BEFORE THE HEARINGS PANEL

IN THE MATTER	**of hearings on submissions concerning the Proposed One Plan notified by the Manawatu-Wanganui Regional Council**

SUPPLEMENTARY EVIDENCE OF DR JON ROYGARD

FOR THE WATER HEARING

ON BEHALF OF HORIZONS REGIONAL COUNCIL

---

1. PART ONE: INTRODUCTION AND EXECUTIVE SUMMARY

1. I have prepared this report as supplementary evidence to my Section 42A Report. It has been compiled in response to evidence received from experts on behalf of submitters. As a result of considering the expert evidence received and, where appropriate, after meeting and caucusing with those experts, I have revised some of my recommendations as they appeared in my Section 42A Report.

2. This evidence is in four parts:

   Part One: This Introduction and Executive Summary.

   Part Two: Overview of the technical supplementary evidence presented on behalf of Horizons.

   Part Three: Issues raised by submitters' experts and my responses, including any revised recommendations as a result.

   Part Four: Any corrections/clarifications I need to make to my original evidence.

3. I have read a range of evidence provided by submitters, and comment here, on some of the evidence of the following submitters:
   - Dr Mike Scarsbrook on behalf of Fonterra Co-operative Group Ltd.
   - Ms Carmen Taylor on behalf of Winston Pulp International Limited.
   - Dr Jack McConchie on behalf of Palmerston North City Council.
   - Chris Pepper on behalf of Palmerston North City Council.
   - Mr Sean Newland on behalf of Fonterra Co-operative Group Ltd.
   - Mr David Bridges for the Territorial Authority Collective.
   - Mr Gerard Willis on behalf of Fonterra Co-operative Group Ltd.

4. I also comment generally and clarify the following issue which was raised in the evidence of a number of submitters:
   - What are the relative contributions of point source inputs and non-point source inputs to the state of water quality?

5. I have participated in caucusing meetings as outlined in Table 1.

Table 1. Issues discussed at caucusing meetings.

Issue discussed	With experts
Minimum flows and allocation limits for the Turitea catchment	Jack McConchie Raelene Hurndell
Water quality standards & use of ANZECC Guidelines	Kate McArthur Bob Wilcock John Quinn Keith Hamill Paul Kennedy

2. EXECUTIVE SUMMARY OF SUPPLEMENTARY EVIDENCE AND REVISED RECOMMENDATIONS

6. Overall, the evidence provided by submitters shows a high level of agreement with the science behind the Proposed One Plan (POP). There are exceptions to this and some of these are addressed in this supplementary evidence and in the supplementary evidence of other Horizons experts. There are also a number of cases where submitters state openly that they haven't read in full the technical evidence that has been provided. This is understandable given the large amount of technical evidence that has informed Plan development. In replying to the evidence of submitters with regard to the technical issues, our approach has been to avoid repetition of material already presented in the original body of evidence. In some cases where issues have been identified, our supplementary evidence provides a link to where the particular issue is originally addressed, in other cases some further information has been provided. The aim of the supplementary evidence has been only to address issues that have potential to influence policy.

7. In Part Two of this report I provide an overview of Horizons' supplementary evidence that is of a technical nature and outline the issues raised by submitters that the supplementary evidence addresses.

8. In Part Three of this report I provide clarification of some matters raised by submitters' experts and include my comments in relation to some of the matters raised in supplementary evidence. This follows my consideration of the technical expert evidence, and subsequent discussions during, or in association with, caucusing and pre-hearing meetings.

9. In Part Four of this report I have revised/clarified some of my recommendations as presented in my original Section 42A Report, dealing with expressing core allocation limits in Schedule B as daily limits.

10. It is noted that there is no supplementary technical evidence in relation to groundwater allocation and quality. However, the further evidence about discharges to land does relate to groundwater quality.

11. In the remainder of this Executive Summary I provide comments arising from my consideration of the evidence by submitters' experts and subsequent caucusing and discussions with submitters' experts and Horizons' experts. My comments, both in this Executive Summary and in Table 2 and Table 3, are presented in similar sections to those used in my original S42A Report:

(a) Overall water management framework;
(b) Surface water allocation;
(c) Surface water quality; and
(d) FARM strategies for contaminant management.

3. OVERALL WATER MANAGEMENT FRAMEWORK

12. The Water Management Zones/Subzones and values provide a framework to customise management within a local area and in relation to the broader catchment.

13. Some comments in submitters' evidence suggest the POP water management framework is a "one size fits all" approach and some of those comments question the use of numerical values for minimum flows and allocation limits, or water quality standards or methodologies for determining efficiency criteria.

14. However, as stated in my earlier S42A Rreport, the aim of the technical work for the One Plan was to provide certainty for all involved in the implementation of the Plan, through the provision of numerical values or standardised methodologies. The reasoning for this was to provide greater certainty for all involved in the implementation of the plan and to determine these numerical values or standarised methodologies at the plan level rather than on a consent- by- consent basis. The evidence of submitters and discussions with some of the experts providing evidence on behalf of submitters has shown a desire for more flexibility in the Plan, eg. so that the numerical values or standarised methods can be debated at a later date.

15. The technical recommendations to the POP are based on an open and thorough scientific programme which has been documented and presented to the Panel. My recommendation is to provide certainty through specified numbers and/or methodologies where possible and let the policies provide guidance on the application of these.

4. SURFACE WATER ALLOCATION

Core Allocation Limits in Schedule B

16. Throughout the One Plan process core allocation limits in Schedule B have been expressed in units of m^3/s. The use of the m^3/s numbers as their equivalent maximum daily limits was always intended.

17. The use of maximum daily rates of take is consistent with the use of the 1 day mean annual low flow (MALF) as a base statistic for the water allocation regime. There are many reasons that takes have rates of use on an instantaneous or hourly basis that are higher than if the water was abstracted evenly over the day. To allocate these on a m^3/s rate would reduce the amount of water allocable in the Region considerably, compared to using their maximum daily rate equivalents. This would significantly change the assessment of allocation status of catchments as presented in the original evidence of Raelene Hurndell (Appendix 1, page 124).

18. Therefore, <u>I now recommend that these core allocation limits are converted to units of m^3/day and expressed as maximum daily limits in Schedule B and that some controls be provided re the timing or rate of take on an instantaneous or maximum hourly rate of take</u>, as is current practice within Horizons surface water allocation consents. Further detail on this is provided in Section Four of my report below.

Minimum Flows and Allocation Limits for the Turitea Catchment

19. The minimum flow and core allocation limit for this subzone (Mana 11b) used in the POP were set via a “policy call”. This was addressed in the evidence of Dr Jack McConchie on behalf of Palmerston North City Council (PNCC) and subsequent caucusing with a view to developing a more scientific approach to determine a minimum flow. The Turitea subzone includes the water supply dams which are one component of the water supply for Palmerston North.

20. As a result of the caucusing <u>it was recommended to maintain a minimum flow of 0.041 m^3/s at the flow recording site Turitea at Ngahere Park.</u> This is recommended to replace the proposed wording in Schedule B of the POP for a minimum flow of 0.050 m^3/s at the Turitea at Ngahere Park flow recorder.

21. Also as a result of the caucusing a recommended core allocation volume of 37,000 m^3/day, equivalent to the current consent conditions, was agreed to. The recommended changes to the core allocation reflect an improved understanding of the effect of the dams on flushing flows and the setting of a higher minimum flow than is currently required in the catchment.

22. The decisions with regard to minimum flows and allocation limits for the Mana 11b subzone reflect a pragmatic decision, based on the available information from the various methodologies trialed to determine recommendations. Further detail on this is provided in Part Two below.

Allocation Methodology for Permitted Water Takes

23. The allocation methodology for permitted water takes used in the POP has been subject to comment from a range of submitters. To inform decision- making around various methodologies for determining the basis of permitted take rules, a short technical report has been prepared to demonstrate the application of these methods in two study catchments (the upper Manawatu and Mangatainoka). The report (Appendix 1) trials various non-consented take allocation mechanisms, eg. through per property or per hectare approaches, to determine the level of water that would be allocated through the different approaches. To indicate the relative size of the allocations under these mechanisms, each scenario compares the amount of non-consented allocation to the proposed core allocation limits for these areas. These study catchments are currently close to fully allocated based on proposed core allocation limits.

24. In my opinion, in assessing non-consented take mechanisms from a technical perspective, consideration should be given to:

(a) Differentiating between the likely level of uptake under various regimes and the levels of uptake that are theoretically possible, ie. if 15 m^3/day is allocated per property, it is unlikely that every property will use this full amount every day;

(b) Assessing whether the water is provided where it is needed, ie. what operations of a similar type would/would not require consent under the mechanism;

(c) Determining the overall level of allocation, ie. the level of core allocation plus the non-consented takes. Further, how the level of non-consented takes may change over time, eg. stock-drinking water needs may increase if there is intensification of stock numbers in the catchment;

(d) Understanding the effects of the total level of allocation on surety of supply for consented takes and the effects of the total level of allocation on the core allocation limits. These effects can be considered based on current levels of non-consented takes and how these might change into the future under the mechanism, eg. as per point (c) above with regard to intensification;

(e) The consequences of effects of non-consented take regimes on stream/river health at low flows at a range of scales, eg. what will the effects be at the subcatchment/catchment level? Further, will a non-consented take regime provide for some small streams to be dried up through cumulative non-consented takes; and what will be the effect of the total allocation at a range of flows on stream ecology at the local, subcatchment and catchment level?

Further information on these non-consented take scenarios is presented in Section 2.

National Environmental Standards

25. An update on the status of the Proposed National Environmental Standard (NES) for Water Measuring Devices was sought from the Ministry for the Environment (MfE) to inform the Panel. A summary of the MfE response is:

"*Since this policy approval and prior to a NES being drafted into regulations, MFE and MAF officials have investigated the use of an alternative form of regulations (made under section 360(1)(d) of the RMA) to give effect to the approved policy. This new proposal will be submitted for Cabinet's consideration before Christmas 2009. The proposed alternative regulations set the same minimum requirements, for measuring and reporting water taken by all water take consents, that were previously approved for the NES.*" Miriam Eagle, MfE (16 November 2009).

The statement is provided in full in Section 2 of my evidence below.

