IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER **appeals under clause 14(1) of Schedule 1 of the Act in respect of Proposed Southland Water and Land Plan**

between:

TRANSPOWER NEW ZEALAND LIMITED
(ENV-2018-CHC-26)

FONTERRA CO-OPERATIVE GROUP LIMITED
(ENV-2018-CHC-27)

HORTICULTURE NEW ZEALAND
(ENV-2018-CHC-28)

ARATIATIA LIVESTOCK LIMITED
(ENV-2018-CHC-29)

WILKINS FARMING CO
(ENV-2018-CHC-30)

(Continued on next page)

STATEMENT OF SUPPLEMENTARY EVIDENCE OF DR CRAIG VERDUN DEPREE FOR DAIRYNZ LTD AND FONTERRA COOPERATIVE GROUP LTD (DEPOSITED SEDIMENT)

20 May 2022

Solicitor acting:
Katherine Forward
Duncan Cotterill
PO Box 5, Christchurch
Phone +64 3 379 2430
Fax +64 3 379 7097

katherine.forward@duncancotterill.com

GORE DISTRICT COUNCIL, SOUTHLAND DISTRICT COUNCIL & INVERCARGILL DISTRICT COUNCIL
(ENV-2018-CHC-31)

DAIRYNZ LIMITED
(ENV-2018-CHC-32)

H W RICHARDSON GROUP
(ENV-2018-CHC-33)

BEEF + LAMB NEW ZEALAND
(ENV-2018-CHC-34 & 35)

DIRECTOR-GENERAL OF CONSERVATION
(ENV-2018-CHC-36)

SOUTHLAND FISH AND GAME COUNCIL
(ENV-2018-CHC-37)

MERIDIAN ENERGY LIMITED Act 1991
(ENV-2018-CHC-38)

ALLIANCE GROUP LIMITED
(ENV-2018-CHC-39)

FEDERATED FARMERS OF NEW ZEALAND
(ENV-2018-CHC-40)

HERITAGE NEW ZEALAND POUHERE TAONGA
(ENV-2018-CHC-41)

STONEY CREEK STATION LIMITED
(ENV-2018-CHC-42)

THE TERRACES LIMITED
(ENV-2018-CHC-43)

CAMPBELL'S BLOCK LIMITED
(ENV-2018-CHC-44)

ROBERT GRANT
(ENV-2018-CHC-45)

SOUTHWOOD EXPORT LIMITED, SOUTHLAND PLANTATION FOREST COMPANY OF NZ, SOUTHWOOD EXPORT LIMITED
(ENV-2018-CHC-46)

TE RUNANGA O NGAI TAHU, HOKONUI RUNAKA, WAIHOPAI RUNAKA, TE RUNANGA O AWARUA & TE RUNANGA O ORAKA APARIMA
(ENV-2018-CHC-47)

PETER CHARTRES
(ENV-2018-CHC-48)

RAYONIER NEW ZEALAND LIMITED
(ENV-2018-CHC-49)

ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND
(ENV-2018-CHC-50)

Appellants

and: **SOUTHLAND REGIONAL COUNCIL**
Respondent

1. INTRODUCTION

1.1 My full name is Craig Verdun Depree. My qualifications and compliance with the Environment Court's Code of Conduct are set out in my primary evidence dated 20 December 2021 and I do not repeat these here. However, of particular relevance to this evidence, I was the project leader and co-author of the first set of NPS-FM numeric thresholds for suspended and deposited sediment undertaken for the Ministry for the Environment.

Scope of evidence

1.2 I have been asked to prepare this supplementary evidence for Fonterra Co-operative Group Ltd (**Fonterra**) and DairyNZ Ltd (**DairyNZ**), collectively referred to as the 'dairy interests'. My evidence responds to the Forest and Bird and Fish and Game (**F&B/F&G**) proposed amendment to the current '10% change' standard in Appendix E and Rule 13, where F&B/F&G seek to introduce an additional absolute standard of deposited fine sediment coverage for different river classes.

2. CONTEXT / BACKGROUND

2.1 Deposited sediment is an important driver of ecosystem health and needs to be managed (Ryan 1991, Clapcott et al. 2011)[1,2]. Complicating management of deposited sediment is the high temporal variability of deposited sediment, and low precision accuracy of measuring (measured to nearest 5% cover, refer to Figure A1, Appendix 1) that it is poorly related to catchment sediment loads.

