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On-Farm Trials and Demonstrations to Address Seeps in the Murray Mallee.

Report for NR SAMDB

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1 Project Summary

Seeps and freshwater soaks are becoming an increasing problem across the SA Mallee. There is a need to both understand the dynamics of these generally localised catchment systems, as well as find ways for farmers to practically utilise the excess water. This project seeks to achieve this by establishing demonstration sites of various higher water use options that enhance the profitability and sustainability within landholders' actual farming systems.

Four sites have been established to meet these objectives, and include:

- a 20ha lucerne and sala trial,
- areas planted to saltbush, tagasaste and mallee trees,
- intensive catchment dynamics analysis through soil pits, description and the establishment of piezometers
- improving sand hill water use efficiency through spading in high rates of chicken manure,
- EM38 soil mapping and ground truthing soil analysis at each site
- the establishment of 4 capacitance soil moisture probes to monitor moisture use at 2 sites.

This project has essentially focussed on the establishment of each site, to gain key knowledge and demonstrate clear strategies within a variety of situations and farming systems. Ongoing monitoring will be required to assess the long term benefits and outcomes of this project and extend these findings throughout the mallee communities.

Figure 1. Soak demonstrations sites in Mannum/Karoonda region of the SA Mallee

2 Completion of Project Milestones

2.1 Project requirements

Rural Solutions SA was required to;

- Contact farmers willing to participate in establishing on farm trials and demonstration sites to address seeps. To liaise with Rural Solutions SA consultant contract 118C to co-ordinate visits.
- Undertake farm visits and provide agronomic advice
- Co-ordinate and manage trial sites including an EM38 survey in paddocks to be determined and co-ordinate and manage establishing summer crop trials in paddocks yet to be determined
- Undertake monitoring and collection of data from trial sites as required
- Liaise with Team Leader Land Management NR SAMDB.

2.2 Project Milestones

Table 1. Project achievements against milestones

Milestone		**Date and Evidence of Completion**
Milestone 1	Contact farmers willing to participate in establishing on-farm trial and demonstration sites to address seeps.	Four farmers were contacted and a field day of site inspections was held with key NR SAMDB Officers Kym Haebich and Eliza Rieger, Rural Solutions SA consultants Chris McDonough and Chris Hentschke (Project 118C consultant), James Hall (soils and landscapes consultant) and Tanja Morgan (consultant and NRM committee member). Each site was inspected with the farmer, discussing soak history, landscape issues, farming systems, management options and possible demonstration trial establishment. A report by Chris Hentschke has been submitted for the NR SAMDB under project 118C summarising these site findings. After further discussion with farmers, potential contractors, suppliers and key stakeholders and meeting was held between Chris McDonough (RSSA), Kym Haebich and Eliza Reiger (NR SAMDB) on March 25th to finalise the trial activities to be established at each site and the basic allocation of funds agreed. These were: • Bond - Lucerne for hay for high water use above large soak • Arbon – Tree planting above midslope soak to intercept and utilise excess water. Plantations of saltbush and tree lucerne through other scalded soak areas to utilise water and provide valuable grazing for livestock • Rose/Thomas – an in-depth analysis of the local catchment and landscape using soil pits and establishing piezometers using expert consultants to better understand catchment dynamics and water flows to be able to target more informed amelioration strategies. • Pope - Spading in of various rates chicken manure to improve the poor crop growth and water use in the growing season on non-wetting sands surrounding key soak area.

Milestone 2	Co-ordinate and manage trial sites including an EM38 survey in paddocks yet to be determined and co-ordinate and manage establishing summer crop trials in paddocks yet to be determined.	100ha of EM38 mapping was conducted around each soak demonstration site area (400ha total), and 4 deep soil tests (with 4 depth segregations) to 80cm were conducted at each site on the range of soil types present (see separate site results in next section). Each site has been established and studied according to each trial plan (see section 3 with pictorial evidence of activities). The initial project emphasis on summer crops has been altered slightly, as they are highly risky in nature and are generally difficult to practically fit within the farmers systems. However, the utilisation of summer moisture through lucerne (essentially a summer actively growing perennial) and trees, saltbush and tree lucerne (also using summer moisture) in ways that can be profitable to the farmer at relatively low risk, was seen as an appropriate compromise by the management team and farmers.
Milestone 3	Undertake monitoring and collection of data from trial sites as required. Report on trial progress and results	The appropriate timing of the establishment of each site demonstration has meant that limited site monitoring and data collection has taken place. However, recent site visits have shown: • generally excellent lucerne establishment on the majority of the Bond site, with less germination on the most severe non-wetting sand. • good initial tree and shrub establishment at the Arbon site. • significant improvements in crop establishment and growth at the Pope chicken manure spading site. This report fulfils the final milestone for this project.

Figure 2. Initial site inspection team at Arbons' soak, February 2015

3 Site Details

3.1 Bonds Lucerne for Hay Demonstration

Bonds are large scale farmers with an intensive cropping farming system and no livestock. Perennial grazing options such as saltbush and tree lucerne therefore did not provide a commercial grazing opportunity for them. While various summer cropping options were discussed, some of which they had tried previously, they were considered too risky and not practical for them to pursue.

Establishing lucerne for hay production proved to be the best option at this site, situated directly above the main soak area across a considerable length of catchment area. The soils vary from deep non-wetting sand to sand over clay and stone soils. This trial will give us an excellent indication as to the success of lucerne establishment and growth on the various soil types that may be contributing to soak issues, particularly when matched against EM38 soil survey.

A 1 ha area of sala (salt tolerant pasture) has also been established at the base of this trial, which will help assess its suitability to the area and situation.

Two soil moisture probes have been established, one within the lucerne area, and one directly adjacent in the normal cropping area. These probes each contain 5 sensors at 10cm, 30cm, 50cm, 70cm and 90cm and continually log soil moisture, and will be analysed along with a tipping bucket rainfall gauge nearby. This will allow for a clear comparison of the two farming systems risk of allowing rainfall to pass through and contribute to recharge and soak build up. It is expected that the lucerne will ultilise all rainfall and deeper moisture, whereas the cropping system with chemical summer weed control will not use all of the large summer rainfalls.

