Appendix 2 – Application of Digital Elevation Models (DEM)

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Application of Digital Elevation Models (DEM) to identify zones of critical contaminant transfer to waterways

Using simple topographic and hydrological methods it is possible to objectively identify and rank areas that represent a high risk to water quality from wintering. The following informal paper is in response to a request to provide a brief example of how Li-DAR could be used to identify 'critical transfer zones' (critical source areas) for the purpose of excluding these areas from intensive winter grazing. A similar, albeit slightly less resolved assessment than our example, can be undertaken utilising NASA's Shuttle Radar Topography DEM which has national scale coverage.

Li-DAR survey data, at a resolution of 1 m x 1 m, was used to objectively identify and rank areas of high risk of contaminant transfer across the entire Waituna Catchment, Southland as part of a project for Living Water (DOC-Fonterra Partnership) (Couldrey et al., 2018)[1]. Zones of highest risk of contaminant transfer are associated with ephemeral drainage pathways that are directly connected to waterways (Figures 1 and 2). When soils are saturated or rainfall intensity exceeds the infiltration capacity of the soil, ephemeral drainage pathways are activated. The episodic channelisation of overland flow via the ephemeral drainage network is the *key* mechanism by which nutrients, sediment, and microbes are transported directly to waterways. Identifying these 'critical transfer zones' and excluding them from wintering provides a topographically guided basis for mitigating runoff.

Leaving the transfer zone as a vegetated buffer aids in the reduction of contaminant export via physical filtering, the reduction of the velocity of runoff and as a result its capacity to transport contaminants. In Figure 3, buffer zones of 5, 10 and 30 m around the ephemeral drainage network (critical transfer zone) are provided as an example of how Li-DAR derived mapping can be used to objectively identify these high risk areas. Buffer widths can be further refined using soil hydrological properties and slope to allow a variable width buffer along the length of the critical transfer pathway. Importantly, the widely used River Environment Classification (REC), a landscape based classification of surface waterways, does not identify ephemeral waterways nor associated drainage areas.

For the Southland region, it would take approximately 6 months to map all critical transfer zones and rank them in terms of risk using a combination of NASA Radar Topography and existing Li-DAR

[1] **The outputs of Couldrey et al. (2018) have been incorporated into Fonterra's Tiaki Farm Environment Plans for the catchment.**

coverage. Scaling this work nationally would require additional time but could be undertaken in collaboration with other specialists.

