Soil Acidity in the N & Y NRM region

Introduction:

Within the Northern and Yorke (N & Y) NRM region it is estimated that approximately 270,000 hectares or 13% of the area is susceptible to soil acidification (DENR, 2009).

This occurs mostly on the sandy loam to clay loams in the medium to high rainfall areas, north of Kapunda through to Jamestown and from Crystal Brook through to Melrose with a smaller area around Redhill (Figure 1).

Many of the soils throughout these areas are naturally acidic but soil acidity is accelerated by more intensive and productive farming systems. To maintain production and profitability the surface soil pH should be at or around soil pH 5.5 ($CaCl_2$) and the sub-surface soil should be maintained at a soil pH of 5.0 ($CaCl_2$).

As part of the CFOC *Reducing the risk of soil acidification in the Northern and York region of SA* and two smaller N & Y NRM soil acidity projects, a soil sampling program was undertaken between 2011 – 2015 to investigate the extent and severity of surface and sub-surface soil acidity.

Methodology:

Throughout the region paddocks were selected mostly within the area susceptible to soil acidity and across the area to provide a good geographical spread. Approval was provided by the landholders to take soil samples. In total, 170 paddocks were sampled.

For each paddock, approximately 15 samples (0-10 and 10-20cm) were taken along a transect and within the same soil type. The transect was gps located at the start and at the end.

The samples for each layer were bulked and then a sample was sent to the CSBP laboratory in WA for analysis. The soil samples were tested for soil pH (water and $CaCl_2$) and extractable aluminium.

Results:

The results show that of the samples from 0-10 cm (Figure 2) 101 (59%) had a soil pH < pH 5.5 ($CaCl_2$) and that 63 (37%) had a soil pH < 5.0 ($CaCl_2$). The soil pH ranged from 4.3 to 7.6 ($CaCl_2$).

Of the samples from 10-20 cm (Figure 3) 34 (20%) had a pH < 5.0 ($CaCl_2$) and 3 (2%) had a pH < pH 4.5 ($CaCl_2$). The soil pH ranged from 4.2 to 7.8 ($CaCl_2$).

Appendix I & II show the soil pH test results for the surface soil and sub-surface soil for each Hundred. Of the Hundreds that had five or more paddocks sampled the Hundred of Wongyarra (Melrose) and Appila (Wirrabara) had the lowest surface soil (0-10 cm) pH and the Hundreds of Appila, Milne (Hilltown), Wongyarra and Hanson (Farrell Flat) had the lowest sub-surface (10 – 20 cm) soil pH levels.

