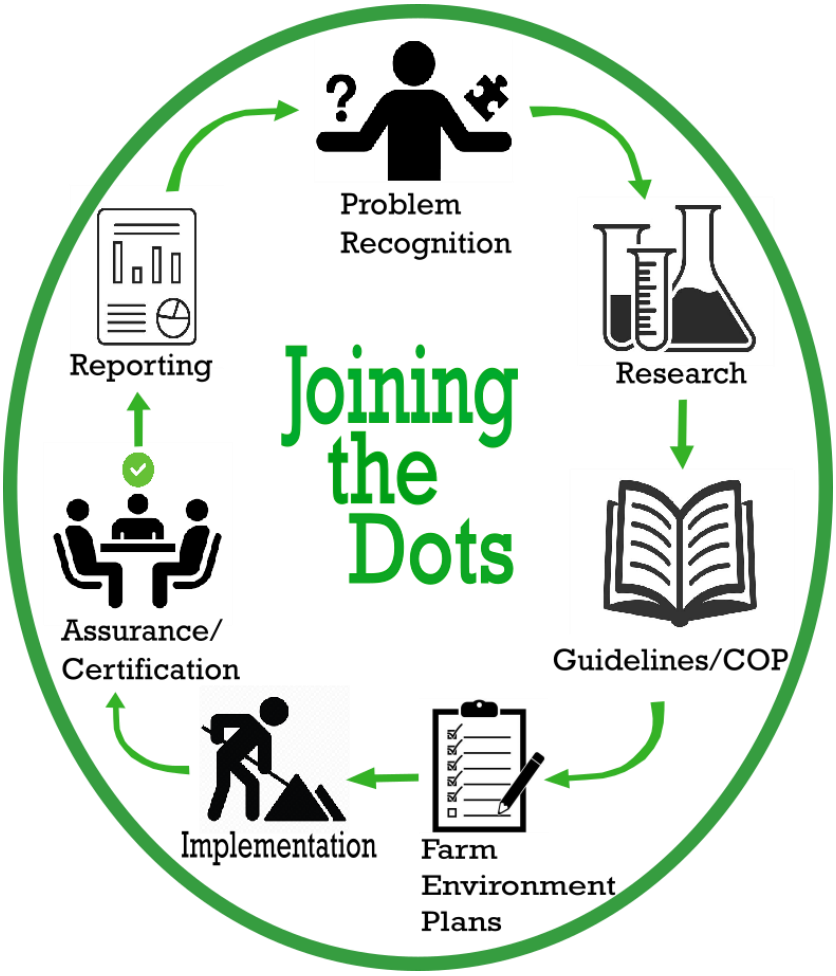
Joining the Dots – 2020 Update

Problem Recognition, Research, Guidelines, Implementation, Reporting and Assurance

April 2020



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April 2020

(This is an updated version of the original June 2019 report)

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1. Agrilink NZ

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Disclaimer

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1 Overview

Joining the Dots is a structured approach to progressing from problem recognition, to implemented and audited mitigations, and benchmark sustainability reporting.

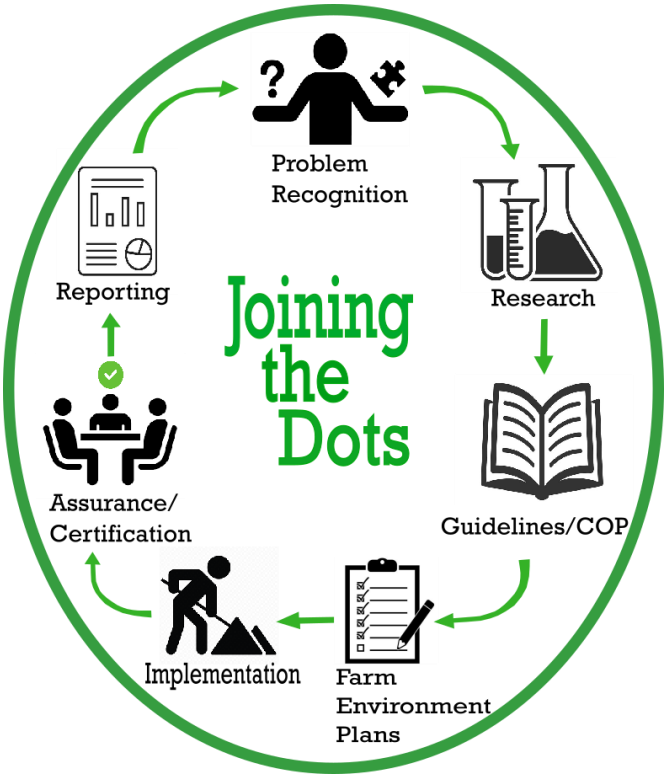
The original intent of the project was to create Farm Environment Plans (FEPs) that could be audited under the New Zealand Good Agricultural Practice (NZGAP) Environmental Management System (EMS) add-on, to provide assurance to regional councils that the outdoor fresh vegetable industry is undertaking continuous improvement with the goal of increasing sustainability.

As part of the work to date, Agrilink NZ and NZGAP, commissioned by the Vegetable Research and Innovation Board (VR&I), have stepped a grower through the process using the problem of soil erosion on cultivated vegetable paddocks. The case study grower developed an Erosion & Sediment Control Plan (a component of an FEP), which has a staged implementation, and has been audited through NZGAP.

The research results are from the Sustainable Farming Fund (SFF) project 'Don't Muddy The Water' underpins the Erosion & Sediment Control Guidelines for Vegetable Production.

The project also explored the potential for collection, aggregation, analysis, and display of national and regional scale metrics via NZGAP EMS. Individualised benchmarking reports could be generated for growers to inform future decision making and priority management areas, as well as aggregated environmental metrics to report on the industry's sustainability progress over time. This report demonstrates individualised reporting using soil erosion and mitigation data, as well as regional and national level reporting.

The next phase needs to be rolling out, at scale, FEPs, as the vehicle for growers to adopt and document further good and best management practices. Alongside this is further development of the data collection, aggregation, and dashboard system. As the number of completed FEPs builds, the baseline data will become more robust and form a factual basis for prioritising areas for improvement, and setting targets, timelines, and reviews. This then feeds back into problem recognition, new research, and targeted grower engagement and extension activities.



2 Problem Recognition

The first step towards improved practice is problem recognition. Without recognition and consequently motivation to change, none of the steps described in Joining the Dots through to implementation are likely to occur.

