Livestock Grazing Management Plan

Gunsynd Solar Farm

21 November 2023

Prepared by:

Ecosite Solutions Pty Ltd

5 Cramsie Cres

Glen Innes NSW 2370

Document Control

Livestock Grazing Management Plan

Gunsynd Solar Farm

6 October 2023

Version V2			
Issued to:			
Sri Sahaarenghan Sri Renganathan - Project Manager, PCL Solar, PCL Constructors Pacific Rim Pty Ltd			
Prepared by:		**Reviewed by:**	**Approved by:**
Patric Millar Director, Ecosite Solutions Pty Ltd		Helen Barby-Millar Director, Ecosite Solutions Pty Ltd	Patric Millar, Director, Ecosite Solutions Pty Ltd
Previous versions:			
Version:	1	04/10/2023	Issued for internal review
	2	06/10/2023	Issued to PCL
	3	26/10/2023	Final Version Issued to PCL
	4	27/10/2023	Updated Final Version Issued to PCL
	5	21/11/2023	Updated Final Version Issued to PCL

Copyright

Disclaimer

The information contained in this report is based on sources believed to be reliable. Ecosite Solutions Pty Ltd, together with its members and employees accepts no responsibility for the results of incautious actions taken as a result of information contained herein and any damage or loss, howsoever caused, suffered by any individual or corporation.

The findings and opinions in this report are based on research undertaken by Patric Millar BSc, ME, Dip Man, Dip SIS, Certified Environmental Practitioner, Certified Professional in Erosion and Sediment Control, MEIANZ, MEICA, ARLF, of Ecosite Solutions Pty Ltd, independent consultants, and do not purport to be those of the client.

Contents

Tables

Figures

Abbreviations

AC	alternating current
AS	Australian Standard
Biosecurity Act	Biosecurity Act 2014
Biosecurity Regulation	Biosecurity Regulation 2016
BoP	balance of plant
CoC	condition of consent
DES	Department of Environment and Science
DN	decision notice
Echo Consultants	Echo Consultants Pty Ltd
EP Act	Environmental Protection Act 1994
EPC	engineering, procurement and construction
EPP (Water and Wetland Biodiversity)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
EP Regulation	Environmental Protection Regulation 2019
ERA	environmentally relevant activity
ESCP	Erosion and Sediment Control Plan
GBO	General Biosecurity Obligation
GED	General Environmental Duty
GRC	Goondiwindi Regional Council
Goondiwindi Region PS	Goondiwindi Region Planning Scheme
Gunsynd SF	Gunsynd Solar Farm
km	kilometre
kV	kilovolt
Metis Energy	Metis Energy Ltd
MW	megawatts
NEM	National Electricity Market
O&M	operations and maintenance
PCL	PCL Constructors Pacific Rim Pty Ltd
PD Act	Plumbing and Drainage Act 2018
Redleaf Environmental	Redleaf Environmental Pty Ltd
SDS	safety data sheet (for chemical use)
Site EMP	Site Environmental Management Plan
WMMP	Waste Minimisation and Management Plan
WPMP	Weed and Pest Management Plan
WRR Act	Waste Reduction and Recycling Act 2011
WRR Regulation	Waste Reduction and Recycling Regulation 2011
WTC	waste tracking certificate

1 Introduction

The Gunsynd Solar Farm (Gunsynd SF) project is a solar farm in southern Queensland that is being developed by Metis Energy Ltd (Metis Energy - the proponent). Metis Energy has engaged Constructors Pacific Rim Pty Ltd (PCL) as the engineering, procurement and construction (EPC) contractor for the project.

1.1 Purpose and scope of this document

Ecosite Solutions Pty Ltd were engaged by Accent Environmental to develop a Livestock Grazing Management Plan (LGMP) for the operational and construction phases of the Gunsynd SF Project.

The purpose of this LGMP is to provide a framework for the management of grazing within the Gunsynd SF project. This LGMP is a subplan of the Site EMP is the key document outlining the requirements for landscaping treatments during construction and operations. As shown in Figure 1.1, the Site EMP falls under the environmental management system (EMS) for the project. The EMS provides a framework for managing project-related environmental risks (during both construction and operation) by:

- clearly setting out PCL's environmental management obligations and the means by which they will be managed, implemented, monitored and reviewed
- systematically tracking and documenting compliance with the DN CoCs, Planning Report commitments, external regulatory requirements and internal policy obligations
- effectively communicating with external and internal stakeholders, including Metis Energy, regulators, the community, subcontractors and company personnel to achieve a high level of environmental management and ongoing, continuous improvement.

Together the subplans and Site EMP form the strategic framework for environmental management for the Gunsynd SF project.

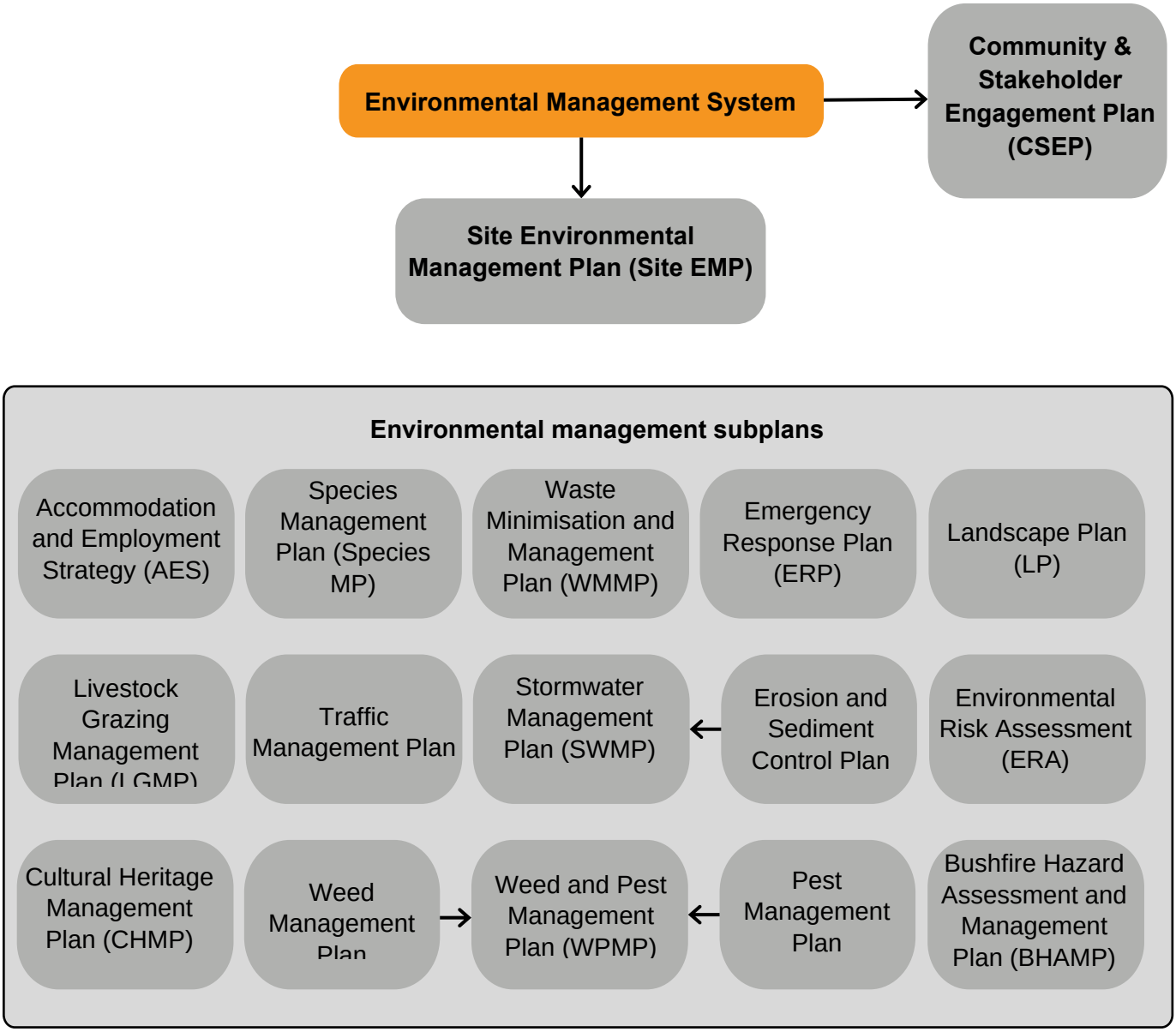


Figure 1.1 Site EMP and subplans

The LGMP covers the operation of the Gunsynd SF to be managed and undertaken for Metis Energy by PCL, including the activities undertaken by construction subcontractors, and by operations and maintenance (O&M) subcontractors.

