# REVIEW OF HIGHLY PRODUCTIVE LAND (HPL) ASSESSMENT

**Prepared for:** **Selwyn District Council (SDC)**

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## 1. Introduction

Jane Anderson (Consultant Planner SDC) has requested a review of the Highly Productive Land assessment provided as part of the application by Darfield Solar and Energy Storage Limited to construct a new solar farm at 1352 Homebush Road, Darfield. The current farm size is approximately 154 hectares and does not have any irrigation. This review has been undertaken based on information provided by the SDC, with particular reference to the AEE and the associated appendix 2 *"Land Productivity Assessment"*, prepared by Landvision. For the purposes of this report the Landvision report will be referred to as the LPA. Other New Zealand and international information has been researched and used alongside internal knowledge and information. The site was not visited or inspected as part of this review.

The review considers any impacts in relation to the 2024 updated version of the National Policy Statement for Highly Productive Land (NPS-HPL), focusing primarily on the productive capacity of the land.

The AEE states that *"The project is an agrivoltaic system, designed to maximise land-use efficiency with solar generation sharing space with productive agricultural activity. The site is currently used for sheep production, and it is proposed to continue this practice, allowing sheep to graze around the solar panels"*.

## 2. NPS-HPL

**NPS-HPL Objective**: Highly productive land is protected for use in land-based primary production, both now and for future generations. Land-based primary production is defined in the NPS-HPL as *"production, from agricultural, pastoral, horticultural, or forestry activities, that is reliant on the soil resource of the land".*

Key Policies with regard to this review are:

**Policy 1:** Highly productive land is recognised as a resource with finite characteristics and long-term values for land-based primary production.
**Policy 4:** The use of highly productive land for land-based primary production is prioritised and supported.
**Policy 8:** Highly productive land is protected from inappropriate use and development.

Clauses 3.9 and 3.10 of the NPS-HPL are of particular relevance to this review.

| | |
|---|---|
| **Clause 3.9** | Protecting highly productive land from inappropriate use and development. |
| **Clause 3.10** | Exemption for highly productive land subject to permanent or long-term Constraints. |

# 3. Soil Type

Figure 1 shows the HPL areas on the site as mapped by OURENVIRONMENT, with the entire farm being LUC 3.

LUC 3 soils are classified as having "*moderate limitations, restricting crop types and intensity of cultivation, suitable for cropping, viticulture, berry fruit, pastoralism, tree crops and forestry" (OURENVIRONMENT).*

The ability to grow different arable and horticultural crops will also depend on climatic factors, altitude and access to irrigation.


*Figure 1: HPL Land*
*Source: https://ourenvironment.scinfo.org.nz/*

Landvision have undertaken a comprehensive review of the soils including a property inspection. They noted in their report that some soils did not display the productive characteristics of LUC 3 soils. However, for the purposes of this review the soil is assumed to be HPL – LUC 3.

# 4. Solar Farm Configuration

Section 3.2.1 of the AEE states that there will be 188,000 solar panels mounted on single axis tracker (SAT) tables. Whilst there are design drawings in both the AEE and Appendix 12A (Engineering Drawings), they focus on the overall site plan and not specific drawings of the solar panel and table configuration. The design specifications of the solar panels and table are important as they will impact the ability to optimise agricultural productivity.

The dimensions of the SAT panels are documented in the AEE (and Appendix 16) as follows:

i. Panels 2.2m long

ii. Height when horizontal – 1.5m

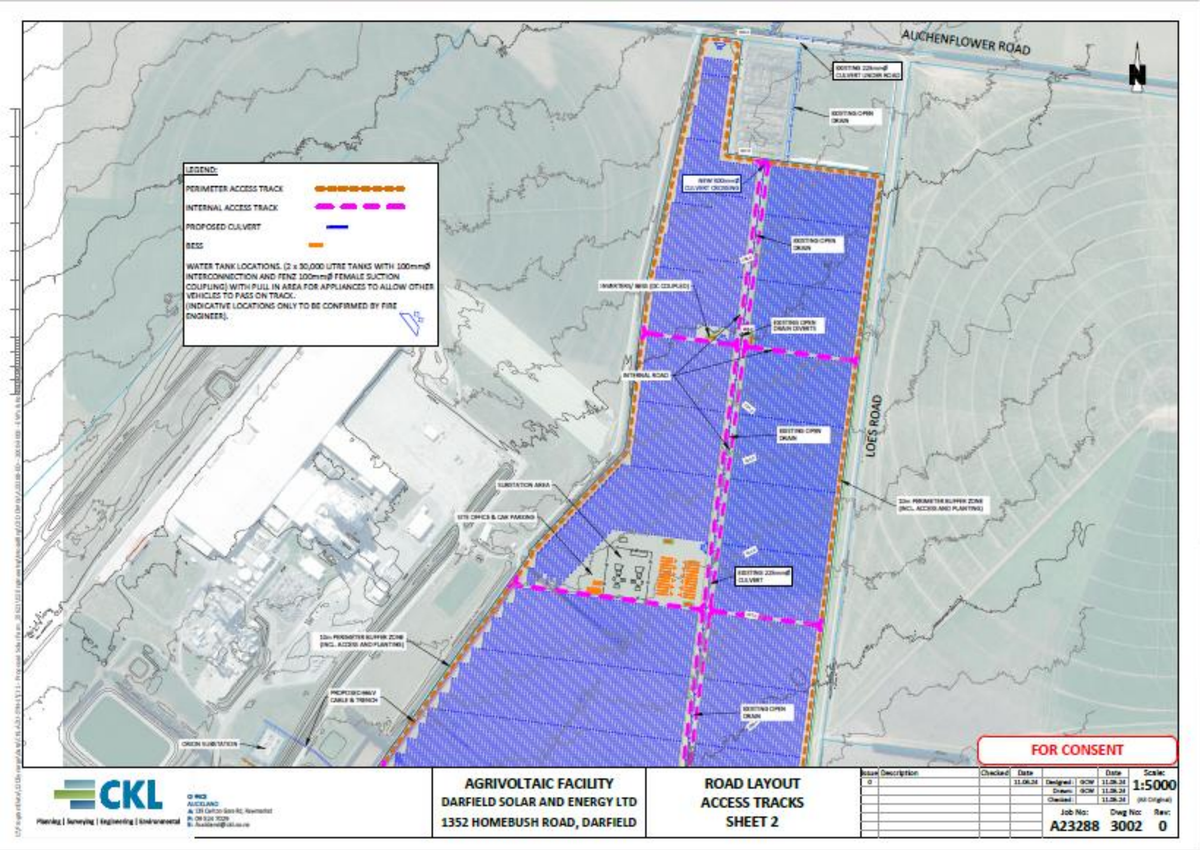
iii. Height above ground when fully vertical – AEE states 0.3 – 0.9m and Appendix 16 states 0.9m. This is an important height as it will impact the movement of sheep under the panels. In my opinion, the minimum height above the ground should be 0.7m to allow for adult sheep to move freely under the panels.

iv. The AEE states *"Each row of solar tables will be separated by an approximately 3.22m gap"* It is assumed that this is the gap between the edge of the solar panels when horizontal. Based on the solar panels being 2.2m long, this would equate to the gap between the poles holding up the panel beds being approximately 5.4m – 5.5m apart. This is an important dimension as it will impact vehicle movements for any agricultural activities. A wider gap is desirable. Other solar farms visited or reviewed have had gaps between the rows of 6.0 – 7.0m.

v. The drive system to rotate the panels throughout the day is not documented. Most SAT solar tables are driven by a power shaft running perpendicular to the tables. Figure 2 shows an example of this. This is a key consideration as this type of drive mechanism seriously impacts the ability to manoeuvre vehicles for agricultural activities such as mowing, drilling, spraying, fertilising and baling etc. It can also impact on the movement of sheep.

vi. The AEE or associated appendices do not document the gap at the end of each row of tables. This is important for turning of vehicles, particularly if they have attached implements, such as mowers, or longer trailing implements. The maps provided in Appendix 12A, shown in figure 3, do not quantify the gap, but they appear too small for large vehicles with attached or trailing implements to turn. The turning area for different machinery would need to be assessed, but it is estimated that a turning area in the order of 10 - 12m would be required depending on the type of vehicle and implement.


