Appendix D

CSU Report

Report to Edify Energy on the proposed solar voltaic farm at Darlington Point.

Effects of solar voltaic farm installation and operation on Riverine Plain Grasslands

Authors

Dr Jeff McCormick BScAgr Hons (Syd), PhD (CSU).
Lecturer in Agronomy, Charles Sturt University.

Dr Peter Orchard BScAgr Hons (Nottingham), MScAg (UNE), PhD (UNE). Adjunct Senior Lecturer and Visiting Scientist Graham Centre for Agricultural Innovation, Charles Sturt University.

Date 11/4/2018

Author biography

Dr Jeff McCormick
Dr McCormick has lectured at Charles Sturt University since 2016 in pastures and rangelands as well as weed and pesticide science. In 2012, Dr McCormick moved to New Zealand and taught plant science at Lincoln University. Prior to that he worked at NSW DPI on pasture establishment in the mixed farming zone as part of the EverCrop program funded by Future Farm Industries CRC.

Dr Peter Orchard
Since 2013 Dr Orchard has been a member of the Graham Centre for Agricultural Innovation an alliance between CSU and NSW DPI where he conducts research into pastures and landscape biodiversity. Dr Peter Orchard was formerly with NSW DPI (1987-2013). At retirement (June 2013) he held the position of State-wide Manager Pasture and Rangelands Research and Extension.

Dr Jeff McCormick

Dr Peter Orchard

Executive summary

Charles Sturt University (CSU) were appointed by Edify Energy to provide specialist input into the impact assessment and proposed site management of Riverine plains grasslands for the Darlington Point Solar Farm (DPSF) project.

Management recommendations have been developed in relation to the three aims given in the Management Strategy section regarding maintenance of grassland diversity, habitat value (structure and ground cover) and fire risk.

The report, based on observations of the site together with the available scientific literature, concludes that the overall impacts of the photovoltaic solar (PV) array on grassland species diversity, habitat values and fire fuel load for the site would not be significant and in certain aspects such as weed management potentially highly positive.

Given the dynamic nature of biological systems, monitoring will be essential and an adaptive management approach implemented based on, and responsive to, seasonal/annual conditions. This will be critical during the early stages when the solar plant has been set up and the grassland is re-establishing.

There will be a need from the site development phase onwards for a focus on monitoring annual exotic weeds numbers and the strategic imposition of interventions via grazing, mowing and possibly herbicides to maintain and improve the present condition.

Introduction and Scope

Charles Sturt University (CSU) were appointed by Edify Energy to provide specialist input into the impact assessment and proposed management of Riverine Plains Grasslands for the Darlington Point Solar Farm (DPSF) project. Common species found within the region include a range of native grasses, herbs and shrubs. Additionally, ingress of exotic grasses (mainly annual) and dicotyledonous weeds has occurred as a result of the 200 year history of pastoralism/grazing.

The scope of this study was to determine what impacts the construction and operation of a PV system would have on the Riverine Plain Grasslands diversity, persistence and structure. This included a determination of current botanical composition and dry matter and what effect changes in light availability and management practices would have on the grassland.

Methodology

The site proposed for the photovoltaic solar array at Darlington Point for Edify Energy was visually inspected by Dr Jeff McCormick and Dr Peter Orchard on November 24 and December 11, 2017.

Botanical Composition

Six (6) transects were taken across the Tubbo Station section and three (3) transects across the Anderson's block as shown in Figure 1. Transect locations were selected to broadly represent the grassland area of the site. Approximately 11 km of transects were conducted across the site. Botanical composition sample were taken every 100 m by ranking the greatest three species in order of dry matter using a modified dry-weight-rank method (t'Mannetje and Haydock 1963).

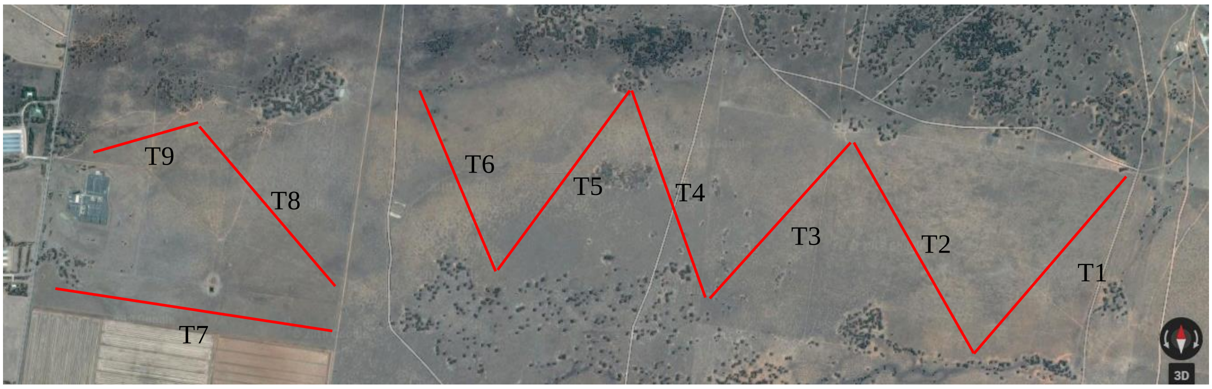

Figure 1. Darlington Point Solar Farm (DPSF) project site with approximate position of transects

Seed Bank Assessment

Twenty one surface soil samples were taken across the site on the transects to determine the seeds present in the soil. The samples were taken at approximately 2 cm depth using a 20 cm x 25 cm spade and placed in plastic bags. These were then transferred into plastic containers located in a glasshouse with air temperature kept at 22°C and regularly watered to ensure seed germination. Seedlings species were counted at regular intervals as they germinated and grew. The glasshouse temperature was selected to allow both winter and summer species to germinate.

