IN THE ENVIRONMENT COURT AT WELLINGTON

IN THE MATTER	of the Resource Management Act 1991 ("**the Act**")
AND	
IN THE MATTER	of clause 14 of the First Schedule of the Act
BETWEEN	**MIGHTY RIVER POWER LIMITED**
	ENV-2010-WLG-000139
AND	**TRUSTPOWER LTD**
	ENV-2010-WLG-000145
AND	**FEDERATED FARMERS OF NEW ZEALAND**
	ENV-2010-WLG-000148
AND	**MERIDIAN ENERGY LTD**
	ENV-2010-WLG-000149
AND	**MINISTER OF CONSERVATION**
	ENV-2010-WLG-000150
AND	**PROPERTY RIGHTS IN NEW ZEALAND**
	ENV-2010-WLG-000152
AND	**NEW ZEALAND TRANSPORT AGENCY**
	ENV-2010-WLG-000153
AND	**HORTICULTURE NEW ZEALAND**
	ENV-2010-WLG-000155
AND	**WELLINGTON FISH & GAME COUNCIL**
	ENV-2010-WLG-000157
AND	**A DAY**
	ENV-2010-WLG-000158
AND	**GENESIS POWER LTD**

ENV-2010-WLG-000159

AND **WATER & ENVIRONMENTAL CARE ASSOCIATION INC.**

ENV-2010-WLG-000160

Appellants

AND **MANAWATU-WANGANUI REGIONAL COUNCIL**

Respondent

STATEMENT OF EVIDENCE BY ANDREW JOHN BARBER FOR HORTICULTURE NEW ZEALAND IN RELATION TO THE APPEALS ON THE PROPOSED ONE PLAN FOR MANAWATU WANGANUI REGIONAL COUNCIL ON SUSTAINALBE LAND USE/ACCELEATED EROSION

(17 FEBRUARY 2012)

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QUALIFICATIONS AND EXPERIENCE

1. My name is Andrew John Barber. I am a Director of AgriLINK NZ and work as an Agricultural Engineering Consultant based in Auckland. I have a Bachelor of Horticulture (Tech) with first class honours from Massey University.

2. I have spent over 16 years as a consultant in the agricultural industry, specialising in resource use optimisation. This includes energy efficiency, resource use benchmarking and most recently carbon footprinting everything from onions to ships.

3. In my years as a consultant I have helped develop vegetable industry soil and erosion management guidelines, and individual cultivated property erosion and sediment control plans.

4. I was Project Manager on the Franklin Sustainability Project (**FSP**) and provided technical advice on managing soil erosion on cultivated land. This was a multi-stakeholder project that ran between 1996 and 2004, which while having a broad goal of improving the overall sustainability of outdoor vegetable production in the Franklin region, had a clear focus on keeping soil on the paddock and mitigating any effects of off-site discharges. The project directly involved the growers, Vegfed (now Horticulture New Zealand (**HortNZ**), MfE, MAF, Auckland Regional Council, Environment Waikato, and the Franklin District Council

5. I have been involved in the preparation of a number of individual cultivated property erosion and sediment control plans, which have involved mapping the properties and designing suitable control measures including the sizing and placement of silt traps.

6. I have also worked on stormwater projects for the Franklin District Council where I designed the stormwater system for Pukekohe Hill and the Bombay Hills that ensured an integrated system between the council and grower drains that were sized to cope with high intensity storm events.

7. In 2009/10 I was engaged by HortNZ to help develop a set of Best Management Guidelines for cultivated soil in the

Horowhenua District. These guidelines are based on local grower experience, my experience in the Franklin District, and trials that were conducted both with and alongside the Holding it Together (**HIT**) Project. The HIT Project is a HortNZ led research project that focuses on preventing soil loss, soil degradation and adverse effects on surface water ways.

8. I provided evidence to the Hearings Panel on the issues in this statement of evidence in February 2010. My earlier evidence is not included in the Technical Evidence Bundle as it was not considered technical evidence by the Hearings Panel because, as I understand it, due to time constraints imposed on the exchange of technical evidence at that time. A copy of my statement of evidence is attached as an appendix to my "will say" statement provided for expert witness caucusing.

9. I have been provided with The Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note dated 1 November 2011. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

CONTEXT AND SCOPE OF MY EVIDENCE

10. I have attended witness caucusing and have signed the Record of Witness Caucusing on Sustainable Land Use and Accelerated Erosion dated 16 February 2011 (**Joint Statement**).

11. The particular issue that my evidence is addresses is the proposed regulatory framework for cultivation. The details of that regulatory framework are set out in the planning evidence. My understanding of the framework proposed by Council[1] is:

[1] Statement of Evidence of Phillip Hindrup, Appendix 1

(a) Cultivation in all parts of the Region is provided for as a permitted activity subject to a number of conditions being met[2];

(b) Cultivation that does not meet the permitted activity conditions falls to be considered as a restricted discretionary activity[3].

12. At the joint caucusing meeting the primary area of disagreement relates to condition (b) or Rule 12-3 which states:

> Any ancillary discharge of sediment into water must not, after reasonable mixing, cause the receiving water body to breach the water quality numerics for visual clarity set out in Schedule D for that water body.

SCOPE AND SUMMARY

13. I do not support the proposed as referred to above. It is my opinion that to minimise soil loss from cultivated land, an inclusive process involving growers, industry representatives, council and soil management practitioners is essential for the development and implementation of robust long term erosion minimisation measures.

14. I have divided my evidence into six parts as follows:

- Best management practice approach;
- A best management code of practice for minimising soil erosion;
- Horowhenua sediment loss trial;
- Sediment control measures – Rule 12-1;
- The effectiveness of a 5m riparian buffer;
- A recommended approach to soil management and minimising erosion on cultivated soils in the region.

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[2] Ibid see Rule 12-3, page 67
[3] Ibid see Rule 12-4, page 69

BEST MANAGEMENT APPROACH

15. As stated in my Evidence to the Council in February 2010 the best approach for affecting change is to get recognition of the problem, then cooperatively develop a solution, and then disseminate that information and allow sufficient time for the practices to be implemented before finally following up with enforcement where changes are not occurring. Enforcement without education is confrontational, the problem is not recognised and the solutions are disjointed and often inadequate. Likewise voluntary measures without enforcement, after an appropriate time, do not achieve widespread adoption and ultimately penalises the early adopters.

16. This position is consistent with the most recent caucusing statement between Dr Botha and Dr Parminter. While referring to the dairy industry it is equally applicable to other primary sectors. Specifically they state:

> In summary, it is our view that a mix of rules and voluntary approaches are required. The rules are for a minority of recalcitrant farmers whilst it is expected that other people will respond to a well-designed voluntary strategy involving the regional council and the dairy industry working together.

17. Botha and Parminter also agreed that, there is a risk with using deterrence theory, namely:

> Rules constructed from deterrence theory make identifying non-compliant behaviour as easy as possible for the enforcer, the rules make no allowance for context or discretion, and identified non-compliance is made costly and punitive.
>
> … we agree that there are advantages in using social learning theory over deterrence theory, because for example:
>
> Enforcement is kept to the worst examples in a population (e.g. less than 20%), to back up and support non-regulatory methods.