26. An update on the status of the Proposed NES on Ecological Flows and Water Levels was sought from MfE to inform the Panel. MfE provided the following statement:

"*Submissions on a proposed National Environmental Standard on Ecological Flows and Water Levels and alternative options closed in August 2008. Analysis of submissions has led to some changes to the options set out in the discussion document. A full cost-benefit analysis of the revised set of options began on 5 November 2009 and is scheduled for completion in early March 2010. The results of this analysis will inform decision-making on a preferred option, and also whether any additional work is required* *on the details of the proposal, prior to submission to Cabinet for its consideration later in 2010.*" Jason Holland, MfE (17 November 2009)

5. SURFACE WATER QUALITY

27. The supplementary evidence below clarifies a range of points in relation to water quality state and trends reporting as presented in my original S42A Report. This evidence is provided in response to comments by submitters. In summary, my assessment is that the information on water quality state as presented in my original S42A report is fit for the purpose of reporting water quality state in the Region. Further, the use of state and trends information combined is the best approach to inform decision-making, as opposed to some other experts' opinions that trends alone are more informative.

6. FARM STRATEGIES FOR CONTAMINANT MANAGEMENT

28. Evidence on behalf of Fonterra Co-operative Ltd suggests alternate limits for Table 13.2 of the POP. The catchment outcomes based on these alternate numbers have been calculated for the Upper Manawatu catchment and the Mangatainoka catchment, and are presented in Part Three of my evidence below.

7. PART TWO: RESPONSE TO ISSUES RAISED BY TECHNICAL EXPERTS

29. Table 2 below summarises the further technical supplementary reports presented by Horizons in its expert supplementary evidence. To avoid unnecessary repetition of material, Table 2 provides only a very broad overview of what each report addresses.

30. The supplementary evidence from Horizons has focused on issues raised by submitters' experts that are not covered in original evidence from Horizons, and areas that may require further explanation. Where issues raised by submitters' experts are considered to have been already covered in Horizons' original evidence, we have attempted to minimise repetition by not commenting on these issues through supplementary evidence. However, we are happy to address those issues and any others in response to any questions the Panel may have.

Table 2. Summary table of supplementary evidence provided by technical experts on behalf of Horizons.

Horizons supplementary evidence	Broad overview of material presented
OVERALL WATER MANAGEMENT FRAMEWORK	
Dr Jon Roygard	Overview of the technical supplementary evidence on behalf of Horizons, comments in relation to issues raised by submitters around water allocation, water quality and FARM strategies for contaminant management.
WATER ALLOCATION	
Joe Hay	Material in relation to Policy 6-18b (supplementary allocation). Discussion of methods for defining flushing flows, natural flow regime and significant departure from natural flow regime.
WATER QUALITY	
Kate McArthur	Comments in relation to issues raised by submitters around water quality state and trends, control of periphyton growth, values in relation to nutrient standards, reference water quality data and periphyton cover data. Recommended changes to Schedule D standards resulting from experts caucus are included. Changes to Schedule H are proposed as a result of further technical advice received.
Dr John Quinn	Presents analysis of the relationship between nutrients and periphyton at National River Water Quality Network (NRWQN) sites.
Dr Barry Biggs	Comments on issues raised by submitters around the use of effects-based versus reference-based standards, periphyton growth and potential limiting nutrients, natural versus land-use associated enrichment, seasonal application of nutrient standards and seasonality of periphyton growth, application of the periphyton-nutrient model to Horizons' Region, and uncertainty and adaptive management.
Dr Bob Wilcock	Provides clarification on control of nutrient in water bodies to control periphyton growth and best management practices. Includes information to support recommendations on changes to ammonia standards in Schedule D.
Dr John Zeldis	Comments on the effects of discharge of nutrients from the lower Manawatu River on estuarine and coastal ecosystems in response to submitters' comments. Includes a correction to recommended macro-algal cover standard for estuaries and the algal biomass standard in seawater.
Graham McBride	Comments on the use of water quality trend analysis and factors which can influence water quality trends, in response to submitter evidence.
DISCHARGES TO LAND AND WATER	
Hamish Lowe	Provides a comparative review of recent and projected municipal wastewater treatment plant upgrades, highlighting the issues addressed by the upgrades and their costs. The second part of Mr Lowe's evidence provides a commentary on the limited extent to which land application of municipal wastewater has been pursued in New Zealand. These two issues are summarised in a recent report titled Recent History and Rationale for Wastewater Treatment Plant Upgrades (November 2009) that CPG Ltd has prepared for Horizons and which is attached to and forms part of Mr Lowe's evidence.
Dr David Houlbrooke	Provides further information compiled since the preparation of his S42A report on farm dairy effluent (FDE) management. This evidence also addresses pond sealing requirements for FDE storage.

Horizons supplementary evidence	Broad overview of material presented
FARM STRATEGIES FOR CONTAMINANT MANAGEMENT	
Peter Taylor	Reports on additional analysis of four of the 21 test FARM strategies and includes a replacement for Table 11 in Mr Taylor's original evidence
Roger Parfitt	Further clarification of items in Mr Parfitt's original S42 Report
BEDS OF RIVERS AND LAKES	
James Lambie	Responds to Fish and Game and DoC evidence regarding permitted activity provisions in Table 16.1. Responds to DOC evidence regarding additional SOS-A and a name change to SOS-R. Responds to DOC and TMI evidence regarding the Environmental Code of Practice for River Works
BIODIVERSITY	
Fleur Maseyk	Responds to Palmerston North City Council (PNCC) evidence regarding classification of Turitea Dams under Schedule E. Responds to PNCC evidence and comments on Horowhenua District Council evidence regarding classification of wetland habitat that receives stormwater discharge under Schedule E. Refers to evidence presented to the Biodiversity and Heritage Hearing Panel.

8. PART THREE: RESPONSE TO ISSUES RAISED BY TECHNICAL EXPERTS

31. Table 3 below summarises the issues raised by submitters that I am responding to and outlines any resolution or explanation that is necessary.

32. I have focused on issues raised by submitters' experts that are not covered in my original evidence or require further explanation. Where issues are raised by submitters experts that I consider are already covered by material in my original evidence I have attempted to minimise repetition by not commenting on it here. However, I am more than happy to address those issues in response to any questions the panel may have.

Table 3. Summary table of matters raised by technical experts in evidence on the Water provisions of the Proposed One Plan.

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
OVERALL WATER MANAGEMENT FRAMEWORK			
The One Plan approach is "one size fits all"	Dr Mike Scarsbrook and other submitters	Disagree	The overall framework of the water management approach in the Proposed One Plan (POP) provides for management at a localised level through the identification of values and standards within specified Water Management Zones and reaches of river within these Water Management Zones. This is addressed in my original evidence in Chapter 2.
WATER ALLOCATION			
Access to publicly available information on the volume of core allocation that is currently available in various Water Management Zones/ Subzones	Carmen Taylor Para 52 & 53	Disagree	The levels of current allocation in the Region's Water Management Zones/Subzones are updated and provided publicly each day on Horizons' WaterMatters website (<u>www.horizons.govt.nz/WaterMatters</u>). Using this information volumes available can easily be calculated. Planned upgrades to this website will provide more specific information on current allocation in relation to core allocation volumes. This information does not, however, include any applications that are currently being processed by Horizons Regional Council. Calculations of the volumes available (accounting for existing applications, or not) can be obtained by contacting Horizons staff.
Level of prescription required for water metering devices inconsistent with NES for Water Measuring Devices	Carmen Taylor Para 40- 46	Disagree	The NES for water metering is not yet gazetted. This matter was addressed in my original evidence (Section 4.10.1 page 58). In section 4.10.1 of my original evidence, it is stated that MfE staff have indicated that s330 of the RMA may be utilised in place of the proposed NES. Clearly this is a mistake and the appropriate section of the RMA is s360. Miriam Eagle, who co-ordinates the implementation taskforce for the proposed measurement of water takes for MfE, has, at my request, provided the following statement: "*A policy proposal for a National Environmental Standard on Measurement of Water Takes was approved by the previous Cabinet in February 2008. Since this policy approval and prior to a NES being drafted into regulations, MFE and MAF officials have investigated the use of an alternative form of regulations (made under section 360(1)(d) of the RMA) to give effect to the approved policy. This new proposal will be submitted for Cabinet's consideration before Christmas 2009. The proposed alternative regulations set the same minimum requirements, for measuring and reporting water taken by all water take consents, that were previously approved for the NES. The benefit of the proposed alternative approach is that it negates the need for reviews of consents, which would be required under an NES, and so avoids imposing unnecessary transaction costs for regional councils and end-users.* *The proposed regulations set equivalent <u>minimum</u> standards for the measuring and reporting of water take records, and for the installation and verification of systems to collect these records. Like the proposed NES, the proposed regulations will allow regional councils to set higher standards as necessary.*" Miriam Eagle, MfE (16 November 2009). The above statement reiterates the minimum standard required by the proposed regulations. Horizons' approach to

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			water metering is documented in 4.10 of my original evidence (pages 58-65). The need for this type of monitoring system, which determines any issues in near real time, is reiterated by statements such as those of David Bridges, who presents information for the Territorial Authority Collective (Para 29 page 8), "*A key issue is the lack of accurate and informative data on actual usage. For example for one water take that renewal of consent was being sought 3 years of data, when analysed provided on 3 months of data that could be relied upon.*" Further to that statement, I would like to reiterate the need for accurate water use data from which to naturalise flow statistics to inform future water allocation decisions. Further to the comments on the measurement of water use, Carmen Taylor also includes reference to the discharge volumes to water. To accurately calculate naturalised flows and impacts of discharges, measurement of discharge volumes provides very useful information. This is outlined in my original evidence in section 4.10 (pages 58-65) and section 6.18.3 (page 139).
Turitea catchment minimum flows	Dr Jack McConchie	Agree (in part)	At the caucusing meeting it was agreed that the appropriate recording site in Mana 11b should be the Turitea at Ngahere Park flow recorder (as is specified in Schedule B in the POP). Further discussion related to the appropriate minimum flow and core allocation limit to be placed in Schedule B. Horizons' technical reporting fully acknowledges that the numbers in the POP were a "policy call". In my opinion, this is the only minimum flow that has been set in that way in Schedule B. To determine the minimum flow on a more scientific basis, Dr McConchie completed an assessment of flows in the Turitea catchment, including modelling flows using information from nearby catchments. The caucusing meeting agreed to establish a naturalised mean annual low flow (MALF) for the flow site Turitea at Ngahere Park. A naturalised MALF is that which would be recorded at the Ngahere Park recorder if the dams were not in the catchment and no abstraction was occurring. A methodology to determine this naturalised MALF was agreed. Information from a nearby catchment (ie. the Kahuterawa) and agreed methodologies were to be used to appropriately compensate for differing variables between the Kahuterawa and Turitea catchments. Alternative methods to establish this naturalised MALF were also discussed and it was agreed to also trial these methods. Dr McConchie's original evidence and supplementary statement of evidence documents these methods and outcomes. Dr McConchie's supplementary statement of evidence recommends that the flow record from the Turitea itself be utilised to determine the MALF for the Turitea at Ngahere Park flow site. From my perspective this is a less than ideal, but pragmatic recommendation following the trialing and assessment of a range of alternative methodologies. The MALF derived from this process is 0.041 m^3/s (41 l/s).