Dry matter assessment

An assessment of grassland species composition by dry matter was undertaken during the 11 December site visit using the visual estimation method developed by Haydock and Shaw (1975) and commonly used with landholder extension programs (Prograze) to determine grazing management strategies. Whilst grazing management strategies usually focus on optimum grazing yields, the same techniques can also be applied to functional management strategies for habitat and fire management. A single large tussock of plains grass was cut at several heights to determine the vertical distribution of dry matter.

Current status of the site – visual observations

Site assessment and conditions

Riverine Plains Grassland dominates the solar farm site and are common in the riverlands of the Murrumbidgee. The majority of Riverine Plains Grassland in the region would have historically been used for grazing of sheep and/or cattle as has the proposed solar farm site. The site is typical for the region and reflects past seasonal conditions with greater growth following the 2016 growing period.

At the first visit the site on 24 November, the site was very dry with minimal green growth and only residual plant dry matter. Between the visits approximately 100 mm of rainfall fell resulting in increased growth from grasses observed on 11 December (Figure 2) with Plains grass (*Austrostipa aristiglumis)*, Wallaby grass *(Rytidosperma duttonianum*) Windmill grass (*Chloris truncata)* and Rigid panic (W*alwhalleya proluta)* particularly responding to the rainfall.

Figure 2. Field site at Darlington Point December 11, 2017 with noticeable green tinge following 100 mm of rainfall.

Biodiversity / botanical composition

A range of native and exotic grass and broad leaf species were identified across the site (Table 1). Old Plains grass seed heads approached 2 m in height and was reflective of the different season experienced in the region in 2016 where 686 mm of rainfall fell which was approximately 280 mm greater than average of

400mm. This year only 244 mm of rainfall had fallen during the normal growing season excluding the 100 mm experienced in December. The current reproductive growth of Plains grass still contained its seed and was 50 cm tall reflecting the season. Wallaby grass was present throughout the site. Seed heads were still obvious at a height of 20-30 cm although most seeds had been dispersed. Rigid panic was also present in some sites at high numbers but generally had already lost the seed head. Wild oats was the dominant exotic annual grass still standing but there were no seeds present in the heads. Some areas had high concentrations of vulpia and barley grass. Annual ryegrass appeared to be present in high numbers but was prostrate on the ground and was difficult to identify. Native herbs such as *Sida corrugata* and Chocolate lily were present on site but at low abundance. This may well be related to the current dryness at the site being not sufficient for continued growth of the species late in spring.

Table 1. Plant species identified at Andersons and Tubbo Station

Common name	Scientific name	Origin and growth habit
Plains grass	*Austrostipa aristiglumis*	*Native perennial*
Wallaby grass	*Rytidosperma duttonianum*	*Native perennial*
Rigid panic	*Walwhalleya proluta*	*Native perennial*
Annual ryegrass	*Lolium rigidum*	*Exotic annual*
Barley grass	*Hordeum leporinum*	*Exotic annual*
Vulpia	*Vulpia bromoides*	*Exotic annual*
Spear grass	*Austrostipa scabra*	*Native perennial*
Windmill grass	*Chloris truncata*	*Native annual*
Wild oats	*Avena fatua*	*Exotic annual*
Roly Poly	*Bassia divaricata*	*Native perennial*
Patersons curse	*Echium plantagineum*	*Exotic annual*
Corrugated Sida	*Sida corrugatus*	*Native perennial*
Chocolate lily	*Dichopogon strictus*	*Native perennial*
Cudweed	*Gnaphalium lueto-album*	*Exotic annual*
Silverleaf nightshade	*Solanum elaeagnifolium*	*Exotic annual*
Bathurst Burr	*Xanthium spinosum*	*Exotic annual*
Tussock Rush	*Juncus aridicola*	*Native perennial*
Lambs tails	*Ptilotus exaltatus*	*Native perennial*

The botanical composition determined by the dry rank method across nine transects across Tubbo and Anderson properties, are summarised in Table 2. The dominant species on site was Plains grass ranging from 42-70% of dry matter on the transects and averaged 56% over the entire site. Wallaby grass ranged from 4-40% and Rigid Panic was apparent on individual transects. These three native species contributed greater than 75% of the dry matter across each transect. Wild oats was the most obvious annual exotic species. It remained upright but had lost all of its seed. There were sporadic patches of barley grass through the site. Vulpia appeared prominently in the botanical composition as it remained standing but had lost its seed. It is thought that vulpia may be in much higher density but that much of it was on the ground. Annual ryegrass did not feature in the botanical composition but it was noted as lying on the ground. It was difficult to determine as it had begun to deteriorate.

Table 2. Botanical composition determined by the dry rank method across nine transects

	Botanical composition (%)								
	Tubbo Station						**Anderson's**		
Species Trans	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Plains grass	70	56	46	48	42	49	54	70	66
Wallaby grass	22	32	40	18	20	13	4	12	23
Rigid Panic				22	13	15	19		
Wild oats		1		11	14	11	17	15	9
Vulpia	7	2		2	12	3	5		
Speargrass		2	14						2
Barley grass		6							
Windmill								3	
Tussock Rush	2								

Dry matter present on site.

