A PRECISION AGRICULTURE JOURNEY TO AMELIORATE SOIL CONSTRAINTS, INCREASE PRODUCTIVITY AND PROTECT SWAMPS IN HIGH RAINFALL ZONE (HRZ) FARMING SYSTEMS

Introduction

Glenelg Hopkins CMA's 'Our Catchment, Our Communities' focus region is a productive high rainfall region in a landscape of wetlands, many of which are not permanently wet.

Due to the seasonal variability of these wetlands, in dry years these wetlands are trafficable and have therefore historically been considered part of the arable area.

This project aims to encourage cropping farmers to use precision agriculture strategies to improve their productivity whilst managing their wetlands.

Focus Farm: Tarnawa

Simon Gabb is managing 950Ha at Skipton, with a mixed enterprise of sheep and cropping. While the enterprise split does vary year to year based on cropping and pasture rotations, on average over a 5 year period, Simon aims for a 50:50 split. The cropping cycle includes a wheat, canola and faba bean rotation, with strategic pasture phases.
Precision ag technologies are already implemented on Tarnawa with use of regular grid soil mapping to manage soil pH with VR Lime applications, and to also track micro nutrients. There is also a VR nitrogen strategy based off production zones.

Simon was keen to be involved in the project to help create "more awareness and education around the value of Precision Ag and also how to try and integrate PA to better manage our natural capital assets such as swamps."

The project area comprises of four paddocks totalling to 134ha near Skipton. A portion of the project area includes 'temporary freshwater marsh and meadows', however, in some of the project paddocks, there are seasonal waterflows that can significantly impact surrounding wetlands.

The property has a long history of having a rotation of both crop and pasture phases. It is currently in a cropping phase.

Figure 1: Wetlands GIS layer identifying numerous Temporary Freshwater marshes and meadows in the Skipton region, including the identified project paddocks outlined in red. Each identified wetland has a unique colour identification.

Wetlands

Seasonal herbaceous wetlands are isolated freshwater wetlands that fill seasonally with rainfall. They are generally inundated by water in winter/spring and dry by late summer. So, while they are regarded as wetlands, surface water is not always present. The wetlands of note on Tarnawa include many seasonal wetlands with connecting waterflows between nearby lakes, such as Slaters lake and other permanent or semi-permanent bodies of water.

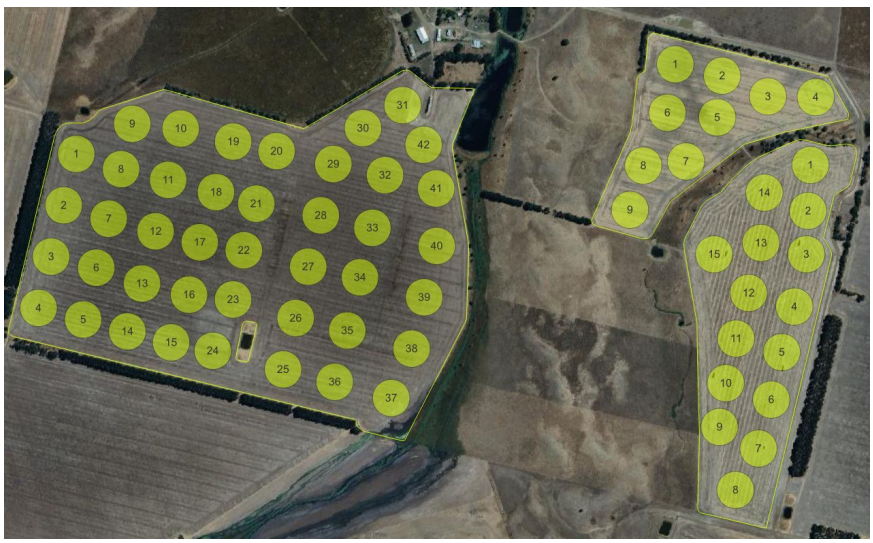
Historically, these water sources supplied the local township of Skipton, and while the township no longer relies on this water source. This is a great example of the interconnected nature of waterways and wetlands, particularly with neighboring properties.

Method

Precision Ag's research has shown that grid soil sampling is the best approach to the targeted amelioration of surface soil properties as the different surface soil characteristics rarely correlate with each other or yield and NDVI based management zones.

Compiled farm and paddock spatial data, including wetland layers were utilised to devise a grid soil sampling plan using a 2-hectare size grid sampling strategy. In this instance, the sampling plan from 2020 was reused to ensure consistency. For each grid, 8 soil cores were collected along a 120m transect to a depth of 10 cm, with the cores combined into a composite soil sample for each grid. Each soil sample was submitted to an independent NADA-accredited soil laboratory and analysed for Phosphorus (Colwell), Exchangeable Cations (Ca, K, Mg, Na, CEC) & pH (1:5 CaCl2). Phosphorus Buffer Index (PBI) is also tested at strategic sites.

Once laboratory analysis was completed, the soil data was processed and contoured using Precision Ag's Soli software. Following on from consultations with Simon and his relevant consultant/s, key soil constraints and amelioration strategies were developed. On-farm prescription files were created and where appropriate wetland areas were excluded from cropping inputs.



Alongside the grid sampling, EM38 and elevation data were collected to build a better understanding of the subsoil conditions and soil types.

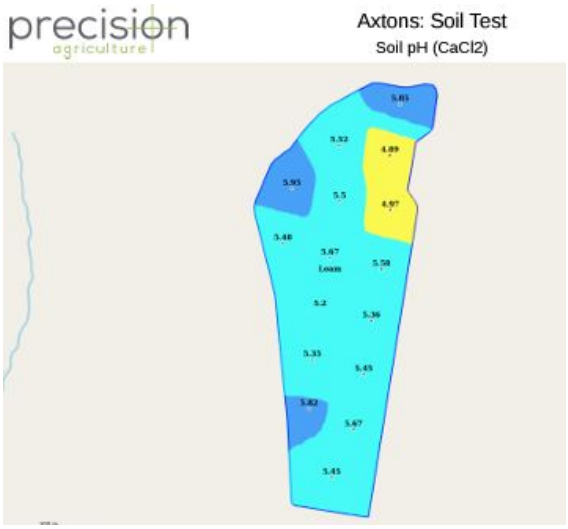
For this particular set of paddocks, the project was looking to understand why there were significant production differences in neighboring paddocks despite topsoil nutrition not being a limiting factor.

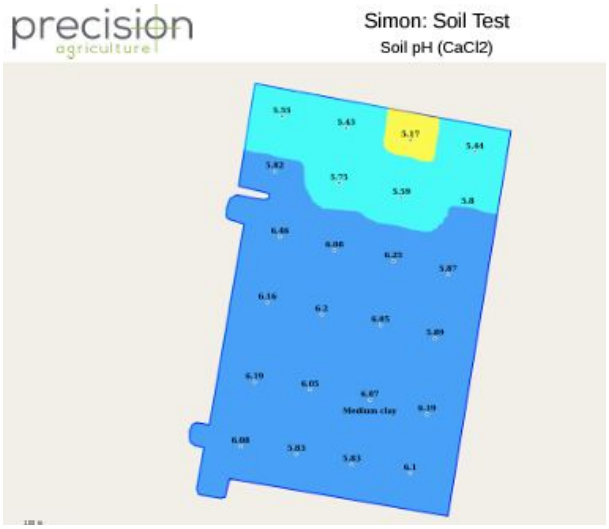
Figure 2: Sampling plan with each point representative of a 2-hectare region. The sampling plan has been designed collect samples in the currently cropped regions.

Soil Test Results and Variable Rate Applications

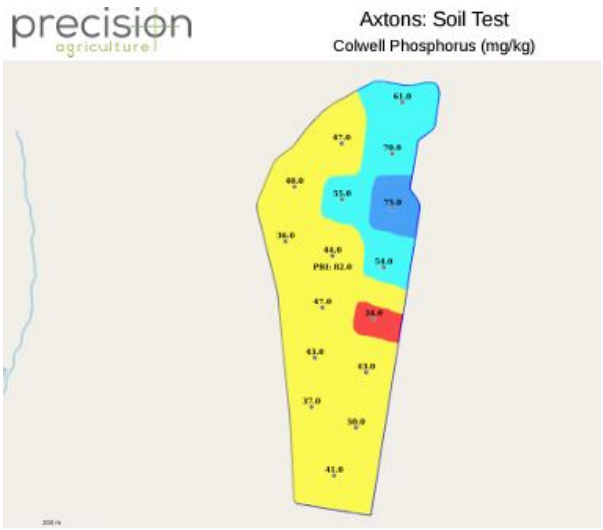
As part of their long-term strategy, grid soil sampling has been an integral part of top-soil amelioration for Tarnawa. This is the second time these paddocks have been sampled, allowing for the efficacy amelioration strategies to be assessed. These results focus on just two of the paddocks which sit to the East of the wetland area.

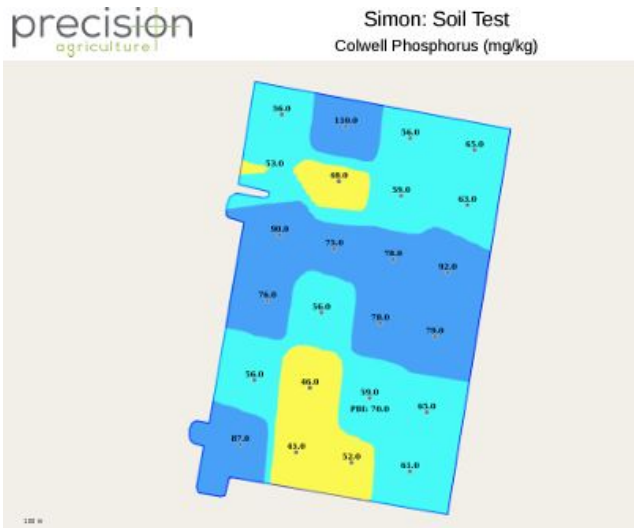
A)





B)





	pH	CEC cmol(+)/kg
	< 4.5	< 24
	4.5-4.8	24-35
	4.8-5.2	35-53
	5.2-5.8	53-71
	>5.8	> 71

Figure 3: Axtons and Simons paddocks first sampled in 2020 for soil (a) pH (CaCl2) and (b) Colwell Phosphorus.