1.2 Project overview

The project is a utility-scale solar renewable energy development, capable of generating up to 94MWac / 111MWdc megawatts alternating current (MWAC) via photovoltaic modules (solar panels).

1.3 Project works

Project works include the construction of the following infrastructure:

1. Site office and warehouse building
2. Car parks and temporary laydown areas
3. Solar panels
4. Power conversion units on skids
5. Electrical substation
6. NSP Switchyard
7. Upgrade of local public roads

1.4 Project site

The project site is situated on land identified as Lot 51 on MH115 'Glenoe', Jacksons Road, Goondiwindi. The project site is located approximately 14 kilometres (km) away from the Goondiwindi township in southern Queensland, on the border between Queensland and New South Wales (Figure 1.2). The property details for the project site are shown in Table 1.1 Property Information.

Table 1.1 Property Information

Address	'Glenoe', Jacksons Road, Goondiwindi
Lot / Plan	Lot 51 MH115
Area ($m^{2)}$	2, 601, 794 m^2 (260.18 ha)
LGA	Goondiwindi Regional Council
Zone	Rural
Precinct	Alluvial Plains Precinct

1.5 Generation

The solar panels will generate direct current (DC) electricity that will be inverted to AC electricity via the use of power conversion units (PCUs). The generated electricity will then be transmitted from the PCUs to an on-site substation via underground cables. The substation will connect to the NSP Switchyard via overhead cables.

1.6 Transmission

From the NSP switchyard, generated electricity will be supplied to Ergon Energy's 132 kV Bulli Creek – Waggamba electricity transmission line. This transmission line is located adjacent to the substation and transects the project site diagonally, from the north-eastern to south-western boundary.

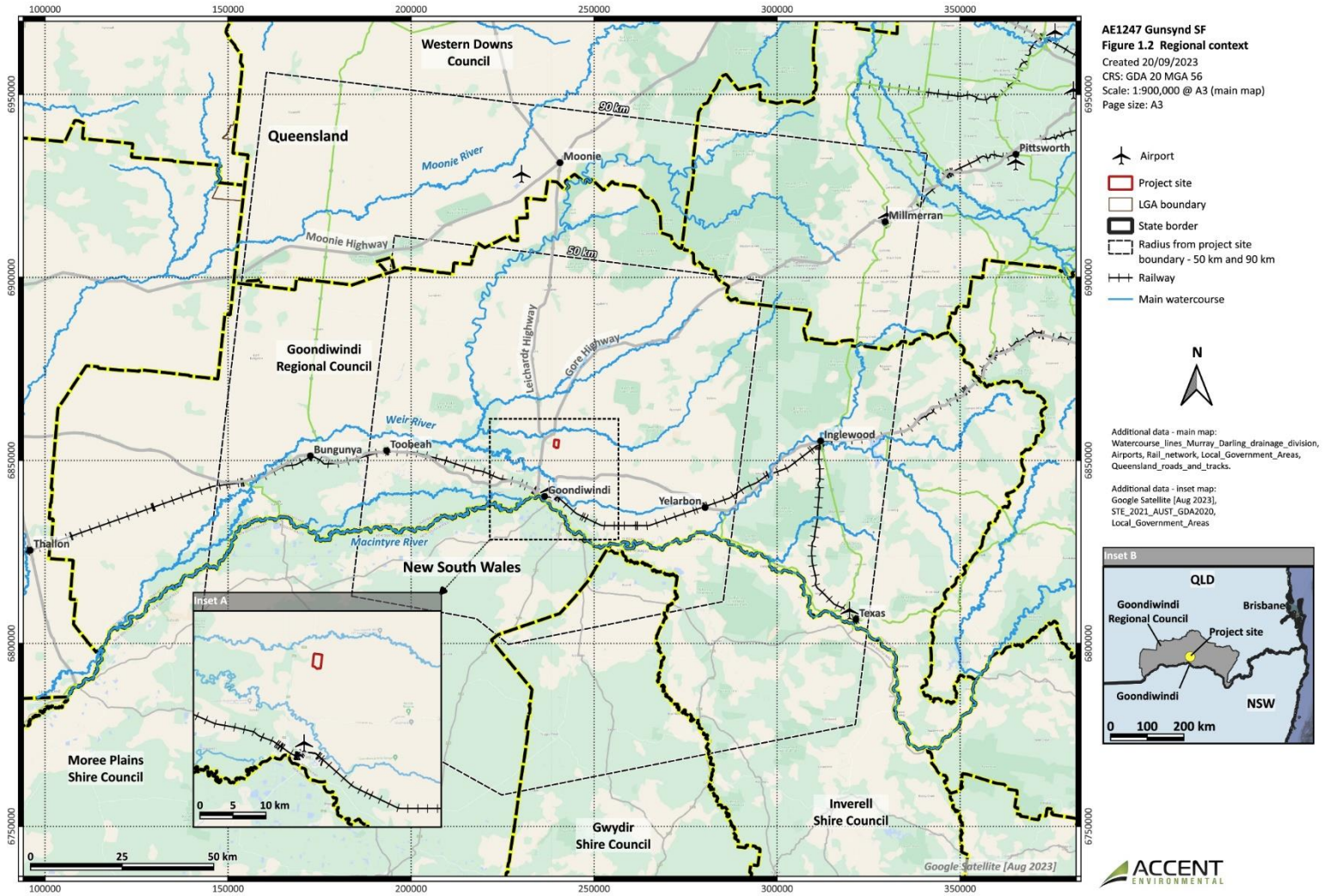


Figure 1.2 Location

1.7 Project objectives

Metis Energy and PCL's project objectives for the construction and operation of the Gunsynd SF project include:

- Protecting the agricultural productivity of the project site and surrounding land while maximising agricultural co-existence opportunities within the project site (sheep grazing).
- Preventing harm to sensitive flora, fauna and livestock on the project site and surrounding land through good design, best practice and compliance with legislation.
- Avoiding and minimising adverse social and environmental impacts on the local community and environment.
- Forming mutually beneficial relationships with host communities, First Nations and other stakeholders through community engagement and benefit sharing (employment, training, social procurement and investment).
- Setting a target of zero injuries during construction and operation of the project.
- Contributing to Australia's transition to a clean energy future.

These objectives will be achieved by implementing all reasonable and feasible measures to prevent, minimise or offset any material harm to the environment arising from the construction and operation of the Gunsynd SF. These measures will also ensure specific environmental criteria prescribed in Commonwealth (Cth) and Queensland (Qld) legislation are met (see Chapter 2).

2 Statutory requirements and project commitments

This section outlines key legislation, policies and standards that are relevant to the construction and operation of the Gunsynd SF.

2.1 Conditions of consent

The conditions of consent (CoCs) for DN 19/04W are stipulated in Attachment 1 – Assessment Manager's Conditions. These CoCs have guided the development of the Site EMP and subplans, and are provided in Appendix A of the EMP.

2.2 Legislation and planning regulation

Key legislation that has guided the development of the Site EMP and site plans are outlined in Table 2.1 property information.

Table 2.1 Relevant Commonwealth, State and local legislation and regulations

Legislation	Reference
Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999	EPBC Act
State	
Aboriginal Cultural Heritage Act	ACH Act
Planning Act 2016	Planning Act
Biosecurity Act	Biosecurity Act
Biosecurity Regulation	Biosecurity Regulation
Environmental Protection Act	EP Act
Environmental Protection Regulation	EP Regulation
Environmental Protection (Noise) Policy	EP (Noise)
Environmental Protection (Water and Wetland Biodiversity) Policy	EP (Water and Wetland Biodiversity)
Fisheries Act	Fisheries Act
Water Act	Water Act
Vegetation Management Act	VM Act
Work Health and Safety Act 2011	WHS Act
Local	
Schedule 6.2 – Land Development Standards	Schedule 6.2
Schedule 6.4 – Landscaping Standards	Schedule 6.4
Local Law No. 3 (Community and Environmental Management) 2011	Local Law 3
Local Law No. 8 (Waste Management) 2018	Local Law 8

3 Project description

This section describes works needed to construct and operate the Gunsynd SF.