Dry matter was assessed on December 11, 2017 across the site using nine transects that were at similar locations to the botanical composition data (Figure 1). Site dry matter averaged 2878 kg/ha and ranged from 944-4052 kg/ha (Table 3). Tubbo Station (transect 1-6) and Andersons (transect 7-9) differed in the amount of dry matter. Differences between the properties can be easily related to historical grazing management with Tubbo Station appearing to have a low stocking rate of sheep whereas there was apparently a higher grazing intensity on the Anderson block with cattle. Cattle and sheep differ in grazing preferences with cattle likely to graze the stems of the plains grass and trample it. Sheep will generally avoid such material resulting in the larger dry matter of Plains grass on Tubbo Station. Minimum levels of dry matter were less than 500 kg/ha where ground cover was low. Highest points of dry matter were 9000 kg/ha in the densest Plains grass swards.

Table 3. Average dry matter across nine transects at Tubbo Station and Andersons block.

Transect	kg/ha
1	3991
2	2829
3	3768
4	3246
5	2655
6	3172
7	4052
8	1249
9	944
Average	2878

A single large tussock of plains grass was cut at several heights to determine the vertical distribution (where the percentage) of dry matter (Figure 3). Twenty nine percent (29%) of the total biomass was under 10 cm in height with a further 30% of dry matter between 10-30 cm.

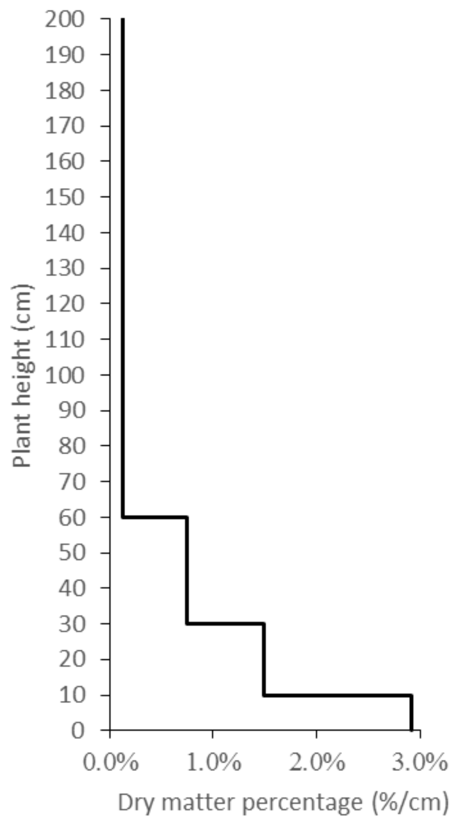

Figure 3. Percentage of dry matter in a single Plains grass tussock relative to height

Construction Phase Impacts

Persistence of perennial grasses

It is understood that during the construction period that the site would need to be mown but there would not be widespread grading of the site. Mowing at 10 cm is unlikely to effect the persistence of the perennial native grass species present as the new growing points in the grasses are below that level. Mowing will impact native shrubs within the grassland community but they will persist and regrow following the construction phase. If there are areas where shrubs are in high density then mowing could be done strategically to minimise impact.

High traffic over the site during construction is another risk with potential to impact on the persistence of the grassland. Vehicle traffic over the site could cause some damage to the grassland but it is likely that these will be able to recover. Management strategies could be implemented to reduce the risk to the grassland community such as only allowing construction to occur when soil conditions are dry. Even if there is some plant death the seed bank (see below) will enable grassland to recover quickly with sufficient seasonal conditions. There will be little impact on the annual species as these will have set seed and be senescing in late spring. Mowing in late summer after all native species have set seed will minimize the effect on persistence.

Seed bank assessment

The 21 soil samples were assessed over a period of four months and an average of 441 plants/m^2 emerged. Monocotyledon species (Poaceae and Juncaceae families) were the primary vegetation type with 89% of all species from the seed bank. Individually, the most common species was Annual ryegrass (56%), followed by Windmill grass (17%) and Juncus spp. (14%). For the native grass species present Rigid panic (17 plants/m^2) and Wallaby grass (3 plants/m^2) were the most common. Wild oats emerged with only 1 plant/m^2 but this is presumably due to a chemical seed dormancy still present after maturity. Dicotyledonous species were lower in number and included: Cut-leaf medic (*Medicago laciniata*, 14 plants/m^2) Caustic creeper (*Euphorbia drummondii*, 9 plants/m^2), Haresfoot clover (*Trifolium arvense*, 3 plants/m^2), Woolly clover (*Trifolium tomentosum* 2 plants/m^2), Sowthistle (*Sonchus oleraceus*, 2 plants/m^2), Paterson's curse (*Echium plantagineum* 1 plant/m^2), Narrow-leaf clover (*Trifolium angustifolium* 1plant/m^2), *Sida spp*. 1 plant/m^2. It would be expected that over time other broadleaf species would continue to emerge but they often have specific seed dormancy regimes.

The key conclusion from the seed bank assessment is that under current management practices (sheep grazing) there is an abundance of species within the soil seed bank (Figure 4). Of note is the dominance of annual ryegrass which competes vigorously with all other species within the community reducing diversity across the site. Management strategies to reduce the dominance of annual ryegrass and other exotic annual grass species have been identified below (see Physical impacts on the grassland community).

