Understanding Our Land to Drive Change

A Hedgehope Makarewa Catchment Group Project

17th March 2023

Claymore Dairies and Roslyn Downs

Owned by the Millers:

Quentin and Eleanor, Jason and Jocelyn, Andrew and Rachel

This project wouldn't have been possible without the help of our project partners:

THRIVING SOUTHLAND
Tōnui ana te whenua. Tōnui ana te takata.
A thriving, prosperous land. A thriving, prosperous people.

LAND & WATER SCIENCE

Project Background

There are two main factors controlling water quality outcomes – the landscape and us.

Water quality varies widely between regions around New Zealand, even where there are similar land uses and pressures. This is because the natural landscape can have a much bigger influence on water quality outcomes than land use on its own. This means in areas with lots of landscape variation, the effect from similar land use activities can be very different. In areas with little landscape variation, land use pressure is the main control over water quality.

This project gives landowners a better understanding of how the landscape influences water quality and greenhouse gas emissions.

Land & Water Science partnered with the catchment group to create several online landscape susceptibility maps. These maps bring together a range of information:

- Airborne Radiometric data
- Existing soil maps (Beacon, S-maps etc) and soil auger data
- Drone survey data (digital terrain model)
- Ground truthing (digging soil pits)
- Satellite data
- Surface and ground water quality

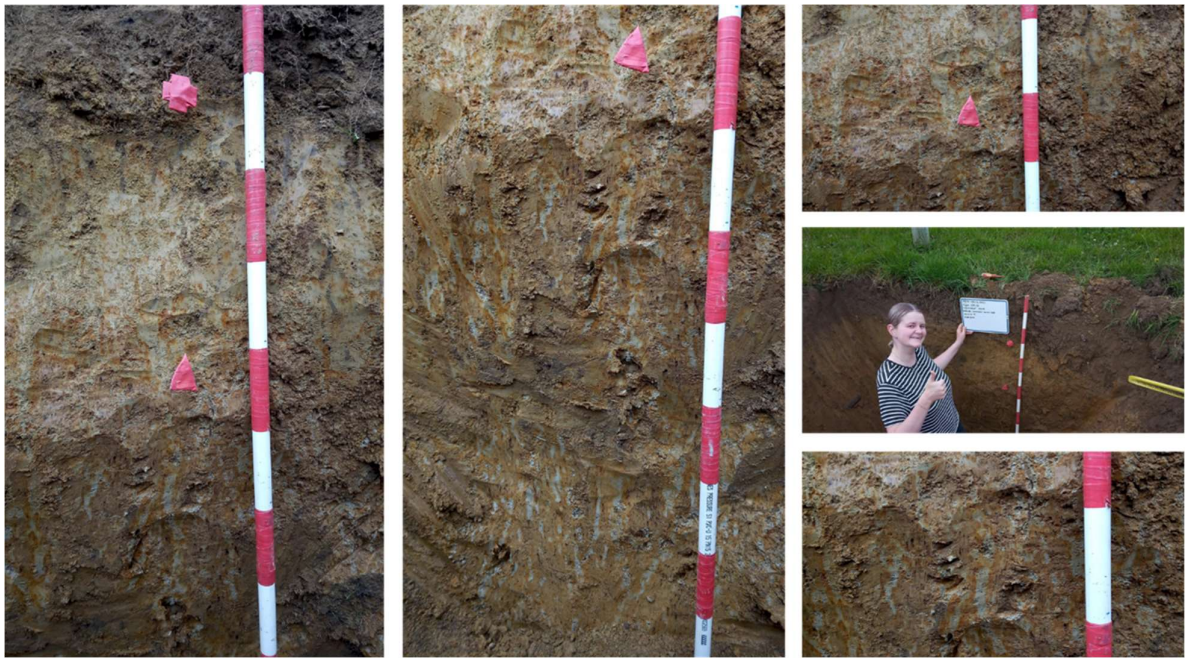


Figure 1. Photos of a soil pit dug on Southern Dairy Hub. The soil is relatively poorly drained (shown by the mottles present). Previous soil mapping identified this area as a well-drained Waikiwi soil.

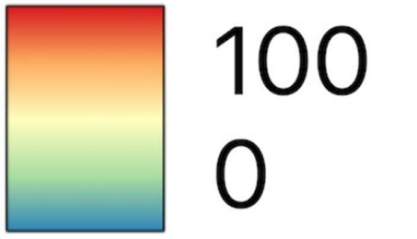
The landscape susceptibility maps:

The information collected from these sources is brought together to create high resolution maps. The maps give a picture of how susceptible the landscape is to losses of:

- Soil nitrous Oxide (N_2O)
- Nitrate-Nitrite-Nitrogen (NNN)
- Particulate Phosphorus (PP)
- Dissolved Reactive Phosphorus (DRP)
- Total Suspended Sediment (TSS)
- *E. coli* (used as a microbial indicator)

Interpreting the maps:

The colour of the map indicates a susceptibility score ranging from 0 - 100. A score of 0 (darker blue) indicates that the land has a low susceptibility for the contaminant of interest. A score of 100 (bright red) indicates that the land is highly susceptible to losses.



