2.54 Regular updates in Overseer model versions

As previously discussed there have been a number of changes to Overseer to incorporate model changes, bug fixes, updated science and research. Inevitably with version changes, output estimates will change for the same farm system. My own personal experience has witnessed the frustration that this can cause farmers and consultants, where the Overseer number has significantly increased or decreased with no change in farm practice or input data.

This can have significant implications in a regulatory regime and was highlighted by Ledgard (2012) as a potential issue in the Horizons One Plan. In the One plan, this has been seen to be problematic to implement as the numbers for different land unit classifications were generated using Overseer 5.4 and are now written into policy.

For farmers in the Lake Taupo catchment, it has meant that they are now consented to use Overseer version 5.4 to calculate their yearly Nitrogen discharge allowance figure to meet Variation 5 requirements. This now means that they cannot receive attribution (within the model) for mitigations or improved Overseer accuracy that comes with the release of later versions.

2.6 Present and future Overseer use for compliance and regulation.

As previous discussed Overseer was originally developed to aid production decision making processes to meet a farmers goals. However, regional councils see the use of Overseer as an integral part in the development of policy to meet their obligations under the National Policy Statement for Freshwater Management (NPS-FM).

New Zealand already has examples of nutrient management compliance where Overseer is being used. The Lake Taupo catchment has implemented limits based on Overseer estimated farm N losses benchmarked between 2001 and 2005 to calculate a nitrogen discharge allowance at property level. From July 2007 farms have been capped at this benchmarked average leaching level (Monaghan et al, 2010). The Environment court endorsed the use of overseer within this regulatory framework. As with the Lake Taupo Catchment, the use of Overseer as part of the Horizons One plan has successfully been written into policy and with its use also being endorsed by the Environment Court.

Environment Canterbury, Otago Regional Council, Environment Southland and Waikato Regional Council all currently looking to use Overseer to varying degrees for environmental monitoring (Dunbier, 2013).

2.7 Accepting change.

Over the past 50 years Farmers have made significant production and economic gains. This has been where the farmer is in control of the goals, targets and objectives. Farmers have first and foremost have been food producers.

Edmeades (2011) highlighted that meeting the requirements of the NPS FM will involve the introduction of environmental and social limits, which will be set largely by society in which the farmer operates. On the whole, this should not be an issue, but other examples around the world have shown that this can be a long term barrier to change. As Overseer is developed to be used in regulation, there is now a new additional goal around environmental management. If farmers do not understand these goals and the information that Overseer is providing to meet these, then there can be a disconnect in terms of the benefits that information provided in influencing on change.

The older generation of farmer has farmed through an era where a good farmer was someone who produced product, increased output, kept his farm in a good condition and provided work for the family (Kizos and Kristensen, 2011). However the "good farming" concept is under more scrutiny as consumer demands around animal welfare, food quality and the environment increase. The potential introduction of environmental compliance restrictions will test this good farmer ideal for all farmers.

In a study in Finland looking at policy integration, it was found that although farmers possessed the skills for agri-environment management, they were also unaware of the environmental impacts of their practices and how they should look after the environment to acceptable standard (Akerman et al, 2007). My own experience during recent farmer meetings to discuss the Waikato's proposed plan change process, found that farmers highlighted many barriers to change during discussion. However, when the values of the farming community towards water quality were discussed, they were seen to be very similar to the wider community. So the question needs to be asked, is it the proposed enforced rules that are a barrier or the understanding of the issues and agricultures' contribution to these? As a consequence, it could be Overseer is seen as the issue, rather than the policy or regulation. Overseer is just the measurement mechanism

As an industry we need to provide farmers with the tools, resource and support to maintain and improve productivity, while minimising the environmental impacts to agreed community levels. But we also need to be providing farmers with opportunity to understand the issues and how they collectively contribute to the issues and potentially the solutions. Sufficient farmer education is required, including an on farm context including the impacts on productivity and profitability to increase farmer understanding and engagement. (Monaghan et al, 2010).

In the United Kingdom on farm change in many cases is driven through monetary policy instruments that are linked to practice change. Completing actions or farming in a certain way, will influence the level of payment received.

Closer to home, the use of incentives are also being considered in the plan change process for the Rotorua lakes catchment, where an $40M incentive fund is available to support reductions of 100t of nitrogen from the catchment (Primary Producers Collective, 2014)

3.0 Methodology.

A survey questionnaire was developed to qualitatively examine the attitudes and perceptions of interviewees towards Overseer. A summary of the interview questions can be found in appendix 1.

The aim of the survey was to:

- Gather qualitative information on users perceptions of Overseer

- Inform a better understanding of the limitations and barriers of Overseer use and its acceptance.

- Provide evidence to confirm the achievements of industry programmes to date

- Provide insights into the potential future development of Overseer, to inform the strategic direction.

- Assess the buy-in to industry and regulatory compliances processes to support managing within environmental limits.

To gain an industry wide view of the perceptions of Overseer, but within the limitations of the project, 35 interviews were completed. The interviewees are split into 5 categories:

1. 10 Waikato dairy farmers,
2. 5 Waikato dry stock farmers,
3. 5 farmers in compliance catchments (Rotorua Lakes or Taupo),
4. 10 Agricultural consultants and
5. 5 Regional council employees.

Interviews were completed either personally or by phone, in general interviews were 30-45 minutes in length. The selection of farmers was based primarily on location and standing in the farming community.

An analysis of the results was carried out across each group of interviews to assess the perceptions of participants.

4.0 Results and discussion.

The results of the survey have been analysed to help draw a picture of interviewee's perceptions of Overseer. These results are discussed below.

4.1 The age of farmers

The age range of farmers was not considered in the selection process, but the results suggest that age will influence a farmer's desire and ability to increase their knowledge of Overseer. The age distribution of the farmers interviewed (figure 3) was consistent with industry data showing the average age of dairy and dry stock farmers being 43 and 58 years respectively
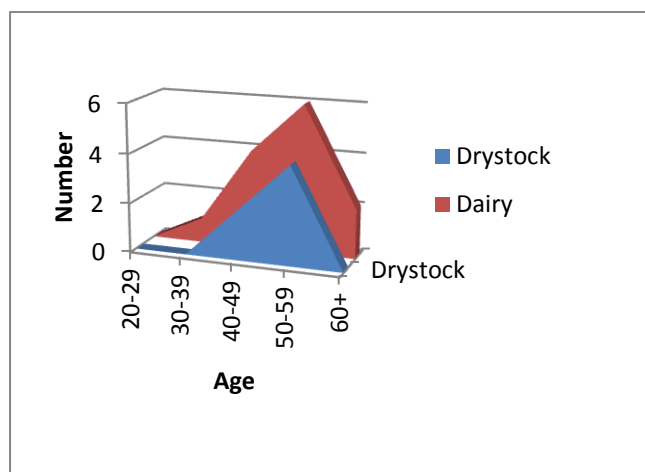

Figure 3: Age distribution of farmers interviewed.

Age was indicated as a barrier to increasing basic knowledge and understanding, with 3 of the dairy farmers indicating that their solution would be to "pay for services" around Overseer, rather than upskill themselves. This age barrier is important as the owners of Overseer have the challenge of 1) Communicating with as many farmers as possible to raise awareness and understanding and 2) Having timely and targeted communication with farmers to minimise any negative impacts of version changes, and technology requirements.

In terms of the consultant group questioned, there was an even split across the age ranges. A larger survey group would need to be interviewed to get a better picture as to whether age potentially could limit the support for the provision of a nutrient budgeting service.