18. I believe that the approach adopted by FSP of bringing councils, growers and soil experts together, holding workshops, preparing detailed guidelines, and disseminating that information through a range of channels

is the most successful way of effecting change. With this cooperative multi-stakeholder approach there was general agreement on the solution.

19. This cooperative approach was used to integrate council and landowner stormwater systems on Pukekohe Hill from late 1999. Prior to this the consequences of not working together were made clear when 70% of severe erosion from the 21st January 1999 storm resulted from drains overtopping[4].

20. Prescriptive performance standards as proposed by Hindrup[5] while arguably measurable make no allowance for context or discretion. Those growers directly affected by reference to Schedule D river water performance standards will be in the minority. Very few growers directly discharge stormwater into a river, and those that do have no way of determining the correlation between their activity and water clarity. What's more, the test is significantly influenced by measures outside of a grower's control, namely the intensity and distribution of rainfall events.

21. All growers have control over the practices that they put in place to minimise soil erosion and sediment loss. Consequently the focus should be on engagement, problem recognition, and cooperatively developing solutions. Sending an abatement notice for breaching Schedule D, even if it could be attributed to a single source, is not going to achieve the goal of minimising sediment loss from cultivated land. As Botha and Parminter agreed[6]:

> … not enough is currently known about the interactions between best management practices, between best management practices and farming systems, and between land uses within a catchment, to guarantee that a prescriptive approach to individual farm strategies will achieve the objectives desired by Manawatu-Wanganui Regional Council". This applies whether the prescriptions are

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[4] Basher, L.R., and Thompson, T., 1999. Erosion at Pukekohe during the Storm of 21 January 1999. Landcare Research Contract Report: LC9899/096. Prepared for Agriculture NZ and FSP.
[5] Paragraph 108, page 31
[6] Point 8 of their joint expert witness statement, In the evidence from Terry Parminter para 42:

associated with a regulatory approach (as applies here) or in cases where a voluntary approach is used.

22. Unless council and growers work together we will not determine what the best solutions are. Punitively penalising a few growers for non-compliance to a water standard will not ensure others adopt the best management solutions.

23. The process of determining the best management strategies takes time and resources and is achieved with all stakeholders contributing. In the first version of the FSP 'Doing it Right' guidelines, the pictured silt trap was little more than a shallow depression in the corner of a paddock. There was no sizing or context around catchment area and slope. Several years later the updated version was considerably more detailed; having learnt from the research conducted through FSP and incorporated the contributions from growers, researchers, council, private erosion specialists, and roading engineers. These guidelines are about to be reviewed again to improve their language by making the terms consistent with other erosion and sediment control guidelines, and to improve referencing for use in Auckland Council plans. No one group has the solution and only cooperatively can the goal of minimising sediment loss be achieved.

BEST MANAGEMENT CODE OF PRACTICE

24. In my evidence to the Council Hearing in February 2010 I described the Code of Practice for Commercial Vegetable Growing in the Horizons Region. This still stands as the best approach for minimising soil erosion and sediment loss.

25. A copy of the Code of Practice is attached to my evidence at Appendix 1.

26. In summary the Code of Practice is based on years of experience from many practitioners, through research conducted by FSP and the HortNZ HIT projects, their associated guidelines, as well as other erosion and sediment control guidelines such as Auckland Council's TP90 and TP233.

27. Minimising soil erosion on cultivated paddocks has four stages:

    1. Paddock assessment – risk management.
    2. Identifying and then stopping or controlling water entering the paddock.
    3. Implementing in-paddock control measures to minimise soil movement within the paddock.
    4. Managing the water that flows off the paddock.

28. Minimising erosion and sediment loss is about getting each of these four stages right. Within paddock measures without the planning and risk assessment could lead to unforeseen washouts, likewise within paddock measures without managing the paddock discharge water still leaves the paddock vulnerable at certain times like around cultivation and harvest.

HOROWHENUA SEDIMENT LOSS TRIAL

29. In 2009/10 eight sediment monitoring sites were established as part of a HortNZ investigation to provide a visual demonstration of whether or not, and if so in what situations, soil erodes from cultivated paddocks in Horowhenua.

30. Very little evidence of soil erosion was found; which is consistent with what most believe, that there is very few erosion problems associated with cultivated horticulture in the Horizons Region. We observed one instance of soil being captured by a silt fence after an overland flow path through cultivated ground. This type of overland flow path will most likely only carry water in significant rain events, and includes instances where stormwater is discharged onto cultivated land from adjacent properties or overtopping roadside drains. The situation can be mitigated through various measures set out in the Code of Practice for Commercial Vegetable Growing. Auckland Regional Council requires Erosion and Sediment Control Plans on an as needed basis using enforcement provisions, including abatement notices, requiring immediate action for any problem sites.

SEDIMENT CONTROL MEASURES – Rule 12-1

31. In the cultivation rule (12-3) proposed by Council the unintended consequence of removing any reference to sediment control measures such as benched headlands, bunding, silt traps, interception drains etc., may mean that these activities are captured by the land disturbance, Rule 12-1. Properties over 5ha are likely to have more than 2,500m^2 of headlands that need maintaining each year. If blading of headlands or other sediment control measures are treated as earthworks, the grower will need to apply for a consent. Perversely an Erosion and Sediment Control Plan will need to be prepared by an appropriately qualified person in order to maintain and install sediment control measures. This creates a further barrier to installing sediment control measures.

RIPARIAN 5m BUFFER

32. Mr Hindrup[7] states that the use of a 5m riparian margin around rivers as necessary to reduce sediment. While I agree that cultivation should not occur within 5m other ancillary structures and activities like bunds and benched headlands could occur within this 5m zone and result in a better outcome than simply requiring a 5m riparian margin.

33. My suggestion would be to have a 5m riparian margin unless other more effective sediment control measures are used. There needs to be the flexibility to adopt the most appropriate control measures and not have it stipulated in regulation. The paddock assessment, which is the first stage in the Code of Practice (para 29), will lead to different tools depending on the circumstances. Vegetated riparian margins are described amongst a suite of control measures.

34. On cultivated land, water runoff is channelised which will flow through riparian margins. Mr Hindrup[8] points to the evidence of Dr Quinn to justify the 5m riparian zone where research shows sediment trapping efficiency of at least 80% for all riparian margins of greater than approximately 5

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[7] Paragraph 129, page 36 in his evidence

[8] Paragraphs 148, 149 and 150, page 42.

metres. This is based on the conclusion in a review by Yuan et al., (2009) on the effectiveness of vegetated buffers on sediment trapping in agricultural areas. However most of the cited research in this review does not relate to cultivated agriculture. Where it does the Fasching and Bauder (2001) trial used sheet erosion and stated that the results were most likely better than in actual field conditions. Mankin et al., (2007) showed 98% reduction in sediment, however >75% of the sediment removal was due to infiltration alone. This will not be the case in practice where flows are channelised. Blanco-Canqui et al., (2004) found a 90% reduction in sediment after an 8m vegetated filter strip. In the treatments that used a 0.7m wide switchgrass barrier 91% of the sediment was trapped <u>in front</u> of the treatment. The barrier was the most significant measure, not the vegetated land that followed.