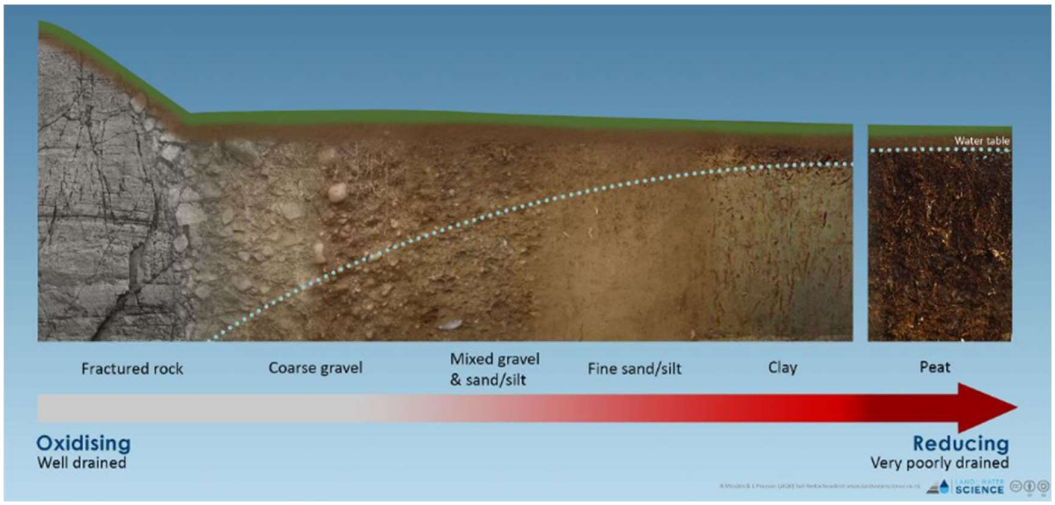
Susceptibility scores range from 0 (blue) to 100 (red).

Important:

The susceptibility maps are intended to support decision-making that enhances economic, social and environmental resilience of your catchment. They provide insights about the landscape's natural susceptibility to contaminant losses. **It is important to note that they do not attribute contaminant loss based on current land use pressures**. Rather, the susceptibility maps identify where the landscape has a greater or lower susceptibility to contaminant loss, irrespective of land use.

NEW soil maps

New, high resolution **soil maps** have been developed for the Hedgehope Makarewa catchment. The maps show the drainage characteristics of the land:



Where do I find the maps?

The **Hedgehope Makarewa** maps are FREE to access at https://bit.ly/HMCGstorymap

The website presents each of the susceptibility maps:

- Particulate Phosphorus
- Organic and Ammoniacal Nitrogen
- Nitrous Oxide
- Nitrate Nitrogen
- Dissolved Reactive Phosphorus
- The NEW soil map

The website explains in detail why an area is more, or less, susceptible to losses of each contaminant. It also has a generalised explanation of potential mitigation strategies.

For those looking for even **more detail**, or information **outside of the Hedgehope Makarewa catchment**, the LandscapeDNA website is also FREE and can be found at https://landscapedna.org/

The website includes a "maps" tab that presents:

- Physiographic data
- Hydrology data (particularly soil drainage characteristics)
- The redox potential
- Other helpful information such as slope, rainfall, altitude and temperature

The website also has in detail explanations of the science behind creating the maps ("science" tab), and an exhaustive list of mitigation strategies ("actions" tab).

Claymore Dairies

The Miller family purchased this property in June 2021. The property is Contract Milked by Chris Henderson and his team.

The property was farmed intensively prior to the Miller's purchasing it. Since purchasing the property, the Miller's have reduced cow numbers, whilst maintaining production, in line with their preferred farm system.

The farm boundaries the Titipua Stream and is a mix of flat to rolling country. The mean slope of the property is 6.9°. The farm has an elevation of 50m to 115m above sea level.

Farm details

Total: 408ha

Cows milked: 870 at peak

Wintering:

450 cows wintered on farm

7.5 ha Swedes

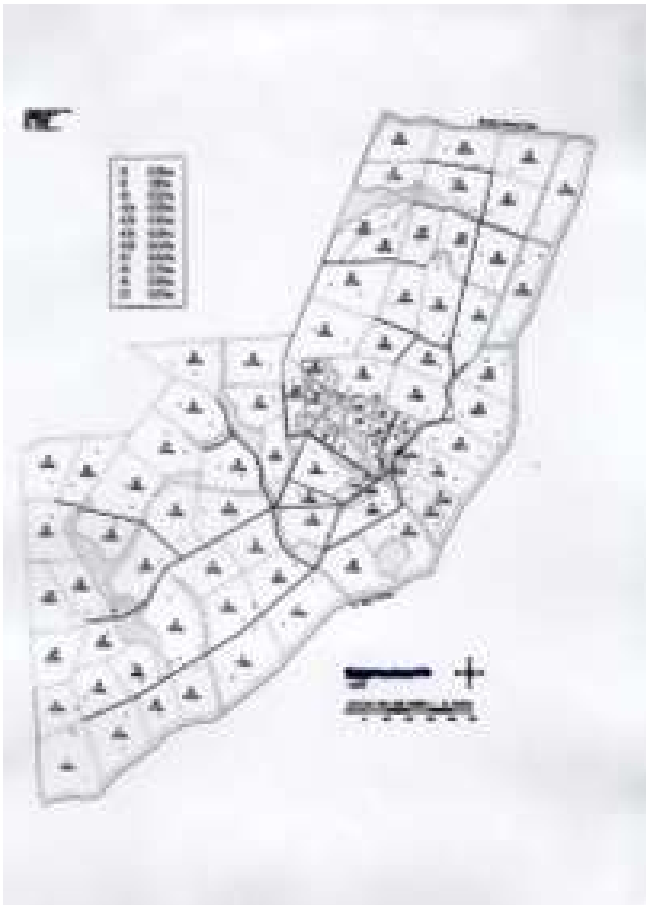
18.5 ha Kale

Farm infrastructure:

50 bail rotary

Calving pad

Feed pad



Soil Maps (new vs traditional)

A NEW higher resolution soil map was created for the property.