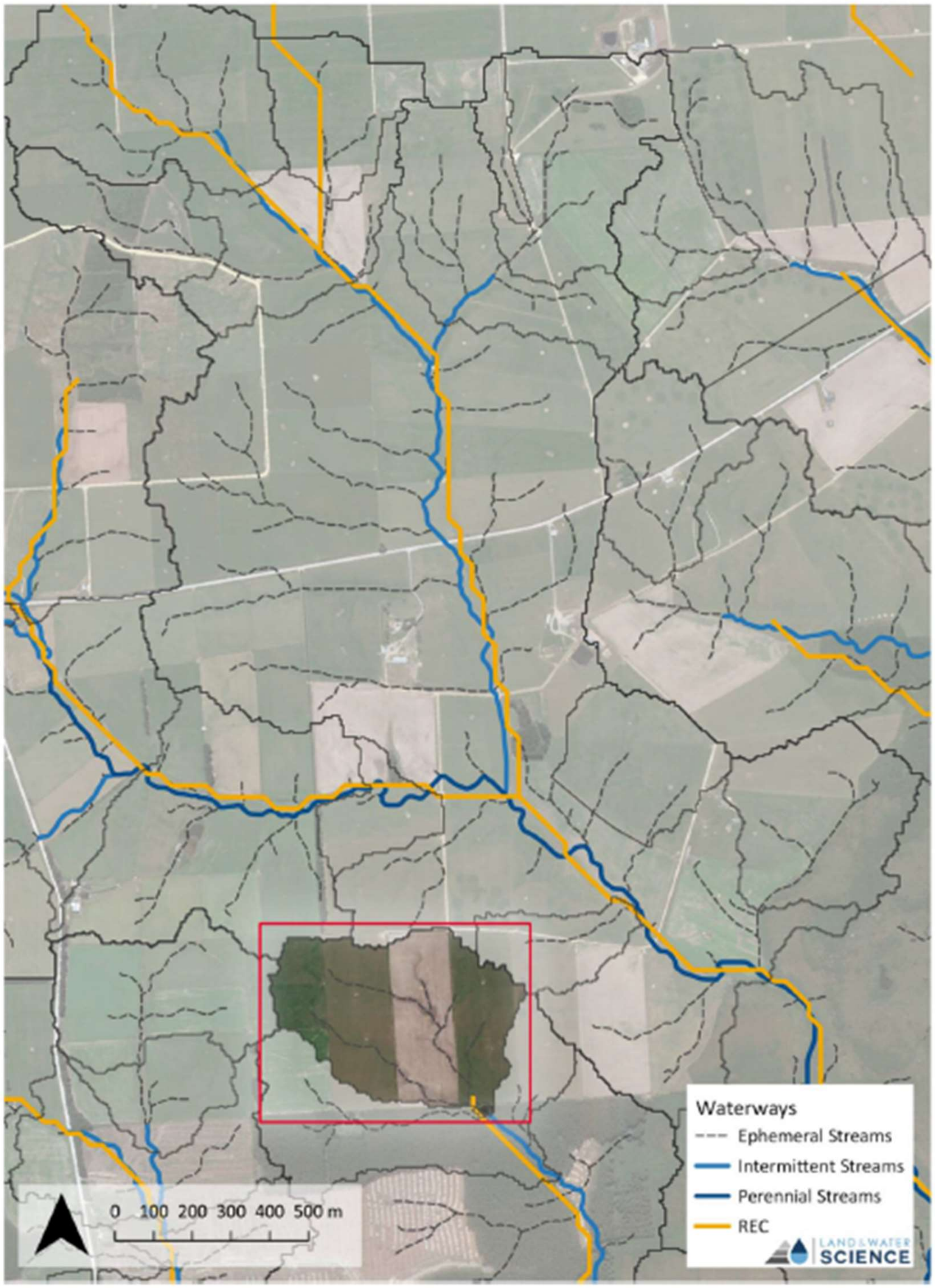

Figure 1: Drainage shed (unshaded = 22.5 Ha), associated ephemeral drainage network (dashed black lines) and their connection to the intermittent and perennial stream network. The drainage shed includes an area of winter grazing that drains directly to the surface water network. The waterways are derived from LiDAR, where REC is the national River Environment Classification for comparison.