*Figure 2: SAT Solar Panel*



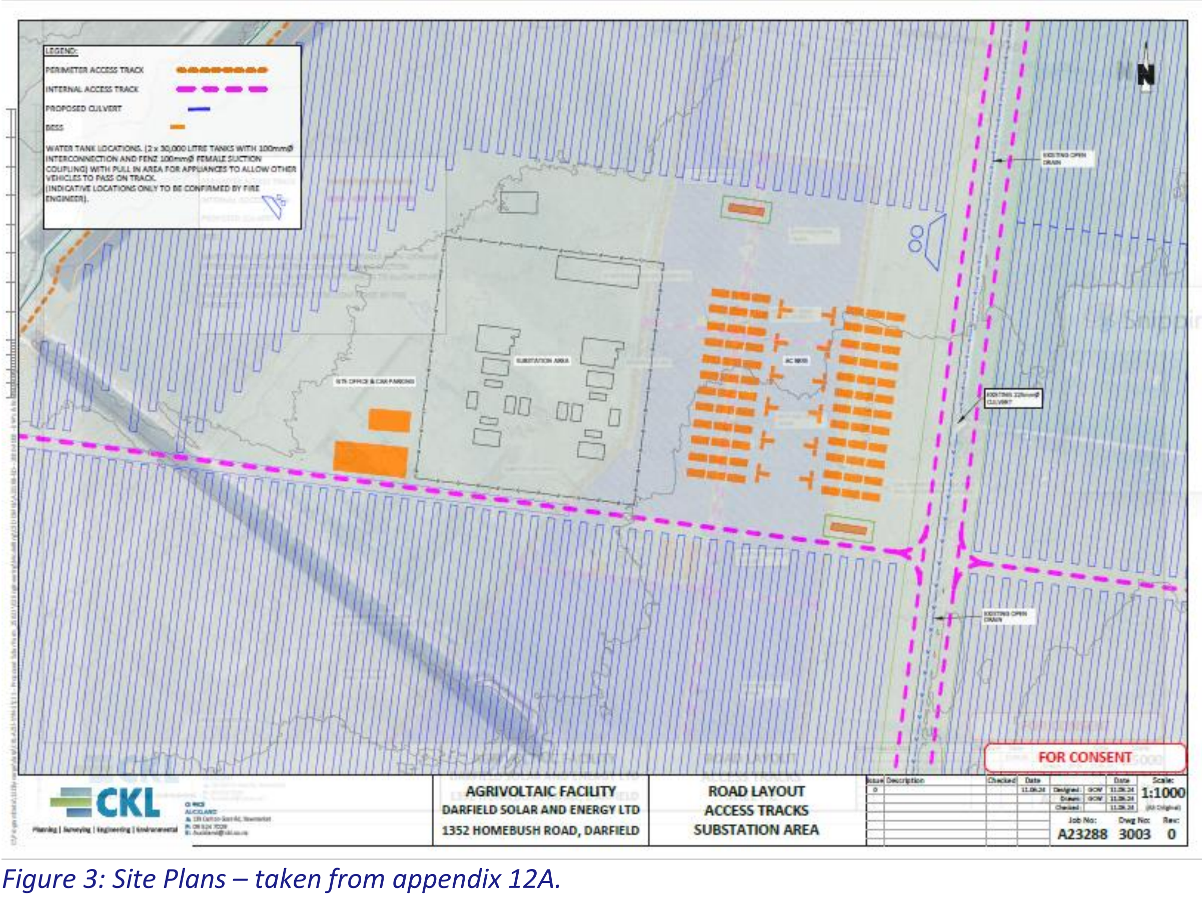




*Figure 3: Site Plans – taken from appendix 12A.*

# 5. Farm Production

## 5.1. Current Farm System

The property is currently farmed as a dryland pastoral farm. Section 4.2 of the LPA states the property is currently finishing lambs and that some fodder crops are grown for the lambs and this forms part of a re-grassing programme. Cereal crops have been grown in the past but with mixed results. It should be noted that other properties in this area successfully grow cereal crops on dryland.

Satellite maps taken from Google Earth show that significant cropping has been undertaken since 2011. Silage or hay making was also undertaken in this time. These maps are displayed in appendix I.

## 5.2. Future Land Use

Currently land uses such as specialist cropping, horticulture and dairying are constrained by either regulations, climate and/or the lack of irrigation. Section 4.2 of the LPA summarised that that potential evapotranspiration (PET) typically exceeds rainfall through the months of October to March. This is typical on the Canterbury Plains and farmers have become adept at designing farm systems that cope with this constraint. The LPA report stated that *"Installation of irrigation on site would require the farm to convert to dairy. Conversion to dairy is no longer a permitted activity."* Whilst it is correct that dairy conversion is no longer a permitted activity, with the appropriate mitigations and management, regulation does not consider conversion to dairy a prohibited activity. Additionally, there are many farmers in this area that have converted to irrigation and farm successfully without having to convert to dairying.

The property is in the Central Plains Water (CPW) Irrigation command area but is currently not a shareholder. CPW have informed that they have ceased allocating any more water in this area as they assess future demand. They are currently seeking submissions from farms in this area who require extra water or want to become new shareholders. If there is sufficient commitment for new water supply, CPW will potentially install a new pipeline, enabling more dryland to be irrigated. The property at 1352 Homebush Road could access water from this pipeline if it was installed, but would have to commit to becoming a shareholder by 31st January 2025. Assuming that the current owners will not meet this deadline, this report has been written on the basis that the property will not attain any irrigation capability.