2.2 The poor relationship between deposited sediment and catchment sediment loads is discussed in the Science Technical Advisory Group (STAG) meeting minutes,[3] MfE staff note:

"…*for deposited sediment, research has shown that in many cases it's not possible to link the suspended sediment load to deposited fine sediment. There is a stronger relationship between the hydrograph and deposited sediment so there are different management actions. For*

[1] Paddy A. Ryan (1991) Environmental effects of sediment on New Zealand streams: A review, New Zealand Journal of Marine and Freshwater Research, 25:2, 207-221, DOI: 10.1080/00288330.1991.9516472

[2] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

[3] Science and Technical Advisory Group Meeting Minutes 16 April, 2019. https://environment.govt.nz/assets/publications/freshwater-policy/10-STAG-meeting-docs-16-April-2019_0.pdf

deposited sediment, you can't prove that a particular management action will lead to a particular deposited sediment level."

2.3 The above conclusion led to deposited sediment being introduced as an 'action plan' attribute in Appendix 2B of the NPS-FM (2020), as opposed to suspended sediment (measured via visual clarity) that was included as a 'limit setting' attribute in Appendix 2A; which is able to be linked to catchment sediment loads.

2.4 This does not lessen the importance of managing deposited sediment, but it acknowledges the challenges of managing the compliance of discharge activities that may or may not be associated with any 'detected' non-compliance with the standard.

3. DISCHARGE MONITORING VS ABSOLUTE STANDARDS FOR ASSESSING CURRENT STATE OF DEPOSITED SEDIMENT

3.1 In my opinion, reference to any change in deposited sediment cover in Appendix E should be clear with respect to its intent and application. My understanding is that the inclusion of the 10% change in deposited sediment in Appendix E was to provide a pathway to assess/monitor compliance of discharges from farms (e.g. from subsurface drains). Although the feasibility of detecting a meaningful 10% change in deposited sediment at a downstream site (relative to upstream) is likely to be marginal[4], a relative change in sediment cover is the only way, in my opinion, to assess compliance of individual discharges.

3.2 In contrast, the use of absolute standards (or threshold values) for deposited sediment are not useful for assessing the compliance of an individual discharge. Threshold values (e.g. the NPS-FM deposited sediment attribute) are based on long-term medians[5] (i.e., the effect of deposited sediment on aquatic organisms has been related to a median value, not individual values of deposited sediment measured on any given day). By definition, these absolute standards will be exceeded 50% of the time in the stream. As such, it is difficult to see how individual farm discharge compliance could be linked to an absolute standard based on a multi-year median of deposit sediment.

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[4] For example, 10% change is within the error of the method (supported by Dr Death's evidence paragraph 3.4 that he considers little practical difference between 10, 15 and 20% cover), but more importantly, it will be impossible to determine whether any non-compliance with the standard is attributable to the discharge in question, or another upstream discharge (tile drain or other activity surface runoff), or an event unrelated to anthropogenic discharges such as bank slumping/collapse upstream of monitored discharge.

[5] For example, the NPS-FM deposited sediment attribute requires a minimum of 5-years of monthly monitoring to grade a site against the absolute numeric band thresholds.

3.3 Although not well suited for regulating individual discharges, absolute standards for deposited sediment are useful to understand the long term state and trend of sediment in a receiving water body and can inform the need for action plans and broader policy responses.

4. ABSOLUTE THRESHOLDS PROPOSED BY FOREST AND BIRD / FISH GAME

4.1 The Appendix E deposited sediment bed cover standards proposed by F&B/F&G range from 5% to 30%, and do not appear to have any robust technical 'provenance'. In his Evidence dated 4 April 2022, Dr Death states that in his opinion, there is little difference between 10, 15 and 20% sediment cover[6]. This presumably explains why Table 1 of his Primary Statement of Evidence[7] included a 20% threshold for all river classes (except lowland soft-bed) "to protect ecosystem health".

