BEFORE THE HEARING COMMISSIONERS

IN THE MATTER	of the Resource Management Act 1991 ("**the Act**")
AND	
IN THE MATTER	of the Resource Management Act 1991 and the Environment Canterbury (Temporary Commissioners and Improved Water Management) Act 2010
AND	
IN THE MATTER	of the hearing of submissions on the Variation 2 to the Proposed Land and Water Regional Plan

STATEMENT OF EVIDENCE BY LYNETTE PEARL WHARFE FOR HORTICULTURE NEW ZEALAND

15 MAY 2015

[redacted] ATKINS | HOLM | MAJUREY

Helen Atkins
PO Box 1585
Shortland Street
AUCKLAND 1140

Solicitor on the record Helen Atkins Helen.Atkins@ahjmlaw.com (09) 304 0421

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QUALIFICATIONS AND EXPERIENCE

1. My name is Lynette Pearl Wharfe. I am a planning consultant with The AgriBusiness Group. I have a BA in Social Sciences and post graduate papers in Environmental Studies, including Environmental Law, Resource Economics and Resource Management.

2. I am an accredited commissioner under the Making Good Decisions programme with Ministry for the Environment.

3. I have been a consultant with The AgriBusiness Group since 2002. The Agribusiness Group was established in 2001 to help build business capability in the primary sector.

4. I have spent over 16 years as a consultant, primarily to the agricultural industry, specialising in resource management, environmental issues, and environmental education and facilitation.

5. In my years as a consultant I have worked primarily in the rural sector across a range of projects and clients, including 15 years of providing advice to Horticulture NZ and its precursor organisations NZ Vegetable and Potato Growers Federation, NZ Fruitgrowers Federation.

6. I have been involved as a consultant to Horticulture New Zealand on Variation 2 (Hinds) of the Proposed Land and Water Regional Plan for Canterbury contributing to the submission and further submissions.

7. I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise, except where I state I am relying on what I have been told by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

8. This evidence provides a planning assessment of those provisions on which Horticulture New Zealand submitted and addresses the Section 42A report prepared by Environment Canterbury and dated 23 April 2015.

APPROACH TAKEN IN VARIATION 2

9. Variation 2 has been developed through a collaborative planning approach resulting in the ZIP Addendum setting out the 'solutions package' for the Hinds catchment.

10. The background to the Zone Committee and its role in the process is set out in Section 3 of the s42A Report.

11. The Variation is designed to deliver the outcomes sought by the Zone Committee.[1]

12. The s42A Report considers that the solutions package is a *relatively delicate balance*[2] of a range of activities and mitigations that encompass:

    (a) Enabling activities

    (b) Mitigations (both regulatory and non-regulatory)

    (c) Improvements in on-farm practice

    (d) Range of limits and targets

    (e) Different treatment of different sectors

13. The s42A Report expresses concern that changes sought by submitters will *likely upset this balance* and the overall achievement of the outcomes are *often put at risk.*[3]

14. The report then states:

> *The Zone Committee has arrived at its solutions package on the basis of a collaborative planning process that has involved the community and industry and other groups. Therefore I am hesitant to recommend significant departure from this solutions package.*

15. This position is reflected in recommendations throughout the s42A Report, which essentially seeks to 'give effect to' the solutions package and retain the 'balance' as notified.

16. Policy 4.9 in the pLWRP sets out how reviews of the sub regional sections will be undertaken. Clause c) requires:

    Have particular regard to collaboratively developed local water quality and quantity outcomes and methods, and

[1] Pg 6 Ashburton ZIP Addendum Hinds Plains Area March 2014

[2] 9.8 Variation 2 pLWRP – Section 42A Report

[3] 9.9 Variation 2 pLWRP – Section 42A Report

timeframes to achieve them, including through setting limits and targets.

17. The policy seeks that 'particular regard' be given to the collaborative planning process outcomes. It does not limit the ability to of the Council to amend the Variation as a result of submissions and evidence.

18. While the solutions package may be considered to represent a *balance* it does not mean that it is the only balance between the range of competing interests that could be reached.

19. The submissions process and hearing of evidence provides an opportunity to reassess the range of interests and the package that will meet the outcomes sought for the Hind/Hekeao Plains Area, while still ensuring the viability of those who undertake activities in the area.

MY UNDERSTANDING OF HORTICULTURE NEW ZEALAND'S SUBMISSIONS

20. The Horticulture New Zealand submission on Variation 2 and evidence of Angela Halliday identify a number key matters for the horticultural sector:

    (a) The horticulture sector in Hinds/ Hekeao Plains Area is small, but none the less important in terms of contribution to horticulture production in Canterbury.

    (b) Horticultural operations can vary from year to year and season to season, with rotations and leased land being components of the operations.

    (c) The operations may be either operator on one property or across a number of properties, either leased or owned. The latter are regarded in the Variation as 'farming enterprises' as defined in the pLWRP.

    (d) Many of the operations currently have relatively low nutrient loss rates and the provisions unfairly penalise such operations.

    (e) The Variation is primarily focussed on dairy and dairy support as these have been identified as the key contributors to nutrient loads in the catchment.

(f) The resulting framework leads to challenges for existing growers to operate.

(g) There are a number of uncertainties which contribute to the challenge of being able to meet the requirements of the Variation, including uncertainties in the science-based approach and modelling.

(h) That there is new nutrient allocation 30,000 hectares but it appears that it is unlikely to be available to growers outside of the consented irrigation schemes, thereby limiting potential to change land use or increase nutrient baselines.

21. These matters are reflected in the submission seeking changes concerning:

- Nutrient management framework
- The policy and rule framework
- Land use change
- Activity status
- Farming enterprises
- Timeframes for implementation
- Reliability of water takes
- Schedule 24a

These matters are addressed below in this evidence.

22. In the Appendix to this evidence I have included a table of the all the Horticulture New Zealand submissions which sets out my position in relation to each submission. Horticulture New Zealand also submitted an extensive number of further submissions. As no formal summary of further submissions is available I have not provided a similar table for further submissions. I will address any specific relevant further submissions in this evidence but the main response to further submissions will be appropriately considered in my rebuttal evidence as Horticulture New Zealand's position will be affected by what submitters are saying about its position in their evidence.

HOW VARIATION 2 REQUIREMENTS FOR NUTRIENT MANAGEMENT WOULD APPLY TO VEGETABLE, FRUIT AND BERRY GROWERS

23. To understand how Variation 2 would apply to a growing operation a number of steps need to be taken to determine which rules would apply. In this section of my evidence I have undertaken a synopsis of the rule framework and assessed it to see how it may apply practically to a horticulture operation in the Lower Hinds area outside of an irrigation scheme.

24. **Step 1 – Identify nutrient baseline.** This step is based on the definition of nutrient baseline in the pLWRP and requires:

    (a) The modelling of nitrogen below the root zone using OVERSEER® or an equivalent model approved by the Chief Executive of Environment Canterbury.

    (b) Data for four years from 1 July 2009 – 30 June 2013 and averaged over that time frame.

    (c) If OVERSEER® is updated the most recent version is to be used for recalculate the nitrogen baseline using the same input date for 1 July 2009 – 30 June 2013.

25. As stated in the evidence of Stuart Ford for Horticulture NZ there are challenges for growers in meeting step 1 of this process, including that not all crops are in OVERSEER® so approval for an equivalent model would need to be sought, In addition there are issues with the variation between versions of OVERSEER® and also the requirement for four years of data from 2009 -2013.

26. **Step 2 – Identify nitrogen loss calculations for the property as set out in the definition for nitrogen loss calculations in the pLWRP**. This requires:

    (a) Modelling of the discharge of nitrogen below the root zone on OVERSEER® or an equivalent model approved by the Chief Executive of Environment Canterbury;

    (b) Averaged over the most recent four years 1 July – 30 June;

    (c) If OVERSEER® is updated the most recent version is to be used.

27. As with Step 1 there are challenges with the use of OVERSEER® and meeting the requirements to establish the nitrogen loss calculation.

28. **Step 3 – Is the operation to be classified as a 'farming enterprise?'** If so, Rule 13.5.18 will apply as a discretionary activity. No permitted or controlled activity status applies, even if the operation has a low nutrient loss calculation. The nutrient loss calculation and nutrient baseline need to be established for each parcel of land in the farming enterprise and aggregated across the farming enterprise.

29. Rule 13.5.18 has no timeframe included so applies immediately, (subject to section 20A RMA which applies to existing uses under regional planning provisions) where as other rules apply from 1 January 2017, thereby creating a harsher regulatory regime for farm enterprises.

30. **Step 4 – Non-farming enterprise operations need to determine the activity status until 1 January 2017**:

    (a) Does the nitrogen loss calculation increase above the nitrogen baseline; and

    (b) Is a Farm Environment Plan or Schedule 34a practices implemented?

    If the response to a) is ***yes*** then the activity is prohibited under Rule 13.5.20 and consent cannot be applied for.

    If the response to b) is ***no*** then consent for a non-complying activity is required.

31. The immediate step to prohibited activity status if a) is not met, before the requirements in Policy 13.4.13 apply and good management practices implemented, is harsh as it provides no time for improvements to be made to reduce the nitrogen loss calculation.

32. **Step 5 – Non-farming enterprises need to determine activity status from 1 January 2017** based on the nitrogen loss calculation and whether it is less than or exceeds 20kg per hectare per year.

    (a) If the nitrogen loss calculation is 20kg per hectare per year or less then Permitted Activity Rule 13.5.16 may apply;

(b) If the nitrogen loss calculation is over 20kg per hectare per year then Restricted Discretionary Activity Rule 13.5.17 may apply.

33. **Step 6 – Permitted Activity Rule 13.5.16**. To meet the permitted activity conditions:

(a) The nitrogen loss calculation must not exceed 20kg per hectare per year or less **AND**

(b) The nitrogen loss calculation must not increase above the nitrogen baseline **AND**

(c) Schedule 24a practices are implemented **OR**

(d) A Farm Environment Plan is prepared, implemented and provided to ECAN.

If b) cannot be met then the activity is prohibited and consent cannot be applied for.

If c) or d) are not met then consent for a non-complying activity is required.

34. The approach in Rule 13.5.16 means that a permitted activity defaults to prohibited if the nitrogen loss calculation increases above the nitrogen baseline. This effectively caps the operation to the 2009-2013 baseline, even though the nitrogen loss calculation is less than 20kg per hectare per year. Given the rotational and variability of horticulture operations there could be variation in the nitrogen loss calculations but the rule framework provides no flexibility for such situations even though the operation is a low leacher at 20kg or less.

35. Rule 13.5.14 may assist in that discretionary consent could be sought for up to 27 kg per hectare per year, but the property would need to be provided within the 30,000 hectares of land for intensification set out in Table 13 i). The s42A Report (Para 9.295) identifies that this area of land is effectively allocated through existing consents so unless the grower is in one of the relevant irrigation scheme areas, then consent could not be granted.

36. **Step 7 – Restricted Discretionary Rule 13.5.17.** To meet the restricted discretionary activity conditions:

(a) The nitrogen loss calculation is greater than 20kg per hectare per year or less **AND**

(b) The nitrogen loss calculation must not increase above the nitrogen baseline **AND**

(c) A Farm Environment Plan is prepared in accordance with Schedule 7 Part A.