In our example problem recognition came in the form of a major storm in May 1996, resulting in sediment and stormwater flooding parts of Pukekohe. Grower members of the Pukekohe Vegetable Growers Association needed to find a way of reducing the effects of erosion. The Franklin Sustainability Project (FSP) was born.

The path to implementation was described in the final FSP report (Barber, 2004) and is shown in the diagram below.

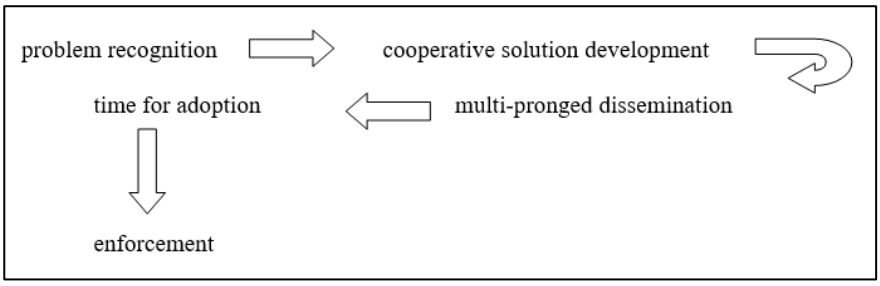


Figure 1. The path to implementation proposed by FSP in 2004.

FSP delivered through to the multi-pronged dissemination. The expectation was that given enough time (now 15+ years) that there would be wide scale new practice adoption, and if not, council enforcement. The reality is that implementation has been mixed, and enforcement complaints driven.

The new approach of Farm Environment Plans gives structure during the “time for adoption” that was previously missing. FEPs are underpinned by research, solution development, COPs, and dissemination, but crucially provide a structured process to plan, document, and implement good/best practice which is verified via independent audits.

3 Research

Cultivated vegetable cropping research into erosion and sediment control began with trials as part of FSP and later the MPI SFF project Don't Muddy The Water.

3.1 Erosion and sediment control

A large quantity of research has been conducted on Erosion and Sediment (E&S) control, particularly in the construction industry. There has however, been limited data on the efficiency of E&S control strategies on cultivated horticultural land. The SFF project 'Don't Muddy The Water' (2015-2019) was conducted to test several mitigation methods on cultivated horticultural land.

The main output of the project was understanding the effectiveness of different sized Sediment Retention Ponds (SRPs). The results are shown in Table 1 and Figure 2 below. These results supported the existing guideline (*Erosion & Sediment Control Guidelines for Vegetable Production*, Barber 2014) specifications for a minimum size of SRPs on cultivated horticultural land of 0.5% (50 m^3/ha).

The main outcomes of the SRP efficiency trial were:

- The existing minimum size of SRPs at 0.5% (50m^3/ha) detailed in *Erosion & Sediment Control Guidelines for Vegetable Production* (Barber, 2014) were supported by the data gathered from this trial.
- Undersized SRPs (<0.5%) detain almost all (>99%) bedload erosion, which itself comprises around 95-98% of total erosion. The size of an SRP is therefore dictated by suspended sediment reduction efficiency, which increases as the ponds become larger.
- While undersized SRPs were extremely effective at bedload capture, they become inundated during storms or over winter when they can not be cleaned out.
- The 0.5% SRP had an average total sediment reduction efficiency of 88%. The median suspended sediment concentration in the discharge water was 130 g/m^3.
- Phosphorus is predominantly lost from cultivated horticultural land in the form of particulate phosphorus in overland flow, that is detained attached to sediment by sediment retention ponds.
- The DMTW App has been developed to help in the risk assessment process when preparing an E&S Control Plan. The app calculates unmitigated and mitigated erosion and sediment loss rates using the Revised Universal Soil Loss Equation (RUSLE), as well as the trial results.
- Four example E&S Control Plans have been developed. These plans incorporate the E&S Control Guidelines, Actions Plans, and link to the NZGAP assurance programme.

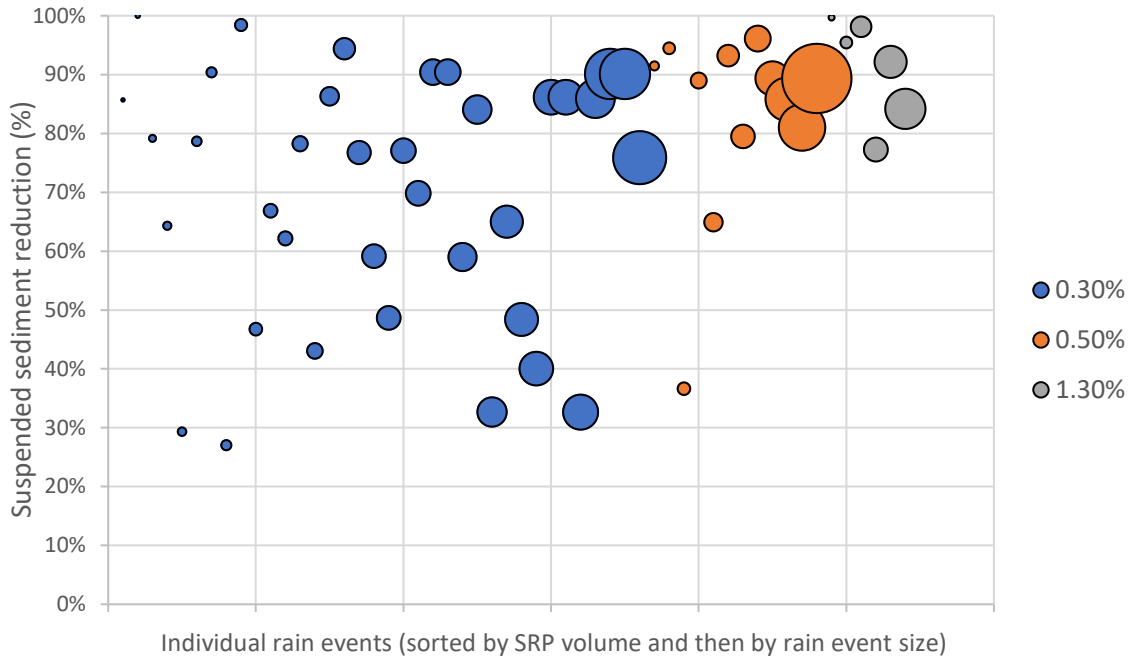


Figure 2. Summary of 4 years of SRP trials - proportion of suspended sediment removed by different sized SRPs. The colour of each bubble refers to the size of the SRP as a percentage of its catchment area, whilst the size of the bubble indicates the relative size of the rainfall event.