Figure 3. Bond main soak area, July 2015

Figure 4. Soak area destroying crop, Winter 2014

3.1.1 EM38 Map with soil sampling locations and results

Figure 5. Previous and new EM38 survey of catchment area showing soil test areas

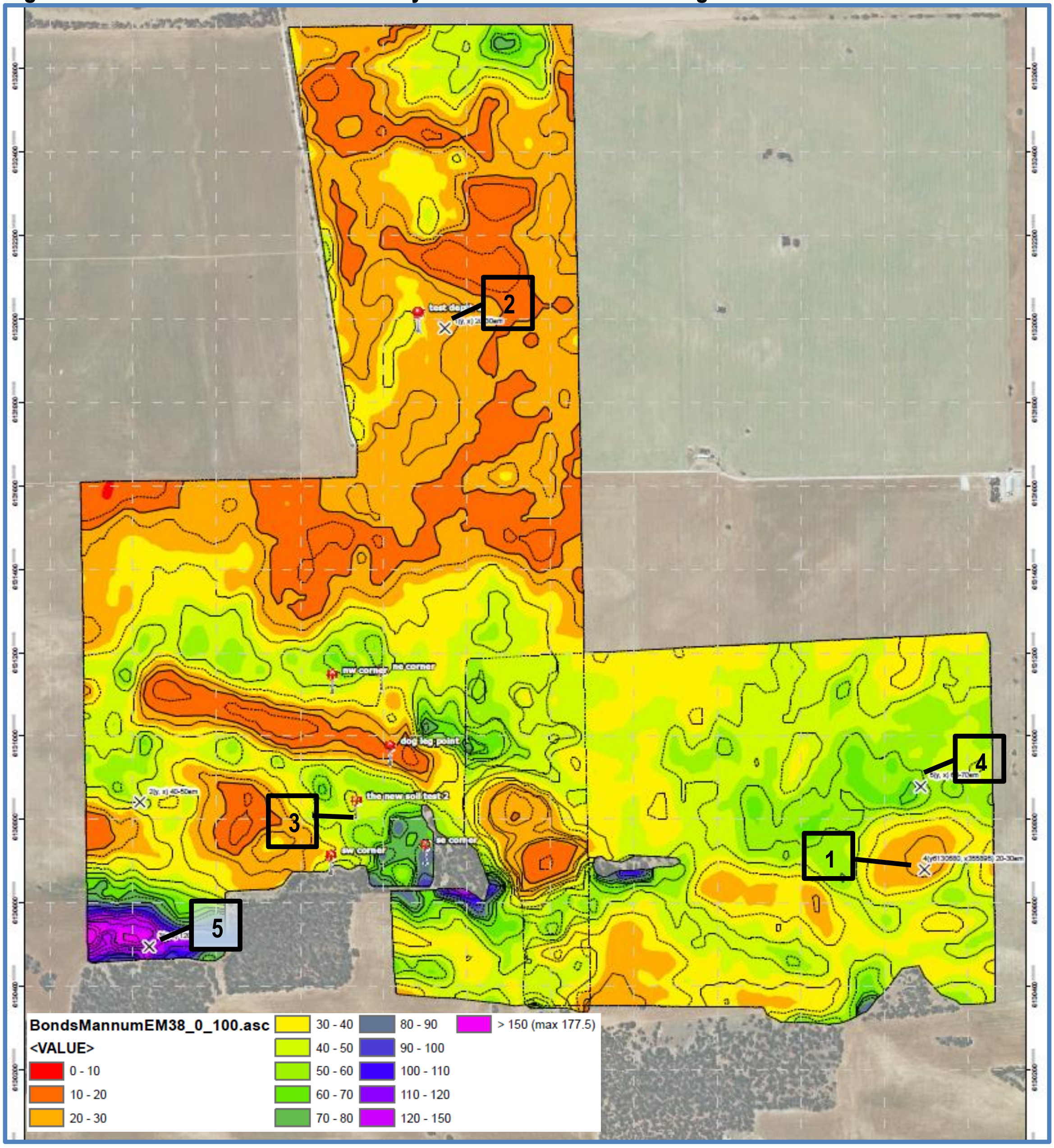


Figure 6. Lucerne and Sala Trial site areas with soil moisture probe and piezometer sites marked