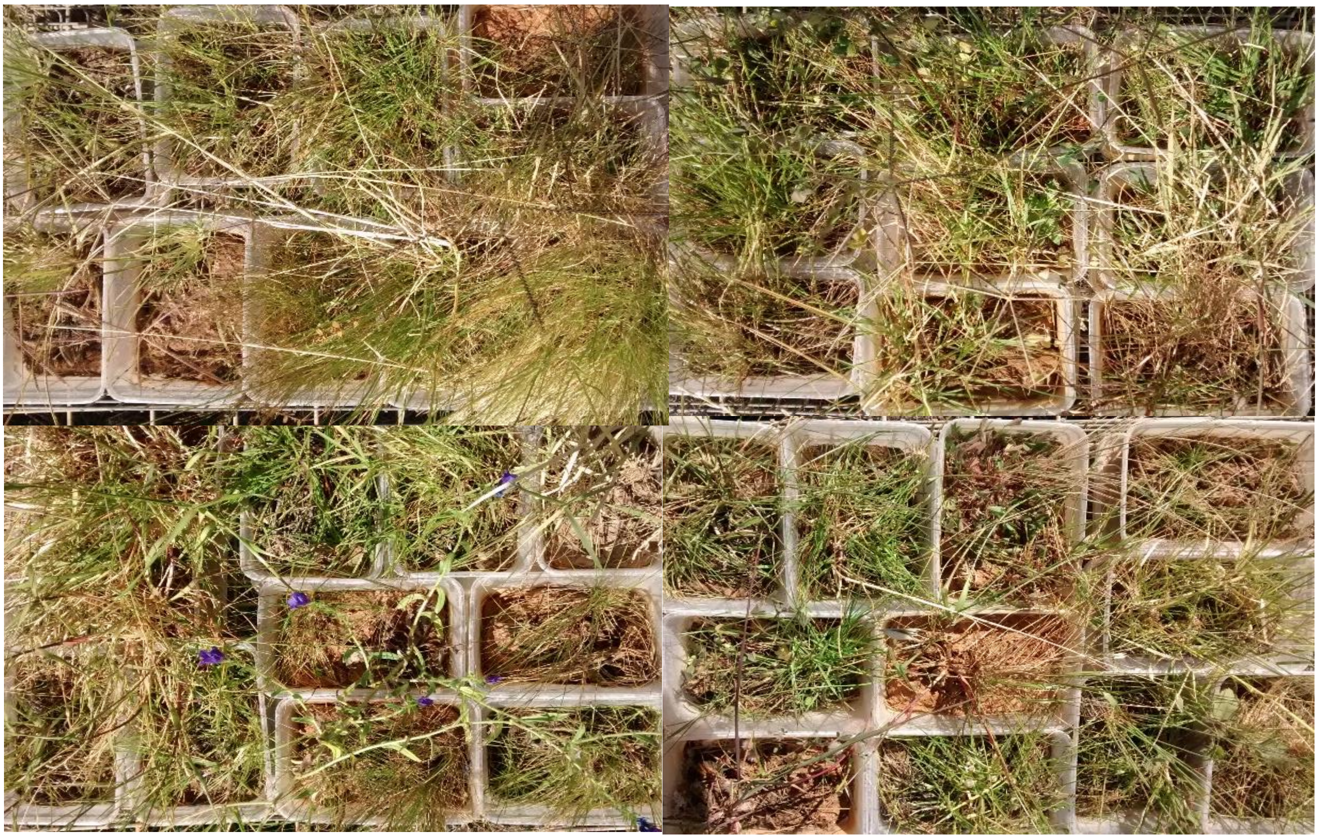

Figure 4. A snapshot of the seed bank assessment after four months.

Operational Phase Impacts

Biophysical constraints under a solar array.

Growth and development of grasslands like all plant species is primarily determined by soil water, temperature and light. The construction of a photovoltaic solar array will change the light conditions of the grassland but understanding the current limits to growth at Darlington Point is essential. Using a simple Growth Index model (Fitzpatick and Nix 1970) gives an indication to the growing conditions available at the site for all species within the Riverine Plain Grassland community. A low value indicates limitations to growth whereas a value of one denotes there are no limitations to growth. An index was calculated for light, soil water and temperature. These values were multiplied together to calculate a Growth Index. More complex crop growth models could have been used but they are not calibrated for the species present and the light calculations for growth do not have increased capacity to take shading into account. The site at Darlington Point has significant limitations on growth due to soil moisture throughout the year (Figure 5) but most particularly during the summer period. Low temperatures during the winter strongly reduce growth. In comparison (under normal circumstances) light is generally not the limiting factor for growth.

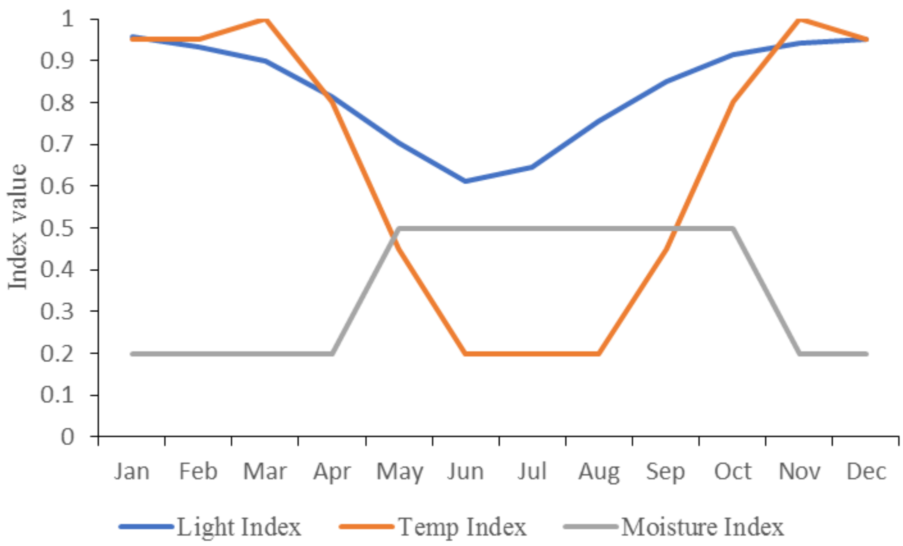

Figure 5. Indices for soil moisture, temperature and light at Darlington Point.