Table 1. Average suspended sediment reduction efficiency by pond size

Pond Size	Number of rainfall events	Average Efficiency
1.3%	6	93%
0.5%	12	87%
0.3%	36	73%

4 Guidelines and COPs

4.1 Erosion and sediment control guidelines

FOUR STEPS TO MINIMISING SOIL EROSION & SEDIMENT LOSS

1. Paddock assessment

Map and describe the paddock (slope, area, history)

Identify where water is coming from

Identify where water leaves the paddock

2. Implement control measures for stopping or controlling water entering the paddock

Interception drains

Correctly sized culverts

Benched headlands

Bunds

Grassed swales
(controlled overland flow through the paddock)

3. Implement erosion control measures to keep soil on the paddock

Cover crops

Wheel track ripping / Wheel track dyking

Contour drains

Using short row lengths

Cultivation practices including minimising passes

Harvest management – timing / all-weather facilities

Post-harvest field management

Wind break crops (wind erosion)

4. Implement sediment control measures to manage the water and suspended solids that move off the paddock

Ensure access ways are not at the lowest point

Raised access ways / Bunds

Vegetated buffers / Riparian margins / Hedges

Super silt fences

Stabilised discharge points and drains

Decanting earth bunds and silt traps

Version 1.1 - 2014 7

The Erosion & Sediment Control Guidelines for Vegetable Production[1] was prepared in 2014 and specifies the four-step process needed to conduct an E&S risk assessment and to generate a mitigation plan. The guidelines details a large array of E&S control measures suitable for cultivated horticultural land. Measures detailed in the guideline include vegetated buffers, sediment retention ponds (SRPs), cultivation practices, interception drains, and wheel track ripping amongst many others. These guidelines specify the minimum standards for construction and maintenance SRPs.

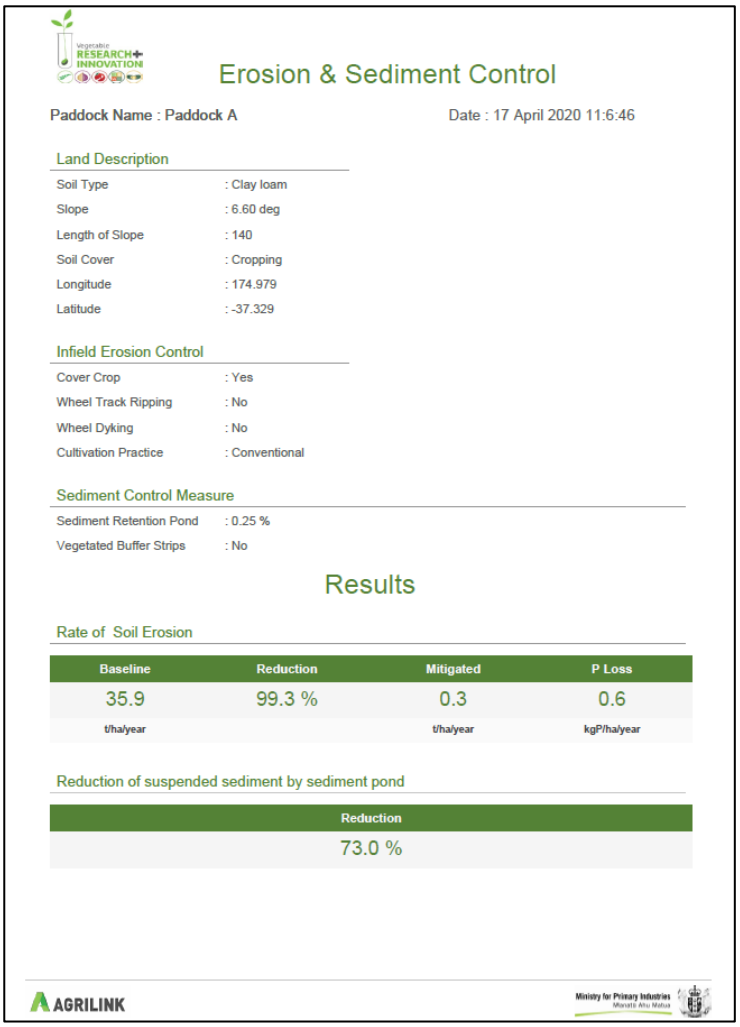
[1] Barber, A. 2014. Erosion & Sediment Control Guidelines for Vegetable Production. Prepared for Horticulture New Zealand. Prepared by Agrilink NZ, Kumeu.

5 Farm Environment Plans

The next step in 'Joining the Dots' involved utilising the erosion and sediment research to inform and improve on farm management practices. There has been a growing desire from regional councils around the country to monitor the environmental effects of agriculture and horticulture, and this has been expressed by several councils bringing in requirements for Farm Environment Plans (FEPs). These plans assess the environmental impact of growing activities, and where risks are identified prescribe actions to be implemented to mitigate these risks. The three main environmental concerns for cultivated vegetable production are sediment, phosphorus, and nitrogen loss. This project developed several case study erosion and sediment management plans, which have been progressively updated.

5.1 Erosion and sediment control plans

The general process of preparing an E&S Control Plan involves a site inspection to conduct a paddock risk assessment. This is followed by mapping to determine contours, soil type and land area. These factors are then put into the DMTW App to establish baseline erosion rates, and the erosion and sediment loss rates from current practice. This forms the risk assessment component of the plan.