35. I contend that rather than supporting a blanket 5m riparian margin these results show that riparian margins are unlikely to be effective at minimising sediment entering water in actual field conditions. Other measures such as bunding (barriers) may be more effective and will result in less productive land being lost.

RECOMMENDED APPROACH

36. It is the development of the best management practice which is critical to achieving the desired outcome of minimising soil erosion and sediment loss from cultivated horticulture. This approach is supported by Policy 5-5:

> Supporting codes of practice, standards, guidelines, environmental management plans and providing information on best management practices.

37. As demonstrated through FSP, and advocated by Policy 5-5, best management practices jointly engage land owners, researchers and council in problem recognition and solution development. It is this process of all stakeholders learning together that not only results in solution development but also ensures ownership of the solution and subsequent implementation.

38. Unless Council and growers work together, regulating based on river water quality standards that only affect a

few and are not correlated to management practices will not ensure the best erosion and sediment control measures are implemented throughout the region.

A J Barber

17 February 2012

APPENDIX 1

CODE OF PRACTICE FOR COMMERICAL VEGETABLE GROWING IN THE HORIZONS REGION VERSION 2010/2 – JUNE 2010

Final Version of Part A: A Code Of Practice For Minimising Erosion On Cultivated Land.
Final Draft of Part B: Nutrient Management, subject to decisions on the proposed One Plan.

Code of Practice for Commercial Vegetable Growing in the Horizons Region

Best Management Practices for Nutrient Management and Minimising Erosion on Cultivated Land

Version 2010/2

June 2010

Horticulture™
New Zealand

Code of Practice for Commercial Vegetable Growing in the Horizons Region

Best Management Practices for Nutrient Management and Minimising Erosion on Cultivated Land

Version 2010/2

June 2010

Prepared by
Andrew Barber[1] and Lynette Wharfe[2]

Contributions and reviews by Paul Johnstone Plant & Food Research, Horticulture New Zealand and commercial vegetable growers

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INTRODUCTION

This Code of Practice incorporates two parts:

Part A: Soil and Erosion Management
Part B: Nutrient Management.

Part A is designed to provide a suite of tools that can be used by growers to meet requirements in the One Plan for use of appropriate management practices to minimise soil and water runoff as a result of cultivation activities.

Part B sets out nutrient management approaches that can be used to meet the requirements in the One Plan for nitrate leaching. Rule 13.X in the One Plan seeks that commercial vegetable growing in the specified water management zones demonstrate through a New Zealand GAP audit that the operation is compliant with New Zealand GAP Nov 2009 Version 5.0 nutrient management plan requirements by either meeting the standards specified in the Plan or the standards in this Code of Practice.

The use of the Code of Practice will assist in meeting all legal and industry requirements for soil and nutrient management. Legal requirements that need to be met include those required in the Horizons One Plan.

There are a range of vegetable growing activities throughout the Horizons Region in Horowhenua, Ohakune, Palmerston North, Rangitikei, Opiki and Wanganui. Key produce includes:

- Yams in Rangitikei
- Potato and onion growers in Opiki, Ohakune, Rangitikei and Horowhenua
- Carrots, parsnips, brussel spouts and swedes in Ohakune
- Kabocha in Lower Manawatu, Rangitikei and Tararua
- Fresh vegetables - such as brassicas, leafy vegetables, brussels sprouts and salad vegetables throughout the region – but predominantly in Horowhenua and Palmerston North
- Asparagus growers in Wanganui, Palmerston North, Bulls, Mangaweka, Levin, and Feilding
- Process vegetable growers in Tararua
- Seed potatoes in Lower Manawatu and Rangatikei.

How to use this Code of Practice

The Code of Practice sets out a range of best management practices which can be adopted as appropriate. It is not a *one size fits all* approach. Rather it presents a range of options that should be assessed by the grower to determine which is most appropriate in particular circumstances. For instance the tools used may vary across the region depending on the nature of the cropping activity, number of crops over a year, rotation, rainfall, topography, and soil types.

The aim of the Code of Practice is to provide information to growers on the range of possible tools and options to assist in achieving sustainable management of their land.

The critical thing is that you are assessing your paddocks and risks then using appropriate tools or methods that reduce those risks.

PART A: A CODE OF PRACTICE FOR MINIMISING EROSION ON CULTIVATED LAND

The Soil Resource and Approach in This Code of Practice

Soil is a critical resource for any commercial vegetable growing operation. Natural characteristics such as water holding capacity, soil nutrients, soil structure and biological activity all contribute to the success of a growing operation. When soil moves within or off a paddock, there can be a loss in productivity and profitability. Therefore retaining soil and its inherent characteristics is critical to the business of growing.

Several factors inherent to the business of crop production (e.g. cultivation, tractors working in the paddock, irrigation, rainfall and wind) mean there is considerable potential for soil movement and loss of important soil characteristics. When the soil moves off the property it is not only a loss to the grower, but also creates sediment which ends up on roads, in drains, streams, rivers and lakes. These flow-on impacts create costs which are borne by all.

This Code of Practice sets out a range of measures that will assist growers minimise erosion.

There are four steps:

1. Know your paddock – undertake a paddock assessment
2. Measures to stop or control water entering the paddock
3. Measures to control in-paddock movement of soil and water
4. Managing water and soil that moves off the paddock.

Each step is a progression in that it is easier to control water entering the paddock than it is to manage sediment laden storm water leaving the paddock.

The key to minimising soil movement is to know your paddock and identify the likely risks. A paddock assessment forms the foundation on which to implement measures that firstly stop or control water entering the paddock, secondly keep the soil on the paddock, and lastly minimise the quantity of soil that is discharged off the paddock.

Usually a number of measures can be easily implemented in a paddock to minimise potential soil movement. The measures you choose for each paddock will be influenced by factors such as the paddock topography, cropping system, resource availability and risk assessment of the property. In as much, they may differ from paddock to paddock.

Minimising erosion is about getting each of these four stages right. Within paddock measures without the planning and risk assessment stages could lead to unforeseen washouts. Likewise within paddock measures without managing the paddock discharge water still leaves soil vulnerable after cultivation and harvest.

There are a range of measures that can be used for each of these stages. This COP will describe these mechanisms. These guidelines are based on current grower and scientific knowledge. They will be updated as further research results become available, particularly through the work being undertaken as part of the Holding it Together (HIT) Project.

THE FOUR KEY STAGES TO MINIMISING SOIL EROSION

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 in-paddock 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. Managing water and soil that moves off the paddock to minimise effects

Ensure the accessway is <u>not</u> at the lowest point

Raised accessways / Bunds

Vegetated buffers / Riparian margins / Hedges

Silt fences

Stabilised discharge points and drains

Silt traps

1. PADDOCK ASSESSMENT

This is a critical step and should be undertaken for every paddock you grow in.

The assessment initially involves walking each paddock, mapping and identifying significant features (drains, culverts, slope, area, etc) particularly overland flow paths, where water is coming from and going to, and the location and type of existing control measures. Knowing the paddock history is invaluable. This first paddock assessment becomes the basis on which control measures are built as well as future updates planned (e.g. raising the access point).