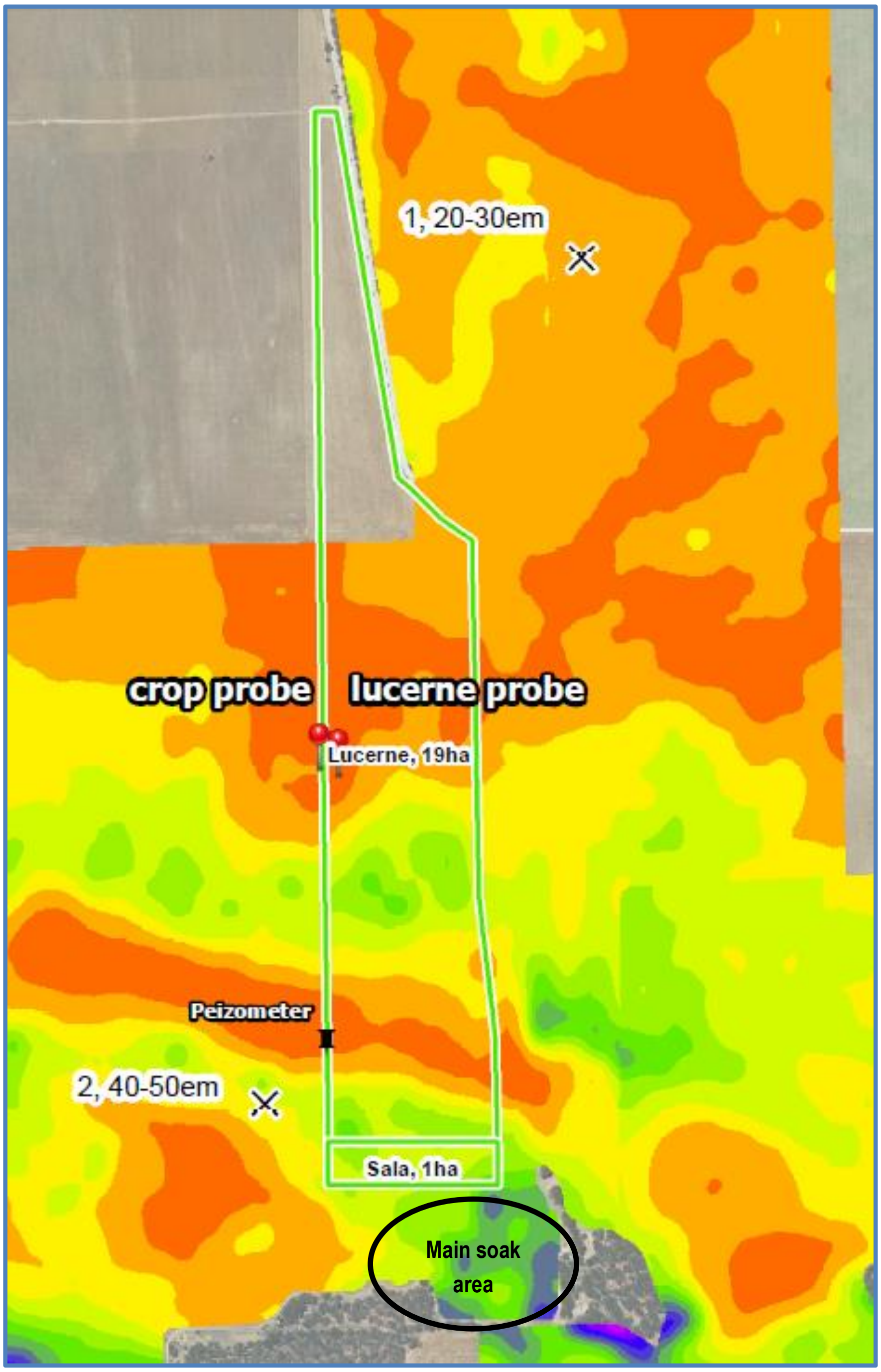


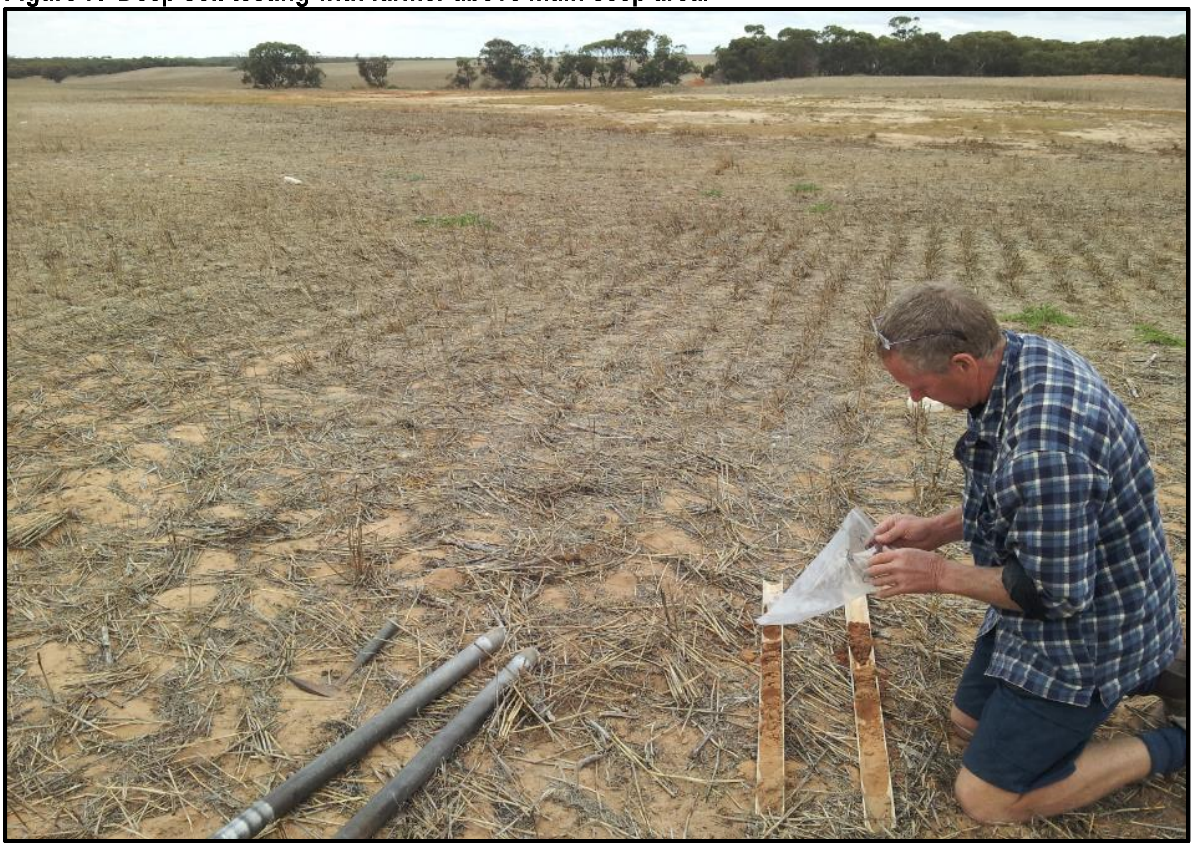
Table 2. Bond Topsoil Test Results

Code	Customer	EM38 Value	Name	Depth	Colour	Gravel	Ammonium Nitrogen	Nitrate Nitrogen	Phosphorus Colwell	Potassium Colwell	Sulphur	Organic Carbon	Conductivity	pH Level (CaCl2)	pH Level (H2O)
						%	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	dS/m	pH	pH
02/04/15	Bond	15	Lt	0-10	BRWH	0	9	3	40	80	3.7	0.32	0.024	5.2	5.8
02/04/15	Bond	25	LtMd	0-10	LTBR	0	6	3	45	154	5.3	0.48	0.04	5.6	6.1
02/04/15	Bond	40	Md	0-10	LTBR	0	4	7	29	216	7	0.47	0.066	5.2	6.1
02/04/15	Bond	75	MdHv	0-10	BRGR	5	4	13	37	454	3.5	0.89	0.075	6	6.8
02/04/15	Bond	130	Hv	0-10	BR	5	2	14	62	1014	25.9	1.68	0.262	7.5	8.5

Table 3. Bond Subsoil Test Results

No.	Name	Farm	Depth	Ammonium Nitrog	Nitrate Nitrogen	Sulphur	Conductivity	pH Level (CaCl2	pH Level (H2O)	Exc. Aluminium	Exc. Calcium	Exc. Magnesium	Exc. Potassium	Exc. Sodium	Boron Hot CaCl2	Chloride	Moisture %
				mg/Kg	mg/Kg	mg/Kg	dS/m	pH	pH	meq/1	meq/1	meq/1	meq/1	meq/1	mg/Kg	mg/Kg	%
1	Lt	Bond	10-30	3	3	2.3	0.048	7.5	8	0.06	2.05	0.29	0.09	0.03	0.18	1.3	2.36
1	Lt	Bond	30-50	2	0.5	1.4	0.053	7.7	8.2	0.096	2.93	0.4	0.14	0.03	0.21	1.4	3.5
1	Lt	Bond	50-80	0.5	0.5	1.9	0.042	7	7.7	0.134	1.73	0.28	0.1	0.02	0.19	2.3	3.79
2	LtMd	Bond	10-30	3	4	8.6	0.065	7.4	7.9	0.106	1.93	0.43	0.2	0.04	0.25	5.3	0.82
2	LtMd	Bond	30-50	1	2	3.1	0.054	7.9	8.5	0.144	2.36	0.48	0.32	0.04	0.27	4.6	3.88
2	LtMd	Bond	50-80	2	3	4	0.064	7.7	8.3	0.105	4.35	0.65	0.32	0.12	0.55	4.4	5.39
3	Md	Bond	10-30	2	3	24.8	0.217	7.9	8.8	0.064	16.89	3.8	1.07	1.67	3.18	65.3	8.03
3	Md	Bond	30-50	1	2	33.2	0.225	8.2	9.5	0.053	10.4	5.22	0.6	2.95	5.32	103.1	10.06
3	Md	Bond	50-80	0.5	0.5	30.3	0.301	8.2	9.5	0.064	7.28	4.75	0.78	3.8	9.6	63.1	13.5
4	MdHv	Bond	10-30	4	11	4.3	0.125	8.1	8.9	0.17	8.37	5.62	0.64	0.64	3.6	12	8.29
4	MdHv	Bond	30-50	2	6	3.4	0.143	8.2	9.1	0.172	8.34	4.18	0.41	0.21	2.46	4	9.53
4	MdHv	Bond	50-80	2	6	5.3	0.183	8.2	9.1	0.138	7.82	6.41	0.81	0.71	5.01	6.7	11.95
5	Hv	Bond	10-30	0.5	3	23.8	0.532	8.5	9.5	0.167	5.95	6.6	1.16	5.5	10.34	212.1	13.14
5	Hv	Bond	30-50	1	0.5	99.7	0.82	8.4	9.5	0.145	7.19	6.91	1.55	8.82	21.24	459.8	15.38
5	Hv	Bond	50-80	2	0.5	89.3	0.7	8.4	9.6	0.114	6.82	4.62	1.04	6.56	14.39	330.5	12.28

Figure 7. Deep soil testing with farmer above main seep area.