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			As agreed in the caucusing, this MALF has then been used to determine a minimum flow using the relationship of MALF * 0.909 established in my original evidence (Figure A, Box 11, page 48). Using this relationship, the minimum flow recommendation for a MALF of 0.041 m^3/s (ie. 41 l/s) is 0.037 m^3/s. Dr McConchie states (in para 4.6) in his conclusions that the MALF of 41 l/s is likely to be less than the MALF under the natural flow regime. To reflect this, Dr McConchie's conclusions (para 4.7) recommend the maintenance of a MALF at Ngahere Park (ie. 41 l/s rather than the 37 l/s) calculated by the adjustment from MALF to minimum flow. I agree with the recommendation for maintenance of a minimum flow of 0.041 m^3/s (41 l/s) at Ngahere Park and recommend this be the value that is placed in Schedule B for this zone. The Turitea subzone includes the water supply dams which are one component of the water supply for Palmerston North. Maintenance of a minimum flow means that this system differs to the way that other public water supplies are recommended to operate under the POP. For the majority of public water supplies, provisions around restrictions on volumes abstracted are triggered when the flow drops below the minimum flow. The maintenance of the minimum flow, as recommended by Dr McConchie, implies that the flow will always be at or above 41 l/s, and therefore such provisions would not be triggered for the PNCC take. I have not made any recommendations in relation to the appropriate volumes to flow from the dam in order to meet this minimum flow requirement, as this is outside of the scope of the setting of minimum flow for the subzone and is a matter of detail for the consent process. Based on my knowledge of the operation of Turitea dams in the catchment and discussions with PNCC staff and Dr McConchie, I have gained an appreciation of the effects of the dam structures on flushing flows. In summary, during high flow events, once the dams are full they have little effect on the flushing flows. The major effects occur when the dam reduces these high flows through storage of water that would otherwise have flowed downstream. Taking into account the long-term nature of the existing set up and the increased minimum flow agreed to, I agree with Dr McConchie's assessment of a 37,000 m^3/day core allocation limit for this catchment. It is my opinion that the maintenance of a minimum flow of 41 L/s in the Turitea catchment will somewhat offset the reduction in flushing flows due to the impoundment of water during freshes. Again, this recommendation reflects a pragmatic approach based on available knowledge. More detailed analysis could be completed in relation to this.
Permitted takes should be allocated on a per hectare basis rather than a per property basis	Sean Newland Para 119 -132 Gerard Willis Chris Pepper		To further understand various mechanisms provided for non-consented takes within the catchment a scenario-based analysis of various non-consented type regimes has been completed (Appendix 1). The discussion of these scenarios and mechanisms for non-consented takes is presented in the paragraphs following this table.

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
Water use efficiency criteria – Feilding township has lost two wet industries over the last 2 years and this capacity has not been taken up by others	David Bridges	Disagree re capacity of others to take up this allocation	The statement that the available capacity from Feilding has not been taken up is correct. However, there is a demand in the Oroua catchment for increased surface water abstraction for irrigation and for provision of further water for rural water supplies. Further, Manawatu District has declined approaches by the Kiwitea water supply (which abstracts from the Oroua River) to obtain part of the capacity from the Feilding water supply consented volumes to provide for further allocation for the rural water supply during times of water use restrictions in the Oroua catchment.
WATER QUALITY			
Water quality maps are not appropriate to represent water quality state in the Region	Dr Mike Scarsbrook Para 7.1 & Para13	Disagree	The water quality indicator maps produced by Horizons as a part of its State of the Environment Report 2005 provide a representation of water quality based on available information. These maps are discussed further in my original evidence in section 6.7, pages 99 to 101. The maps were generated to display the percentage of time a particular location in the catchment met (or exceeded) a particular standard. The water quality information from a particular location was used to display information for that point as a summary of the cumulative water quality for that area of a catchment. In doing this, the indicator maps showed results for the particular location and used the same colour for the area upstream of this point. These State of the Environment (SoE) indicator maps provide a useful tool to identify easily on a regional scale map which indicators are or are not an issue in a particular area of the Region. Dr Scarsbrook suggests that these maps exaggerate the water quality state in the Region. This is also linked to statements by Dr Scarsbrook with regard to the number of reference sites and the high background levels of some parameters in the Region. These are addressed in the sections immediately below this one. My perspective on this is that the SoE indicator maps have been presented to reflect the available information. The colouring of the whole catchment in these indicator maps has been done to indicate water quality based on the summary information available from the downstream point. In some cases this will over-represent poor water quality state and in other cases this will under-represent poor water quality state. Since completing the State of the Environment Report in 2005, Horizons has upgraded its monitoring network to include about 65 SoE water quality monitoring sites and to monitor upstream and downstream of 36 major discharges into the Region's rivers. This improved monitoring network provides a greater level of resolution from which to define water quality state. The information from this network is available publicly at many levels of specific detail to display the water quality state. Figure 1 to Figure 5 below show various cases where the SoE sites would under-represent or over-represent how poor the state of water quality would be in the Region. A key point to observe in these graphs is that water quality

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			varies, as shown by the box plot graphs in relation to the standards. Percentage of time when the standard is met is only one indicator of water quality used by Horizons. In summary, the water quality indicator maps are fit for purpose and reflect water quality state based on available information. While they may under-represent or over-represent the water quality state in the Region's water bodies, they do accurately reflect the conditions sampled at the monitoring points in a specific river which are influenced by what occurs upstream of these points.
The number of reference sites is insufficient and background levels of some parameters are high	Dr Mike Scarsbrook	Disagree	The adequacy of the number of reference sites in the Region is questioned by Dr Scarsbrook. Horizons has recently completed a major upgrade of the water quality monitoring network, which includes a number of reference sites. These are complemented by sites upstream of discharges in order to separate out the relative contributions of point source inputs from non-point source inputs. With more than 100 monitoring sites, Horizons' Region now exceeds the number of sites in the national network administered by NIWA that is used for national State of the Environment reporting, which has 77 sites. To further clarify the differing water quality throughout catchments and the background levels of nutrients at reference sites, the Horizons science team has prepared graphs showing changes to water quality for several sub catchments of the Region. These graphs are presented in the supplementary evidence of Kate McArthur, along with maps identifying the location of the sites presented.
Analysis of water quality state is just a snapshot in time; analysis of changes or trends over time are often more informative for resource managers	Dr Mike Scarsbrook Para 7.4	Disagree	Horizons' State of the Environment indicators provide a snapshot over the period from 1997 to 2004. Assessments of state used in other parts of Horizons technical evidence are over a specified time period or in some cases a specified number of samples. For example, Horizons' WaterQualityMatters website provides information for the full record of samples as well as the last 12 months and the most recent sample. Water quality trends are informative tools when combined with state of water quality information. For example, some water quality trends show declining water quality over a longer term period, (eg.19 years), though the more recent trends for a 10-year period show some improvement. However, despite the recent improvement, the state is worse than it was 19 years ago. The key point of reference for the trend is the state of water quality. This can be defined by comparison with other sites in New Zealand, as has been done in the Ministry for the Environment's recent league tables, or by comparison to the desired state (eg. the water quality standards proposed in Schedule D). One method for doing this is to compare the mean or median concentration with the desired target or water quality standard. Alternatively, the range of values that occur at a site may be shown in relation to the desired target or water quality standard, and this type of reporting has been completed as part of preparation of technical reports to inform the One Plan process.

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			In summary, combined information from state and trends provides useful information for resource managers. Horizons' science team has prepared a video file of images to demonstrate how water quality state differs in relation to water quality standards over a catchment level at different time. It shows, over a range of sampling events, how *E. coli* levels change within a catchment between the monthly sampling events over a 12-month period. This video file is appended to this evidence. To further clarify the differing water quality trends over various time periods, Horizons' science team has prepared maps showing the water quality trends from the Ballantine & Davies-Colley (2009) report. These maps, presented in the supplementary evidence of Kate McArthur, present spatially the trends at various sites over differing periods. These trends, shown overlaying the target catchments specified in Rule 13.1, provide some further context of the trends in relation to the target zones identified in this Rule. This is similar to the approach to state presented in Maps 10 and 11 on pages 175 and 176 of my original evidence.
"Analysis of recent trends in the Region's rivers indicates that despite land use intensification over the last 10 years, water quality trends have stabilised or improved."	Dr Mike Scarsbrook Para 7.4 & Para 53	Disagree	The statement by Dr Scarsbrook that, despite land use intensification trends, water quality has improved oversimplifies the influences on water quality trends. I note that factors other than intensification in the catchment may have influenced this positive trend, eg. climatic conditions and improvements to industrial, municipal and agricultural point source discharges in those 10 years, to a level greater than any further pressures provided by intensification. The supplementary evidence of Graham McBride and Kate McArthur provides more detail on water quality trends and the factors that can influence these.
Limiting nutrients and methodologies to assess these	Dr Mike Scarsbrook Para 32	Disagree	The analysis in Roygard & McArthur (2008), and further elaborated on in the evidence of Jon Roygard (section 6.13.4, pages 113-119) clearly identifies differing methods of assessing nutrient limitation. These methods include uses of absolute concentrations, using the originally recommended more stringent nutrient standards, and the more pragmatic standards in the POP. The method also presents the use of ratios of soluble inorganic nitrogen/dissolved reactive phosphorus (SIN/DRP). The broad generalisation by Dr Scarsbrook that phosphorus is always limiting does not hold true and analysis of the data sets shows that at times, particularly at low flow, nitrogen is the limiting nutrient. Dr Biggs, Ms McArthur and Dr Wilcock provide supplementary evidence in relation to limiting nutrients.
Adequacy of the amount of data available to determine the background levels of periphyton in the Region's rivers, or for use in validating the model used to aid definition of nutrient standards that seek to control periphyton	Dr Mike Scarsbrook Para 7.7	Disagree	Horizons' periphyton monitoring programme and upgrades to this are discussed in my original evidence (section 6.10.4, page 107). Further information from the recently upgraded periphyton monitoring programme has been included in the supplementary evidence of Barry Biggs and Kate McArthur. John Quinn provides analysis of the periphyton data at the NIWA national network sites within Horizons' Region, demonstrating the relationships between nutrient concentrations and periphyton cover.