4.2 It is my understanding that the deposited sediment cover measurement[8] applies to hard bed, riverine receiving environments; and more specifically to run habitats within those environments (i.e. not riffles or pools). As such I disagree with the following:

a) The 30% deposited cover for lowland soft-bed streams. By definition, a soft bed stream comprises >50% fine sediment cover. Accordingly, it does not make sense to have an absolute standard that is more stringent than the threshold that defines the river classification; and

b) The standard for "no discernible change" in deposited sediment cover for lakes and wetlands. Depositional areas like lakes constantly receive sediment loads from inflowing rivers, and retain more sediment than they export (i.e. they continually accumulate sediment). Accordingly, I have concerns about a standard defining "no discernible change" for receiving environments that are known to continually accumulate sediment.

4.3 Current state information available indicates minimal issues with deposited sediment in Southland (I discuss this in para. 6.3). Experts indicated that this may not be representative of the extent of degradation[9] (they did not elaborate on why this was the case), however, even if additional sites that were 'more representative' were identified, it will take approximately 5-years of data to determine current state of

[6] Evidence of Dr Death, dated 4 April 2022 (at para. 3.4)
[7] Evidence of Dr Death, dated 15 February 2019 (Table 1, referenced at para. 8.1 and 8.2).
[8] For the avoidance of doubt I am referring to sediment cover assessed by instream visual assessment, which is known as the Sediment Assessment Method 2 (or SAM2) – refer to Clapcott et al. (2011).[2]
[9] Water Quality JWS, 20-22 November 2019 (para. 48)

deposited sediment cover. Robust state data for new sites is unlikely to be available for the operative period of the pSWLP, and therefore defining absolute thresholds in Appendix E (to assess current state) is arguably of limited practical use.

5. THE 10% CHANGE IN DEPOSITED SEDIMENT

5.1 The maximum 10% change in deposited sediment cover in Appendix E was recommended to the Hearing Panel by Mr Hodson.[10] The origin of the 10% change in sediment cover is a report by Clapcott and Hay (2014)[11] who define the change relative to a reference state, (i.e. near natural state). My interpretation of Clapcott and Hay is that the increase in sediment cover of 10% would be assessed against a multi-year median value (to determine state), as opposed to individual measurements.

5.2 Accordingly, the adoption of a 10% change in deposited sediment for monitoring potential impacts of individual discharges relative to an upstream site is, in my opinion, bespoke to the pSWLP and not consistent with the science used to support it.

5.3 Furthermore, there is potential ambiguity in how a '10% change' is interpreted. It can be an absolute increase of 10% cover (i.e. upstream 10% going to 20% cover downstream), or a relative 10% increase (1.1x increase). I believe that the former definition is the only workable definition given the limitations of the sediment assessment methodology (that is, the inability of the measurement to discern small changes in sediment cover).[6]

5.4 In my opinion, a pragmatic way that the 10% change in sediment cover could work for consent compliance is the cleaning of subsurface drains. If undertaken during base flow conditions, there is potential for the discharge of relatively large amounts of sediment to the stream under hydrologic conditions that would favour deposition. Dr Death in his supplementary evidence refers to the potential for "small patches of high deposited sediment" that can arise from discharges from tile drains under low flow conditions.[12] In response, I consider the existing Rule 13 requirement for the discharge to not cause a conspicuous change to the colour or clarity of the receiving

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[10] https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan/documents/background-documents/hearing/council-documents/Reply%20Report.pdf

[11] Clapcott, J., Hay J. (2014). Recommended water quality standard for review of Marlborough's resource management plans. Prepared for Marlborough District Council. Cawthron Report No. 2522. 50 pp. plus appendices. CawRpt_2522_Recommended water quality standards for MDC plan update (envirolink.govt.nz)

[12] Evidence of Dr Death, dated 4 April 2022 (at para. 5.1)

waters, after reasonable mixing, to be a more sensitive measure (i.e. upstream and downstream turbidity monitoring).

6. CONCERNS REGARDING CUMULATIVE EFFECTS ARISING FROM THE 10% CHANGE IN SEDIMENT COVER IN APPENDIX E

6.1 I understand that there is concern regarding the potential for cumulative effects from multiple discharges. These concerns are unwarranted based on a number of factors discussed below.