Traditional Map – taken from S-maps/beacon using data from the 90s and early 2000s

- The **names (ie "woodlands")** denote the soil type name
- The **white lines** show the soil type boundaries

New soil map – using existing data plus new soil pit information and radiometric data

- The **colours** denote the drainage class of the soil

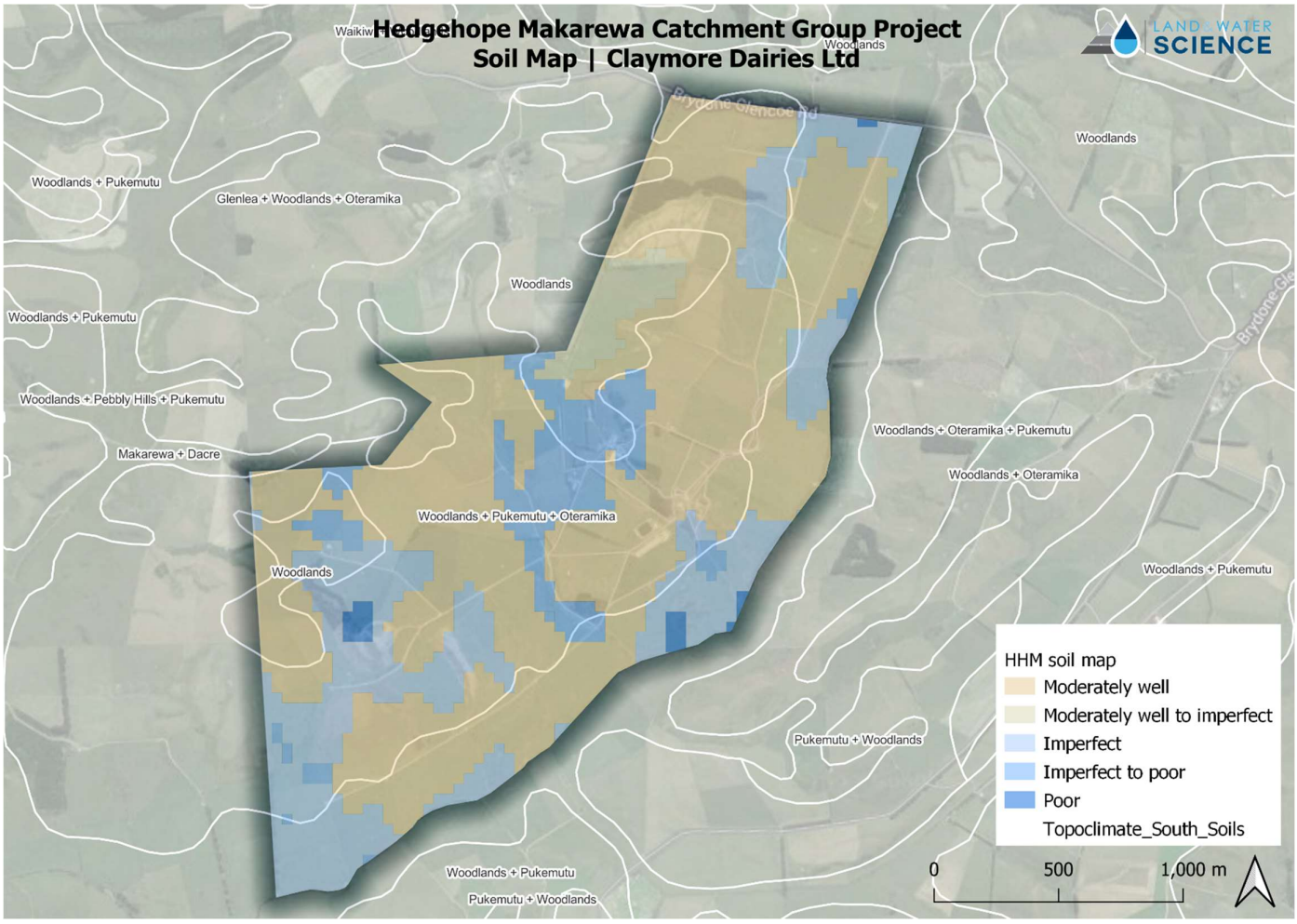


Figure 2. The new high resolution soil map (colours showing drainage properties). This is overlaid with the traditional S-maps soil map (soil type boundaries shown by the lines)

Landscape Hydrology - Drainage Network and Watershed outlines

The map gives an insight into how water moves through and away from the property. Importantly – the map does not consider the tile drainage network on farm. Where present, artificial drainage will significantly modify the hydrological properties and behaviour of water movement across or through the landscape.

The **blue** lines denote the water movement – darker lines denote a higher order and are thus likely to have move water movement.

The **black lines** show catchment boundaries. Much of this farm drains directly to the Titipua stream on the eastern boundary. There are small areas on the western side that drain to the Titipua through neighbouring properties.