Soil test results show high P levels across all soil types. Organic carbon levels are low in the majority of soils (<0.5%) due to the sandy nature of much of the topsoil. Subsoil chemical constraints are only a problem in the heaviest soil that was sampled within a soak affected area, showing levels of both boron and salinity that would greatly inhibit root growth.

Figure 8. Soak affected cropping land appearing up slope where clay close to surface.

Figure 9. Lucerne seedling establishment, July 2015

Figure 10. Sown lucerne area showing piezometer and crop area to right and soak in distance.

3.2 Arbon Tree and Fodder Shrub Trial

The Arbon site consists 3 main soak areas at the base of sandy rises which are now consistently saturated (but not excessively salty as yet) and unsuitable for cropping. As this farm has a significant sheep enterprise, the idea of converting this presently degraded land (useless for cropping, but a haven for weed growth) into perennial grazing was very appealing. Since grazing will be targeted in summer when feed is generally low and crops are not growing, there is no need to fence these sites, but grazing may be limited until the second summer after planting, depending on seedling growth.

Initial discussion considered plantations on the sand above the soaks to try and restrict their moisture contribution which may lead to a reclamation of the soak areas. However, it was decided that the seeding establishment on the non-wetting sand would be risky, and it was far more suitable to the farmer to utilise the existing excess water within the now useless soak areas, which should be capable of supporting excellent fodder production and provide useful and strategic grazing.

It was decided that one large area and a smaller adjoining area would be planted to 405 Tagasaste (Tree Lucerne) interspersed with some saltbush, while the other area would be planted to 360 old man saltbush (*Atriplex nummalaria*). The plantations were established through the soak areas and slightly up the sandy rises in ways that allowed for reasonable machinery manoeuvrability around them. One main risk to these demonstration sites is whether these sites may become too saturated or saline for the seedlings (particularly the less salt tolerant tree lucerne) while they are becoming established. This could prove to be a key learning from this trial site.

The Arbon site also consists of a major mid-slope saturated area south of a fence line (soil test site area 4 in Fig. 13) which is consistently saturated and mostly growing ryegrass instead of crop. This area had the potential to spread further down the slope. It was decided that rows of local eucalypts could be relatively easily grown along this fence line in an attempt to intercept excess moisture flowing laterally from the sandy rises toward this area.

Approximately 4-5 rows of trees were sown for a length of 250m for this purpose, consisting of approx. 400 *Eucalyptus oleosa*, *Eucalyptus porosa*, *Eucalyptus incrassata*, *Eucalyptus Dumosa and Eucalyptus socialis* seedlings. The farmer will fence the paddock side of these trees to protect them from grazing in the future.

Figure 11. Eucalypt seedlings being planted along fence line with mid-slope soak area below.

Figure 12. Saltbush planting with farmer firming around each seedling.

3.2.1 EM38 Map with soil sampling locations and results

Figure 13. Arbon EM38 map of site with numbered soil test zones and approximate treatment areas

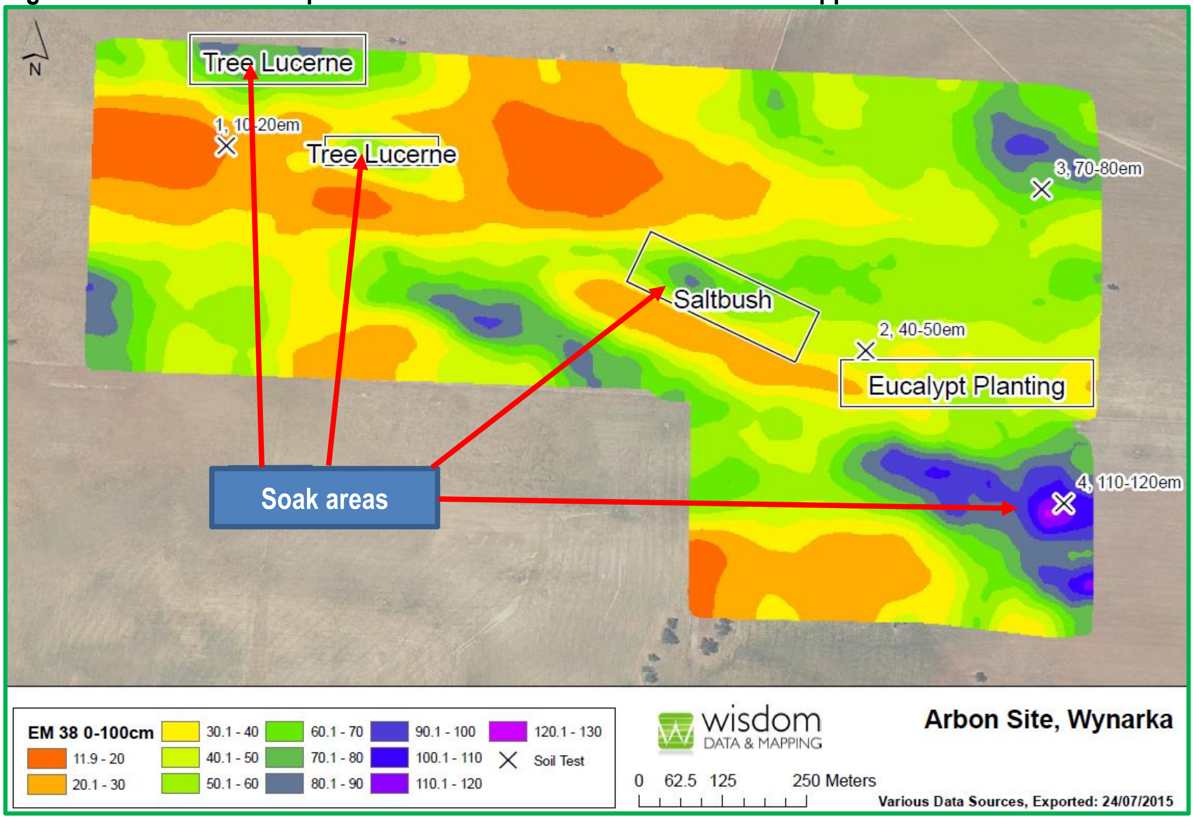


Table 4. Arbon Topsoil Test Results

Map Site	Name	Date	Depth	Colour	Gravel	Texture	Ammonium Nitrogen	Nitrate Nitrogen	Phosphorus Colwell	Potassium Colwell	Sulphur	Organic Carbon	Conductivity	pH Level (CaCl2)	pH Level (H2O)	Moisture %
			cm		%		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	dS/m	pH	pH	%
1	Arbon S	03/06/15	0-10	LTBR	0	1.5	16	5	35	65	5.4	0.39	0.028	5.4	6	1.62
2	Arbon MS	03/06/15	0-10	BRGR	0	1.5	16	9	48	81	7.4	0.71	0.041	5.1	5.9	2.44
3	Arbon L	03/06/15	0-10	BR	5	1.5	2	16	37	344	5	1.49	0.123	7.5	8.4	7.42
4	Arbon HF	03/06/15	0-10	DKBR	5	2	2	23	21	184	81	1.04	0.452	7.8	8.8	11.51