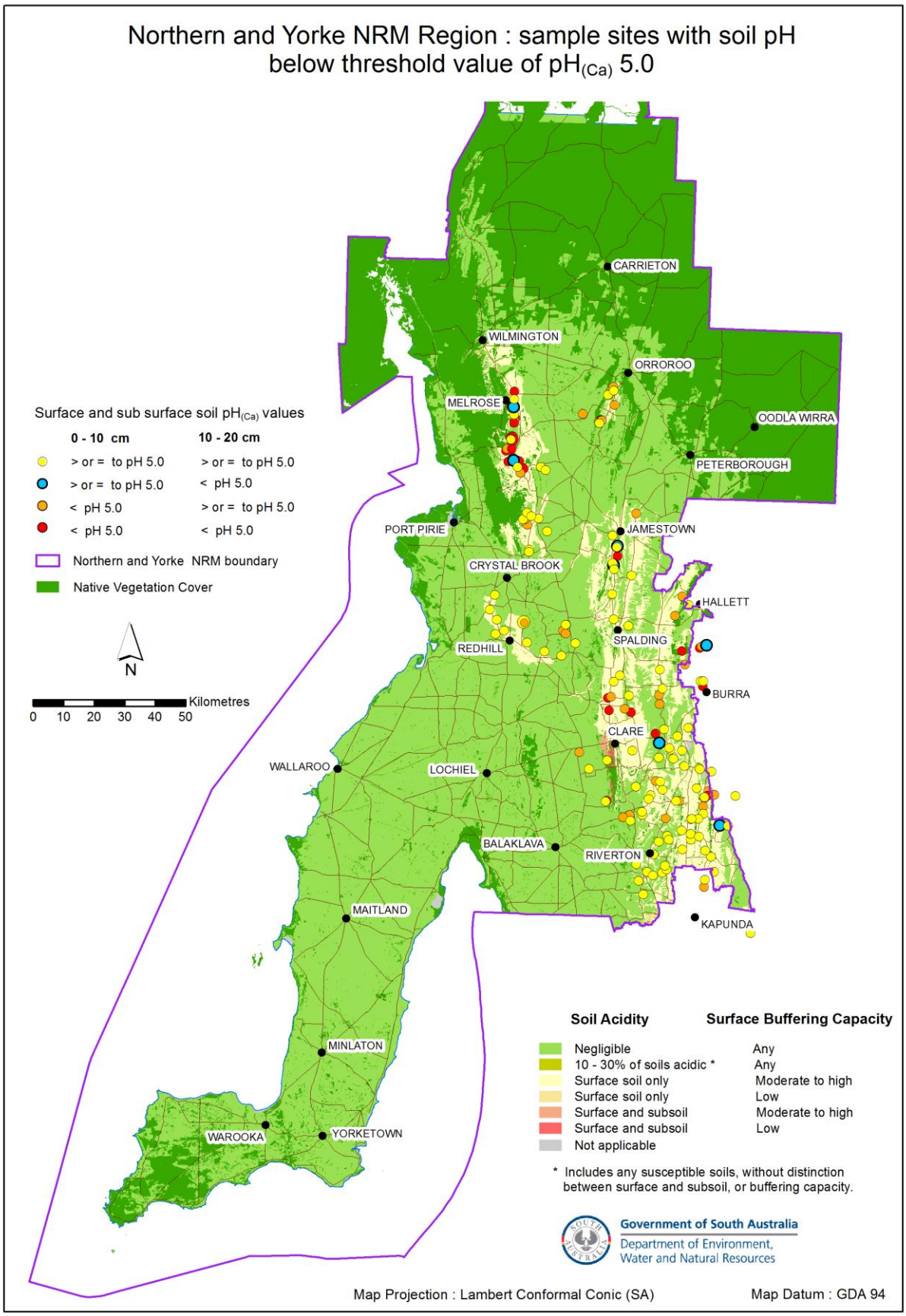

Figure 1: Location of sampling sites and pH levels (170 paddocks)