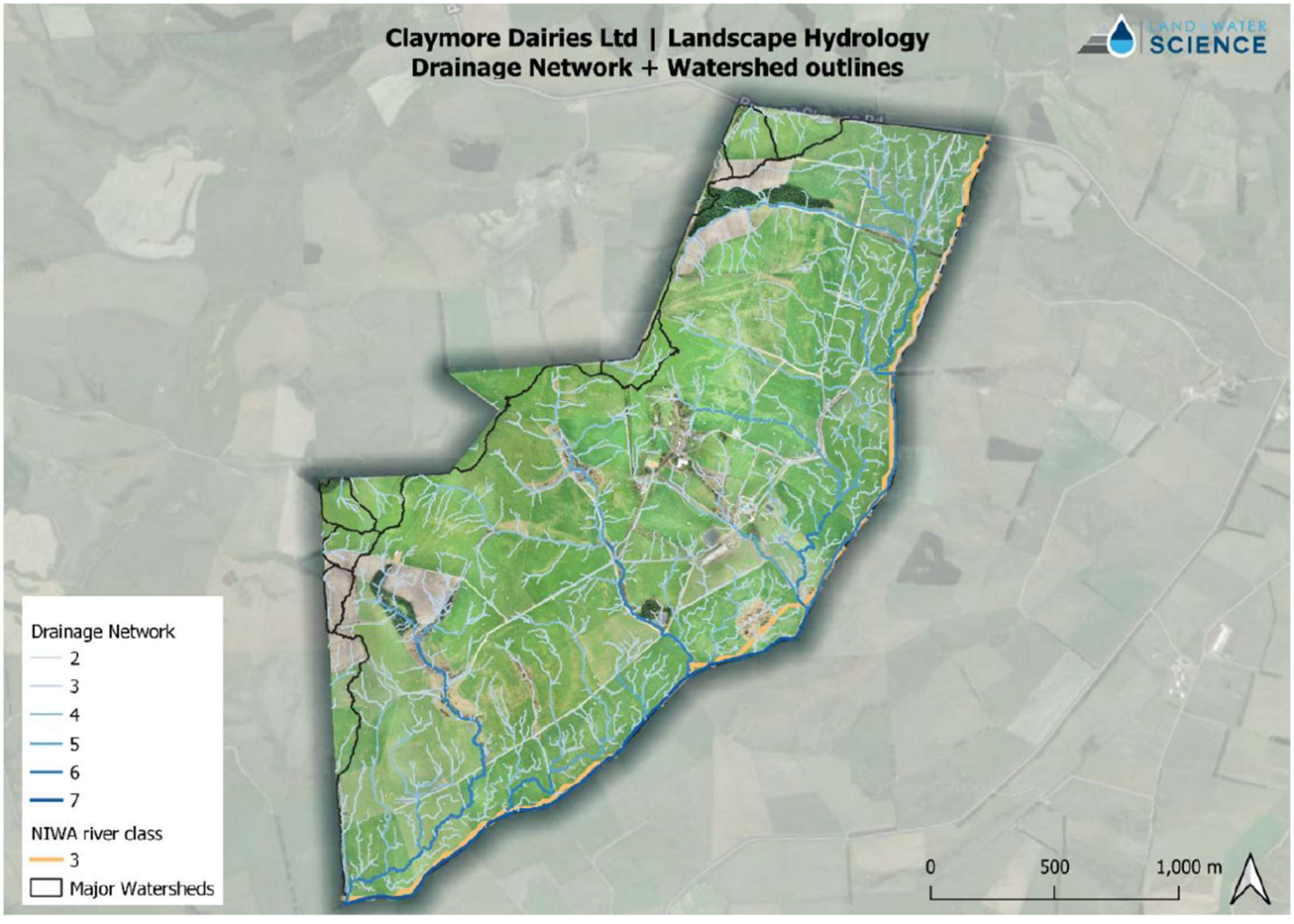


Figure 3. Claymore Dairies - landscape hydrology - drainage network. The legend denotes the 'order' of drainage lines, with low order drainage connecting to generate higher order drainage lines.

Landscape Susceptibility to Nitrate-Nitrite-Nitrogen loss

Nitrate is a highly soluble and easily transportable nutrient. Nitrate that isn't used by the plant can be transported to ground and surface waters where it may cause human health and ecological issues.

Susceptibility of Nitrate loss is higher in well drained soils. Depending on the conditions of the aquifer that receives the nitrate, nitrate may accumulate or be removed. Aquifers that contain abundant oxygen can accumulate Nitrate to high concentrations. Aquifers that contain low oxygen levels are more likely to remove nitrates. These low oxygen aquifers often contain elevated iron levels.

The effect of artificial drainage. Tiles and moles modify the drainage characteristics of a soil. In areas of artificial drainage, nitrate will be lost via the tile to surface water.

Nitrous Oxide loss (N_2O). Nitrous oxide is a potent greenhouse gas. Soils that saturate may convert nitrates into nitrous oxide (N_2O), in a process called "Denitrification".