4.2 Awareness of Overseer

The survey found that a higher percentage of dairy farmers compared to drystock farmers have been exposed to Overseer over recent years (figure 4). There has been a wider use of Overseer over the past 15 years in the dairy industry to meet milk supply company and Sustainable Dairying: Water accord requirements.
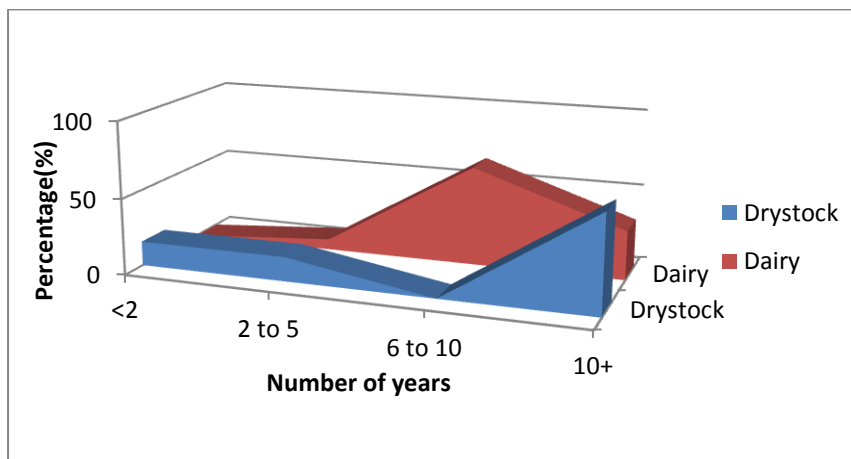
Figure 4: Farmers awareness to the Overseer programme

A concern highlighted by a number of dairying farmers during the interview process was around their future exposure to Overseer in normal daily activities. Over the last couple of years, Fonterra has, on behalf of suppliers, been supplying N loss figures based on dairy diary data to meet Sustainable Dairying: Water Accord requirements. As a result there is now no perceived requirement for farmers to provide an Overseer nutrient budget (as previously required) for the shed inspection. For many, this was the only time that a nutrient budget was created and provided an opportunity for discussion with the fertiliser representative or farm consultant. From my own experience, it is far too easy for the farmer to "commit to the same fertiliser as last year" with a fertiliser rep, when the farmer is busy and as it is now not required to spend time with a professional to create a nutrient budget.

The results suggest the high percentage of drystock farmers that had a good understanding of Overseer were involved in the Taupo catchment Variation 5 scheme. The remaining

drystock farmers had only relatively recent exposure, resulting from either involvement in the Ballance Farm Environment Awards or Beef and Lamb NZ monitor farms. A personal observation, not born out in the survey results, is that use of Overseer on a drystock property would be relatively low and at around 20-30% compared to 80-90% of dairy properties.

4.3 Understanding of Overseer.

Most interviewees felt that their understanding was not to the level that it should be. Overall the consultant group felt that their level of understanding was the greatest as shown in figure 5. The respondents that were actively using the software (from all categories) were more confident in their understanding of the model. This is to be expected, as all consultants indicated that they were actively using Overseer in their daily roles. Nearly all of their use of Overseer was around creating nutrient budgets for dairy farms, with only limited use for drystock, cropping and the compliance situations.

There was not a significant difference in farmers responses to their understanding of the model, however further questioning (to be discussed later) showed a significant difference in knowledge, suggesting that some knowledge led to a greater appetite to become more knowledgeable, this was mainly noted with the compliance and engaged dairy farmers.
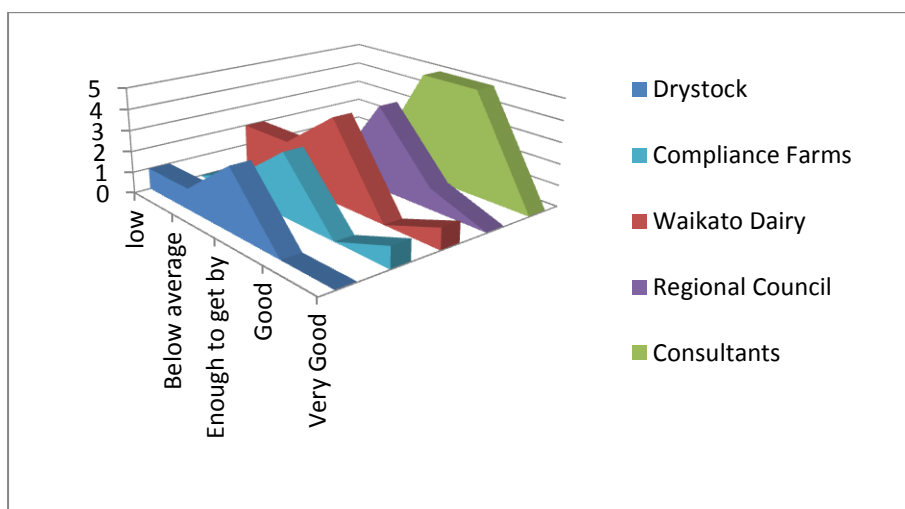
Figure 5: Interviewees understanding of the Overseer model.

4.4 Understanding of the merits and limitations of Overseer

It is often people's understanding of Overseer's limitations that influence their perception. Again, respondents that use or have regular contact with Overseer felt that they had a better understanding of the merits and limitations. Farming in a proposed or regulatory environment was shown to drive farmers increased understanding of Overseer as shown in figure 6a.
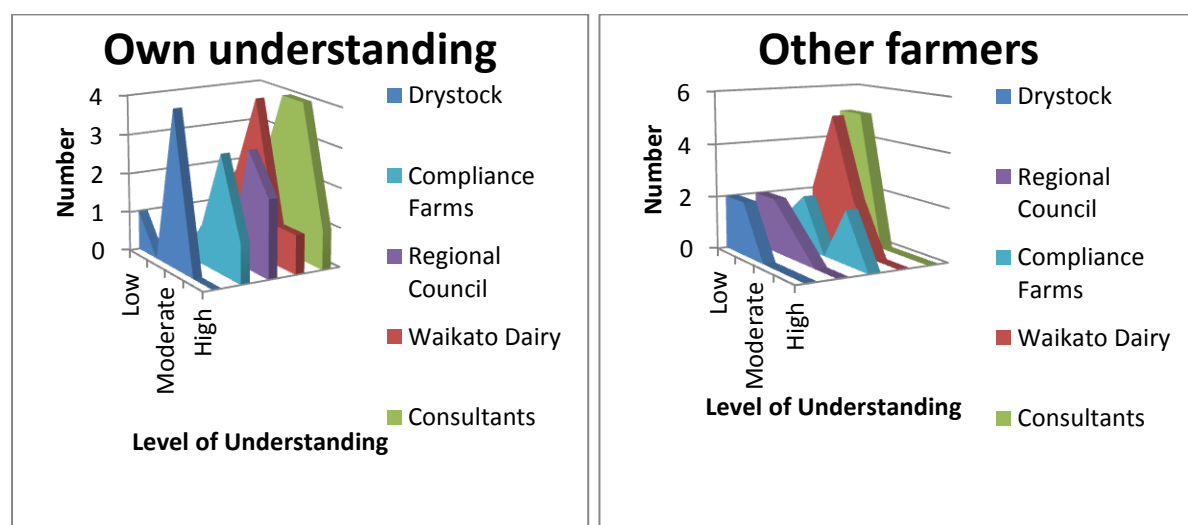
Figure 6 a&b: Interviewees understanding of the merits and limitations of Overseer and how they rated other farmers.

All respondents graded the understanding of "other farmers"lower or the same as their own (figure 6b). This would suggest that there could be a limited base knowledge of the wider industry, which could have a major influence of farmers ability to analyse and "make sense" of what they hear and read from their peers and in the media. Oenema et al (2003) also suggested that this could create uncertainty or a lack confidence in the outputs of a nutrient budget that can lead to confusion or wrong conclusions, to postponement of decision making leading to ineffective management.