3.1 Site layout

Construction infrastructure to support the development of the Gunsynd SF will include:

- temporary laydown areas and parking for construction equipment, plant and vehicles
- access roads throughout the project site
- a site office

During operations, the project site will contain:

- an operations and maintenance building, including a warehouse facility and emergency equipment.
- all-weather access driveway and roads throughout the project site
- solar arrays, composed of:
    - solar panels
    - tracking motors
    - solar inverter stations with integrated transformers; and
    - a high-voltage step-up transformer.
- above and underground electrical conduits and cabling
- switchyard, substation and control building
- security fencing along the site boundaries with access gates (2) to the site

The indicative site layout is shown in Figure 3.1.

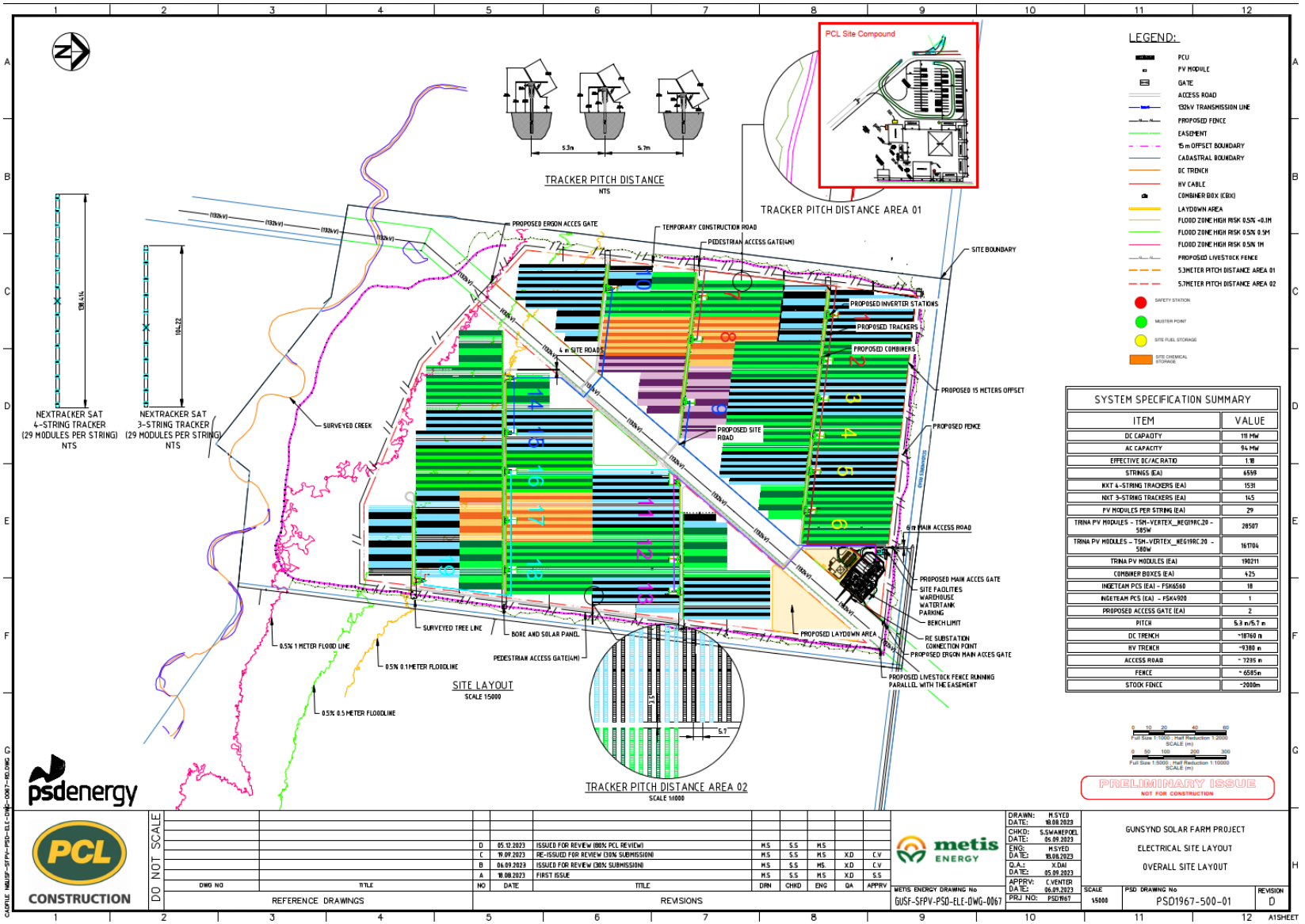


Figure 3.1 Site Layout of Gunsynd Solar Farm

4 Environmental context

The Site EMP considered how actions might impact on various aspects of the environment (physical, ecological, heritage, socio-economic). During the construction and operation of the Gunsynd SF project, the environmental aspects described below need to be considered.

4.1 Topography

The site generally comprises slightly undulating plains. The northern portion of the site is flatter. There is a gentle slope towards the southern extent of the site.

The majority of the site and surrounding area has been cleared for agricultural uses, primarily grazing, with patches of remnant vegetation associated with waterways.

4.2 Hydrology

Southern Front (2023) note that the project is adjacent to Murri Murri Creek, which runs along the southern site boundary. The Stormwater Management Plan prepared by Southern Front (2023)) indicates that flooding from Murri Murri Creek may occur in the southern portion of the site. The remainder of the site is shown as being free from flooding hazard and the proposed layout plan has taken the potential flooding onto consideration.

4.3 Soils

The geotechnical investigation undertaken by Morrison Geotechnic (2019) comprised the drilling and sampling of 28 boreholes. Further investigations and drilling was undertaken by Tonkin and Taylor (2023) who drilled a further 40 boreholes. Results provide the following details in relation to the subsurface profile:

- Silty SAND/Sandy SILT typically stiff/medium dense consistency to depths of 0.7 m.
- Silty/Sandy CLAY, of very stiff or stronger consistency, high plasticity, to borehole termination depth (3.0 m).
- Clayey sands were noted at depths below 1.8 to 3.0 m in boreholes generally positioned in the southern portion of the site closest to Murri Murri Creek.
- The presence of gravel was noted in boreholes generally positioned in the north west corner of the site.

The regional geology of the area comprises undifferentiated sand and soil deposited during the Quaternary Geological Time Period.

4.4 Groundwater

Groundwater was not encountered in the boreholes at the time of geotechnical investigation, (Tonkin and Taylor 2023) however the presence and depth to groundwater is dependent on rainfall, subsurface material and permeability. Groundwater bores were installed in three (3) of the boreholes.

4.5 Ecological aspects

The site is highly modified due to its history of cropping and grazing. Vegetation on the project site consists mainly of cleared grazing land, and regulated native vegetation exists along the lower western and southern boundaries of the site. The Murri Murri Creek, a mapped second-order stream, runs along the southern boundary of the site. A brief description on flora, fauna, weeds, pests and threatened species are discussed below. More detailed information is included in Redleaf's Environmental Assessment Report (Redleaf Environmental (2023).