Deposited sediment does not just uniformly accumulate:

6.2 Deposited sediment cover can vary significantly through time and space. Sediment does not just accumulate like it does in say a depositional receiving environment like a lake. In rivers, the movement of sediment longitudinally down the river is a natural process dependant of topography (slope), soils, rainfall, supply of sediment, and size of the river. Examples of the variability in deposited sediment cover at Southland sites are shown on Figure A2, Appendix 1. One of the sites in Figure A2 is a reference[13] site on Dunsdale Stream (top left). Between 2015 and 2019, deposited sediment cover ranged from 0% to 67%, with a median cover of 15% (B-Band). This site has exceeded 15% and 20% sediment cover on 23 and 14 occasions respectively, and on three occasions recorded 0% sediment cover. This demonstrates the dynamic nature of deposited sediment in river environments, and therefore, the inappropriateness of this measurement standard.

Existing data shows good state with respect to deposited sediment:

6.3 To provide an indicative assessment of current state of monitored Southland rivers, I graded the sites against the deposited sediment attribute threshold values[14] (i.e., absolute effects-based standards). Of the 33 sites, **31 (94%) were A-band**, two were B-band, and one was C-band. I also note that **no sites were below the national bottom-line** for deposited sediment. Long-term medians for all sites are summarised in Figure A3 (Appendix 1).

[13] For the avoidance of doubt, 'reference' implies a site where upstream area is predominantly native
[14] Refer to Table 16 of the NPS-FM (2020). National Policy Statement for Freshwater Management 2020 (environment.govt.nz)

Mitigations reducing sediment loss to water:

6.4 Mitigations / on-farm actions are likely to reduce sediment losses to water in productive catchments. For example, at the national scale, between 1995 and 2015, Monaghan et al. (2020)[15] estimated that sediment losses from pastoral land reduced by 26 million tonnes, with much of this coming from retirement and afforestation of erosion prone land. With respect to losses from high risk activities such as intensive winter grazing[16] (which have greater effect on small 'adjacent' streams) Monaghan et al. (2017)[17] has shown that good management practice can reduce sediment losses by at least 80%.[18] This opinion has also been confirmed in the farm systems expert conference[19].

Reduced sediment loads = improved deposited sediment outcomes:

6.5 Although there is not a good relationship between catchment sediment load and deposited sediment, ultimately, the supply of additional anthropogenic sediment must be driving deposited sediment; even if a robust relationship currently eludes scientists. This logic was emphasised by Dr Clapcott (STAG member) who stated:[3]

> "*The fact that we are unable to quantify the relationship between deposited sediment and land use (via suspended sediment) does not negate the fact that the primary management intervention is to limit the amount of sediment entering waterways*."

6.6 Accordingly, if catchment sediment loads, on average are decreasing because of management actions, then it is reasonable to anticipate improved deposited sediment outcomes as a result.

Artificial subsurface drainage is on land that yields relatively low amounts of sediment:

6.7 With particular reference to Rule 13, estimates of land suitable for artificial drainage[20] correspond to flat, lowland areas (refer to purple areas in Figure A4-A, Appendix 1).

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[15] Ross Monaghan , Andrew Manderson , Les Basher , Raphael Spiekermann , John Dymond , Chris Smith , Richard Muirhead , David Burger & Richard McDowell (2021): Quantifying contaminant losses to water from pastoral landuses in New Zealand II. The effects of some farm mitigation actions over the past two decades, New Zealand Journal of Agricultural Research, DOI: 10.1080/00288233.2021.1876741

[16] Noting that intensive winter grazing accounted for 4% of regional sediment load (Neverman et al.)[21]

[17] Monaghan RM, Laurenson S, Dalley, DE, Orchiston TS (2017). Grazing strategies for reducing contaminant losses to water from forage crop fields grazed by cattle during winter. New Zealand Journal of Agricultural Research. 60 (3), 333-348.

[18] The research[17] showed that these reductions in soil loss were from overland flow paths which accounted for around 90% of total sediment losses under standard grazing practice (i.e. soil loss via subsurface drainage was c. 10% of total losses).

[19] Farm systems Join Witness Statement, dated November 2021.

[20] Andrew Manderson (2018). Mapping the extent of artificial drainage in New Zealand. Manaaki Whenua Report LC3325 for Lincoln Agritech. 32 p. Mapping the extent of artificial drainage in New Zealand (landcareresearch.co.nz)

These areas correspond to areas with relatively low soil erosion rates (<10 t/km^2) based on the Southland erosion rate maps in Neverman et al. (2020)[21] (refer to pink/purple shaded areas in Figure A4-B, Appendix 1). This indicates that erosion from artificially drained land typically has 10- to 100-times less than that from surrounding, steeper hill country areas.