There are matters of discretion listed.

If b) cannot be met then the activity is prohibited and consent cannot be applied for.

If c) is not met then consent for a non-complying activity is required.

37. Discretionary consent under Rule 13.5.14 would also apply but has the same limitations as set out in 5.12 above.

38. In all cases, from 1 January 2017, implementation of good management practices as set out in Policy 13.4.13 a) is required with the nitrogen loss rate to be no more than reasonably expected, based on baseline land uses, which is defined as land uses on a property between 1 July 2009 and 20 June 2013.

39. This framework presents considerable challenges to growers and is the basis for the submissions made by Horticulture NZ seeking changes to Variation 2.

NUTRIENT MANAGEMENT FRAMEWORK

40. The nutrient management framework in Variation 2 is based on the scientific modelling to establish the load calculations.

41. The evidence of Nic Conland (Para 22- 31) raises issues and uncertainties with how the scientific modelling has been undertaken. In his opinion the consequence is that the load calculations are also considered to be uncertain, with the flow on effect to the allocation framework and how nutrients are managed in the area.

42. Mr Conland supports the scenarios undertaken as part of the collaborative planning framework but is concerned about the outcomes, given the "ability of the combination of models used by ECan to represent the connections between the implementation of policy on physical outcomes for the catchment and the dynamics of the movement of flow and nutrients through the catchment via surface and groundwater flow paths." (Para 31)

43. In his Conclusion (Para 61) Mr Conland raises five questions that he considers need to be answered to determine setting an allocation limit to manage catchment inputs and achieve the groundwater and surface water objectives.

44. It was for these reasons of uncertainty that Horticulture NZ sought that a review of the framework and limits to ensure that they are appropriate and that the plan be regarded as 'interim' until such time as the review was completed. A number of other submitters sought a similar approach.

45. The s42A Report does not support such an approach on the basis that the technical advice from the council scientist is that the limits and targets are appropriate. (Para 9.139)

46. While the Variation has been developed through a science informed collaborative planning process I consider that the matters identified by Mr Conland raise significant questions that need to be answered and so support the need for further modelling to ensure that the provisions in the Variation are robust and agreed.

47. While such a review is being undertaken the Variation should be regarded as 'interim' and timeframes adjusted accordingly.

48. The Horticulture NZ submission sought a policy framework to enable the Plan to be an interim plan until the review is undertaken.

49. The s42A Report (Para 14.5) notes the submission but seeks further information about the relief sought.

50. I consider that the Horticulture NZ submission is clear about the reasons for seeking an interim plan:

    (a) Uncertainty regarding Good management practices; and

    (b) Uncertainty in the modelling on which the loads and limits are based and the need for further modelling.

51. Such an approach does not mean that progress toward reducing nutrient loads is put on hold. Rather it enables progress to occur pending further information and ensuring that the resulting plan is robust and contains appropriate loads and limits.

52. On the basis of such uncertainty I support the approach to regard the plan as an interim plan and seek that the policy sought by Horticulture NZ be included in the Plan.

53. The other aspect of the nutrient allocation framework is how the limits and loads are managed in the Plan. The s42A Report describes the nutrient allocation framework in Variation 2 as a 'hybrid of different approaches' (Para 9.20).

54. At para 9.155 this is explained further:

> *There is a subtle change in this Variation, in that the LWRP concept of grandfathering, or a rule regime based on previous land use, has been significantly modified, to the extent that in some ways it is closer to an equal allocation model. The rule regime in Variation 2 clearly targets the greatest level of reduction being required from those farming sectors that have been modelled to have the highest loss rates.*

55. The approach has led to a number of submitters seeking alternative nutrient management frameworks. It is anticipated that submitters will provide more detail on the alternative frameworks in evidence.

56. Horticulture NZ is concerned about aspects of the framework that limits opportunities for growers who are currently undertaking low leaching activities and have limitations imposed on land use change and so is supportive of modifications or changes that would address this matter would be appropriate.

57. Such an approach is consistent with the statement in the s42A Report above (Para 9.155) where allocation in Variation 2 has moved away from being based on previous land use or grandfathering.

58. In the absence of details on all the alternative approaches Horticulture NZ will evaluate those presented in evidence and address in rebuttal evidence.

59. I concur with that approach as it enables all alternatives to be considered side by side and will assess the planning implications when the evaluation has been undertaken.

60. The Horticulture NZ submission sought that a new policy be added to provide for a transfer regime for nitrogen. The evidence of Stuart Ford supports this approach as an important component in being able to achieve the outcomes sought for the Hinds Plains Area.

61. The s42A Report notes the submission at 9.342 but does not address it in the following discussion.

62. Given the challenges that will exist in achieving the targets in the Variation I consider that all possible tools should be used to achieve those outcomes, including the use of a transfer regime.

THE POLICY AND RULE FRAMEWORK

63. Key concerns that Horticulture NZ have identified with the policy and rule framework relate to:

    (a) Establishing baseline land use

    (b) Deriving nutrient baseline and limiting operations to that baseline

    (c) Use of OVERSEER®

    (d) Use of Good Management Practices

64. The use of OVERSEER® and Good Management Practices have been addressed in the evidence of Angela Halliday and Stuart Ford.

65. Given their evidence I consider that there needs to be caution in the use of these tools in the regulatory framework as proposed.

66. In the synopsis of the rule framework in section 5 of this evidence it is apparent that the rule framework lacks flexibility for land uses, and recognition of the rotational nature of some horticultural operations, even if they are currently undertaking operations that have low nutrient loss calculations. These operations are limited because:

    (a) They are tied to the land use in that was on the property between 1 July 2009 and 30 June 2013;

    (b) They are tied to the nutrient baseline from 1 July 2009 and 30 June 2013;

    (c) The good management practices to be adopted are linked to the baseline land use.

    (d) There is no recognition of the rotational nature of horticulture operations and hence variability in nitrogen loss calculations.

67. The submission by Horticulture NZ sought that the definition of baseline land use be amended to provide for horticultural crops over the crop rotation and farm enterprises and inclusion of a policy to enable reconsideration of nutrient baselines:

> *Amend the definition of Baseline land use: means that land use, or uses, on a property or farming enterprise either between 1 July 2009 and 30 June 2013, or for horticultural crops over the crop rotation, and used to determine the 'nitrogen baseline' as defined in section 2.9 of this Plan.*
>
> *Add a new policy: The nitrogen baseline for a property or enterprise can be reassessed where it can be demonstrated that the 4 years 2009-2013 do not accurately reflect the nature of the operation.*

68. Essentially the nutrient baseline and baseline land use is contingent on what stage of the crop rotation was being undertaken between 2009 and 2013. That may, or may not, have been the highest leaching part of the rotation. If it happened to be the highest leaching part of the rotation then the grower is fortunate. However I do not consider that 'luck' is a strong basis for a fundamental tool in the Plan.

69. The s42A Report addresses the definition of baseline land use at Para 9.192 – 9.210 and recommends that the definition be retained as notified.

70. I note that the decisions on Variation 1 include farming enterprises in the definition of baseline land use, as is sought by Horticulture NZ for the Hinds Plains Area.

71. It is also noted that the decisions on Variation 1 have included a new Policy 11.4.12A that enables reconsideration of the nitrogen baseline.

72. I support the submissions of Horticulture NZ to include provisions that enable a robust calculation of baselines on which the plan is founded. Such changes include amending the definition of baseline land use and a new policy to provide for a reassessment of nutrient baseline when it can be demonstrated that the 4 years 2009 – 2013 do not accurately reflect the nature of the operation. Such an approach will not increase the effects on the environment from what is currently occurring. Rather it better recognises the existing activities which the baselines are intended to reflect.

LAND USE CHANGE

73. The policy framework in Variation 2 severely limits the potential for any land use change to occur in the catchment unless it is to a lower leaching farming activity.

74. The evidence of Nic Conland has identified that there are areas suitable for potential land use change and intensification.

75. The only option for intensification of land use is the 30,000 hectares which the s42A report notes is all effectively allocated through irrigation scheme consents (Para 9.295)

76. Rule 13.5 14 provides for use of land where the nitrogen loss calculation will be less than, or equal to, 27kg per hectare per annum. However if condition 2 relating to not exceeding 30,000 hectares is unlikely to be met unless a grower is in an irrigation scheme.

77. Therefore the ability to change land use is limited to activities that do not exceed the nitrogen baseline. Where this baseline is low then the options are very limited.

78. I consider that it is inequitable that landowners who cannot meet condition 2 of Rule 13.5.14 are penalised by not being able to apply for consent for activities that increase the nutrient baseline, even to a low level, such as less than 20kg.

79. The s42A Report (Par 9.297) recognises that:

> *…there is an overriding need to provide for additional economic development in the Hinds/ Hekeao Plains Areas through enabling a moderate level of intensification.*

80. I would concur with that statement. However the intensification provided for is not contestable as it is already committed. Essentially it is 'a fait accompli.'

81. Some of the opposition to the provision for intensification is because it is seen to be inequitable to allow intensification when other operations are having to reduce nitrogen leaching rates.

82. However Horticulture NZ's opposition is based on the inequity of not enabling lower leaching operations to intensify beyond the nutrient baseline. This has significant implications for the leasing of land and rotational cropping systems as

demonstrated in the statement of evidence provided by Hamish McFarlane.

83. If the allocation framework is more an equal allocation model as described in the s42A Report (Para 9.155) rather than based on existing land use or grandparenting, then it is questioned why there is a cap on low leaching activities to the nutrient baseline.

84. The Horticulture NZ submission sought that "on a maximum of 30,000 hectares of land" be deleted from Rule 13.5.14 and that there be provision for land use changes where the nitrogen loss is no more than 27 kgs per hectare per year.

85. The s42A Report is not recommending any changes to the provisions for intensification which would be a departure from the position reached by the Zone Committee and the Council.

86. The Desired Outcomes of the Zone Committee 'solution package'[4] include economic growth in Hinds and Mayfield communities and sustainable, diverse and productive land use.

87. The potential to achieve these outcomes will be constrained by the inflexibility to change land use or increase nutrient baselines to even low levels.

88. Therefore I consider it is appropriate to include provision for change of land use and increase in nutrient baselines to 20kg per hectare per year.

ACTIVITY STATUS

89. Linked to the limitations on land use change is the rule framework where activities that do not meet conditions in the permitted or restricted discretionary activity rules default to non-complying or prohibited, as shown in my synopsis above.

90. The Horticulture NZ submission sought that the activity status for the following rules be amended:

    (a) Rule 13.5.11 – Non complying to discretionary

    (b) Rule 13.5.12 – Prohibited to non-complying

[4] Ashburton ZIP Addendum Hinds Plains Area march 2014 Pg 6

(c) Rule 13.5.19 - Non-complying to discretionary

(d) Rule 13.5.20 – Non-complying to discretionary.