Light availability was determined by constructing shading diagrams for winter and summer at two hour periods from 8am to 4pm throughout the day at 0.5 m increments between solar panels to predict whether or not the grassland would be in shade (Figure 6).

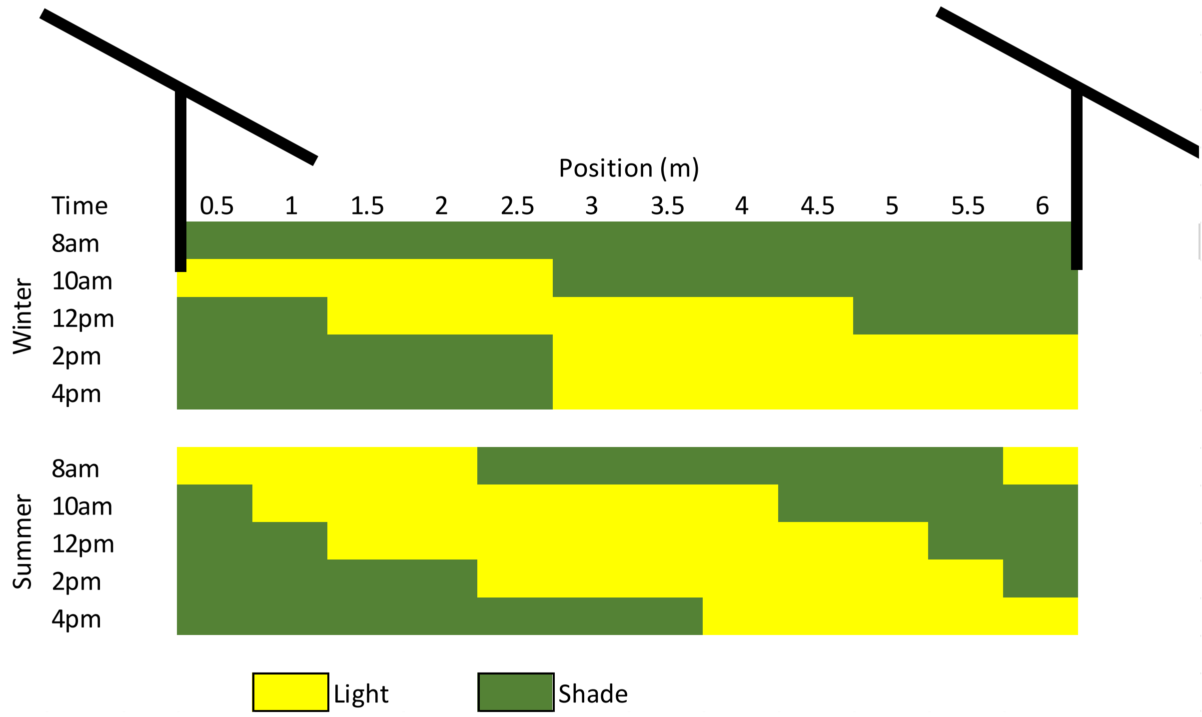

Figure 6. Shade diagram for photovoltaic solar array spaced 6 m apart. Pivoting panels placed 1.5 m above the ground and 2 m in width.

Light level was calculated by using minute solar radiation data from Wagga Wagga (Bureau of Meteorology) with shaded areas only accumulating diffuse radiation while sunlit areas accumulated total radiation (direct + diffuse radiation). This was accumulated over the day and calculated as a proportion of total radiation with the monthly average daily radiation reduced by the equivalent amount. This value was then used to calculate the light index as used by Fitzpatrick and Nix (1970).

Under the panels light was reduced across the year by 58 – 63% compared to a reduction in light between the panels across the year from 16-52%. This indicated that immediately below the panels there is still significant levels of light which will enable plant growth and development to occur. Incorporating these values into the Growth Index calculation indicated that grassland growth directly under the panels (i.e. Figure 5, position 0-1m; 5-6m) may be reduced by a maximum of 33% compared to an unshaded area, whilst between panels (i.e. Figure 5, 1-5 m) the growth may be reduced by 13%. Growth is not limited as much as the reduction in light because it is only the most limiting resource in May (Figure 7). In every other month soil water or temperature are more limiting than light. The potential reduction in growth between the panels (< 500 kg/ha) is unlikely to be observable due to the limited difference and the large variation across the site.