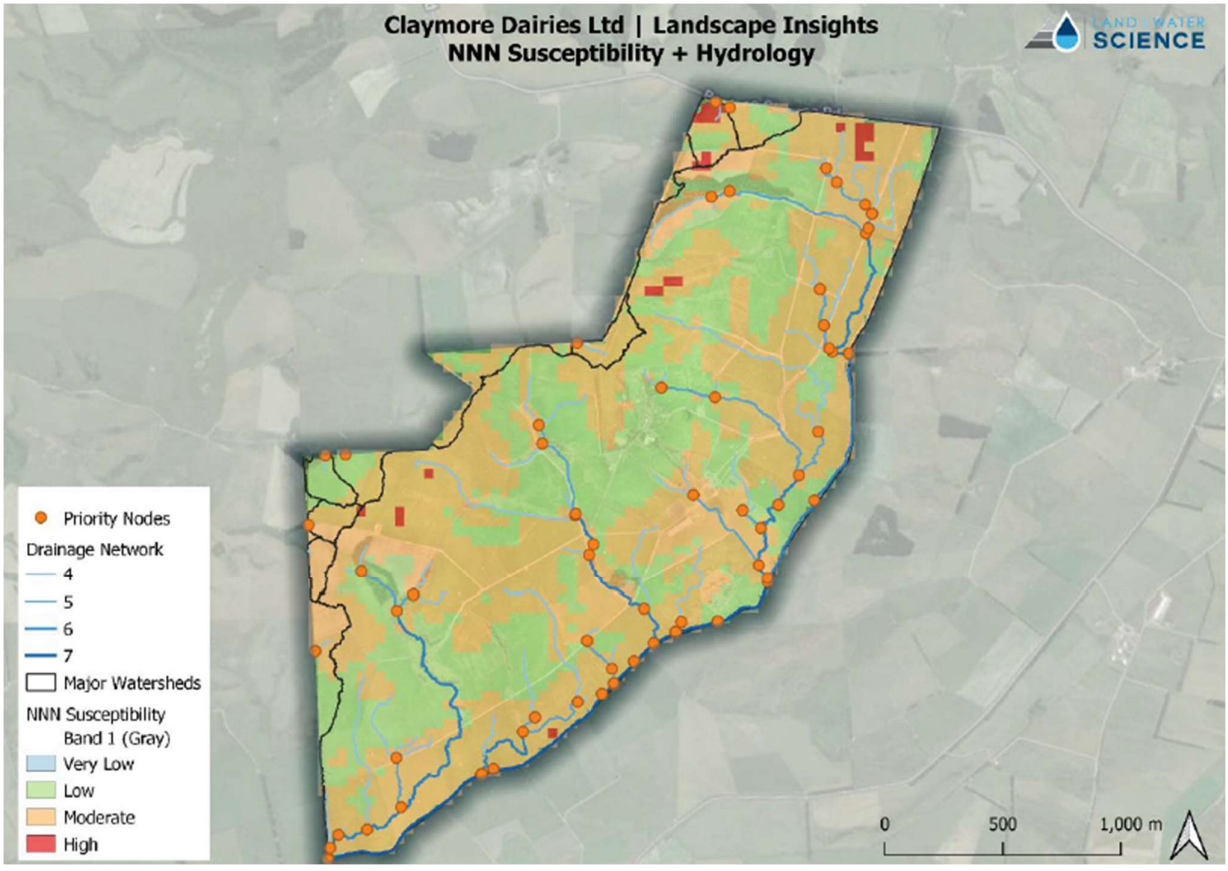


Figure 4. Claymore Dairies - landscape susceptibility to NNN (Nitrate-Nitrite Nitrogen) contaminants, overlaid with the hydrology.

Landscape Susceptibility to Particulate Phosphorus Loss

Particulate phosphorus is phosphorus that is attached to sediment. This can be naturally occurring (ie rock weathering) or a result of landuse (ie animal dung and fertiliser). When soil is lost by runoff, it takes the phosphorus with it. In receiving waterways, it can be used as a nutrient by plants and algae where it can cause problems.

Susceptibility to Particulate Phosphorus loss is higher where there is sediment runoff. This includes poorly drained soils and areas of active soil erosion (steeper landscapes). Particulate phosphorus may also be elevated in subsurface artificial drainage, especially where the drained soils contain significant organic carbon (such as peat soils).

For Claymore Dairies, there are some elevated areas of high Particulate Phosphorus susceptibility. These coincide with the steeper terrain, as well as with the poorly drained Makarewa soils in the east, especially where the water table is elevated or where soils are prone to saturation.

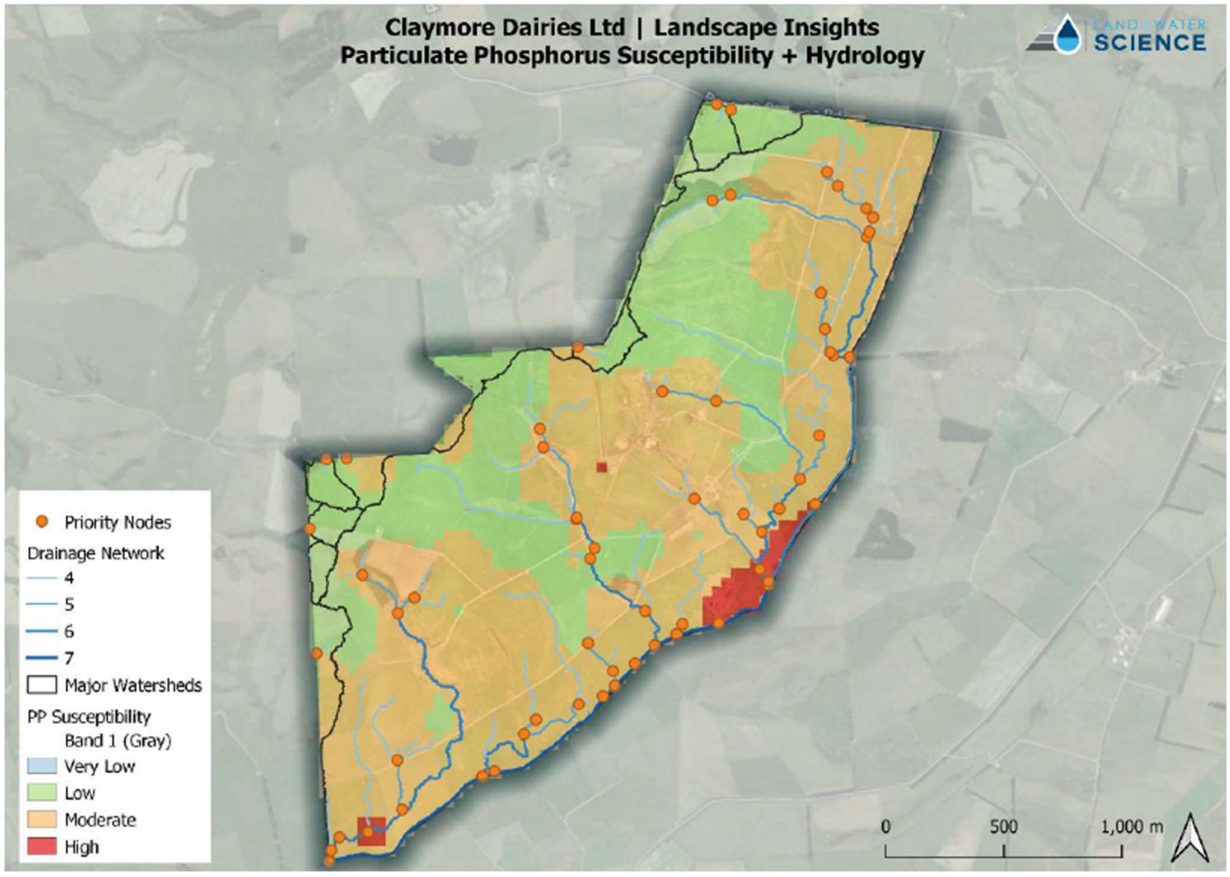


Figure 5. Claymore Dairies - landscape susceptibility to PP (Particulate Phosphorus) contaminants, overlaid with farm hydrology.

Roslyn Downs

The Miller family purchased their first block in the 1960s. Over the next 30 years, a further three blocks were added to the farm. The property is farmed in partnership by three families – Quentin and Eleanor Miller, Jason and Jocelyn Miller, and Andrew and Rachel Miller.

The Brydone Glencoe road runs through the farm at the southern end. The detached block at the northern end of the property is on the corner of McDonald Road and the Glencoe Hwy. The Hedgehope Stream travels through the north-western corner of the main block. The property is a mix of low relief and rolling country, with a mean slope of 7.3°, and lies between 30m and 95m above sea level.