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
Are point source inputs or non-point source inputs to blame for degraded water quality state?	Various submitters		A range of submitters raise questions in relation to the importance of either non-point source or point sources to overall water quality state and trend. This is addressed in my original evidence (section 6.15 pages 126-132). To reiterate the key points from that evidence, the relative contributions are catchment specific. In the upper Manawatu and Mangatainoka catchments the analysis clearly shows that for SIN and DRP the predominant overall source of the nutrients is from non-point sources. However, at low flows the point source component becomes the dominant contributor. A major driver behind the upgrades to the SOE and discharge monitoring network has been to provide further information regarding the relative contributions from non-point sources and point sources across a range of flows.
Does Horizons' analysis of catchment nutrient loads overestimate the contribution of non-point source loads and underestimate point source loads? Were the natural background loads of nutrient in rivers considered?	Dr Mike Scarsbrook Para 61	Disagree	Dr Scarsbrook suggests the methodology for calculating the relative non-point source load/ point source load contributions underestimates the point source load contribution, particularly as the background loads from land being used for intensive agriculture are not accounted for. I disagree with this assessment. With the recent information from the discharge monitoring programme, considerable information is available to calculate the relative inputs from the major discharges. The methodology to calculate point source loads (Roygard & McArthur, 2008) likely overestimates the relative contributions of point sources at a catchment level. This is due to the assimilation (including via uptake by periphyton) that occurs between sites downstream of discharges and the downstream SoE monitoring sites. For example, Figure 1 to Figure 5 below show data from a selection of discharges in the Region. The assimilation of point source inputs can be observed in several of these data sets. The background losses from the intensively farmed land are included in the totals determined for these areas by the analysis of Clothier *et al*. (2007) for nitrogen and Parfitt *et al*. (2008) for phosphorus. I also note that the methodology for calculating the relative contributions between various sources of non-point source inputs in Clothier *et al*. (2007) and Parfitt *et al*. (2007) did factor into account all sources, including background sources from native forest.
That sediment and faecal contamination are big issues and nutrient is a lesser issue	Dr Mike Scarsbrook Para 44.2	Disagree	The POP addresses a range of water quality parameters through the provisions of the Plan. An easy way to demonstrate this is the list of parameters that have recommended standards in Schedule D to provide for the life-supporting capacity values and a number of other values. For example, the approach of the FARM strategy for contaminant management has been proposed in order to address non-point source inputs of nitrogen, phosphorus, faecal contamination and sediment loss.

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			The Sustainable Land Use Initiative (SLUI), which was discussed in more detail in relation to the Land provisions of the POP, will provide benefits in terms of water clarity improvement, and sediment and phosphorus reduction, through reducing hill country erosion. The SLUI initiative and the priority catchments for this work are briefly discussed in my original evidence in section 7.4 (pages 172 and 175).
FARM STRATEGIES FOR CONTAMINANT MANAGEMENT			
Revised catchment outcomes based on the revised Table 13.1 N loss limits provided by Gerard Willis for Fonterra	Gerard Willis Attachment 4 page 43		Box 1 below presents the calculated catchment outcomes based on the Value A numbers, for N loss limits in the revised Table 13.2 provided by Gerard Willis. The catchment outcomes from the version of Table 13.2 originally notified are presented in Box 59 of my original evidence. The differences between these two approaches are compared in the following two tables (Table A and Table B).

Table A: Total catchment load outcomes for the Upper Manawatu catchment based on the Value A numbers for N loss limits in the revised Table 13.2 provided by Gerard Willis and the values in the POP.

Upper Manawatu	Total catchment load (tonnes/year)		Difference	
	As originally notified	Fonterra revised version	Tonnes/year	Percentage
Year 1 (when Rule comes into force)	859	1080	221	26%
Year 5	824	1029	205	25%
Year 10	773	962	189	24%
Year 20	751	751	0	0%
Standard load limit	358			
Measured load	745			
NPS load	729			

Matter raised by submitters' experts	Expert	Degree of agreement	Explanation/ outcome
			Table B: Total catchment load outcomes for the Mangatainoka subcatchment based on the Value A numbers for N loss limits in the revised Table 13.2 provided by Gerard Willis and the values in the POP.

Mangatainoka	Total catchment load (tonnes/year)		Difference	
	As originally notified	Fonterra revised version	Tonne/year	Percentage
Year 1 (when Rule comes into force)	360	426	66	18%
Year 5	334	407	73	22%
Year 10	311	380	69	22%
Year 20	301	301	0	0%
Standard load limit	266			
Measured load	603			
NPS load	600			

Non-consented take scenarios

Introduction

33. Several submitters have commented on the provisions for allocation in relation to non-consented takes. To further understand various allocation mechanisms for non-consented takes some scenario-based analysis has been completed to modelled the significance of these at the catchment scale under different policy regimes in two study catchments. The study catchments chosen were the Upper Manawatu (upstream of the Hopelands recorder site) and Mangatainoka subcatchment of the Manawatu catchment. Both catchments are very close to fully allocated (see original evidence of Raelene Hurndell Appendix 1, page 125).

34. The scenarios for non-consented takes assume all uses for a specific purpose, eg. stock drinking water and dairy-shed washdown, are included in the non-consented regime. However, due to current practice, some of the core allocation limit is actually allocated to stock drinking water and dairy-shed washdown consents. Horizons has had an active programme of working with landowners to establish consents for water requirements over the current permitted take thresholds in Horizons' current suite of Plans (15 m^3/day for surface water and 50 m^3/day for groundwater). Typically the operations with consents for stock drinking water and/or dairy-shed wash down are dairy farms. Many of these consents have been established through the dairy grace period (as discussed in the evidence of Alison Russell) or as part of standard compliance inspections of dairy farms.

35. Estimating the current demand for water for some of these uses provides a benchmark to compare with the established core allocation limits and to estimated overall allocation in the catchment at present, ie. the sum of non-consented use and the current consented volume. For the purposes of this analysis the core allocation limit has been used in place of the current consented volume as the study catchments are close to fully allocated and the core allocations reflect the proposed limits on consented volumes.

36. In my opinion, in assessing non-consented take mechanisms from a technical perspective, consideration should be given to:

(a) Determining the overall level of allocation, ie. the level of core allocation plus the non-consented takes and the effects of the total level of allocation on the core allocation limits. Further, consideration needs to be given to how the level of non-consented takes may change over time, eg. stock drinking water needs may increase if there is intensification of stock numbers increase in the catchment;

(b) Understanding the effects of the total level of allocation on surety of supply for consented takes. These effects can be considered based on current levels of non-consented takes and how these might change into the future under the mechanism, eg. as per point (a) above with regard to intensification;

(c) The consequences of effects of non-consented take regimes on stream/river health at low flows at a range of scales, eg. what will the effects be at the subcatchment/catchment level? Further, will a non-consented take regime provide for some small streams to be dried up through cumulative non-consented takes, and what will be the effect of the total allocation at a range of flows on stream ecology at the local, subcatchment and catchment level?

(d) Differentiating between the likely level of uptake under various regimes and the theoretically possible levels of uptake, ie. if 15 m^3/day is allocated per property, it is unlikely that every property will use this full amount every day; and

(e) Assessing whether the water is provided where it is needed, ie. what operations would/would not require consents under the mechanism.

Understanding the effects of the total level of allocation and the impacts of these on the core allocation limits.

37. Understanding the recommended core allocation limits in the POP and the takes that occur but are not consented is a first step to assessing the impact of non-consented takes on overall allocation in the catchment, and the impact of these on core allocation limits.

38. In an ideal situation, the volumes taken and timing of non-consented takes would be known and could be calculated into the water allocation regime. If these allocations were known, the volume for these non-consented takes could be allowed for within a total allocation to inform the development of the core allocation limits, eg. by defining the desired total level of allocation then subtracting the non-consented takes to determine the core allocation.

39. As the actual volumes and timing of non-consented takes is unknown, an alternate approach was used to develop the proposed core allocation limits for the POP. This approach assumed that the flow statistics generated for the catchment were measured after the abstraction, based on the historic level of any non-consented takes. In accounting for historic levels of abstraction for such purposes, the approach does not fully account for intensification in the catchment. In the absence of better information on

the level of non-consented takes, this presents a pragmatic way to determine levels of core allocation with some consideration of the non-consented abstraction.

40. Therefore, the proposed core allocation limits have accounted for historical levels of abstraction by takes outside of the consented regime. Any allocation above these historic levels is likely to reduce the surety of supply for consented users, ie. increase the frequency of minimum flows (see below). Any mechanism for maintaining non-consented takes close to these historic levels will not reduce the surety of supply for consented users. If allocation for non-consented takes increases over these historic levels, consideration should be given to reducing the core allocation limits in order to provide the same level of surety of supply to users.

41. Of the scenarios presented of Appendix 1, Scenarios 3 & 4 show the closest estimates to the historic levels of abstraction. Scenarios 3 & 4 estimate current demand for stock drinking water and, in the case of Scenario 4, stock drinking water and dairy-shed washdown. Scenarios 3 & 4 likely overestimate historical demand as provided for in setting core allocation limits, due to intensification in the catchment. That is, the numbers used to calculate stock drinking water requirements and dairy-shed washdown requirements are based on levels of stocking in recent years, not the long-term historic stocking rate that is accounted for in the flow statistics.

