Eyre Peninsula
Mallee Seeps Sites
Report Dec 2021

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1 Project Aims and Activities

Sites on 5 farmer's properties have been established to investigate and demonstrate the dynamics and potential strategies to manage mallee seeps on Eyre Peninsula. These include established with high water use options, salt tolerant grasses and strategically placed monitoring equipment from seeding time in 2020 means that the new project could hit the ground running and provide an extra season of key information and outcomes to discuss and share with the Eyre Peninsula farming community.

The continuous measurement of water table levels, soil moisture and rainfall using specialised equipment along with soil and water testing and satellite NDVI mapping, will be invaluable for helping to understand the local EP situations, the most effective strategies and build the best messages for the EP farmers. This data will also be matched against MSF Mallee Seep Project findings and outcomes. The sites will continue to be monitored, analysed and demonstrated as a part of the EP Seeps Project.

This project has taken an "on ground participatory approach" to working with the farmers, to ensure the specific and most appropriate management strategies to be demonstrated will be decided collaboratively, and in line with what are practical solutions for them to employ at their own cost. This is a vital component of ensuring local project ownership and to increase the likelihood of adoption by EP farmers and beyond, based on sound technical information.   Satellite NDVI Maps have already been made of the various sites, and this report highlights key applications from these.

With any seeps management, there are 3 key zones to address, being the **Recharge, Discharge and Interception Zones** (Figure 1). Given the short timeframe for site analysis and establishment with farmers, it was expected that the **Recharge Zone** sandhills would already be sown, meaning the opportunity for any major subsoil amelioration work to be undertaken (such as deep ripping or spading) had already passed in the 2020 season. The main areas to be addressed would be the **Interception Zone** mid-slopes (through strategic lucerne strips, tree or pumping water out for other farm use), and the **Discharge Zones** (such as spreading sand on top and re-cropping, establishing salt tolerant pastures, and the preparation and summer cropping to maintain soil cover and reduce surface salinisation over the dry season), with chosen strategies depending on initial site assessment, including landscape, water, soil/salinity measurements and farmer preferences.

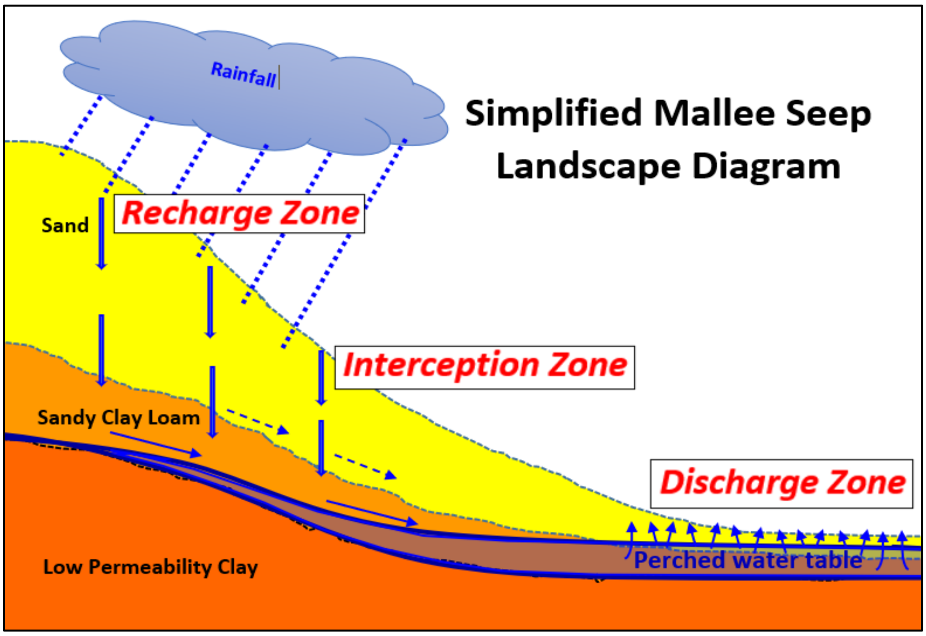
2 Background and context of EP Seeps

The Eyre Peninsula has two types of water table related saline land degradation. The first are associated with established creek lines though very large catchment areas with highly saline shallow water tables. These cannot be easily managed or rehabilitated by individual farmers at a local paddock level, as problems of water flows need to be addressed on larger and co-ordinated scale, with significant ground works required to change water flows and discharge impacts.

The EP mallee seeps project is focussed on the second scenario of localised seeps developing as perched water tables, usually associated with excess water passing through deep sandhills with poor water holding capacity. Many of these sites have appeared more recently as a direct result of farming system changes. The advent of more intensively managed No-till farming systems has led to the reduction and control of deep rooted summer weeds (such as skeleton weed) which had previously been responsible for using up summer rainfalls before the moisture could accumulate and move down through the soil profiles. This results in the formation of perched water tables above areas of essentially impervious clay layers and water moving laterally toward lower lying areas (as demonstrated in Figure 1) to find surface expression where the clay comes close to the soil surface in mid-slopes or at the base of swales. This leads to waterlogging, capillary rise, evaporation and a process of surface salinisation over time.

These seeps generally begin as waterlogged areas after high rainfall periods but this will lead to permanent salinisation and land degradation if no remediation takes place. Many perched water tables have existed and become quite saline over a longer period, but have only more recently found surface expression due to changes in recent years. The key to managing seeps is to identify the problem early, assess and apply appropriate management into the three key zones of Recharge, Intercept and Discharge areas (Figure 1). Living cover needs to be established over affected areas and high water use strategies employed to stop the flow of water into problem areas.

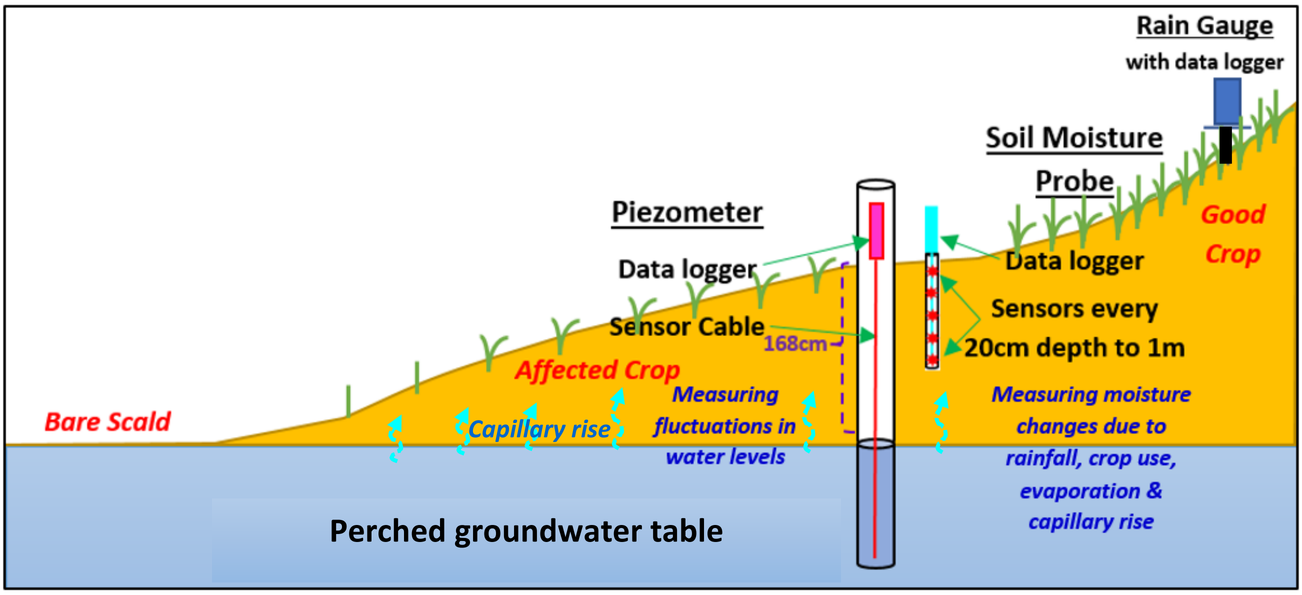
Figure 1. The basic features and causes of mallee seeps



3 Seep site monitoring

The project demonstration sites use various types of monitoring equipment assess the dynamics of the landscape water and the impacts of the treatments used for rehabilitation. Figure 2 represents three of these monitoring devices. Piezometers are generally placed within the discharge zones and slightly up the slopes within the interception zone penetrating the perched water tables. They have a single sensor wire and data logger to continuously measure any rises or falls to the shallow ground water table that may occur due to rainfall events and high water use strategies. Successful strategies should result in a lowering or drying out of these water tables so that they will no longer impact the paddock above and topsoils can be protected or restored from degradation.
The probe alongside in Figure 2 measures soil moisture at 20cm, 40cm, 60cm, 80cm and 100cm and shows the soil moisture penetration of rainfall (indicating any recharge events), as well as any capillary rise of water table moisture from below that will gradually bring salt to the surface to accumulate. A “tipping bucket” rainfall gauge is also placed at some site where other weather recording stations are not available and is useful to measuring and aligning all rainfall events and patterns to changes in perched water table levels and soil moistures through the profiles.

Figure 2. Piezometer, moisture probe and rain gauge set up at seep sites.



Soil tests will be taken from key demonstration sites areas in the surface layers and at depth, to understand key soil characteristics and the impacts of various treatments over time. Photos and videos are also a key part of investigations, so that before and after pictures give a clear visual reference to farmers of the changes resulting from seasonal factors and strategic management approaches.

4 Demonstration Site Locations, Descriptions and Progress

4.1 Site 1: Baldock Farms (Tola AG), Kimba.

"Establishing sandhill to lucerne pasture to bring recent seep scalds back to cropping"

4.1.1 Purpose

The initial aim of this demonstration is to test whether planting a sandhill to lucerne can utilise sufficient excess water to prevent the spread of surface degradation at two very different bare scalded areas on either side and possible bring them back to cropping within 3-5 years.

4.1.2 Background and site assessment

This "Outlook paddock" site was originally inspected on June 2nd 2020, with bare areas either side of a large, long sandhill running in a north-westerly direction through the paddock (Figure 3).

The mallee seep site (0.3ha bare scald) on the north-eastern side of the sandhill has formed since the wet season of 2016. This is evident from the NDVI images in Figures 4 & 5, showing strong green plant growth in the November after the 2017 season, with this effect still clearly visible mid-2018. A perched water table was found at the scald area at a depth of 55cm with a very low salinity level of 1.8 dS/m, with wet clay to a depth of about 160cm and the drier tight clay layer beneath. A piezometer with data logger was established at this point to monitor any changes in water level over time due to seasonal conditions or management treatments (Photo 1).

A second piezometer was placed 20m above the base of the sand hill which appears to contribute recharge water into the seep area. Here the perched water table was measured at 1.2m depth with a similarly fresh water quality. The top of the sandhill was another 40m up the sandy rise (Photo 2).

This site appears to have a clearly defined Recharge Zone, being the sandhill to the west, Discharge Zone, being the growing scald area and surrounding crop affected area at the base of the hill (although further investigation should be made of the clay flat to the east of this), and a potential Interception Zone, being the crop growing area at the lower edge of the sandy rise, where there is a clear water table underneath.

Soil salinity on the scald (Table 1, Outlook East 1) was not initially high in the surface, but increasing to moderately high levels at 20-30cm. The high pH levels and possible water logging appear to be the most threatening impediment to crop growth at the present time. Bare patches are likely to become salinised in coming years if management steps are not taken. This also means that if the recharge water can be stopped then positive rehabilitation is expected.

A second bare clay loam area of about 1ha of bare ground on the southern side of the sandhill was investigated (Figure 3) but found not to have an obvious perched water table. Soil tests showed only low salinity levels in the top 30cm and a history of NDVI images did not show indications of excessive water accumulation producing longer growth patterns. It was therefore thought that this area's poor growth may be due to the heavy clay and the dry season opening, but this may need further investigation as the farmer believes that periodic soil saturation may still play a part here.

Figure 3. Demonstration Site 1, Google Earth Image 2015, before mallee seeps present.