91. Rules 13.5.11 and 13.5.12 are triggered by non-compliance with conditions in Rules 13.5.9 and 13.5.10.

92. Rules 13.5.19 and 13.5.20 are triggered by non-compliance with conditions in Rules 13.5.15, 13.5.16, 13.5.17 and 13.5.18.

93. The submission of Horticulture New Zealand is predicated on the uncertainty of the science in the catchment model. It would be unreasonable to prohibit an activity where there is uncertainty as to the numbers in the tables.

94. The leap from permitted activity status to prohibited is considered to be unjustified and should provide the ability to be assessed as a discretionary activity.

95. Rule 13.5.15 is a permitted activity rule that applies until 1 January 2017. If the nutrient loss calculation exceeds the nutrient baseline it defaults to prohibited even before the good management practices in Policy 13.4.13 a) apply. It provides no time for an operation to implement changes to reduce the nutrient loss calculation.

96. It is noted that the equivalent rule in Variation 1, 11.5.7 defaults to non-complying rather than prohibited. Such an approach would enable assessment of effects prior to the regulatory regime post 1 January 2017.

97. The s42A Report (Para 9.250) comments that the issues relating to activity status have been well traversed through both the LWRP and Variation 1 hearings and see no reason to depart from the existing situations.

98. It is noted that the decision on Variation 1 has added a new discretionary rule, 11.5.9A for where conditions relating to nitrogen loss calculations of permitted activity rules cannot be met. Such an approach provides for an assessment of the effects of the activity providing conditions are met, including a nitrogen loss calculation no greater than the maximum annual loss of nitrogen of any single year between 2009 – 2013.

99. I would support inclusion of such a rule in Variation 2 as it would allow for an assessment rather than defaulting direct to prohibited activity.

FARMING ENTERPRISES

100. Horticulture NZ made a number of submissions regarding provisions for farming enterprises because a range of provisions in the Variation use property as the basis for the policy or rules, thereby excluding farm enterprises.

101. Horticultural operations may traverse a number of 'properties' so 'farming enterprises' more readily encompass some of the range of horticultural operations that may be found in Hinds/ Hekeao Plains Area.

102. The pLWRP defines a farming enterprise as follows:

> *Means an aggregation of parcels of land held in single or multiple ownership (whether or not held in common ownership) that constitutes a single operating unit for the purpose of nutrient management.*

103. The evidence of Ms Halliday and Mr Read refer to examples of farming enterprises and that they can, and do, manage nutrients and water across the enterprise to achieve a range of environmental outcomes and economic success.

104. Section 42A report at 9.208 notes that farming enterprises are a common occurrence throughout Canterbury and that changes are recommended to better recognise these farming practices, on the basis of not greater effects on nitrogen.

105. Specific consideration to farming enterprises is given at 9.355 and refers to the discussion and changes made during the Variation 1 hearings. On the basis of the Variation 1 decision changes are being recommended to Variation 2.

106. The changes to Variation 1 included the addition of a policy so that such enterprises are clearly anticipated and provided for in the Plan.

107. The s42A Report (Para 9.358) recommends inclusion of new policy 13.4.13A that is essentially the same as Policy 11.4.15A in Variation 1. The only amendment is the addition of reference to Policy 13.4.13 which applies to farming enterprises as well as farming activities.

108. The Report then recommends changes to Rule 13.5.10 and 13.5.18 to align with changes in Variation 1 Rule 11.5.10, including the aggregation of the nitrogen loss calculation.

109. The changes address some of the concerns relating to farming enterprises, however there are other matters that need to be considered.

110. Rule 13.5.18 is a discretionary activity and no permitted or controlled activity status applies to farm enterprises, even if the operation has a low nutrient loss calculation. The nutrient loss calculation and nutrient baseline need to be established for each parcel of land in the farming enterprise and aggregated across the farming enterprise.

111. As noted in the synopsis of the rule framework above Rule 13.5.18 has no timeframe included so applies immediately, (subject to section 20A RMA which applies to existing uses under regional planning provisions) where as other rules apply from 1 January 2017, thereby creating a harsher regulatory regime for farm enterprises and before Policy 13.4.13 a) is required to be implemented.

112. Horticulture NZ sought that Farming enterprises be either incorporated into Rules 13-5.15 – 13.5.17 or Rule 13.5.18 be amended to be a Restricted Discretionary rule.

113. Incorporation into Rules 13-5.15 – 13.5.17 would have the benefit of having a timeframe applied rather than the immediate effect.

114. The immediate application of the rule presents challenges for implementing good management practices that are yet to be determined.

115. It is not clearly apparent why there is no timeframe included in Rules 13.5.18 (and 13.5.10) and thereby requiring a different consenting regime for farming enterprises.

116. Earlier drafts of Variation 2 included the farming enterprises rule as a restricted discretionary activity. It is not clear why it was amended to discretionary in the notified plan.

117. While I note that the rule is carried over from the pLWRP I do not consider that full discretion appears is necessary as matters of discretion could be developed to support a restricted discretionary activity status.

TIMEFRAMES FOR IMPLEMENTATION

118. A key part of the submission by Horticulture NZ focussed on the timeframes included in Variation 2 and sought changes

to enable sufficient time for the MGM project to be completed and implementation begun.

119. The Variation sets dates at which the rule framework applies – 1 January 2017 and the date by which the target is to be reached – 2035.

120. The s42A Report (Para 9.275) acknowledges the debate about setting the target date and that 2035 is '*aggressive but achievable'*.

121. A longer timeframe is sought to enable adequate time for adjustment and to reduce the economic and social impacts.

122. The s42A Report is concerned that a change in the timeframe may upset the balance of the solution package and not be able to meet the Zone Committee outcomes. (Para 9.275).

123. A change in the timeframe does not mean that the balance and outcomes will not be met. Rather that they are met as well as considering other outcomes, such as economic, for the area.

124. Given uncertainties regarding a number of aspects of Variation 2 providing a longer period to reach the targets will assist with the clarifications and greater certainty that are required to enable the targets to be met.

125. The Horticulture NZ submission identified that the timeframes need to consider the inter-generational nature of over-allocation by setting longer timeframes for the transition.

> *Given that the state of water quality in the water management unit has been created over significant time periods, we consider it may be necessary to transition to a more desirable state over a longer and perhaps an intergenerational timeframe. (Horticulture NZ submission 1.3)*

126. The s42A Report does not appear to consider the intergenerational responsibility when considering submissions relating to extending the timeframes. I consider that it is a valid matter to be addressed because as currently proposed the responsibility for addressing the over-allocation is largely falling on the current generation.

127. I consider that it is inappropriate to establish timeframes that are aggressive as the potential to not meet them is

considerable. A more realistic target date would be more readily achievable. The Variation should establish a framework to succeed, not fail. The information available suggests that the target date of 2035 is in the latter category. Therefore I support an extension of the target date to 2050.

128. The other timeframe matter relates to when the regulatory regime will apply. Horticulture NZ sought that 2017 be amended:

(a) by changing 1 January 2017 in Policy 13.4.13 a) to 1 January 2020;

(b) by changing 1 January 2020 in Policy 13.4.13 b) to 1 January 2022;

(c) that the dates in the rules be amended correspondingly; and

(d) amending the date in Schedule 7 bullet point 1 to 2020.

129. The effect of this would be that the date that Good Management Practices apply would be 2020, after MGM is completed, and consent required by 1 January 2022.

130. Horticulture NZ did not seek the removal of the provisions – rather that a more realistic timeframe be set. Therefore the signalling of the steps that need to be taken to reduce nutrient losses is not removed from the Plan.

131. Given the lack of information regarding the MGM project and the fact that not all horticultural crops are included within MGM it is important that adequate time is provided before implementing the unknown through a date set without knowing what will be required.

132. The s42A Report (Para 9.28) acknowledges that there are arguments both for and against delaying the process in the interim till more information is known. However makes the recommendation to retain the proposed dates.

133. Given the uncertainty that is acknowledged I err on the side of caution and support the submissions that seek that the dates be amended to 2020 and 2022.

RELIABILITY OF WATER TAKES

134. The Horticulture NZ submission sought a suite of provisions relating to provision of crop survival water and the need for reliability greater than 9 years out of 10.

135. Schedule 10 Reasonable use test has a 9 out of 10 year reliability for a system with an application efficiency of 80% and Horticulture NZ sought that this be amended to 10 out of 10 for specific horticultural crops in times of water shortage.

136. The rationale for the provisions is set out in the evidence of Angela Halliday and Stuart Ford. Essentially the horticultural sector has no alternative to the key input of water so providing broad policy support to consider the loss of reliability is in my opinion appropriate.

SCHEDULE 24

137. Horticulture New Zealand expressed general support for the Farm Practice requirements set out in Schedule 24, but sought changes to clause d) cultivation and the imposition of a default requirement for a 3m uncultivated vegetation strip by sought that 'or other appropriate sediment control measures' be added.

138. The reasoning was stated:

> *It is acknowledged that potential for sediment loss should managed, but there are a range of tools available to manage sediment. Reliance and requiring only one method means that the most suitable method may not be used.*

139. The s42A report addresses this matter at 9.407, 9.412 and 9.414 and expresses concern that "somewhat generic and more lenient "other methods" should be enabled."

140. Horticulture NZ has developed a Code of Practice for sediment and Erosion management that details a range of 'other methods' that are available to be used to address the potential for sediment loss. A vegetated strip is only one such method and may not be the most appropriate for the situation.

141. A better environmental outcome can be achieved by ensuring that the most appropriate and responsive tool is used for the environmental conditions of the site. A site with topography that ensures no potential runoff of contaminants

into an adjacent waterbody will not require an additional buffer. Crop type and seasonal activity may also affect the risk of runoff and dictate more appropriate tools.

142. I consider it would be appropriate to add wording to Schedule 24a) d) ii as follows: "or other appropriate sediment control measures such as benched headlands, interception drains, bunds, grassed swales, contour drains or sediment ponds." A note could be added to refer to the Horticulture NZ Erosion and Sediment Control Guidelines Vegetable Production June 2014.

http://www.hortnz.co.nz/assets/Uploads/Auckland-Waikato-ES-Control-Guidelines-1-1.pdf

CONCLUSION

143. The following provisions of the Plan included in Attachment 1 should be amended as proposed for the reasons set out in the body of this evidence.

Lynette Wharfe

May 2015

ATTACHMENT 1

Provisions Proposed to be Amended

Attachment 2

Erosion and Sediment Control Guidelines for Vegetable Production Horticulture NZ June 2014.

Erosion & Sediment Control Guidelines for Vegetable Production

Prepared by Andrew Barber for:
Horticulture New Zealand
June 2014

PUKEKOHE Vegetable GROWERS ASSOCIATION

Horticulture™ New Zealand

AGRI LINK

EMPOWERING
SUSTAINABLE
GROWTH

Erosion & Sediment Control Guidelines for Vegetable Production

Good Management Practices

Version 1.1

June 2014

Prepared by
Andrew Barber[1]

1. Agrilink New Zealand
P.O. Box 351, Kumeu 0841, Auckland, New Zealand

Telephone: + 64 9 412 5520
Fax: + 64 9 412 5521
Email: andrew@agrilink.co.nz
Web: www.agrilink.co.nz

Cover picture courtesy of Balle Bros - Pukekohe.