1.1 Paddock Plan

Planning should be done on a paddock by paddock basis, building up to a whole farm plan. This will make it easier to identify soil erosion problem areas. Erosion control measures will then be better integrated with your whole farm system to have maximum impact.

Start the planning process by walking around each paddock – particularly when it is raining – and mark on a paddock map:

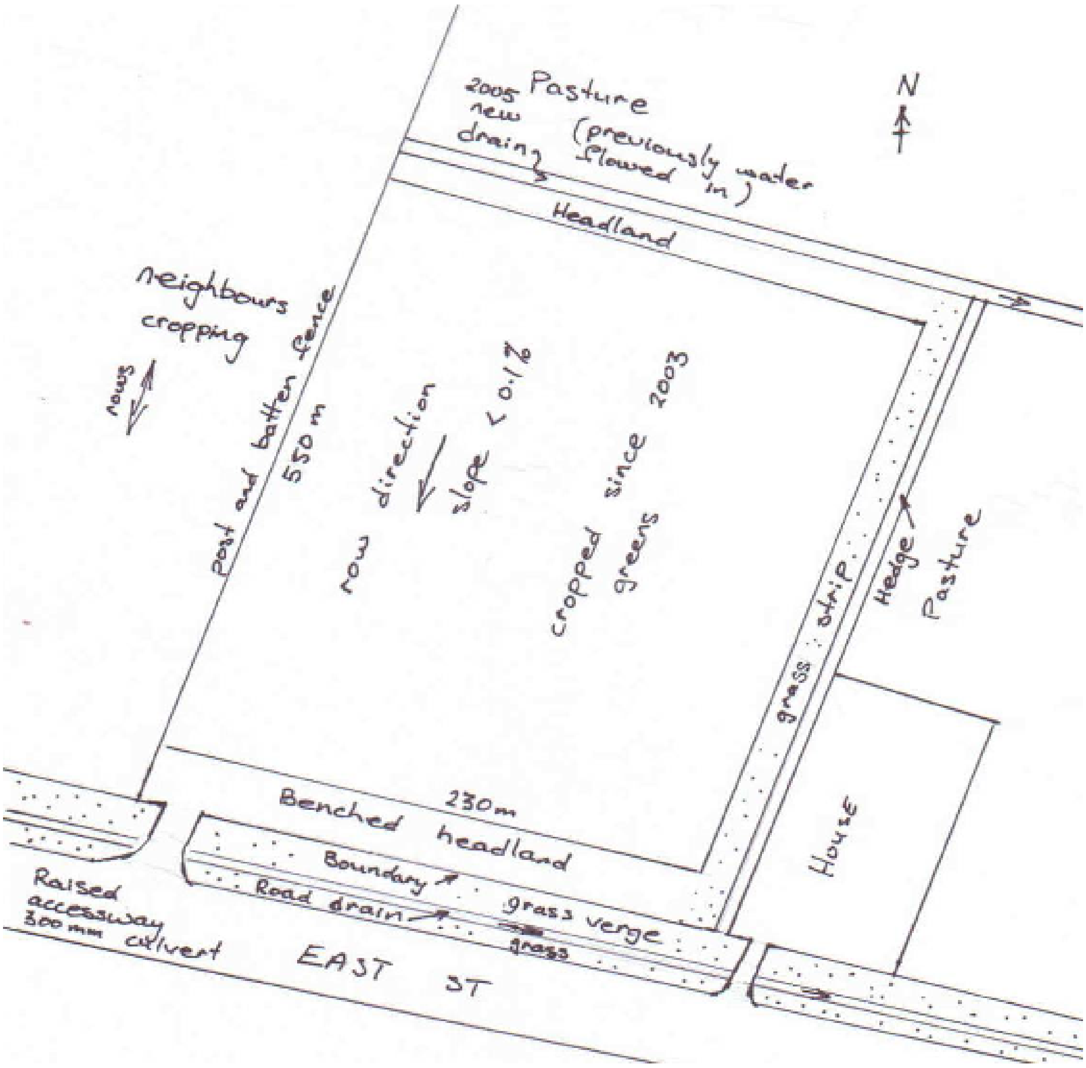
- Where water is coming from (e.g. roads, drains, buildings etc.)?
- Where water is going or should go? (e.g. any overland flow paths)
- Any existing erosion control measures?

Also on the map:

- Note the length of the sides of the paddock.
- Mark the direction and indicate the steepness of the slope in different parts of the paddock
- Mark any streams or drains and a setback margin

This map and information will be used to plan the most efficient and effective set of erosion management tools.

REMEMBER: If you fail to plan, you plan to fail



A paddock map should incorporate all physical dimensions as well as observations and comments from experience.

Coordinating erosion control practices

Soil lost from a paddock equals lost productivity. To protect the long term future of commercial vegetable growing businesses and the environment, it is important to keep soil where it is.

Drains overtopping can be one of the biggest causes of erosion. Coordination of drains and erosion control practices between neighbours and council is essential to minimise soil loss. Meet on site with them (particularly when it rains to see the problems firsthand) to talk through and agree on what needs to be done.

Also:

- Ensure all drains are linked
- Check that drains and culverts are large enough to cope with the volume of water
- Carry out regular drain maintenance
- Discuss with your neighbours linking the drainage systems and catchment sizes.

2. IMPLEMENT CONTROL MEASURES FOR STOPPING OR CONTROLLING WATER ENTERING THE PADDOCK

Identifying and then stopping or controlling water entering the paddock is crucial. Experience has shown that the most severe damage during a storm is caused where uncontrolled run-off enters the paddock as a result of overflowing drains. Inadequately sized culverts also significantly contributed to the problem of drains overflowing. Keeping water off the paddock using interception drains or bunds wherever possible is crucial. Where this is not possible, due to the contour, grassed swales through the otherwise cultivated paddock should be considered.

2.1 Interception Drains

These need to be built large enough to cope with the flow of water from the catchment above. Where the drain has a steep fall check dams should be used to slow water flow and minimise drain erosion. Drains need to be stabilised with vegetation or rocks otherwise they to become a source of sediment as they are scoured out.

2.2 Culverts

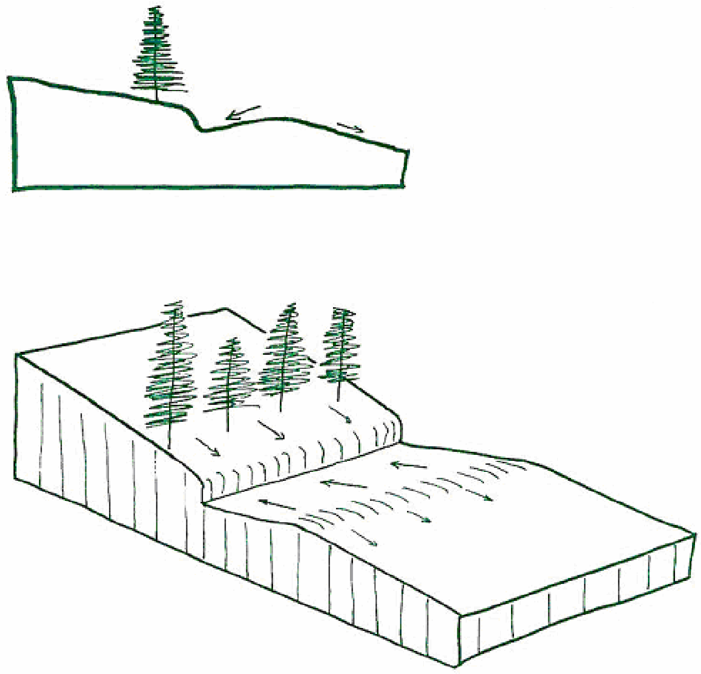
Culverts in drains are often undersized and either quickly block with debris and rubbish or simply can not cope with the volume of water and overtop. Like the drains themselves culverts need to be correctly sized and should have well formed headwalls. Generally the bigger the better. The drain at the discharge end of the culvert should be protected with rock to prevent scouring.