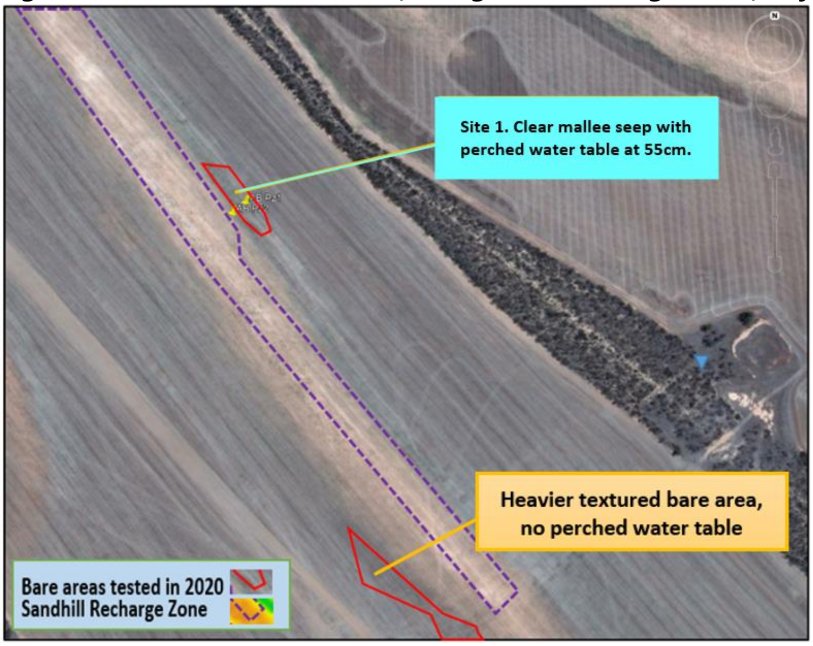


Figure 4. Nov 2017 NDVI image showing strong post season growth at eastern base of sandhill

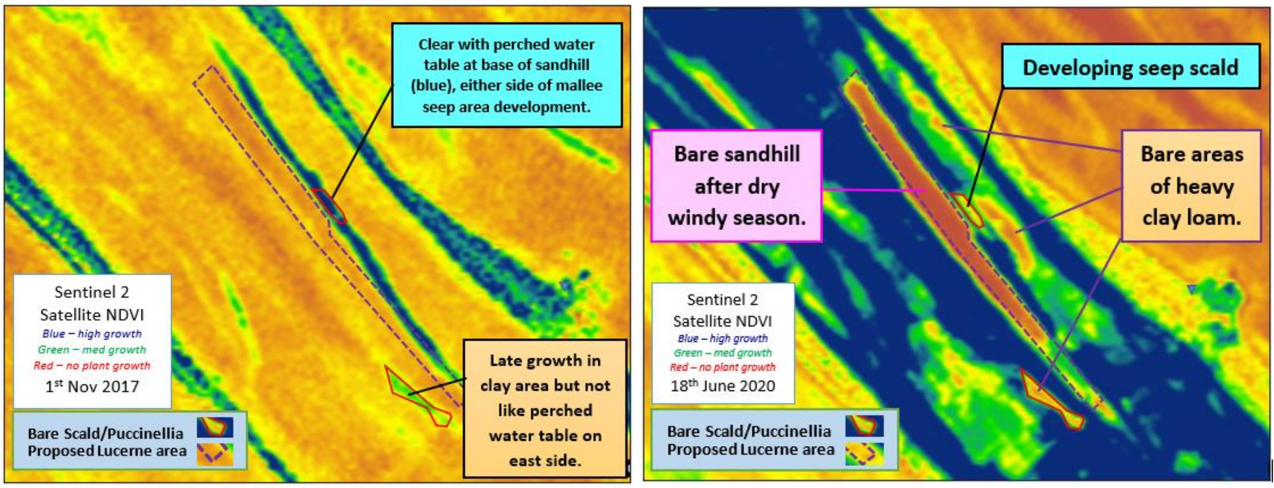


Table 1. Soil test results from Baldock Farms Sites 1 and 2.

Main Mallee Seep north east side of sandhill

Depth	Test	Units	Jun-20	Sep-20	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	0.33	1.6	0.45	0.65	0.4
	pH water	pH	9.82	9.74	10.3	10.4	10.2
	pH CaCl2	pH	8.92	8.81	9.25	9.23	9.19
	Moisture	%	8.5	5.9	7	11.4	7.3
	TDS	mg/L		1000		420	260
10-20cm	EC1:5	dS/m	0.28	1.1	0.35	0.51	1.1
	pH water	pH	9.82	10.01	10.1	10.3	10.4
	pH CaCl2	pH	9.79	9.01	9.01	9.22	9.49
	Moisture	%	12.3	14		10.7	3.2
	TDS	mg/L		730		320	700
20-30cm	EC1:5	dS/m	0.58				
	pH water	pH	10.2				
	pH CaCl2	pH	9.42				
	Moisture	%	11.1				
	TDS	mg/L					

Bare area south west of sandhill

Depth	Test	Units	Jun-20
0-10cm	EC1:5	dS/m	0.33
	pH water	pH	9.82
	pH CaCl2	pH	8.92
	Moisture	%	8.5
	TDS	mg/L	
10-20cm	EC1:5	dS/m	0.28
	pH water	pH	9.82
	pH CaCl2	pH	9.79
	Moisture	%	12.3
	TDS	mg/L	
20-30cm	EC1:5	dS/m	0.58
	pH water	pH	10.2
	pH CaCl2	pH	9.42
	Moisture	%	11.1
	TDS	mg/L	

Photo 1. Establishment of Scald (AB Pz1) and Mid-slope (AB Pz2) piezometers

Photo 2. Sandhill 40m of Recharge Zone sand above mid-slope piezometer

Photo 3. Bare scald area west of sandhill but with no perched water table

4.1.3 Treatments

After discussion with the farmers about how to increase the water use on the Recharge and Interception Zones of this site, and given the significant livestock enterprise within their business, it was decided that the whole sandhill (which has been of limited crop production value in recent years) would be sown to lucerne (Figure 3). Once established, this perennial, deep rooted pasture will utilise all water moving within these zones and prevent excess water entering the Discharge Zones on both sides of the sandhill, which should prevent them from land degradation and increasing in area. The use of other summer growing mixed species was also discussed as an option for this Interception Zone, particularly if conditions for lucerne establishment were not favourable.

It was also decided that the current bare scalded areas (Discharge Zone) be sown to puccinellia to establish soil cover immediately to prevent capillary rise and evaporation that could lead to rapid increase in surface salinisation. Given that the topsoil was not highly saline, it is expected that once the flow of recharge water was stopped, the scalded zone should be returned to cropping.

There was no specific management targeted on the south western bare area, as it was not thought to be a mallee seep and could return to productive cropping given favourable seasonal conditions. The lucerne establishment on the sandhill could help utilise any south flowing recharge water if this was creating any intermittent issues.

Site will be monitored by assessing the establishment of both the lucerne and the puccinellia and its effectiveness at achieving its desired outcomes. The success of the lucerne will be monitored in coming years be measuring the drop in the perched water table at both the scald (AB Pz1) and mid-slope (AB Pz2) piezometers which are both equipped with continuous data loggers. This will also be analysed against rainfall events.

Further investigation into the soil factors that are actually preventing crop growth on these various bare areas will be made. This should greatly improve our understanding of the driving forces associated with mallee seep formation on the Eyre Peninsula.

Successful outcomes for the farmers at this site will depend on their ability to:

1. stabilise and gain valuable grazing and/or haymaking production from the sandhill;
2. dry out perched water and stop the rapid spread of land degradation in the discharge areas;
3. restore these bare scald areas back to cropping in the coming years.

4.1.4 Ongoing Monitoring and Activities

Season 2020 proved to be a poor year with a late break and strong damaging winds. While lucerne was sown on the sandhill, it was not successful creating an erosion hazard. The farmer did achieve some cereal rye cover as well as some mixed summer species, mainly sorghum to grow just above the seep area over the summer, which may have been of some benefit. Some sorghum did reshoot in 2021 (Photo 6) and carried through to following summer. While this strip may intercept some recharge water it is not expected to have as significant impact as lucerne. It will be interesting to compare this site against similar sites that have established lucerne and are lowering water tables.

In 2021 the paddock was sown to canola, which grew well around the seep scald, and some puccinellia plants were established on the bare ground and thickened up slightly over the season (Photo 4).

Figures 5 & 7 show that approximately 90mm rainfall in Sept/Oct 2020 was enough to raise the water table in the scald by about 50cm, near the surface over a 2-3 week period as the water moved down from the sandy rise. Similarly, the mid-slope piezometer also showed a 50cm rise (Figure 6) over the same period.

Figure 5. Site 1 scald piezometer water level, June-Nov 2020

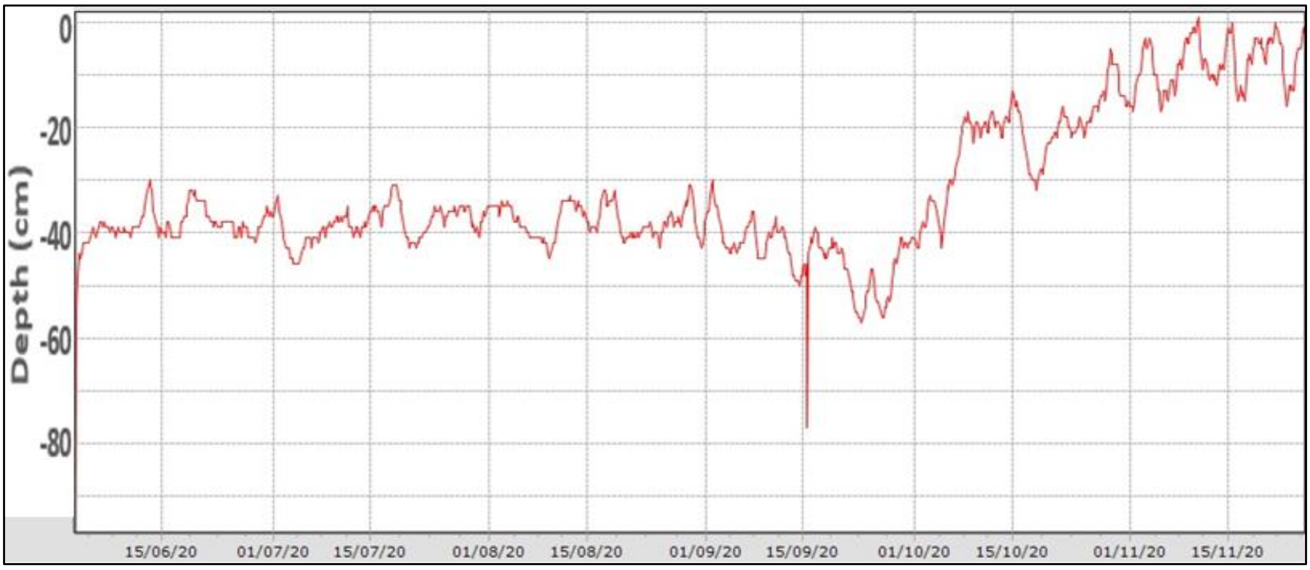


Figure 6. Site 1 Mid-slope piezometer water level, June-Nov 2020

Figure 7. Tola Farm Rainfall. June-Nov 2020

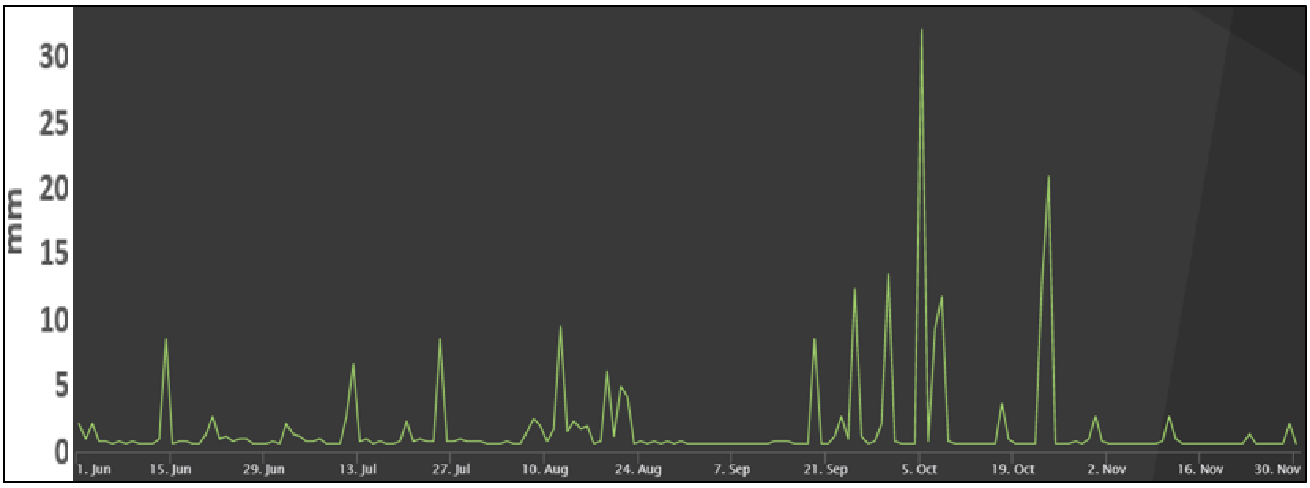


Photo 4. Baring scalded area Dec 2021 showing some puccinellia establishment

Photo 5. Seep affected area expanding along base of sandhill

Photo 6. Some regenerating sorghum in March 2022 above seep area

4.1.5 Current Assessment

It is expected that this Site 1 scald will continue to grow, salinise and spread along the base of the sandhill (Photo 5) until the flow of the water into the discharge zone is stopped. However, it is possible that strong seasonal crop growth on the sandhill, along with mixed species growing over summer and autumn may be sufficient to achieve this and may be a good comparison with other project sites relying on strategic lucerne.

However, the establishment of a lucerne strip from the base to the ridge of the sandhill would still be the preferred options as it will provide the best and most assured way to overcome this issue with the least amount of ongoing management. Once it is established, it will continuously be achieving the outcomes, with no breaks for seeding, crop establishment and reliance on spring/summer rainfall to establish warm season crops.

The management strategies for this site will continue to be opportunistically discussed and applied with the farmer, according to what best suits the season, the system, soil protection & production.

4.2 Site 2. Baldock Farms (Tola AG), Kimba.

"Pumping out perched water table for productive farm use & seep scald rehabilitation"

4.2.1 Purpose

The aim of the demonstration site is to test how seep water can potentially be pumped out and used on farm and how effective this can draw down perched water tables, along with other high water use strategies, to help restore degraded land back into production.

The unknown questions include:

- What rate of water extraction can take place?
- How quickly with the water refill the sump?
- How far will the pump extractions draw the water from?
- How quickly and effectively can this draw down the perched water table over time?
- Can this lead to a permanent rehabilitation of the seep scald area?
- What can the water be successfully used for, and will the water quality vary over time?
- Will there be opportunities for alternative water uses (such as irrigated lucerne for hay production) to keep up with the water extraction rates?