4.6 Flora and fauna

Desktop and field assessments have been completed as a part of the Environmental Assessment Report, conducted by Redleaf Environmental. The following was found:

- The site is mapped with high value regrowth vegetation along the western and southern edges of the site (partly associated with the Murri Murri creek) as classified by the Queensland Herbarium regional ecosystem vegetation mapping. These areas are characteristic of *Eucalyptus populnea* or *E. woollsiana*, *Acacia harpophylla, Casuarina cristata* open forest to woodland on margins of Cainozoic clay plains, and *Eucalyptus tereticornis* or *E. camaldulensi*s woodland fringing drainage lines.
- Non remnant areas are mapped for the remainder of the site, as classified by the Queensland Herbarium regional ecosystem vegetation mapping.
- Botanical inspections revealed 30 species. Of these 19 were native and 11 were exotic species to the area. All native species are categorised as Least Concern under the *Nature Conservation Act 1992* (lowest category).
- Thirteen bird species and one mammal species (eastern grey kangaroo) were observed during the site visit. All are classified as Least Concern under the *Nature Conservation Act 1992*.
- Ten potential fauna habitat and/or animal breeding places were located on site. Four hollow bearing trees, two stags and four log piles.
- No essential habitat was found on site.
- Non-juvenile koala habitat trees (NJKHT) were located on the borders of the site. The trees included have the genus *Corymbia*, *Eucalyptus*, *Lophostemon* or *Melaleuca*, that are of the size requirements defined in the *State Supported Infrastructure Koala Conservation Policy 2023.*
- Wondali Creek is around 8 km south of the site. There is a fish passage culvert south east of the site beneath Scudamores Road, an entrance route to the site. 40 fish species are known to partially inhabit the creek (8 are likely to occur). The channel has a flat bottom and shallow banks.

4.7 Weeds and pests

Four restricted invasive plants were observed on site by Redleaf Environmental under the *Biosecurity Act 2014*. These species are listed in Table 4.1.

Table 4.1 *Restricted invasive plants on site under the Biosecurity Act 2014*

Scientific name	Common name	Observed Location
Bryophyllum delagoense	Mother of Millions	Scattered throughout site but largely associated with the perimeter/ border vegetation see Figure 4.1.
Harrisia martini	Harrisia cactus	Scattered throughout site but largely associated with the perimeter/ border vegetation see Figure 4.2.
Lycium ferocissimum	African boxthorn	Scattered throughout site but largely associated with the perimeter/ border vegetation see Figure 4.3.
Opuntia stricta	Prickly pear	Scattered throughout see Figure 4.4.

Figure 4.1 Mother of Millions

Figure 4.2 Harrisia cactus

Figure 4.3 African boxthorn

Figure 4.4 Prickly Pear

4.8 Threatened species

No threatened fauna or flora species or threatened ecological communities were identified during the field survey by Redleaf Environmental.

Database searches lists eight species and one threatened ecological community known to be present in the site area. Those that are at risk of being impacted by the project, as determined by Redleaf Environmental and are outlined in in the Environmental Assessment Report.

Threatened Ecological Communities

- Brigalow (*Acacia harpophylla* dominant and co-dominant):

Medium Risk Flora

- *Lepidium monoplocoides* (Winged Pepper-cress)

Low Risk Fauna:

- *Aphelocepha la leucopsis* (Southern Whiteface)
- *Calyptorhynchus lathami* (glossy black cockatoo (eastern))

- *Chalcites osulans* as *Chrysococcyx osculans* (Black-eared Cuckoo)
- *Erythrotriorchis radiatus* (red goshawk)
- *Falco hypoleucos* (grey falcon)
- *Anomalopus mackayi* (five-clawed worm-skink)
- *Hemiaspis damelii* (grey snake)

4.9 Socio-economic environment

The region where the project site is located is largely used for agricultural purposes, such as cotton and grain production, sheep and cattle grazing, as well as forestry

The total population of the GR local government area (LGA) is 10,310. The working age population (15 to 64 years) was comprised of 5,003 people (61.4% of the population). The main industries of employment include beef cattle farming, other grain growing, grain sheep or grain beef cattle farming, primary education or hospitals.

The median weekly rent for the GR local government area (LGA) was $250 per week (ABS 2021), and the rental vacancy rate for the Goondiwindi township is 0.2% in July 2023. This indicates an undersupply of rental properties in the area.

More detailed information on social and economic aspects of the region are provided in the AES.

4.10Vegetation

The site is highly modified due to its history of cropping and grazing. Vegetation on the project site consists mainly of cleared grazing land, and regulated native vegetation exists along the lower western and southern boundaries of the site. The Murri Murri Creek, a mapped second-order stream, runs along the southern boundary of the site. A brief description on flora, fauna, weeds, pests and threatened species have been provided above. More detailed information is included in Redleaf's Environmental Assessment Report.

Construction and operation activities for the Gunsynd SF project will impact the vegetation on site. All vegetation within the site that will have panels or other infrastructure will be cleared. A range of management techniques have been developed to minimise the impact. Further details can be found in the Environmental Management Plan and the Landscape Plan.

The Environmental Management Plan, Stormwater Management Plan and the Erosion and Sediment Control Plan detail the rehabilitation and revegetation techniques to be applied to the Gunsynd SF project. Additionally, there will be screening plantings along sections of the site boundary as detailed in the Landscape Plan.

All grazing activities will be undertaken in a manner that does not adversely impact on any sown or planted vegetation.

5 Grazing Management Objectives

Grazing of livestock will only be undertaken on site following the completion of all construction activities and there is suitable groundcover to sustain grazing. Grazing is undertaken to achieve a range of outcomes. Traditionally, this is focussed on livestock production outcomes such as:

- Meat production, and
- Wool production,

Additionally in a solar farm setting the following outcomes are required:

- Groundcover management for erosion control,
- Weed management, and
- Vegetation management for fire.

Grazing management is achieved through a combination of the following factors:

- Balancing forage growth and use so that land condition is improved,
- Accurate assessment of pasture quality and quantity,
- Accurate assessment of animal demand for forage,
- Optimisation of water point distribution and paddock design, and
- Management of stocking rates to reach production and land condition targets.

Grazing of the land associated with solar farms is increasing in popularity in Australia. The reason being that ground mounted panels allows sufficient space for animals such as sheep to graze underneath (Clean Energy Council 2021). This reduces the reliance on mechanical or chemical means for vegetation control. Figure 5.1 shows sheep grazing in a solar farm.

Figure 5.1 Sheep grazing within Solar farm

5.1 Livestock types

Grazing of livestock within the Goondiwindi region is dominated by cattle and sheep enterprises. There is also opportunistic grazing of goats. Grazing of cattle within solar farms is generally not undertaken. This is because cattle are large beasts and they can damage panels and other infrastructure. Similarly, goats are not suitable for grazing within solar farms because of their tendency to climb on panels and eat exposed items such as wiring.

Sheep grazing is the preferred livestock management tool for grazing within solar farms. Sheep have been successfully grazed in solar farms within Australia and the United States. Grazing has been achieved on many solar farms in Australia where panels are attached to fixed axis arrays on a 20-degree tilt, where the height of its panels sits as low as 30 cm above ground level (Downer 2019).

5.2 Grazing Management options

There are several approaches to grazing in the landscape. These include rotational grazing, set stocking, resting pastures for seed production, and supplementary feeding. When settling on a grazing technique it is important to understand why grazing is being undertaken. An effective grazing strategy addresses all or some the following landscape outcomes:

- Improved pasture quality,
- Increased livestock production
- Weed control,
- Reducing fire risk through dry matter reduction, and
- Reducing environmental damage.

5.2.1 Set stocking

Set stocking involves grazing livestock for a set period of time in a particular paddock without any resting phase. This is quite common on small properties where landholders have low stock numbers and production is not a major objective.

Where a property consists only of one main grazing area, and has not been subdivided into smaller paddocks, the landholder often has no choice but to apply set stocking. In this case the overall stocking rate is generally calculated so that area of land will carry a set number of livestock for the year.

A common problem with set stocking is the potential for the build-up of weeds and a decline in pasture quality. Livestock tend to consume palatable pasture species and leave the unpalatable species, which in many cases are weeds. This is known as ‘selective feeding’. In this situation, the seed set of weeds increases and the balance of the pasture changes as weeds begin to dominate the pasture.

A recommended set stocking rate will depend on the quality of the available pasture. A range of 2.5 to 5 Dry Sheep Equivalent (DSE) per hectare is recommended (Queensland DPI 1991). A DSE is used as a method of standardising an animal unit and is the amount of feed required by a two year old, 50 kg Merino wether to maintain its weight.