Table 5. Arbon Subsoil Test Results

Map Site	Name	Date	Depth	Ammonium Nitrogen	Nitrate Nitrogen	Conductivity	pH Level (CaCl2)	pH Level (H2O)	Exc. Aluminium	Exc. Calcium	Exc. Magnesium	Exc. Potassium	Exc. Sodium	Boron Hot CaCl2	Chloride	MCP Sulfur	Moisture %
			cm	mg/Kg	mg/Kg	dS/m	pH	pH	meq/10	meq/10	meq/10	meq/10	meq/10	mg/Kg	mg/Kg	mg/Kg	%
1	Arbon S	03/06/15	10-30	1	7	0.042	6.1	6.6	0.113	1.9	0.43	0.13	0.03	0.33	4	13.1	3.71
1	Arbon S	03/06/15	30-50	1	4	0.088	8.1	8.9	0.23	2.91	0.53	0.13	0.02	0.36	5	4.2	5.43
2	Arbon MS	03/06/15	10-30	4	6	0.028	6	6.5	0.164	1.98	0.38	0.16	0.01	0.31	4	4.2	4.45
2	Arbon MS	03/06/15	30-50	2	4	0.066	7.8	8.5	0.265	3.41	0.59	0.25	0.03	0.4	4	3.7	6.27
3	Arbon L	03/06/15	10-20	3	7	0.109	8	8.7	0.106	11.46	1.29	0.54	0.21	1.25	12.1	3.5	9.35
3	Arbon L	03/06/15	20-40	3	14	0.154	8	8.8	0.105	13.52	2.99	0.33	0.51	1.81	54.9	14.5	14.4
4	Arbon HF	03/06/15	10-30	< 1	11	0.147	8.3	9.4	0.143	3.87	1.02	0.35	1.19	2.85	25.6	8.6	13.88
4	Arbon HF	03/06/15	30-50	< 1	5	0.157	8.6	9.6	0.174	5.14	1.81	0.39	1.1	2.09	38	11.8	16.02
4	Arbon HF	03/06/15	50-80	< 1	6	0.245	8.6	9.8	0.157	6.56	4.23	0.99	3.36	8.46	21.3	9.6	23.11

The topsoils at this site show a good phosphorus levels across all sites. Organic carbon levels are typical of the soil types, with the sand being very low at 0.39%. There are no significant chemical subsoil constraints that would limit plant root growth at this site.

Figure 14. NR SAMDB Landcare officer planning native trees above soak

Figure 15. Farm hand planting tree lucerne seedlings in soak area

Figure 16. Saltbush establishment 3 weeks after planting

Figure 17. Tree Lucerne establishment 3 weeks after planting

3.3 Rose/Thomas Soak Catchment Analysis Site

In discussion at all sites at the initial planning field day, the need to better understand the underlying dynamic of the soil, the landscapes and water flows became very evident. There was concern that high water use options used to intercept water in mid-slopes may be of little affect if the water was flowing vertically to lift an underlying water table, rather than flowing laterally across the subsoil clays into the soak areas.

It was therefore decided that one site should concentrate its efforts on an in-depth analysis of the local catchment and landscape using soil pits, establishing piezometers and using expert consultants to better understand catchment dynamics and water flows. From this, more informed and targeted amelioration strategies could be planned and implemented that could benefit soak management across the wider region.

It was decided that this site should be used in this way, by employing the services of expert consultants James Hall and Chris Hentschke. A separate report has been submitted by James Hall to the NR SAMDB detailing the findings from studying this catchment site, and accompanies this report.

Figure 18. Rose/Thomas main soak site in Winter 2014

Figure 19. Developing soak area through cropped land showing soil moisture probe nearby.

Figure 20. Large farmer interest at field day in Sept 2015 at Rose/Thomas soak.

3.3.1 EM38 Map with soil sampling locations and results

Figure 21. Rose/Thomas Soak site EM38 area with soil test sites

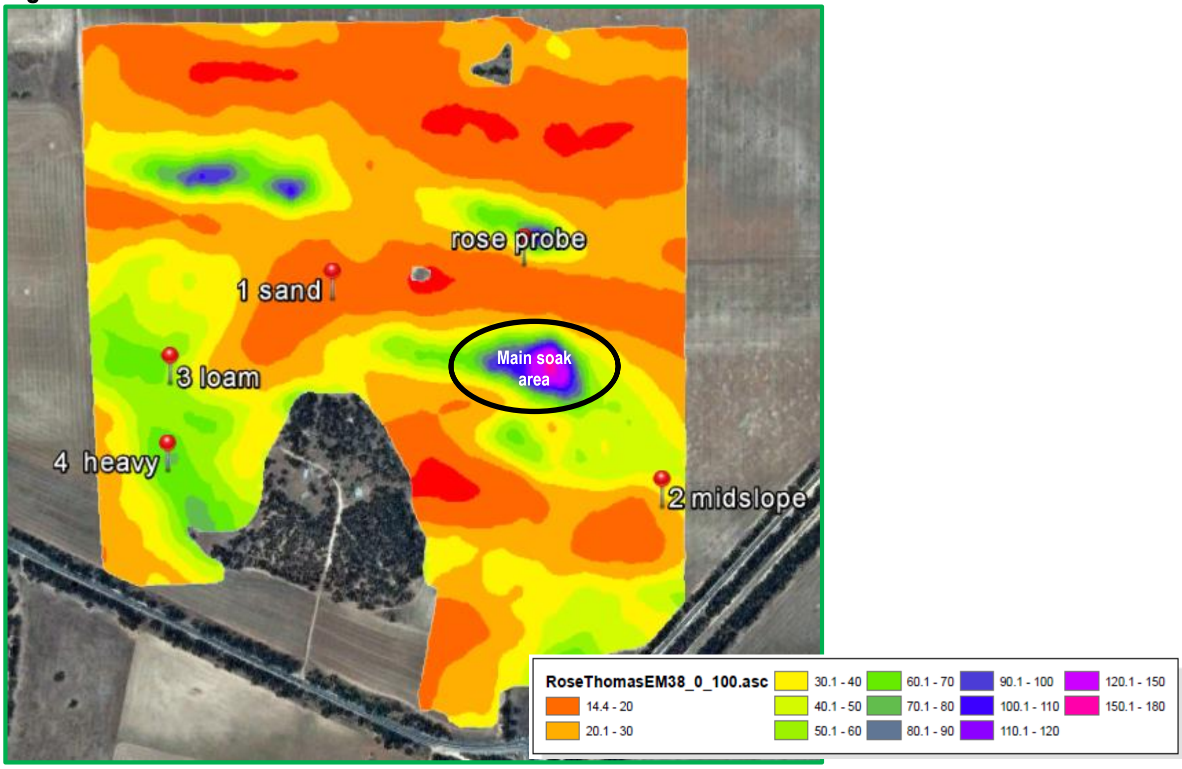


Table 6. Rose/Thomas Topsoil Test Results

Name	Date	Farm	Depth	Colour	Gravel	Texture	Ammonium Nitrogen	Nitrate Nitrogen	Phosphorus Colwell	Potassium Colwell	Sulphur	Organic Carbon	Conductivity	pH Level (CaCl2)	pH Level (H2O)
					%		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	dS/m	pH	pH
1 S	30/06/15	Thomas	0-10	LTGR	0	1	5	9	32	68	3.8	0.5	0.036	5.3	6.1
2 MS	30/06/15	Thomas	0-10	BRGR	0	1	8	9	22	71	3.2	0.4	0.034	5.4	6.2
3 L	30/06/15	Thomas	0-10	GRBR	0	1.5	1	9	27	261	5.8	0.91	0.059	6.5	7
4 HF	30/06/15	Thomas	0-10	GRBR	5	2	1	13	34	416	4.8	1.6	0.102	7.6	8.6