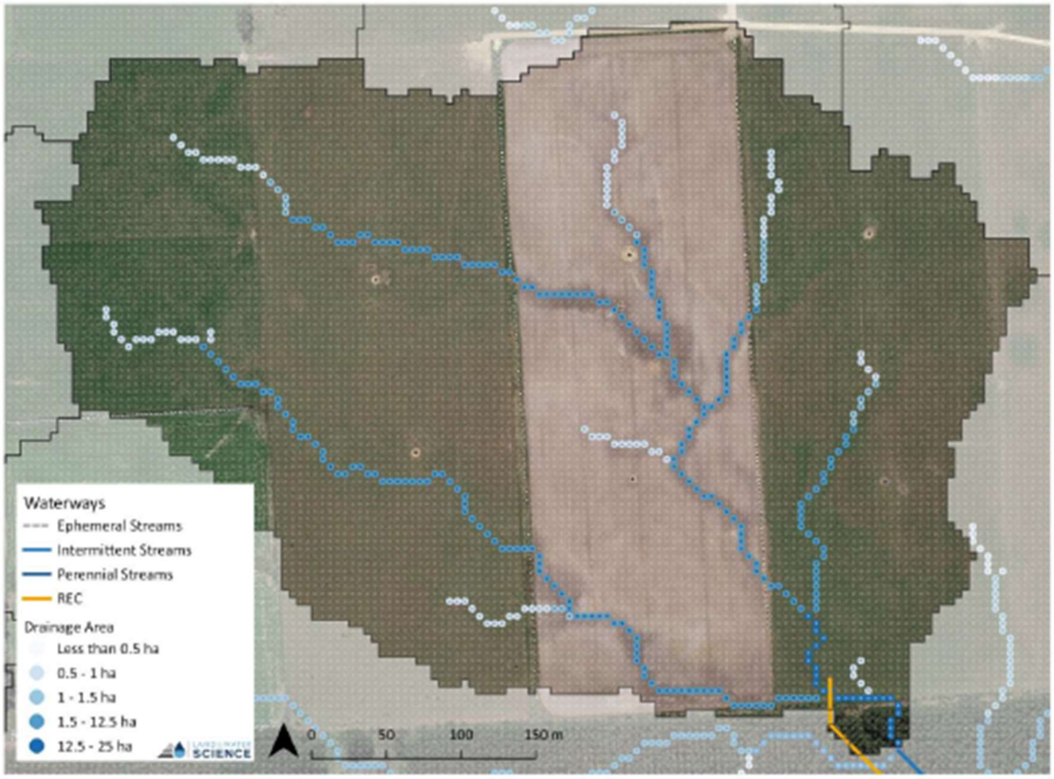

Figure 2. Close up of ephemeral drainage pathways and associated drainage area (unshaded) and their connection to the stream network. Note the area of winter grazing (bare ground) directly within the ephemeral drainage network. Small arrows (1 m²) depict drainage water flow direction and coloured circles denote flow accumulation, which increases down gradient towards the intersection with the intermittent and perennial stream network.

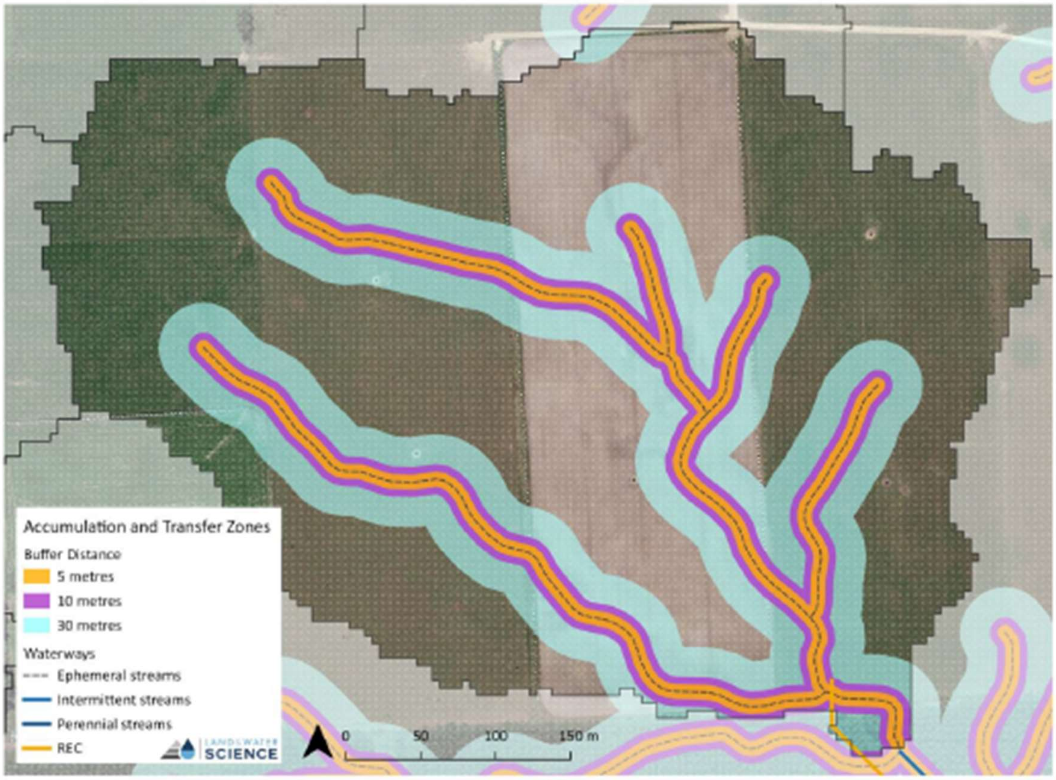

Figure 3. Five, ten and thirty meter buffers around the ephemeral stream network that act as critical transfer zones to surface waters. Excluding wintering from within these transfer zones is highly likely to reduce losses to waterways. Buffer widths can be refined according to local soil and topographic properties.

Identification of critical transfer zones and their associated risk profile can also be used to support other mitigation efforts on farm, such as the placement and scaling of peak runoff control structures (detainment structures) within the catchment.

Sincerely,

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Reference

Couldrey, M., Pearson, L., Rissmann, C., and Newe, H. (2018). Peak runoff control for farm contaminant retention in the Waituna Catchment. Land and Water Science Report 2018/12. 53p.