2.3 Benched Headlands

Modifying headlands is a simple and effective way of controlling and managing soil and water runoff from paddock rows, particularly wheel tracks (a major source of sediment). Often called 'benched' or 'contoured' headlands, the entire headland area is designed to direct water to the side of the paddock or to a drain within the paddock.

One option is to form a broad shallow 'V' shape, with the bottom of the 'V' between the headland and the end of the rows. A second option is to shape the headland away from the rows, sloping towards an earth bund. The headland is still used in the normal manner for access to planting, spraying and harvesting operations.

Grassing headlands are protected from scouring and encourages silt to drop out before entering surface drains.



Benched headland

The easiest way to construct a benched headland is using a grader blade. Once in place, particularly if it is grassed, the only maintenance is to clear deposited soil and reshape in dry conditions or if major scouring occurs.

Benched headlands are used to good effect in breaking up the length of long paddock runs. If constructed to a broad shallow design, a tractor can be driven across the headland.

When constructing a benched headland attention needs to be paid to:

- Where water from the benched headland is being directed, for example to a permanent drain which will carry it off-site in an effective manner
- Where silt will be deposited in the benched headland, and further down the drainage system.

Scouring of benched headlands can occur if:

- Excessive water volumes flow into a headland. Use contour drains across the field to reduce this
- Soil in the headland has not been compacted
- The slope of the headland is too steep, creating high water speeds during rainfall. Take measures to reduce volumes reaching the headlands by diverting water to drains or vegetate the headland to cope with the high water speed.

Check what happens when the water reaches the end of a headland and make sure the headland connects with a suitable control measure or stabilised discharge point.

2.4 Bunds

Rather than a drain an earth bund can be used to divert water away from a vulnerable cultivated paddock.

2.5 Grassed Swale (Controlled Overland Flow through the Paddock)

A swale is a surface drain that is often shaped into a shallow saucer. They are used to ensure water flowing along natural overland flow paths through cultivated areas does not cause significant erosion. Clean water can be directed along the swale, following its natural course, to a stabilised discharge point. Once formed the swale needs to be immediately stabilised with grass. The size is based on the catchment area above the paddock. As a minimum the swale should be at least 3m wide. The swale is shaped into a flat shallow saucer about 0.3m deep that can be easily driven across if it needs to intersect the cultivated rows.

A grassed swale may have prevented this damage (right). An interception drain could not be used to cut this water off due to the contour. The water entering the paddock was clean so does not need any further treatment if it passed over a grassed swale.

3. IN-PADDOCK CONTROL MEASURES FOR KEEPING SOIL ON THE PADDOCK

Implementing in-paddock control measures to minimise soil movement will retain and even improve soil structure. Although eroded soil caught in a silt trap can be redistributed back over the paddock, it is invariably in very poor condition and certainly no substitute for preventing it from moving in the first place.

The suite of measures used will predominantly be dependent upon the paddock slope. For example, flat paddocks will benefit from cover crops but contour drains would be of limited value, while even gently sloping paddocks may benefit from wheel track ripping. Work is planned to provide guidance on what paddock characteristics trigger different measures.

Within paddock control measures include the use of:

- Cover crops
- Wheel track ripping
- Wheel track dyking
- Contour drains
- Paddock length
- Cultivation practices including minimising passes
- Harvest management
- Postharvest management minimising the fallow period (with cover crops or grass)
- Wind break crops

3.1 Cover Crops

<u>What are cover crops?</u>

Green manure or cover crop describes any crop which is grown to be ploughed into the soil rather than harvested. This incorporation of a crop back into the soil is to improve soil quality, and long term production.

An emerging cover crop through the stubble of the previous crop.

Benefits

The use of cover crops is beneficial in all long-term cropping situations for three main reasons:

1. To stabilise soil from erosion and improves water penetration and drainage
2. To produce dry matter which improves organic matter and soil structure
3. To trap and cycle mobile nutrients from the previous crop

Other benefits of using cover crops include:

- Smothering weeds (can help reduce weed control costs)
- Improved soil fertility (improves productivity)
- Stimulating soil biological activity (e.g. earth worms) and assisting in breakdown of previous crop residues to reduce disease carry over and soil-borne diseases
- Providing a habitat for beneficial insects
- Fixation of nitrogen by some species

The use of cover crops suitable for the Franklin District was investigated by FSP on several grower demonstration sites to address issues of soil erosion, soil stability and nitrate leaching. Results are available in a fact sheet that can be downloaded from www.agrilink.co.nz/Technical-Reports.aspx

3.2 Wheel Track Ripping

Wheel track ripping increases rainfall infiltration rates and significantly decrease soil movement. Ripped wheel tracks allow water to percolate into the soil rather than flow down the wheel tracks.

Compacted wheel tracks can act as drainage channels. Shallow ripping of wheel tracks, to just below the cultivation compaction zone can reduce soil and crop loss.

Water flowing down the wheel tracks undermines the adjoining crop beds leading to extensive crop and soil loss. Where the wheel marks are ripped, water is able to soak downward into the soil with the result that little soil loss and no crop loss occurs.

Wheel tracks in the rows used for spraying should not be ripped, as the resultant loose track makes spraying difficult.

Ripped wheel tracks beside the unripped sprayer tracks (sprayer tracks are left unripped to ensure sprayer stability)

When any runoff reaches the bottom of the paddock, it needs to be dealt with by other soil erosion measures (e.g. vegetated buffers, silt traps etc). The easiest and most effective way to deal with this problem is to prevent runoff in the first place. Ripped wheel tracks minimise this runoff.

Why rip wheel tracks?

Trials have found that wheel tracks are the key zones for initiation of surface runoff and erosion.

Reduction of water movement along wheel tracks is the key to reducing erosion rates. In a Franklin trial, ripping wheel tracks increased the infiltration rate from 0.5 mm per hour to more than 60,000 mm per hour (Table 1). This reduced the movement of water down the wheel tracks. The erosion rate from the unripped tracks was 21.3 t/ha, compared to 1.1 t/ha on the ripped wheel tracks (Table 2). Ripping wheel tracks following planting was found to be the single most effective measure for reducing soil erosion within the paddock in the Franklin region.