This Guideline has been prepared by Andrew Barber of Agrilink NZ with contributions and reviews by commercial vegetable growers, Horticulture New Zealand, Auckland Council and Environment Waikato their contractors and staff. It has been built upon the FSP Doing it Right and the Code of Practice for Commercial Vegetable Growing in the Horizons Region.

INTRODUCTION

These Guidelines have been built upon many years of grower experience and research trials conducted during the Franklin Sustainability Project (FSP), as well as the more recent Holding it Together (HIT) project and the Code of Practice developed in the Horizon Region. The Guidelines also draw on Auckland Council's TP90 Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region and the 2007 changes, plus TP223 Forestry Operations in the Auckland Region A Guideline for Erosion & Sediment Control.

The recommended volumes and area protected using various sediment control devices differs from those in TP90, reflecting the difference in soil type and runoff factors from cultivated land compared to earthworks. It was concluded, and accepted in submitted evidence to the Environment Court, that on cultivated land 0.5% storage is equivalent to or outperforms 2.0% storage on an earthworks site. The report Justification of Silt Trap Capacity for Cultivated Land 0.5% vs. 2.0% (Barber, 2012) describes this in more detail. A copy is available from Horticulture New Zealand.

Table 1 outlines a range of control measures with estimated effectiveness and costs. The estimate of effectiveness was provided by John Dymond (Landcare Research). It assumes that the measures are used within their design limitations. For example a well-constructed Super Silt Fence protecting a small area for a short period of time while having high effectiveness would be extremely ineffective protecting a large area. There is no single silver bullet. Therefore, planning and implementation must include a number of complimentary control measures.

Table 1. Cost and effectiveness of various mitigation measures.

Control measure	Range in effectiveness (%)	Cost per hectare ($)
Detailed erosion mgmt plan	-	$80 - $180
Cover crop	90 - 99	$80
Minimum tillage	-	-
Setback or buffer strip	50 - 80	$100 - $250
Wind break crop	-	-
Stubble mulching	-	$70
Wheel track ripping or dyking	50 - 80	$35
Contour drains	30 - 70	$75
Benched headlands	50 - 80	$65
Super silt fence	80 - 95	$380
Decanting earth bund	80 - 95	$130
Silt trap	80 - 95	$750 - $1,300
Silt trap maintenance	-	$75/ha/year

How to use these Guidelines

The Guideline aims to provide information to growers on a range of possible control measures and options to assist in achieving sustainable land management. The Guideline directs growers to more detailed information contained in FSP Doing it Right, TP90 or TP223.

There are four key steps:

1. Know your paddock – undertake a paddock assessment
2. Measures to stop or control water entering your paddock
3. Erosion control measures
4. Sediment control measures.

Each step is a progression in difficulty, time and energy. It is easier to control water entering a paddock than it is to minimise erosion. Likewise minimising erosion is easier and less costly than managing sediment laden storm water leaving the paddock.

The key to minimising soil erosion 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.

Minimising erosion and soil loss is about getting each of the four steps right. Within paddock erosion control measures without the planning and risk assessment stage could lead to unforeseen washouts. Likewise erosion control measures without sediment control, leaves the downstream environment vulnerable after cultivation and harvest.

The Soil Resource

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 is a loss in productivity and profitability. Therefore retaining soil and its inherent characteristics is critical to the business of growing.

When 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 the whole community.

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 <u>not</u> 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

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.

"When we first go into a new block, planning the layout revolves around the lay of the land…where drains logically must go…look at entry and exit points…what is happening around the block...history...row direction etc." Kevin Balle – Balle Bros

1.1 Paddock Plan

Planning should be done on a paddock by paddock basis, building up to a whole farm plan. Erosion and sediment 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 during or after heavy rain, 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),
- Drains and bunds,
- Any existing erosion or sediment control measures.

Also on the map:

- Note the paddock dimensions,
- Mark the direction and steepness of the slope in different parts of the paddock,
- Mark any streams and riparian strips.

A picture is worth a thousand words. It is a good idea to document your actions and keep a photographic record of where you started and what changes you have made. Also many of the erosion control measures, like cover crops and wheel track ripping, may only be visible for a few months. Documenting your use of these erosion control measures is invaluable.

This map and information will be used to plan the most efficient and effective set of erosion and sediment control measures.

Maps can be simple hand drawn diagrams, or based on electronic aerial photographs. Electronic maps are readily available from Google Maps, or the Councils' GIS systems like http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer/ or http://www.waikatoregion.govt.nz/Services/Maps/ .
The advantage of using the electronic mapping systems is that you can easily determine the catchment areas for your various sediment control options.

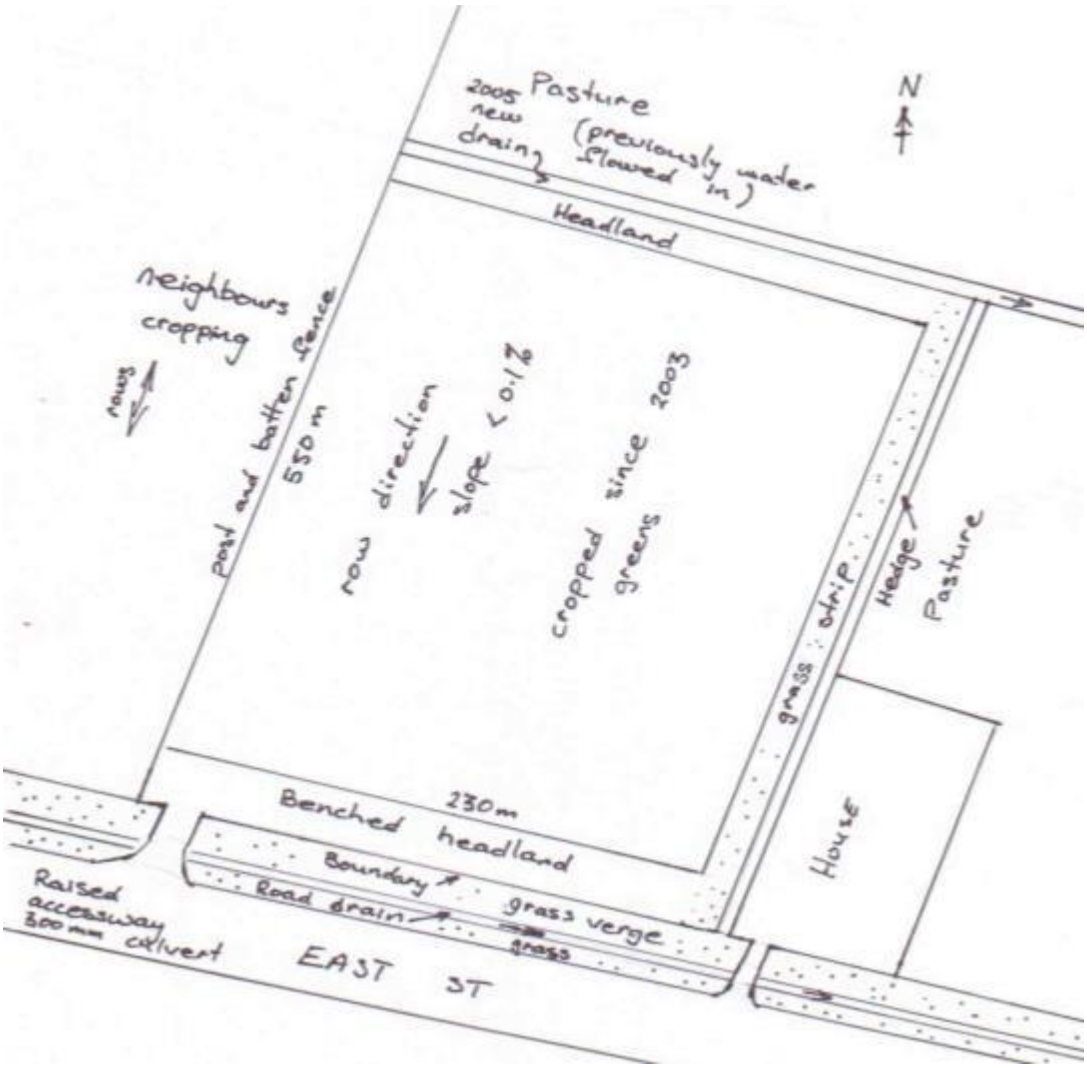


Figure 1. A simple hand drawn paddock map.

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

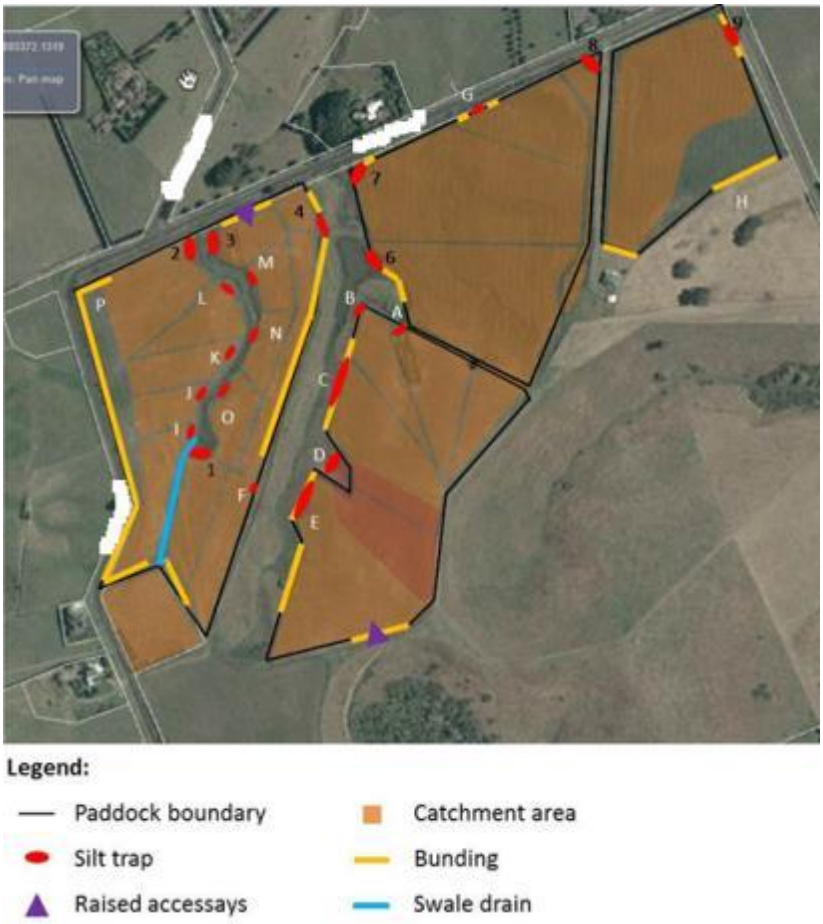


Figure 2. A digit paddock map.

Table 2. Example silt trap details (accompanying the Figure 2 map).