4.2.2 Background and site assessment

Figure 8 shows some evidence of changed farm machinery patterns around this site prior to 2015, but still with strong plant growth. However, since the 2016 season the effects of waterlogging and salinisation become evident (Figure 9 & 10), developing into a large bare scalded area (Figure 11). Landscape observations suggest that a large mass of water flows from the sandy catchment above to be concentrated through the sandy surface area where the scalded seep has appeared. The drilling of numerous test wells and placement of piezometers (Photos 7-8) showed a saturated sandy soil layer from 10cm to at least 2.5m depth with water quality tested at 2.8 dS/m. The sandy nature of this soil profile meant that water inflow into each hole was rapid. This suggests that there is a very large volume of water present which appears suitable for stock water and could possibly be used for tank spraying with the blending of some rainwater. This could prove to be a very valuable farm resource given the cost of purchasing water for farm use on the Eyre Peninsula.

Figure 8. 2015 Google Earth image showing crop stubble through most the current scald area

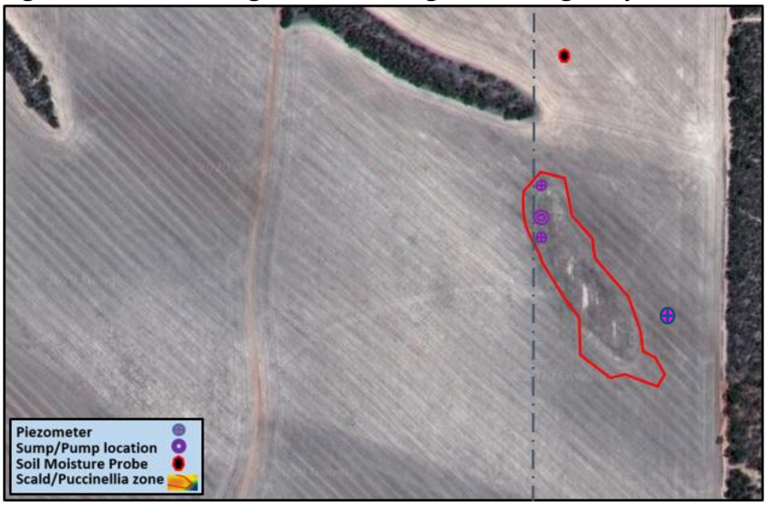


Figure 9. March 2017 large area of plant growth where seep formed following wet 2016 spring

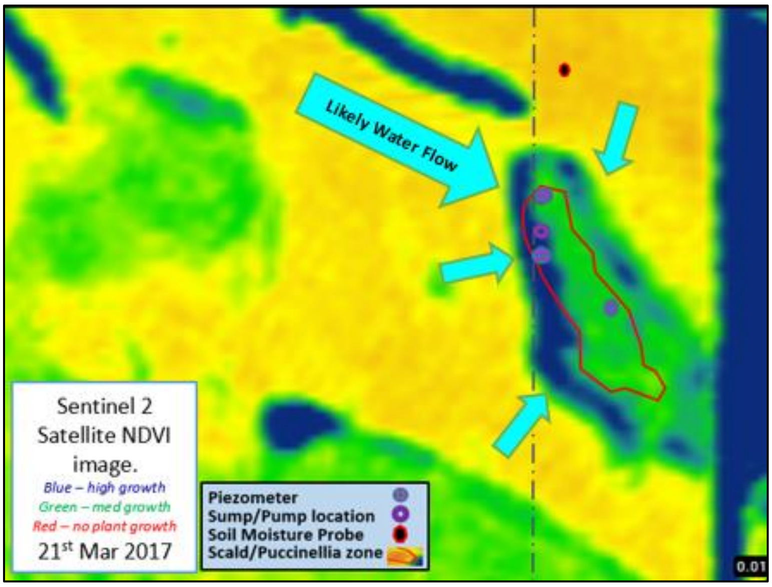


Figure 10. Sept 2018 NDVI image showing bare scald forming within high growth area

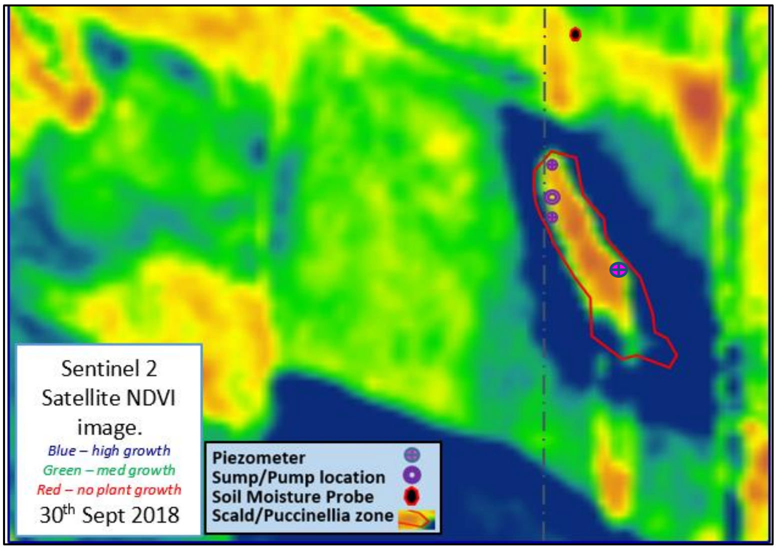


Figure 11. Sept 26th 2020 with strong surrounding growth despite dry season start.

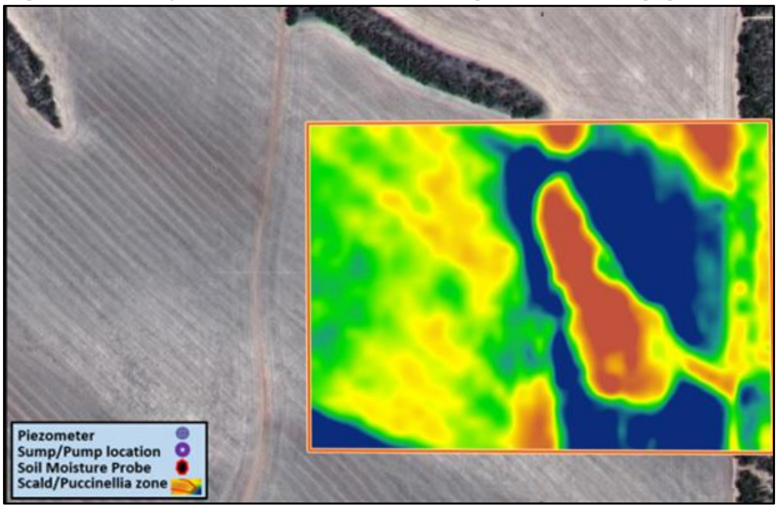


Photo 7. Digging test well at site of proposed sump and solar pump location AB Site 2.

Photo 8. Digging for AB Piezo 3, 40m north of pump site.

Photo 9. Water oozing out of sandhill on the western seep edge

4.2.3 Treatments

This site is being set up with a sump at a key location at the top edge of the scalded area near the fence, close to a small open dam that was dug in 2018. It was very important to set up a properly constructed, deep covered sump to collect the water, as the water quality in open dams will deteriorate very quickly. The site needed to be in a place that would have maximum impact, being not too high in the catchment to miss significant inflows from either side below the site, and not too low to prevent degradation above. The water will be pumped up to a large tank which already sits at the top of the hill to the south.

The farmer acquired a large tuna pipe (50cm diameter) in which holes were drilled to create a well into the lined sump pit to 2.5m depth. This is to be set up with a solar pump and floatation switch and flow meter to allow for the measurements of water extraction. A water level monitor with continuous data-logging was placed within the sump to give an indication of the very localised water table changes and sump recharge rates (Photos 10-12). Two piezometers were strategically placed, one 20m to the south, one 40m to the north, with data-loggers attached to measure the corresponding changes to water table levels as water is pumped out. A third Piezometer was later placed 80m to the southeast of the sump to test the treatments effectiveness. Being lower in the catchment it was found to have very black water with a higher salinity of 8 dS/m (Photo 14).

The Site 2 bare scald is also in the process of being sown to the salt tolerant puccinellia to provide perennial soil cover and grazing and reduce topsoil salinisation because of capillary rise and evaporation of this waterlogged landscape. Topsoil (0-10cm) salinity was measured at 0.49 dS/m, 0.2 dS/m (10-20) and 0.34 dS/m at 20-30cm depth, which is not considered too saline to grow crops at this stage (Table 3). However, the high pH levels of 10 at this site may well be the most toxic factor inhibiting rehabilitation to cereal growth. It may also be that waterlogging in the rootzone may also be the main driver of this bare patch, which hopefully will be changed through this sites management strategies. All these factors will need to be progressively monitored over time.

Photo 10. Sump being constructed with lining, stone backfill and well pipe.

Photo 11. Sump area prior to final cloth and covering

Photo 12. Scald at Dec 2021 with solar pump over sump well and some puccinellia establishing.

A soil moisture probe was placed in the deep sand at the top of the sandhill to the north of the seep scald, to help assess how compacted this sand may be (measuring profile moisture extraction by crop roots) as well as which rainfall events may be contributing to recharge (Photo 13).   This photo also shows the successful lucerne establishment on the sand, which fits well with the grazing systems of this mixed farm. It is important that multiple strategies are are being used for intercept water flowing into this area, which will compliment the pumping strategies for complete site restoration over time.

Photo 13. Moisture probe in deep sand above AB Site 2 with good lucerne establishment.

Photo 14. Black, moderately saline water drawn from piezometer 80m southwest of sump.

4.2.4 Ongoing Monitoring

Site assessment includes:

1. downloading and analysing all water dynamic information from piezometers, sump and tank flows to test how much water is being drawn out and utilised and what the direct effects on the seep landscape are;
2. recording the success of puccinellia the establishment to fully cover the bare scald area in coming years;
3. measuring any changes in water and soil quality at the site;
4. reporting on the value of the water use by the farmers.

The ultimate success of this site will be the rehabilitation of this whole scald site back to cropping in time by reducing the water table and water logging issues, as well as the gaining of critical information to support how this innovative strategy can be employed by other farmers across the EP, Mallee and further afield.

Table 2. Soil test results Baldock Sump Site 2

Depth	Test	Units	Jun-20	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	0.49	1.2	0.82	0.56
	pH water	pH	10.1	10.5	10.5	10.3
	pH CaCl2	pH	9.32	9.31	9.43	9.26
	Moisture	%	11.7	11	12.3	8.1
	TDS	mg/L			530	360
10-20cm	EC1:5	dS/m	0.2	0.24	0.58	0.35
	pH water	pH	10	10.1	10.4	10.2
	pH CaCl2	pH	9.23	9.23	9.36	9.27
	Moisture	%	12.3		10.7	8.5
	TDS	mg/L			370	220
20-30cm	EC1:5	dS/m	0.32			
	pH water	pH	10.2			
	pH CaCl2	pH	9.4			
	Moisture	%	11.3			
	TDS	mg/L				

Depth	Test	Units	Mar-21	Jun-21	Bare Sept 21	Puccs Sept 21
0-10cm	EC1:5	dS/m	1.2	0.75	0.83	0.42
	pH water	pH	10.5	10.5	10.4	10.2
	pH CaCl2	pH	9.53	9.44	9.43	9.39
	Moisture	%	5.4	7.4	4.6	1.5
	TDS	mg/L		480	530	270
10-20cm	EC1:5	dS/m	0.54	0.8	0.68	0.67
	pH water	pH	10.3	10.4	10.4	10.3
	pH CaCl2	pH	9.29	9.31	9.47	9.39
	Moisture	%		7.4	8.3	4.4
	TDS	mg/L		510	440	430

4.2.5 Ongoing monitoring, activities and recommendations

This site has progressed well in the building of the sump well by the farmers. Unfortunately the solar powered pump initially used did not quite have the power to lift the water to the height of the tank on the hill. While the farmer has purchased equipment to change this, numerous unforeseen circumstances has delayed its implementation.

The farmer did attach a firefighting pump to the site and pumped approximately 5000 litres up to the tank in Sept 2021. Interestingly this immediately lowered the sump level by over 1m which took some time to refill. While the water level of the piezometer 20m south showed very little fluctuation, the level 40m to the north dropped by nearly 1m. A smaller drop was also shown at the lower piezometer 80m away to the southeast. This shows that this strategy of pumping out water for farm use may well work in lowering the seeps perched water table, but there appear to be preferred waterflow pathways that will be further analysed once the system becomes fully functional.

There has been some issues in recovering some data-logger results from the farmers computer, which will be rectified, analysed and reported in time. However, it is planned that all data-logger downloads be conducted by the Landcare Officer in future, as at numerous other sites, rather than utilising the farmers computers and time resources.

The establishment of lucerne in the immediate paddock surrounding the seep has been excellent in 2021. While this may have significant impacts on lowering the perched water table and pumping water results, it is felt that the two strategies are very complimentary, given the size of the local recharge area, and the amount of water involved due to numerous high rainfall events. All seep management strategies should be multifaceted for achieving optimal results. While the lucerne may help lower the water table quicker, this should not impede our ability to measure and understand the critical water dynamics at the site, once the pumping system fully operates.

There will be much to gain from continuing to monitor and rehabilitate this site beyond the life of this current project.