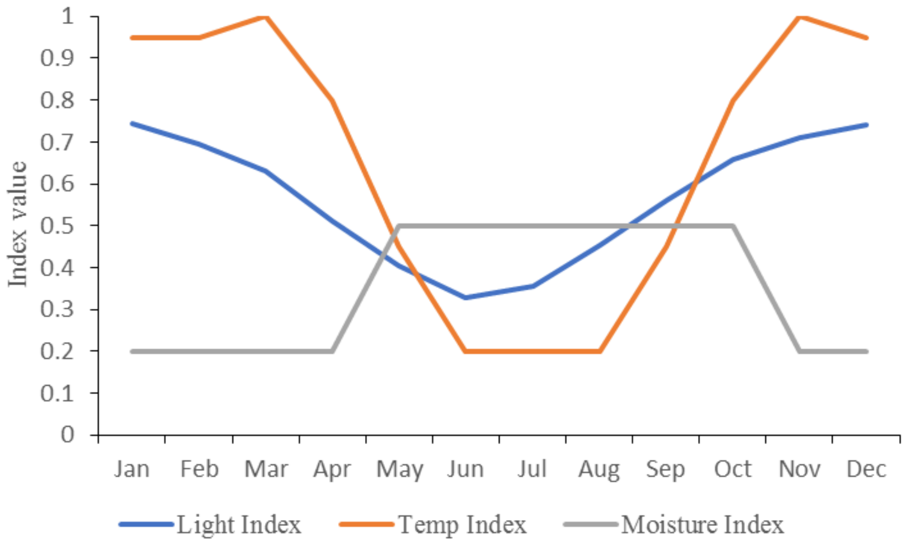

Figure 7. Indices for soil moisture, temperature and light at Darlington Point directly under the PV panels

Shaded conditions may in fact benefit some dicotyledonous species with planophile leaves as a horizontal leaf is more effective in utilising light in a lower light conditions although there is no specific information on most native species in the Riverina Plains Grassland. Shading will have some effect on plant morphology and likely to cause a degree of etiolation due to natural internal changes within the plants. No studies are available to predict these changes in terms of botanical composition although annuals are likely to be more affected as greatest impact will occur in lower light conditions of winter-early spring when they are more actively growing. The tendency to increase elongation and change leaf-stem ratios will be to potentially increase accessibility and digestibility of these species to stock and hence allow more effective grazing control in late winter-early spring. This simple model does not have the ability to deal with changes in leaf morphology under shaded conditions and it is well documented that leaf/stem morphology adapts to lower light conditions. Reductions in growth to decreased light are not simply linear and plants compensation/adaptation for lower light conditions will limit growth impacts.

The changes in soil moisture under photovoltaic panels are impossible to predict as it depends on the angle of the panel and direction of the rainfall at each event. The soil type at the site is commonly used for irrigation around the district. One of the features of the soil is the ability for water to move laterally both at surface and subsurface levels. Thus, it is unlikely that the photovoltaic panels will create marked changes in soil moisture.

Temperature is likely to be reduced under the photovoltaic panels due to a reduced load of solar radiation. In winter growth may be reduced due to average lower temperatures but in spring growth may be increased as the evaporative demand would be reduced allowing more efficient use of soil moisture. This combination of effects is likely to have a greater effect on exotic annuals than the native perennials.

The predicted growth index comparison between an unshaded area versus directly under the panels is shown in Figure 8.

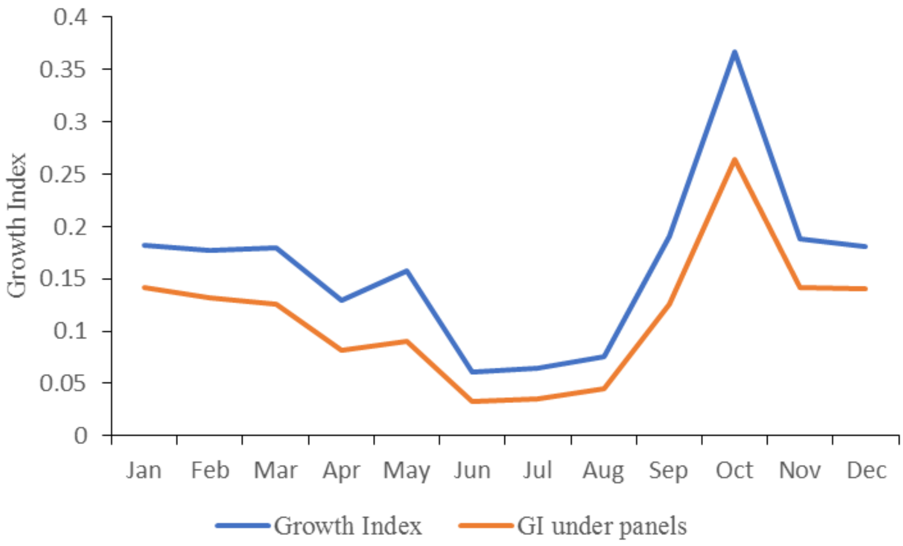

Figure 8. Comparison of predicted growth index between an unshaded area versus directly under the panels.

Physical impacts on the grassland community

During the operational phase there will be ongoing management of the solar voltaic farm of both the assets (solar panels) and the grasslands.

The management of assets will include monitoring and inspections during day to day operations with periods of maintenance if required. Most monitoring of the photovoltaic panels can be conducted remotely either by computer systems and/or drones. Vehicle inspections will primarily be conducted within the formed roads within the site. Inspection or maintenance of the panels will primarily be conducted on foot as it is impractical to move vehicles between the rows of solar panels. Intensity of traffic across the site will not increase compared to current management practices of an extensive grazing property. Therefore the grassland community will not be affected by the asset management during the operational phase.

During the operational phase of the site a grassland management strategy will need to be implemented. The primary aims of this strategy would be:

- To enhance native species within the pastures (diversity and abundance)
- Provide sufficient structure within native grasses for habitat
- Reduce fuel load during the fire danger season.

The primary management tools to achieve the aims of the management strategy will focus on grazing and mowing that will reduce potential fuel load but that they will occur at times that are advantageous to the native perennials while inhibiting the exotic annuals. To achieve the aims of the management strategy with the tools available the following management strategy is suggested:

- **During winter graze sheep/mow**. Primarily this will reduce the level of dry matter from annual growing species for summer fire hazard. The annuals will tend to have a greater palatability/digestibility than the natives at this stage and be preferentially grazed.