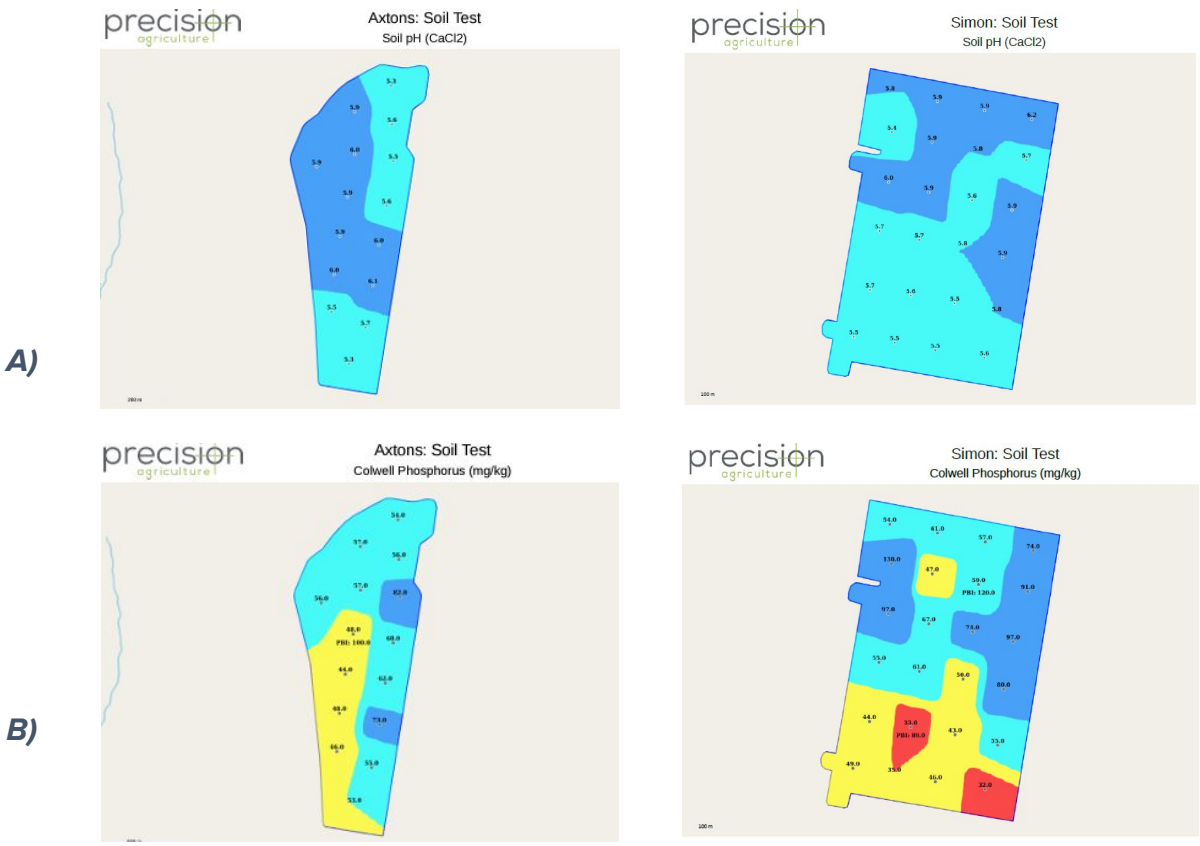


Figure 4: January 2024 results for Axtons and Simons paddocks for soil (a) pH (CaCl2) results and (b) Colwell P results.

In 2020 the average pH was 5.5 (range 4.9 to 6.0) in Axtons, 5.9 (range 5.2 to 6.5) in Simons, while the average pH was similar the pH variation across the paddocks decreased slightly in the return sampling 2024 where the average pH was 5.7 (range 5.3 to 6.1) in Axtons, 5.7 (range 5.4 to 6.2) in Simons.

In contrast, Colwell P trends varied between the two paddocks. The average Colwell P increased between seasons in Axtons with the average Colwell P in 2020 of 49 mg/kg (range 34 to 75 mg/kg), and in 2024 this was 57 (range 44 to 82) with similar variability across the paddocks. While in Simons the average Colwell P decreased from 67 mg/kg (range 45 to 110 mg/kg) in 2020 down to 57 (range 44 to 82) in 2024 with a decrease in variation across the paddock.

The grid soil sampling results identified no overarching yield constraints in the topsoil, and any ameliorants or fertilizer applications are targeted at continued maintenance of soil conditions and to support yield targets. However, long-term yields show that Simons Paddock is consistently higher producing than Axtons paddock. In 2023, Simons paddock yielded an average of 6.6t/ha of red wheat, compared to 4.1t/ha of faba beans in Axtons (Figure 5). While a direct comparison of yields is not really possible with a single years data from different crop types it is important to note that both yield results are on trend for the season in the Western Districts for 2023. As a part of his precision agriculture journey Simon Gabb was keen to better understand the variation in soils between the two paddocks, as this variation in yields cannot be explained through surface soil characteristics or visual differences in the paddocks.

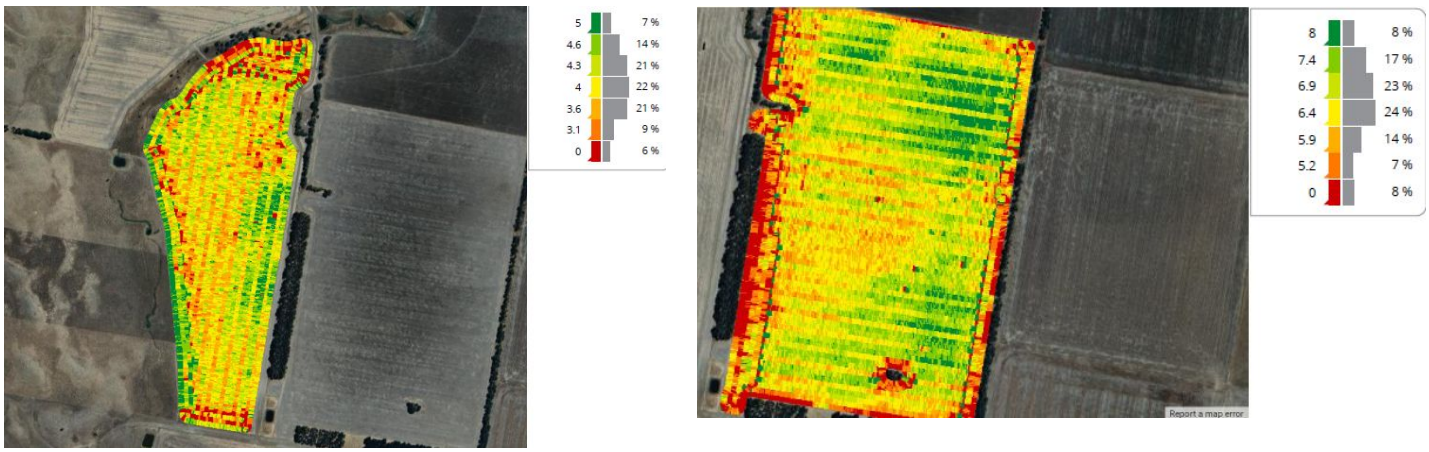


Figure 5: 2023 faba bean harvest data with Axtons paddock with average yield of 4.1t/ha (left) and red wheat in Simons paddock with average yield of 6.6t/ha (right).

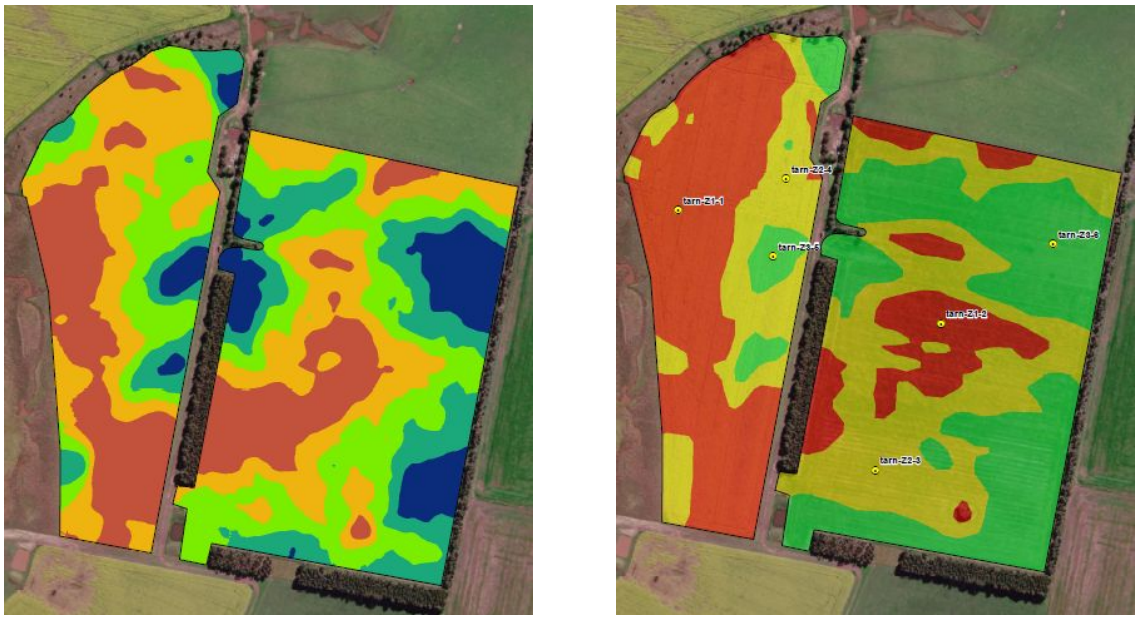


Figure 6: Simons and Axtons paddock Deep EM38 (0-1.5m) map on left with proposed 3-zone management with strategic sampling plan on right.

The EM38 maps show the variation in apparent Electrical Conductivity across the two paddocks; this is affected by soil type (particularly clay content), soil moisture and may also be influenced by salts if present. An analysis of the Deep EM38 map shows that there are more areas of high conductivity in Simon's paddock, as highlighted with the dark blue in figure 6, these areas would generally be an indication of heavier soils, and may also be a reflection of water or salts. The underlying drivers for the differences in the EM38 readings require ground truthing through strategic soil sampling.