4.3 Site 3, Jericho Farm, Kimba.

"Using strategic lucerne strip to intercept lateral water flows & rehabilitate scalds"

4.3.1 Purpose

This demonstration aims to use a strategic strip of lucerne surrounding connected seeps, along with salt tolerant pastures on scalds at different stages of development, can successfully reduce perched water tables and re back to cropping or productive pasture. If proven successful, this technique may prove advantageous to farmers who wish to minimise changes and impacts to paddock operations while halting further land degradation and restoring seep areas back to productivity.

4.3.2 Background and site assessment

The Jericho 'Trough' Paddock was visited on June 3rd 2020. The paddock has many jumbled sandy rises, loamy flats and 3 seep areas of varying stages of development as shown in Figure 12.

The first large white established scald that has been present since before 2000 but in recent years has begun to extend in an easterly direction (Photos 15 & 16). It has a large sandy rise to the northwest, the northeast and southeast that are all contributing recharge water (Figure 13). This NDVI image shows a clear connection of subsoil moisture flowing through Site 3a to Site 3b and the key recharge area that kept plants alive well through November 2018.

The scalded area has had most of the sand eroded from the topsoil over the years, exposing the slippery wet clay to the surface. Interestingly, a bore hole drilled to over 2m depth in the middle of the scald revealed no clear water table (Photo 17), with just enough water seeping in to test after 6hrs, reading at a very high 15 dS/m. It appears that the less permeable clay layer was now very close to the eroded surface, rather than at depth. It is possible that here the saturated zone is in the surface layers after rainfall, but soon dries out. A shallow water table was found at both the northern edge (2.9 dS/m salinity) and western edge (6.3 dS/m). These readings gave confidence that lucerne planted close to the seeps could successfully intercept water moving into this scald.

Initial soil tests from the centre of the Seep 3a showed levels salinity above cereal toxicity at 1.2 dS/m through the top 30cm (Table 3), but was more moderate down to 160cm. Although this has been a well established scald for over 20 years, it was considered suitable for establishing puccinellia. The high pH affects may cause some initial variations in establishment. The surface salinity dropped by over 50% to a more moderate 0.49 dS/m at the northern edge of the scald.

Photo 15. Jericho Seep 3a scald in middle of paddock

Figure 12. 2015 Google Earth image of the demonstration "Trough" paddock

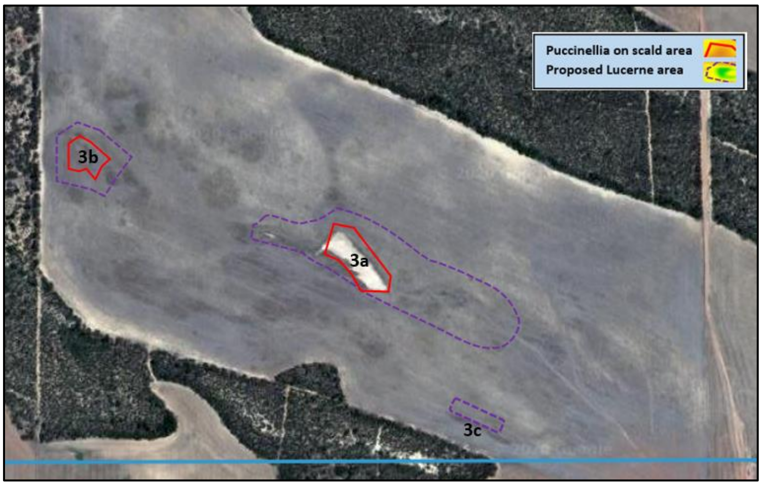


Figure 13. Nov 2018 Satellite NDVI image highlighting deep sand (orange) and loamy (blue) areas

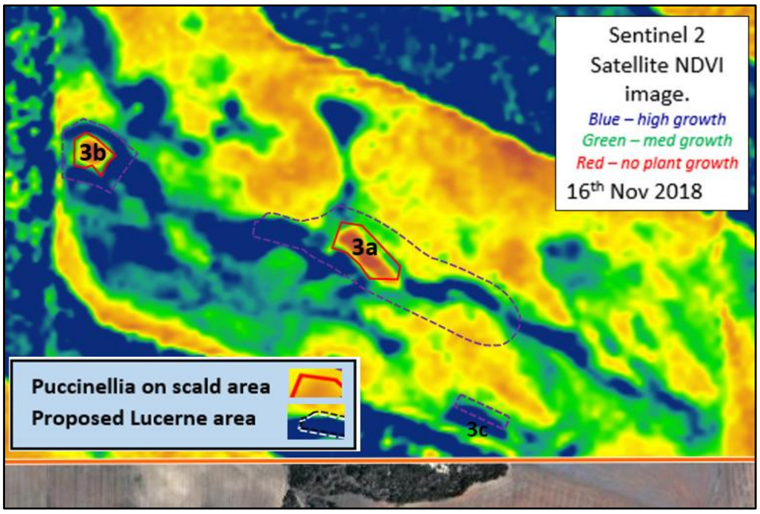


Table 3. Jericho Trough Paddock scald areas soil test results.

SampleName	units	SJ Trough Seep 3a Mid	SJ Trough Seep 3a Mid	SJ Trough Seep 3a Mid	SJ Trough Seep 3a Mid	SJ Trough Seep 3a Mid	SJ Trough Seep 3a Nth Edge	SJ Trough Seep 3b	SJ Trough Seep 3b	SJ Trough Seep 3b	SJ Trough Seep 3b	SJ Trough Seep 3b	SJ Trough Seep 3b
SampleDepth	cm	0-10	10-20	20-30	50-80	140-160	0-10	0-10	10-20	20-30	0-10	10-20	20-30
Salinity EC 1:5	dS/m	1.2	1.4	1.2	0.59	0.62	0.49	0.79	0.26	0.21	0.45	0.87	0.95
pH 1:5 water	pH	10.2	10.2	10.2	9.99	9.73	10.1	10.2	9.97	9.93	9.85	9.83	9.88
pH CaCl2	pH	9.5	9.59	9.57	8.99	8.7	9.03	9.2	9.35	9.37	9.18	9.2	9.24
Grav moisture	%	12	16	14.5	20.3	15.8	19	12.1	14	15.2	7.7	15.3	17.8

Photo 16. Clear indications of water seeping out of the sandy rise to the north of scald.

Photo 17. Deep test hole revealing no sloppy clay layer at depth, Seep 3a.

The second Site 3b has a sandy rises to the north (Figure 13, Photos 18 & 19) which appeared to be contributing water to the seep. This was confirmed by the piezometer established approximately 30m up the slope that had a water table at 2.2m, and a salinity level of 3.3 dS/m. A piezometer was also placed in the middle of the scald, showing a water table at 30cm with a salinity level of 4.5 dS/m. This has given confidence that a ring of lucerne established around this scald could utilise the water and reduce the water table. Data loggers were set in each piezometer so that continuous monitoring of the perched water table levels can be analysed in response to both rainfall events and management practices undertaken. A probe containing 5 soil moisture sensors at 20cm, 40cm, 60cm, 80cm and 1m was also set up in the mid-slope to assess how this soil retains loses water throughout the seasons, as well as there is a compacted layer preventing root access.

Soil tests from the middle of the scald show a high salinity level concentrated in the surface of 0.79 dS/m, with low salinity levels of 0.21 dS/m at 10-20cm and 0.21 dS/m at 20-30cm depth within this sandy profile (Table 3). This is indicative of a recently formed scald (since the wet season of 2016) with capillary rise bringing slightly saline water to the surface where it evaporates, but leaves the salt behind to gradually concentrate.

The final Site 3c (Photo 20) showed only mild salinity in the surface, with higher levels of transient salinity in the clay layers beneath. While this small site had suffered some waterlogging after rainfall, it was decided to focus the project rehabilitation demonstrations to Sites 3a and 3b.

Photo 18. Jericho Seep 3b showing mid-slope piezometer and moisture probe in foreground.

Photo 19. Jericho Seep 3b scald area rapidly spreading though cropping land.

Photo 20. Jericho Seep 3c site that is its early stages of development

4.3.3 Treatments

The Discharge Zones

The bare scalded areas of Seep 3a and Seep 3b were to have the salt tolerant puccinellia grass established to provide soil cover, grazing and water use. This will stop further surface soil degradation by utilising water within the rootzone, rather than allowing it to rise to the surface, evaporate and leave salts to concentrate. In time it may be possible to return Seep 3b to cropping, possibly with the addition of sand to the surface, however, such rehabilitation may take far longer in Seep 3a, given the much higher salinity levels of soil and water measured.

The Recharge Zones

The farmer intended to undertake some deep ripping and clay spreading into the sandy rises in this paddock in the future to help break compacted layers and allow plant roots to access and utilise more soil water before it contributes to recharge. While this may provide some benefit to increase water use, the impacts of sand amelioration is generally far less than what can be achieved with deep rooted perennial vegetation intercepting water flows.

Interception Zones

The initial main innovative practice to be tested at this site was to use of strategic 20-30m wide lucerne strips planted immediately around the discharge zones (Figure 14), to utilise enough excess water to lower the water tables, to stop the spread of the land degradation and, in time, possibly restore areas back to crop production. However, after examinations of satellite NDVI imaging, and with sheep being a key part of their farming system, the owners were happy to plant a 10ha strip of lucerne through the centre of the paddock, covering the swale where the water is collecting and moving through, as well as the deep sands on either side (Figure 16, Photo 22). This is expected to have a dramatic impact on lowering the perched water tables and restoring the sites.

4.3.4 Ongoing Monitoring, Results and Recommendations

Puccinellia has been established on the site in 2020 and 2021 through a combination of:

- casting seed and seed heads out that had been hand cut and collected from other sites,
- the planting of puccinellia seedlings (Photo 21), and
- seeding though using some light harrows and a bait layer to spread it, and then lightly harrow it in.

All three methods have been successful in various situations, with Site 3b (more recent, less saline) almost completely covered within 18 months. The older, more saline Site 3a has established puccinellia from seed well around the edges, but is more gradually filling up the centre scald areas over time. The Figure 14 NDVI images reveal the bare scald area on Site 3a reducing from 1.03 ha to 0.27 ha, while Site 3b has gone from 0.6ha to almost completely covered.

The sown seedlings have often been more reliable in the most saline scalded areas where the clay is at the surface, but even some of these perished over the summer months. Digging, splitting and replanting established puccinellia plants has also helped fill in gaps at this site.

It is full expected that all scalded areas will become full covered with puccinellia within the next season, showing that even established severely saline scalds can be covered and improved.

Photo 21. Seedling planted puccinellia at Site 3b and dividing and redistributing plants at Site 3a.

Figure 14. NDVI images showing large reductions in bare scald areas at Sites 1 and 2.

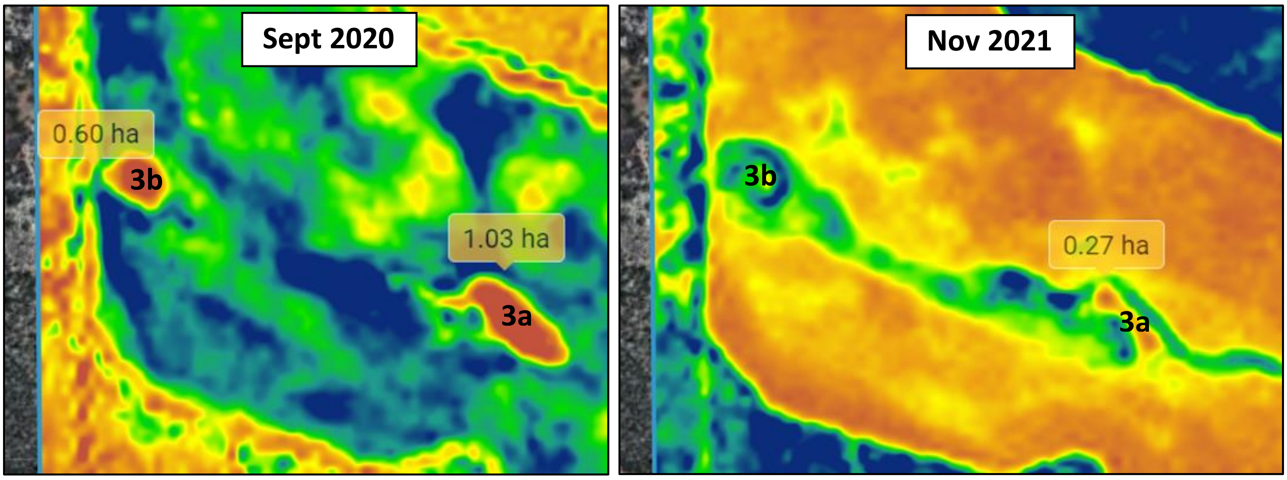


Figure 15. NDVI Image Jan 2022 showing areas actually established lucerne & puccinellia

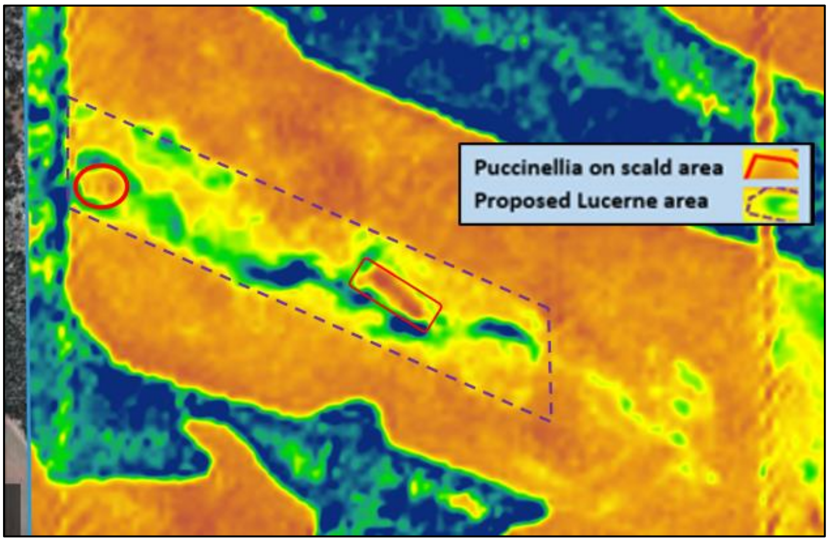


Photo 22. Seep 3b covered with puccinellia and surrounded by lucerne, December 2021.