Erosion & Sediment Control

Paddock Name : Paddock A

Date : 17 April 2020 11:6:46

Land Description

Soil Type	: Clay loam
Slope	: 6.60 deg
Length of Slope	: 140
Soil Cover	: Cropping
Longitude	: 174.979
Latitude	: -37.329

Infield Erosion Control

Cover Crop	: Yes
Wheel Track Ripping	: No
Wheel Dyking	: No
Cultivation Practice	: Conventional

Sediment Control Measure

Sediment Retention Pond	: 0.25 %
Vegetated Buffer Strips	: No

Results

Rate of Soil Erosion

Baseline	Reduction	Mitigated	P Loss
35.9	99.3 %	0.3	0.6
t/ha/year		t/ha/year	kgP/ha/year

Reduction of suspended sediment by sediment pond

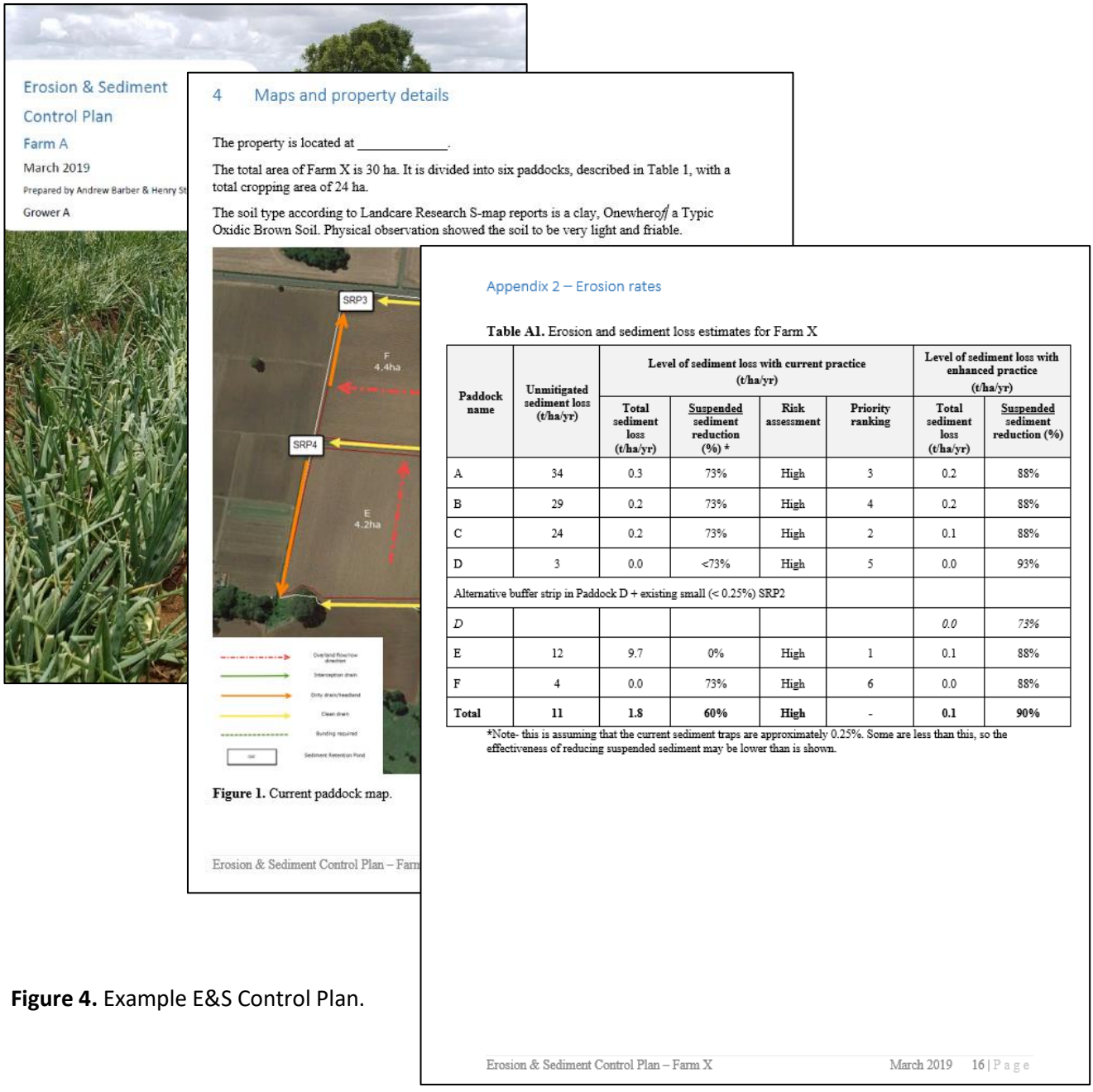
Reduction
73.0 %

AGRILINK

Ministry for Primary Industries

Figure 3. The output report from the DMTW App.

The NZGAP Templates are used to determine the existing Good Management Practices used on farm. The risk assessment and GMP assessment is then used to assemble an Action Plan – which may be staged over several years accounting for field conditions and construction seasons.



Erosion & Sediment Control Plan
Farm A
March 2019
Prepared by Andrew Barber & Henry St
Grower A

4 Maps and property details

The property is located at _____.

The total area of Farm X is 30 ha. It is divided into six paddocks, described in Table 1, with a total cropping area of 24 ha.

The soil type according to Landcare Research S-map reports is a clay, Onewhero/ a Typic Oxidic Brown Soil. Physical observation showed the soil to be very light and friable.

Figure 1. Current paddock map.

Erosion & Sediment Control Plan – Farm

Appendix 2 – Erosion rates

Table A1. Erosion and sediment loss estimates for Farm X

Paddock name	Unmitigated sediment loss (t/ha/yr)	Level of sediment loss with current practice (t/ha/yr)				Level of sediment loss with enhanced practice (t/ha/yr)	
		Total sediment loss (t/ha/yr)	Suspended sediment reduction (%) *	Risk assessment	Priority ranking	Total sediment loss (t/ha/yr)	Suspended sediment reduction (%)
A	34	0.3	73%	High	3	0.2	88%
B	29	0.2	73%	High	4	0.2	88%
C	24	0.2	73%	High	2	0.1	88%
D	3	0.0	<73%	High	5	0.0	93%
Alternative buffer strip in Paddock D + existing small (< 0.25%) SRP2							
D						*0.0*	*73%*
E	12	9.7	0%	High	1	0.1	88%
F	4	0.0	73%	High	6	0.0	88%
Total	**11**	**1.8**	**60%**	**High**	-	**0.1**	**90%**

*Note- this is assuming that the current sediment traps are approximately 0.25%. Some are less than this, so the effectiveness of reducing suspended sediment may be lower than is shown.

Erosion & Sediment Control Plan – Farm X March 2019 16 | Page

Figure 4. Example E&S Control Plan.

The case study E&S Control Plans went through multiple revisions in order to make them easy to use for the growers – and streamlined for auditing (see next section). The E&S Control Plan development process:

1) Beginning in late 2018, site inspections and Google Earth mapping of the site was used to draft the first report. NZGAP templates and other checklists from Horticulture New Zealand guidelines were used as part of the risk and mitigation assessments.
2) Further site inspections and visits which led to a streamlining of the report, as well as the creation of a short Construction Summary that can be provided to the machinery operators who are installing the mitigation measures.
3) During one of the site inspections an issue with one of the SRP outlets, with the road drain being too high to allow for enough volume in the SRP. This highlighted the need for a coordinated catchment-based approach between growers, their neighbours and council.
4) The E&S Control Plan was again modified and underwent an NZGAP audit, which identified further streamlining opportunities.