5.2.2 Rotational grazing

Rotational grazing is a practice where livestock are grouped together and rotated through a number of paddocks in order to rest pastures. Resting pastures is a vital practice if landholders wish to

improve pasture quality, reduce weeds, and increase productivity. This process relies on the rest period being long enough to allow sufficient pasture growth so that grazing can begin again.

Rotational grazing can increase stocking rates by up to 20% compared with set stocking. Under these circumstances grazing pressure is higher than under set stocking and relies on more intensive grazing of the vegetative pasture phase. Livestock graze less selectively when grazing pressure is high which helps to keep weeds under control.

Rotational grazing helps to reduce 'patch' grazing and livestock camps, minimises broadleaf weeds and annual grasses. It also provides a more even distribution of manure and urine to the pasture. If managed appropriately ground cover over summer will be improved. It is essential that paddocks are not grazed for too long since this will result in plants not recovering as quickly as they should. The height at which pastures are grazed is a critical part of the success of this grazing strategy. Pasture utilisation is best when plants are growing between 5 cm and 12 cm. The use of a pasture ruler such as the one designed by the Meat and Livestock Authority (MLA) is helpful when estimating pasture height (Figure 5.2). A full explanation of the MLA Pasture Tool is contained in Section 5.6.

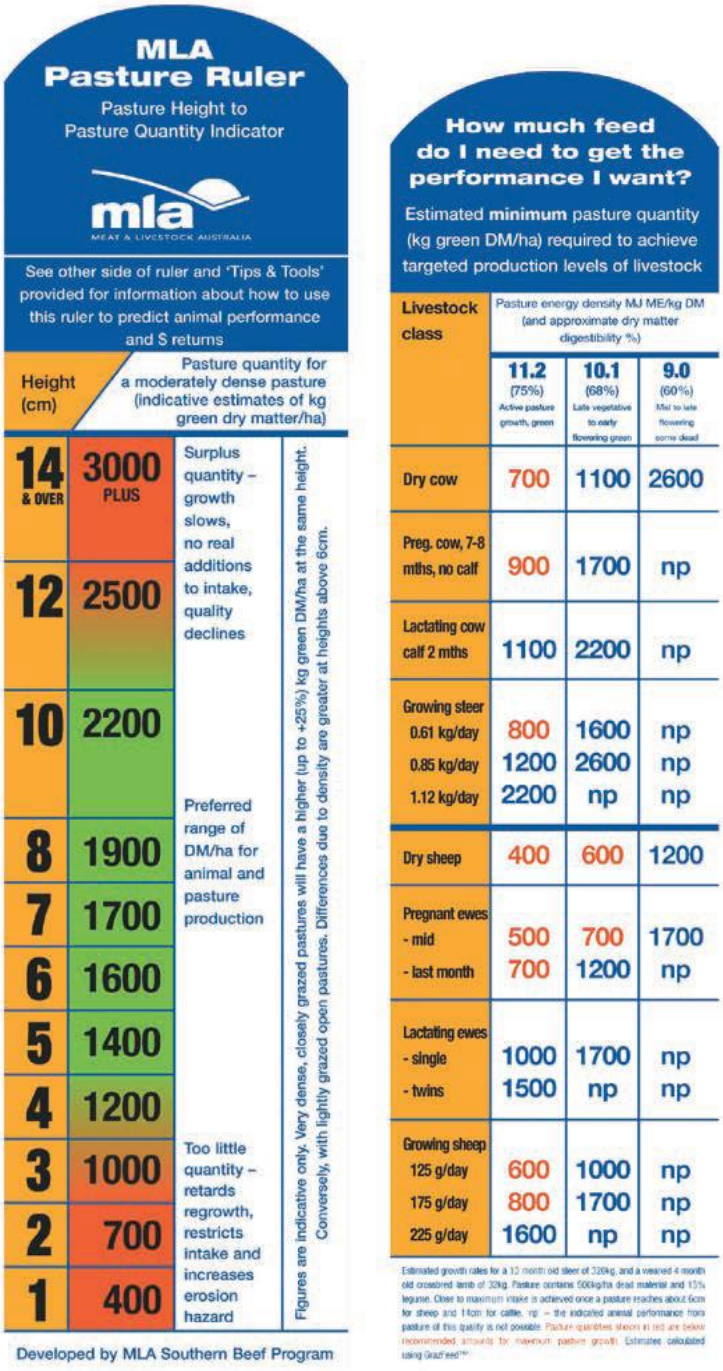


Figure 5.2 MLA Pasture Measuring Tool

5.3 Intensive rotational grazing

This grazing system involves stock being rotated frequently (every 1–3 days) through a large number of paddocks (up to 20 or 30). Intensive rotational grazing systems are also referred to as:

- high density grazing
- short duration grazing
- block grazing
- strip grazing
- cell grazing.

Intensive grazing is a very efficient method of utilizing pasture and relies on rotations being planned around the most desirable plant species in the pasture which grow actively in different seasons.

Stocking densities are very high and so grazing periods are short. They can be as low as one day depending on pasture growth rates and stock numbers. Stocking densities of 100 Dry Sheep Equivalent (DSE) per hectare and higher are manageable provided paddock numbers and resting periods are carefully determined. A DSE is used as a method of standardising an animal unit and is the amount of feed required by a two year old, 50 kg Merino wether to maintain its weight.

Dairy farmers have used strip grazing as an efficient grazing strategy for decades. The use of electric tape is effective, and animals quickly adapt to the system.

Speeding up the rotation when growth is rapid is important to ensure pasture can be maintained in the vegetative state with plenty of leafy grasses and a high legume content. During spring some paddocks will need to be dropped out of the rotation and used for silage or hay production if they cannot be kept to below 14 cm in height. Avoid grazing pastures lower than 4 cm if using this system, and monitor pastures to avoid overgrazing.

5.4 Grazing to manage pasture species

During the construction phase the site will be sown with a range of perennial grass pastures species. Given the placement of panels and other infrastructure the ability to resow areas that may become degraded for some reason are limited. Degradation of pasture species may occur due to poor management, adverse climatic conditions or overgrazing from feral animals. Particular care be taken careful during flowering and seed set, and during establishment because pastures are particularly vulnerable to overgrazing at these stages.

Grazing undesirable species to prevent seed set, or resting desirable species to encourage seed production are two key strategies to maintain pasture quality.

Lack of attention to grazing management is the cause of common problems in grazing land ecosystems, such as:

- The loss of desirable pasture plants, which are usually replaced by undesirable ones,
- Forage supply being out of balance with forage demand,
- Livestock not meeting production targets,
- Declining land condition, and
- Uneven use of pasture, with some areas of paddocks grazed out and others hardly touched.

5.5 Weed management

There are six principles of weed management.

The following principles provide a basis for managing weeds.

1. Awareness—be aware of existing and potential weed problems.
2. Detection—be on the lookout for new weed infestations before they become too large and difficult to contain.
3. Planning—prioritise efforts and plan a strategy for successful control.
4. Prevention—is better than a cure, so preventing new weed infestations and containing spread of existing weeds will make life easier.
5. Intervention—and do it early. Controlling weeds now rather than later will prevent them spreading out of control.

6. Control and monitor—as always, monitoring is a critical component in weed management. Managers need to gauge how well they are controlling weeds and re-plan their efforts for the future.

Managers need an understanding of weed ecology to prevent introduction of new weeds and contain existing weeds. The knowledge of a weed's life cycle can help to identify the weed's strengths and weaknesses. This assists the formulation of plans to attack the weed's weaknesses and avoid its strengths.

Important facts to know:

- how weeds are transported and how they spread
- the preferred habitats of a species and what grazing management regime encourages its growth
- the relative life of seeds of different species

Good property weed hygiene is essential. Early intervention is also critical, knowing the location of weeds on the property and prioritising actions to control them as soon as possible can prevent any future outbreaks.

It is important to know where weed outbreaks have occurred in order to monitor the success of initial control measures.

Follow-up management is also important. Monitoring suspect areas and areas where weeds were previously controlled will help to prioritise weed management. Ensure that grazing management enhances land condition to help reduce weed problems, and recognise that failure to manage early weed problems leads to major outbreaks.