4.5 Influences on the perception of Overseer

Interviewees were questioned to assess their perception of Overseer, the responses at group level are show in figures 7a and 7b. To allow for simple analysis, the responses are averaged across each group shown in the graphs as a bar. Then the Standard Deviation is shown as a measure to indicate the spread of the responses within the range.
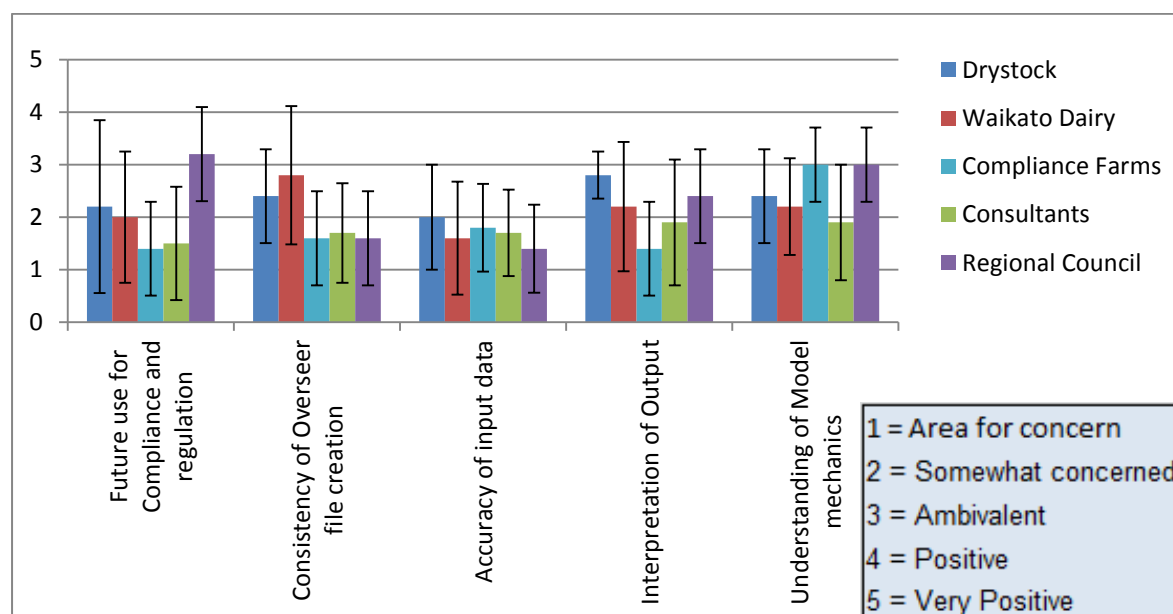
Figure 7a. Influences on the perception of Overseer

4.51 Future use for Compliance and regulation

One of the biggest concerns for the majority of farmers was the potential future use of Overseer for compliance and regulation. When investigating the reasons for this, they were two fold. Firstly, a farmers concern is that the accuracy of a "number" generated could influence the profitability and security of the farm and home by the implementation of restrictions. Secondly, that future farming decisions and investment could be dictated by the requirement to influence the farms Overseer N loss estimate.

It was also noted that the very well informed farmers rated this question higher, as they were much aware of the contribution that agriculture has on declining water quality. By having a good level of understanding as to why a farmer was being asked to change, then changes are less likely to be seen as the implementation of rules and more as improvements to the environment. Also they were aware of the alternatives to output based controls, such

as restriction on inputs (e.g. stocking rate or fertiliser use). This rational needs to be explained to the wider farming audience to help farmers to increase acceptance in output based rules.

Regional Council interviewees had a far greater confidence in the use of Overseer in regulation. By having a value that is measurable and can be attributed to an individual property, allows them to better monitor farmer's contributions and progress towards catchment targets and water quality improvements. There is a risk here that a farmers' requirement to change practices to meet a desired Overseer output figure, means that other positive practice changes could be bypassed as they do not "change my number". An example of this could be the action of plastic lining of an effluent pond. This would make no change to an Overseer output figure (as Overseer already assumes that an effluent pond is lined as a good management practice). However in practice, this could have a significantly impact in reducing whole farm losses in some situations.

The use as a compliance tool was noted as Overseers greatest challenge over the coming years, especially if its use and it accuracy is challenged in the environment court.

4.52 Consistency of Overseer file creation

Most farmers were unaware of the data input standards and previously used dairy protocols. The majority of dairy farmers noted experiences where they had received two different Overseer numbers for the same farm and attributed this to user error. Better awareness to the wider farming community, as to how the industry has addressed the issue of the variation of file creation, would improve farmer's perceptions in this area.

4.53 Accuracy of input data

The accuracy of input data again is an area of concern across all respondents. There is more consistency in the responses, represented with a lower standard deviation (range 0.54 – 1.07). The industry needs to raise awareness with farmers around the importance of better data entry. An example of this is having accurate, auditable data to populate monthly cow numbers vs defaulting peak cow numbers can influence predicted N loss by up to 6 kgN/ha/yr on a dairy property. This is significant when working to a cap or target. A study by (Oenema et al, 2003) also indicated in the Netherlands, that improved quality assurance

and quality control mechanisms would foster increased confidence in final nutrient balances.

Indications are that for some farmers, time limitations and simple data collection systems are not in place to enable increased precision in data collection. One interviewee noted that as an owner operator, "when working 15 hour days, seven days a week, siting in the office for 30 minutes every night to note down what has changed on the farm e.g. cow numbers, fertiliser applications, effluent applications, is not the first thing on their mind when they get home". The value of available technology to automate precision data collection in this space needs to be demonstrated to farmers who struggle in this area of their business.

4.54 Interpretation of Output/third party motives

Mixed results were noted for respondent's perception of Overseer due to the interpretation of output data. On average in both compliance and non-compliance situations, there is a general concern around interpretations. Farmers felt that in some cases the programme could be used to "allow more fertiliser to be sold". But the main concern was that Overseer will be used to drive on farm change to meet farm targets that may not lead to the improvements in water quality relative to the investment.

4.55 Understanding of Model mechanics

A poor understanding of how the model works was seen as a concern for the majority interviewed. It was not seen as adequate to just "accept" the model outputs, without fully understanding how the model works. A requirement to understand the methodology, defaults and assumptions, was seen as a critical to improving the perception of Overseer. However this is not as simple as it would seem, the owners currently publish a technical manual on its web site. The manual provide details of principles, definitions, calculations and assumptions for aspects of the model. This technical detail would be very advanced technically for most farmers and some consultants. So the challenge for the Overseer owners is to how to break this down enough to allow a "layman" to understand how the model works.
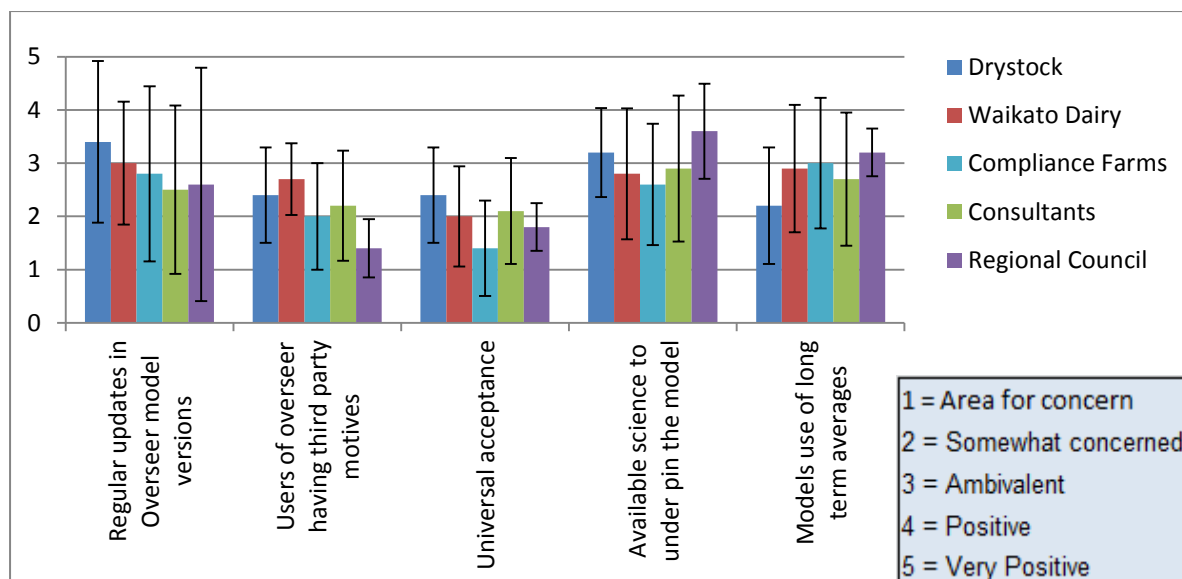
Figure 7b: Influences on the perception of Overseer

4.56 Regular updates in Overseer model versions

Interviewees were split regards to their perception due to the updates of Overseer. They felt updates were good, as it allowed new science and improvements to be incorporated. However there was a real sense of frustration when the update caused a significant change in the output figures. For most, there was an expectation that an update should be fine tuning a previous figure, rather than there being major changes. Consultants were especially critical, as often they were in a situation with a farmer "where they were at a loss to explain to a farmer, why the output figure had changed so much, when no other input had changed between versions. The reasons for the possible changes in Overseer numbers due to version changes need to be communicated more clearly to users, with the appropriate expectations set, especially in certain farming situations, if updates are known to significantly change output results. If users can get a better understanding of what has changed in the model and why, they will be better able to communicate this effectively to others.