Having now prepared four E&S Control Plans, the process has been well refined. The anonymous case study E&S Control Plan can act as a template to follow and is available from Horticulture NZ.

Figure 5. Construction of an SRP following the E&S Control Plan.

Figure 6. A completed 0.5% SRP. The important elements being volume, snorkels, and a protected level emergency spillway.

6 Assurance – NZGAP

The horticultural industry has a well-established quality assurance programme through New Zealand Good Agricultural Practice (NZGAP). This is a self and externally audited program. Currently, NZGAP has mostly been involved in food safety, health and safety, and workplace management auditing; however. it has recently added an Environmental Management System (EMS) to empower growers to adopt environmentally sustainable growing practices and audit good and best management practices and environmental outcomes.

The EMS is comprised of Templates – covering property mapping, soil, nutrients, water and irrigation, and mahinga kai and biodiversity. Practice changes, responsibility, and a timeline for implementation are documented in the Action Plan. Growers are audited against a Checklist of requirements.

The structure and wording of the Templates went through minor revisions during this project. This included rewording and adding the option of 'Partial' to the Template questions in recognition that not all practices were binary yes / no answers.

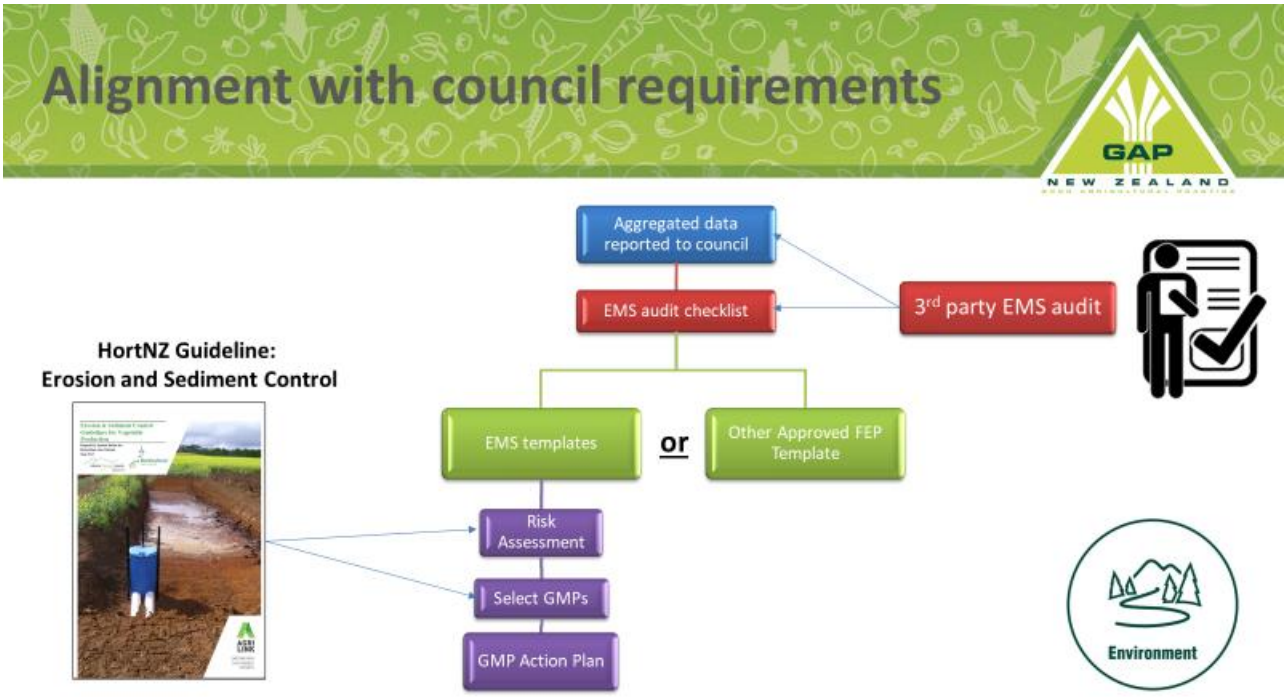


Figure 7. The structure of NZGAPs EMS.

7 Grower and industry reporting

Having developed E&S Management Plans, there is potentially a lot of data that is being collected that if aggregated properly could be used to help drive practice-based change. This has been the experience in the wine industry where the NZ Sustainability Dashboard Project developed energy, water, and plant protection dashboard reports. Growers and wineries can now assess themselves against tuned benchmarks. These individualised benchmarking reports have been used to track progress and link Sustainable Winegrowing NZ members to learning resources when they are engaged in an issue through seeing their own performance.

The final part of this project was therefore to investigate what metrics could be collected, and how these could be used in individualised and industry scale reporting. When aggregated at a higher level the metrics can be used by the industry to show progress at a catchment, regional or national scale towards improved GMP's and greater sustainability.

7.1 Data collection

Several data collection methods were considered, with Formstack being chosen due to its simplicity and ease of use. At this early stage the method of collection is less important than investigating the metrics themselves. Selecting the metrics involved considering what could be usefully reported on in an individualised benchmarking report, tracked over time, and how the NZGAP mitigation measure templates should be incorporated.