42. Scenarios 11, 12 & 13 (in Appendix 1, and discussed further below) provide a mechanism of allocation on a per hectare basis up to specified maximum limits for properties over a certain size. This mechanism could be tailored to provide for the needs for smaller properties, while providing a cap on overall volumes of allocation. A cap on total allocation provides control on surety of supply for consented users, stability in levels of allocation to enable defining of core allocation limits, and a fixed volume to consider the effects of takes at low flows at a catchment level. Also, effects at a local scale of larger takes requiring consenting can be assessed. This type of approach could be done in a way that provides similar levels of allocation to the historic long-term use by these non-consented takes and would not provide further pressure on the resource at low flows, nor would it impact on surety of supply for other users or the established core allocation limits. <u>In my opinion, this type of approach is the preferred approach</u>, <u>taking into account the considerations outlined in paragraph 24 above.</u>

43. It is noted that due to the calculation methodology used, Scenarios 11,12 & 13 will overestimate the non-consented allocations of an allocation mechanism on a per hectare basis, up to a certain property size. This is due to the calculation methodology

using a per hectare mechanism through property size categories. For example, all properties between 1-4 ha in size were allocated the volume required for a 4 ha property.

The effects of the total level of allocation on surety of supply for consented users

44. The impact of increased non-consented use is reduced surety of supply for consented users as minimum flows will occur more often if more water is abstracted from the rivers of the catchment during low flow periods. Analysis of increased levels of allocation on the frequency of minimum flows for the two study catchments is presented in the original evidence of Raelene Hurndell (Upper Manawatu, Table 19, page 45 and Mangatainoka, Table 25, page 54). At proposed levels of core allocation:

(a) The frequency of minimum flows at the Manawatu at Hopelands site is predicted to be in the order of 23 days a year on average with a range of up to 80 days per year. It is recognised that these are likely overestimates[1].

(b) The frequency of minimum flow events at the Mangatainoka at Pahiatua site is predicted to be in the order of 16 days a year on average with a range up to 80 days per year. It is recognised that these are likely overestimates[2].

Effects on abstraction pressures during low flows

45. The mechanism of Minimum Flows for reducing the abstractive pressure on water bodies works well the Upper Manawatu case study example. This is due to a large proportion of the consented volumes being used for irrigation. Irrigation takes are required to cease at minimum flow[3]. This considerably reduces the volume able to be abstracted when the river is below minimum flow.

46. In the Mangatainoka catchment, there is less of a reduction in pressure from consented water takes at Minimum Flow. This is due to consented use being predominately for public water supply and industry.

1 These statistics are likely overestimates as the flow at the Hopelands site has not been naturalised for historic abstraction by consented takes. Consented takes in this area increased from about 10% of the mean annual low flow (MALF) in 1997 to around 30% of the MALF in 2004. The flow record starts in 1989, so the earlier part of this flow record is not likely to be as heavily influenced by the level of abstraction as the more recent data.

2 These statistics are likely overestimates as the flow at the Pahiatua Town Bridge site, and the former site at Suspension Bridge, in this catchment have not been naturalised for historic abstraction by consented takes. Consented takes in this area have been relatively stable over time, although actual use by these has likely fluctuated. Consented water use in the Mangatainoka is predominately for public/rural water supply (Eketahuna, Pahiatua, Pleckville rural water supply scheme) and industrial use (DB breweries and Fonterra Pahiatua). There are two irrigation takes in this catchment. These irrigation takes were established in the later part of the long-term (over 50 years) of flow record for the Mangatainoka.

3 Based on current consent conditions and proposed provisions of the One Plan.

47. Any takes outside of the consented regime in the Upper Manawatu and the Mangatainoka place further pressure on the river during minimum flows. Any increase in the non-consented takes will add to this pressure.

48. At a more localised scale, cumulative non-consented takes have been known to dry up small streams. In one example of this, during a low flow event, Horizons received a complaint about an upstream land owner irrigating within permitted take limits at a time when downstream users were unable to obtain stock water.

Results from the scenarios of non consented use allocation mechanisms

49. Appendix 1 presents 15 scenarios of water demand under a range of non-consented take allocation mechanisms. It is noted that the scenarios completed as a part of this analysis are not an exhaustive list of the possible scenarios to model. Further scenarios can be modelled for the Panel upon request.

50. Scenario 1 models the theoretical levels of allocation possible similar to the proposed Rule (and the existing Rule under the POP's provisions for land and water for surface water takes), assuming all properties can take 15 m^3/day of surface water. This scenario could potentially allocate the equivalent of 77% or 130% of the core allocation limits for the Upper Manawatu or Mangatainoka respectively. In all likelihood these levels of allocation would never be taken up due to:

(a) The consented water takes in these catchments, eg. Dannevirke, Eketahuna and Pahiatua town supplies and the rural water supplies portions of these takes, and the rural water supply schemes, eg. Pleckville rural water supply.

(b) The inability of all properties to access surface water.

51. Scenario 2 repeats Scenario 1, demonstrating 30 m^3/day per property for each property in the catchment similar to the volumes mentioned in a proposed Rule (subject to conditions). This scenario is highly unrealistic given the provisions of the proposed Rule and the issues discussed as a part of Scenario 1 above.

52. Scenario 3 (allocation by sector) is likely the closest estimate of the actual current peak daily use for stock water by the dairy sector and sheep and/or beef farming land in these catchments, excluding use for dairy-shed washdown. This likely overestimates the historic average use in the catchment that is provided for in the setting of core allocation limits. The overestimation is due to intensification of stocking rates in the catchment over time.

53. The mechanism of allocation by sector has merit for providing water in the right amounts where it is needed, in a way that is likely to be nearly fully taken up. The method does not provide for any other uses, eg. domestic use or dairy-shed washdown. This method does not allocate a defined volume at a catchment scale as the relative area of some sectors could change considerably. This is investigated in Scenario 5, which shows scenarios for increased dairy farming in the Upper Manawatu catchment.

54. Scenario 3 estimates requirements for stock drinking water on a per sector basis at a rate to provide the volumes required for that sector. Water use for stock-drinking water for these sectors sums to the equivalent of 11% and 15% of the core allocation in the Upper Manawatu and Mangatainoka catchments respectively. This assumes these takes are solely outside the core allocation limit. The overall water use in the Upper Manawatu would equal the core allocation limit 83,808 m^3/day (0.970 m^3/s) plus the volume 9,583 m^3/day for stock-drinking water. Total water use would equal 93,391 m^3/day. This total use figure assumes (for this scenario) that all dairy-shed washdown use would be consented as a part of core allocation. The total water use figure includes the water use for the purposes of public water supply that is consented in this area, including Dannevirke water supply. However, it does not account for any non-consented domestic use.

55. Scenarios 3 and 4 calculations are completed by sector, by hectare and by average stocking rates. Specifying the allocation rate based on stocking rate could theoretically provide for the farms with greater than average stocking rates could and this would be compensated by those with less than average stocking rates. It is recognised that stocking rate information is not readily available to the Horizons to assess compliance. Changes in catchment level totals allocated under this type of mechanism could increase due to intensification in terms of stock/ha if this type of approach was used. If these levels of total allocation increase, there may be effects on surety of supply or core allocation limits as outlined in the sections above.

56. Scenario 4 (allocation by sector) is likely the closest estimate of the sum of current peak daily use for stock water and dairy-shed washdown by the dairy sector, and stock-drinking water by the sheep and/or beef farming sector in these catchments. This estimate likely overestimates the historic average use in the catchment provided for in the setting of core allocation limits, due to intensification over time. This mechanism of allocation has its merits for providing water in the right amounts where it is needed, in a way that is likely to be nearly fully taken up. The method also does not provide for any other uses, eg. domestic use. This method does not allocate a defined volume at a

catchment scale as the relative area of some sectors could change considerably. This is investigated in Scenario 6, which shows scenarios for increased dairy farming in the Upper Manawatu catchment.

57. Under Scenario 4, the water used for stock drinking and dairy-shed washdown, sum to the equivalent of 17% and 24% of the core allocation in the Upper Manawatu and Mangatainoka catchments respectively. If all of these takes are solely permitted (ie. outside the core allocation limit),.the overall water use in the Upper Manawatu would equal the core allocation limit 83,808 m^3/day (0.970 m^3/s) plus the volume 13,897 m^3/day for stock-drinking water and dairy-shed washdown, ie. total water use would equal 97,705 m^3/day. This total use figure includes the water use for the purposes of public water supplies that are consented in this area, including Dannevirke water supply. However, it does not account for any non-consented domestic use.

58. Scenarios 5 and 6 increases the area of dairy farming from 17% to 25% in the Upper Manawatu catchment and re-runs the allocation by sector scenarios of Scenarios 3 and 4. These rates of intensification are based on the intensification scenarios outlined by Clothier *et al.* (2007) for the Upper Manawatu catchment.

59. Scenario 6 shows this land use intensification scenario including dairy-shed washdown. This level of intensification increases the overall water demand for stock drinking and dairy-shed washdown from 13,897 to 18,126 m^3/day. Should such an increase occur the options include:

(a) Allowing this to add to overall total allocation. This results in a 4.4% increase in overall water use and would reduce surety of supply to irrigators.

(b) Reducing the core allocation by 4,229 m^3/day (0.050 m^3/s). This is equivalent to the rate required to irrigate 107 ha at 4 mm/day or approximately half the maximum daily limit for the water supply for Dannevirke.

60. Scenarios 7 to 10 trial the options of a per hectare allocation with every hectare receiving the same amount of allocation.

61. Scenario 7 allocates on a per hectare basis for the needs of dairy cows' peak drinking water requirements. Allocation at this level would be equivalent to 32% of the core allocation limit in both the Upper Manawatu and the Mangatainoka. The actual use of this level of allocation may not however be realised, given the whole catchment is not used for dairy farming. This scenario would require all dairy farms to obtain consent for washdown from the core allocation limit. Depending on the wording of the rule, a per

hectare allocation on this basis may require those with above average stocking rates to obtain consents.

62. Scenario 8 allocates on a per hectare basis for the needs of dairy cows' peak drinking water requirements plus an allowance for dairy-shed washdown. Allocation at this level would be equivalent to 65% and 64% of the core allocation limit for the Upper Manawatu and the Mangatainoka catchments respectively. The actual use of this level of allocation may not however be realised, given the whole catchment is not used for dairy farms. This scenario would provide all dairy farms with average stocking rates with all of their stock drinking water and dairy shed washdown water needs. Depending on the wording of the Rule, a per hectare allocation on this basis may require those with above-average stocking rates to obtain consents.

63. Scenario 9 allocates on a per hectare basis for the needs of peak drinking water requirements for a typical sheep and/or beef farm. Allocation at this level would be equivalent to 9% and 10% of the core allocation limit in the Upper Manawatu and the Mangatainoka respectively. The actual use of this level of allocation would likely be close to be fully realised. This scenario would not provide the full volumes required for the dairy farms in the catchment and would likely require them to obtain water for stock drinking water and dairy-shed washdown through some other mechanism. Depending on the wording, a non-consented take regime on a per hectare allocation on this basis may not provide for those sheep and/or beef farms with above average stocking rates.