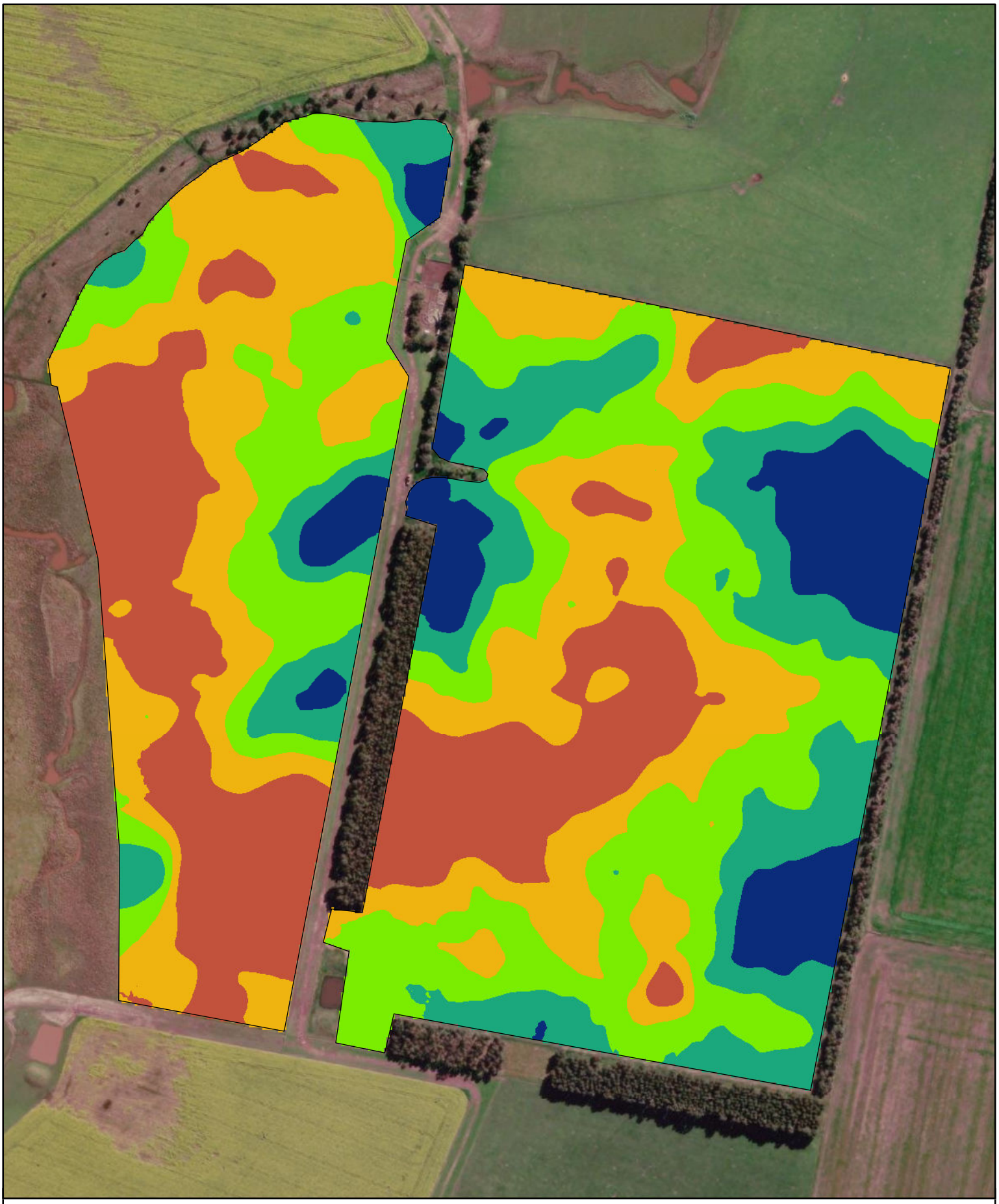
When we consider the spatial variation in yield and EM38 maps together we can see strong correlations between the brown and orange zones in the EM38 map and the lower yielding areas for 2023. This consistency between the spatial layers, suggests that underlying soil types may be affecting the production potential in the two paddocks.

Next Steps

Utilising the grid soil results, Simon was able to make some informed decisions about his lime strategy for the coming season. In the case of Simon and Axtons paddocks, there was no lime applied following the 2024 results, however continued monitoring overtime is required as pH will naturally continue to decline over time.

The phosphorus strategy at Tarnawa is somewhat limited with the lack of variable rate seeding equipment, however when it is time to upgrade the equipment, variable rate capability has been noted as a necessity. Subsequently, the current strategy for phosphorus includes drilling a base rate of 100kg/ha of SSP pre-seeding, as well as adding 75kg/ha at seeding for canola.

The next major step on their PA journey is to investigate the underlying yield constraints between the two paddocks, starting with the strategic sampling program. The recommended sampling strategy (Figure 6) would be a 3 segmented 'soil health test' that will assess the soil at 0-10cm, 10-30cm and 30-60cm. This sampling strategy will be able to outline the the characteristics of the soil zones, as well as understanding the different root zones. From this, we will be able to identify any underlying sub-soil constraints, and depending on those outcomes either address them or more likely, be able to manage yield expectations. The results of which may also be supported by digging a soil pit to understand the soil profile and also investigate rooting depth.



LEGEND

Tarnawa

EM38 Shallow (0-0.75m)

- 50.126 - 56.832
- 56.833 - 61.582
- 61.583 - 66.751
- 66.752 - 73.178
- 73.179 - 85.613

N

0 25 50 100 Metres

Tarnawa

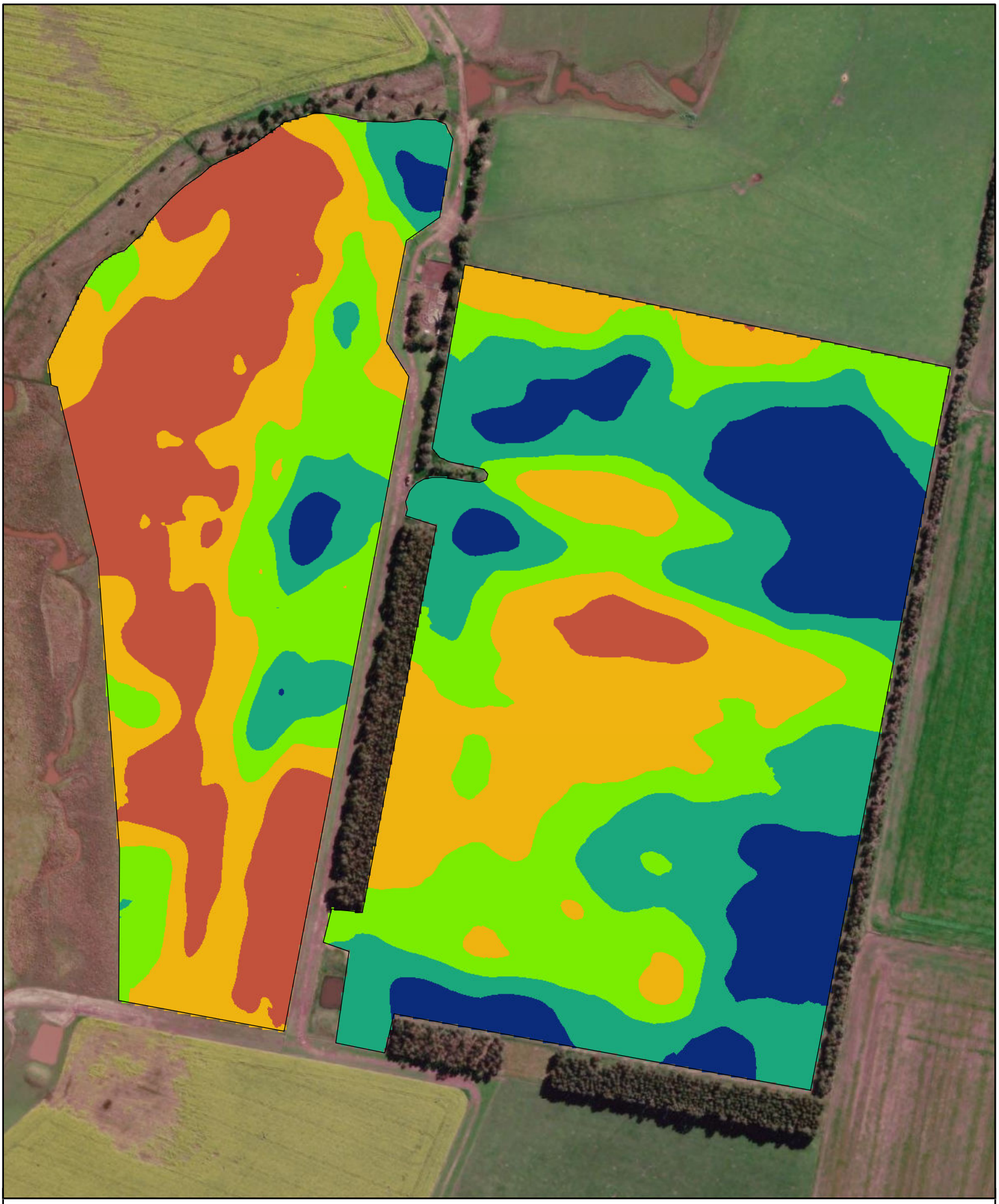
EM38 & Elevation Mapping

Date Prepared: 9/04/2024
Projection & Datum: GDA 1994 - MGA 54

File Reference: Tarnawa

precision agriculture

Prepared by: www.precisionagriculture.com.au
Email: info@precisionagriculture.com.au
Phone: 1800 PRECISION AG



LEGEND

Tarnawa

EM38 Deep (0-1.5m)

- 48.142 - 63.780
- 63.781 - 73.212
- 73.213 - 82.644
- 82.645 - 93.317
- 93.318 - 111.436