Despite being unirrigated, the installation of a solar farm will constrain the type of farming that can take place. It is unlikely that any cattle can be grazed as they will damage the panels whilst scratching on them, and it is unlikely that dryland cereal crops will be grown without investment in specialist machinery to plant, fertilise, spray and harvest the crops. Therefore, the most practical farm system will be sheep farming. This is in agreement with the AEE and the LPA report. However, the inability to diversify the type of farm system could impact the productive capacity of the property.

## 5.3. NPS-HPL Compliance

**2.1 Objective** "***Objective:*** *Highly productive land is protected for use in land-based primary production, both now and for future generations*."

Based on the Solar Farm being fully established in pasture for grazing then the farm system meets this objective.

**Clause 3.10 (b)** *(b) the subdivision, use, or development:*

*(i) avoids any significant loss (either individually or cumulatively) of **productive capacity** of highly productive land in the district;*

As stated previously, the inability to diversify farm systems could impact the productive capacity of the property. This will be minimised if the factors discussed in section 5.4.4 are considered and implemented.

There will some loss of productive soils in the substation area and the main access tracks (refer section 5.4.1).

**1.3 Interpretation**

***productive capacity**, in relation to land, means the ability of the land to support land-based primary production over the long term, based on an assessment of:*

*(a) physical characteristics (such as soil type, properties, and **versatility**);*

The construction of the solar farm will impact versatility. However, given the current restrictions of climate and the lack of irrigation, diversification opportunities are minimal.

Based on the property being dryland and provided the productivity of the farm under the solar panels is optimized, as described in section 5.4, then the land should continue to support primary production and the loss of productive capacity will be minimised.

## 5.4. Productive Capacity

Productive capacity under a sheep grazing pastoral system is influenced by 3 main factors:

- Ineffective area lost to agricultural production.
- Total annual feed production and quality.
- Feed utilisation and animal production.