Table 1 Infiltration rate (mm/hr)

Treatment	**June**	**October**	**January**
Uncultivated wheel track	0.5	12.7	77.2
Cultivated wheel track	60,312	12,456	8,582
Onion beds	411	485	907

Table 2 Erosion rate (t/ha)

Treatment	**Jun – Aug**	**Sept – Dec**	**TOTAL**
Uncultivated wheel track	16.7	4.6	21.3
Cultivated wheel track	0.98	0.13	1.1

Because the infiltration rates are so high in both the ripped wheel tracks and onion beds, runoff would only be generated if the capacity for the soil to store water is exceeded.

How to rip wheel tracks?

Wheel track ripping is carried out as soon as possible after planting. A shallow tyned implement pulled behind a tractor is used for this purpose. It has double leg subsoiler shanks with small wing bases, mounted behind the wheels on a straight toolbar. Weights attached to the middle of the toolbar help with penetration of the implement.

Wheel tracking ripping in action (above) and the small torpedo foot (insert).

3.3 Wheel Track Dyking

Dyking is a simple practice that creates a series of closely-spaced soil dams in wheel tracks (pictured below, right). These dams capture water in what amount to small indentations. Water can then soak into the profile, minimising runoff and any associated movement of soil and nutrients. As with wheel track ripping, dyking offers a practical solution to reduce soil erosion before it becomes a bigger issue.

The wheel track dyking implement in action (above) and small indentations along the wheel track can be seen filled with water (right). These slow the water down and settles the suspended solids. Water also has a longer duration to seep into the soil.

Why dyke wheel tracks?

Initial trials in the Horowhenua and Hawke's Bay have shown that dyking wheel tracks can be extremely effective in reducing runoff and soil and nutrient loss. In low and high rainfall events dyking eliminated runoff compared to undyked (standard) wheel tracks. This largely reflects the longer retention time water has behind soil dykes.

In dyked wheel tracks (left) there is no standing water after a winter rain event. By comparison, in undyked wheel tracks (right) water has ponded.

Dyking can have clear production benefits too. By eliminating the movement of water, ponding within paddocks can be minimised. Recent trials have shown just how costly this type of damage can be. In affected areas there can be total crop loss even as a result of only short-term ponding. Even where crops survive the initial ponding events, crop performance is still often affected. Importantly, there are few crops that like wet feet, especially during early phases of growth.

Areas that are affected by short-term ponding damage (foreground) can significantly reduce profitability

How to dyke wheel track?

Soil dykes are created by a propeller-like instrument. A ripper shank works immediately in front of the propellers both to loosen the soil to create the small soil dams and to allow quick drainage (see the previous section). There are several different designs available, though most create soil dams about every 30 to 45 cm. The equipment itself is pulled behind a tractor and is mounted to a standard straight toolbar.

The best time to dyke is when the soil has been recently worked. It is following this disturbance that soil is most at risk of moving. Soil dykes should be formed slightly below the top of the bed, so that if they overflow during extreme rainfall events the water will flow down the wheel track rather than across the bed. Don't dyke if the soil is too wet – damage to soil structure is likely to outweigh any potential benefits.

In some situations there may be value in reforming dykes several times during the season, where in others once will suffice. Sowing oats at the same time the wheel tracks are dyked can increase the stability of the soil dams, but is not essential. Wheel tracks in the rows used for spraying should not be dyked.

3.4 Contour Drains

Contour drains can be considered if the paddock is on a slope of 2% (equivalent to about 1° degree) or more.

Contour drains are temporary drains used to collect runoff water. They effectively reduce the length of rows that runoff water can flow down, by collecting water in shallow drains that run at a gentle gradient across the slope of the paddock. Water is then channelled into permanent drains or grassed alleyways. Contour drains also control the speed of runoff water when the correct gradient is used.

Contour drains MUST discharge into a permanent drain; otherwise the problem of erosion is simply shifted from within the paddock to the margins. The permanent drain must be capable of handling the volume of water discharged from the contour drains.

To work well, contour drains must be designed and constructed properly, taking the field's characteristics into account.

Contour drain spacing

The steeper the slope, the greater the number of contour drains needed.

Table 3 Contour drain spacing

Paddock slope	**Drain spacing**
> 10% (i.e. 10m rise per 100m length)	20m
3 - 10%	30m
< 3%	50m

As a general rule contour drains should never be more than 80m apart.

Getting the spacing of contour drains right is very important. Getting it wrong can actually create more problems than it solves. The golden rule is to avoid placing drains too far apart, as contour drains spaced too widely can overflow and CAUSE erosion.

<u>Contour drain slope</u>

It is important that contour drains are sloped correctly. If too flat they can silt-up or overflow, if too steep they become gauged-out. The best way to get the slope right is to survey the paddock to get the right fall in the contour drains.

Trials in Franklin have found a slope of 1.5 - 2.5% is appropriate for their clay loam soil. Trials in Tasmania found the best results at between 5 to 7% on their clay loam to clay soils and 0.5 to 2% on sandy soils. Local trials are required to localise the recommendations.

The most common fault seen with contour drains is that they are too steep and too far apart. To compensate for this they are often deeper than necessary and therefore become a hindrance to sprayers and other field equipment.

<u>Contour drain length</u>

For contour drains, shorter is definitely better. The longer the drain, the more likely it is to overflow. As a guide, the Kindred Landcare Group in Tasmania recommends that contour drains be no longer than 50m.

<u>Contour drain construction</u>

A clinometer, two equal length poles, an assistant and marker pegs should be used to mark out the placement of contour drains.

1. Stand at the top of the paddock halfway between the vertical drains on either side of the paddock or at the far side of the paddock if there is only one vertical drain.
2. Send your assistant to the edge of the paddock, their pole held upright.
3. Set the clinometer to the required angle. Rest it on your pole and look through it.
4. Ask your assistant to move down the paddock until the top of the poles line up with the hairline on your clinometer.
5. Peg both your and your assistant's position. This is the line for the contour drain.
6. Both move down the paddock 20 - 80m, depending on the paddock's characteristics, and repeat steps 3 and 4 and 5.

Once pegged out, drains can be constructed with a grader blade set on an angle. Soil should be pushed to the downhill side. Drains may need to be finished off by hand.

Contour drains should be put in immediately after sowing the crop - not the next week. It may be too late or may not get done at all.

3.5 Paddock Length

Row length is important if the paddock is on a slope of 2% (equivalent to about 1° degree) or more. If the rows are oriented up and down the slope, restricting row lengths to 200m is recommended, potentially broken with several contour drains. In longer rows the rate of water flow often increases, increasing the risk of soil erosion.

3.6 Cultivation Practices

Cultivation reduces the stability of most cropping soils over time. Adopting minimum tillage approaches or minimising the number of cultivation passes can be an effective means to reducing soil erosion.

The how, when and where cultivation is done can have a big impact on the erosion potential of your soil. Good cultivation techniques can increase productivity and help conserve soil and keep it in good condition for the future.

<u>Cultivation and row orientation should follow the land contour across, rather than up and down the slopes.</u>

This will slow down the speed that water runs off and reduce the volume of runoff by permitting more water to soak into the soil. The combination of these two factors can reduce the amount of soil moved off the cultivated area into the drains and streams.

<u>Paddocks should be cultivated in alternating directions in successive years to avoid moving whole fields downhill.</u>

The soil resource can take many years to rebuild once it is lost through erosion. The exposure of less fertile subsoils can require higher inputs of fertiliser (added cost) to maintain crop productivity.