A real fear noted is where a farmer may be consented to a number or is working to a farm baseline figure calculated by Overseer that then changes when the next version is released. In these situations there are two options 1) The same Overseer version is used to calculate future N losses, as was used in the rule setting process e.g. Taupo Variation 5 or 2) Regional councils update their N loss expectations as versions update. This option is currently under

consideration in some regions. Clear guidance to farmers on the use of Overseer in regulation in their regions will help to address the fear and uncertainty.

Another theme that came through was the frustration that often updates and changes were due to bug fixes rather than updates due to science. Reducing the number of changes for "bug fixes" would significantly improve the consultant's acceptance of Overseer version changes and was seen as a challenge for the Overseer owners.

Effectiveness of notification around changes and updates to the Overseer model

In an attempt to increase user's awareness of changes and updates that are made to the programme, Overseer now provides updates via email, detailing changes and updates, to registered users. For the interviewees that receive the Overseer email updates (14 out of the 35 interviewed), their responses to the effectiveness were 5 highly effective, 4 below average and 4 adequate.

The comments were varied but included:

"They highlight issues and bugs that I did not realise were an issue, which was a frustration as it put doubt into the robustness of previous budgets completed"

"They are transparent and upfront"

"There are too many of them indicating still too many changes and bugs"

Suggestions made were for the format of the updates to be standardised, more user friendly to read, provide indications of future developments and potential timelines for fixes.

4.57 Universal acceptance

The limitations of the study did not allow for mores sectors to be interviewed to gauge the perceptions of a broader range of the industry. For example, it would be envisaged that responses from the horticultural or cropping sectors, would have provided another dimension to discussions, due to their complex, multi crop systems and extent of relevant scientific research available and its incorporation into Overseer.

The question was clarified in the interviews with two examples given 1) that are in some instances due to the complexity of cropping systems, the horticultural industry felt that Overseer was not an appropriate to accurately estimate nutrient flows. 2) Industry

organisations such as Federated farmers may debate against the use of Overseer in policy due to perceived limitations and short falls.

Participants in the study felt that the fact that there was not universal acceptance across the industry was of concern. This was the lowest scoring of all the questions in this section and the owners of Overseer need to be mindful of this. As we move into the compliance era, areas of the industry are looking to attribute responsibility, as to who has contributed the most to perceived declining quality. So is it that they are not accepting of the tool or of the policies that the tool is used to inform and monitor?

Dunbier et al (2013) also highlighted that creating common perceptions and knowledge across all stakeholders would provide benefits and an increase acceptance.

Overseer should continue to work with the industry to ensure that farming leaders have the correct understanding to Overseer, to allow positive messaging to be delivered from the top down, both now and in the future.

4.58 Available science to under pin the model.

Through discussions, most interviewees were comfortable with the level of science that has taken place in New Zealand to date. However, they felt that more science is required to 1) improve the scientific robustness of the current model through a wider spread of calibration to increase confidence and 2) Further science to allow the use of Overseer as a regulatory tool.

Given the significant lack of data available on diffuse nutrient losses from farmland, Overseer has been built to operate with the available data and where it is lacking with a probable affect assessment using science principles and/or any relevant research results. This assessment should consider the impact of including a process on first principles as opposed to not including the process (Wheeler and Shepard, 2013). This in itself will drive the direction for further science to provide more robust evidence to back up model additions and changes.

The fact that Overseer is calibrated to New Zealand soils and climates and is based on actual data where possible was not lost on the interviewees. A New Zealand developed

programme to assess local issues, is a positive aspect that should be promoted to sell the value of Overseer as part of the process to investigate solutions to the issues.

A review by Williams et al (2013) and Dunbier et al, (2013) suggested that an independent review of the science underpinning Overseer and assumptions made, would go a long way to building confidences in its integrity and use.

A main concern was the urgency in terms of time for this to occur with regulation already upon many, also as to how this was to be funded. There was some indication from interviewees that if regional council wanted to use Overseer in regulation, then they need to have "skin in the game" in terms of the funding of independent trail work to meet the requirement of the above points. The increasing complexity of farm systems, effectiveness of mitigation options and improving accuracy were key areas for further development.

We need to remember that no matter how much science is made available to inform Overseer we will never be able to calibrate all scenarios against field trails, a thought echoed by Edmeades (2013).

**4.59 Models use of long term averages**

The concept of the use of long term averages in the model, in many cases had to been described in more detail to farmers to allow them to get a better understanding of the concept. Farmers and consultants were generally split in their views, hence a high standard deviation. In a compliance regime, it would be really difficult to monitor farms against policy where actual yearly rain data for quantity and timing were used. But with any complex model there is a requirement for the use of default settings and assumptions. Overseer estimates an annual average nutrient budget based on the long-term average rainfall, monthly rainfall distribution, and other climate data and assumes that the farm maintains the long-term production system entered (Data Input Standards, 2013). This causes confusion with farmers, when they are unable to use actual yearly measured farm weather data, (as measured by themselves) with default weather data being deemed to be more accurate for their farm.

4.6 Is Overseer meeting its Vision?

Interviewees were asked to rate "in their opinion" whether Overseer meets a number of tasks that contribute to meeting the Overseer owners vision (shown below)

"A robust, science-based decision support tool and policy support tool that is widely used for improving farm profitability, optimising nutrient use and minimising impacts on air, soil and water quality". (Overseer, 2010).

Figure 8 provides an insight into the responses. Overseer was originally designed as a support tool to aid fertiliser decision making. The response shows that those interviewed agree with this and their responses are consistent (indicated with a tight standard deviation). The confidence in achieving this function is confirmed with the responses for "optimising nutrient use" and providing "increase an understanding of nutrient cycling", which again scored well.
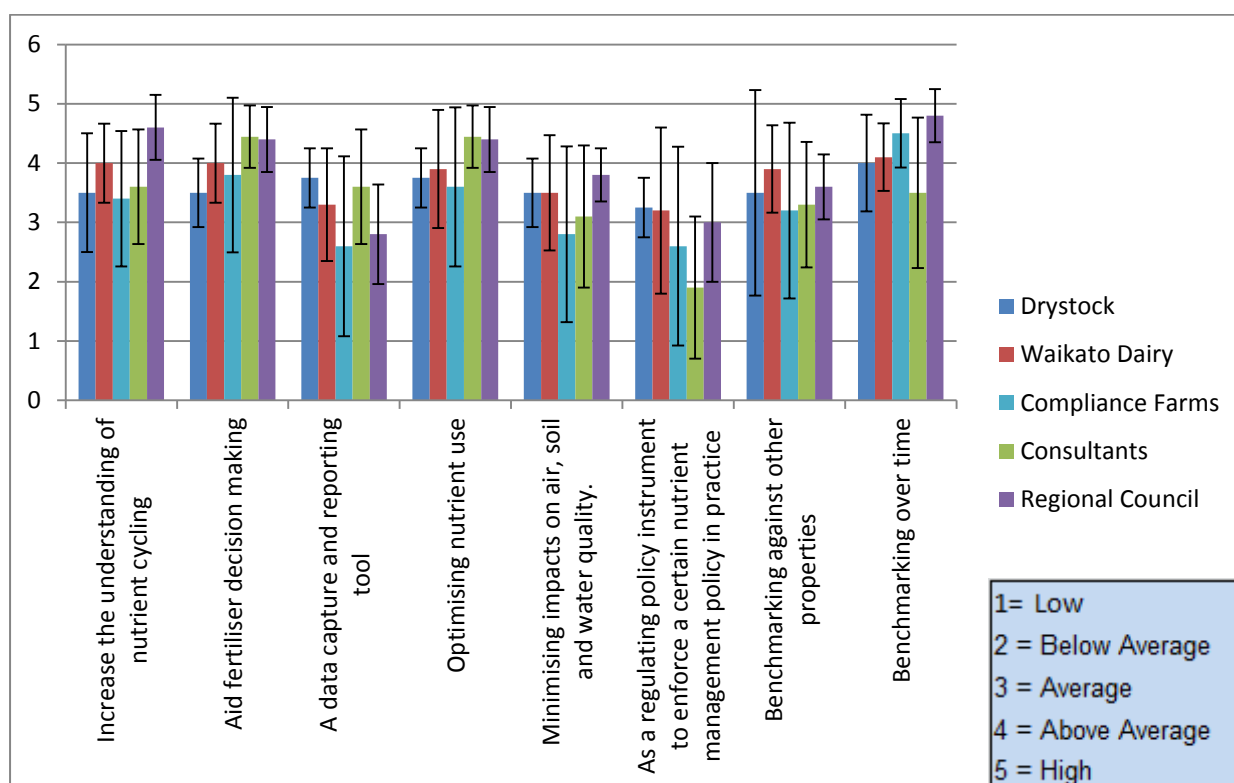
Figure 8: Rate your level of confidence for Overseer to contribute to the following task?