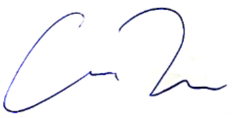
6.8 This combined with the finding from Monaghan et al. (2016)[22] that subsurface drains account for 1/3 of sediment losses (2/3 via surface flow; refer to para 6.10 below) suggests that tile drains are a relatively minor source of sediment inputs at a FMU / part FMU scale. Even at smaller/local scales, in my opinion, the major source of sediment inputs is likely to be via surface runoff.

Biggest risk of soil loss to water (and hence greatest potential to reduce sediment loads) under intensive winter grazing is via surface flow pathways

6.9 With respect to intensive winter grazing activities on land with subsurface drains, work by Monaghan et al. (2017)[17] showed that under standard grazing practice (i.e. no management of critical source areas (**CSA(s)**), around 90% of soil losses occur via overland/surface flow pathways (c. 10% via subsurface drains). As noted above (para. 6.4), the implementation of good management practice, (including critical source area management) reduced soil losses, via surface flows, by around 80%.

Subsurface drainage may not increase the total amount of sediment lost from pastoral land.

6.10 Monaghan et al. (2016)[22] reported that overland runoff was the major pathway for sediment loss on plots with subsurface drains. As noted above, approximately 2/3 of sediment losses were via surface runoff and 1/3 via subsurface drains. Importantly, the research showed that on plots without subsurface drains, the total yield of sediment lost to water was the same or higher than plots with subsurface drains.



DR CRAIG VERDUN DEPREE

20 May 2022

[21] Andrew Neverman, Hugh Smith, Alexander Herzig, Les Basher (2021). Modelling baseline suspended sediment loads and load reductions required to achieve Draft Freshwater Objectives for Southland. Manaaki-Whenua Client Report LC3749. 66p. LandCare Report (es.govt.nz)

[22] R.M. Monaghan, L.C. Smith and R.W. Muirhead (2016) Pathways of contaminant transfers to water from an artificially-drained soil under intensive grazing by dairy cows. Agriculture, Ecosystems and Environment 220 (2016) 76–88. http://dx.doi.org/10.1016/j.agee.2015.12.024