N

0 25 50 100 Metres

Tarnawa

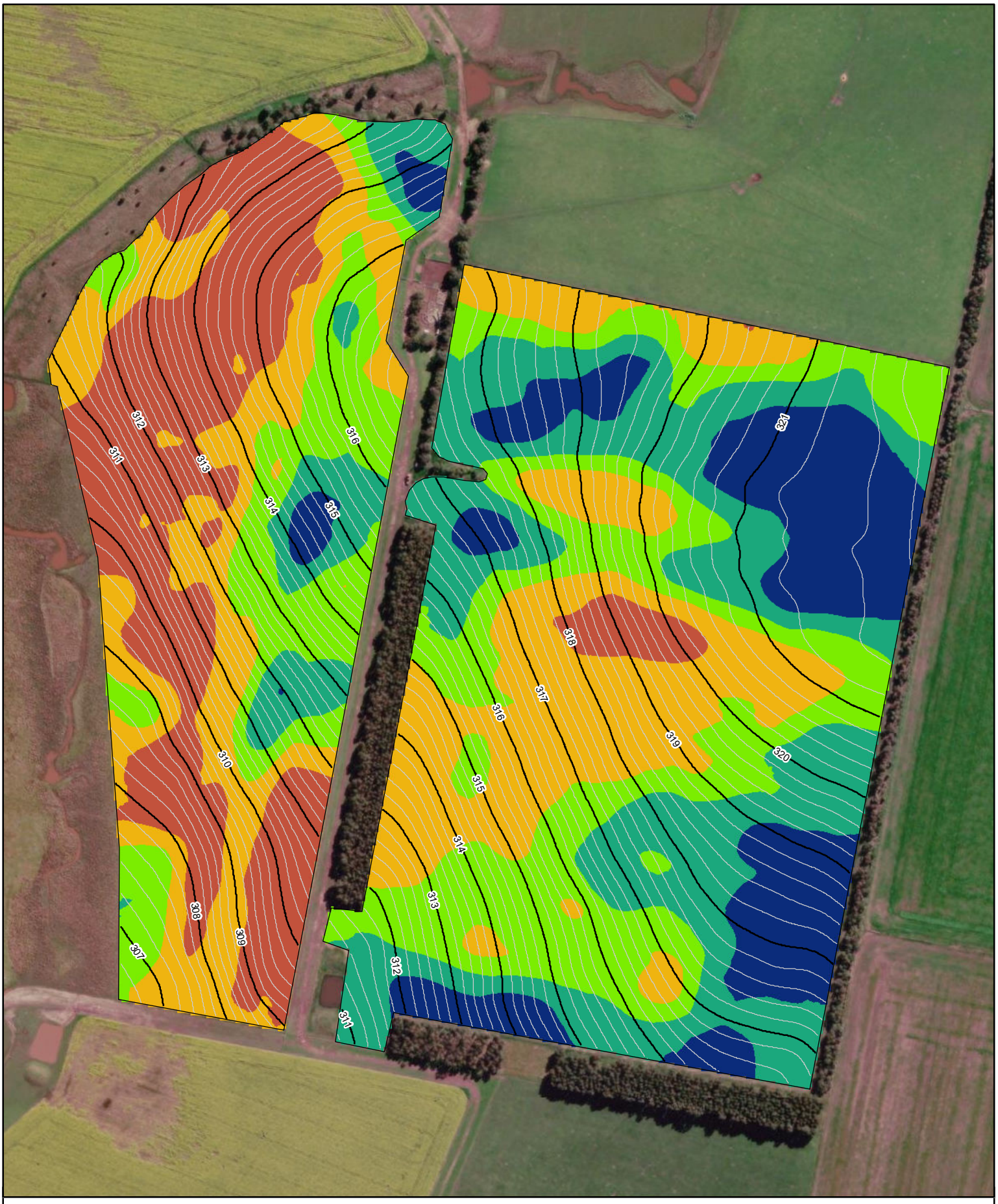
EM38 & Elevation Mapping

Date Prepared: 9/04/2024
Projection & Datum: GDA 1994 - MGA 54

File Reference: Tarnawa

precision agriculture

Prepared by: www.precisionagriculture.com.au
Email: info@precisionagriculture.com.au
Phone: 1800 PRECISION AG



LEGEND

Tarnawa

Contour

Major (1.0m)

Minor (0.2m)

EM38 Deep (0-1.5m)

- 48.142 - 63.780
- 63.781 - 73.212
- 73.213 - 82.644
- 82.645 - 93.317
- 93.318 - 111.436

N

0 25 50 100 Metres

Tarnawa

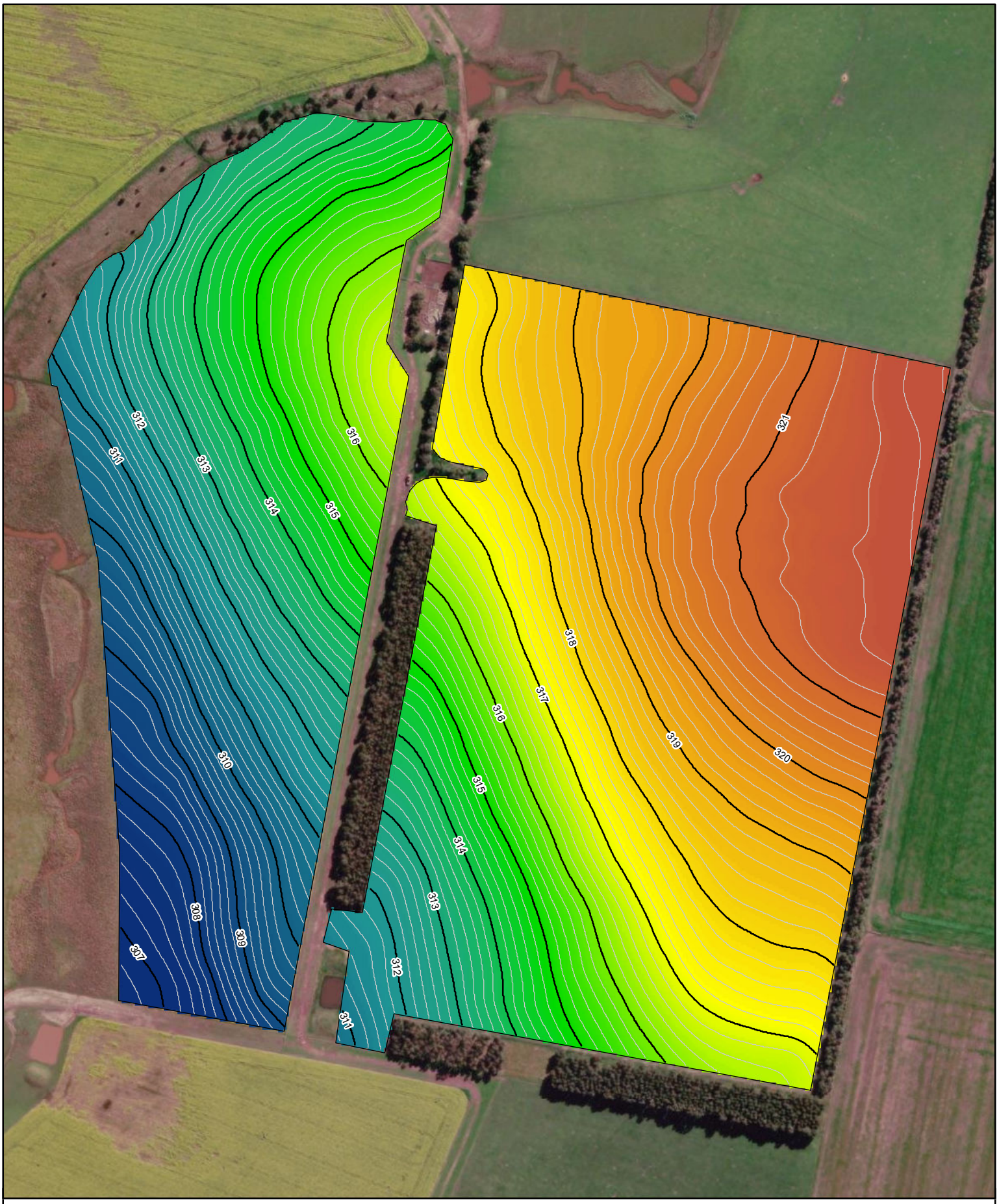
EM38 & Elevation Mapping

Date Prepared: 9/04/2024
Projection & Datum: GDA 1994 - MGA 54

File Reference: Tarnawa

precision agriculture

Prepared by: www.precisionagriculture.com.au
Email: info@precisionagriculture.com.au
Phone: 1800 PRECISION AG



LEGEND

Tarnawa

Contour

Major (1.0m)

Minor (0.2m)

DEM

Elevation (m)

High : 321.8

Low : 306.6

N

0 25 50 100 Metres

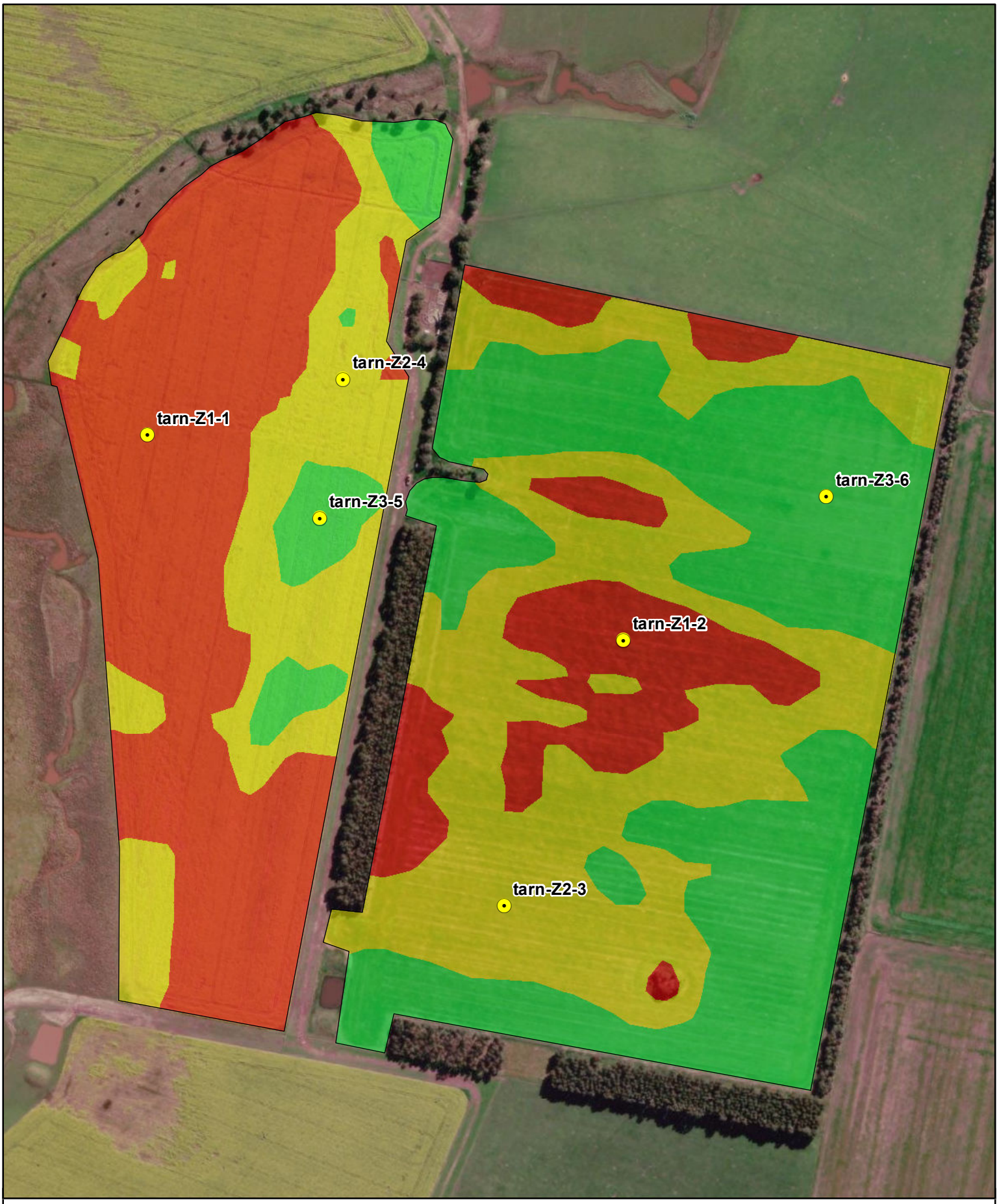
Tarnawa

EM38 & Elevation Mapping

Date Prepared: 9/04/2024
Projection & Datum: GDA 1994 - MGA 54

File Reference: Tarnawa

Prepared by: www.precisionagriculture.com.au
Email: info@precisionagriculture.com.au
Phone: 1800 PRECISION AG