When we start to look at some of the tasks that Overseer is being developed to try to achieve. We find that the level of confidence decreases and the range of responses within

the groups increase. Unsurprisingly, in the current climate around the potential setting of nutrient limits in many regions, all groups still have concerns around Overseers use to inform compliance. However, there is a range in the responses. It is interesting to note that 3 farmers rated this question with a high level of confidence. Their consistent reasoning was that their knowledge and investigations into Overseer, had allowed them to also see the alternative compliance mechanisms that could be used. These could be input based rules such as limitations on stocking rates or nitrogen use restrictions for example.

When using Overseer to benchmark farms, there was greater confidence when benchmarking the same property over time opposed to benchmarking different properties. This suggests there is a perceived value in the use of Overseer for predicting the magnitude of change due to on farm change, rather than the absolute values produced. The range of responses were consistent here accept for the consultant group. On further investigation, within the consultant group there was a level of frustration, due to changes in Overseer versions over time, which limits the confidence in the comparison process unless the same Overseer version is used. This issue has already been highlighted earlier in discussion and could add considerable cost to monitoring trends/changes over time in a compliance regime.

Most users do not see Overseer as a data capture tool, which has influenced the confidence levels measured. In reality this is an important function that Overseer could play in the future. Industry is looking for "one source of the truth", farmers only want to provide the information once rather than different people coming down the driveway to ask the same question for different reasons. There are already industry initiatives underway to try to address this, the Overseer owners will need to make sure that the requirements of information required to create an Overseer nutrient budget are taken into account. The automatic data uploading of information was indicated as a future development for Overseer.

The final question looked at Overseers ability to provide information to minimise impacts on air, soil and water quality. Most respondents were confident in the use of Overseer to predict soil and water losses, but there was limited understanding of the emissions to air. Two answers were received for some interviewees as a result of reduced knowledge around Overseers ability to model atmospheric impacts.

4.7 Improving perceptions through education.

One of the purposes of the survey was to assess the current understanding of the interviewees. The survey has identified that many respondents feel their current level of understanding is lower than they would like. How to increase this level of understanding will be a challenge to the Overseer owners, as each person's capability, learning methods and time availability will be different.

Farmers desire to upskill and become more knowledgeable around Overseer, seems to directly relate to the farmers previous interaction with Overseer and their location in a compliance region. 100% of drystock farmers, 60% of Dairy farmers, but only 20% of compliance farmer were not actively seeking information on a weekly, monthly or twice yearly basis. All but one of the consultants was actively seeking to increase their understanding and knowledge of Overseer. This is summarized in figure 9.
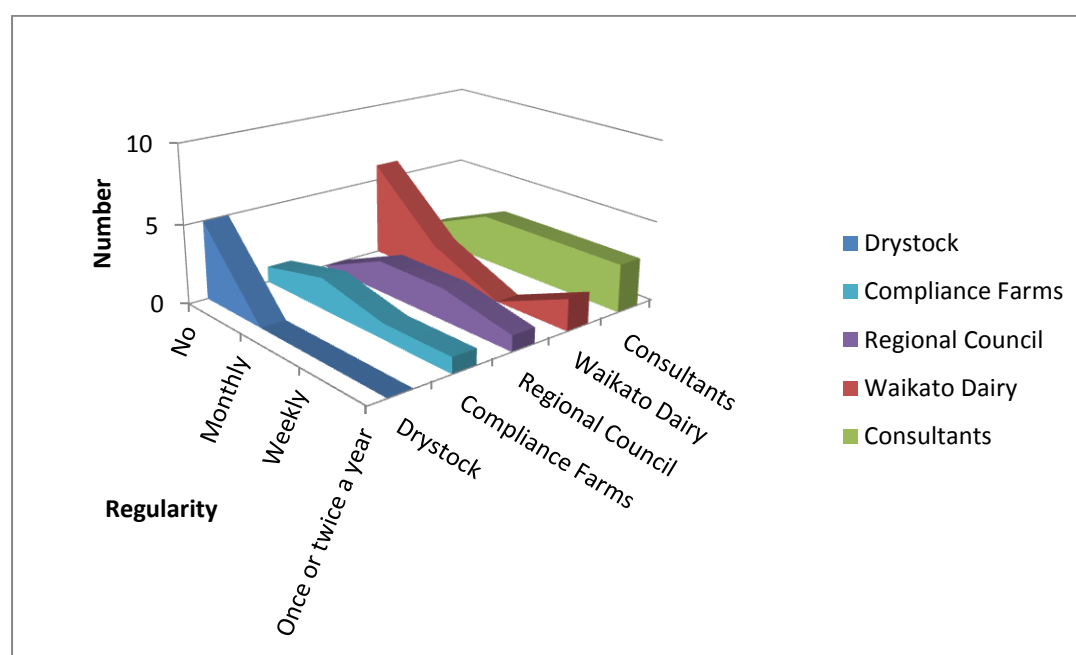
Figure 9: Regularity for seeking out for information and advice on the understanding and use of Overseer?

The rural press was shown to be a key source of information for all those interviewed. Most indicated that the information provided in an article was judged according to the credibility of the author. Often the article would create a need for further investigation or debate, rather than directly influencing one's perception.

For the users of Overseer, 70% of Consultants and 60% of Regional Council interviewees indicated that they regularly use the Overseer website and user manual, as a source of information and upskilling. However a number of interviewees indicated that the website was difficult to navigate and not too "inviting" to use, which was putting people off from using it.

Most farmers interviewed were unaware 1) Overseer had a website 2) The Overseer programme was available to download, free of charge. Improving the interaction with both users and farmers through the Overseer website, in this internet and app era could help to positively inform the influencers in the industry.

The use of the internet to source information was still fairly limited, with industry good web sites and supplier websites being mostly used. Consistent messaging across these sites could be ensured by providing regular articles to be shown on the websites with links back to the Overseer website. Farmers with more background knowledge showed an increased desire to search for more technical information relating to the use of Overseer, to increase their understanding.

50% of the consultants interviewed had already attended one or both of the nutrient management courses provided by Massey University. All consultants that had not previously attended the introductory course indicated that they were planning to do so in the next year. Two of the compliance famers indicated that they were also considering this as an option.

Any education provided needs to be an on-going process, as the software and the environment that is being used in, is constantly changing. Creating good links with the Nutrient Management Advisors Certification Programme (NMACP) will be one way achieving this for consultants. This is a platform that the Overseer owners can use to provide regular training opportunities to maintain users' competency in using and understanding Overseer.