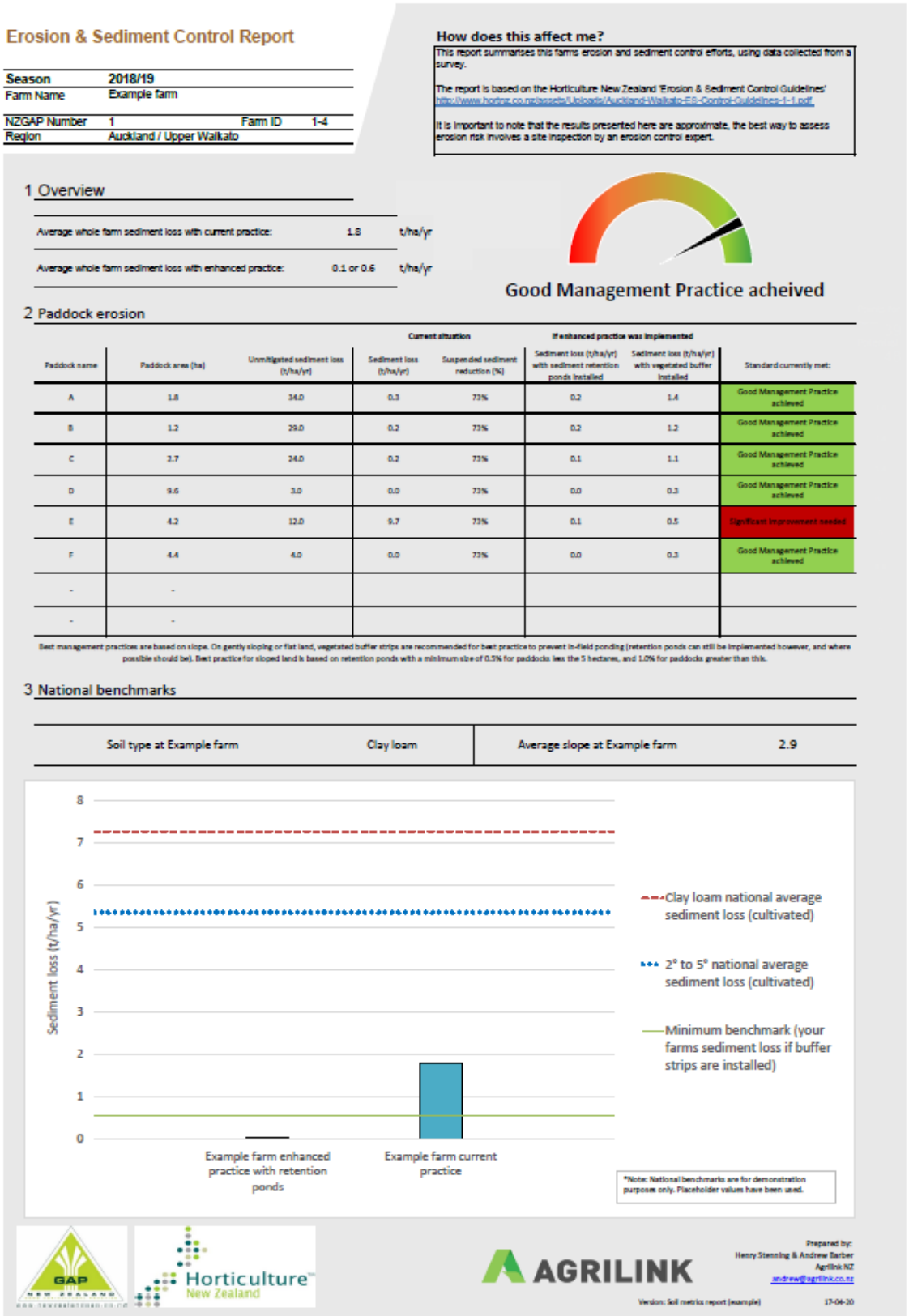
Through an iterative process the E&S Control Plans provided information necessary to calculate baseline paddock erosion rates, as well as sediment loss from current and future enhanced practices. These metrics were added to the collection of GMP practices collected through NZGAPs Template questions.

7.2 Individualised benchmarking reports

Individualised erosion and sediment benchmarking reports have been developed. The reports are generated in Excel and exported as individualised 1-page pdfs.

Paddock descriptions, GMPs, and erosion and sediment loss rates are imported into Excel as a csv file, having been (at this stage) exported from Formstack. Grower details are imported from the NZGAP database.

The metrics used in the report include unmitigated erosion rates, along with current and future enhanced practice sediment loss rates. Enhanced practice is based on the use of cover crops, wheel track ripping, vegetated buffer strips or SRPs. The benchmarks are tuned for slope, location, and soil type. There is a link in the report through to the E&S Control Guidelines on the HortNZ website.



Erosion & Sediment Control Report

Season	2018/19
Farm Name	Example farm
NZGAP Number	1
Farm ID	1-4
Region	Auckland / Upper Waikato

How does this affect me?

This report summarises this farms erosion and sediment control efforts, using data collected from a survey.

The report is based on the Horticulture New Zealand 'Erosion & Sediment Control Guidelines' http://www.hortnz.co.nz/assets/Uploads/Auckland-Waikato-ES-Control-Guidelines-1-1.pdf

It is important to note that the results presented here are approximate, the best way to assess erosion risk involves a site inspection by an erosion control expert.

1 Overview

Average whole farm sediment loss with current practice:	1.8	t/ha/yr
Average whole farm sediment loss with enhanced practice:	0.1 or 0.6	t/ha/yr

Good Management Practice acheived

2 Paddock erosion

			Current situation		If enhanced practice was implemented		
Paddock name	Paddock area (ha)	Unmitigated sediment loss (t/ha/yr)	Sediment loss (t/ha/yr)	Suspended sediment reduction (%)	Sediment loss (t/ha/yr) with sediment retention ponds installed	Sediment loss (t/ha/yr) with vegetated buffer installed	Standard currently met:
A	1.8	34.0	0.3	73%	0.2	1.4	Good Management Practice achieved
B	1.2	29.0	0.2	73%	0.2	1.2	Good Management Practice achieved
C	2.7	24.0	0.2	73%	0.1	1.1	Good Management Practice achieved
D	9.6	3.0	0.0	73%	0.0	0.3	Good Management Practice achieved
E	4.2	12.0	9.7	73%	0.1	0.5	Significant improvement needed
F	4.4	4.0	0.0	73%	0.0	0.3	Good Management Practice achieved
-	-						
-	-						

Best management practices are based on slope. On gently sloping or flat land, vegetated buffer strips are recommended for best practice to prevent in-field ponding (retention ponds can still be implemented however, and where possible should be). Best practice for sloped land is based on retention ponds with a minimum size of 0.5% for paddocks less the 5 hectares, and 1.0% for paddocks greater than this.

3 National benchmarks

Soil type at Example farm	Clay loam	Average slope at Example farm	2.9

GAP NEW ZEALAND

Horticulture New Zealand

AGRILINK

Prepared by:
Henry Stenning & Andrew Barber
Agrilink NZ
andrew@agrilink.co.nz

Version: Soil metrics report (example) 17-04-20

Figure 8. Individualised E&S Control benchmarking report.

7.3 National benchmarking and progress tracking

One of the aims in instituting a benchmark reporting program is to track regional and national Good Management Practice changes over time. As participation increases, the industry will be able to track its progress at catchment, regional and at a national level.