APPENDIX 1

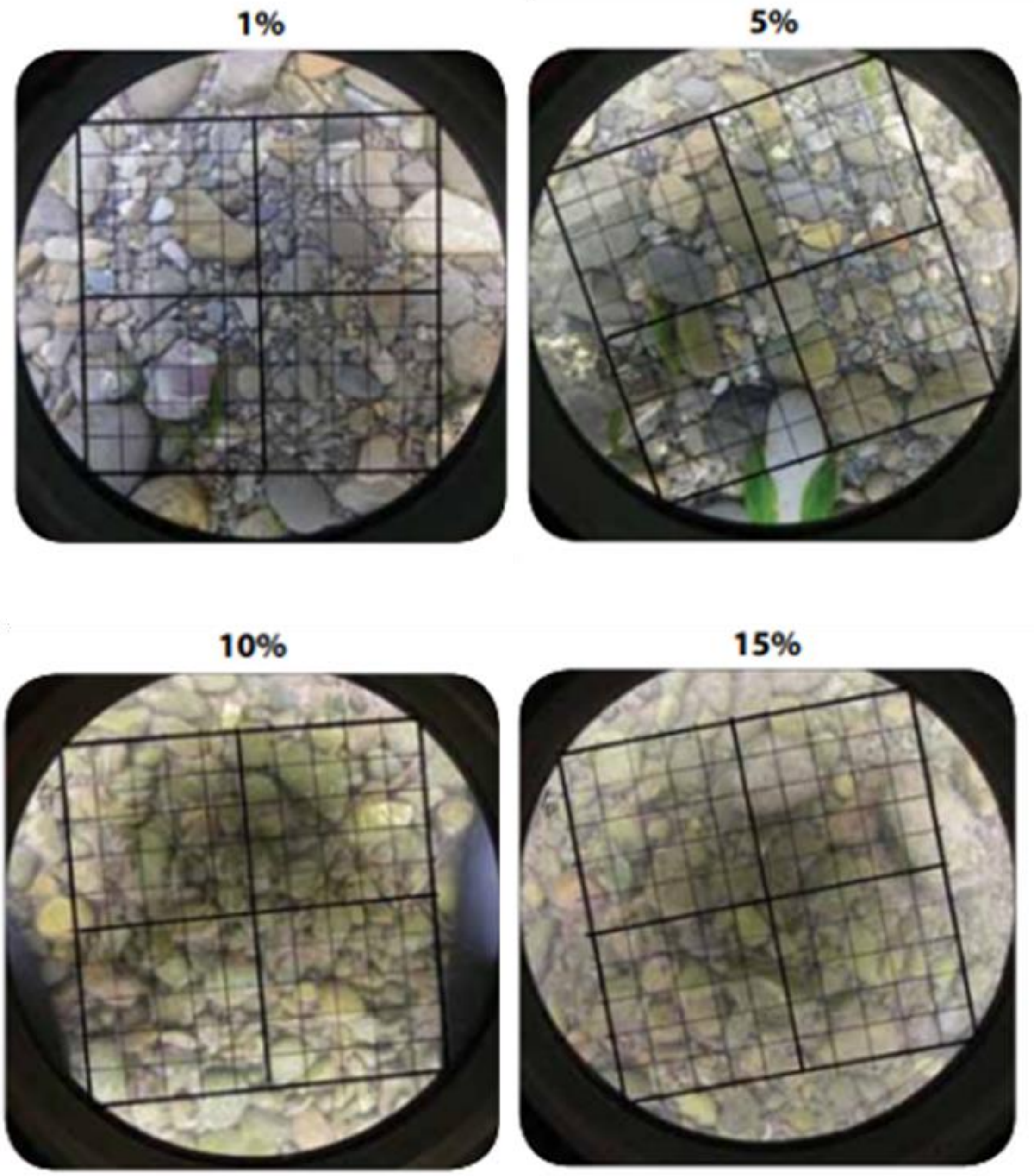


Figure A1. Examples of photos showing examples of deposited sediment cover to the nearest 5% (Clapcott et al. 2011)[2]