Silt trap	Volume (m^3)	Catchment (ha)	Spillway width (m)	Proposed silt trap dimensions (m)[1]	
				Width	Length
A	35	0.69	1.0	3.0	10.5
B	36	0.72	1.1	3.0	10.9
C	61	1.22	1.8	2.0	27.7

[1] Based on a depth between the silt trap base and spillway of 1.1 m. These are given simply as examples, to get a feel for the trap size.

"When first setting up a paddock we will contact the neighbours, particularly when installing surface drains" Harry Das – B. Das & Sons Ltd

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

Identifying and then stopping or controlling water entering the paddock is crucial. Drains overtopping can be one of the biggest causes of erosion. In Pukekohe on the 21st January 1999 a short-duration high intensity storm struck. The most severe damage was caused where uncontrolled run-off entered paddocks as a result of overflowing drains. In many places inadequately sized culverts also significantly contributed to the problem of drains overflowing. Keeping clean treated water off the paddock using interception drains wherever possible is crucial. Coordination of drains and erosion and sediment control practices between neighbours and council is essential to minimise soil loss. Meet on site with them 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 know the catchment sizes above you.

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 gradient check dams (energy dissipaters) should be used to slow water flow and minimise drain scouring. Some drains will need to be stabilised with vegetation or rocks otherwise they themselves can become a source of sediment.

2.2 Culverts

Culverts in drains are often undersized and either quickly blocks with debris and rubbish or simply cannot 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. Table 3 gives an indication of the maximum catchment area for a range of culvert sizes for a 20% (1 in 5 year) and 5% (1 in 20 year) AEP rainfall event. The flow is based on having a 0.2m headwall above the top of the socket end culvert. The quantity of stormwater generated from a certain size catchment will vary depending on rainfall intensity, overland flow length, slope, and surface characteristics. The maximum catchment area given in Table 3 is a guide only, and is based on a stormwater study conducted for the Bombay Hills. The area guide is likely to be conservative for most catchments as culverts in flatter catchments with less intense rainfall events could cope with larger catchment areas.

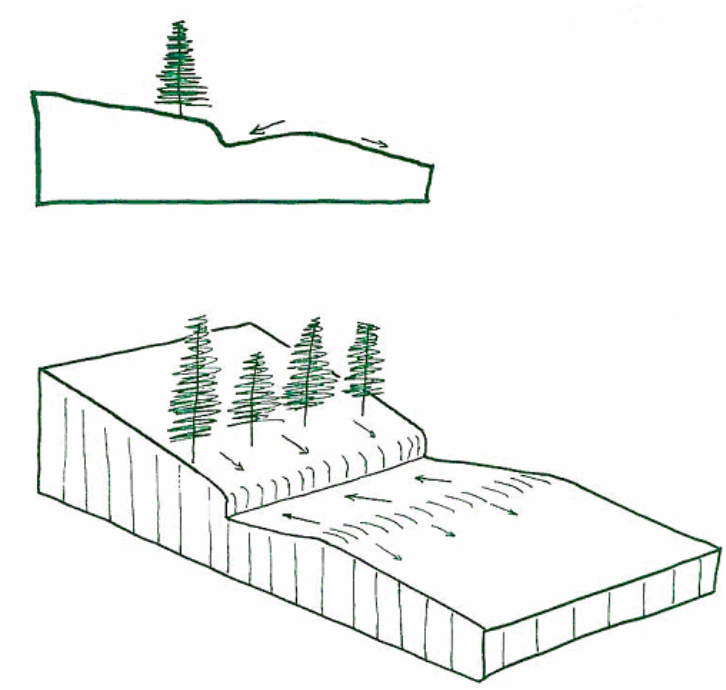
Table 3. Culvert size and associated flows and catchment area.

Culvert size (mm)	Flow (L/sec)	Maximum catchment area	
		20% AEP	5% AEP
300	120	3.4	1.8
375	200	4.8	2.3
450	295	8.1	3.7
525	405	11.3	4.8
600	545	15.0	7.1
675	725	19.3	9.3
750	925	26.9	11.7
825	1100	35.9	14.8
900	1400	48.0	17.8
1050	2000	64.8	29.0
1200	2790	87.5	48.0
1350	3550	115.1	61.4

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.

The headland slopes 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.



Benched headland

Grassing headlands will protect them from scouring and encourages silt to drop out before entering surface drains.

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 sediment control measure or stabilised discharge point.

2.4 Diversion Bund

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 do 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.

Photo 1. Scouring out along a cultivated overland flow path.

A grassed swale may have prevented the damage shown in Photo 1. An interception drain or bund 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 had passed over a grassed swale. Without the grassed swale the volume required in the sediment control measures needs to account for the cultivated paddock as well as the catchment area above the paddock.

3. EROSION CONTROL MEASURES FOR KEEPING SOIL ON THE PADDOCK

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

The suite of erosion control 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.

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

What are cover crops?

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.

Photo 2. An emerging oats 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 http://agrilink.co.nz/archive.php.

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 infiltrate into the soil with the result that little soil loss and no crop loss occurs.

Photo 3. Ripped wheel tracks beside the unripped sprayer tracks (sprayer tracks are left unripped to ensure sprayer stability).

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

When any runoff reaches the bottom of the paddock, it needs to be dealt with by sediment control measures (e.g. decanting earth bunds or silt traps). The easiest and most effective way to deal with this problem is to minimise runoff in the first place. Ripped wheel tracks minimise runoff and subsequently reduces the pressure on any sediment control device.

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 District trial, ripping wheel tracks increased the infiltration rate from 0.5 mm per hour to more than 60,000 mm per hour (Table 4). 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 5). Ripping wheel tracks following planting was found to be the single most effective measure for reducing soil erosion within the paddock in the Franklin District.

Table 4. Infiltration rate (mm/hour).

Treatment	June	October	January
Uncultivated wheel track	0.5	12.7	77.2
Cultivated wheel track	60,300	12,500	8,600
Onion beds	400	500	900

Table 5. 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.

As a word of caution, some growers attribute wheel track ripping to increased erosion. This underscores that no single measure will work for everyone in all situations. However, many growers and the research trials show that in most circumstances wheel track ripping will significantly reduce soil erosion.

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.

Photo 4. 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.

Photo 5. The wheel track dyking implement in action (above).

Photo 6. Small indentations along the wheel track can be seen filled with water (left).

These small dams slow the water down and settles the suspended solids. Water also has a longer duration to infiltrate 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.

Photo 7. Dyked wheel tracks.

There is no standing water after a winter rain event.

Photo 8. Undyked wheel tracks.

Alongside the dyked wheel tracks water has ponded in these undyked wheel tracks.

Creating these small dams along the wheel tracks can have clear production benefits too. 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.

Photo 9. Areas that are affected by short-term ponding damage (foreground) can significantly reduce profitability.

How to create wheel track dykes?

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 create the dams 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 work the wheel tracks 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 disturbed.

3.4 Contour Drain

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 6. 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.

Contour drain slope

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 the Franklin District have found a slope of 1.5 - 2.5% is appropriate for the 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 2.0% on sandy soils.

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.

Contour drain length

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.

Contour drain construction

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 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 erosion is often evident.

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.

Where possible, paddocks should be cultivated in alternating directions in successive years to avoid moving whole fields downhill.

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.

Excessive cultivation with rotary hoes should be avoided.

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.

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

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. However one of the problems is that cultivated paddocks often form channelised flow paths, rather than sheet flow, which can cut through these vegetated margins no matter how wide they are.

Refer to Section 4.3 Vegetated Buffers, Riparian Margins and Hedges 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 organic matter through decomposition and can have a detrimental effect on soil structure.

2. DO build the 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 Cover Crops) or compost. 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 in the 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 requirements (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 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 increased soil organic matter, slow the breakdown of the soil structure and provide a feed resource for grazing. See Section 3.1 Cover Crops 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.

Photo 10. Strip contour cultivation of a fallow paddock following harvest.

Returning paddocks to pasture at regular intervals is an effective way of building up soil organic matter and avoids 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.

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.

4. SEDIMENT CONTROL MEASURES TO MANAGE THE WATER AND SUSPENDED SOLIDS THAT MOVE OFF THE PADDOCK

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. Having sufficient capacity is critical.

Managing water leaving the paddock can be achieved using:

- Raised access ways and ensuring they are not at the lowest point
- Benched headlands
- Diversion bunds
- Vegetated buffers, riparian margins and hedges
- Silt fences
- Stabilised discharge points and drains
- Decanting earth bunds
- Silt traps

4.1 Raised Access Ways

Raised access ways 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.

Photo 11. Raised access way.

An access way raised with metal (right) directs water flowing down the track into a small decanting earth bund. Note the black snorkel should be cut below the height of the emergency spillway so that it can act as the primary spillway. Behind the pictured decanting earth bund is a bund protecting the adjacent roadside drain and downstream environment from the paddock above.

Photo 12. Raised access way.

The access way in Photo 12 has been raised using a culvert with bunds either side directing water to a Decanting Earth Bund further down the paddock.

The effect of having the access way in the lowest point is graphically shown in the series of photographs below. Sediment is lost from a paddock through the access way at the lowest point, with some of the sediment settling in a dip beside the road.

Photo 13. Erosion from an unprotected paddock.

Photo 14. (below) Sediment settles in a dip just down from the paddock in Photo 13.

Photo 15. Unprotected access way at the lowest point (above).

Remember – access ways are there to provide for vehicle crossings, they are not a discharge point for stormwater.

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

1. Position access ways away from lowest point
   Never place access ways at the lowest point of the field where water is naturally diverted or concentrates. This may mean "off-setting" it from the bottom corner where a decanting earth bund is installed.
2. Raise access ways
   Raise the access way above the surrounding area to divert water into your sediment control system. This may be as simple as using a load of metal to form a hump over the access way (see Photo 11).
3. Check point
   Use the access way 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 access ways that go directly onto a road should be piped. The size of the pipes/culverts is important – the BIGGER the BETTER. See Section 2.2 Culverts.

4.2 Diversion Bund

Diversion Bunds are raised earth walls prevent water discharging straight off the paddock. Like raised access ways they divert water into a sediment control device like a decanting earth bund or silt trap.

Photo 16. A diversion bund protecting a pond.

4.3 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 allowing the sediment to settle out. They should be at least 3 to 6m wide. 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. Where the flow is channelised, as occurs in the majority of cases on vegetable cropping land, riparian margins may be of limited value as sediment control devices with water and sediment pass straight through. They do however have other benefits such as stabilising banks and shading streams.

Photo 17. A wide grassed riparian margin protecting a stream.

Photo 18 (below). This recently cultivated paddock is protected by the dense grass buffer left alongside the fence.

Photo 19 and 20. Headlands set back from the paddock boundary with a wide crop strip acting 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.

FSP trialled vetiver grass as a soil barrier. Planted at 20cm intervals it will form a dense hedge, approximately 1.5m tall of stiff erect stems in 3 years. Once established it can filter the water leaving sediment to settle in front. It suits temperate regions of New Zealand.

Photo 21. Vetiver grass established along the lower paddock boundary.