Aggregated metrics could track changes in sediment loss. In the case study example above, unmitigated soil loss was 262 t/yr (11 t/ha/yr), current practice has losses of 42 t/yr (1.8 t/ha), reducing to 1.4 t/yr (0.01 t/ha) as more mitigations are implemented.

Figure 9 shows an example of what aggregated E&S Control GMP data could look like.

With multiple years of data and increased participation, these metrics could be used to tell a very compelling story of continuous improvement by the industry. Changes over time could be analysed, for catchment, regional or national sediment loss rates.

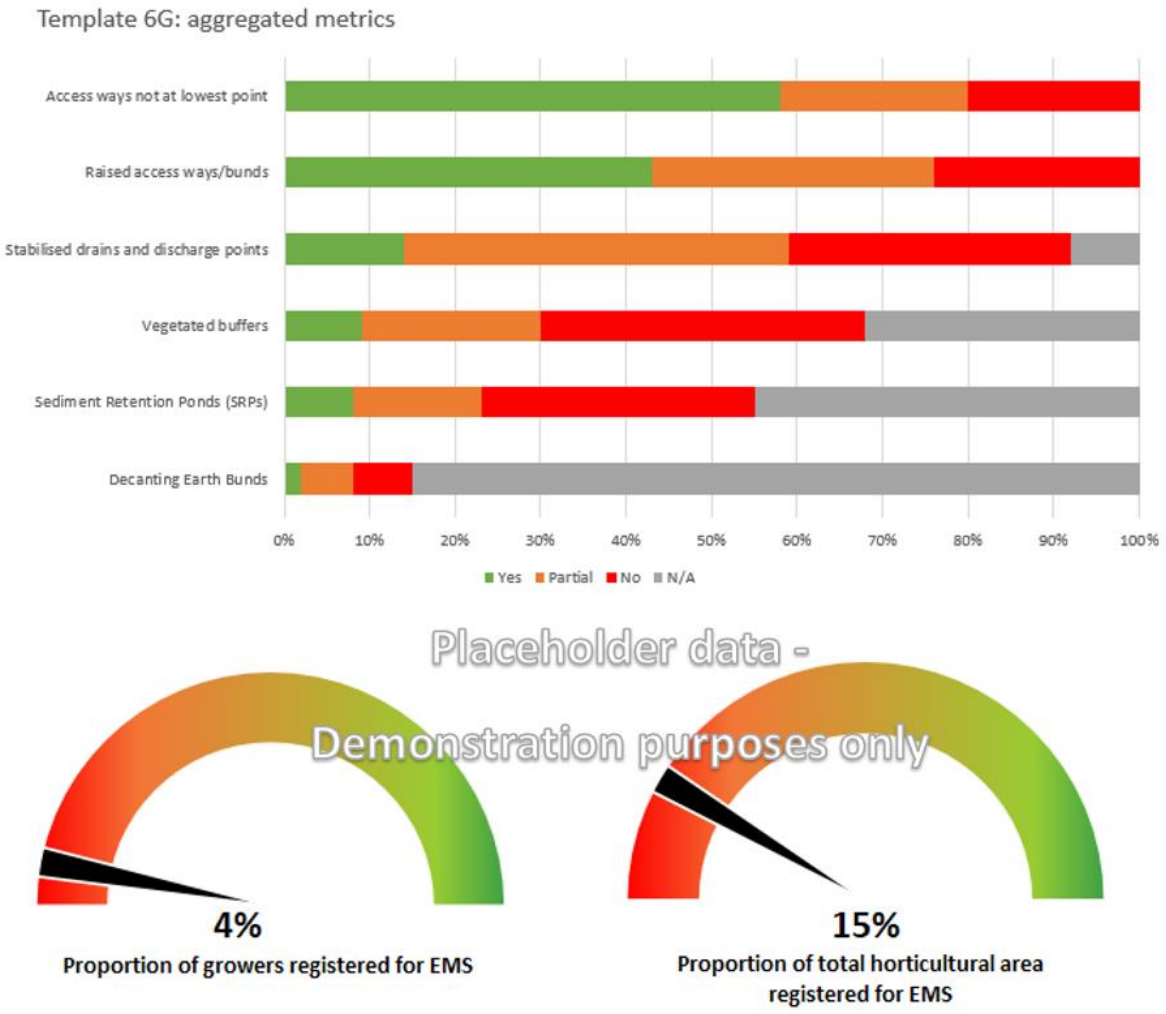


Figure 9. Dashboard report showing the aggregated adoption of sediment control measures to manage the water and suspended solids that move off paddocks.

8 Implementation

Following on from the original Joining the Dots report, there has been a great deal of work in implementing NZGAPs EMS across the industry. A total of 10 workshops have been held in three regions, with 5 in Levin, 2 in Pukekohe, and 3 in Canterbury. Due to the large change in working and social conditions imposed on all industries by the Covid-19 outbreak there has been a pause in the planned rollout of workshops, although there are plans for every major growing region in New Zealand to have several grower workshops focussed on completing the EMS. A stronger emphasis is now being placed on case studies in each region to have a relatable point of focus.

8.1 Pioneering the EMS in the Horowhenua

The Levin horticultural hub was selected as the first area to go through the EMS. This was due to several factors, including plan changes by Horizons Regional Council. The introduction of the EMS was a good opportunity to prove to the regional council that the local industry was taking its environmental obligations seriously. The second major factor was the environmental focus and small catchment size of Lake Horowhenua. This allowed for a catchment scale approach to the issue and acted as a good first example for the potential of data aggregation and presentation of metrics.

Overall, the workshops were well attended, with the majority of the horticulture industry in the Lake Horowhenua catchment attending.

The first workshop focussed on an introduction to the EMS and mapping. The experience at this workshop demonstrated that mapping could become one of the largest roadblocks to successful implementation of an EMS. Very few of the local growers had farm maps. Therefore, the first workshop involved growers hand drawing on provided satellite photographs their key features as they stepped through Template 5A – Property Plan (map).

The maps were collected and entered into Google MyMaps, and then imported into ArcGIS. Whilst extremely time consuming, this process enabled a catchment analysis across the entire industry in the Lake Horowhenua catchment. The maps, in conjunction with the Don't Muddy the Water App, were used to calculate erosion rates across 1,090 ha, comprising of 22 operations and 263 paddocks.