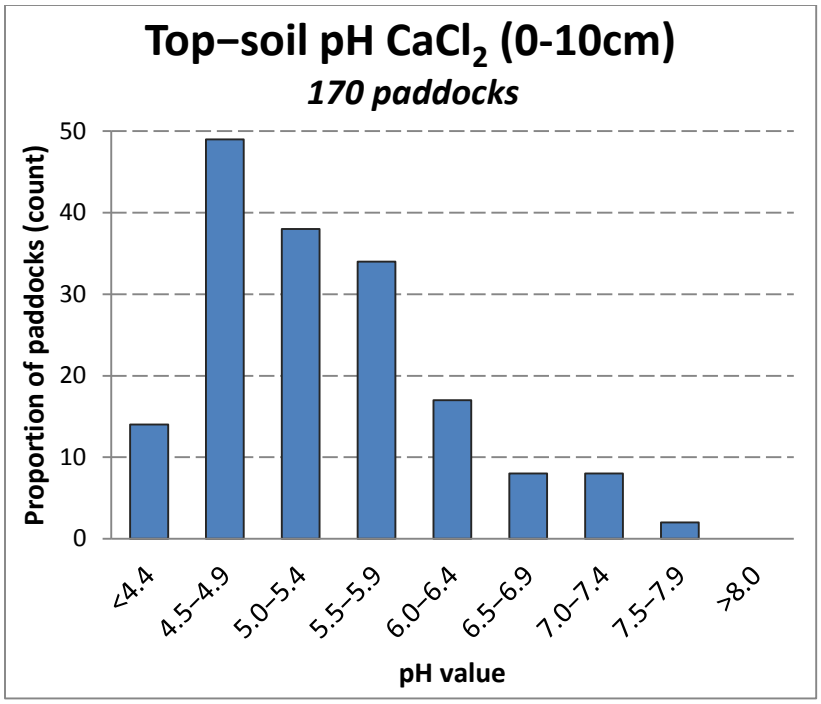

Figure 2: Top-soil pH $CaCl_2$ (0-10 cm) of 170 paddocks

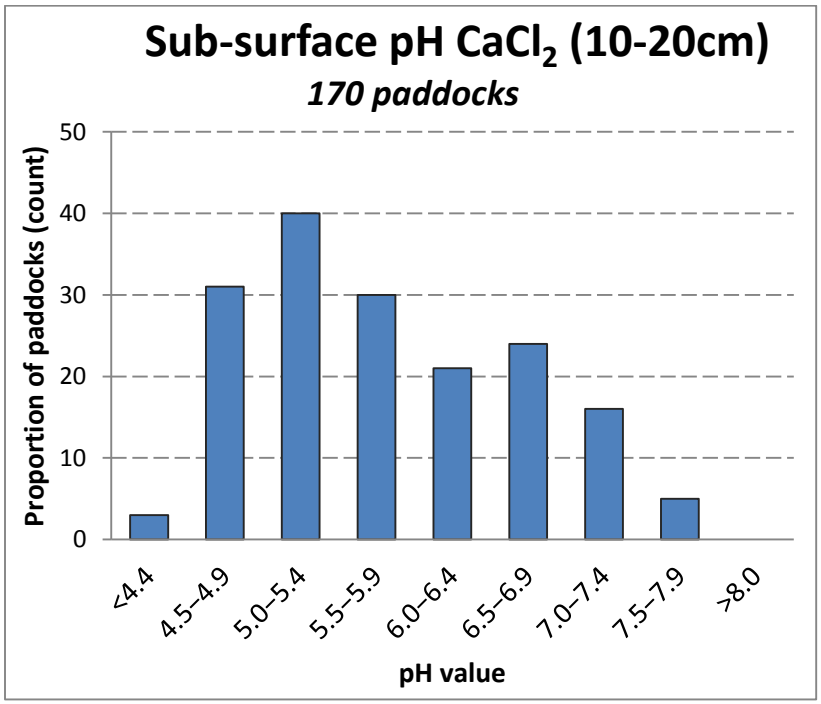

Figure 3: Sub-surface soil pH $CaCl_2$ (0-20 cm) of 170 paddocks

As the soil pH ($CaCl_2$) drops below 4.8 then toxic amounts of aluminium can be released into the soil solution. Aluminium toxicity is a problem when extractable aluminium ($CaCl_2$) is 2 mg/kg or greater. Greater than 2 mg/kg will affect root growth and soil biota. Figure 4 and 5 show the aluminium levels vs soil pH ($CaCl_2$) for the surface and sub-surface soil respectively.