### 5.4.1. Ineffective Area

The loss of area to production under the solar panels would only be near the support poles holding up the solar tables and lost pasture production between the poles due to the inability to crop and re-grass these areas. Other area lost for production are the office/substation/AC Bess area and the access roads where the topsoil has been stripped, as shown in figure 4 ( appendix 12A). It is difficult to assess the cumulative loss of productive area, but it is likely to be in excess of 10 hectares, or 6.5% of the property. However, some of this area may already be ineffective.

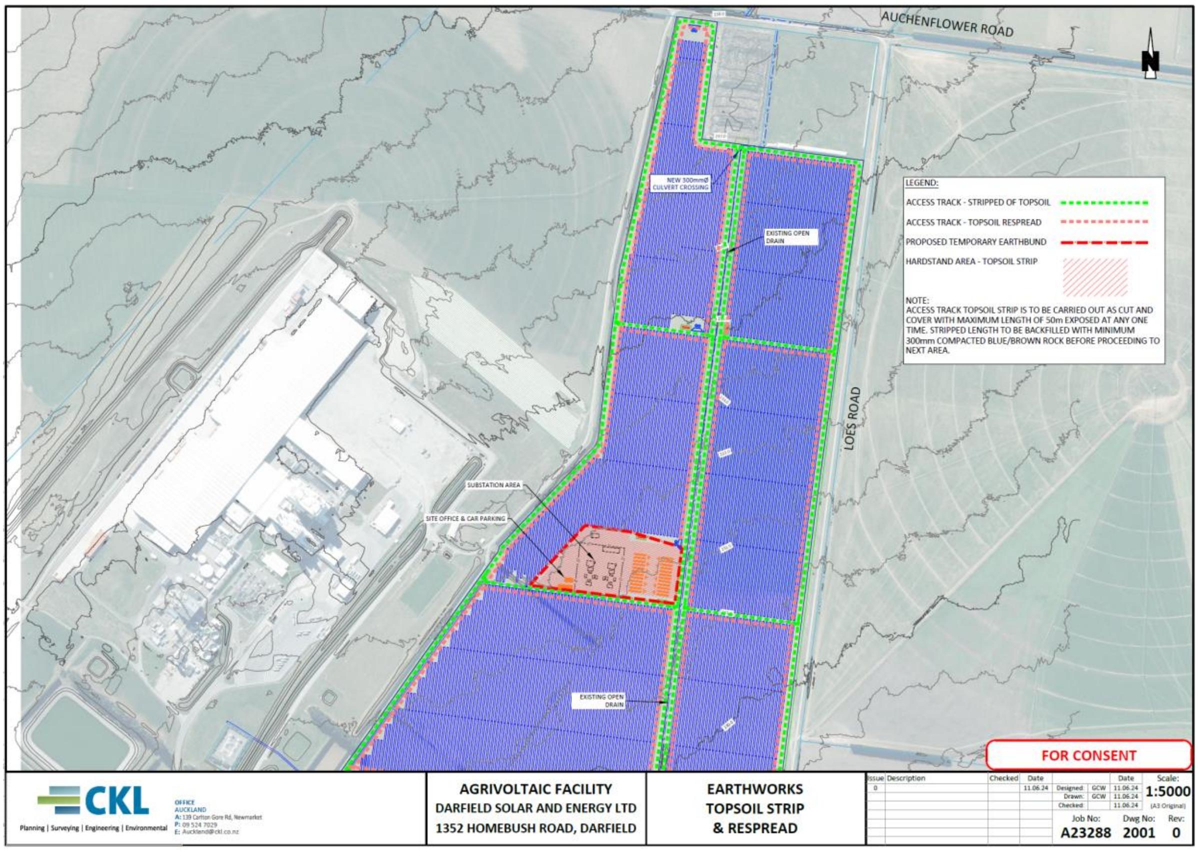


*Figure 4: Potential areas of lost production (Appendix 12A)*

### 5.4.2. Pasture Production

A review of published literature documented a variation in the impact of solar panels on pasture production. The following is a list of some of the literature reviewed:

- An Oregon State University study (Andrew, Higgins, Smallman, Graham, & Ates, 2021) showed similar annual growth in unshaded and partially shaded areas, but lower growth in fully shaded areas. However, feed quality was better in shaded areas.
- A Cornell University Study (Kochendoerfer, C. E. McMillan, M. A. Zaman, S. H. Morris, A. DiTommaso) showed a decline in annual herbage production by 2.5 times in shaded areas and concluded that this was not surprising taking into consideration the vast literature available investigating forage yield in shaded conditions.
- The “Australian Guide To Agrisolar for Large-Scale Solar” report produced by the Clean Energy Council (CEC) did not report any trial work but farmers in Parkes and Dubbo showed improved pasture production during dry periods due to condensation from the panels running off.
- Whilst the Fraunhofer Institute for Solar Energy Systems (ISE) 2020 report focused predominantly on cropping and horticulture, the development of microclimates under Agrivoltaic systems could also enhance pasture production. Grazing under solar panels has been occurring in Europe for a number of years.
- Preliminary results from the first seven months of a study being undertaken at Massey University showed that “*pasture growth was reduced by 84 per cent directly under the panels, but increased by 38 per cent in the larger areas between panels. Pasture growth in both cases was compared to pasture growth in areas away from the panels. Professor Danny Donaghy, who co-led the study, says that direct shading under the panels likely has a negative influence on pasture growth, unlike some previous international research in*

*generally hotter and drier climates. In contrast, in the area between the solar panels, the panels might offer some 'protective' effects, possibly by keeping soil temperatures cooler and also slowing down loss of soil moisture due to wind, compared to an open paddock".* This study is being undertaken under fixed solar panels so there is a large difference in shading under the panels compared to between the panels. The SAT panels being proposed for this site rotate so will not have the same shading impact as fixed panels. The preliminary Massey results demonstrate that there may be a micro-climate impact that could minimise the impact of the solar panels on pasture production.

Differences in climate, pasture types and grazing management need to be considered when comparing grazing systems globally. For example, in Australia some agrisolar systems are in arid climates with no irrigation, have low producing pasture types and low intensity grazing systems with limited subdivision. Similarly, the studies at Oregon and Cornell were undertaken on dryland unimproved pastures. Solar impacts of pasture and animal production in these environments cannot necessarily be transferred to an intensive New Zealand pastoral system.

In the LPA report, studies undertaken on Jacks Solar Garden, a small research facility in Colorado were reviewed. As with a number of other studies it demonstrated that the solar panels impact the distribution of light and moisture and as such can influence the seasonal growth pattern and growth distribution under the panels. As with many other international agrivoltaic studies involving pasture and grazing animals, Jacks Solar Garden is located in a semi-arid region with low rainfall (365mm per annum). It is also at a high altitude (1508m) and has a low mean annual temperature of 9.7°C. This is not a comparable study to the proposed Homebush Solar site which has annual rainfall of 777mm per annum, average annual temperature of 11.6 °C and is at an altitude of approximately 240m.

In summary, the literature available is variable, and the data has been collected in vastly different environments, often with unimproved pasture species and under different solar panel configurations. However, based on the use of the SAT solar panel system, it is possible that the annual pasture production on the proposed solar site will not be negatively impacted, although the seasonal herbage production and distribution of pasture growth under the panels may vary to that outside of the solar farm.

Both the AEE and the LPA report focused primarily on the direct impact of the solar panels on pasture production, with the AEE summarising that *"pasture will still be grown, stock will still graze, and nutrients will cycle through the system"*. However, neither report addressed the importance of other factors such as cropping & re-grassing, fertiliser application, weed control and controlling feed surpluses, and how the introduction of solar panels could impact on the operation of these common farm practises. Section 4.2 in the LPA report discusses the utilisation of forage crops as a form of pasture renewal, but not how this would be undertaken between the solar panels.