Photo 22 show the excellent stand of lucerne that is now established around all seep scald areas. While it is thinner on the sandy rises of the strip, it is starting to thicken up and is expected to dramatically lower the water table from now on. Figures 16 and 17 show that up until Jan 2022 single or clustered rainfall events totalling at least 30-40mm have led to a sharp rise in the water table of 20-40cm which then starts to dissipate over time. Now that the surrounding lucerne is well established it expected that this perched water table will lower and possibly dry out altogether, and each significant rainfall event should only cause a slight jump in the level for a short period of time.

There is one newly forming seep area to the north of Scald 3a which is partially in the lucerne line. The farmers have talked about sowing even more of the paddock to lucerne. This is encouraged as it would then surround this recent seep area and cover even more of the sandy recharge areas. This also works well within their mixed farming system.

Figure 16. Perched water table level at Site 3b scald July 2020 – Jan 2022

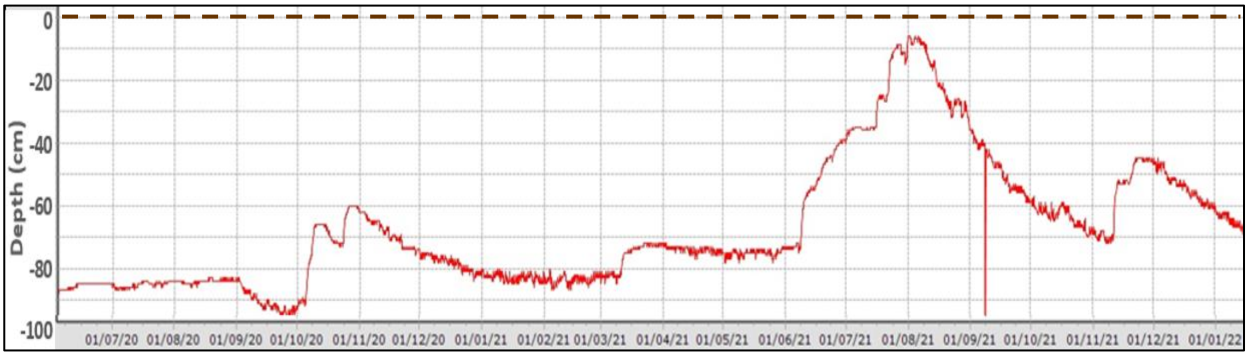
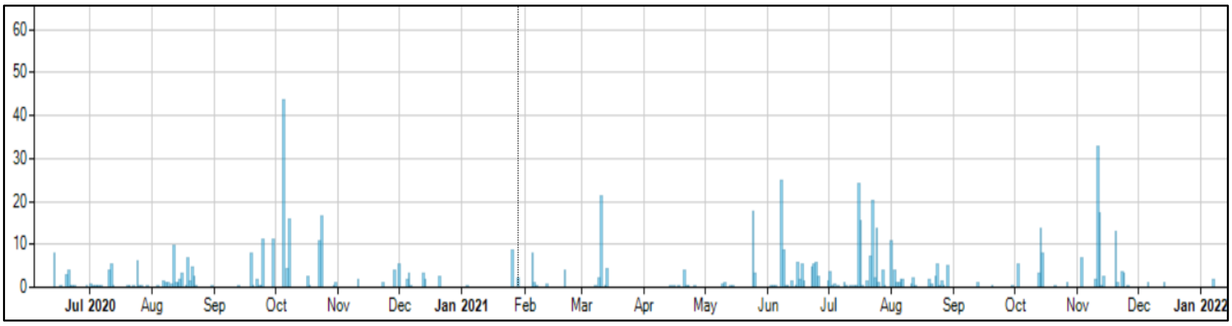


Figure 17. Jericho Site Rainfall, July 2020 - Jan 2022



Soil tests from established puccinellia areas in Site 3a (Table 4) has shown a clear decrease in topsoil salinity when compared directly to bare scalded areas nearby. Some seasonal variation is evident from June 2020 through to Sept 2021 on bare scalded areas (becoming higher in dry periods and lower after significant rainfall events) ranging from a toxic level of 0.93-1.5 dS/m. However, an area just meters away that now has established puccinellia has reduced salinity to a mild 0.2-0.4dS/m to 20cm. The soil was clearly drier and healthier looking, which is a positive outcome in the hope of restoring land back to cropping in time.

A similar affect is seen at soil test from the edge area within the scald, where a mildly saline area of 0.49-0.75 dS/m area has now reduced to 0.35 dS/m as the puccinellia has become established.

As this site has lost much of its topsoil to erosion in the most hostile areas of this scald, it may be necessary to bring some in on the worst scald areas before attempting to resow any cereals. However, now that this paddock has been set with a higher pasture emphasis, the farmers may well choose to keep the established puccinellia as a grazing resource in the foreseeable future.

Soil tests at the western Site 3b (Table 5) show a lower topsoil salinity that does peek significantly in March 2021 after a dry hot summer (samples taken prior to 22mm rainfall Figure 18) and confirms why it is important to wait for a significant rainfall in Autumn before sowing puccinellia. The 10-20cm salinity is also much lower than Site 3a, which is a positive sign for a faster rehabilitation. It is noted that the soil under the puccinellia has not improved as per other sites, but his may be that it has not been well established for as long. Further tests will be taken to see if this changes in time.

Very high pH levels are also noted across all sites, generally at levels that would greatly inhibit crop growth. There is some evidence of pH rising and falling with salinity levels, so it is hoped that these high pH levels will also be rectified as these sites are rehabilitated.

Table 4. Site 3a comparative soil test results over seasons

Depth	Middle of Scald Test	Units	Jun-20	Sep-20	Mar-21	Jun-21	Bare Sept 21	Puccs Sept 21
0-10cm	EC1:5	dS/m	1.2	1.4	1.5	0.93	1.4	0.2
	pH water	pH	10.2	10.4	10.6	10.5	10.4	9.86
	pH CaCl2	pH	9.5	9.49	9.62	9.44	9.63	8.91
	Moisture	%	12		9.3	11.1	9.1	0.4
	TDS	mg/L				590	880	130
10-20cm	EC1:5	dS/m	1.4		1.2	1.3	1.5	0.35
	pH water	pH	10.2		10.4	10.5	10.3	10.3
	pH CaCl2	pH	9.59		9.53	9.7	9.67	9.29
	Moisture	%	16			14	15.1	1.6
	TDS	mg/L				800	960	230
Depth	Edge scald area →				Puccinellia Established			
0-10cm	EC1:5	dS/m	0.49	0.56	0.65	0.75	0.35	
	pH water	pH	10.1	10.3	10.4	10.5	10.1	
	pH CaCl2	pH	9.03	8.94	9.25	9.57	9.2	
	Moisture	%	19		9.7	12.3	19.8	
	TDS	mg/L				480	220	
10-20cm	EC1:5	dS/m			0.35	0.39	0.21	
	pH water	pH			10.3	10.3	9.75	
	pH CaCl2	pH			9.38	9.33	8.88	
	Moisture	%				13.2	13.6	
	TDS	mg/L				250	130	

Table 5. Site 3b comparative soil test results over seasons

Depth	Test	Units	Bare Jun-20	Bare Sep-20	Bare Mar-21	Bare Jun-21	Bare Sept 21	Puccs Sept 21
0-10cm	EC1:5	dS/m	0.79	0.77	1.8	0.44	0.65	0.63
	pH water	pH	10.2	10.4	10.5	10.4	10.4	10.3
	pH CaCl2	pH	9.2	9	8.9	9.34	9.04	9.39
	Moisture	%	12.1		11.6	13.7	5.5	7.5
	TDS	mg/L				280	410	410
10-20cm	EC1:5	dS/m	0.26		0.82	0.33	0.31	0.35
	pH water	pH	9.97		10.5	10.3	10.2	10.2
	pH CaCl2	pH	9.35		9.45	9.36	9.37	9.38
	Moisture	%	14			13.8	11.9	9.2
	TDS	mg/L				210	200	220
20-30cm	EC1:5	dS/m	0.21					
	pH water	pH	9.93					
	pH CaCl2	pH	9.37					
	Moisture	%	15.2					
	TDS	mg/L						

This site is making excellent progress as the rapidly expanding degradation has now been stopped and reversed. The farmers have been very co-operative and satisfied with the positive outcomes achieved. Now that the lucerne is established it is expected that the perched water table will soon cease to impact scald areas. The puccinellia establishing cover and preventing saline water reaching the surface layer is already showing signs of bringing saline land back to health. It will be important to keep monitoring this site for the next 2 seasons to see these management strategies through to completion, particularly after the recent extremely high rainfall impacts.

This site will always require this strategic lucerne strip to stop the perched water table re-forming.

4.4 Site 4. Glover Farm, Lock

“Early identification and rehabilitation of seep back to cropping using lucerne”

4.4.1 Purpose

This site demonstrates how farmers need to identify and manage seeps early, before they become growing saline scalds. It will investigate the effectiveness of sowing a deep sandy rise to lucerne above the developing seep to:

- utilise water and dry out the perched water
- provide valuable summer and autumn feed for livestock, and
- protect the sand form wind erosion.

It will also test the technique of spreading sand on the recently scalding strip to allow for lucerne to be established over the top of the discharge area to lower the water table and achieve soil cover without having to rely on sowing puccinellia at this early seep development phase.

4.4.2 Background and site assessment

This Site was initially visited in September 2020 where it became evident that seep scald was threatening to develop, due to the increased serial growth at the base of the hill (Figure 18, Photo 25), the small scalded area starting to form and the farmers description of the recent waterlogging threat to machinery (photo 23). This was confirmed by after two piezometer wells and finding a reasonably fresh perched water table at 80cm to 1m depth. Viewing satellite NDVI images (Figure 19) showed extended growth areas due to the perched water table in October 2018, suggesting that 1-2 ha of highly productive cropping land was under immediate threat of degradation.

It was clear from the landscape that the sandhill to the north was the source of the excess water impacting the area. The farmer discussed some efforts to ameliorate the sand through deep ripping and delving. While this may have some impact, it was decided that a strategic lucerne strip above and over the top of the forming seep area would have the greatest impact on reversing the situation. Extending the lucerne to a seeder width beneath the existing seep area would also help prevent the spread of the seep further into the paddock.

The farmer decided he would establish 4-5ha of lucerne over the sandy rise in the coming season to see how well it could combat the seep while providing productive protection for the area.

Photo 23. Bare scald strip beginning to form near bottom piezometer

Figure 18. Early Google Earth image of Site (2006) showing dune/swale landscape

Figure 19. Oct 2018 NDVI image showing 3 seep concern areas in paddock

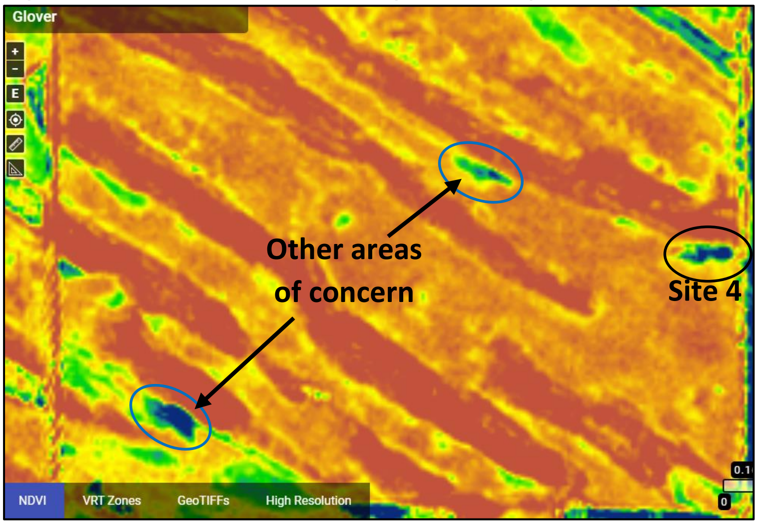


Photo 24. Placing of soil moisture probe on top of sand rise above seep.

Photo 25. Strong crop growth above perched water table.

4.4.3 Treatments

Two piezometers were established in the seep area, firstly at the bottom where the surface scald was developing. The second lies approximately 20m to the north, where the crop growth is vastly improved. There appears to be a clay ridge between the 2 piezometers that suggests that the top water table may fill up and then spill over into the lower perched basin. The dynamics of this will be monitored over time.

It was decided to spread 10-15cm of sand over the areas beginning to scald, to make this topsoil suitable for the lucerne to establish. It was thought that once established it would be able to grow through the slightly saline, crusty layer beneath, provide important soil cover and deep water use that would return the soil back to health without having to revert to the salt tolerant puccinellia.