Farm details:

- 627ha total
- 560ha paddock area

Wintered stock:

- Sheep – 6600 SU
- Beef - 700SU
- Dairy Support – 1400SU

Wintering

- Fodderbeet – 12.5ha
- Swedes – 22ha
- Kale – 16.5ha

Note: the detached block to the north of the property was not included in the project.

Soil Maps (new vs traditional)

Traditional Map – taken from S-maps/beacon using data from the 90s and early 2000s

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New soil map - using existing data plus new soil pit information and radiometric data

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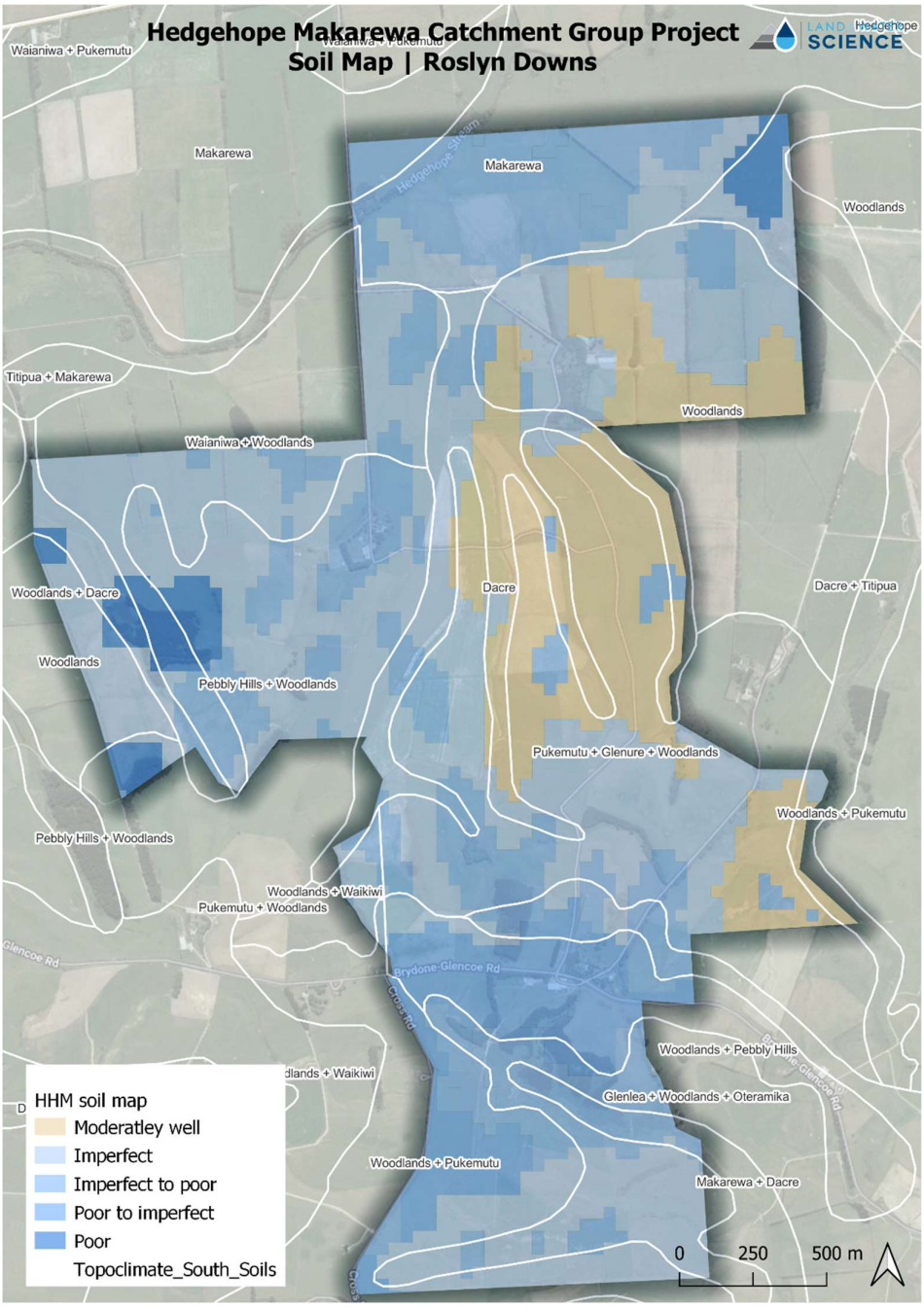

Figure 6. The new high resolution soil map (colours showing drainage properties). This is overlaid with the traditional S-maps soil map (soil type boundaries shown by the lines)

High Resolution Topographical Map

Roslyn Downs was surveyed with a drone to develop a high-resolution Digital Terrain Model (DTM) with a vertical accuracy of 0.02cm. Topography has a large effect on the movement of water across a property and as such the transport of contaminants from one area to another.

Elevation ranges from 30-95m above sea level

A high-resolution topographical map was developed

- The lines show 5m elevation contours – where lines are close together, the area is steep
- The darker the area, the higher it is above sea level