5.6 Measuring pasture cover

In this system, the total area to be grazed (i.e., the solar farm unit) is managed by use of temporary electric fences to provide paddocks. Animals will be confined to each paddock for a specified residency period, i.e., the number of consecutive days of grazing before being moved to a new paddock. This approach allows the remainder of the pasture a rest period to regrow. The rest period necessary for grass to recover to grazing height is dependent on climatic conditions. This may be between 30 and 60 days. It will generally be faster in early spring, and slower in late summer/autumn, and is influenced by soil characteristics and weather variability. The sheep are managed in a controlled manner and not allowed to freely roam or continuously graze. This approach should inhibit weed growth, improve the health of pasture, sustain healthy vegetation, and improve sheep health.

There are several methods to measure pasture growth. It is recommended that the Meat and Livestock Australia (MLA) Pasture Ruler is adopted as the pasture measurement tool for the Gunsynd SF. The tool is easy to use and is well supported within industry. See Figure 5.3 for typical use of the tool. A copy of the MLA Pasture Meter can be obtained from the MLA at https://www.mla.com.au/ A full set of instructions for using the MLA Pasture Ruler is contained in Appendix 1.

Figure 5.3 Usage of the MLA Pasture Measuring Tool

5.7 Gunsynd sheep grazing

To achieve the objectives outlined above, a rotational sheep grazing system is proposed, and a grazing plan has been designed as a template for the potential grazier(s). It is proposed to divide the Gunsynd SF into five discrete paddocks. Four of these encompass solar panels and the fifth is the powerline easement. In order to minimise disruption to site operations the internal temporary electrical fencing should follow internal roads. A suggested paddock layout is shown in table 5.1.

Table 5.1 Suggest paddock layout.

Paddock Number	Panel Blocks
1	1 – 9
2	10
3	11 – 13
4	14 - 19
5	132 KV Power Easement

The aim of the grazing regime on Gunsynd Sf is to ensure that pasture growth under and adjacent to the panels does not exceed 14 cm in height. Conversely it should not be allowed to drop below 2 cm in height. Initially it is planned to graze the paddocks for a period of two weeks grazing followed by four weeks of rest. However, regardless of the length of the planned grazing period, the actual move or rotation to a new paddock is based on plant height thresholds between 3 cm to 14 cm which equates to a range of 1,000 and 3,000 KG green matter/ha. See figure 5.4 for indicative grazing pattern.

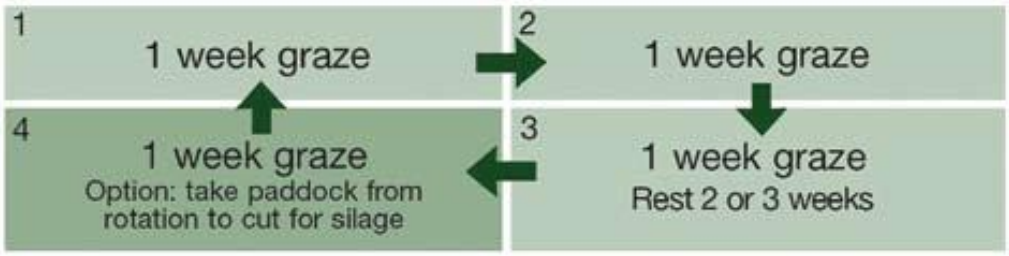


Figure 5.4 suggested grazing rotation pattern.

If the pasture growth begins to exceed 14 cm in height an increase in stocking rate will be required until the pasture height drops to 3 cm at which point stock can be removed and the pasture is allowed to recover. Then rotate stock around the four paddocks in a general program of two week grazing and six weeks rest.

Over time the pasture mix may move towards one dominated by native pasture species. Once this occurs it is possible to change the paddock configuration to two paddocks with a four weeks grazing followed by four weeks rest or a four-paddock rotation with four weeks grazing and twelve weeks resting.

As the pasture of the Gunsynd SF has not been established at the time of writing this plan no stocking rate has been recommended. It is recommended that once the pasture is established that several sites be assessed using the MLA Pasture Ruler to determine the amount of green feed available. Once this amount exceeds an average of 5 cm growth or 1,400 kg green matter per ha then it is recommended that the MLA stocking rate tool be used to determine an initial stocking rate. The stocking rate tool is available here: https://etools.mla.com.au/src/?v=4&r=18&linking=1#/sheep and follow the prompts for paddock size, starting green matter, finishing green mater, pasture growth and stocking days. Initially use the default value for pasture growth, finishing green matter of 1,000 kg/ha and a grazing time of 7 days.

To get a rotational grazing system underway it is recommended that the pasture is growing at a rate of 800-1000 kg/ha and grow more quickly. Depending on seasonal conditions and location, this may take 3-4 weeks. The rotational grazing system can then start with one week grazing on each paddock gradually increasing to reach two weeks grazing, six week rest over winter.

After a trial period, modifications may be required to the system to match pasture growth. It is a flexible system that will require monitoring as outlined in Section 6.5. The aim is to graze down to 3 cm pasture height then allow the pasture to regrow.

5.8 Drought management and supplementary feeding

Droughts are a natural occurrence within the Australian grazing landscape. However, the management of grazing within the Gunsynd SF must be dynamic and respond quickly. The trigger for moving stock is when the pasture height drops to 3 cm. If a prolonged dry period or drought occurs stock are not to be returned to the paddocks until an average of 5 cm growth or 1,400 kg green matter per ha is measured for the paddocks using the MLA stocking rate tool. At no stage can stock be fed within the Gunsynd Solar Farm, unless it is a supplementary feed designed to maximise the palatability of standing dry feed to minimise fire risk.

5.9 Gunsynd cattle grazing

Cattle grazing will be not be allowed within the Project Area, but may occur elsewhere within the property boundary.

5.10 Solar Farm infrastructure considerations

A Solar Farm is different to a typical agricultural grazing enterprise. The main reason being is the presence of the infrastructure associated with the solar farm including solar panels, tilt motors, cable trays, inverters, and electrical cabling. Sheep have been successfully grazed in solar farms within Australia and the United States. Grazing has been achieved on many solar farms in Australia where panels are attached to fixed axis arrays on a 20-degree tilt, where the height of its panels sits as low as 30 cm above ground level.

The use of axial tracking systems has the potential to trap sheep's wool. However, most axial - tracking systems have installed motor guards to prevent the sheep's wool from being caught in the moving parts and universal joints of the motors which drive the solar array trackers. Motor guards also prevent sheep from hitting the equipment, including pressing the emergency stop buttons.

The other potential issue with sheep within solar farms risk of sheep getting tangled on exposed wiring. Cables should be tightly secured to the rear of modules to minimise the risk of interference with module cabling or, at the extreme, the chance of strangulation Clean Energy Council 2021).

6 Infrastructure

6.1 Temporary fencing

The Gunsynd SF site is fenced into two cells. One to the east of the 133 KV power easement and the other to the west. These fences will form three sides of each grazing paddock. The remaining fence will be an electrified temporary fence of at least three electrified wires (Figure 6.1) or equivalent powered by either a battery or solar powered energiser. The exact location and style of the temporary electric fencing will be determined prior to the commencement of operations and will be agreed to by Metis and the Host Landowner.

Figure 6.1 Typical temporary three wire electric fence.

As Solar arrays are configured in long rows with occasional breaks within the row where cross-fencing can be located. The panel arrangement will dictate paddock dimensions and ideally should be along breaks between arrays such as internal roads. Electrified fencing should be posted to prevent accidental shocking of people, and must be properly installed to function effectively.

6.2 Water supply

Sheep require a constant supply of clean water. Assuming grazing and stock is by landowner and not a third party, water will be supplied from combination of three sources being creek / river, dams and bores. The water requirements vary according to stock type and feed quality. Average water requirements are shown in Table 6.1.