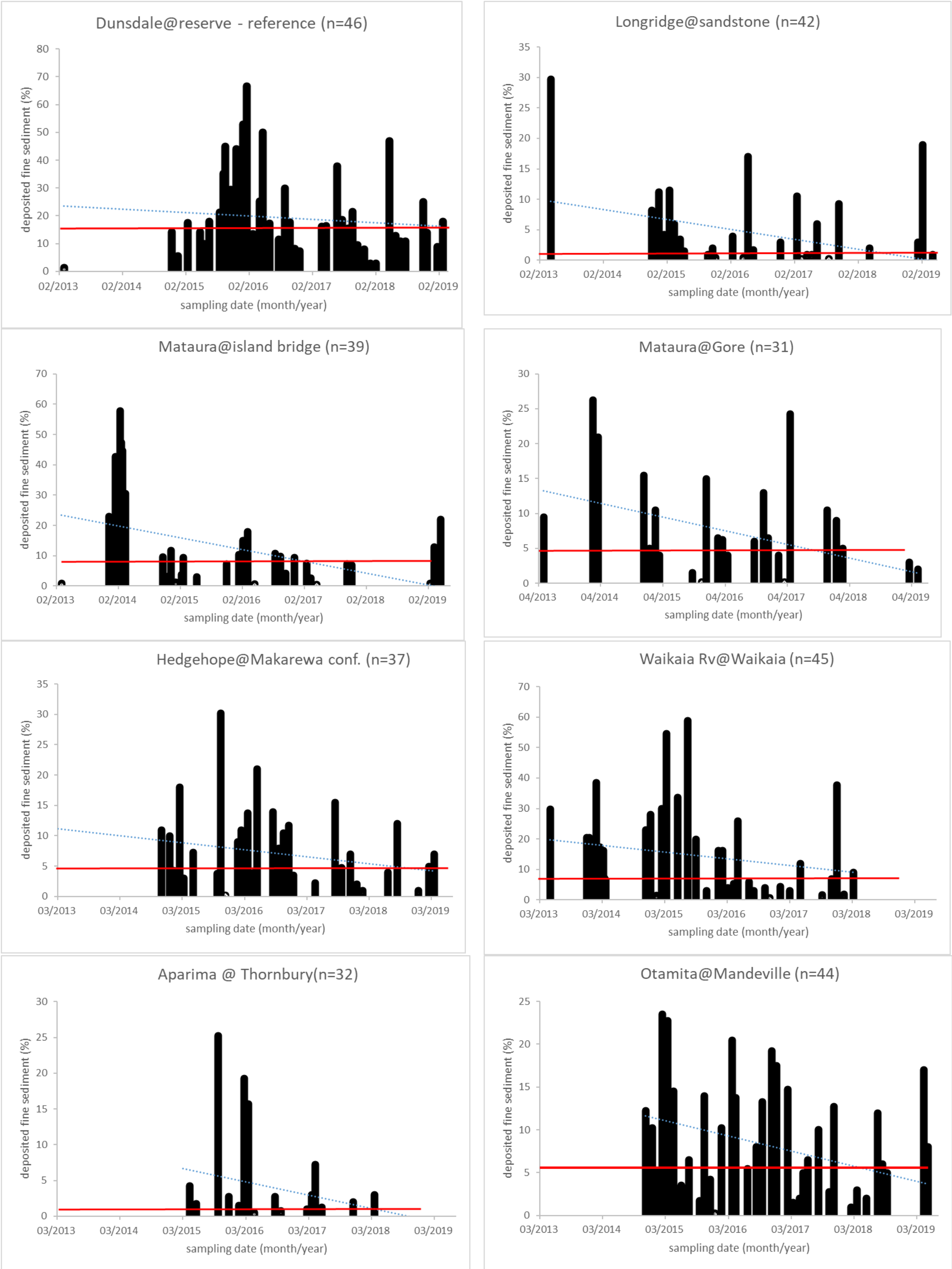


Figure A2. Time-series data of deposited sediment for selected Southland SoE monitoring sites (Environment Southland data). Note that blue dashed lines are 'lines of best fit' for the time-series data and hence are indicative of potential direction of travel (trend) of deposited sediment at each site.