The lucerne was then sown in less than ideal conditions, due to the late season break with poor follow up rains, strong winds and poor soil cover to sow into. While excellent lucerne establishment was achieved in a strip along the base of the sandhill and around the seep area, unfortunately the majority of the sandy rise area suffered severe wind erosion and loss of plants (Photo 27. Figure 24). The farmer will hope to resow the area in better growing conditions in 2022.

A soil moisture probe was placed at the top of the sandhill to 1m depth to help determine which rainfall events may be contributing to the perched water table recharge at this site.

Photo 26. Strong growth immediately around seep in Sept 2021, but failed lucerne above this.

4.4.4 Ongoing Monitoring, Results and Recommendations

The positive development at this site have been the excellent lucerne that has been established slightly above and through the seep area, which should be enough to start lowering the perched water table in coming seasons (Photo 28).

The spreading of sand to help establish lucerne on the scalded area also appeared to have been successful, although there are still saline patches evident (Photo 29).

Photo 27.Lucerne well established along base of sandhill (Dec 2021)

Photo 28. Some lucerne established around bottom piezometer after sand placed on scald

While there have been a few glitches within the monitoring probes that have been rectified, Figure 20 reveales that while some moisture may have passed thought the rootzone with the initial 46mm rainfall event, there was very little else within this time period. Figures 21 and 22 reveal that the water tables did rise significantly after certain growing season rainfall events. The impacts of the lucerne are starting to be seen at the end of the year. It is expected that the lucerne will soon lower the water tables to well below their starting point or even dry them out.

Figure 20. Early soil moisture probe readings (Sept 2020 – Sept 2021).

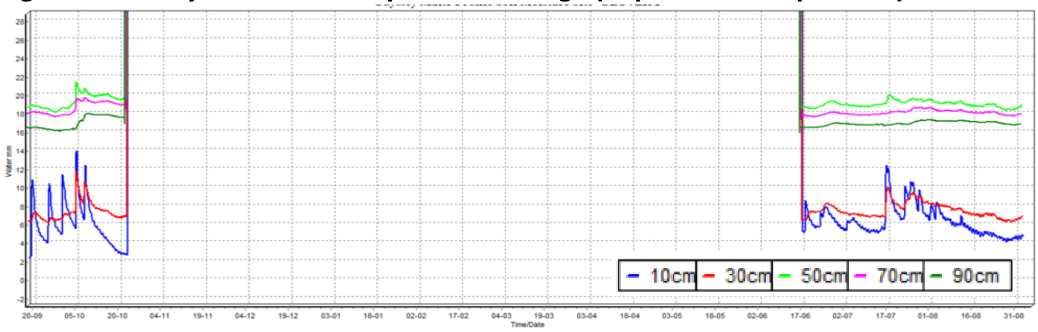


Figure 21. Top high crop area piezometer water table readings, Sept 2020 – Sept 2021

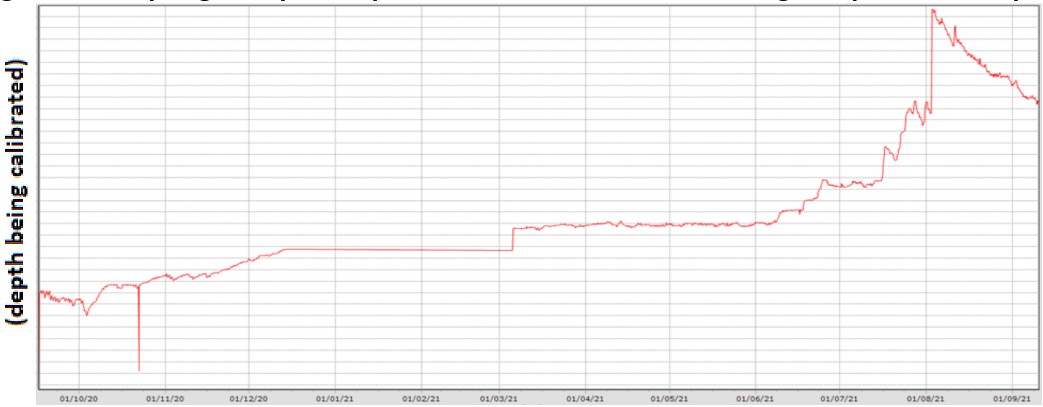


Figure 22. Bottom scald piezometer water table readings, Sept 2020 – Sept 2021

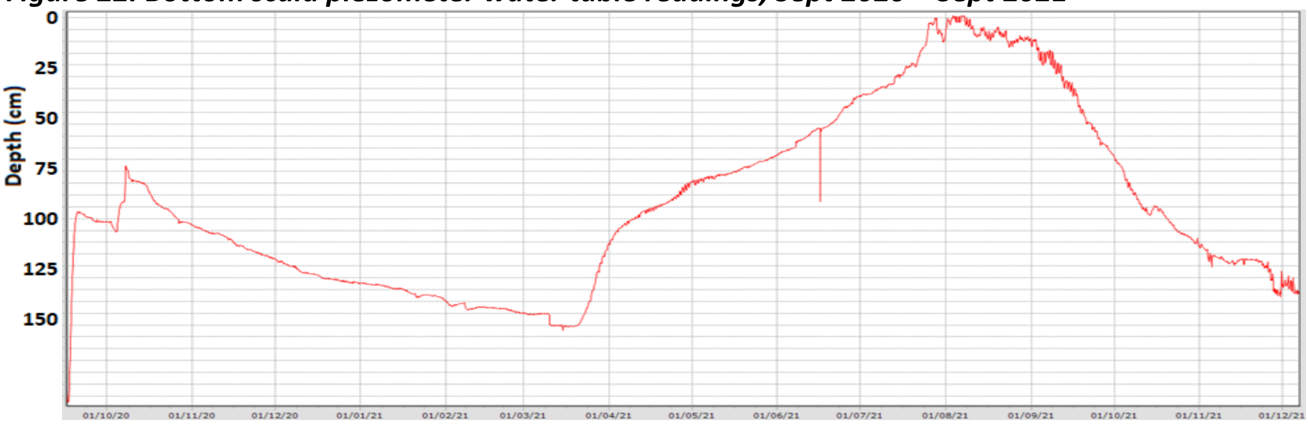


Figure 23. Site rainfall Sept 2020 to Sept 2021.

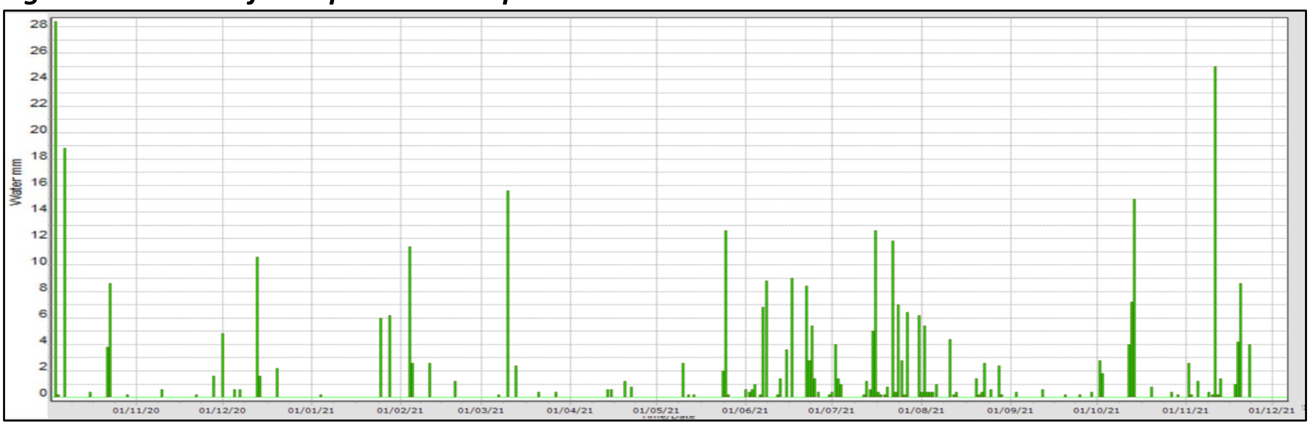


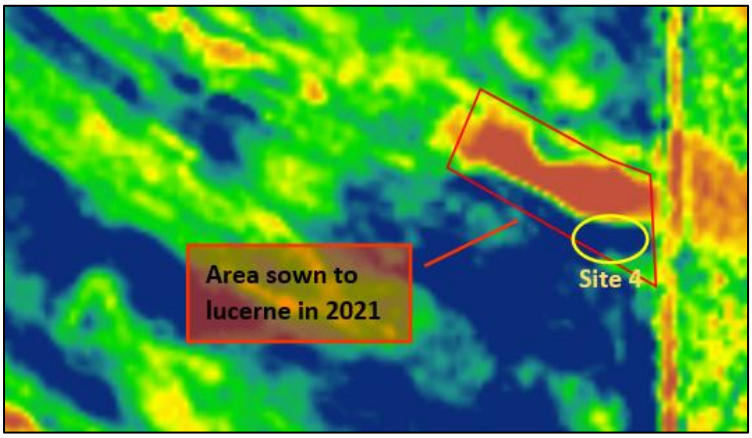
Table 6. Soil test results over the season near the top piezometer

Depth	Test	Units	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	0.26	0.18	0.092
	pH water	pH	7.47	7.26	7.47
	pH CaCl2	pH	6.82	6.61	6.79
	Moisture	%	2	6.5	4.2
	TDS	mg/L		120	59
10-20cm	EC1:5	dS/m	0.19	0.15	0.11
	pH water	pH	8.61	8.23	8.28
	pH CaCl2	pH	7.66	7.52	7.46
	Moisture	%		6.8	4.5
	TDS	mg/L		96	70

Table 7. Soil test results over the season near the bottom piezometer

Depth	Test	Units	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	1.1	1	0.67
	pH water	pH	10.3	10	9.97
	pH CaCl2	pH	9.12	9.06	8.99
	Moisture	%	14.3	9.5	10.1
	TDS	mg/L		650	430
10-20cm	EC1:5	dS/m	0.84	0.93	0.79
	pH water	pH	9.74	9.9	9.83
	pH CaCl2	pH	8.83	8.89	8.75
	Moisture	%		15	16.9
	TDS	mg/L		600	500

Figure 24. Oct 2021 NDVI image showing 4.2ha lucerne sowing that suffered erosion on sandy rise



Tables 6 and 7 show a large difference in soil salinity between seep areas. Not surprisingly the levels are low where the crop is growing well, whereas the developing scald area has toxic salinity levels to 20cm depth. pH levels are not problematic at present at this site.

This site should continue to be managed and monitored through to its full site restoration in coming years, to show that early action can lead to full site recovery, without becoming a significant scald. It is expected the farmer will repair the blown sandhill this season and in future will be able to inter-sow cereal through the lucerne completely over the affected area.

4.5 Site 5. Weiss Farm, Rudall

4.5.1 Purpose

This site aims to test whether a newly formed and rapidly spreading, large mallee seep scald can be quickly restored using a lucerne strip to surround the scald to lower the perched water table. The establishment of the salt tolerant puccinellia grass over the scald to regenerate the topsoil in preparation for possible returning to cropping in time is key to this sites' restoration.

4.5.2 Background and site assessment

The site has grown from a small waterlogged patch evident in 2013 (Figure 26) to a white bare scald area of 0.7ha in 2020 that significantly impacting the crop performance of 3-4ha (Figure 27) with the degradation is rapidly spreading in a north west direction (Figure 28). The deep sandy top half of the paddock has achieved very little crop growth through multiple seasons and is identified as the main localised recharge area contributing the excess water into the seep system. This was greatly exacerbated in the wet year of 2016.

Piezometers have been set up at both the southern top end (Photo 29) and the northern bottom end of the scald. The water table at the bottom end piezometer initially was at 50cm depth with a salinity level of 3.6dS/m (2200ppm). The top end piezometer originally showed the perched water table at 28cm with a salinity of 2.7dS/m (1600ppm). A soil moisture probe was also placed at the top end to assess the impacts of capillary rise bringing salt to the surface. Initial soil testing revealed surface EC1:5 level of 0.5-0.6 dS/m (Tables 8 & 9) which is a medium salinity level.

The fact that this site has formed relatively recently, has low water salinity levels and medium surface soil salinity means that there are good prospects for full rehabilitation back to cropping. This will require stopping flow of excess water into the area from the sandy rise and the initial establishment of living soil cover on the bare scalded land to bring it back to health.