Table 6.1 Average stock water requirements (MLA)

Stock type	Consumption per head per day (L)
Weaners – average all feeds	2–6
Adult dry sheep – grassland	4–12
Adult dry sheep – saltbush	4–10
Ewes with lambs – dry feed	2–4

There are three potential water sources on the property hosting the Gunsynd SF. The first is a solar powered bore and tank on the eastern boundary of the development approximately 1.2 km from Jacksons Road (Figure 6.2 and Figure 6.3). This will be used for supplying water for the sheep grazing within the development area. It is ideal to have multiple water sources so that the proposed rotational grazing can be easily implemented. This will require the installation of four troughs and PVC pipe to reticulate the water to each of the grazing paddocks. The exact location and type of the watering points will be determined prior to the commencement of operations and will be agreed to by Metis and the Host Landowner. A typical permanent concrete watering trough is shown in figure 6.4 and a temporary PVC trough is shown in Figure 6.5.

Figure 6.2 Existing bore on Gunsynd SF.

Figure 6.3 Existing water tank on Gunsynd SF.

Figure 6.4 Example of concrete watering trough.

Figure 6.5 Example of shared temporary PVC watering trough

Stock do best on water that is fresh, cool and clean. Water should be low in salt, low in organic matter (<20 mg/litre Dissolved Organic Carbon (DOC)), low in suspended clay (<200 Nephelometric Turbidity Unit (NTU)) and free of other toxic substances, such as blue green algae. Avoid using water that looks or smells bad. Water should be tested if there is any question of its suitability for stock. The major threat to water quality during drought is high levels of salt, although algae and animal manure can foul water following heavy summer rains or strong winds. (Department of Economic Development, Jobs, Transport and Resources 2018). Annual testing of proposed water supplies is recommended. The use of tanks and troughs is recognised as the best mechanism to preserve water quality by ensuring that stock only drink at the trough. and don't defecate or urinate in it.

A dam is located in the south west corner of the property. The dam is located outside the development area and will be used for cattle grazing outside the fenced Project area as cattle will not be allowed to undertake grazing within the fenced Project area. The third water source is Murri Murri Creek and will not be used for sheep stock water by the Gunsynd SF.

6.3 Stock handling

Access to stock handling facilities will be required to undertake successful grazing on the Gunsynd SF. Suitable facilities will allow for the stock manager to undertake a range of animal management activities such as drenching, drafting and loading for transport. These will be located on Lot 52, adjacent to the Site.

7 Conclusion

A rotation grazing system for weed, fire and groundcover management is recommended for the Gunsynd Solar Farm. Grazing should commence once construction has been completed and the pasture growth on site is at least amount exceeds an average of 5 cm growth or 1,400 kg green matter per ha.

A successful grazing rotation on Gunsynd Solar Farm with sheep will be achieved through:

- Initial, planned grazing rotation
- Experience and ability to observe when the rotation days and stocking density must be adjusted throughout the season
- A well-managed and clean, healthy flock deployed on pasture
- Stringent treatment protocols for flock specific health issues
- Fulfilled nutritional requirements
- Access to mineral feed and clean and fresh water 24/7
- Pasture hygiene (limited faecal contamination, moving of high frequency areas like water and mineral)
- Health checks on every rotation day
- Well-designed handling systems for animal checks and parasite monitoring and treatment

8 References

Australian Government Department of Agriculture, Fisheries and Forestry, 2006 '*The Structure and Dynamics of Australia's Sheep Population*", Office of the Chief Veterinary Officer

Clean Energy Council 2021, *Australian Guide to Agrisolar for Large – Scale Solar for Proponents and farmers*.

Department of Economic Development, Jobs, Transport and Resources, 2018, *Drought Feeding and Management of Sheep A Guide for Farmers and Land Managers* Victorian Government 2018

Downer 2019, *Sheep grazing vegetation management trial report – Numurkah Solar Farm*

Meat & Livestock Australia Limited 2006 *Grazing land management Sustainable and productive natural resource management* Meat & Livestock Australia Limited

Meat & Livestock Australia Limited *Improving pasture use with MLA Pasture Ruler* Factsheet FP03.

Morrison Geotechnic, 2019. *Report on Geotechnical Investigation Proposed Solar Farm Lot 51 Jacksons Road Goondiwindi*, s.l.: Brisbane.

Natural Resources Adelaide and Mt Lofty Ranges 2017 *Best practice land management guidelines for small grazing properties*.

Northern Consulting Engineers 2019. *Gunsynd Solar Farm Project – Surface Water and Drainage Assessment to Support Material Change of Use (Mcu) Application*, MJ1929/01:JS. 24 January 2019.

Queensland Department of Primary Industries 2019, *Land Management Manual Waggamba Shire Part B Field Manual*, Queensland Government.

Redleaf Environmental (2023). *Environmental Assessment Report – Gunsynd Solar Farm, Goondiwindi, Queensland*. June 2023.

Southfront 2023 *PSD Energy Gunsynd Solar Farm Stormwater Management Plan*. Adelaide 2023

Topo (2023). Stormwater Management Plan & Erosion Sediment Control Plan, Gunsynd Solar Farm. 18/09/2023.

Tonkin and Taylor 2023, Geotechnical Investigation Report, Gunsynd Solar Farm Goondiwindi QLD.

9 Appendices

MEAT & LIVESTOCK AUSTRALIA

tips&tools

FP03 FEEDBASE AND PASTURES

Improving pasture use with the MLA Pasture Ruler

The MLA Pasture Ruler provides the basis for a quick and easy way to estimate pasture mass (quantity) and quality. These estimates become a guide to the performance you can expect from your grazing animals.

Why assess pasture

Pasture assessment is the key to making better grazing decisions. To get the benefit of feed budgeting you need to know:

- **Quantity:** the mass of pasture available to your livestock; and
- **Quality:** the feed value of your pasture.

From this you can estimate the number of stock you can carry, for how long, and how well they are likely to grow. With feed budgeting you can determine when and how many stock you need to buy or sell with changing seasonal conditions; or alternatively how much supplementary feed will be needed.

Pasture mass (kg green DM/ha)

The quantity of green feed on offer has a big effect on how much pasture an animal can eat. If there is not enough pasture available (ie it is too short), animals spend more time and energy walking and grazing but may not be able to eat enough to achieve the performance you want. In contrast, when there is too much pasture for the number of grazing animals, pasture is wasted and quality declines. This reduces future intake and therefore the future performance of your stock.

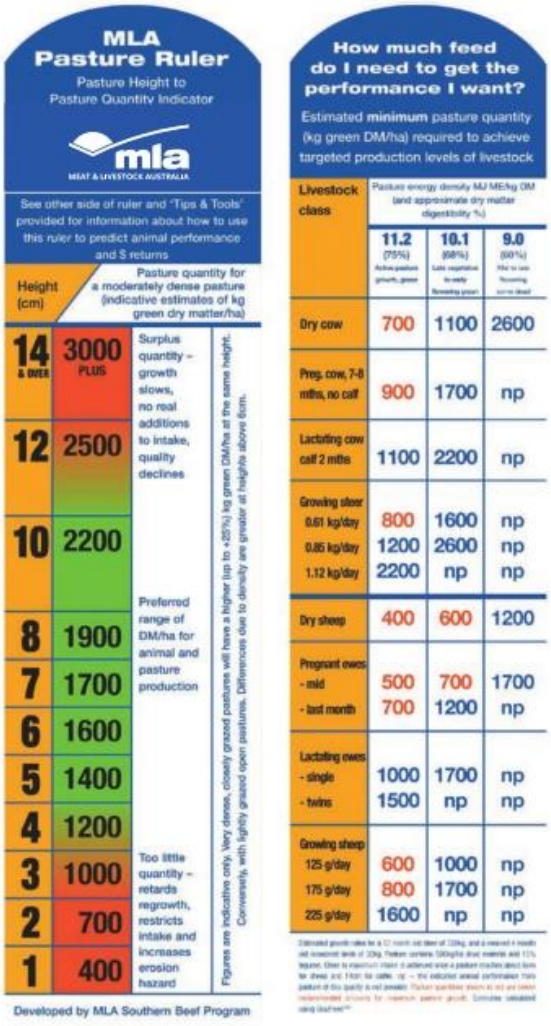
The amount of green material present in a pasture is measured as kilograms of green dry matter per hectare (kg green DM/ha). This amount also affects the ability of the pasture to grow to its potential. When pastures are too short, there is insufficient leaf to capture sunlight and the energy for growth. If it is too long the lower leaves are shaded and plant growth declines.