- **Remove sheep/mow mid August.** This will allow annual grass seed heads to emerge evenly.
- **Mow to 5-10 cm mid September/October when annual grasses flowering**. This will prevent seed set of exotic annual species enhancing native abundance as well as reducing combustible load.
- **Destock/low stocking rate over summer.** Enhance seed set of perennial native species.
- **Only mow/graze during fire season if grassland growth will result in average dry matter exceeding 5000 kg/ha DM.** This value was taken from the Murrumbidgee Irrigation Area Bush Fire Management Committee in regards to Asset Protection Zone (APZ) fuel load in forested areas, in the absence of a defined fuel load for grassland in the RFS guidelines.

Note that the above management actions may vary slightly over years and that observations on the physiological/phenological state of the annuals will be required to give more precise/effective control via an adaptive management approach. Bathurst Burr and Silver leaf nightshade have been identified on the site and will require monitoring in the future. Integrated Weed Strategies would need to be implemented for these weeds. If broad acre spraying was required i.e. infestations were large, most suitable herbicides would impact native broadleaf plants in the grasslands.

It is likely that there will be no change in species diversity or that abundance will be reduced under the panels due to changes in the light conditions, irregular light traffic or following the annual management strategy. It is clear that grass within the Riverine Plain Grassland community will not be affected if management is implemented according to the suggested strategy. This is because management actions such as mowing will occur at a time when exotic annual grasses are reproductive whereas the perennial native grass species will still be in a vegetative stage. Currently the annual exotic grass species are the most competitive species within the grassland which limits native abundance. Reducing abundance of exotic annual grasses will enhance native grass and forb abundance. Changes in grassland botanical composition have previously been demonstrated for wallaby grass and wiregrass grasslands in northern NSW (Lodge and Whalley 1985) and redgrass grass based grasslands in central NSW (Thapa *et al.* 2011). Both of these examples focussed management strategies on the flowering and recruitment period of the species to ensure that the desired species had an advantage over the undesirable species. As for other species in the grassland community a complete list of non-grass species was compiled and species were analysed for growth habit, timing of flowering and predicted effects of site establishment and annual operations on individual species (Appendix 1). It is expected most native forbs within the grassland community will be unaffected by the annual management plan as either they are lower than 10 cm in height and/or flowering will occur after the exotic annual grasses. Annual forbs are also indeterminate in that if some flowers were to be lost the plant will be able to regrow reproductive structures as compared to grass which are determinant and therefore do not have the ability to regrow reproductive structures. This will enhance native forb abundance as they are short in height and sheep will be removed during the time of flowering. Annual mowing would be detrimental to shrubs across the site and therefore should not be conducted on shrubs. It is suggested that due to sporadic abundance of these species it would be possible to avoid them during a mowing operation. The only requirement for trimming would be if they were greater than 50 cm in height and began to interfere with the PV panels. Native grass and forb abundance will increase with the implementation of the suggested management strategy due to the selective pressure against exotic annual species whereas avoiding mowing shrubs will ensure persistence.

Structure of the grassland is an important concept for the functioning of the ecosystem for a range of species but it is poorly defined. There has been no documented benchmark for what height a grassland should be to provide sufficient structure. Plains grass is the tallest species present in the grassland and was observed to grow up to 2 m tall although growth in 2017 was limited to 0.5 m tall. Only 18% of dry matter was above 60 cm (Figure 3). In most seasons Plains grass will not reach 2 m in height due to seasonal conditions. Although growth under the PV panels has been estimated to be reduced by 33% it is unlikely the effect on the value of the structure of the grassland is linear i.e. for every decrease in growth results in an equal decrease in grassland structure value. Rather it is suggested that the response of structure value to decreasing growth is likely to be curvilinear so that although growth may be reduced by 30% the effect on the value of the grassland structure is likely to be decreased by less than 20%. The installation of PV panels and implementation management strategy will reduce the potential height of Plains grass but this species only represents 56% of species across the site as a percentage of available dry matter (Table 3). Other species are much shorter than the Plains Grass and are unlikely to be affected greatly.

Summary of effects of the installation and operation of a photovoltaic panels at Darlington Point

The construction phase of the PV is unlikely to have a significant effect on persistence of the Riverine Plain Grassland community due to construction being limited to heavy and light vehicle traffic and a significant source of seed available in the seed bank. Any disturbance that may be caused should be recovered within 12 months of an average season.

During the operation of the facility it has been assessed that growth under the panels is likely to be reduced by 33% but this is unlikely to have significant effects on diversity, abundance or ground cover of the native species. In fact implementing the suggested management strategy is likely to enhance the diversity, abundance and ground cover of the grassland as the management strategies will reduce the effect of exotic annual grasses that compete strongly against the native species. The component likely to be effected under the PV panels is the value of the grassland structure. This is unlikely to be a linear response to the reduced growth under the panels rather it is likely to be less than 20% although this is difficult to predict as there are no benchmarks on grassland structure.

Conclusion

Management recommendations have been developed in relation to the three aims given in the Management Strategy section. The authors recognise that site observations in mid-spring would have been beneficial in characterising the exotic annual grass components of the system.

However the report, based on observations of the site together with the available scientific literature, concludes that the overall impacts of the photovoltaic solar array on grassland diversity, habitat value and fire risk should be low and in certain aspects such as weed management potentially highly positive.

Given the dynamic nature of biological systems monitoring will be essential and an adaptive management approach implemented based on, and responsive to, seasonal/annual conditions. This will be critical during the early stages when the solar plant has been set up and the grassland is re-establishing.