Photo 29. Wiess Scald June 2021 prior to hand seeding puccinellia

Figure 25. Nov 2013 Google Earth Image showing small waterlogged area developing

Figure 26. NDVI showing scald development Feb 2017 after wet, through to Sept 2019

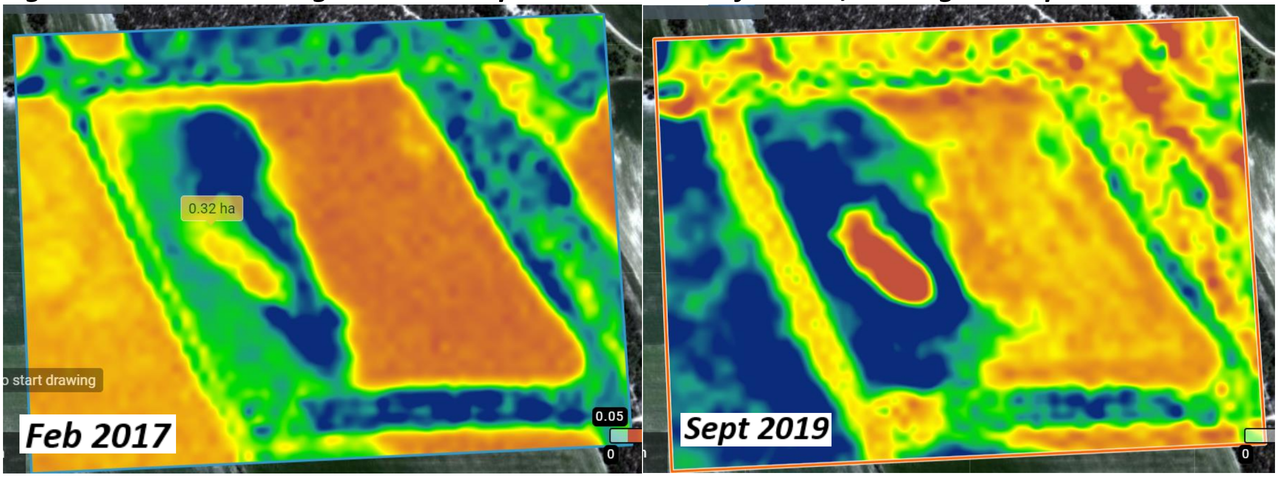
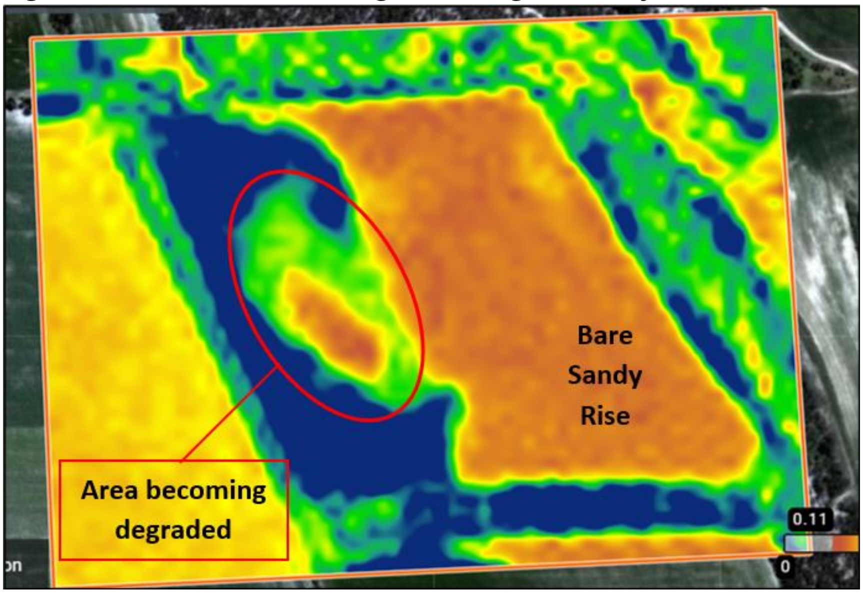


Figure 27 Satellite NDVI image showing extent of bare scald and crop affected on 9th Oct 2020



4.5.3 Treatments

The plan for this site was to firstly to establish a 20-40m strip of lucerne immediately around the scalded site to both intercept and utilise the water entering the perched water table on the eastern side, as well as stop the spread of the of the water table on the western and northern sides of the scald. This will lower the water table and possibly dry it out completely. It is possible that the farmer may establish lucerne on the whole sandy top half of the paddock. This will lead to a faster impact of drying out the perched water table, and a faster rehabilitation of the site.

Secondly, puccinellia (salt tolerant perennial pasture) was to be established on the scald to cover the soil and stop the slightly saline water rising and accumulating in the surface. It is expected that as the water table is lowered or dried out, the topsoil of the scald will improve and within a few years be able to return to cropping. The lucerne strip on the high side of the seep area will need to be maintained to continuously stop the flow of recharge water. It can still be cropped through, grazed or cut for hay to maintain some production.

4.5.4 Ongoing Monitoring, Results and Recommendations

Lucerne was sown around the scald area in 2021 and gained a reasonable germination in a poor season opening. However, there was also very strong competition from ryegrass which choked out most lucerne plants on the higher eastern side of the scald. Further lucerne re-establishment is required in 2022 if site rehabilitation is to be successful.

While it was planned that bagged puccinellia would be sown on the site, seed was unexpectedly unavailable in 2021. However, the site manager had hand cut some seed stalks earlier in the year at Karoonda, and brought numerous stuffed bags with him to the site in mid-June. The farmer roughened up the scalded surface just prior to an opportunistic rain. The seed was thrown out in windy conditions while walking in lines back and forth across the site (Photo 30). The site was driven across in multiple directions to press some seed in (without getting bogged in the process).

This crude seeding method proved to be remarkable successful, resulting in excellent puccinellia germination which continued to thicken up and cover the ground over the summer (Photos 31-32).

Photo 30. Spreading puccinellia seed and stalks over the scald in June 2021.

Photo 31. Evidence of puccinellia germinating in Sept 2021

Photo 32. Strong puccinellia establishment achieved across site by Dec 2021.

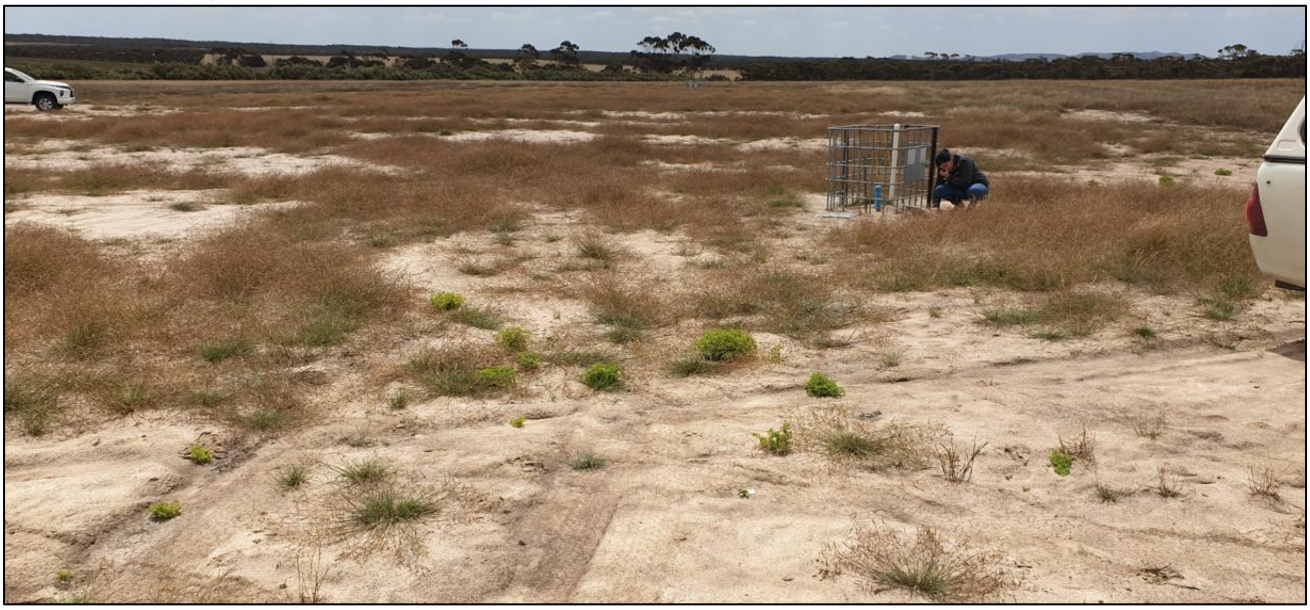


Photo 33. Good lucerne establishment on western side of scald area.

Table 8. Soil test results over time at the Southern top end of the scald area.

Depth	Test	Units	Sep-20	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	0.53	0.59	0.61	0.66
	pH water	pH	10.2	10.4	10.4	10.3
	pH CaCl2	pH	9.32	9.33	9.47	9.47
	Moisture	%		10.5	12.7	7.5
	TDS	mg/L			390	420
10-20cm	EC1:5	dS/m		0.28	0.36	0.17
	pH water	pH		10.2	10.3	10
	pH CaCl2	pH		9.22	9.28	9.18
	Moisture	%			11.9	12.3
	TDS	mg/L			230	110

Table 9. Soil test results over time at the Northern bottom end of the scald.

Depth	Test	Units	Sep-20	Mar-21	Jun-21	Sep-21
0-10cm	EC1:5	dS/m	0.58	1.3	0.5	0.42
	pH water	pH	10.4	10.5	10.4	10.3
	pH CaCl2	pH	9.32	9.38	9.32	9.36
	Moisture	%		11.4	12.8	4.4
	TDS	mg/L			320	270
10-20cm	EC1:5	dS/m	0.55	0.25	0.25	0.17
	pH water	pH	9.89	10.1	10.1	10
	pH CaCl2	pH	8.81	9.21	9.12	9.18
	Moisture	%			13	12.3
	TDS	mg/L			160	110

Soil test results (Tables 8-9) did show a spike in topsoil salinity in March at northern end, which is to be expected as capillary rise and evaporation concentrates salt in the surface in the summer heat. This is why it is often better of establish puccinellia in the growing season after rainfall has leached surface salt into lower layers. It is pleasing to see that generally the 10-20cm layer has relatively low salinity levels across the scald, giving excellent prospects for site rehabilitation.

Graphs from the piezometers (Figures 28, 29 & 30) show that when 30mm of rain falls it is enough to raise perched water table levels by 50-75cm at this site, and had led to surface ponding, particularly at the northern end. This suggests that until the lucerne is established there is unlikely to be a lasting reduction in the water table and the scald area will continue to increase. However, if successful, a significant lasting reduction or complete drying out should take place. Once the water table is dried up or lower than 180cm and the topsoil salinity reduces to around 0.2-0.3 dS/m, then re-cropping this site may be attempted.

The moisture probe readings (with sensors every 20cm to 1m, Figure 31) have generally shown little change at depth due to the closeness of the watertable and soil saturation. The 20cm and 40cm sensors have shown response to rainfall events. This probe will be interesting once the water table is lowered and the effects of capillary rise or puccinellia protective impacts can be observed.