The quantity of green feed on offer is related to a combination of pasture height, pasture density and percentage of dry matter (the non-water component).

Key benefits

- Increase your productivity by making better grazing decisions.
- Better manage stock numbers to increase the utilisation of available pasture.
- Learn to use the MLA Pasture Ruler to predict animal performance and dollar returns.

Figure 1. The MLA Pasture Ruler



Measuring pasture height and converting to pasture mass:

1. Place the MLA Pasture Ruler vertically onto the soil surface. Do not push it into the ground or sit it on top of dead pasture.
2. Slide your thumb down the ruler until it touches green leaves. This measured height will generally be less than that of the taller leaves in the pasture.
3. Do not measure dead stems or leaves or unpalatable weeds like onion grass, as stock do not readily eat these. If no green pasture is present, height is recorded as zero.
4. Measure the height of the green pasture at an appropriate number of sites to get a good representative sample of the pasture availability. Depending on the physical characteristics of the paddock (eg slopes and aspect), the best method might be to walk across the paddock in a zigzag pattern, tossing the ruler out in front of you as you go (to account for variations in pasture height and density), taking measurements where the ruler lands and recording the observations.
5. To convert from the average pasture height in the paddock to kilograms of green dry matter per hectare, simply read the kg green DM figure from the adjacent column on the MLA Pasture Ruler.
6. For information on how to adjust for pasture density and percentage of dry matter, refer to the text below.

Pasture height

Simply by measuring pasture height an estimate can be made of the amount of green feed available in a paddock. Although approximate, this is a quick and easy way to assess the pasture mass.

The MLA Pasture Ruler is specifically designed to help with this assessment. With practice, this assessment can be made 'by eye', assessing the height and density of the pasture and estimating the amount of available herbage (kg green DM/ha). If pasture height is measured in an ungrazed area of the paddock at intervals of a week or so, an estimate can be made of how fast the pasture is growing.

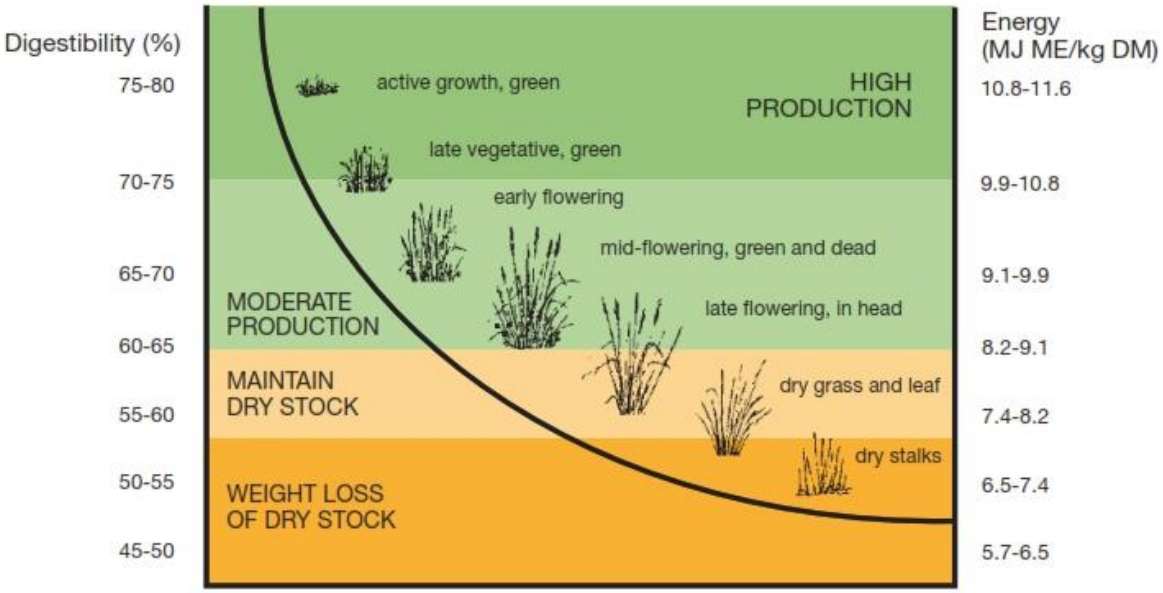
Pasture density

The MLA Pasture Ruler is a guide to pasture quantity for a **moderately dense pasture**. Adjust the estimate of pasture mass (up or down) according to the pasture density. Very dense, closely grazed pastures will have a high (up to 25%) kg green DM/ha at the same height. Conversely with lightly grazed open pastures.

Dry matter percent

The amount of moisture in plant material varies between species, growth phases, seasons and even weeks. There is a tendency to overestimate herbage mass in young actively growing pasture that may contain over 80% water (ie less than 20% dry matter), but as plants mature, dry matter content increases.

Figure 2. A guide to digestibility decline as temperate pastures mature



Pasture quality and animal needs

When pasture mass is assessed, stock numbers can be managed to increase the utilisation of available pasture as long as the quality and quantity is at or above the minimum benchmark for that class of livestock or performance level.

Pasture quality directly influences animal intake and production. This occurs in two ways:

- by influencing the amount of pasture consumed; and
- through determining how much of the feed consumed is converted into animal product.

There is no single measure of pasture quality. It is a combination of the proportion of legume, green and dead material, and digestibility – all of which affect pasture energy content.

Pasture energy content is the main driver of animal production and is measured as megajoules (MJ) of metabolisable energy (ME) per kilogram of dry matter (and is related to digestibility of the pasture). The higher the quality (and therefore energy content) the less the amount animals need to eat to achieve the same growth rate or level of milk production. Also, pasture of high energy (and therefore digestibility) takes less time to break down and moves quickly through the rumen. This allows more pasture to be eaten and therefore used for production.

Green, actively growing pasture is of the highest quality. Legumes such as clover are of higher quality than grasses at the same stage of development.

Figure 2 shows that as pastures mature the energy available for livestock production declines. This means that as pastures mature, animals need to eat more to achieve the same production level. However, it takes longer to go through the rumen so less pasture is consumed and animal production is reduced.

Developing skills in pasture assessment and feed budgeting enables estimation of the amount of feed available and calculation of the stocking rate for a known grazing period. By using the MLA booklet, 'Pasture tools for a profitable beef enterprise', you will be able to:

- Estimate stocking rate over short periods;
- Make better tactical grazing decisions about the short-term stocking rate per hectare;
- Plan seasonal pasture and animal performance to achieve targets; and
- Calculate the gross financial benefit to the grazing business.

This information enables the grazing operation to be more precisely managed and is highly applicable and useful to both cattle and sheep producers.

Balancing performance of both pasture and stock

How can quality and quantity of pasture be managed to maximise intake of nutrients by livestock? In general this is achieved by keeping high quality pasture within the band of 1,500 to 2,500 kg green DM/ha for growing cattle and 1,000 to 1,700 kg green DM/ha for sheep.

The MLA Pasture Ruler provides guidelines for the combinations of quantity and quality required by different classes of stock. By ensuring the right quantity and quality is available, production targets can be achieved. The table on the MLA Pasture Ruler provides a guide to pasture benchmarks indicating how much green herbage mass is required to satisfy the nutritional requirements of stock at various stages of their reproductive cycle, and for growth. The benchmarks provide 'ball park' estimates for the minimum green pasture mass on which stock can graze and still maintain satisfactory levels of production.

Managing natural resources

Managing pastures for highest pasture and animal productivity is also sound natural resource management. If pasture mass is maintained above a total of 1,000 kg DM/ha (green and dead), the surface movement of water, nutrients and soil is greatly reduced. Also, deep drainage of water is least when pastures are growing rapidly.

Further information

Skills in pasture assessment can be developed by participating in a MLA EDGE*network* Grazing Land Management® workshop. Call 1800 023 100 for more information.

To order your free MLA Pasture Ruler call 1800 023 100 or go to www.mla.com.au/creative-commons

MEAT & LIVESTOCK AUSTRALIA

Level 1, 40 Mount Street,
North Sydney NSW 2060
Tel: (02) 9463 9333
Fax: (02) 9463 9393
www.mla.com.au

MLA logo updated Feb 2019
ISBN: 174036 528 3