The option of a farmer level tailored course was discussed with interviewees and this was seen as a suitable resource to help farmers to upskill. The challenge will be tailoring the course at the right level in terms of technical content to provide a sound picture for farmers. The risk is too little information could lead to the wrong perceptions being formed. Also,

identified was a requirement for follow up training particularly around significant version changes that include new science and technology changes.

Peer support and on the job training (for farmers, working with their fertiliser rep or consultant), was seen as the main source of upskilling across all groups interviewed. The risk here is the "trainers" perception of Overseer could then influence the farmer's perception. So adequately informing those who find themselves in this position would have positive benefits. These roles were mainly seen as farm consultants and fertiliser representatives.

Most of the "trainers" noted that they regularly use conferences as a method of sourcing robust information. Making sure the papers on Overseer continue to be presented at Grasslands, NZIPIM, FLRC and NZARM will ensure that consultants receive consistent messaging. For farmers, free conferences such as the DairyNZ farmer forums, Beef and Lamb events and Fonterra days were visited more regularly. This provides the Overseer owners the opportunity to work with other industry partners to provide consistent messaging. Subtle changes to messaging such as the use of "uncertainty" rather than "error" when describing the accuracy of the model should also be considered. Some farmers are of the opinion that if programme can't be 100% accurate in a regulatory environment, then it is not fit for purpose. The real value of the programme to aid decision making will not be realised, while these perceptions are still of common place.

Both DairyNZ and Beef and Lamb have been highlighted as good sources for general farm information. Both bodies are already using this link with their levy payers as a forum for Overseer messaging. DairyNZ are currently developing discussion group modules to be used "in the field", that have environmental and Overseer nutrient budgeting focuses. Beef and Lamb are providing training to enable farmers to complete Land Environment Plans, which have a strong nutrient management focus.

There are many touch points that can be used as a method to communicate with farmers and users of Overseer. Timing, credibility and cost (in time and money), will all influence how successful this communication is in terms of the net increase in the understanding of the industry.

4.8 Potential future development.

The interview process also provided an opportunity for respondents to provide views as to potential future developments for Overseer. These have been compared against the Overseer owner's strategic plan for future development.

4.81 Interfaces

Overwhelmingly interviewees felt that there were development opportunities through being able to link Overseer to other interfaces, which would help Overseer to become an integral part of the farm decision making process. This is seen as a key area for the Overseer owners that are "in scope". The closer the link between Overseer file and the actual farm was seen as positive to increasing farmer acceptance that Overseer was relevant to them. With this, farmers are more likely to innovate to find local solutions for local problems, rather than being concerned around recommendations for generic mitigation options to change an Overseer number.

Mitigation justification.

On-farm change to reduce environmental impacts can often involve significant investment or farm system change. It was felt that farmers would be more willing to carry out farm change, if they had a greater confidence in the financial and economic implications to their business. An example will be to have links to programmes such as FARMAX or Cash manager software. My own observations during in the Upper Waikato Sustainable Milk project, confirms the thoughts of the farmers interviewed. This project aims to support dairy farmers that are committing to actions to accelerate their rate of adoption of good environmental practice, while maintaining farm profitability. Here we have found that farmers will not make significant decisions without the correct information for it to be an informed decision. More so, they need the confidence that the outcome will be both economically and environmentally acceptable.

Spatial interpretation

A limitation of Overseer is being able to relate risk, thus potential mitigations to a sub-paddock level. This would help farmers to understand exactly which parts of their farming

system are driving losses. This would also allow the cost of investment to be related to the environmental improvements, which would then improve the justification for change. The development of Ballance's MitAgator is an example of this, where phosphate losses will be linked to a GIS map of the farm.

To use Overseer in isolation, we run the risk of encouraging on-farm change to meet a number derived by the regulatory compliance process. The positive environmental influence of ensuring farmers work towards industry agreed best management practice should not be overlooked. Whether it is through a nutrient management plan or a more whole farm focussed farm environment plan.

4.82 Delivery

More "user friendly" is a term that was consistently used by farmers and users of Overseer. It is inevitable that the software will become more complex to take into account the diversity and complexity of farming systems. But making the software "too specialist" to use, will impact on the agricultural support industry ability to meet the requirements of the regulatory process.

With the time required to complete an Overseer file (to meet the increasing expectations around data collecting and inputting accuracy) consultants felt a more interactive platform is required. This would aid the file creation process and budget report explanation. This included more flexibility around the creating and printing of reports to simplify them and the ability to "mix and match" according to their reporting requirements. This could be further enhanced with cut and paste options, as the use of Overseer was usually only part of a whole farm system analysis and support activities with a farmer.

It was suggested that the programme could have two versions. A light version for non-compliance everyday use, such as fertiliser application decision making. This data could then be copied across into a compliance version (if required) with the additions of further data in more detail to meet compliance reporting. This would encourage the upskilling and the use of overseer by a wider number of consultants. The regular use of Overseer by users is crucial for their confidence and understanding of the software to remain high.

4.83 Customers

To be understood and trusted by customers, those being (farmers and growers, advisors of farmer and growers and policy makers) Overseer needs to continue to invest heavily validation of the current model and future developments. The use of funding partners outside of the owners would send powerful signals to everyone, as to the importance of the model. This is also seen by interviewees as a key focus for the Overseer owners moving forward. Areas where interviewees highlighted that they would like to see more validation are:

- A wider range of crops
- The arable model
- Wintering off options
- More mitigation strategies

(These are in no order of preference or magnitude)

4.84 Services

There is real frustration for farmers in the amount of doubling up that occurs in supplying farm data for a number of requirements. Farmers may already have data automatically generated that could be uploaded directly into Overseer. There is also an opportunity for fertiliser application records at paddock level that have been GPS'd by the spreading contractor to be directly uploaded into Overseer. Production information (milk and stock sales), stock movement and stock fertility data could also be uploaded directly into Overseer. This would improve the quality of data and the timeliness of its supply. A national approach, standardised processes and systems would need to be developed to enable this to occur. Industry is already making strides in this area of development.

Future reporting to meeting regional council's requirements will require farmers to provide Overseer output data to monitor changes over time, as a result of on-farm change. Currently this data would be reported outside of Overseer in a separate farm environment plan. There is an opportunity for this reporting to take place within the Overseer file, with the data saved, to then potentially be used to create a base file for subsequent Overseer files.

The survey results have highlighted that the Overseer Strategic Plan will cover many of the issues that have been raised. The survey also raises the big concern around the use of the Overseer model in compliance monitoring. Suggestions have been made in terms of solutions and the future direction of Overseer to counter these concerns. More investigation is required to determine if these are appropriate or whether a different direction is required. What is known is that there needs to be a significant change in Overseer perception, to allow its value to be judged separate to its proposed use in compliance.

5.0 Conclusion

Throughout the project, it has been highlighted that there are many factors that can influence perceptions of Overseer across the range of users. Farmers' perceptions are heavily influenced by a fertiliser representative, agricultural consultant, their peers and the media. However the main driving factor is the use or potential use of Overseer outputs in compliance and regulation.

Overseers use in compliance is currently having a significant negative impact on the credibility of the model. Industry and regional councils have a big part to play in gaining the acceptance of farmers for Overseer to be used in compliance and regulation. The rationale for using an output-based model in regulation and compliance needs to be clearly communicated to farmers, whether it is through media, training or one on one advice. Alternatives to Overseer also need to be socialised, to allow farmers to understand the risks of input-based regulation on their businesses, such as imposed stocking rate, N uses and geographical production limitations.

To meet an output-based number generated by Overseer, farmers will undoubtedly need to adjust their farm system. With that, farmers will want to see evidence that by changing their farm system to reduce their impact on the environment as determined by the change in Overseer, will lead to actual improvements in regional water quality. If not, then the Overseer is at risk of becoming the scapegoat in the whole process.

But all is not lost, the perception survey has also clearly demonstrated that as knowledge and experience with Overseer increases, so does perception. This is a real opportunity with the project highlighting a number of areas for raising awareness and increasing understanding. The challenge is to raise the awareness with farmers before imminent regional policy change forces awareness raising, as this often causes a reactionary response to the programme, rather than an informed non emotive response.