LEGEND

- Tarnawa
- Sampling Pt

Management Zone

- 1 (25.7ha)
- 2 (27.5ha)
- 3 (22.8ha)

N

0 25 50 100 Metres

Tarnawa

EM38 & Elevation Mapping

Date Prepared: 9/04/2024
Projection & Datum: GDA 1994 - MGA 54

File Reference: Tarnawa

precision agriculture

Prepared by: www.precisionagriculture.com.au
Email: info@precisionagriculture.com.au
Phone: 1800 PRECISION AG

Field: AXTONS
Client: Gabbs | **Farm:** Blacks Creek

2023 Broad (Tick, Field, Faba) Beans Harvest: Yield (Weight)

Start: Dec 22, 2023 1:50 PM
End: Dec 22, 2023 5:20 PM

Operator Name: Paul

Work Totals

Area Harvested: 29.3 ha
Total Yield: 121 t
Wet Weight: 4.4 t/ha

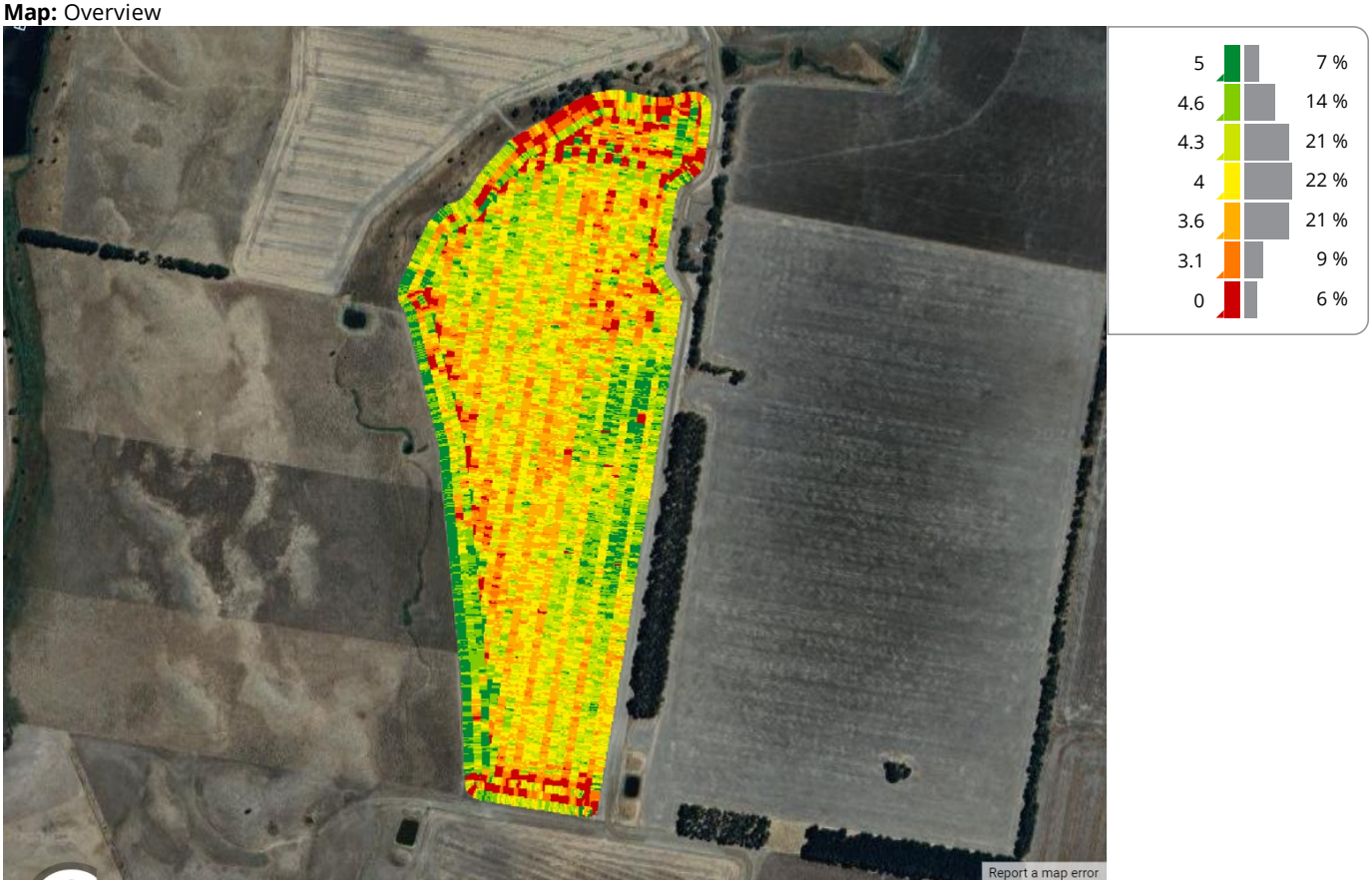
Yield: 4.1 t/ha
Moisture: 5.9 %
Total Wet Weight: 129 t

Performance

Speed: 8.8 km/hr
Working Time: 2 hrs 54 mins
Throughput (Dry): 41.5 t/hr
Fuel Efficiency: 0.5 t/l
Fuel: 79.1 l/hr

Productivity: 10.1 ha/hr
Total Fuel: 229.5 l
Throughput (Wet): 44.1 t/hr
Fuel: 7.8 l/ha

Map: Overview



Equipment

Liston X9 1H0X910XVP0825586

Varieties

Amberly (1)

Field: SIMONS
Client: Gabbs | **Farm:** Blacks Creek

2023 Wheat (Soft Red Winter) Harvest: Yield (Weight)

Start: Jan 6, 2024 7:30 PM
End: Jan 11, 2024 7:46 PM

Operator Name: Paul

Work Totals

Area Harvested: 45.9 ha
Total Yield: 305 t
Wet Weight: 6.7 t/ha

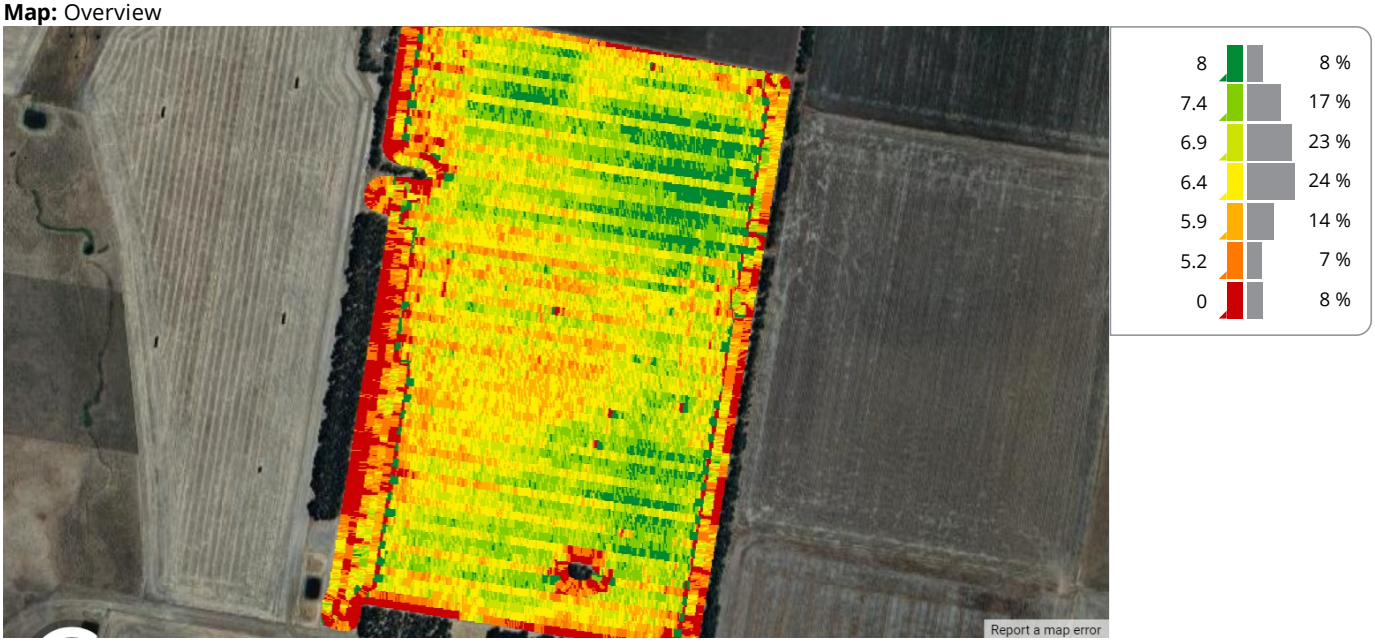
Yield: 6.6 t/ha
Moisture: 13.2 %
Total Wet Weight: 307 t

Performance

Speed: 4.5 km/hr
Working Time: 8 hrs 52 mins
Throughput (Dry): 34.4 t/hr
Fuel Efficiency: 0.6 t/l
Fuel: 59.7 l/hr

Productivity: 5.2 ha/hr
Total Fuel: 529.8 l
Throughput (Wet): 34.6 t/hr
Fuel: 11.5 l/ha