64. Scenario 10 allocates on a fixed rate of 200 l/h, which is just below the 214 l/ha required for dairy stock peak drinking water requirements only.

65. Scenarios 11 to 13 presents allocation per hectare, scaled by property size. The scenarios calculate requirements for particular property size classes by multiplying the largest property size in a category by a fixed volume per hectare and providing this amount to all properties in this size category. The exception is those properties greater than 50 ha, which are assigned a maximum allocation per property 15 m^3/day and 30 m^3/day for Scenario 11 and 12 respectively. The fixed per hectare rates used are 200 l/ha and 400 l/ha for Scenario 11 and 12 respectively. These are slightly lower than the requirements for dairy drinking water only (214 l/ha) and dairy drinking and washdown requirements (428 l/ha).

66. Scenario 11 allocates 13% and 20% of the core allocation for the Upper Manawatu and Mangatainoka respectively. This scenario models a level of water allocation that is

similar to Scenario 3. Scenario 11 is a mechanism that provides for the stock-drinking needs of most properties, however it requires large properties and properties requiring water for dairy-shed washdown to obtain consent from the core allocation.

67. Scenario 12 allocates 26% and 39% of the core allocation for the Upper Manawatu and Mangatainoka respectively. This scenario models a similar level of water allocation as Scenario 4. Scenario 12 is a mechanism that provides for the stock drinking and dairy-shed washdown needs of most properties, however it requires large properties and properties requiring water for dairy-shed washdown to obtain consent from the core allocation.

68. Scenario 13 repeats Scenario 11, adding 1.5 m^3/day to provide for domestic needs. Scenario 13 provides allocation equivalent to 13% and 32 % of the core allocation in the Upper Manawatu and Mangatainoka respectively.

69. Scenarios 14 and 15 present an interpretation of the suggestions by Gerard Willis for Fonterra. This is to enable comparison with other scenarios presented. It is noted that the two case study catchments contain very few cropping farms. Overall, the allocation presented in Scenario 14 reflects the volume of water allocated under this regime, excluding the requirements for stock water. Scenario 15 adds to Scenario 14 the stock water requirements to enable comparison with the other scenarios presented. Scenario 15 allocates the equivalent to 29% and 69 % of the core allocation in the Upper Manawatu and Mangatainoka catchments respectively.

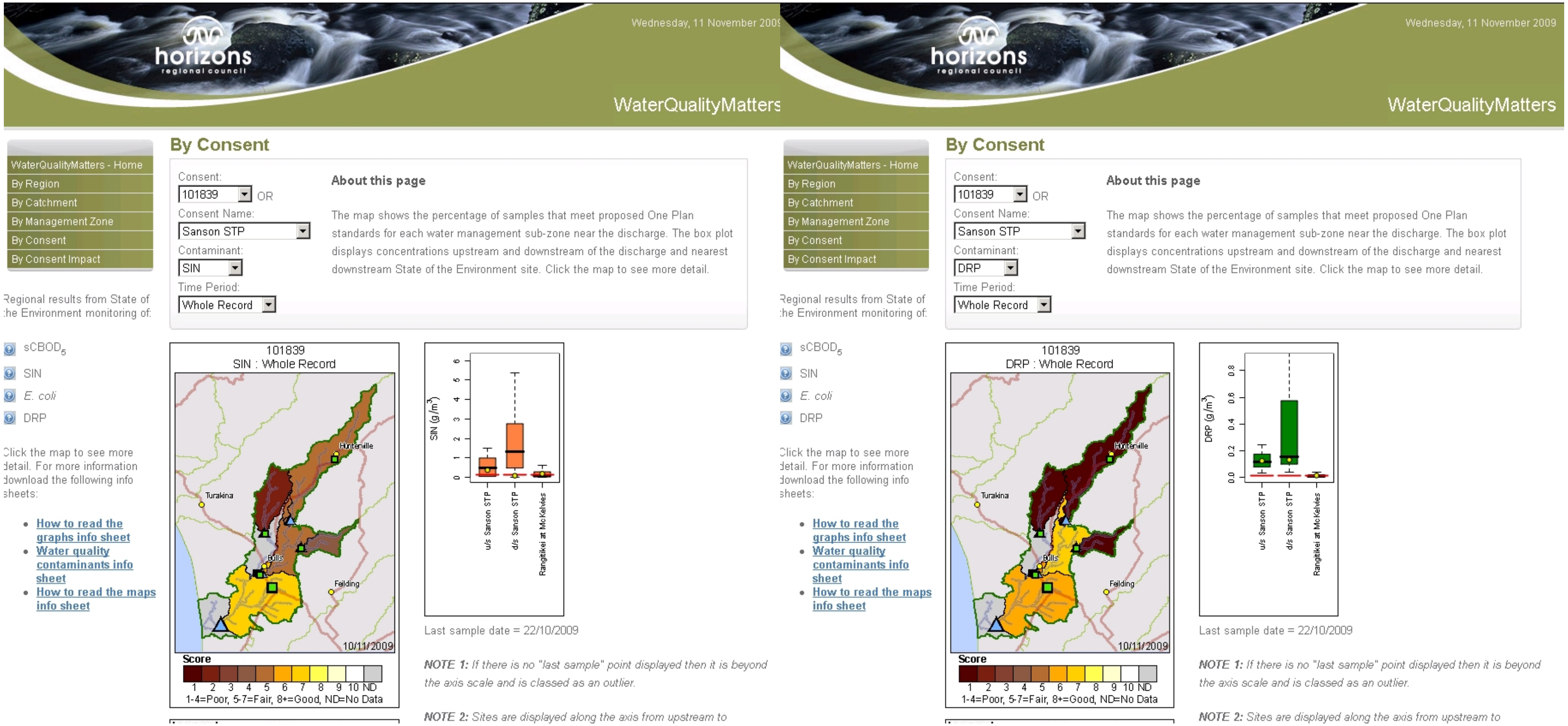

Figure 1. WaterQualityMatters website screenshots of Sanson sewage treatment plant (STP) discharge information. Left: For the "last sample" displayed in these plots (yellow dots) the STP discharge dilutes the SIN concentration implying water quality was worse upstream than downstream of the discharge for this SIN measurement. For SIN, water quality in the tributary where this discharge is measured is generally poorer than the overall SOE reporting site downstream. Right: For DRP overall the results show increases in DRP levels do occur downstream of the discharge. For both SIN and DRP, the overall water quality result for the SOE site shows greater precentage of time that the water quality meets the standard than the information from the tributary. In summary, for this tributary using the SOE indicator results would not overstate the water quality issue in the Region.

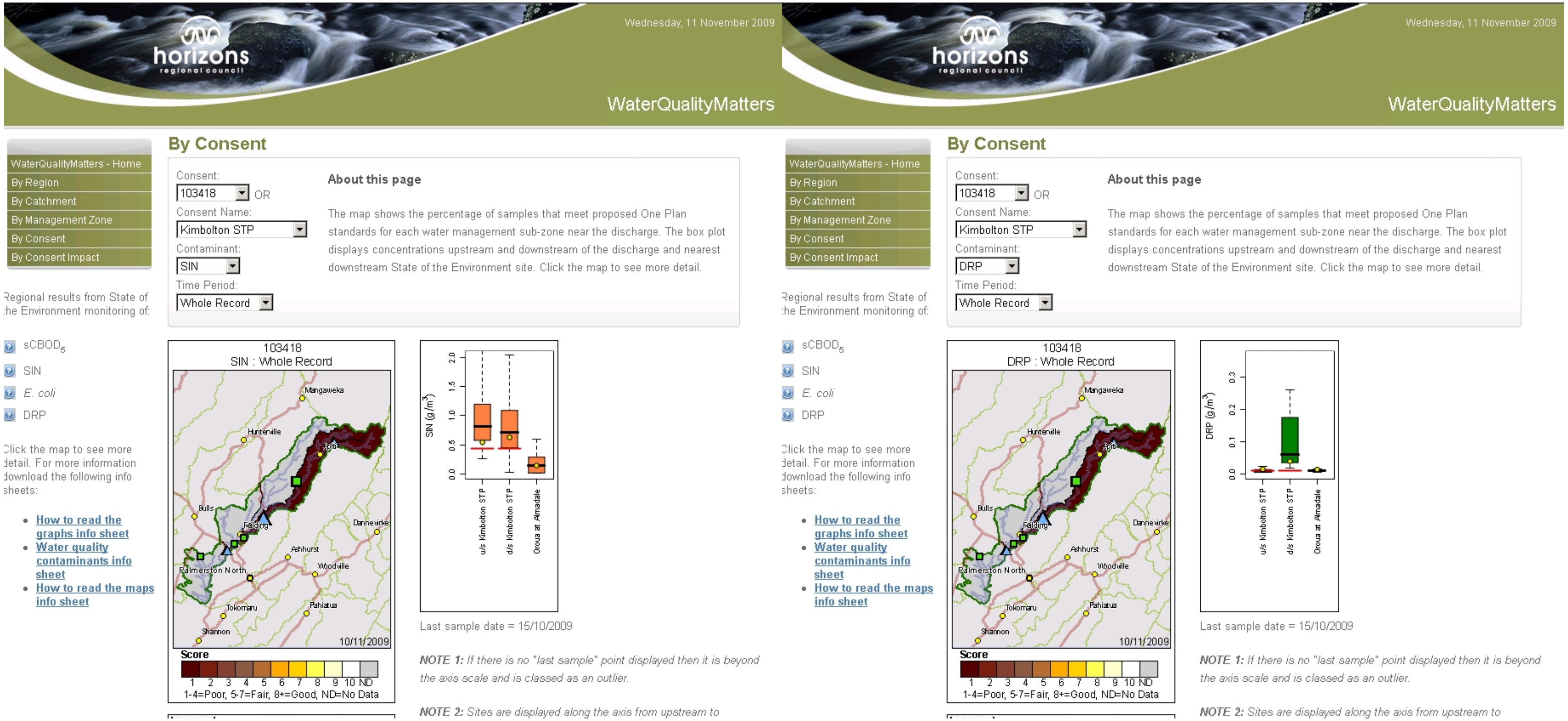

Figure 2. WaterQualityMatters website screenshots of the Kimbolton sewage treatment plant (STP) discharge information. For both SIN (left) and DRP (right), the overall water quality result for the downstream SoE site (Oroua at Almadale) shows greater precentage of time that the water quality meets the standard than the information from the tributary. In summary, for this tributary using the SoE indicator results would not overstate the water quality issue for this tributary.