 Increasing the relevance of Overseer for farmers is another area of opportunity to increase the models acceptance. The results of the survey highlighted that in its current form, the perceived relevance is limited. Developing the model to allow an increased confidence in output values, in the midst of version changes and the ever changing complexity of farming

systems, will be a key measure of success. Increasing relevance can also be achieved, by developing the programme to aid on farm decision making rather than just monitoring changes. For this to occur, Overseer will need to be developed to integrate with other models and software. Outside of this study, the economic impacts of "farming to limits" are a real concern for all farmers. If Overseer is able to work in tandem with economic programmes to help farmers to make the appropriate decisions for their business. Then this will help improve the models credibility as the solution and not the problem.

So is Overseer an unsung hero? What we do know, is that it is leading edge modelling. Where strong science is available to underpin the model, there is good correlation between theory and practice. There is a strong commitment by the owners to invest in the model to address concerns and improve accuracy. It has been recognised by regional councils, as a suitable alternative to input-based rules in the compliance space. There is strong interest from third parties to develop linkages with the model and other platforms.

The challenge is to continue to develop and improve Overseer at a rate that allows perceptions of the model not to be tinged with the issues associated with its use in compliance and regulation. The impact that this will have on the livelihood of farming in the quest for improved water quality for a nation will continue to drive farmer perceptions unless we change their perception.

As one of the interviewed farmers suggested "don't shoot the messenger".

References

AgResearch. 2013. OVERSEER®: Answers to commonly asked questions. Retrieved from http://www.overseer.co.nz/OVERSEERModel/Information/Notes.aspx

Åkerman M,. Kaljonen M., M. Peltola, T.2007. Integrating environmental policies into Local practices: The politics of agri environmental and energy policies in Rural Finland. The International Journal of Justice and Sustainability.Vol 10, No 6. 595-611

Beef and Lamb. 2013. Beef + Lamb New Zealand Economic Service Statistics New Zealand

Born, I.O., Edwards, A.C., Witter, E., Oenema, O., Ivarsson, K., Withers, P.J.A., Nilsson, S.I. and Richert Stinzing, A. 2003. Element balances as a tool for sustainable nutrient management: a critical appraisal of their merits and limitations within an agronomic and environmental context European Journal of Agronomy 20 211 - 225

Cherry, K. A., Shepherd, M., Withers, P.J.A., Mooneya, S.J., 2008.   Assessing the effectiveness of actions to mitigate nutrient loss from agriculture: A review of methods. Science of the total environment 40 6. 1 – 2 3

DairyNZ. 2013a. New Zealand Dairy Industry Audited Nutrient Management Scheme: A protocol for the use of the Overseer model to measure, model and audit nitrogen information from New Zealand Dairy Farms. DairyNZ.

DairyNZ. 2013b. Sustainable Dairying: Water Accord. DairyNZ, Hamilton. New Zealand.

DairyNZ. 2014. DairyNZ: Economic Survey 2012-2013. DairyNZ, Hamilton. New Zealand.

Dunbier, M., Brown, H., Edmeades, D., Hill, R., Metherell, A., Rahn, C., Thorburn, P. and Williams, R. 2013. A peer review of OVERSEER® in relation to modelling nutrient flows in arable crops. Foundation for Arable research. 1-30

Edmeades, D. 2011. Statement of evidence of Douglas Charles Edmeades for Federated Farmers of New Zealand. 1-15

Edmeades, D. 2013. Fertiliser Review: Overseer. Winter 2013. 4-9.

Kizos, T. and Kristensen, L.S. 2011. The 'good farmer': Studies of farm management practices and landscape change. Danish Journal of Geography, 111:2, 105-106.

Ledgard. 2009. Proposed One Plan – Section 42A Report of Dr Stewart Francis Ledgard on behalf of horizons Regional Council concerning water quality. 1-28

Ledgard, S.L., 2012. Statement of evidence of Dr Stewart Francis Ledgard for Fonterra Co-operative Group Limited. 1-20

Monaghan, R.M., Hedley, M.J., Di, H.J., McDowell, R.W., Cameron, K.C. and Ledgard S.F. Nutrient management in New Zealand pastures— recent developments and future issues. 2010. New Zealand Journal of Agricultural Research, Vol. 50: 181-201

Ministry for the Environment. 2013. Freshwater reform 2013 and beyond. Wellington: Ministry for the Environment.

Nutrient Management Adviser Certification Programme. NMACP. 2014. Retrieved from http://www.nmacertification.org.nz/site/nutrient_management/
Overseer. 2010. OVERSEER® Nutrient Budgets: Supporting Smart Farming :Summary of Strategic Plan 2009-2019.

Overseer. 2014. Best practice data input standards. Retrieved from http://www.overseer.co.nz/OVERSEERModel/Information/DataInputStandards.aspx

Oenema O, Kros H, de Vries W, 2003. Approaches and uncertainties in nutrient budgets: implications for nutrient management and environmental policies. European Journal of Agronomy 20. 3-16

Primary Producers Collective. 2014. Retrieved from http://www.rotoruafarmers.org.nz/draft-nutrient-rules/

Shepherd, M. and Wheeler, D. 2012. OVERSEER® Nutrient Budgets – the next generation. In: Advanced Nutrient Management: Gains from the Past - Goals for the Future. (Eds L.D. Currie and C L. Christensen). Occasional Report No. 25. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

Shepherd, M., Wheeler, D, and Selbie, D, Buckthought L., and Freeman, M. 2013. OVERSEER®: Accuracy, precision, error and uncertainty. Accurate and efficient use of nutrients on farms. (Eds L.D. Currie and C L. Christensen). Occasional Report No. 26. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 8 pages.

Waikato Regional Council. 2014a. Farmer's guide to permitted activities. Waikato Regional Council. Retrieved from http://www.waikatoregion.govt.nz/Community/Your-community/For-Farmers/News-and-events/Permitted-activity-guides/

Waikato Regional Council. 2014b. Protecting Lake Taupo strategy. Retrieved from http://www.waikatoregion.govt.nz/Community/Your-community/Lake-Taupo/Protecting-Lake-Taupo/

Wheeler, D. and Shepard, M. 2013. Overseer Technical Manual: Introduction. Retrieved from http://www.overseer.co.nz/OVERSEERModel/Information/Technicalmanual.aspx

Williams, R., Hamish Brown, H., Dunbier, M., Edmeades,D. , Reece Hill, R., Metherell A., Rahn, C., and Thorburn, P. 2013A critical examination of the role of Overseer in modelling nitrate losses from arable crops. 1-8

Appendix 1.