4.4 Silt Fences or Super Silt Fences

Silt Fences and Super Silt Fences are considered a temporary measure for trapping sediment-laden runoff from small catchments of usually less than 0.5 ha. When used on larger catchments careful consideration of the site characteristics is needed or other alternative control measures may be more appropriate. For gradients of less than 10% the slope length behind the Super Silt Fence is unlimited, however Silt Fences have a slope restriction of just 40m. FSP used them in trials as an effective means of demonstrating the quantity of soil that was 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 the 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 in TP90 Part B 2B and the 2007 changes. The geotextile fabric must meet the following minimum requirements. Grab Tensile Strength: >440N, Tensile Modulus: 0.140 pa, Apparent Opening Size 0.1 – 0.5mm. Suitable fabric can be found at www.permathene.com/htm/erosion.shtml

Table 7. Super Silt Fence Design Criteria.

Slope Steepness (%)	Maximum Slope Length (m)	Spacing of Returns (m)
0 – 10%	unlimited	60
10 – 20%	60	50

Source: TP90 (2007)

Detailed construction guidelines can be found on the Auckland Council website's technical publications page. Either TP90 and the 2007 changes or TP223 sediment control for forestry, are excellent guides showing a wide range of erosion and sediment control measures.

4.5 Decanting Earth Bund

A Decanting Earth Bund is often constructed along the flat contour at the bottom of a paddock. By moving the headland itself several meters further up the paddock the full width of the paddock can form a ponding area that will hold runoff long enough to allow sediment to drop out of suspension prior to discharge. This approach can avoid having to build deeper silt traps in the corner of paddocks in order to achieve the required volume.

Photo 22. 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.

Creating sufficient capacity in Decanting Earth Bunds and Silt Traps is essential for giving sediment sufficient time to settle. The recommended capacity is 0.5% (50 m^3/ha) for catchments of less than 5ha and 1% (100 m^3/ha) for catchments over 5ha. Full details are included in the FSP Soil and Drainage Management Guide. This can be downloaded from http://agrilink.co.nz/archive.php.

Photo 23. Decanting snorkel.

Photo 24. A Decanting Earth Bund.

Decanting rate

Decanting Earth Bunds and Silt Traps need to dewater so as to remove the relatively clean water without removing the settled sediment. The decanting rate is critical. Too fast and the sediment will not have time to settle, slush in and slush out. Too slow and the primary and emergency spillways will operate in even moderate sized rainfall events, which will also result in poor sediment capture efficiencies.
The recommended decant rate is 3 L/sec/ha.

Table 8Table 8 shows the number of 10mm holes required for various lengths of vertical snorkel in order to decant at a rate of 3 L/sec/ha. As the silt trap becomes deeper (longer snorkel) the average flow rate through each hole increases, hence less holes are needed. For example if the Decanting Earth Bund has a 1 hectare catchment; on a 1m snorkel drill 60 10mm diameter holes. This can be done in 6 vertical rows with 65 mm spaces from the top of the snorkel down to 0.3 m from the silt trap floor. A deeper trap with a 1.3m snorkel requires just 54 holes to achieve the same decanting rate of 3 L/sec/ha.

The number of holes will need adjusting based on the catchment area and the snorkel height. Larger catchments may require several vertical pipes or the use of plastic drums has proven to be an effective inexpensive option. The drums provide more surface area to get the required number of holes on larger catchments in shallow silt traps. Getting the height of the drums correct takes a little more work compared to simply cutting a PVC pipe to the correct length. The drums also need a large hole cut in the lid to act as the primary spillway.

Table 8. Snorkel - Number of 10mm holes per hectare.

Snorkel height above base (m)	Perforation length (m) [1]	Average flow per hole (L/hour)	Number of holes per hectare of catchment	Distance between holes (mm) [2]
0.5	0.4	2.2	84	25
0.8	0.5	2.7	66	45
1.0	0.7	3.1	60	65
1.3	0.9	3.5	54	90
1.5	1.1	3.9	48	125
1.8	1.2	4.2	42	165

1. The bottom 30% of the snorkel does not have any perforations
2. Based on 6 vertical rows

It is recommended that the bottom 30% of the snorkel is not perforated. This will result in a permanent pool at the bottom of the silt trap, which helps sediment settle. 30% of the volume of the trap should be “dead storage” i.e. a pool of water and the other 70% is operating volume i.e. is the volume decanted off through the perforated upstand during and after rainfall events.

Key decanting snorkel requirements

1. The open top of the snorkel also acts as the primary spillway. There should be 100mm gap between the top of the snorkel and the emergency spillway.
2. The decant rate should be 3 L/sec/ha. See Table 8.
3. The bottom 30% of the snorkel should not be perforated in order to leave dead storage
4. Snorkel should be securely fastened to a stake
5. The discharge point should be stabilised by discharging onto rocks or stabilised ground.

Emergency spillway

The emergency spillway discharges excess water in major storm events when the perforated snorkel and primary spillway are unable to cope. Position the spillway so that it is not inline for the entrance, baffles may be needed to achieve this. The spillway needs to be stabilised with rock, geotextile or on firm vegetated undisturbed ground. The minimum width is 1.5m/ha of catchment. The spillway must be level and 100mm above the primary spillway. There should be 400mm between the top of the bund and the emergency spillway.

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 factsheet developed for FSP that can be found at http://agrilink.co.nz/archive.php or design details are included the in the Auckland Council Technical Publication 90 and the 2007 changes.

The Silt Trap should be 3 times longer than it is wide with inflow entering at one end and the discharging through the outlet at the other. Baffles may be necessary to achieve this. A baffle is a barrier constructed across the pond to direct flows and so maximise the efficiency of the Silt Trap. Its height should be the same as that of the top of the perforated snorkel. It can be constructed from silt fence fabric or shaped when being excavated leaving a clay barrier. The clay barrier is easier for maintenance as cloth barriers are invariably ripped out by the excavator.

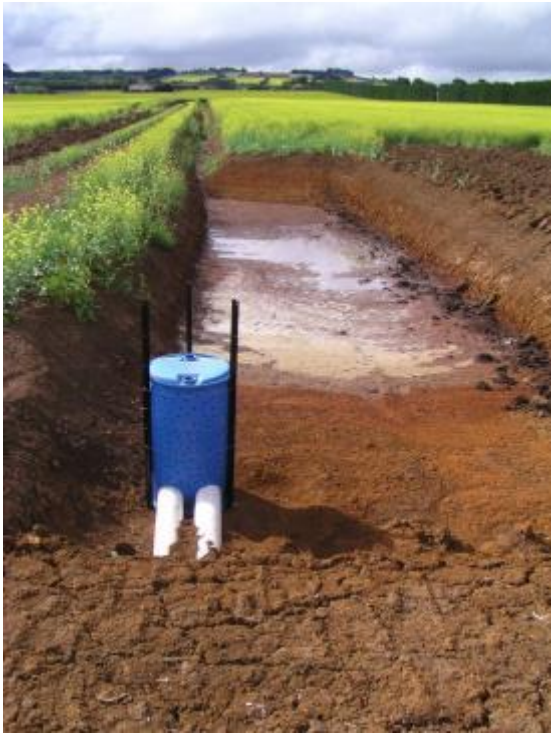


Photo 25. A silt trap with the blue snorkel in the foreground for slowly decanting the trap. A mustard cover crop is planted in the immediate paddock along with many of the paddocks in the background.

GLOSSARY

Annual Exceedance Probability (AEP)
A statistical term defining the probability of an event occurring annually. Expressed as a percentage to define rainstorm intensity and frequency. For example, a 5% AEP event has a 5% chance of being exceeded in any one year. This has replaced the return period concept. A 5% AEP event expresses the 20 year return period in more probability terms.

Baffles
Semi-permeable or solid barriers placed in a sediment retention pond to deflect or regulate flow and effect a more uniform distribution of velocities, hence creating better settling conditions.

Batter
A constructed slope of uniform gradient.

Catchment
An area within which surface runoff flows to a common outlet or outlets.

Channel Stabilisation
Stabilisation of the channel profile by erosion control and/or velocity distribution through reshaping, the use of structural linings, rocks, vegetation and other measures.

Clean Water
Any water that has no visual signs of suspended solids, e.g. overland flow (sheet or channelled) originating from stable well-vegetated or protected surfaces.

Contour
A line across a slope connecting points of the same elevation.

Contributing Drainage Area
All of that drainage area that contributes to the flow into a treatment device (e.g. earth bund). A contributing drainage area can include both clean and sediment-laden water flows. Commonly referred to as the catchment area.

Decant Rate
The rate at which water is decanted from a Decanting Earth Bund or Silt Trap. This should be 3 L/sec/ha.

Deposition
The accumulation of material that has settled because of reduced velocity of the transporting agent (water or wind).

Emergency Spillway
An Earth Bund, Silt Trap or Dam spillway designed and constructed to discharge flow in excess of the structure's primary spillway design discharge.

Energy Dissipater
A designed device such as an apron of rip-rap (rock) or concrete bags placed at the end of a water conduit such as a pipe, paved ditch or flume for the purpose of reducing the velocity and energy of the discharged water.

Rip-rap
Rock or other material used to armour channels, culvert abutments, and spillways against erosion.

Ephemeral Watercourse
A watercourse that flows only part of the year; may include overland flow paths such as grassland swales and dry gullies which only flow during more intensive rainstorms.

Filter Strip
A long, narrow vegetative planting (e.g. vetiver grass) used to retard or collect sediment for the protection of adjacent properties or receiving environments.

Level Spreader
A device used to convert concentrated flow into sheet flow.

Overland Flow Path
The route of concentrated flow.

Perennial Stream
A stream that maintains water in its channel throughout the year

Primary Spillway
The snorkel inlet within a Decanting Earth Bund or Silt Trap.

Riparian margin
An area adjacent to a watercourse designated as a non-disturbance zone to provide a buffer between the watercourse and cultivated paddock.

Sediment
Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from the original paddock by water or air and has come to rest.

Sediment Yield
The quantity of sediment discharged from a paddock in a given time, measured in dry weight or by volume. When erosion and sediment control measures are in place, sediment yield is the sediment discharged from the site after passing through those measures.

Settling
The downward movement of suspended solids through the water column.

Snorkel
In a Decanting Earth Bund or Silt Trap, a vertically placed pipe which decants water and forms the inlet to the primary spillway.

Spreader (Hydraulics)
A device for distributing water uniformly in or from a channel.

Stabilisation
Providing adequate measures, vegetative and/or structural that will protect exposed soil to prevent erosion.

Surface Runoff
Rain that runs off rather than being infiltrated or retained by the surface on which it falls.

Suspended Solids
Solids either floating or suspended in water.

Swale
A constructed depression or shallow channel across a paddock, that can be used to transport clean stormwater. It is usually heavily vegetated, and normally only flows during heavy storm events.