Table 7. Rose/Thomas Subsoil Test Results

Site	Farm	Depth	Ammonium Nitrogen	Nitrate Nitrogen	Conductivity	pH Level (CaCl2	pH Level (H2O)	Exc. Aluminium	Exc. Calcium	Exc. Magnesium	Exc. Potassium	Exc. Sodium	Boron Hot CaCl2	Chloride	MCP Sulfur	Moisture %
			mg/Kg	mg/Kg	dS/m	pH	pH	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	mg/Kg	mg/Kg	mg/Kg	%
1 S	Thomas	10-30	< 1	5	0.03	6.7	7.2	0.1	1.63	0.3	0.07	0.03	0.16	4.2	1.3	2.94
1 S	Thomas	30-50	< 1	2	0.024	7	7.6	0.15	1.04	0.26	0.09	0.03	0.18	2.3	1.2	5.59
1 S	Thomas	50-80	< 1	2	0.076	8	8.9	0.202	6.9	1.62	0.44	0.06	0.92	2.8	1.9	8.94
2 MS	Thomas	10-30	< 1	3	0.038	7.3	7.8	0.153	3.53	0.48	0.25	0.03	0.34	2.3	1.6	5.91
2 MS	Thomas	30-50	< 1	6	0.091	7.8	8.8	0.21	10.58	1.68	0.45	0.11	1.27	4.2	7.3	14.12
2 MS	Thomas	50-80	< 1	6	0.085	7.7	8.6	0.165	14.49	3.48	0.62	0.22	1.1	6	5.2	17.99
3 L	Thomas	10-30	< 1	10	0.102	7.4	8.2	0.12	11.83	1.47	0.72	0.13	0.86	6.2	6.8	8.53
3 L	Thomas	30-50	< 1	15	0.143	7.9	8.7	0.066	14.36	2.76	0.58	0.44	2.3	21.9	12.9	15.75
3 L	Thomas	50-80	< 1	12	0.245	8.4	9.6	0.109	8.94	6.03	0.67	2.82	6.21	89.5	19.8	16.52
4 HF	Thomas	10-30	< 1	8	0.121	7.9	8.9	0.157	11.38	2.94	0.49	0.67	2.08	17.1	13.5	13.48
4 HF	Thomas	30-50	< 1	8	0.175	8.2	9.5	0.102	9.08	5.88	0.52	2.16	4.55	22.4	11	13.97
4 HF	Thomas	50-80	< 1	7	0.297	8.5	9.9	0.065	5.95	6.53	0.9	3.7	11.5	34.9	9	14.85

Soil test results at this site are very typical of the Mallee, with low organic carbons in the sands, emphasising their lack of inherent fertility, despite all areas showing excellent phosphorus levels. There appears to be very little chemical subsoil constraints in any of these soils, apart from the physical barriers of stone that was encountered in some areas.

Figure 22. Soil pit at top of sandhill above soak

Figure 23. Mid-slope soil pit above soak area

Figure 24. Soil pit at soak area filling with water

3.4 Popes Chicken Spaded Manure Trial

This farmer uses a continuous cropping farming system with no livestock. He is most committed to trying to improve the crop production on his sandy soils during the growing season to increase profitability while also using up more soil moisture and reduce recharge into the soak areas. He was less interested in pursuing options of tree planting or lucerne as this did not suit his farming system.

Other sand amelioration trials have been used on this property around soak areas (such as clay spreading and deep ripping with nutrients), but so far without the dramatic improvement necessary to justify the expense of further investment into these soils. However, in an attempt to replicate the best principles demonstrated at last seasons' New Horizons sand trial at Karoonda of spading in nutrient rich organic matter to 40cm, and with readily available sources of affordable chicken manure, it was agreed that a spaded chicken manure trial should occur. Rates of 5t/ha and 10t/ha chicken manure (approx. $25/t) were planned to be spread and then spaded in (approx. $100/ha) over 2 approximately 4ha trial areas. This was slightly modified on the northern site due to issues with spreader (Fig. 28).

Early crop growth results shown in Figures 29-30 show that this trial could be well on the way to achieving its goal of both higher water use and production during the growing season on these non-wetting sands. 2 soil moisture probes have been strategically placed to measure the key differences between the spaded chicken manure and the control areas.

Figure 25. Scalded soak area surrounded by non-wetting sandy rises

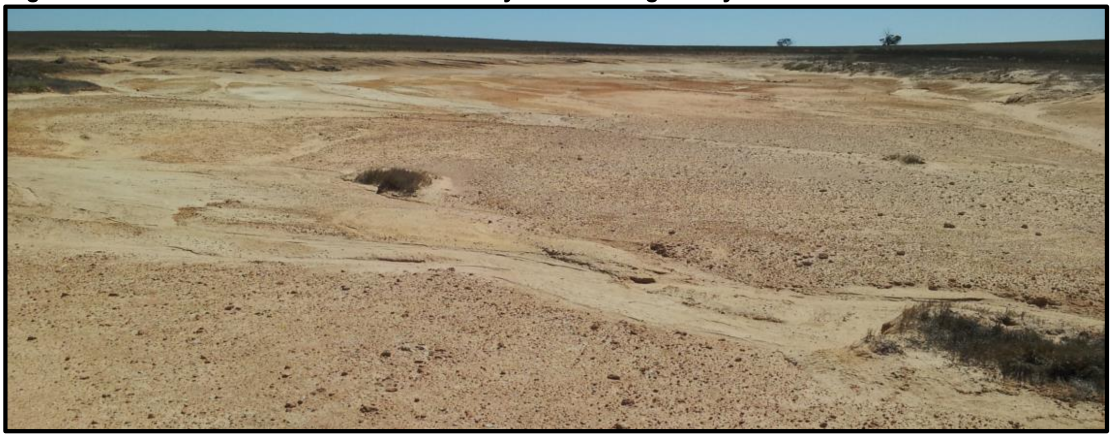


Figure 26. Scalded soak area clearly showing where moisture oozes out of sandhill above

3.4.1 EM38 Map with soil sampling locations and results

The EM38 map shows areas of deep sand (orange and red colours), sandy loams (green areas) and the soak affected areas (generally the dark blue to purple areas).

The EM38 mapped area in the top left corner of Figure 27 has had a history of clay spreading, which the farmer has not considered to have been very beneficial in increasing yields on this sand, possibly due to the higher moisture tie up in dry seasons on this non-wetting sand. Some of this clayed area has been spaded which as improved the situation, but not dramatically.