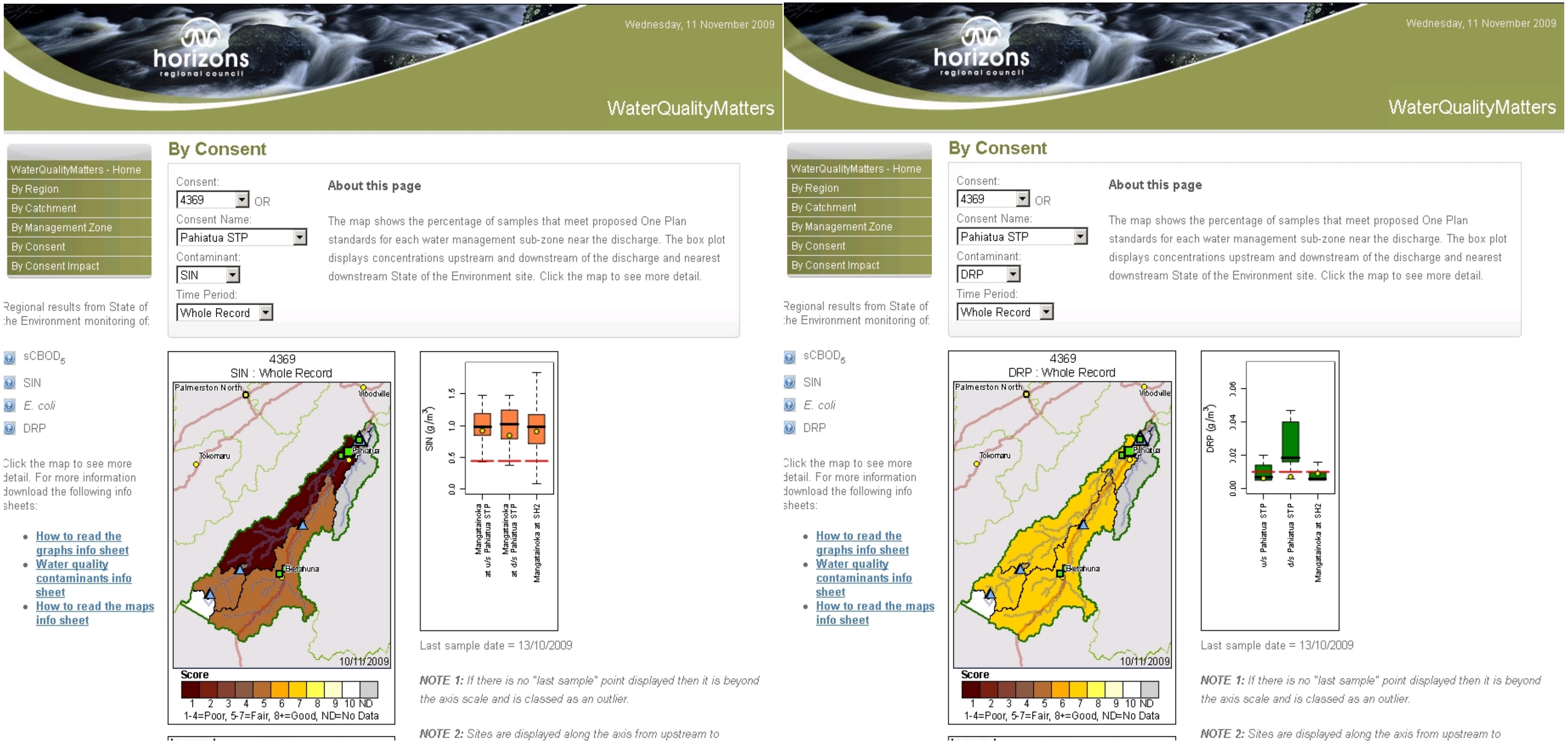

Figure 3. WaterQualityMatters website screenshots of the Pahiatua sewage treatment plant (STP) discharge information. For both SIN and DRP, the overall water quality result for the SoE site meets the water quality standard more often than the sites upstream and downstream of the discharge by a small percentage of time. The phosphorus screenshot (on the right) also shows a considerable reduction in DRP concentration from the site downstream of the discharge to the point of the SoE monitoring site.

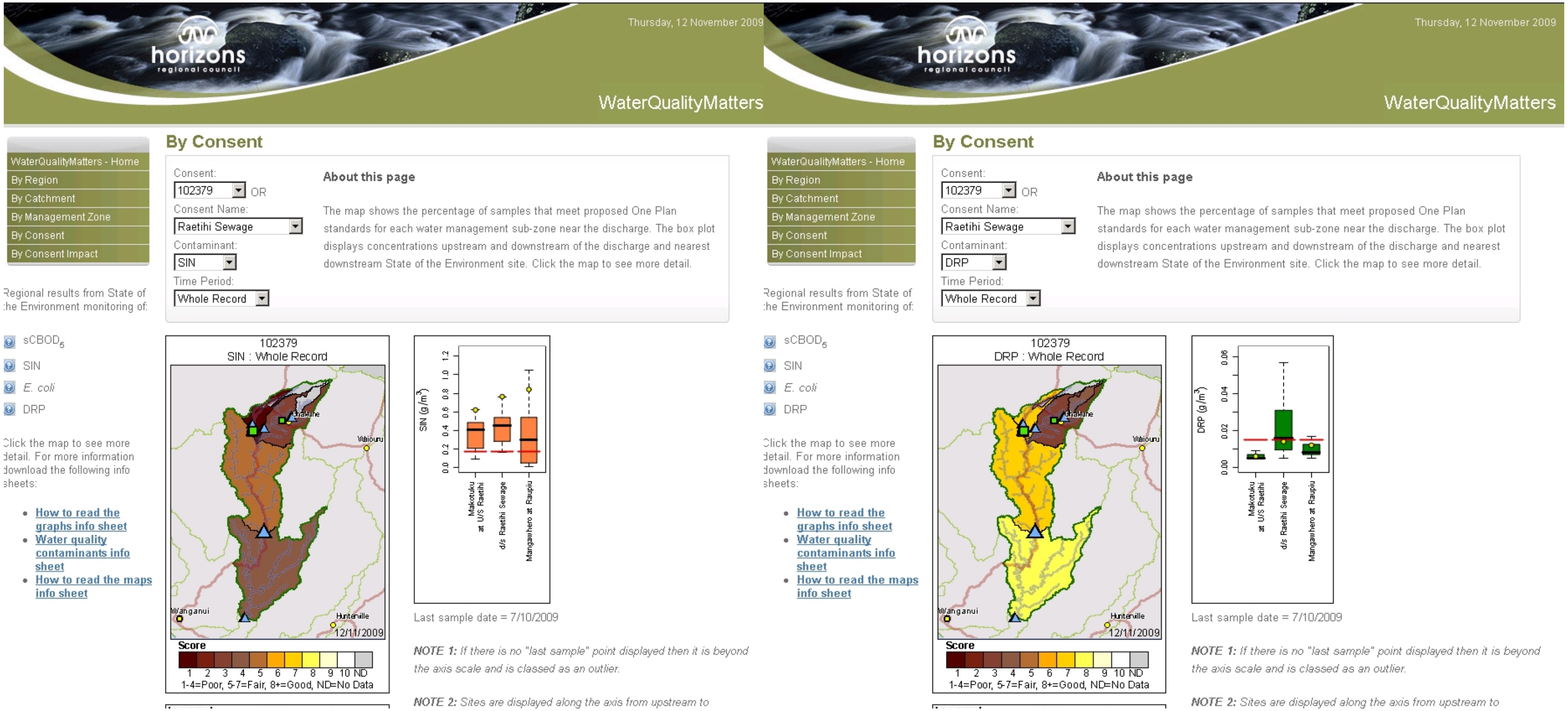

Figure 4. WaterQualityMatters website screenshots of the Raetihi sewage treatment plant (STP) discharge information. The SIN screenshot (left) shows water quality upstream of the SoE site does not meet the standard as often as the downstream SoE site. For DRP (right), the overall water quality result for the SoE site meets the water quality standard less often than the site upstream of the discharge and more often than the site downstream of the discharge. For both SIN (left) and DRP (right) the screenshots show a considerable reduction in concentration from the site downstream of the discharge to the point of the SoE monitoring site.