Map: Overview



Equipment

S670-2015 1H0S670SPF0775825

Varieties

cesario

Brand Name: wheat

Conditions

Temperature

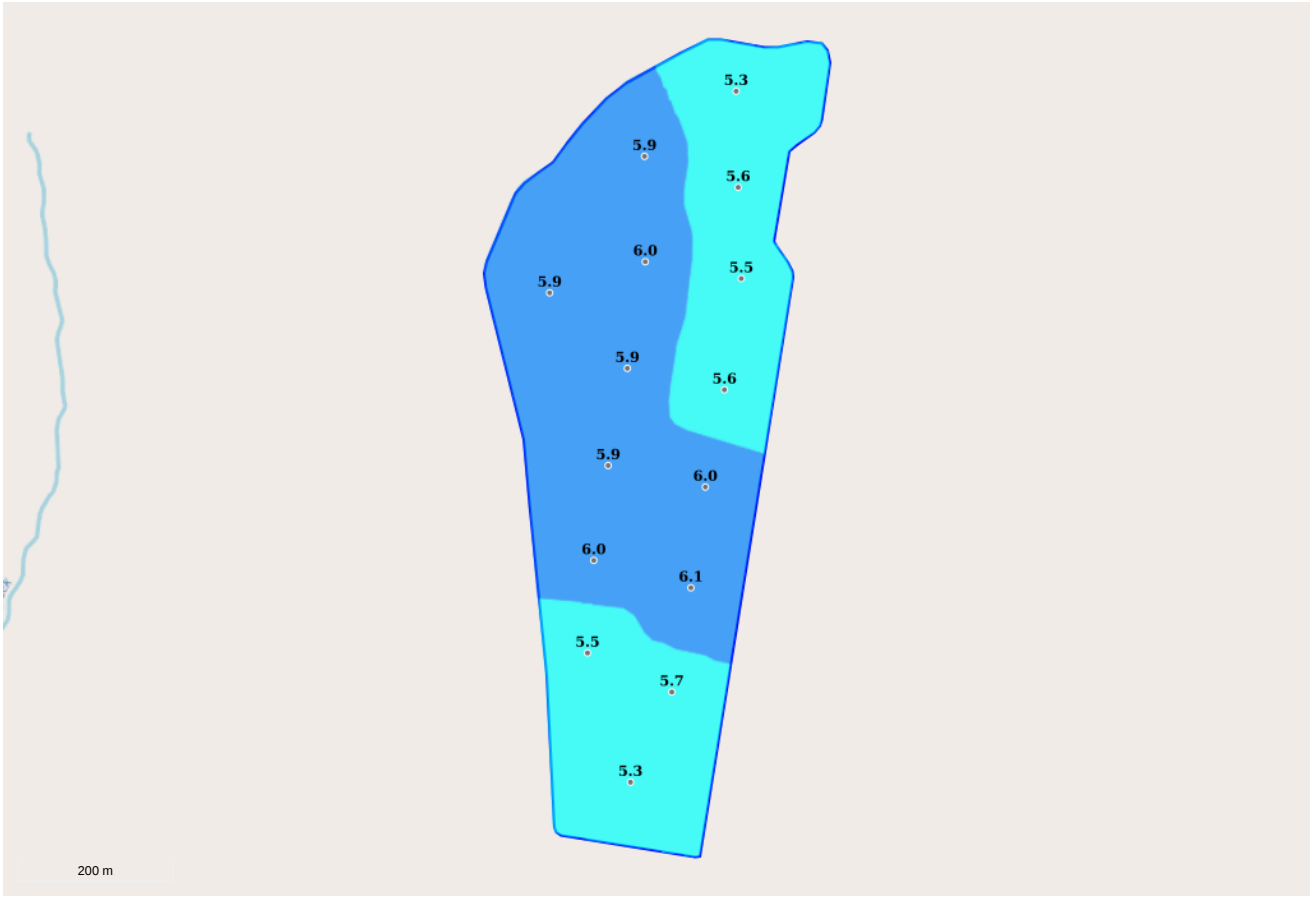
Average: 28 °C

Start: 28 °C

End: 28 °C

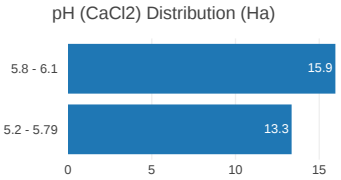
Axtons: Soil Test

Soil pH (CaCl2)



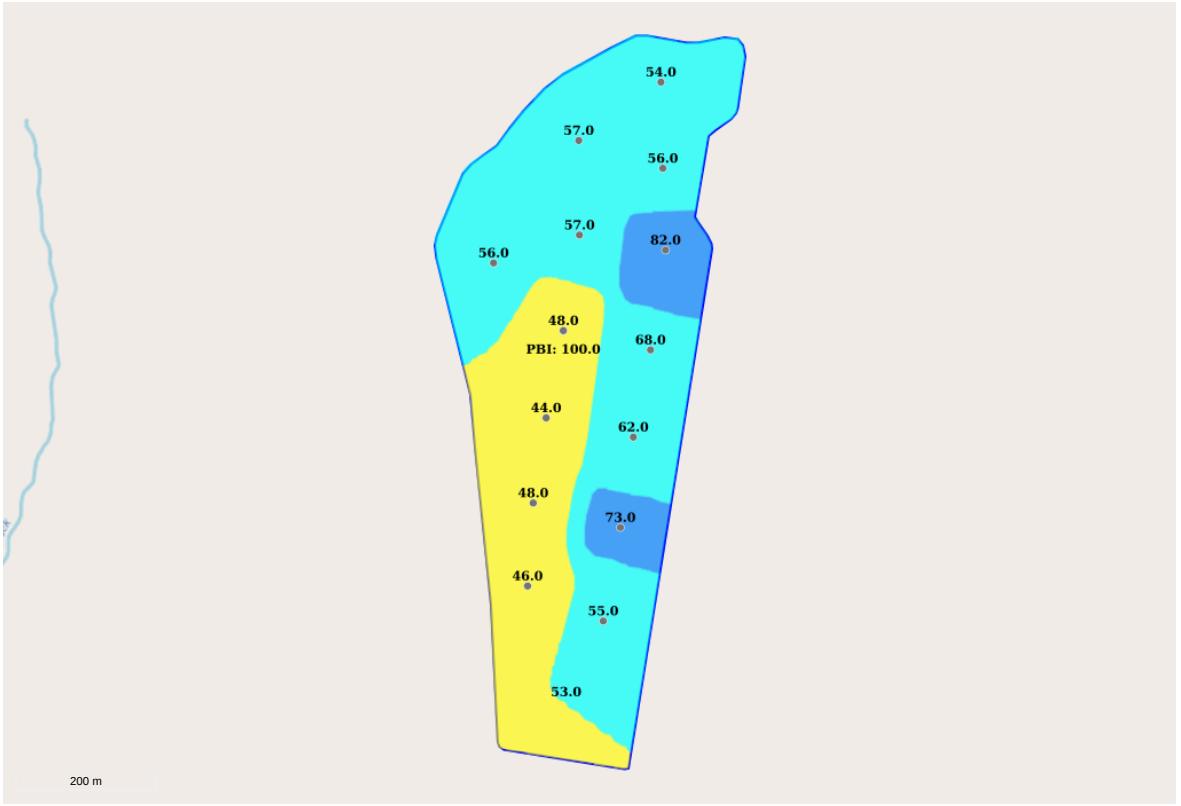
Client:	Tarnawa Pastoral Co (Al Gabb)
Farm:	Blacks Creek
Paddock:	Axtons
Name:	Axtons
Type:	Soil Test
Date:	19/01/2024
Min:	5.3 pH
Max:	6.1 pH
Avg:	5.7 pH

- Above 5.8 pH
- 5.2 - 5.79 pH
- 4.8 - 5.19 pH
- 4.5 - 4.79 pH
- Below 4.49 pH



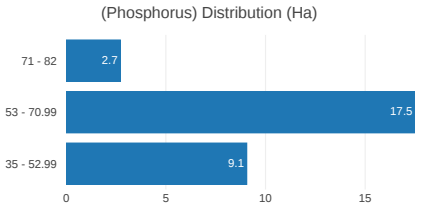
Axtons: Soil Test

Colwell Phosphorus (mg/kg)



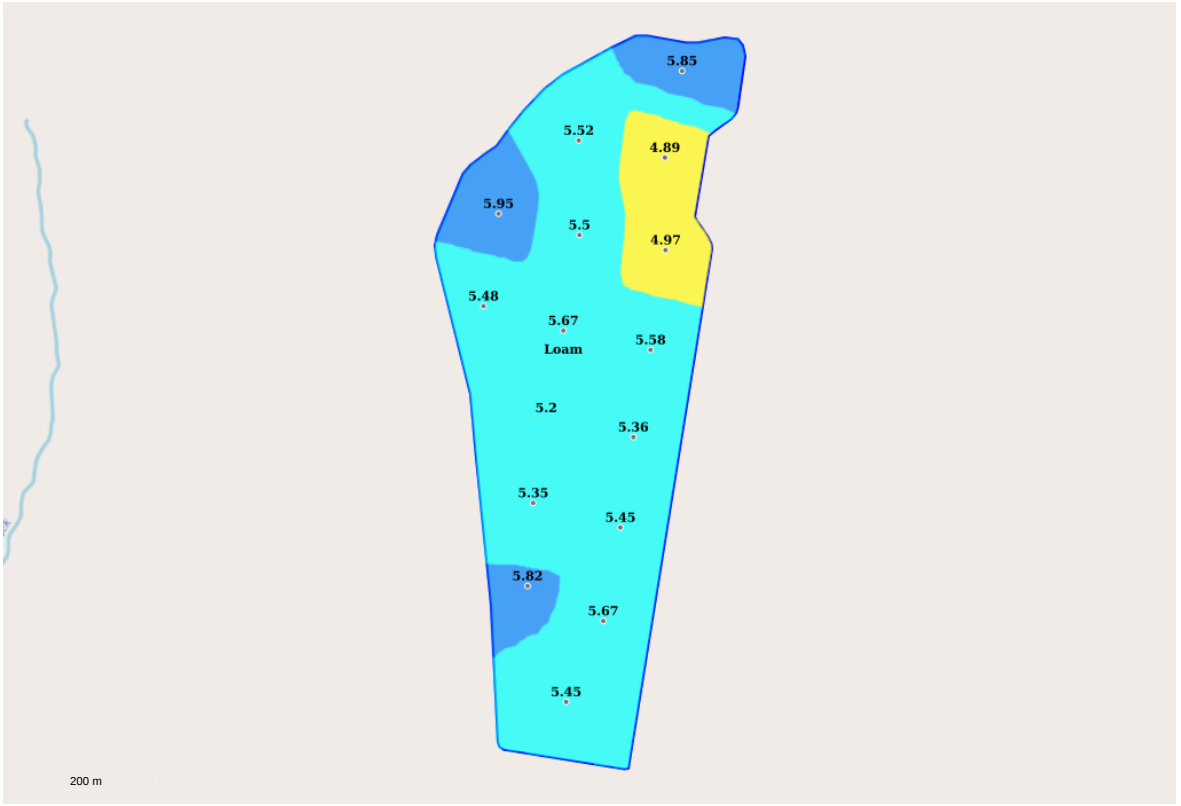
Client: Tarnawa Pastoral Co (Al Gabb)
Farm: Blacks Creek
Paddock: Axtons
Name: Axtons
Type: Soil Test
Date: 19/01/2024
Min: 44.0 mg/kg
Max: 82.0 mg/kg
Avg: 57.3 mg/kg