Interestingly, the deep red area above the marked Trial Area, was not considered by the farmer to be his worst sand. In fact some areas spaded on that rise brought clay to the surface, meaning it was less than 40cm deep. The most unproductive sand was to the south of this soak area, where the main part of the spading trial is located (see Fig 28).

Figure 27. Pope soak areas (blue/purple areas) showing soil test sites and spading trial areas

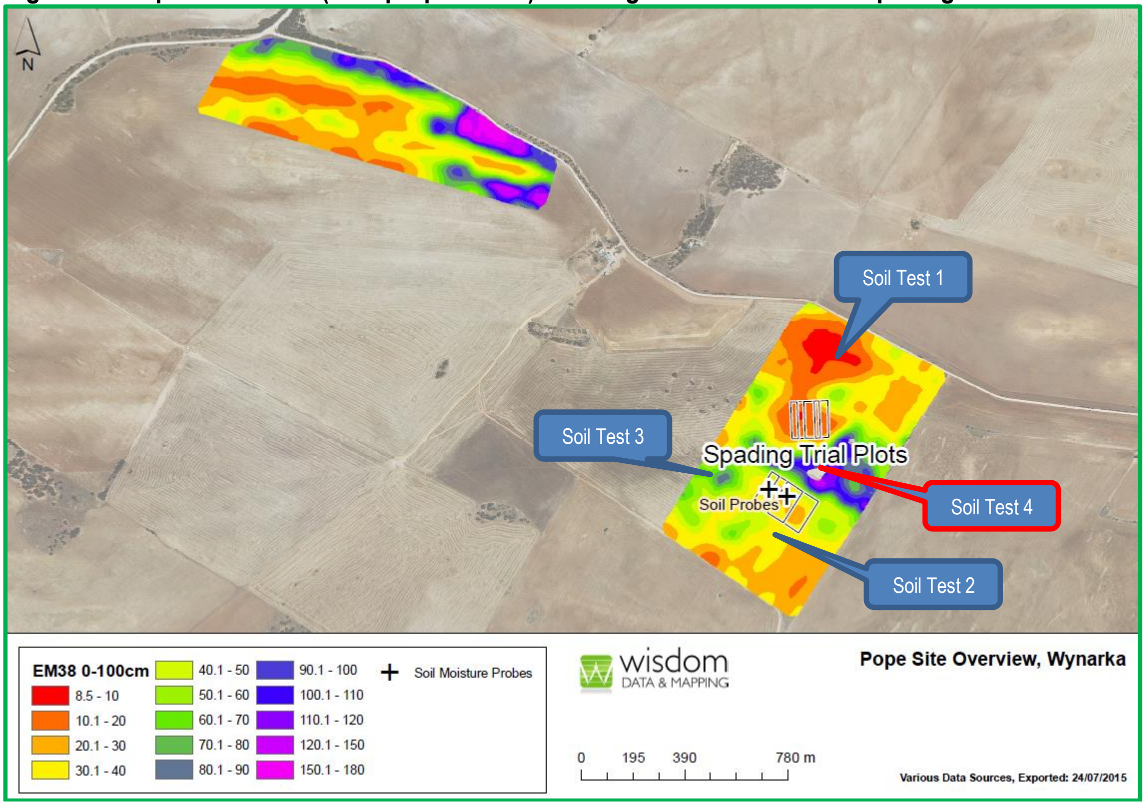


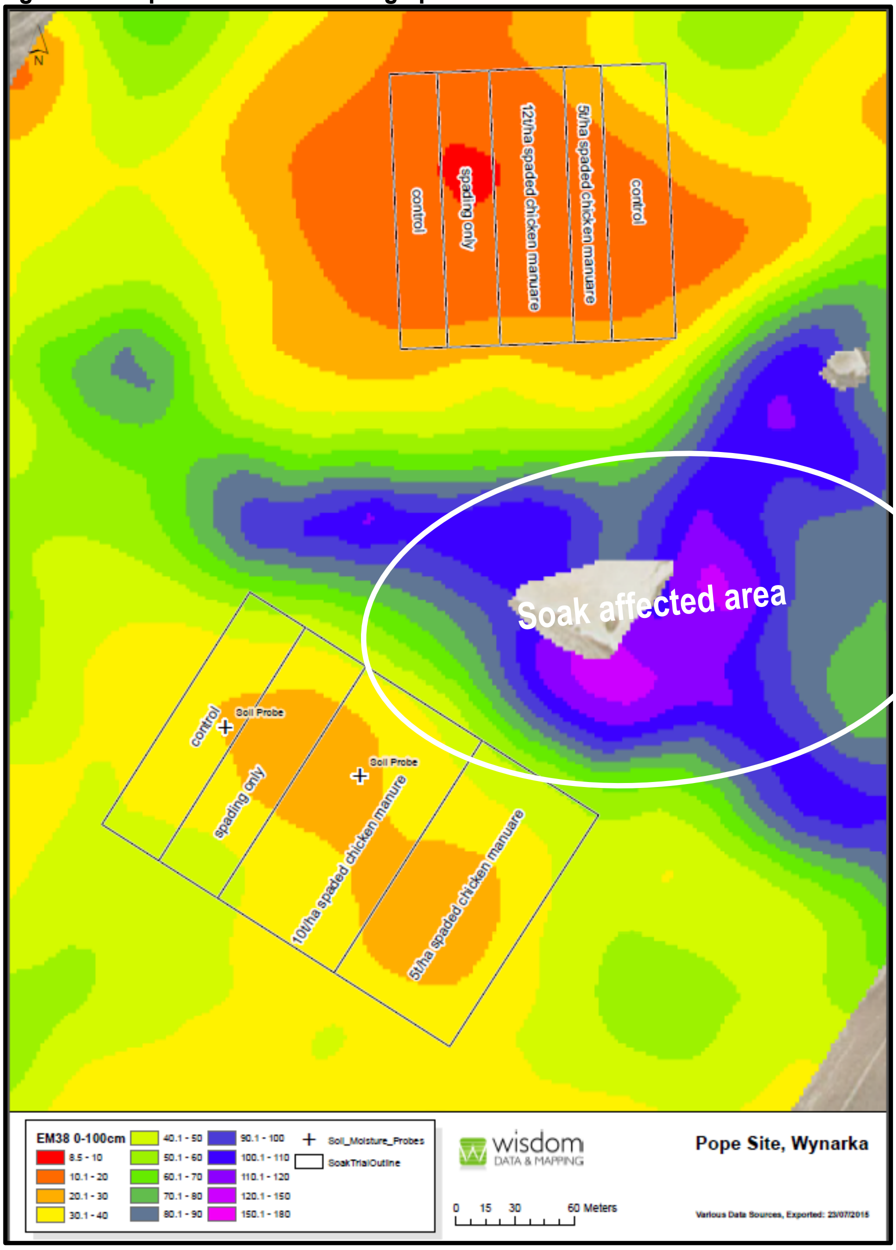
Table 8. Pope Topsoil Test Results

Map Site	Name	Date	Depth	Colour	Gravel	Texture	Ammonium Nitrogen	Nitrate Nitrogen	Phosphorus Colwell	Potassium Colwell	Sulphur	Organic Carbon	Conductivity	pH Level (CaCl2)	pH Level (H2O)	Moisture %
			cm		%		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	%	dS/m	pH	pH	%
1	Pope S	03/06/15	0-10	LTBR	0	1.5	6	5	26	83	5.6	0.58	0.029	5.4	6	2.6
2	Pope MS	03/06/15	0-10	GRBR	0	1.5	6	10	17	87	3.4	0.61	0.038	5.8	6.3	3.28
3	Pope L	03/06/15	0-10	BRGR	5	1.5	3	11	14	100	2.9	0.68	0.032	5.4	6	4.94
4	Pope HF	03/06/15	0-10	GRBR	0	1.5	37	25	80	106	18	1.04	0.111	6.3	6.7	4.93