OVERSEER® Development timelines

Year	Model	Scale	Drivers	Founder	Main Users	Outcomes
1982-84	CFAS	non-camp paddock	Consistent fertiliser recommendation systems	Public good	Consultants	Nationwide nutrient recommendation system for production Inputs + recycling by animals
1992-94	Database summary of P, K and S field trials	Mostly small plots, 3 yr+ data per trial	Data summary and funding cuts	Fert-Research	Science	Sharpened up recommendations Consensus Nutrients other than P
1996	Outlook	non-camp paddock	Utilise the P, K and S trials	Fert-Research Public good	Fertiliser reps	Productivity and economics Software + CFAS + database
1999	PKS Lime	non-camp paddock	Update to include lime	MAF Fert-Research	Fertiliser reps	Outlook + lime Need to change model name
2000	OVERSEER® 2	non-camp paddock	Environmental	MAF	AgResearch	Include N (environmental)
2000	OVERSEER® 3	non-camp paddock	Development of the Code of Practice for Fertiliser Use	Fert-Research	Fertiliser reps	Combined NPKS Lime (productivity and econometric) and nutrient budget (environmental) into a single model.
2002	OVERSEER® nutrient budgets (ovr 4)	Farm, block Camp/non-camp	Common practice for land application of effluent	MAF public good (effluent)	Ag and Fert consultants	Nutrient budget (including environmental effects) covering farm scale and farm dairy effluent use on land.
2003	OVERSEER® nutrient budgets (ovr 5)	Farm, block Camp/non-camp	Greenhouse gas emissions Sustainability Addition of minor nutrients (Ca, Mg, Na, acidity added)	MAF Public good	Fertiliser reps Farmers Private consultants Science	Educative tool Environmental focus (N leaching, greenhouse gas emissions, energy)
2005	OVERSEER® nutrient budgets (ovr 5.2)	Farm, block Camp/non-camp	Increased functionality and mitigation options P runoff module	MAF	Fertiliser reps Farmers Private consultants Science Policy	Increased use in evaluating farm management effects on nutrient flows and environmental emissions. Interest in possible regulatory role.
2008	OVERSEER® Nutrient Budgets (ovr 5.3)	Farm, block Camp/non-camp	Monthly stock calculator Forage crop Addition of DCD Addition of wetlands and riparian strips	MAF Fert-Research SFF	Fertiliser reps Farmers Private consultants Science Policy	Increased use in evaluating farm management effects on nutrient flows and environmental emissions. Increasing use in regulatory role.
2009	OVERSEER® Nutrient Budgets (ovr 5.4)	Farm, block Camp/non-camp	Input parameter reports added. Major changes to fruit, vegetable and arable cropping models.	MAF Fert-Research SFF	Fertiliser reps Farmers Private consultants Science Policy	Wider applicability of the model to other, non-pastoral, sectors
2012	OVERSEER® Nutrient Budgets (ovr 6.0)	Farm, block Camp/non-camp	Change to web browser model, major chnages in model, including integration of all blocks types, upgrade of N model, ghg product reports	MPI, FANZ	Fertiliser reps Farmers Private consultants Science Policy	Wider applicability of the model to other, non-pastoral, sectors Improved predictions based on new science

(Dunbier et al, 2013)

Appendix 2.

A summary of the main changes included in Overseer version 6

Feature	Benefit
Integration of pasture, crop and horticultural models into a single model.	# All block types now available on an individual farm #More consistency in modelling approaches across the block types resulting in fairer comparisons
Monthly time step for some inputs.	# Allows better modelling of time dependent outputs from the nutrient budget, particularly for N losses.
N and DCD models reviewed and upgraded.	# Better recognition of the timing of farm operations on N losses
Life cycle assessment added to the GHG model.	# Estimation of GHG emissions upgraded # Allows emissions to be expressed on a product basis
Dairy goats added to animal enterprises.	# Model now covers another important enterprise
Better handling of supplements: # Cut & carry block added # More supplement can be removed from a grazed block # Supplement can be fed on forage crop blocks	# The model can now better represent what is actually happening on farms
Improved drainage model	# Improved estimation of drainage from stony/sandy soils and under irrigation
Improved effluent management	# Ability to add effluent to increased range of blocks

(Shepherd & Wheeler, 2013)

Appendix 3.

Overseer Interviews

Interview Date: _____

Interviewee Name:_____

Business Name_____

Farm Type _____

Supply Number (if applicable):_____

Address: _____ Phone: _____

_____ Mobile: _____

_____ Email: _____

What is your current role?

Farm owner/ Operator	Independent Consultant	Fertiliser Representative	Regional Council	Research	Industry Good	Other (Specify): _____
☐	☐	☐	☐	☐	☐	☐

Current Position: _____

Which age group do you belong to:

20-29	30-39	40-49	50-59	60+
☐	☐	☐	☐	☐

1). **How many years have you been aware of the Overseer programme?**

<2	2-5	6-10	10+
☐	☐	☐	☐

2). **How many years have you been actively using the programme?**

0	<2	2-5	6-10	10+
☐	☐	☐	☐	☐

3). **On a scale of 1 – 5, which of the following best describes your current understanding of the Overseer model?**

Poor		Enough to get by		Very Good
1	2	3	4	5
☐	☐	☐	☐	☐

4). **How well do you think you understand of the merits and limitations of the model?**

Low		Moderate		High
1	2	3	4	5
☐	☐	☐	☐	☐

5). **How well do you think farmers in general understand of the merits and limitations of the model?**

Low		Moderate		High
1	2	3	4	5
☐	☐	☐	☐	☐

6). What currently influences your perception of the Overseer model

Area	Not acknowledged	Area for concern	Somewhat concerned	Ambivalent	Positive	Very Positive
	0	1	2	3	4	5
Future use for Compliance and regulation						
Consistency of Overseer file creation						
Accuracy of input data						
Interpretation of Output						
Understanding of Model mechanics						
Regular updates in Overseer model versions						
Users of overseer having third party motives						
Universal acceptance						
Available science to under pin the model						
Models use of long term averages						

7). Where have you sourced information and evidence that has formed your view of Overseer? (answer any that apply)

	Yes/No	Comments and reasons
As part of a tertiary qualification programme (including the SNM short course at Massey University)		
Other profession development training (please state which one)		
From newspapers and articles		
Third party comments e.g. fertilizer rep/consultant		
Peer Opinion		
Scientific papers and conference presentations		
Own use and experience		
Other:		

8).   If you use or are interpreting Overseer nutrient budget estimates, which farm type(s) do you do this for? (answer all that apply)

None	Dairy	Drystock	Horticulture	Cropping	Compliance
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

9). Rate your level of confidence for Overseer to contribute to the following task?

Area		No opinion	1 Low	2	3	4	5 Very
				Level of Confidence			
Increase the understanding of nutrient cycling on individual farms							
Aid fertiliser decision making							
A data capture and reporting tool							
Providing information to optimise nutrient use							
Provide information to minimise impacts on air, soil and water quality.							
As a regulatory tool to inform compliance of nutrient management policy							
Benchmarking against other properties							
Benchmarking over time							

10).   Do you seek out for information and advice on the understanding and use of Overseer?

No	Monthly	Weekly	Once or twice a year
☐	☐	☐	☐

11). Where did you source your information about <u>farming</u> in general in the last 3 years?

Source	Do you use this source		List source
Discussion groups	Yes ☐	No ☐	*List groups* ● ●
Conference	Yes ☐	No ☐	● ●
The internet	Yes ☐	No ☐	● ●
Written media or books	Yes ☐	No ☐	*List material* ● ●
TV or Radio	Yes ☐	No ☐	*List media sources* ● ●
Research or Demonstration Farms or	Yes ☐	No ☐	*List farms* ● ●
Key Influencer	Yes ☐	No ☐	*List farms* ● ●
Other (specify): _____	Yes ☐	No ☐	

12). **Where did you source your information about <u>Overseer</u> from in the last 3 years?**

Source	Do you use this source		List source
Discussion groups	Yes ☐	No ☐	*List groups* • •
The internet	Yes ☐	No ☐	*List sites* • •
Written media or books	Yes ☐	No ☐	*List material* • •
TV or Radio	Yes ☐	No ☐	*List media sources* • •
Conference	Yes ☐	No ☐	*List Conference* • •
Research or Demonstration Farms	Yes ☐	No ☐	*List farms* • •
Key Influencers	Yes ☐	No ☐	*List* • •
Tertiary Education programmes	Yes ☐	No ☐	*List Institutions and courses* • •

13). **How do you rate the effectiveness of notification around changes and updates to the Overseer model?**

Never seen one	Very low					Very high
0	1	2	3	4	5	
☐	☐	☐	☐	☐	☐	

Comment:

14). **what steps have you taken in the past to improve your understanding of Overseer and its use**

None	Peer support	On job training	Overseer manual and help function	Attended Massey Course	Other: _____
☐	☐	☐	☐	**Intermediate SNM** ☐Year:_____ **Advanced SNM** ☐Year:_____	☐

15). **Are you planning to increase your understanding of Overseer in the next year;**

None	Peer support	On job training	Overseer manual and help function	Attended Massey Course	Other: _____
☐	☐	☐	☐	☐Intermediate ☐ Advanced	☐

16). What do you see as are the key challenges for the Overseer in the next 5 years?

i)

ii)

iii)

iv)

17). How would you like to see overseer developed to meet future requirements of the industry?

i)

ii)

iii)

iv)

18). **What would you like to see the Overseer owners do differently?**

_____

_____

_____

_____

_____

19). **Any further comments?**

_____

_____

_____

_____

_____