<u>Excessive cultivation with rotary hoes should be avoided.</u>

Maintenance of good soil structure can actually reduce the costs of cultivation – for example, the number of passes needed to achieve the desired seed bed. Good soil structure also protects the health of the soil by allowing better aeration and drainage.

<u>Leave a setback strip or riparian margin between the cultivated area and any drains or streams.</u>

A riparian margin is a means of managing soil that moves off a paddock, but needs to be planned as part of the cultivation so that an adequate area is left uncultivated. Leaving an uncultivated strip forms a filter than can trap sediment in runoff and prevent it entering the waterway. Many Regional Plans require cultivation to have a setback distance from waterways, including Rule 12.3 in the Horizons One Plan.

Refer to Section 4.4 below for details and examples of setback strip and riparian margins.

Some dos and don'ts for soil cultivation

1. DO minimise the number of passes over the paddock wherever possible.
   Every cultivation pass results in the loss of some organic matter through decomposition and can have a detrimental effect on soil structure.

2. DO build organic matter level of your soils.
   Cultivation reduces organic matter. Building organic matter can be done with the use of cover crops (see the cover crop Section 3.1). Organic matter is critical for maintaining the stability of soil aggregates and reducing nitrate leaching. It also allows for easier preparation of seedbeds.

3. DON'T cultivate right up to the sides of drains or streams.
   This will only speed up the loss of soil from paddocks, block up streams and require more maintenance.

4. DON'T cultivate when the soil is too wet.
   The best way of reducing compaction and the formation of pans is to avoid being on the land when it is too wet. Compaction slows the infiltration of water into the soil and increases the risk of soil erosion.

3.7 Harvest Management

At harvest, operations should be carried out in a manner that has least adverse effect on the soil and water resources.

Working paddocks in wet conditions can lead to loss of soil structure, compaction and increased sediment loading in runoff. In addition to these effects, it can also increase wear and tear on plant and machinery, reduce labour efficiency, increase pressure on washing systems and increase product reject levels. Also, mud left on the road can create a traffic hazard as well as result in public animosity toward land users.

However, timing of harvest operations can be dictated by the demands of markets or factory requirement (process vegetables). This makes it difficult for growers to always operate under good soil and climatic conditions.

All-weather facilities should be established for loading and marshalling areas to prevent severe compaction, breakdown of soil structure, or any limitation to access.

Where required, metal should be used in gateways and loading pads. Load out may occur in an adjacent paddock.

3.8 Post Harvest Field Management

Where a new crop is not going to be immediately sown following harvest consideration needs to be given to paddock management to prevent soil erosion. One effective approach is to sow a cover crop such as oats.

Bare soil surfaces such as those that can occur in paddocks following harvest, are vulnerable to erosion caused by wind and rainfall. Establishing a cover crop soon after harvest can protect the soil and provide other advantages such as enhancement of organic matter in the soil, slow breakdown of soil structure and provide a feed resource for grazing. See Section 3.1 for a detailed description on the use of cover crops.

Where a cover crop cannot be established following harvest, contour cultivation should be considered so that the soil surface is broken up and left in a condition that avoids erosion.

Contour cultivation (right) can provide a similar effect to contour drains. Because crop management no longer needs consideration, there should be greater choice on where such cultivation occurs and whether the whole area is given a breaking up pass or at regular intervals across the slope.

Returning paddocks to pasture at regular intervals is an effective measure to build up soil organic matter and avoid the build up of pests, diseases and weeds. When returning pasture paddocks to cropping take care not to undo all of the good work by over cultivating or working the ground in less than ideal conditions.

Rotation of crops is well recognised as a good management practice. The length of the rotation and cropping practices will influence the extent of soil damage that can result from repetitive cropping. Pasture can be an effective ‘recuperation crop’ in the rotation. In some regions this should be used at a minimum every 7-8 years.

To gain the best recuperative effect from pasture in the crop rotation, the pasture needs to be carefully managed. Overgrazing, particularly at times when soil is vulnerable to pugging or drought, can negate many of the benefits that pasture can provide. Soils can erode or compact, which in turn can lead to increased levels of soil loss through sediment runoff or wind blow.

3.9 Wind Erosion - Wind Break Crops

Most of this COP has focussed on erosion caused by water; however wind in some areas can be equally as destructive.

In those areas where wind erosion is a problem sowing a wind break of oats, maize, or turnips to minimise wind blow.

Research has demonstrated that wind speed at the soil surface is one major determinant of when soil particles lift off the surface in windy conditions. Establishing wind breaks at regular intervals across the direction of the prevailing wind can ensure that wind speed is kept below that critical point.

Shelter can also lower evapotranspiration rate, which can slow down the onset of drought effects and reduce the need for irrigation.

Physical crop damage resulting from wind blow should not be underestimated either. Recent work in central Hawke's Bay showed that physical wind damage to a crop like onions can reduce total yield by as much as 20% by reducing individual bulb sizes.

4. MANAGING WATER AND SOIL THAT MOVES OFF THE PADDOCK TO MINIMISE EFFECTS

Managing the water that flows off the paddock is about minimising the quantity of soil that enters the wider environment and ensuring that water is discharged in a controlled co-ordinated manner. Water is either kept clean by diversion around the paddock or over a stabilised grassed swale, or it is treated and then discharged. Effective treatment relies on a sufficient time for soil to settle out.

Managing water leaving the paddock can be achieved using:

- Raised accessways and ensuring they are <u>not</u> at the lowest point
- Benched headlands
- Bunds
- Vegetated buffers, riparian margins and hedges
- Silt fences
- Stabilised discharge points and drains
- Silt traps

4.1 Raised Accessways

Raised accessways should form part of your co-ordinated sediment control practices. All runoff can then be managed and treated before leaving your property, stopping the loss of valuable soil from paddocks onto roads and into waterways.

An accessway raised with metal (right) that directs water flowing down the track into a silt trap. Note behind the silt trap is an earth bund protecting the paddock above that detains water along the length of the bottom headland before discharging out a snorkel into the roadside drain.

Remember – accessways are there to provide for vehicle crossings, not for soil in storm water.

The following practices, well planned and used together, will avoid or minimise soil losses from accessways:

1. Position them away from lowest point
   Never place accessways at the lowest point of the field where water is naturally diverted or concentrates. This may mean “off-setting” it as little as 2m from the bottom corner.
2. Raised accessways
   Raise the actual accessway above the surrounding area to divert water into your drainage system. This may be as simple as using a load of metal to form a hump over the accessway (see photo above).
3. Check point
   Use the accessway as a check point where you can spend a few minutes removing soil that has become stuck to the tractor. Soil is a valuable resource. Don’t leave it on the road as you drive away. Keep it for your crops.
4. Culvert
   All accessways that go directly onto a road should be piped. The size of the pipes/culverts is important – the BIGGER the BETTER.

4.2 Benched Headlands

See the detailed description Section 2.3.

4.3 Bunds

Earth bunds are often constructed along the edge of a paddock to both keep overland flow off the cultivated paddock as well as prevent runoff from discharging straight off the paddock. Bunds constructed on the contour at the bottom of a paddock can form a ponding area that will hold runoff long enough to allow sediment to drop out of suspension prior to discharge. They can also divert runoff into other silt control devices such as silt traps. Vegetating bunds will improve their stability.