Figure 28. Top End South Piezometer results Sept, 2020-Sept 2021

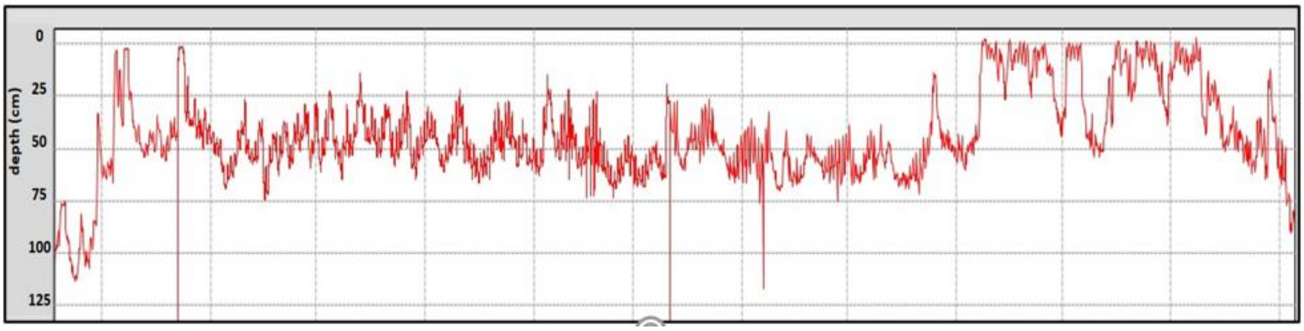


Figure 29. Bottom End Northern Piezometer results, Sept 2020-Sept 2021

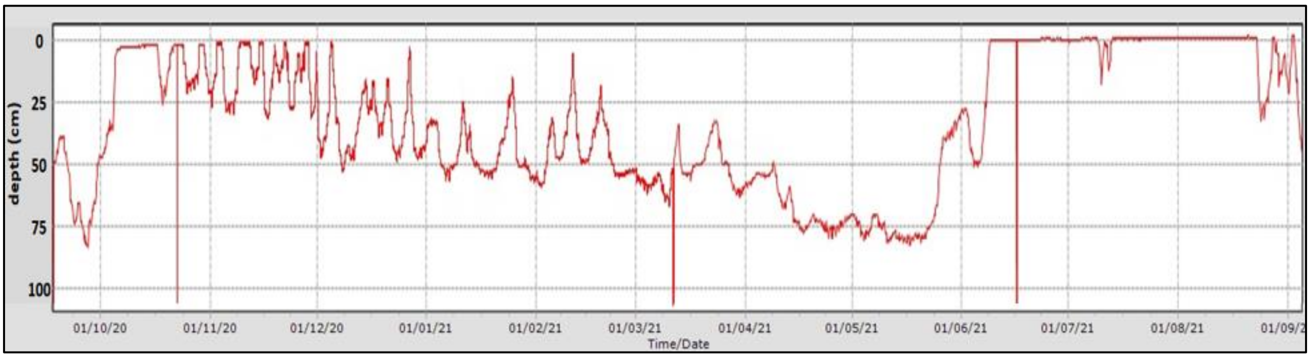


Figure 30. Weiss site rainfall, Sept 2020-Sept 2021

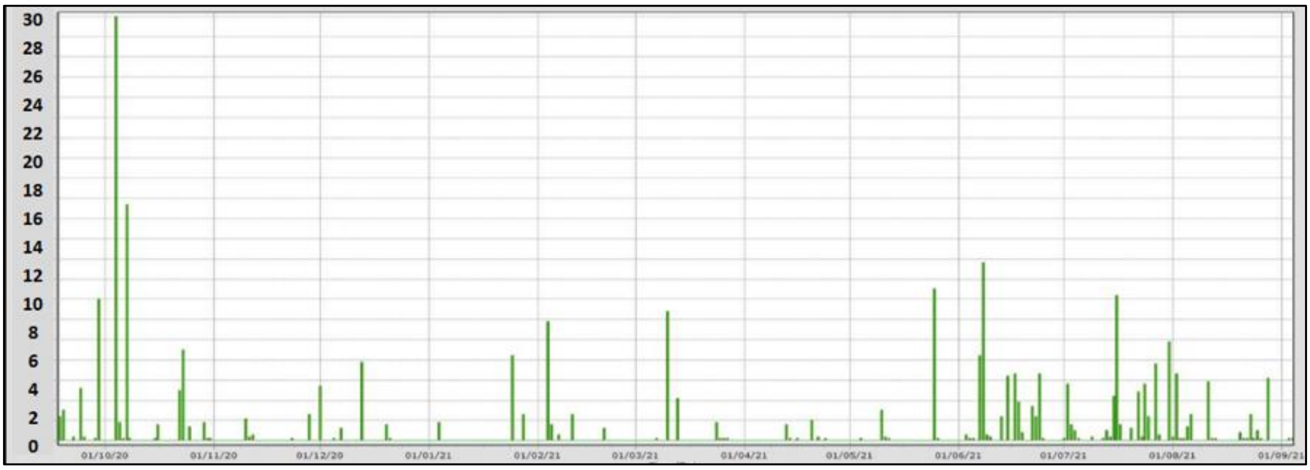
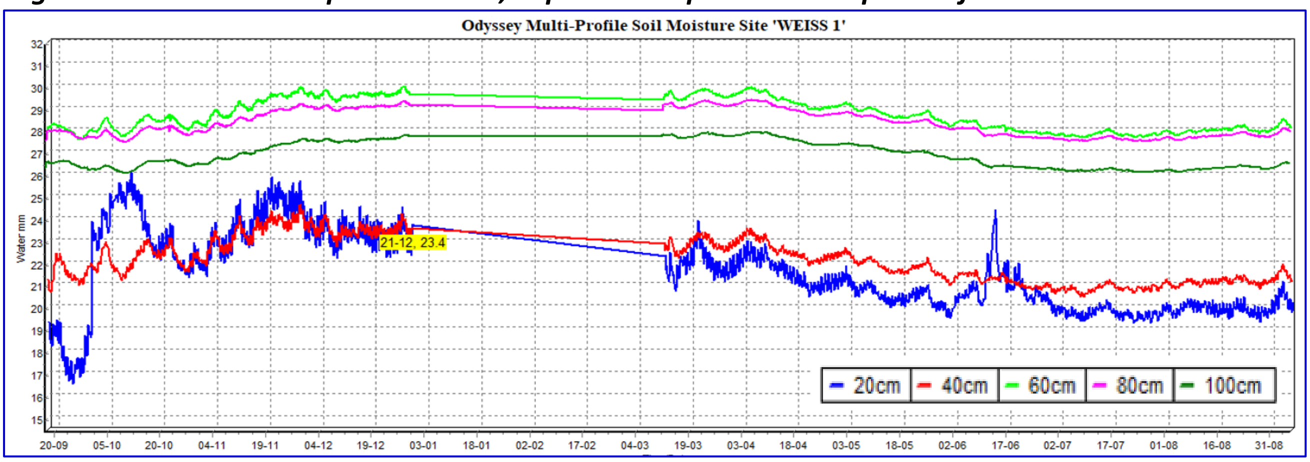


Figure 31. Soil moisture probe results, Sept 2020-Sept 2021 at Top End of Scald



4.6 Site 6. Franklin Farm, Cowell

"Early identification and management of seep to maintain excellent cropping land"

4.6.1 Purpose

The final sites are at Tim Franklin's property north of Cowell. They represent very early-stage Mallee Seeps that are still in the stage of growing an excellent wheat crop with no detrimental crop effects occurring at present. These sites are vital in demonstrating how the early identification (through farmer accessible satellite technology) and strategic management can be applied to prevent a Mallee Seep from causing land degradation in the short or long term. It also addresses the importance of monitoring these early very sites through a season so not to rush into any remedial action that may prove unnecessary or ineffective.

Photo 34. Excellent wheat growth directly above perched water table with piezometer

4.6.2 Background and site assessment

The first Site 6a (Photo 34) was initially discovered though a related project exploring the use of NDVI satellite imaging to identify potential seep developments. While ground truthing various potential sites on the property, it was discovered that most areas of concern involved streamline salinity that was highly saline and needing earthworks to move the water on and out to sea as efficiently as possible. However, there were a few areas the farmer identified as being waterlogged at times in the middle of paddocks below sandy rises. Some test holes were dug, with a piezometer placed at one site where a very fresh perched water table was found at 60cm depth.

While this Site 6a is clearly benefitting from increased water availability through the dry season producing excellent crop growth, it is possible that this area could become too waterlogged for crop growth, begin to bare out and increase in surface salinity and land degradation in the next 5 years if nothing is done. Another Site 6b that was closer to the highway was found to have subsoil layers of moist clay, but not as saturated as the site where the piezometer was initially placed.

4.6.3 Treatments

It was initially decided that the best way manage Site 6a was to reduce the water table by establishing approximately 1ha of lucerne at and around the immediate perched water table zone as identified by the NDVI imagery (Figures 33). The lucerne would begin to fully utilise the excess water entering the area and stop the adverse impacts of topsoil salinisation by providing deep rooted living soil cover all year round. This is vital over the hot summer months when evaporation and capillary rise from the shallow water table can quickly bring salt to accumulate in the surface soil. Soil water being constantly utilised within the rootzone means that the salt will not get the opportunity to rise to the surface.

However, on further inspection of the site in December 2021 it was found that the perched water table had dried after the seasons cropping, suggesting that it has more of a transient nature. Given that the site is currently growing good crops and that there appeared to be no water table present, it was decided that for now the site should be monitored and assessed for longer, before committing to a lucerne strategy.

A second site was then investigated where there was still a sloppy clay layer and relatively fresh water evident at 80cm. A piezometer was established at this site (without a data logger) and the possibility of growing a strategic patch of lucerne here was discussed. This site will continue to be manually monitored for water height and quality leading up to seeding time before any proactive management strategies are decided on.

Figures 32, 33 & 34 show how the site can be identified using google earth, Satellite NDVI and Satellite Moisture Band imagery which is accessible to farmers. This technology will be further researched and developed to assess and improve its application for farmer use.

4.6.4 Ongoing Monitoring, Results and Recommendations

The success of this sites' management strategy will be assessed through monitoring the reduction in the perched water table through a datalogger that has not been placed within the piezometer. If crop and soil health are able to be maintained over a variety of coming seasons through observation and sampling, this will also be a key indicator of successful management.

The impacts of the large January 2022 rainfall may be critical in deciding whether the lucerne strategy may still be required to protect these sites.

Photo 35. Excellent wheat growth at site looking northwest toward sandy rise

Photo 36. Site 6a monitoring finding perched water table dried out in Dec 2021.

Photo 37. Site 6b piezometer establishment at sandhill base, Dec 2021.

Figure 32. Google Earth image of site showing piezometer location and proposed lucerne area

Figure 33. NDVI Satellite image for 5th Nov 2021 with proposed lucerne establishment area

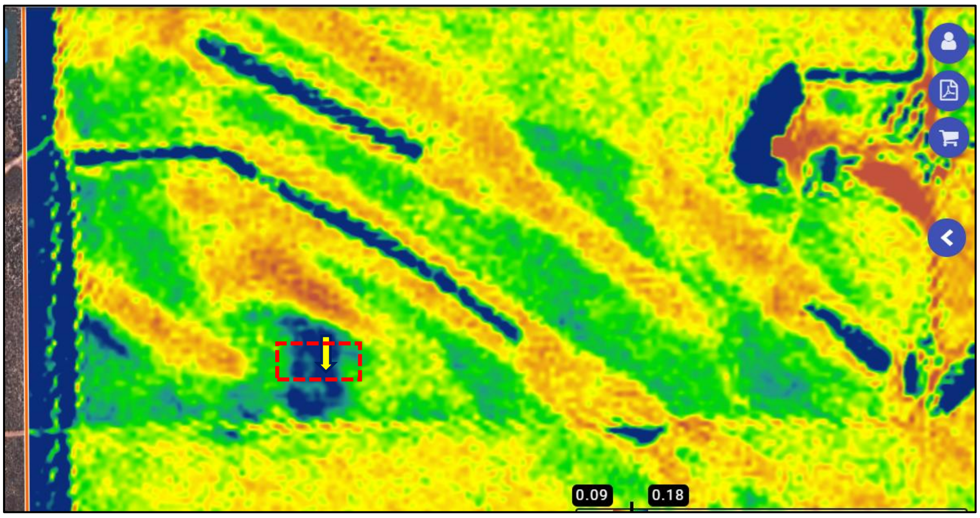


Figure 34. Sentinel 2 Moisture Stress Image, Nov 2021

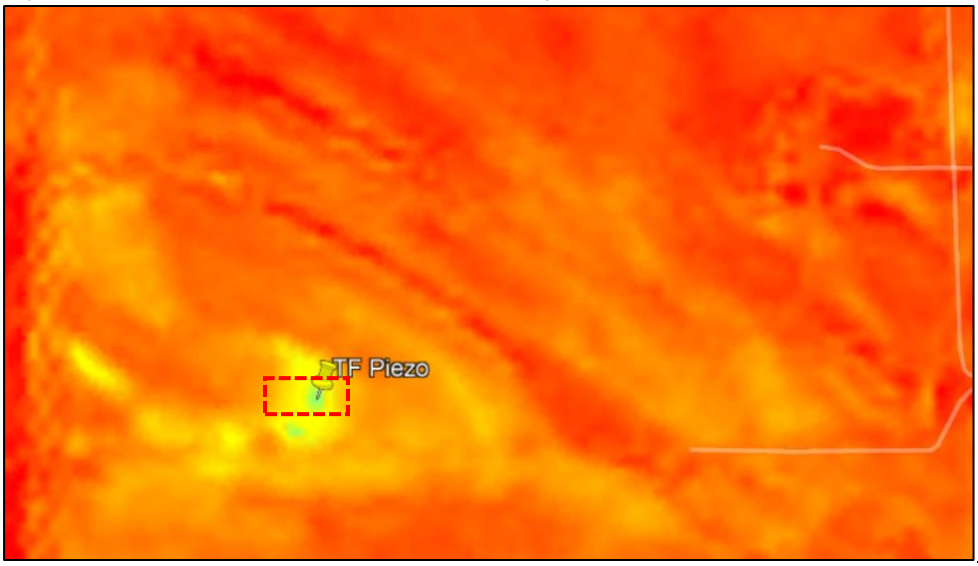
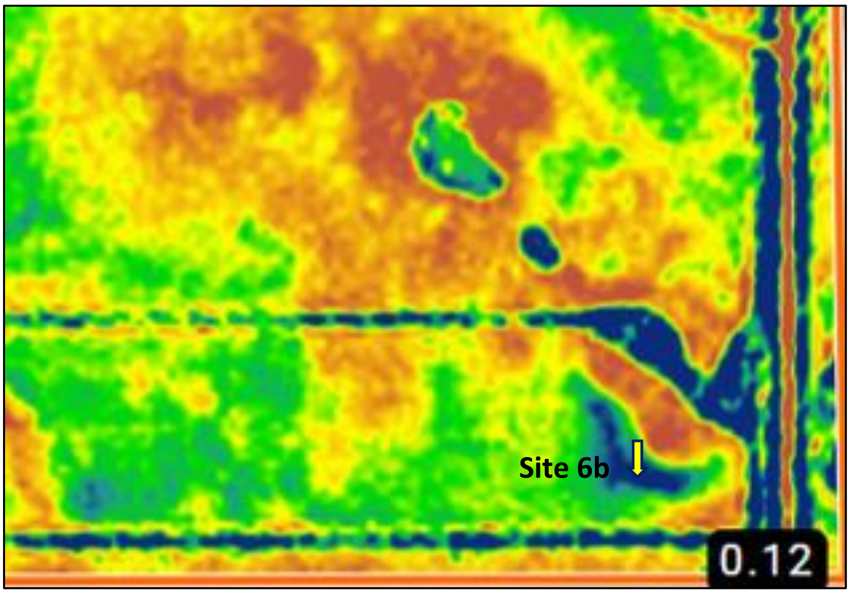


Figure 35. Google Earth image of Site 6b.

Figure 36. Site 6a NDVI image, 1st Nov 2017



5 Summary

This project has successful established six Mallee Seep rehabilitation demonstration sites across key regions within the Eyre Peninsula. While basic approaches using salt tolerant pastures and target higher water use lucerne strategies are often engaged, each site has been quite unique in landscape soils and dynamics, stages of development and farming systems, which is greatly increasing our understanding of effective Mallee Seep management recommendations for the Eyre Peninsula.

While all sites are showing positive outcomes, it is vital that each project is managed and monitored through coming years to gain the full benefits of the management strategies that are just entering the stages of lowering water tables and restoring degraded scalds.

A further report is planned at the conclusion of this project that will give more details of all monitoring outcomes, particularly in light of the exceptional summer rainfall events across the region. This rainfall is expected to trigger a significant increase in seep sites over the coming years.