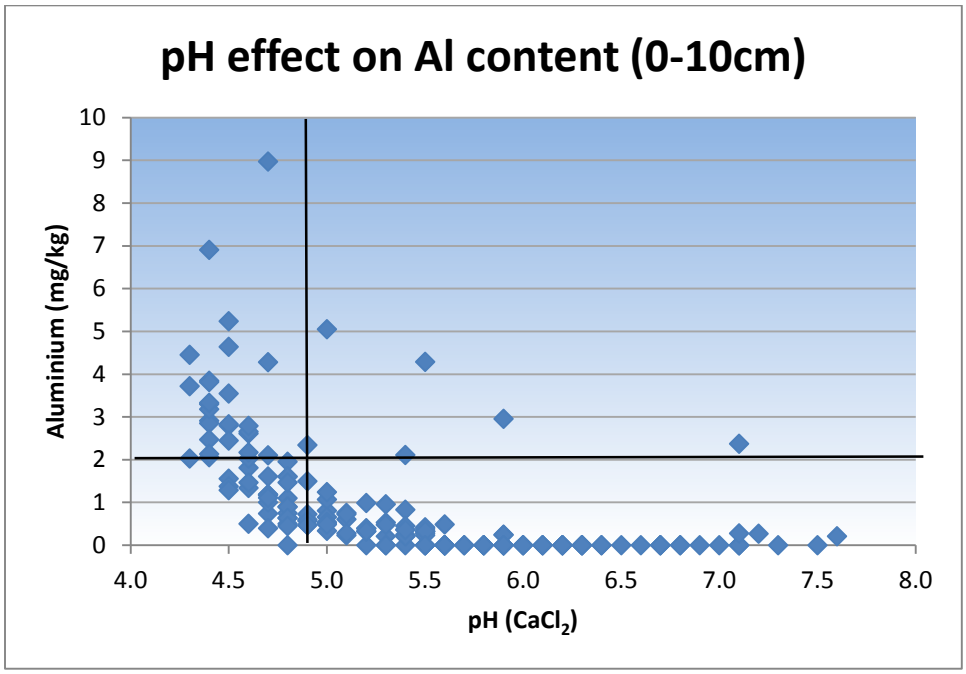

Figure 4: pH ($CaCl_2$) and aluminium levels (mg/kg) for 170 paddocks

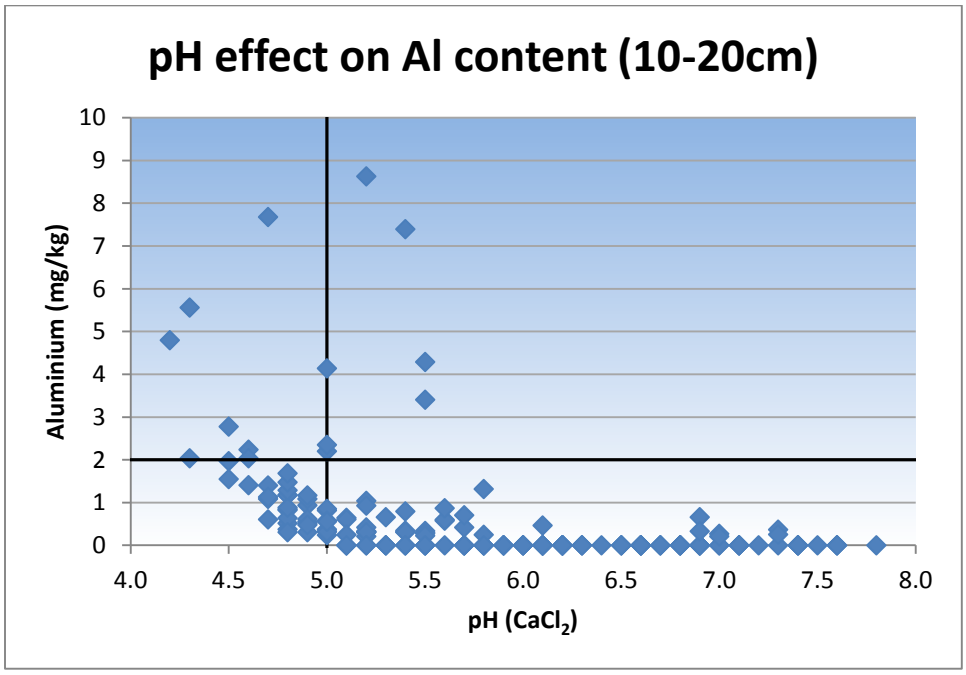

Figure 5: pH ($CaCl_2$) and aluminium levels (mg/kg) for 170 paddocks

The results show that of the samples from 0-10 cm (Figure 4) 37 (22%) had an aluminium level ≥ 2.0 mg/kg. The aluminium levels ranged from <0.20 to 8.97 mg/kg.