An earth bund prevents water spilling in an uncontrolled manner from the paddock into the roadside drain below. The cultivated paddock has been pulled back to allow silt detention along the full length the paddock without having to drive tractors into this detention area.

4.4 Vegetated Buffers, Riparian Margins and Hedges

Vegetated buffer strips and riparian margins - strips of land adjacent to waterways, filter water by slowing down the flow of water allow the sediment to settle out. They should be at least 3 to 6m wide (work is planned to provide more guidance on these distances). There is the issue of what to do with the trapped sediment as it builds up over time. Digging it out is likely to take the vegetation with it while leaving it often means it is susceptible to further erosion.

A wide grassed riparian margin protecting a stream in Ohakune (left). Below this recently cultivated paddock is protected by the dense grass buffer left alongside the fence.

Headlands set back from the fenceline (right and below) with a wide crop strip running alongside the fence acts as both a barrier to soil moving off the paddock (vegetated and raised beds) and provides room for tractor implements to swing around in.

Well maintained hedges can act as barriers that catch silt before it can leave the paddock. Their application is often to stabilise earth bunds and along benched headlands. Hedges are only part of the erosion control system and need other control measures in place to complement their benefits.

Ensuring the hedge is continuous is vital as gaps will allow both water and silt to move through unchecked. To avoid this, gaps should be filled with new plants encouraging the hedge to grow together.

4.5 Silt Fences

Generally silt fences are considered a temporary measure for trapping sediment-laden runoff. They are often an effective means of demonstrating the quantity of soil that is being lost from a paddock. Inasmuch, they can serve as a means of justifying a more permanent, well constructed silt trap.

In cultivated growing situations super silt fences are most appropriate. These use a geotextile fastened to a wire fence (e.g. chain link fence). Regular wind or weed matting cloth is not suitable because these materials do not have good filtering characteristics or high flow rates. Details on suitable geotextiles can be found at www.permathene.com/htm/erosion.shtml

Detailed construction guidelines can be found on the ARC website's technical publications page www.arc.govt.nz/plans/technical-publications/technical-publications/technical-publications_home.cfm. Either TP90 or TP223 sediment control for forestry, are excellent guides showing a very wide range of erosion control measures. The TP90 silt control specific guideline is TP90 Part B 2B.

4.6 Silt Traps

Silt traps impound runoff water and ensure sufficient time for the suspended soil to settle. Volume is the key attribute.

Whenever possible:

1. Break the paddock into smaller catchments with their own treatment measures and silt trap.
2. Treat runoff from a catchment only once, and discharge it from the paddock into a stabilised drain.

Silt traps work best in combination with other practices that reduce the amount of soil reaching the traps. Silt traps alone are not the only means of controlling soil loss, but are part of an overall system.

Full construction details can be found in the ARC technical publications referenced above or in the factsheet developed for FSP that can be found at www.agrilink.co.nz/Technical-Reports.aspx

A silt trap with the blue snorkel (right) in the foreground for slowly decanting the trap. A mustard cover crop is planted in the immediate paddock along with many of the paddocks in the background.

CHECK LIST OF KEY POINTS FOR EROSION AND SEDIMENT CONTROL

1. Use several measures
2. Minimise soil movement within the paddock
3. Manage water movement across the cropping area
4. Take action.

PART B: NUTRIENT MANAGEMENT

Management of nutrients is a critical part of the crop production system.

Each individual crop has specific nutrient requirements. The fertiliser applied should be appropriate for the crop and cultivar type to prevent over application of nutrients. Crop calculators should be utilised to identify requirements.

A nutrient management plan should be in place for the use and application of fertiliser and any other inputs such as compost. The Code of Practice for Nutrient Management should be used to develop the nutrient management plan.

The Code of Practice for Nutrient Management can be accessed free from www.fertresearch.org.nz/code-of-practice/nutrient-management-planning

A nutrient management plan is a written plan that describes how the major plant nutrients (nitrogen, phosphorus, sulphur and potassium, and any others of importance to specialist crops) will be managed. The nutrient management plan aims to optimise production and maximise profit from nutrient inputs while avoiding or minimising adverse effects on the environment, such as leaching to groundwater and eutrophication of water bodies.

A good nutrient management plan:

- Ensures that nutrient management meets all legal and industry requirements
- Includes a nutrient budget which compares nutrient inputs from all sources with all nutrient outputs
- Achieves desired changes in nutrient levels and production (e.g. altering soil nutrient status to suit the crops)
- Minimises the cost of supplying nutrients and avoids wasted spending on unnecessary or unused nutrients
- Minimises the risk of damage to the environment
- Considers the grower's personal objectives.

The nutrient management plan is required by New Zealand GAP and should be developed and recorded on an annual basis. The nutrient management plan includes using Overseer® nutrient budgeting for each crop to determine crop nutrient requirements and leaching.

Regional Council requirements

NOTE: The requirements set out below are subject to decisions on the Proposed One Plan by the Hearing Commissioners. This part of the Code will be amended to reflect those decisions when they are available.

Because of the environmental effects from nutrients getting into water bodies regional councils require measures to ensure that this does not happen. The application of fertiliser is classified as a 'contaminant' under the Resource Management Act and when applied to a paddock it is classed as a 'discharge'. This discharge needs to be provided for in a Regional Plan.

Horizons One Plan has requirements relating to nutrient management for commercial vegetable growing.

The application of fertiliser is addressed in Rule 13-2 as a permitted activity subject to conditions in those parts of the Region that are not in a Target Water Management Zone (Refer to Table 13-1 of the One Plan).

In priority water management zones (such as Ohakune and Horowhenua) application of fertiliser is a permitted activity under Rule 13.X (yet to be included in the One Plan) if it meets one of the following conditions:

The activity shall demonstrate through a New Zealand GAP audit that the operation is compliant with New Zealand GAP Nov 2009 Version 5.0 or New Zealand GAP (GLOBALGAP equivalent) nutrient management plan requirements by either:

- Meeting the specified standards in Table 13.Z (yet to be included in the One Plan) of the One Plan. This is based on an <u>average</u> over the whole *crop rotation* including a pasture phase where applicable.

OR

- On <u>average</u> over the *crop rotation* (<u>excluding</u> the pasture phase) no more than 115 kg/N/ha/year will be applied; and
- No more than 250 kg/N/ha/year shall be applied in any one year.

OR

- The *total amount of nitrogen applied* shall not exceed 200 kgN/ha/year; and
- A single application of nitrogen shall not exceed 120 kgN/ha

The *crop rotation* is the period of time that is required for the full sequence of crops, including pasture, to be grown in a paddock.

The *total amount of nitrogen applied* includes all forms of nitrogen in fertiliser, animal manure or effluent, mulch and compost. It does not include soil nitrogen mineralisation.

Where a paddock is leased, the responsibility for the nutrient management plan and meeting the requirements of this Code lies with the lessee.

Where a paddock is managed by the lessee only for the use of the crops, and not the pasture part of the rotation, the nutrient management plan can only account for that part of the rotation over which the grower has management responsibility.