Table 9. Pope Subsoil Test Results

Map Site	Name	Date	Depth	Ammonium Nitrogen	Nitrate Nitrogen	Conductivity	pH Level (CaCl2)	pH Level (H2O)	Exc. Aluminium	Exc. Calcium	Exc. Magnesium	Exc. Potassium	Exc. Sodium	Boron Hot CaCl2	Chloride	MCP Sulfur	Moisture %
			cm	mg/Kg	mg/Kg	dS/m	pH	pH	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	mg/Kg	mg/Kg	mg/Kg	%
1	Pope S	03/06/15	10-30	8	7	0.035	6.3	7.1	0.16	2.1	0.48	0.16	0.03	0.31	3.3	13.5	1.98
1	Pope S	03/06/15	30-50	3	6	0.03	6.3	7	0.177	1.74	0.39	0.14	0.02	0.26	4	3.6	3.27
1	Pope S	03/06/15	50-80	2	2	0.019	6.7	7.3	0.229	1.71	0.36	0.14	0.02	0.28	2.6	1.2	4.73
2	Pope MS	03/06/15	10-30	2	7	0.093	7.6	8.4	0.138	3.29	0.58	0.23	0.04	0.32	4.3	2.5	5.01
2	Pope MS	03/06/15	30-50	1	5	0.083	8	8.8	0.244	3.24	0.57	0.24	0.07	0.45	3.1	2.7	6.09
2	Pope MS	03/06/15	50-80	1	3	0.085	8.2	9.2	0.24	7.64	2.19	0.74	0.28	2.12	4.3	5.8	11.61
3	Pope L	03/06/15	10-20	3	5	0.025	6.5	7.3	0.086	1.22	0.37	0.25	0.03	0.26	3.7	1.9	5
3	Pope L	03/06/15	20-40	2	9	0.109	8.2	9.1	0.19	8.73	3.09	1.21	0.19	2.26	5.1	5.8	15.41
3	Pope L	03/06/15	40-60	1	5	0.149	8.4	9.4	0.164	8.5	6.51	1.7	1.21	7.79	8.2	8.4	16.91
4	Pope HF	03/06/15	10-30	4	20	0.083	6.3	7	0.129	3.19	0.86	0.26	0.14	0.88	12.8	10.5	3.67
4	Pope HF	03/06/15	30-50	4	7	0.126	8.2	9.1	0.16	3.84	1.07	0.26	0.63	1.72	21	11.5	15.98
4	Pope HF	03/06/15	50-80	< 1	7	0.379	8.5	9.6	0.155	7.58	6.25	1.25	5.19	13.96	105.9	42.5	24.93

Figure 28. Pope soak area showing spaded chicken manure treatment sites and moisture probes



Top soil results show slightly lower organic carbon in sand and mid-slope sand as would be expected. Interestingly, the heavier Site 4 in close to the soak area has extremely high phosphorus levels at 80ppm, suggesting that each year normal application has occurred, with very little leaving the paddock in yield. The loam soil by contrast is on the low side at only 14ppm.

The subsoils at all locations show vary little constraints at depth, with only the 50-80cm sample at site 4 with medium levels of both boron and transient salinity. This should not impede crop roots from growing through this zone to extract some soil moisture from this depth.

Figure 29. Improved crop growth in spaded area south of soak.

Figure 30. Control area (left) next to 10t/ha chicken manure spaded area (right) south of soak.

Figure 31. Trial areas showing moisture probes to compare crop moisture use between treatments

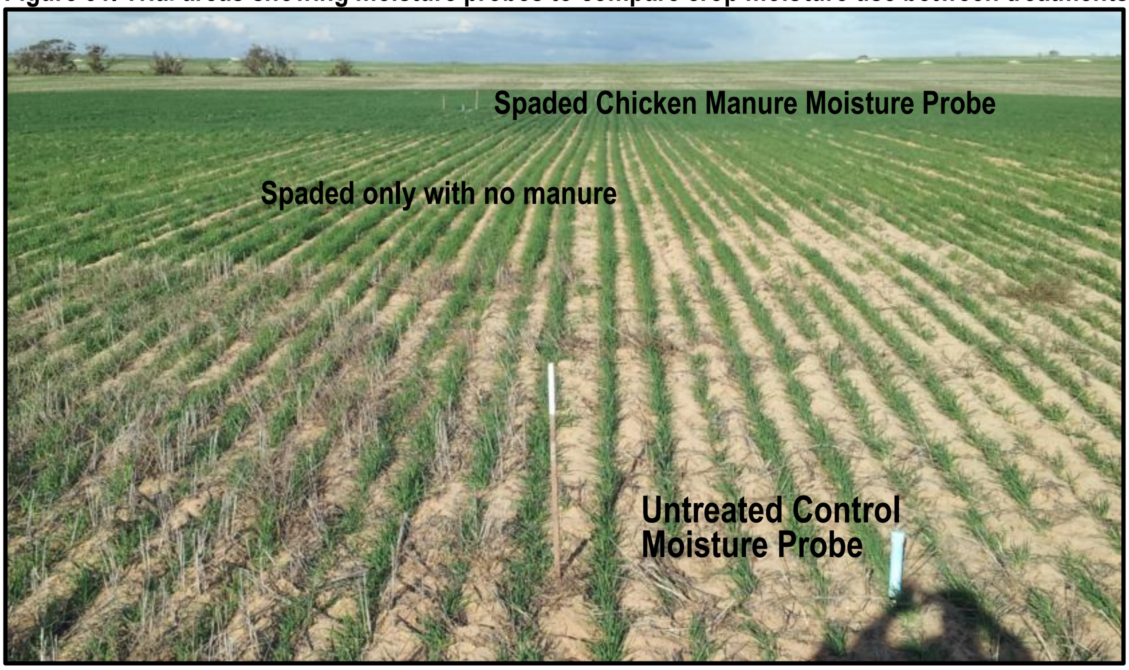


Figure 32. Deep sand profile at moisture probe sites

4 Concluding remarks

This project has been successful in establishing four demonstration sites in the Mannum to Karoonda region of the Murray Mallee that address the issues of the developing soaks. These paddock scale trials both increase our understanding of the landscapes moisture dynamics, and trial practical solutions that are applied to best suit each farmers own needs and types of farming systems, in ways that should improve their profitability as well as increase water use.

Each of these demonstrations will require ongoing site monitoring in areas of moisture use, production, yield, grazing, plant survival and economic analysis to gain the most benefit from the trial results and extend them to the wider farming community over time.