- Above 71 mg/kg
- 53 - 70.9 mg/kg
- 35 - 52.9 mg/kg
- 24 - 34.9 mg/kg
- Below 23.9 mg/kg



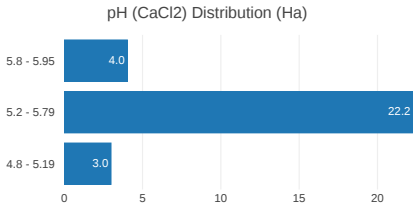
Axtons: Soil Test

Soil pH (CaCl2)



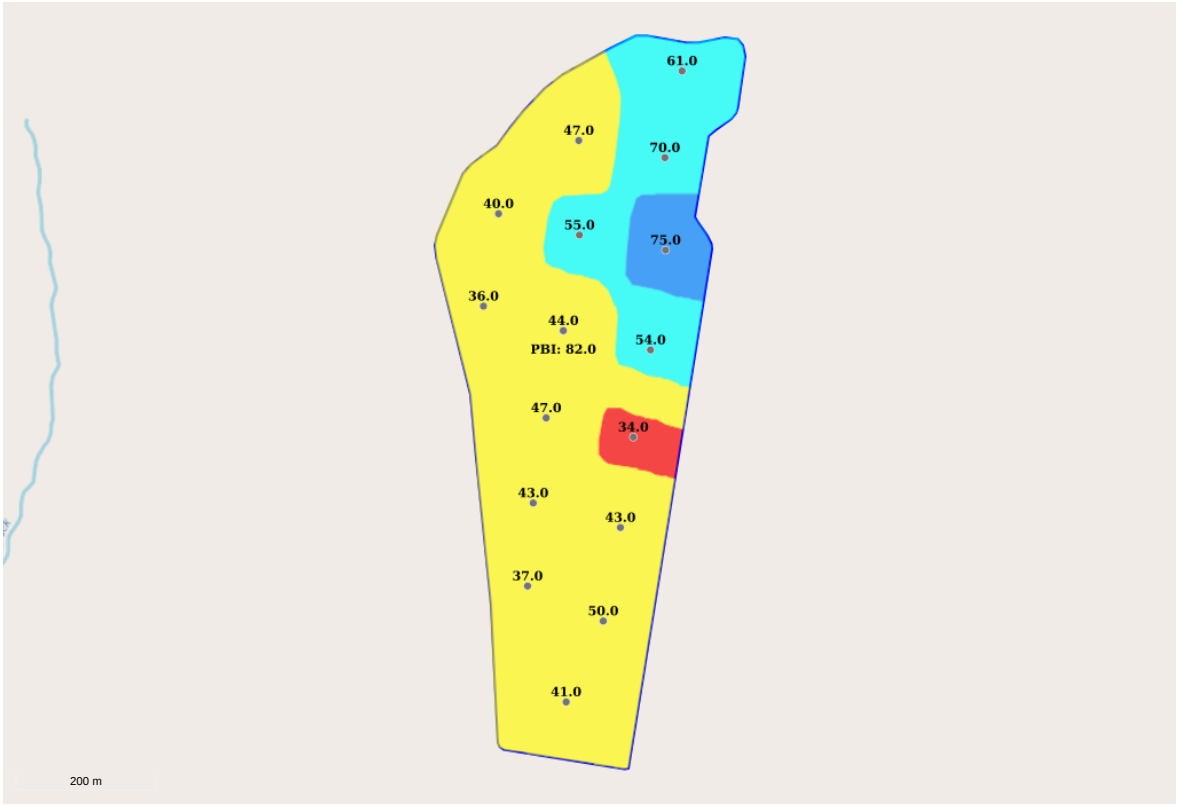
Client: Tarnawa Pastoral Co (Al Gabb)
Farm: Blacks Creek
Paddock: Axtons
Name: Axtons
Type: Soil Test
Date: 05/02/2020
Min: 4.9 pH
Max: 6.0 pH
Avg: 5.5 pH

- Above 5.8 pH
- 5.2 - 5.79 pH
- 4.8 - 5.19 pH
- 4.5 - 4.79 pH
- Below 4.49 pH



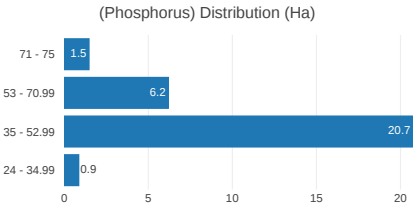
Axtons: Soil Test

Colwell Phosphorus (mg/kg)



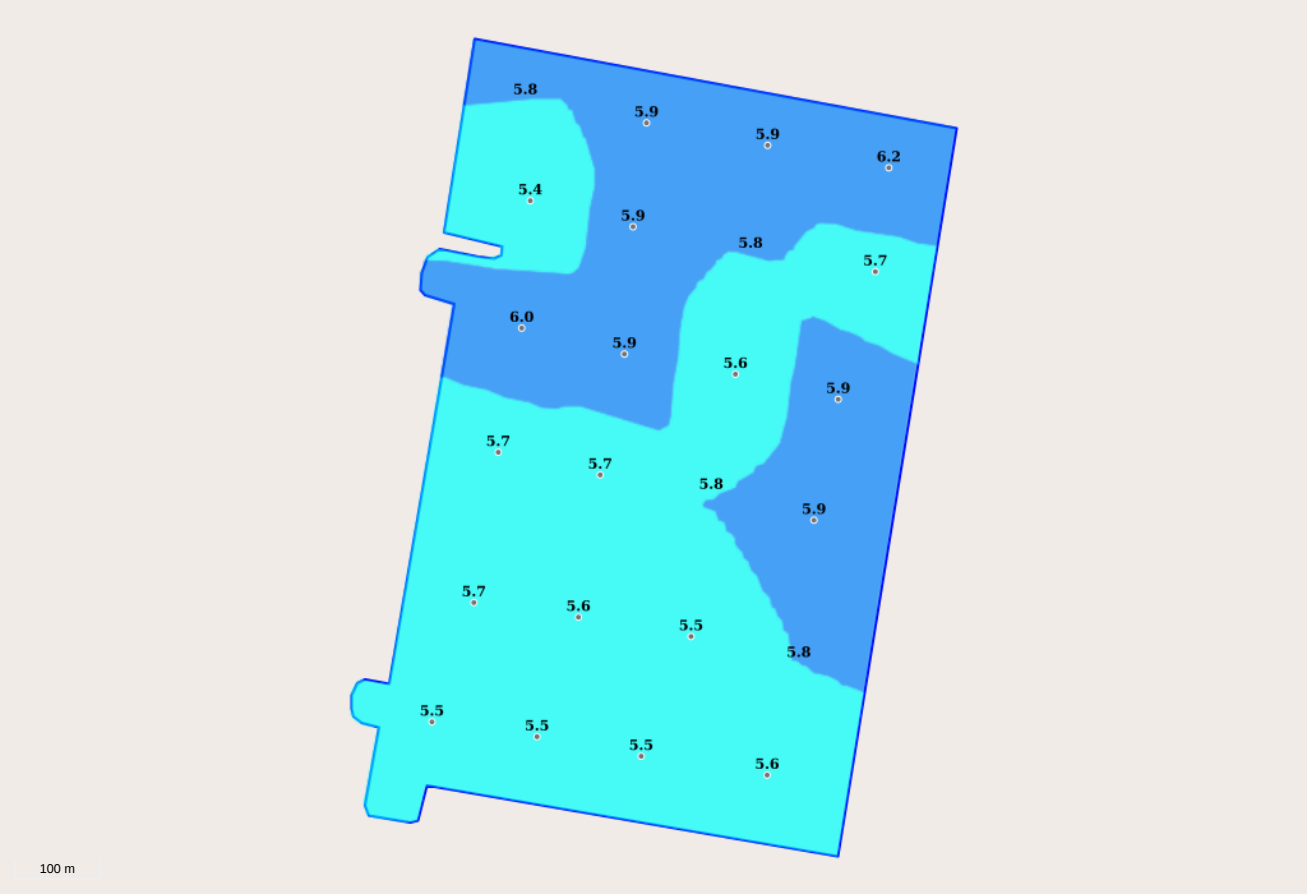
Client: Tarnawa Pastoral Co (Al Gabb)
Farm: Blacks Creek
Paddock: Axtons
Name: Axtons
Type: Soil Test
Date: 05/02/2020
Min: 34.0 mg/kg
Max: 75.0 mg/kg
Avg: 48.6 mg/kg

- Above 71 mg/kg
- 53 - 70.9 mg/kg
- 35 - 52.9 mg/kg
- 24 - 34.9 mg/kg
- Below 23.9 mg/kg



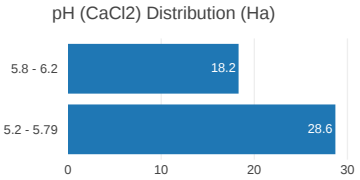
Simon: Soil Test

Soil pH (CaCl2)