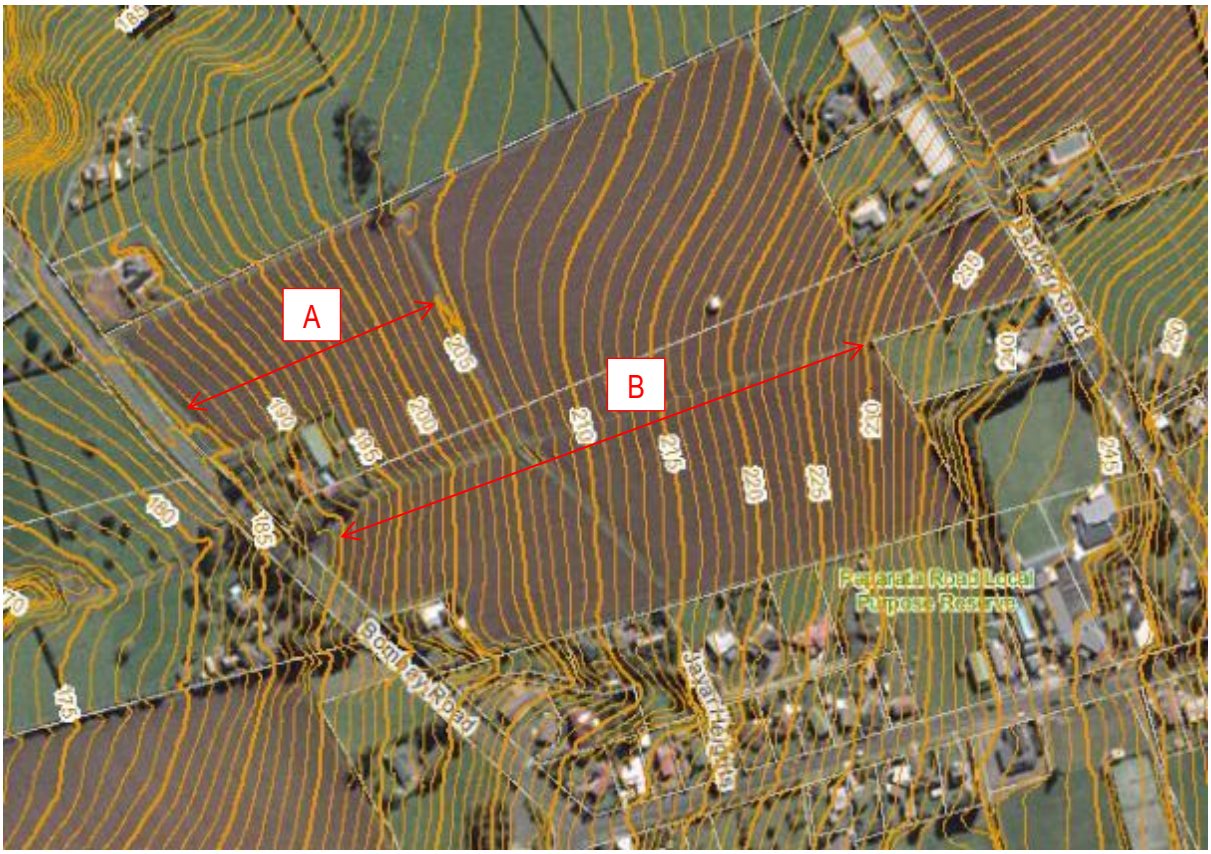
Water Body
Any type of surface water such as watercourses, lakes and wetlands.

Watercourse
Any pathway for concentrated overland flow, including rivers, streams and ephemeral channels.

PADDOCK SLOPE

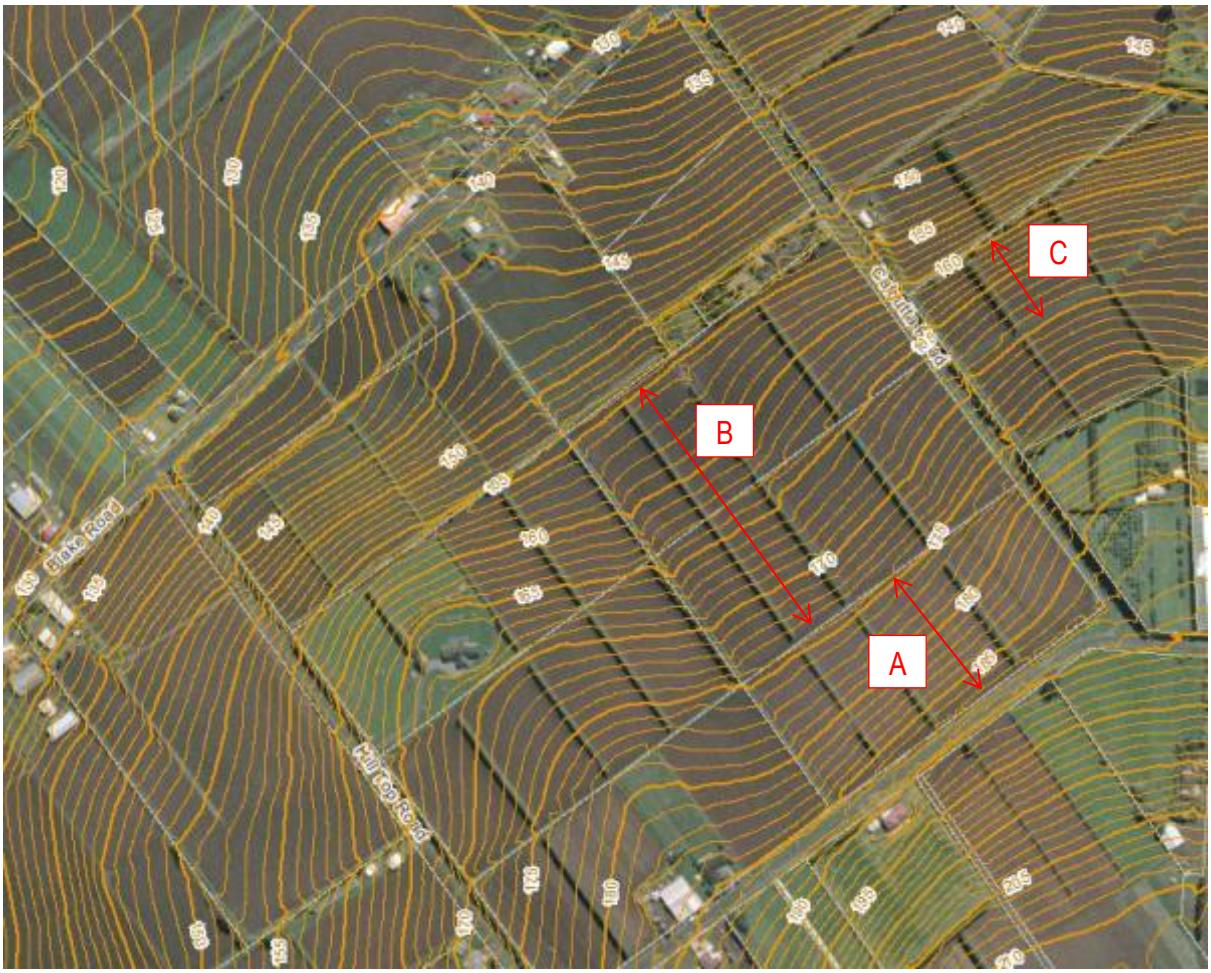
Many erosion and sediment control measures refer to different slopes, as a ratio, percentage or in degrees. With the GIS mapping now available for free on the internet it is reasonably easy to calculate the slope of a paddock. Alternatively a clinometer like that described in Section 3.4 Contour Drains can be used. The figures below show some of the steeper paddocks in the Franklin District to give an idea of the slope at the upper end. Apart from a few areas within a paddock, even the steepest cultivated slopes are generally less than 6 degrees or 10%.

Bombay Hills



Description	ratio	percent	angle
A	10.5 : 1	9.5%	5.4°
B	9.4 : 1	10.6%	6.1°

Pukekohe Hill



Description	ratio	percent	angle
A	10.2 : 1	9.8%	5.6°
B	13.8 : 1	7.2%	4.1°
C	8.2 : 1	12.1%	6.9°

COMMENTS AND FEEDBACK

We will be regularly reviewing these Guidelines. Please help us keep them accurate and practical. Let us know about any changes that need to be made either by contacting the author Andrew Barber directly or by using this form.

1.0 Errors

Are there any errors in the text or diagrams? If so please tell us:

- Which page and/or figure number it is on
- What the error is and how you would correct it

2.0 Omissions

Have we left out any measures/practices commonly used or which you find useful? If so, please tell us, and if possible any pictures and design guidelines for us to include in a future update.

3.0 Effectiveness

Are these Guidelines and the other material that we have linked to (e.g. FSP – Doing it Right) helpful for understanding and implementing erosion and sediment control measures? If not, please tell us how we can improve these Guidelines.

Appendix 1 to the Evidence in Chief of Lynette Wharfe for Horticulture NZ on Variation 2 (Hinds)

Horticulture NZ submission points – Variation 2
Submitter ID 52267

Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
V2 pLWRP - 601	1.2 Transitional interim plan In the absence of information such as MGM, Variation 2 should be regarded as an interim plan with a variation notified by the end of 2017 that will provide greater certainty.	Para 14.5 Rejects submission and seeks further information	Addressed in L Wharfe evidence Section 6 An interim framework is supported
V2 pLWRP - 602	1.3 Timeframes: Amend all 2017 timeframes to 2022	Paras 9.28 and 9.275 Rejects submission	Addressed in L Wharfe evidence Section 11. Amendments to timeframes supported
V2 pLWRP 603 604 605 608 621	1.4 Crop survival water Horticulture NZ seeks specific inclusion for crop survival water in Variation 2. Add an issue: Add a policy: In times of water shortages provide for taking of water for the sole purpose of avoiding the death of horticultural root stock or crops as provided for in consent conditions. Add definition of rootstock and crop survival water: water provided for the protection of root stock of permanent horticulture, and protection of crops, excluding pasture species, animal fodder crops and maize through a reliability standard set at 100%. Include an additional consent assessment matter: Within the Hinds/ Hekeao Plains Area The need for crop survival water as determined using Schedule 10 Method 1 Amend Schedule 10 Reasonable Use Test Method 1: Within the Hinds/ Hekeao Plains Area method 1 shall determine seasonal irrigation demand for horticultural crops for crop survival water as 10 years out of 10. Include text in the s32 Report – refer to submission	Para 10.24 Rejects submission	Addressed in evidence of Stuart Ford and Angela Halliday. Provision for crop survival water supported

Appendix 1 to the Evidence in Chief of Lynette Wharfe for Horticulture NZ on Variation 2 (Hinds)

Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
V2 pLWRP 607	2.1 Section 13 is a description of Ashburton zone. Amend Section 13 by adding a new paragraph: The Hinds/ Hekeao Plains Area is an important area for agriculture and food production which provides significant employment in the area, both on-farm and in processing and service industries. The social and economic wellbeing of the community is reliant on the agricultural industry and it is important that it is retained so that the communities can thrive.	S42A Report Pg 85- 92 Accept in part submission by adding text (Refer Para 7.23)	Support addition on new text
V2 pLWRP - 609	2.2 Values and Freshwater objectives Add a new Objective to recognise and provide for the nationally significant benefits of food and fibre production and their contribution to economic, social and cultural wellbeing. Amend policies, rules, and methods consequentially.	14.27 -14.33 Rejects submission No change recommended	Support an area specific objective
V2 pLWRP 610	3.1 Adaptive management conditions Amend the definition of adaptive management conditions by adding "or provide for flow sharing between users."	No change recommended	Unable to find in s42A Report under Flows and allocation.
V2 pLWRP 611	3.2 Baseline land use Amend the definition of Baseline land use: means that land use, or uses, on a property or farming enterprise either between 1 July 2009 and 30 June 2013, or for horticultural crops over the crop rotation, and used to determine the 'nitrogen baseline' as defined in section 2.9 of this Plan.	Pg 139 – 141 Para 9.192 – 9.210 No change recommended Rejects submission	Support 'farm enterprises' added after property.
V2 pLWRP 612	3.3 Good management practice nitrogen loss rates Amend the definition of 'Good management practice nitrogen loss rates' by adding after 'property': 'or farming enterprise'.	Pg 123- 125 9.99 -9.116 Recommend deleting reference to Good Management Practice Nitrogen Loss Rates	Deletion of definition supported
V2 pLWRP 614	4.1 New policy. Add a new policy: Targets and limits set in this variation will be reviewed before 2017 to ensure that the refinements in methodology and models used are reflected in the	14.5 Rejects submission and seeks further information	Addressed in L Wharfe evidence Section 6 An interim framework is supported

Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
	allocation and targets and limits set and changes notified in a plan change once the MGM outcomes are known.		
V2 pLWRP 615 1237	4.2 Policy 13.4.11 Provide for the 114 tonnes of nitrogen per year as an interim target not a limit, and indicate a deadline of 2018 for catchment hydrological and economic modelling using a model that provides similar functionality to the "Source" model used to measure load in the Selwyn Variation. Use the modelling to describe an NPS limit from 2018 onwards.	Pg 142 – 144 'Maintain' recommended to be amended to 'reduce' current phosphorus losses	Retain 'maintain'
V2 pLWRP 616 1236	4.3 Policy 13.4.12 Describe the 3,400 tonnes of nitrogen per year as an interim target not a limit, and indicate a deadline of 2018 for catchment hydrological and economic modelling using a model that provides similar functionality to the "Source" model used to measure load in the Selwyn Variation, to calculate an actual limit.	Pg 149-152 Recognise uncertainty with 3400 t/N – but don't recommend changes and rejects submission seeking modelling etc re 3400 tonnes	Addressed in evidence of Nic Conland and Lynette Wharfe
V2 pLWRP 617 618 618	4.4 Policy 13.4.13 Amend Policy 13.4.13 a) by changing 1 January 2017 to 1 January 2020 Amend Policy 13.4.13 b) by changing 1 January 2020 to 1 January 2022. Amend Policy 13.4.13 c) by deleting 'on a maximum of 30,000 hectares of land' Add a new policy: The nitrogen baseline for a property or enterprise can be reassessed where it can be demonstrated that the 4 years 2009-2013 do not accurately reflect the nature of the operation.	Pg 117 -123 Paras 9.72- 9.97 Rejects Horticulture NZ submission points Changes recommended linked to deleting Table 13 h)	Addressed in L Wharfe evidence Section 7 and Stuart Ford Provision for greater flexibility in establishing nutrient baseline for horticultural crops supported.
V2 pLWRP 619	4.5 Policy 13.4.16 Make changes as sought to Schedule 10 Method 1 to provide for crop survival water. Amend Policy 13.4.16 by deleting 'prohibiting increased use arising from the transfer of consented volumes of water'.	Pg 193-196 and 234 -236 Reference to Method 1 in Schedule 10 deleted. No change to the method and policy as sought	Support deletion of Method 1. Seek 100% reliability for crop survival water. Addressed in evidence of Angela Halliday and Stuart Ford.
V2 pLWRP	4.6 Policy 13.4.17	Pg 196-198	Addressed in evidence of Angela

Appendix 1 to the Evidence in Chief of Lynette Wharfe for Horticulture NZ on Variation 2 (Hinds)

Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
621	Provide for survival water as per the submission above and exempt horticultural crops from the flow sharing regime.	No changes recommended	Halliday and Stuart Ford.
V2 pLWRP 622 640	4.7 New Policy Add a new policy and commensurate permitted activity rules and methods to enable transfer of nitrogen within and between enterprises and farms within the same water management unit, or similar rules and methods to give effect to development of a transfer system.	Pg 163 – 166 Para 9.342 No change recommended	Addressed in evidence of Stuart Ford and Lynette Wharfe
V2 pLWRP 625	5.1 Rule 13.5.9 Amend Rule 13.5.9 by adding after the words 'property': 'or farming enterprise'.	Pg 145-148 addresses all Upper Hinds rules. No change recommended	Farming enterprises addressed in evidence of Lynette Wharfe
V2 pLWRP 626 1244	5.2 Rule 13.5.10 Delete Rule 13.5.10 and provide for farming enterprises in Rules 13.5.8–13.5.9. Or: Provide an RDA rule for farming enterprises that takes into account the rotational nature of the operation and industry good management practices.	Pg 145-148 addresses all Upper Hinds rules Changes recommended to 13.5.10 to provide for farming enterprises.	Generally support changes but seek change to RDA and inclusion of timeframe, not immediate effect. Addressed in evidence of Lynette Wharfe
V2 pLWRP 627	5.3 Rule 13.5.11 Amend Rule 13.5.11 to Discretionary activity.	Pg 145-148 addresses all Upper Hinds rules:	Addressed in evidence of Lynette Wharfe – Activity Status.
V2 pLWRP 628	5.4 Rule 13.5.12 Amend Rule 13.5.12 to Non-complying activity.	Pg 145-148 addresses all Upper Hinds rules	Addressed in evidence of Lynette Wharfe – Activity Status.
V2 pLWRP 629	5.5 Rule 13.5.14 Delete the reference to Row B Table 13 i) does not exceed 30,000 hectares	Pg 152-155 Particularly Para 9.295 No change recommended to inclusion of 30,000 ha.	Addressed in evidence of Lynette Wharfe and Angela Halliday. Provisions for land use change for low leaching activities sought.
V2 pLWRP	5.6 Rule 13.5.15 Amend the date to 2020 and include farm enterprises within the provisions.	Pg 156- 162 No change recommended.	Timeframes and farm enterprises addressed in evidence of Lynette

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Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
630			Wharfe
V2 pLWRP 631 1246	5.7 Rule 13.5.16 Amend the date to 'From 1 January 2020' and include farm enterprises within the provisions.	Pg 158 – 159 No change recommended.	Timeframes and farm enterprises addressed in evidence of Lynette Wharfe
V2 pLWRP 632 1247	5.8 Rule 13.5.17 Amend Rule 13.5.17 by: changing the date to 'From 1 January 2020' by adding after the words 'property': 'or farming enterprise' and delete Matters of discretion 2 and 3.	Pg 159 – 160 Matter of discretion 2 amended and 3 & 4 deleted	Deletion of matters of discretion supported.
V2 pLWRP 634	5.9 Rule 13.5.18 Delete Rule 13.5.18 and provide for farming enterprises in Rules 13.5.15 – 13.5.17. Or: Amend Rule 13.5.18 to an RDA rule for farming enterprises that takes into account the rotational nature of the operation and industry good management practices.	Recommend amended rule 13.5.18	Generally support changes but seek change to RDA and inclusion of timeframe, not immediate effect. Addressed in evidence of Lynette Wharfe
V2 pLWRP 636	5.10 Rule 13.5.19 Amend Rule 13.5.19 to Discretionary activity.	No change recommended	Addressed in evidence of Lynette Wharfe – Activity Status.
V2 pLWRP 635	5.11 Rule 13.5.20 Amend Rule 13.5.20 to non-complying.	No change recommended	Addressed in evidence of Lynette Wharfe – Activity Status.
V2 pLWRP 638 639	5.12 Rules 13.5.33 and 13.5.34 Amend Rules 13.5.33 and 13.5.34 to Discretionary.	Changes recommended but not to activity status	Seek activity status amendments
V2 pLWRP	5.13 New rule sought: nitrogen transfer. Construct a new rule and method framework to support the policy requested on transfer of nutrients.	Pg 163 – 166 Para 9.342 No change recommended Linked to Sub ID 640 and 622	Addressed in evidence of Stuart Ford and Lynette Wharfe
V2 pLWRP	6.1 13.6 Fresh water outcomes	Pg 253	Refer to Sec 5 of report for

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Submission pt ID	Horticulture NZ submission	ECAN s42A Report response	Horticulture NZ response
641	Reconsider Tables 13 a), and 13 b) as part of a revised Section 32 Report informed by a scientific review and the attributes required to meet the proposed National Objectives Framework	No changes recommended.	implementation of NPS that will include a variation.
V2 pLWRP 643 1248	7.1 Section 13.7 establishes environmental flow and allocation regime and water quality targets and limits. Reconsider Tables 13 d), 13 e) 13 f) 13 g), 13 h) 13 i), 13 j) and 13 k) as part of a revised Section 32 Report informed by a scientific review and the attributes to meet the proposed National Objectives Framework.	Pg 253 No changes recommended.	Refer to Sec 5 of report for implementation of NPS that will include a variation.
V2 pLWRP 642 644 645	7.2 Table 13 g) and Table 13 h). **Decisions sought:** Revise Tables 13 i) and 13 j) to provide an equal allocation across the catchment, reflecting a differing ratio (a 2:1 ratio) across 2 slope classes (>15degrees, less than 15 degrees). Amend Table 13 g) to be interim targets or limits to be reviewed by 2017.	Pg 108 Discussion on equal allocation models Table 13h) Pg 129 – 132 Recommends Table 13 h) be deleted and incorporated into Policy 13.4.13 Table 13 i) Pg 132 - 136 Amendments made consistent with other changes to GMP nitrogen loss rates but substantially unchanged.	Allocation models to be evaluated in rebuttal evidence
V2 pLWRP 646	8.1 Schedule 7 Farm Environment Plan Amend Schedule 7 bullet point 1 'Achieve the Good Management Practice Nitrogen Loss Rates from 2020.'	Pg 171 – 173 Minor changes recommended Reject Horticulture NZ submission re timeframes	Addressed in evidence of Lynette Wharfe – Timeframes
V2 pLWRP 606	8.2 Schedule 10 – Reasonable Use test Amend Schedule 10 Reasonable Use Test Method 1: Within the Hinds/ Hekeao Plains Area method 1 shall determine seasonal irrigation demand for horticultural	Para 10.24 Rejects submission	Addressed in evidence of Stuart Ford and Angela Halliday. Provision for crop survival water

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	crops for crop survival water as 10 years out of 10.		supported
V2 pLWRP 647 648	8.3 Schedule 24 Farm Practices Retain Schedule 24 and clarify that it relates specifically to Ashburton. Amend Schedule 24a b) Cultivation ii) by adding after '3 metres uncultivated strip' 'or other appropriate sediment control measures.	Pg 173 – 179 Recommended changes re Overseer Want details of other methods for cultivation	Cultivation addressed in evidence of Lynette Wharfe and Erosion and Sediment Control Guidelines for vegetable Production included as examples of other methods. Overseer addressed in evidence of Stuart Ford.