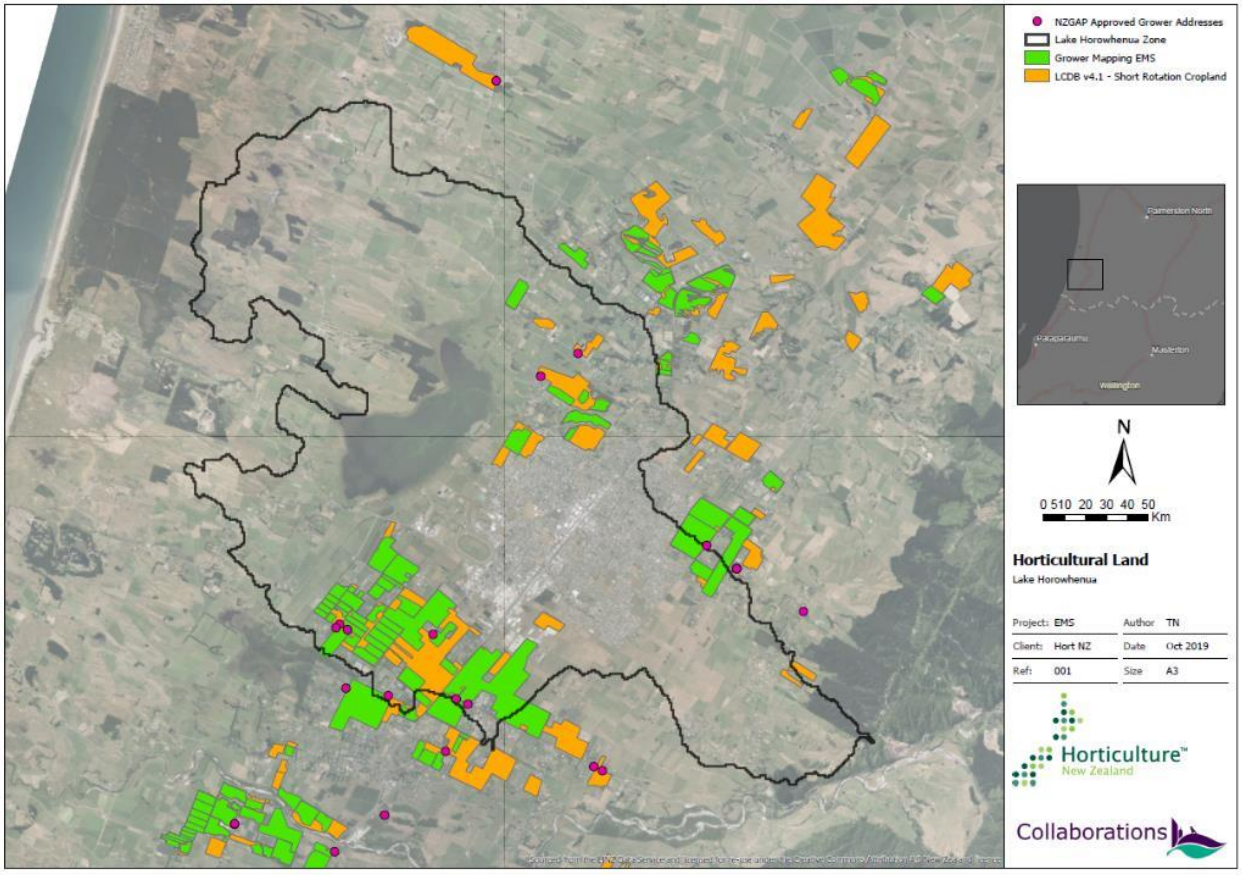


Figure 10. Vegetable cropping land in Levin with a complete or partial EMS in green and the balance of the vegetable cropping land in orange

Based on the data collected through the maps it is possible to calculate unmitigated erosion rates and estimated current and projected erosion rates using enhanced mitigation practices. This method of aggregating erosion rate data in conjunction with mapping, provides a powerful tool in telling an industry story for the Levin area.

Where a grower had not yet completed their EMS, so therefore mitigation practice data gaps, it was assumed no mitigations were installed and any known buffer strips were 50% effective. For enhanced practice we assumed 5m wide buffer strips, that were between 80% and 90% effective. We also tested the impact of including a cover crop in the rotation.

Table 2. Aggregated erosion rates and mitigation practice impacts across 1,090 ha of vegetable cropping land in Levin

Levin	Unmitigated	Current practice	Enhanced practice	Pasture*
Average erosion rate (t/ha/yr)	1.4	0.7	0.3	0.1
Total erosion rate (t)	1,480	760	360	90
Reduction compared to unmitigated (t)	-	720	1,120	-

* Replacing cropping with pasture.

The following Levin workshops were used to discuss each section of the EMS Templates, with one workshop devoted to Erosion & Sediment control, and another focussed on Nutrient Management, Water & Irrigation Management, and Mahinga Kai & Biodiversity.

Following these workshops, a Formstack progress survey has been set up to get feedback on what stage each grower is at in the EMS, and will hopefully act as a prompt to increase the speed with which the growers complete their EMS and sign up for audits.

Several lessons were learned from the first large scale implementation of the EMS. Mapping is the foundation upon which the EMS is built. However, it can be a very manual process, which will need to be streamlined once larger regions and growers with more area start to register for the EMS. There needs to be a range of extension activities, as workshops do not reach all growers. This has especially become true following the Covid-19 outbreak, and alternative methods such as regionally focused case studies, instructional videos and webinars are being considered.

8.2 Workshops and implementation in Pukekohe

To date, two workshops have been held in Pukekohe (one was glasshouse focused). The outdoor focused workshop covered an introduction to the EMS process. There has been limited activity in implementing the EMS since that workshop, partly due to prioritisation of other regions, and partly due to the severe on-going drought afflicting growers in that region. The Covid-19 pandemic has also had a large effect in slowing the rate of adoption of the EMS with planned workshops being cancelled.

8.3 Workshops and implementation in Canterbury

One glasshouse focused EMS workshop was delivered in February. Six outdoor vegetable workshops were scheduled during the second half of March, of which three were delivered in the week preceding

the national lockdown due to the Covid-19 pandemic. The focus is now going to switch to developing case studies and developing virtual grower engagement and extension activities.

8.4 Case study growers

There have been two detailed case studies prepared, one in Pukekohe and the other in Levin. These demonstrate different approaches to flat versus steeper land. There are currently 10 case studies being developed. These include from around the country, indoor and outdoor vegetable production, fruit growers, and a range of operation sizes.