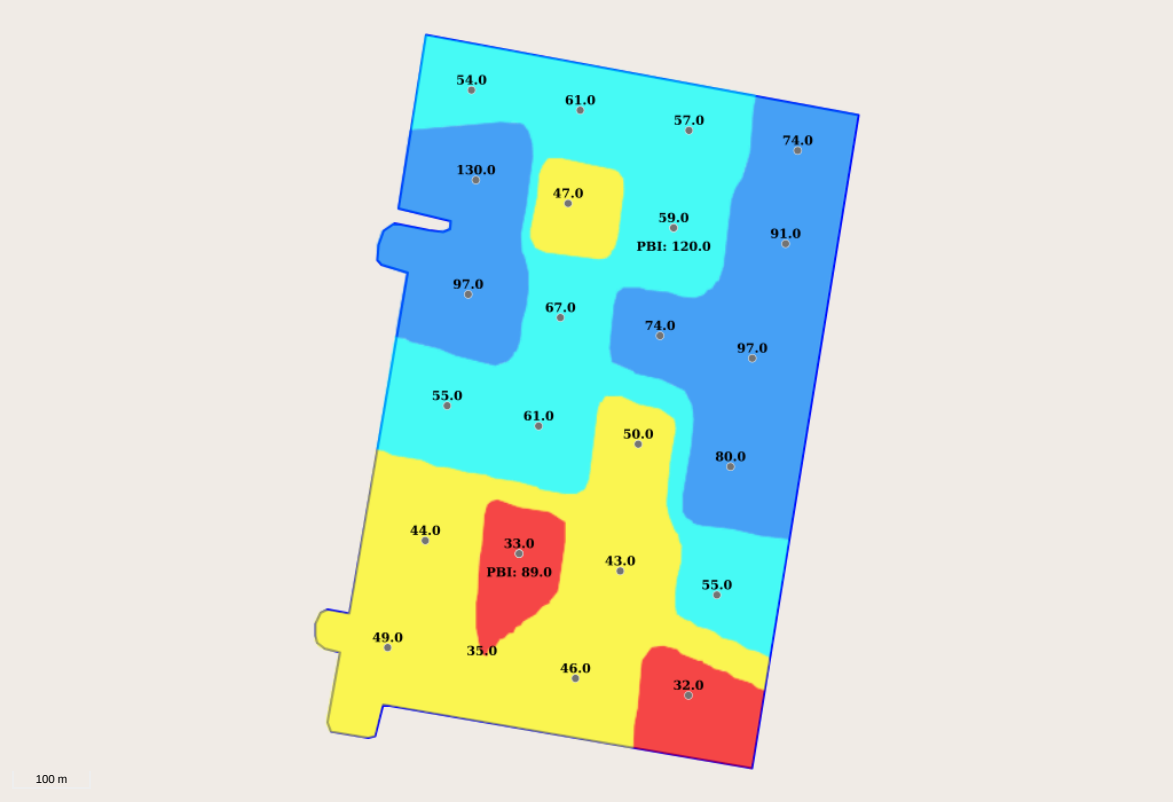
Client:	Tarnawa Pastoral Co (Al Gabb)
Farm:	Blacks Creek
Paddock:	Simon
Name:	Simon
Type:	Soil Test
Date:	19/01/2024
Min:	5.4 pH
Max:	6.2 pH
Avg:	5.7 pH

- Above 5.8 pH
- 5.2 - 5.79 pH
- 4.8 - 5.19 pH
- 4.5 - 4.79 pH
- Below 4.49 pH



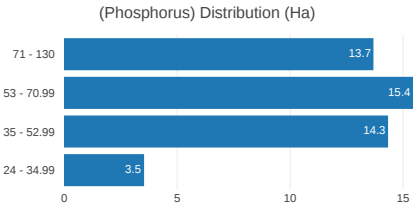
Simon: Soil Test

Colwell Phosphorus (mg/kg)



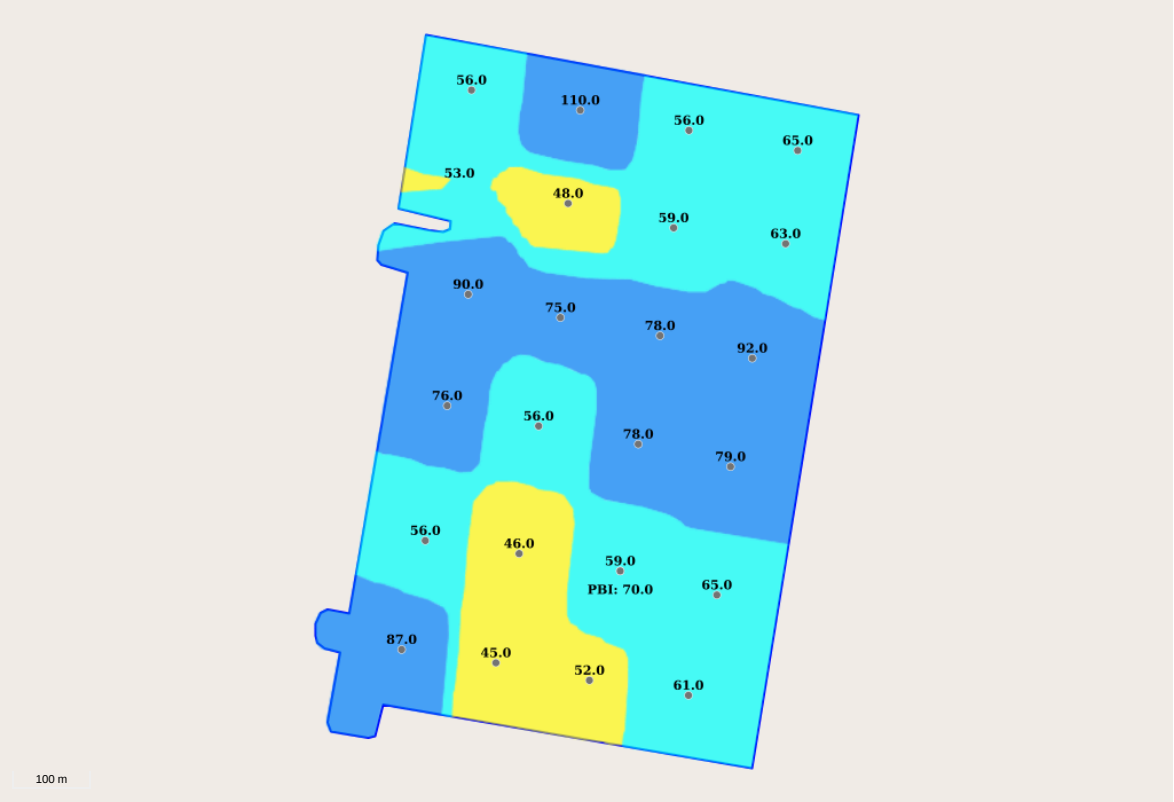
Client: Tarnawa Pastoral Co (Al Gabb)
Farm: Blacks Creek
Paddock: Simon
Name: Simon
Type: Soil Test
Date: 19/01/2024
Min: 32.0 mg/kg
Max: 130.0 mg/kg
Avg: 62.1 mg/kg

- Above 71 mg/kg
- 53 - 70.9 mg/kg
- 35 - 52.9 mg/kg
- 24 - 34.9 mg/kg
- Below 23.9 mg/kg



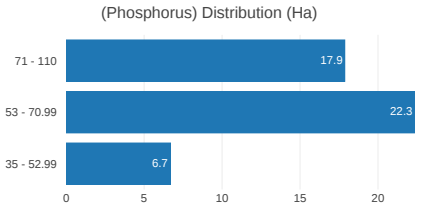
Simon: Soil Test

Colwell Phosphorus (mg/kg)



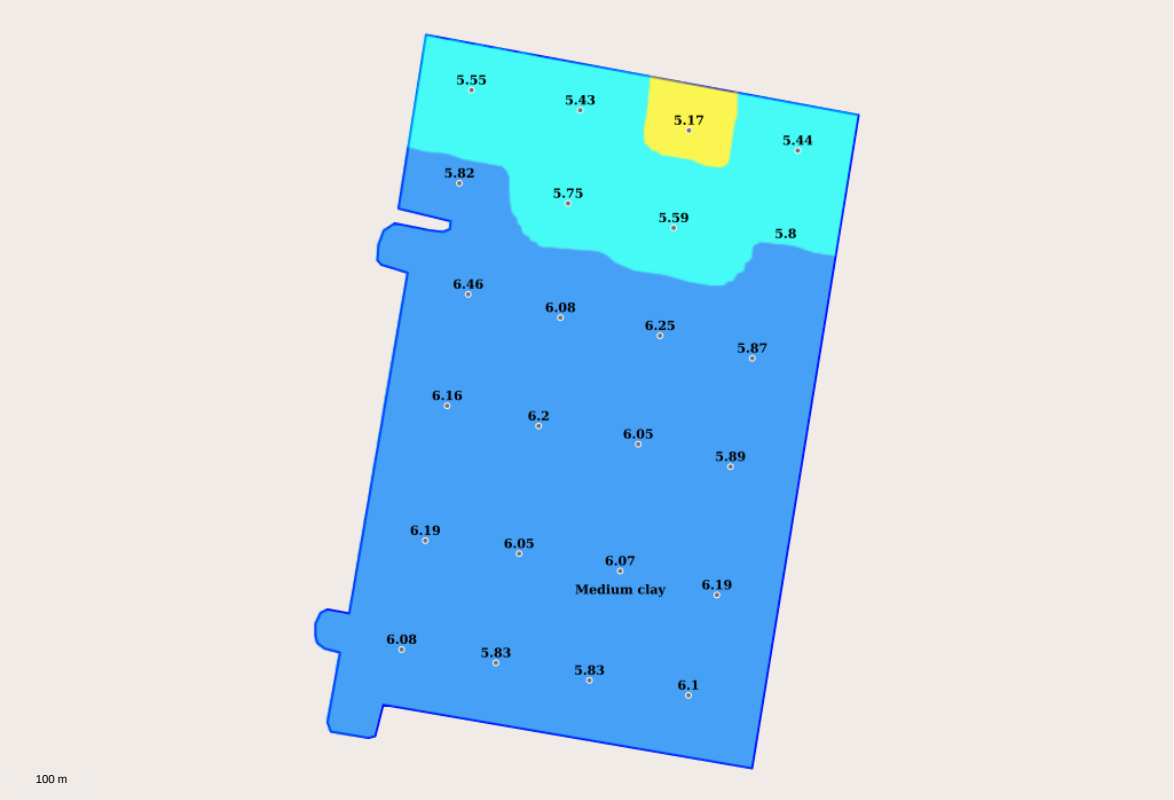
Client: Tarnawa Pastoral Co (Al Gabb)
Farm: Blacks Creek
Paddock: Simon
Name: Simon
Type: Soil Test
Date: 05/02/2020
Min: 45.0 mg/kg
Max: 110.0 mg/kg
Avg: 66.9 mg/kg

- Above 71 mg/kg
- 53 - 70.9 mg/kg
- 35 - 52.9 mg/kg
- 24 - 34.9 mg/kg
- Below 23.9 mg/kg



Simon: Soil Test

Soil pH (CaCl2)



Client:	Tarnawa Pastoral Co (Al Gabb)
Farm:	Blacks Creek
Paddock:	Simon
Name:	Simon
Type:	Soil Test
Date:	05/02/2020
Min:	5.2 pH
Max:	6.5 pH
Avg:	5.9 pH

- Above 5.8 pH
- 5.2 - 5.79 pH
- 4.8 - 5.19 pH
- 4.5 - 4.79 pH
- Below 4.49 pH