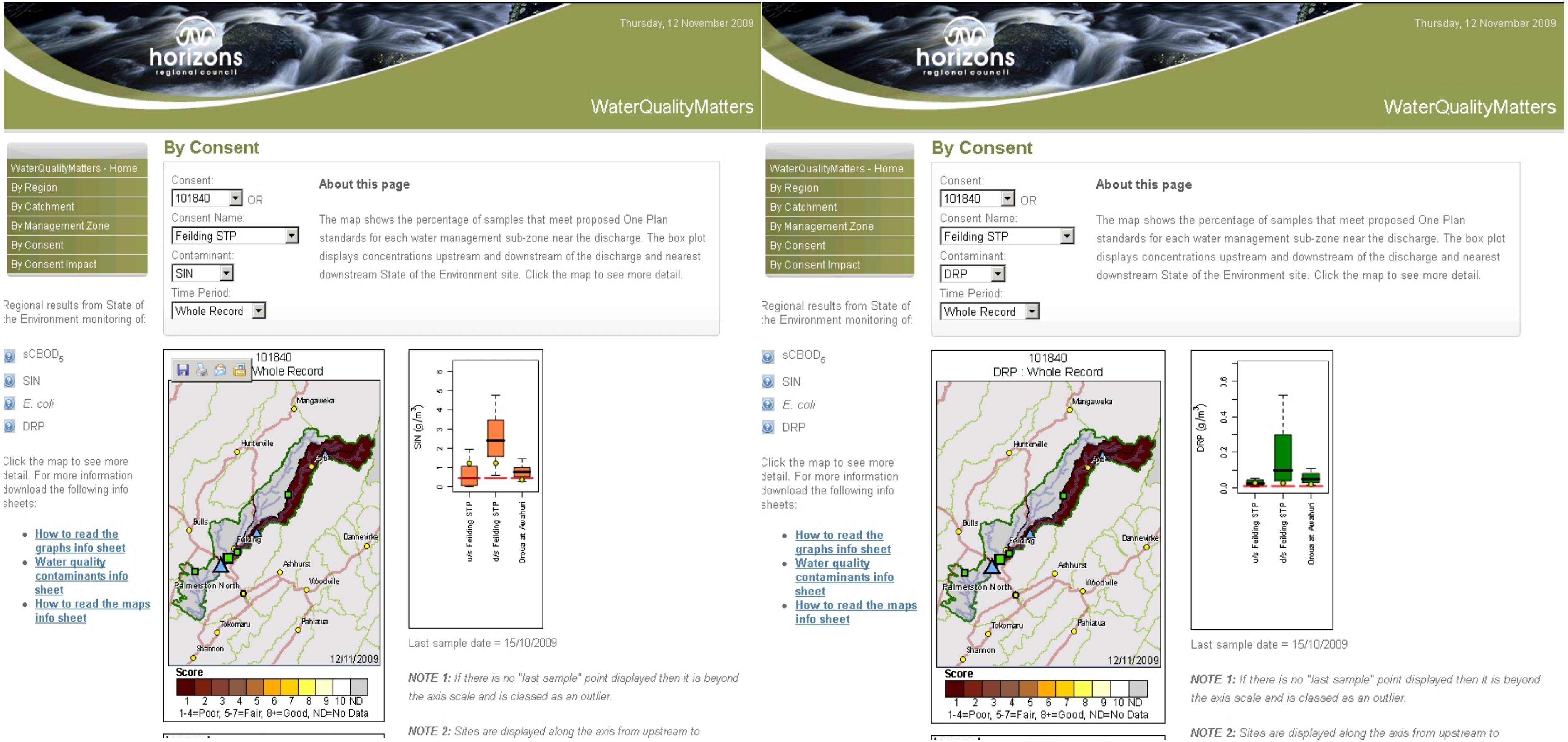

Figure 5. WaterQualityMatters website screenshots of the Feilding sewage treatment plant (STP) discharge information. For both SIN (left) and DRP (right), the overall water quality result for the SoE site meets the water quality standard less often than the site upstream of the discharge and more often than the site downstream of the discharge. For both SIN and DRP the screenshots show a considerable reduction in concentration from the site downstream of the discharge to the point of the SoE monitoring site (Orua at Awahuri). The Oroua at Awahuri site, was recorded to have the worst water quality state in terms of DRP when ranked with 16 SoE sites within Horizons, Region and the 77 NIWA sites nationally that were used in the analysis of water quality state and trends by Ballantine and Davies-Colley (2009).

Box 1: Determining catchment outcomes from the revised Table 13.2 of Gerard Willis

The catchment outcomes from the Value A N loss limits specified in the revised Table 13.1 of Gerard Willis are calculated using the N loss limits (assuming these to be the actual loss) and the area of each Land Use Capability (LUC) class in the catchment, and the attenuation factor. For the examples below[4], an attenuation factor 0.5 has been used.

Example 1: Manawatu at Hopelands

§ The Year 1 target of 1080 t /year is higher than the current measured load 745 t/y. The Year 20 target of 751 t/y is higher than the current measured load and the average standard load of 358 t/y

Upper Manawatu		LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII	Total
Output loss limit	Year 1 (when rule comes into force) (kg of N/ ha/year)	32	29	25	19	18	16	6	2	
	Year 5 (kg N/ha/year)	30	28	24	18	17	15	6	2	
	Year 10 (kg N/ha/year)	28	26	22	17	16	14	6	2	
	Year 20 (kg N/ha/year)	25	21	18	13	12	10	6	2	
Area of LUC in Upper Manawatu (ha)		0	12,424	20,257	11,508	907	57,254	22,108	5,180	129,638
Measured load (in-river)	Year 1 (Tonnes/year)	0	180	253	109	8	458	66	5	1,080
	Year 5 (Tonnes/year)	0	174	243	104	8	429	66	5	1,029
	Year 10 (Tonnes/year)	0	162	223	98	7	401	66	5	962
	Year 20 (Tonnes/year)	0	130	182	75	5	286	66	5	751
Standard load limit (tonnes/year)										358
Measured load (tonnes/year)										745

Example 2: The Mangatainoka catchment

§ The Year 1 target of 426 t /year is lower than the current measured load 603 t/y. The Year 20 target of 301 t/y is higher than the average standard load of 266 t/y.

Mangatainoka		LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII	Total
Output loss limit	Year 1 (when rule comes into force) (kg of N/ ha/year)	32	29	25	19	18	16	6	2	
	Year 5 (kg N/ha/year)	30	28	24	18	17	15	6	2	
	Year 10 (kg N/ha/year)	28	26	22	17	16	14	6	2	
	Year 20 (kg N/ha/year)	25	21	18	13	12	10	6	2	
Area of LUC in Mangatainoka (ha)		549	10,394	6,074	1,498	409	18,110	8,057	3,874	48,965
Measured load (in-river)	Year 1 (tonnes/year)	8.8	150.7	75.9	14.2	3.7	144.9	24.2	3.9	426
	Year 5 (tonnes/year)	8.2	145.5	72.9	13.5	3.5	135.8	24.2	3.9	407
	Year 10 (tonnes/year)	7.7	135.1	66.8	12.7	3.3	126.8	24.2	3.9	380
	Year 20 (tonnes/year)	6.9	109.1	54.7	9.7	2.5	90.6	24.2	3.9	301
Standard load limit (Tonnes/year)										266
Measured load (Tonnes/year)										603
NPS load (Tonnes/year)										599.6

[4] Some of the numbers for measured load and non-point source load differ from those of Mackay *et al.* (2008) and are the numbers from the later analysis by Roygard and McArthur (2008).

9. PART FOUR: CORRECTIONS TO ORIGINAL S42A REPORT

70. The following section provides corrections/clarifications to the recommendations in my S42A Report.

Expressing core allocation limits in Schedule B as daily limits

71. It is recommended that core allocation limits in Schedule B be expressed in m^3/day, ie. not m^3/s as had been documented in the POP throughout its process. The use of the m^3/s numbers as maximum daily limits was always the intention for these numbers. This was not explicitly stated in my original evidence in section 4.7.3 (pages 42 to 45). The use of the maximum daily volume is consistent with the use of a 1 day mean annual low flow (MALF) as the base statistic for calculating minimum flows and allocation limits. The m^3/s values reflect the way the values were used in relation to the flow statistics to determine surety of supply.

72. The maximum daily rate combined with limits on maximum instantaneous limits (or maximum hourly rates) are the mechanisms that are currently used in practice with the surface water allocation regime. It is noted that there are a range of reasons why instantaneous rates may be higher than maximum daily rates, eg. systems set up to abstract during periods of cheaper power, say from 11 pm to 7 am, pump over 8 hours the full daily volume and therefore have abstraction rates 3 times higher on an instantaneous basis than if they abstracted evenly over the day. Similarly, irrigation takes from tidal zones typically abstract for 12 hours a day or less to avoid applying salt water to the crop being irrigated.

73. In recent practice, Horizons has sought the maximum instantaneous take rates to be the same as the daily abstraction rate for all new takes. However, Horizons has not pursued this for existing infrastructure, eg. during consent renewal. There have been exceptions where rate of take and stream flow at the point of abstraction have required changes to pump work for existing takes. Further, there have been exceptions for new takes, eg. for some new large irrigation takes, provision to take over a 16-hour period has been granted to provide for turning the irrigation equipment off during peak power use times in the morning and evening.

74. To allocate water using the m^3/s values as instantaneous rather than daily values would greatly limit the amount of water allocable in the Region compared to using maximum daily rate equivalents. The assessment of allocation status by Raelene Hurndell in Appendix 1 of her original evidence was completed under the assumption of maximum

daily limits being used. Assessing the core allocation limits as maximum instantaneous limits, ie. in m^3/s, would result in considerable change to the assessment of current allocation status as presented by Ms Hurndell, with many more zones being reflected as currently over-allocated.

75. The Upper Manawatu catchment (upstream of the Tiraumea confluence with the Manawatu River provides an example for this. The Upper Manawatu water resource assessment (Roygard *et al.,* 2006, page 222) reported the maximum daily rate of allocation was 1.053 m^3/s on a daily basis, ie. 90,979 m^3/day. However, if the sum of the consented instantaneous rates of takes within the catchment were equivalent to 1.288 m^3/s this would be equivalent to a maximum daily take rate of 111,283 m^3/s. Actual water use in the catchment was limited to the 90,979 m^3/day via the use of both maximum daily rates of abstraction and maximum instantaneous rates of abstraction within consent conditions. If the maximum rate of abstraction was limited to the 1.053 m^3/s on an instantaneous basis, the six water management zones in this area would be calculated to be over-allocated.

76. It is recommended that the values expressed in Schedule B be expressed as maximum daily rates and that some controls be provided re the timing or rate of take. A revised version of Schedule B has been provided in the supplementary evidence of Clare Barton to reflect this recommendation.

10. REFERENCES

Ballantine, D.J. and R.J. Davies-Colley. (2009). Water Quality State and Trends in the Horizons Region. Report prepared for Horizons Regional Council. *NIWA Client Report No: HAM2009-090*.

Clothier B., McKay A., Carran A., Gray R, Parfitt R., Francis G., Manning M., Duerer M., and Green S. (2007). Farm strategies for contaminant management. *A report by SLURI (Sustainable Land Use Research Initiative) for Horizons Regional Council.*

Parfitt R., Dymond J., Ausseil A., Clothier B., Deurer M., Gillingham A., Gray R., Houlbrooke D., Mackay A. & McDowell R. (2007). Best Practice Phosphorus Losses from Agricultural Land. *Prepared for Horizons Regional Council. Landcare Research Contract Report No. LC0708/012.*

Roygard J. and McArthur. K. (2008). A framework for managing non-point source and point source nutrient contributions to water quality, Technical report to support policy development., *Horizons Regional Council Report No. 2008/EXT/792 ISBN 1-877468-39-1.*

Roygard J., Watson J. and Clark M. (2006). Water allocation project upper Manawatu catchment: Water resource assessment – Allocation limits and minimum flows. Technical report to support policy development. *Horizons Regional Council Report No.2006/EXT/684, ISBN: 1-877413-20-8.*

Dr Jon Roygard
November 2009