There will be a need from the site development phase onwards for a focus on monitoring annual exotic weeds numbers and the strategic imposition of interventions via grazing, mowing and possibly herbicides to maintain and improve the present condition.

Appendix 1. Non-grass species description and effect of site establishment and management.

Data sourced from Cunningham et al (2015), Plants of Western NSW and PlantNET (The NSW Plant Information Network System).

Common Name	Scientific Name	Lifecycle	Growth habit	Flowering time	Site establishment impact?	Annual management impact?
Australian Bluebell	*Wahlenbergia stricta*	Perennial	Tall forb	Winter/Spring	None [#1]	Yes [#2]
Berry Saltbush	*Einadia hastata*	Perennial	Low lying shrub	February	None [#3]	None [#3]
Black Cotton Bush	*Maireana decalvans*	Perennial	Erect or spreading shrub	Summer	Yes [#4]	Yes [#5]
Black Rolypoly	*Sclerolaena muricata*	Short-lived perennial	Sub-shrub	All year	Yes [#4]	Yes [#5]
Blushing Bindweed	*Convolvulus erubescens*	Perennial	Creeping prostrate forb	Late spring/Early autumn	None [#3]	None [#3]
Chocolate Lily	*Dichopogon strictus*	Perennial	Tall forb	Spring-Early summer	None [#3]	None [#6]
Common Woodruff	*Asperula conferta*	Perennial	Small forb	Spring/Early summer	None [#3]	None [#6]
Corrugated Sida	*Sida corrugata*	Perennial	Prostrate forb	Spring/Summer	None [#3]	None [#6]
Creeping Saltbush	*Atriplex semibaccata*	Perennial	Prostrate shrub	Summer	None [#3]	None [#3]
Curious Saltbush	*Dissocarpus paradoxus*	Annual/Short lived perennial	Sub-shrub	Spring/Early summer	Yes [#4]	Yes [#5]
Lambs Tails	*Ptilotus exaltatus*	Perennial	Small forb	Spring-Summer	None [#3]	None [#6]
Leafless Bluebush	*Maireana aphylla*	Perennial	Shrub	Spring/Early summer	Yes [#4]	Yes [#5]
Nardoo	*Marsilea spp.*	Perennial	Prostrate fern	Spring -Autumn	None [#3]	None [#3]
Quena	*Solanum esuriale*	Perennial	Small forb	All year	None [#3]	None [#6]
Ridged sida	*Sida cunninghamii*	Perennial	Prostrate forb	Summer/Autumn	None [#3]	None [#3]
Ruby Saltbush	*Enchylaena tomentosa*	Perennial	Shrub	Spring-Early summer	Yes [#4]	Yes [#5]
Spiny-headed Mat-rush	*Lomandra longifolia*	Perennial	Rush	Spring-Early summer	None [#7]	None [#6]
Starwort	*Callitriche spp.*	Annual	Prostrate forb	Spring-Early summer	None [#3]	None [#3]
Swamp Dock	*Rumex brownii*	Perennial	Tall forb	Spring	None [#3]	None [#6]
Tarvine	*Boerhavia dominii*	Perennial	Prostrate forb	Summer/Autumn	None [#3]	None [#3]
Tussock Rush	*Juncus aridicola*	Perennial	Rush	Summer/Winter	None [#7]	None [#6]
Tussock Rush	*Juncus flavidus*	Perennial	Rush	Summer/Winter	None [#7]	None [#6]
Woolly New Holland Daisy	*Vittadinia gracilis*	Perennial	Small shrub	All year	Yes [#4]	Yes [#5]
Wooly Buttons	*Leiocarpa panaetioides*	Perennial	Sub-shrub	Spring-Autumn	Yes [#4]	Yes [#5]

[#1]Unlikely to be present during site establishment, [#2]Flowers at similar time to annual grasses. Should re-flower after mowing, [#3]Most of the plant will be below mower height, [#4]Shrub will regrow following mowing, [#5]Shrub can be avoided with annual management, [#6]Later flowering than annual grasses, [#7] Will regrow after mowing.

References

Cunningham, G. M., Mulham. W. E., Milthorpe, P. L., Leigh, J. H. (2015).Plants of Western NSW. CSIRO.

Fitzpatrick, E. A., Nix, H. A. (1970). Climatic factor in Australian grassland ecology. In Australian Grasslands. Editor Moore, R. M. Canberra, ACT: Australian National University. Chapter 1 pp 3-26

Haydock, K. P., Shaw, N. P. (1975). The comparative yield method for estimating dry matter yield of pasture. Australian Journal of Experimental Agriculture and Animal Husbandry 15(76) 663 – 670.

Keith, D. A. (2004). Ocean shores to desert dunes. The native vegetation of New South Wales and the ACT. Department of Environment and Conservation NSW.

Lodge, G. M., Whalley, R. D. B. (1985). The manipulation of species composition of natural pastures by grazing management on the northern slopes of New South Wales. The Australian Rangeland Journal 7(1) 6 – 16

PlantNET (The NSW Plant Information Network System). Royal Botanic Gardens and Domain Trust, Sydney. http://plantnet.rbgsyd.nsw.gov.au [accessed 6 April, 2018]

Thapa, R., Kemp, D. R., Michalk, D. L., Badgery, W. B., Simmons, A. T. (2011). Seedling recruitment of native perennial grasses within existing swards. Crop and Pasture Science, 62, 591-602.

t'Mannetje, L., Haydock, K. P. (1963). The dry-weight-rank method for the botanical analysis of pasture. Grass and Forage Science, 18, 268-275.