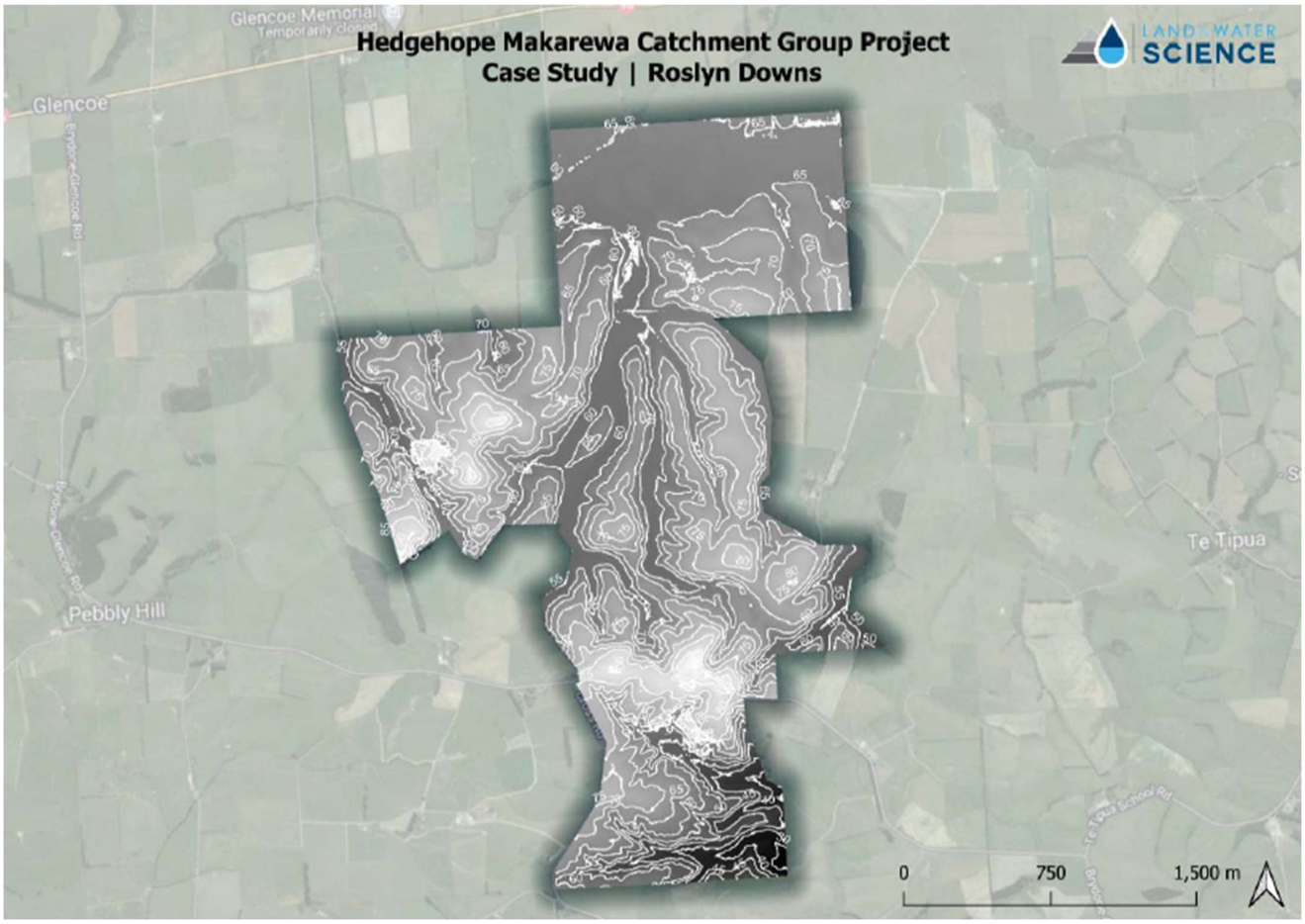

Figure 7. Shade model of elevation overlaid with elevation contours (5m) of property in meters relative to sea level. Note that the closer the spacing of contours, the steeper the land.

Note: High resolution drone mapping to create a Digital Terrain Model (DTM) was undertaken on the case study farms only. It has NOT been completed for the entire catchment. Lower resolution mapping of altitude and slope can be found on the LandscapeDNA website.

Landscape Susceptibility to Erosion

This map is based on the integration of several datasets including the radiometric data and the digital terrain model.

High erosion susceptibility areas are mainly associated with hill and high-country areas that have erodible geologies (ie. poorly drained and/or slowly permeable soils).

Susceptibility to runoff and sediment loss is an important consideration for Roslyn Downs and is a natural phenomenon of contoured landscapes. Land use can exacerbate the loss of sediment, with high-intensity land use on top of naturally susceptible areas associated with the highest rates of contaminant loss. Fortunately, through identifying the inherent susceptibility of the landscape to erosion, it is possible to design strategies to limit contaminant loss that are data-driven and targeted.