Of the samples from 10-20 cm (Figure 5) 14 (8%) had an aluminium level ≥2.0 mg/kg. The aluminium levels ranged from <0.20 to 8.63 mg/kg.

Discussion:

The results show that surface and sub-surface soil acidity is a problem within the N & Y NRM region and that there are areas outside the area susceptible to soil acidity that are also becoming quite acidic.

Soil acidity varies across the area susceptible to soil acidity region and it depends on the soil type, paddock history and the rate and frequency of liming. Forty two percent of the paddocks have a pH in the top-soil of ≤5.0. When the top-soil falls below pH 5.0 ($CaCl_2$) productivity will start to decline. Once the top-soil falls below pH 4.8 ($CaCl_2$) then toxic amounts of aluminium can be released into the soil solution affecting root growth and productivity. If the top-soil is left untreated then there is potential for sub-surface to become acidic and in addition it is much harder to raise the top-soil pH to an optimum level. To maintain production and profitability the top-soil pH should be monitored and maintained at around pH 5.5 ($CaCl_2$).

The sub-surface soil acidity was less of an issue compared to the surface soil but approximately 26% of the sub-surface soils (10—20 cm) still had a pH ≤ 5.0 ($CaCl_2$) and 4% had a pH ≤ pH 4.5 ($CaCl_2$). These pH levels will increase toxic amounts of aluminium into the soil solution and affect plant growth and productivity. Once the sub-surface soil pH falls below pH 5.0 ($CaCl_2$) it is increasing difficult to incorporate lime into this layer and to influence and raise the soil pH. Lime will need to be ripped or slotted into this layer. The top-soil should be maintained at a soil pH around pH 5.5 to prevent the likelihood of developing a sub-surface soil acidity problem.

The major issues for surface and sub-surface soil acidity appear to be within the Hundred of Wongyarra (Melrose) and Appila (Wirrabara). The lighter textured soils in these areas are inherently acidic but also due to the distance from lime sources and cost of freight these soils may not have been limed or limed as often as other areas of the N&Y NRM region.

Liming is the most effective and economical method to raise the soil pH levels and to improve the soil pH for plant growth and production. The amount of lime required to counteract soil acidity depends on the current soil pH; desired or target soil pH; soil texture and lime quality. The lime sale data for the N & Y NRM region suggests that the total annual lime application rate is well below the estimated annual acidification rate. With this trend it is likely that the area of soil acidity will increase in the future.

Farmers should be encouraged to monitor the soil pH of the surface and sub-surface soils on regular basis on about every five years. If the soil pH in the top-soil has been fallen below pH 5.5 ($CaCl_2$) then an application of lime will be required. If left untreated then soil acidification can increase and affect the sub-surface and then it becomes increasingly more difficult and expensive to treat. Monitoring paddocks and preventing acidity is the cheapest and cost-effective method of control.

Recommendations:

- To provide a greater awareness of soil acidity to farmers, farmer groups, resellers and lime spreaders throughout the N & Y NRM region including the results of the projects, issues and treatment of soil acidification.
- Encourage landholders to test and monitor their soils on a regular basis (every 5-6 years) including the surface (0-10 cm) and sub-surface (10-20 cm).
- Continue to develop pH mapping work throughout the region so that farmers can zone their paddocks and only apply lime where it is needed rather than a uniform rate across the paddock. This will save time and costs.
- Establish demonstrations / trials throughout the region to demonstrate the benefit of liming to improve plant growth and production.
- The cost: benefit of lime needs to be developed to convince farmers that it is worth spending $'s on lime.
- Continue to monitor lime sales throughout the district to see to see how it compares with the annual soil acidification rate.
- Alternative treatments for liming could be investigated.