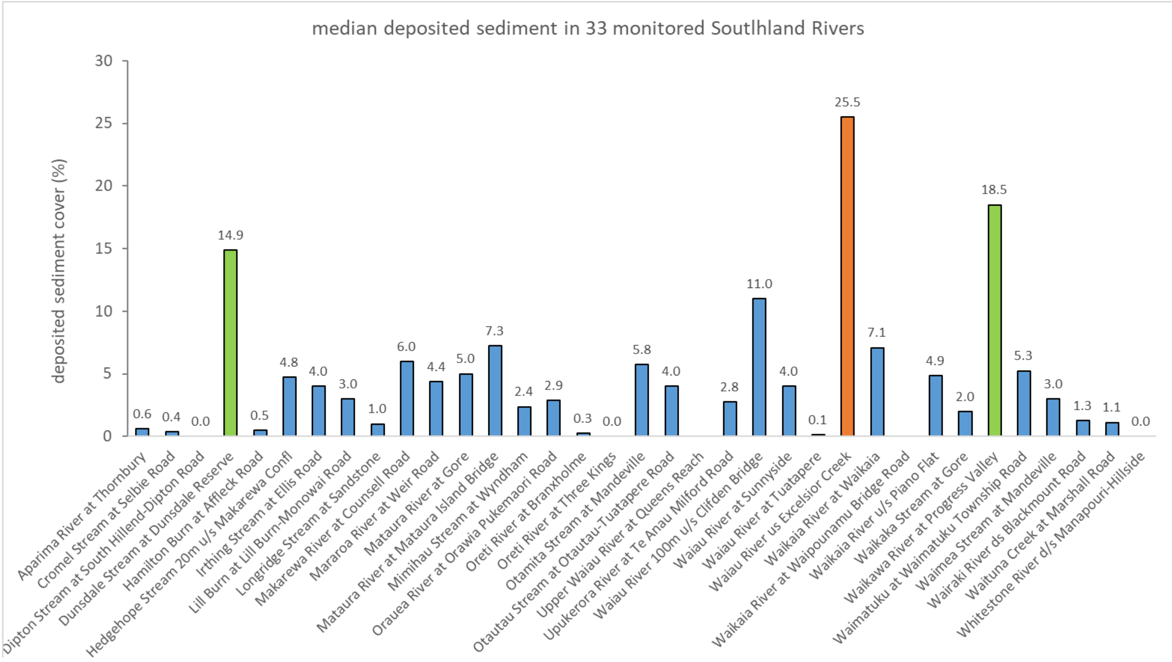


Figure A3. Median deposited sediment cover (%) calculated using available table for 33 Southland SoE river monitoring sites. Blue, green and orange shading refer to an indicative NPS-FM grade of A-band, B-band and C-band, respectively (Environment Southland data).

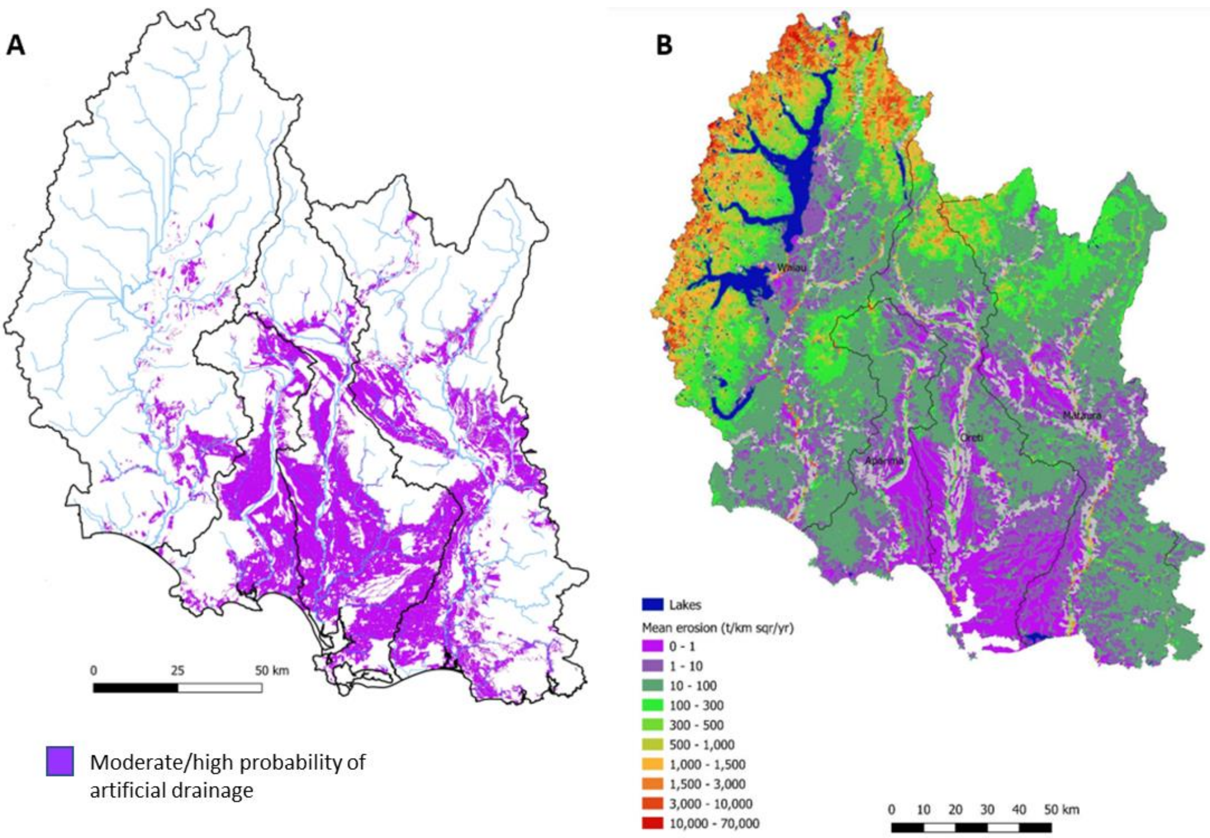


*Figure A4. Maps showing concordance with estimated artificial drainage areas (purple shaded areas in **A**)**Error! Bookmark not defined.** and with areas of low mean erosion rates (t/km^2) (purple shaded areas in **B**).[21]*