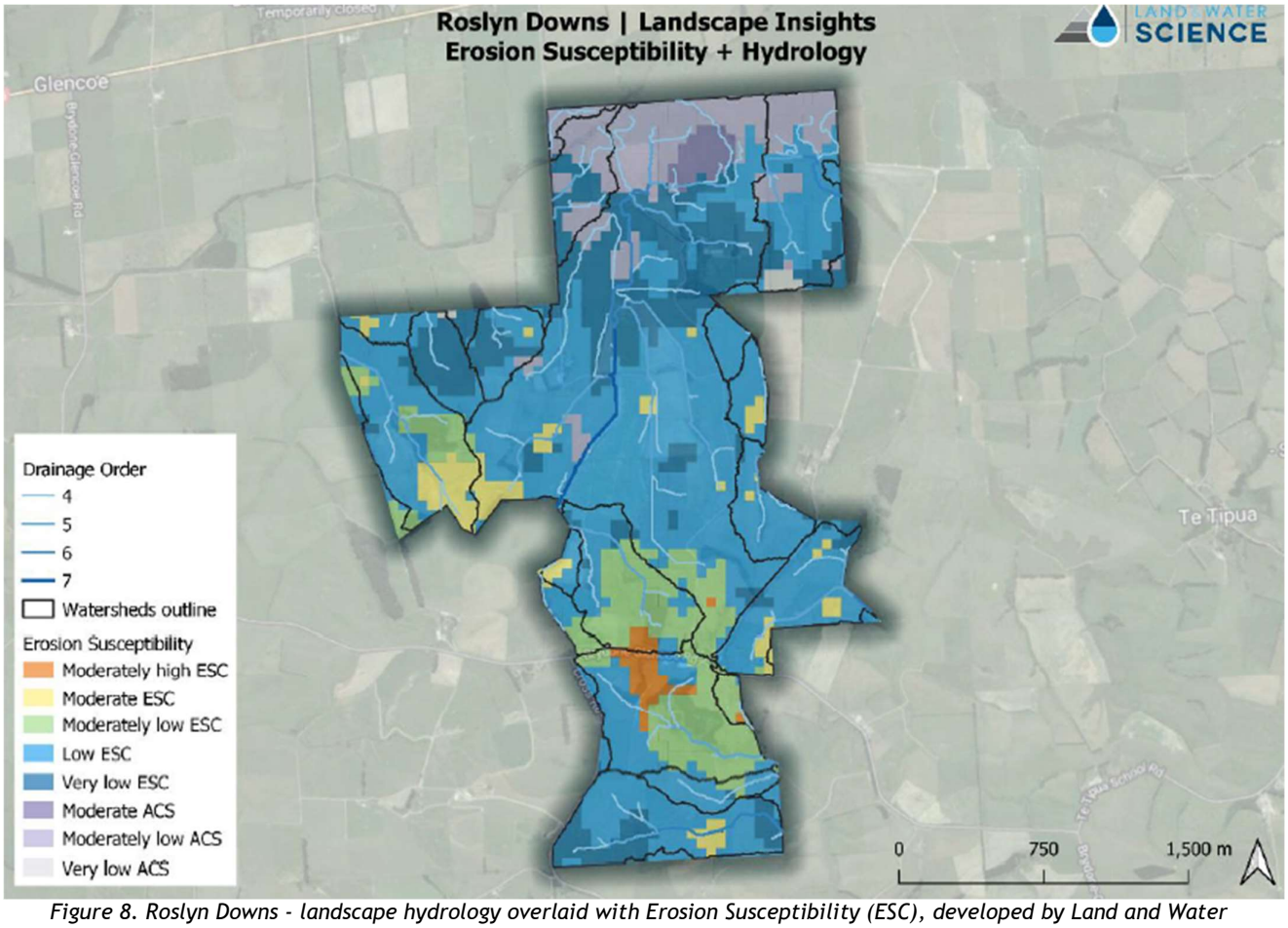

Figure 8. Roslyn Downs - landscape hydrology overlaid with Erosion Susceptibility (ESC), developed by Land and Water Science (2020).

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For Roslyn Downs, there are some elevated areas of high Particulate Phosphorus susceptibility.

- Steeper areas at the southern end of the property
- Poorly drained areas in the north-eastern corner and western boundary.

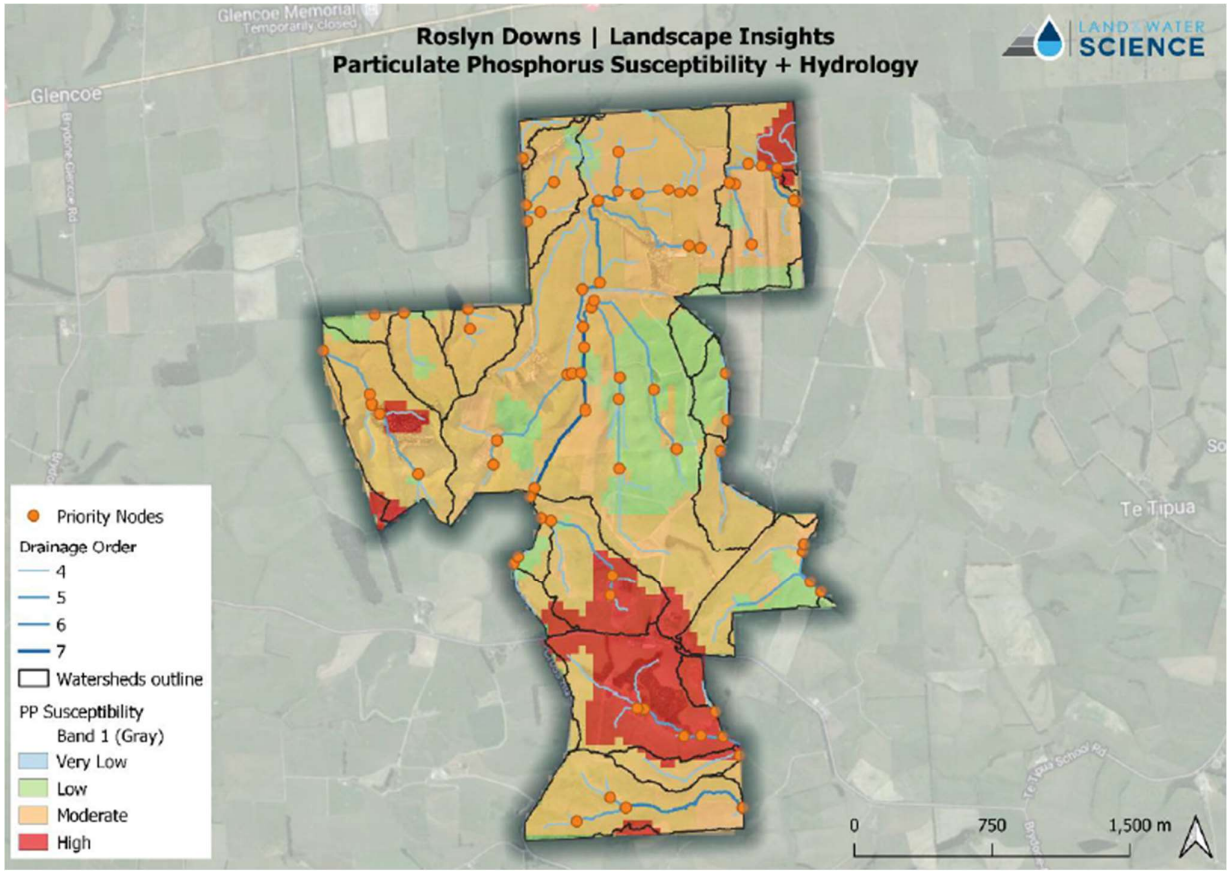

Figure 9. Roslyn Downs - landscape susceptibility to PP (Particulate Phosphorus) contaminants overlaid with the hydrology.