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Appendix I: Results per Hundred (0-10 cm).

		Soil pH (CaCl2)				%			
Hundred	Count	pH <=4.5	pH 4.6-5.0	pH 5.1 - 5.5	pH>= 5.6	pH <=4.5	pH 4.6-5.0	pH 5.1 - 5.5	pH>= 5.6
Alma	2				2	0	0	0	100
Andrews	2				2	0	0	0	100
Anne	1		1			0	100	0	0
Apoinga	5		2	1	2	0	40	20	40
Appila	12	5	4		3	42	33	0	25
Ayers	3	1	1		1	33	33	0	33
Belalie	8		3	4	1	0	38	50	13
Blyth	2		1	1		0	50	50	0
Booyoolie	8		2	2	4	0	25	25	50
Clare	2			1	1	0	0	50	50
Crystal Brook	2				2	0	0	0	100
Dutton	1				1	0	0	0	100
English	1			1		0	0	100	0
Gilbert	10			4	6	0	0	40	60
Gregory	2		2			0	100	0	0
Hanson	10	1	3	2	4	10	30	20	40
Julia Creek	4		1	1	2	0	25	25	50
Kingston	3	2	1			67	33	0	0
Koolunga	4	1		2	1	25	0	50	25
Kooringa	3	1		1	1	33	0	33	33
Laura	1		1			0	100	0	0
Milne	6	1	5			17	83	0	0
Pekina	9	1	6	1	1	11	67	11	11
Redhill	3			2	1			67	33
Reynolds	2		1		1	0	50	0	50
Saddleworth	5		2	1	2	0	40	20	40
Stanley	8		1	4	3	0	13	50	38
Upper Wakefield	10	2	1	5	2	20	10	50	20
Waterloo	14	1	5	4	4	7	36	29	29
Wongyarra	13	6	4	2	1	46	31	15	8
Yackamoorundie	6	1	1	1	3	17	17	17	50
Other	8		2	1	5	0	25	13	63

Appendix II: Results per Hundred (10-20 cm).

		Soil pH (CaCl2)				%			
Hundred	Count	pH <=4.5	pH 4.6-5.0	pH 5.1 - 5.5	pH>= 5.6	pH <=4.5	pH 4.6-5.0	pH 5.1 - 5.5	pH>= 5.6
Alma	2				2	0	0	0	100
Andrews	2				2	0	0	0	100
Anne	1			1		0	0	100	0
Apoinga	5			2	3	0	0	40	60
Appila	12	2	6	0	4	17	50	0	33
Ayers	3		1	1	1	0	33	33	33
Belalie	8		3	4	1	0	38	50	13
Blyth	2				2	0	0	0	100
Booyoolie	8		1	1	6	0	13	13	75
Clare	2			1	1	0	0	50	50
Crystal Brook	2				2	0	0		100
Dutton	1				1	0	0	0	100
English	1			1		0	0	100	0
Gilbert	10				10	0	0	0	100
Gregory	2		1	1		0	50	50	0
Hanson	10	1	2	2	5	10	20	20	50
Julia Creek	4		2		2	0	50	0	50
Kingston	3		3			0	100	0	0
Koolunga	4			1	3	0		25	75
Kooringa	3		1	1	1	0	33	33	33
Laura	1				1	0	0	0	100
Milne	6	1	3	2		17	50	33	0
Pekina	9		1	4	4	0	11	44	44
Redhill	3				3	0			100
Reynolds	2		1		1	0	50	0	50
Saddleworth	5			1	4	0	0	20	80
Stanley	8		1	2	5	0	13	25	63
Upper Wakefield	10		1	1	8	0	10	10	80
Waterloo	14		1	9	4	0	7	64	29
Wongyarra	13	2	9	1	1	15	69	8	8
Yackamoorundie	6		1	1	4	0	17	17	67
Other	8		1	2	5	0	13	25	63