To be confident that the proposed solar farm would not constrain the use or productivity of the land sufficiently as described in the LPA report and AEE, details need to be documented of how other factors such as cropping & re-grassing, fertiliser application, weed control and controlling feed surpluses would be undertaken with the introduction of solar panels.

### 5.4.3. Animal Production

International information reviewed typically demonstrated that there is no negative impact on per head performance of sheep grazed under solar panels, and in some cases it improved. This is provided feed quality can be maintained, requiring the control of feed surpluses and the installation of suitable subdivision to enable livestock grazing rotations.

The ability to seek shade on hot summer days should also have a positive impact on production.

### 5.4.4. Key Infrastructure and Management Considerations

Areas of farm operations that could be impacted by the solar farm installation are listed below. The inability to undertake any of these activities effectively is likely to impact pasture growth, quality & utilisation and animal production. How these operations will take place within the solar farm have not been addressed in the AEE or the LPA report.

- Pasture renewal & cropping, including spaying, drilling and cultivation if required.
- Weed control
- Feed Conservation, including mowing, raking baling and bale removal.
- Fertilisation.
- Subdivision & Livestock water.
- Livestock movement

Table 1 Summarises the key operational parameters that could be impacted by the installation of solar panels and what needs to be considered to mitigate any adverse effects.

*Table 1: Potential Operational Impacts and Considerations*

| Operational Activity | Key Design and Plant Considerations |
|---|---|
| Pasture Renewal & Cropping<br>Weed Control<br>Feed Conservation<br>Fertiliser Application | • Drive Shaft for rotating panels*<br>• Width between rows of panels*<br>• Turning area at the end of rows*<br>• Specialist Vehicles and Plant |
| Fencing Subdivision<br>Stock Water | • Planning prior to installation of underground cables for the solar farm<br>• Flexible fencing structures to allow concurrent solar panel access and sheep grazing. |
| Livestock Movement | • Minimum height of panel above the ground when vertical*<br>• Impact of Drive Shaft across rows* |

**Refer section 4. – Solar Farm Configuration*

The areas marked "*" in table 1 are documented in section 4. The importance of these areas should not be underestimated, as restricting vehicle and plant operation could significantly compromise farm productivity and profitability.

Specialist vehicles and plant are likely to be required to undertake the activities listed in table 1 that would normally be undertaken in an open paddock. Adaptions will be required for fitting down rows, reaching under panels and tight turning spaces.

Fencing subdivision and stock water installation are critical for grazing management. Underground cabling could restrict installation of posts and underground water pipes if they are not planned in conjunction with the solar farm.

## 5.5. Summary

Based on the type of solar panels being installed on the site, the grazing of sheep or lambs is the most probable farm system, and this has been identified in both the AEE and LPA report. Some cropping could also take place in conjunction with this, although investment into specialised tailor-made machinery may be required.

It is probable that pasture production can been maintained under the solar panels, provided standard operational practises are not constrained by the design of the solar farm. Of greatest risk is the restriction of vehicle access and movements which will impact key farming practises such as pasture renewal, cropping, fertilisation and making silage or hay. Specialist machinery may also be required so that maximum coverage under the panels can be achieved.

It is important that the solar farm design does not negatively impact livestock movements and subdivision and stockwater infrastructure will be required for effective livestock grazing rotations.

Assuming that pasture production is not adversely impacted by the solar panels or the solar farm design, and that sheep can be grazed effectively under the panels, then the productive capacity of the land may be reduced but not lost from land based primary production.

## Disclaimer

*Neither the author or Macfarlane Rural Business (MRB) are formally trained in policy and planning or experts in solar electricity generation. MRB consultants are land-based agriculturalists focused on optimising physical production and financial viability of primary production systems.*

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## Appendix I: Historic Cropping Maps

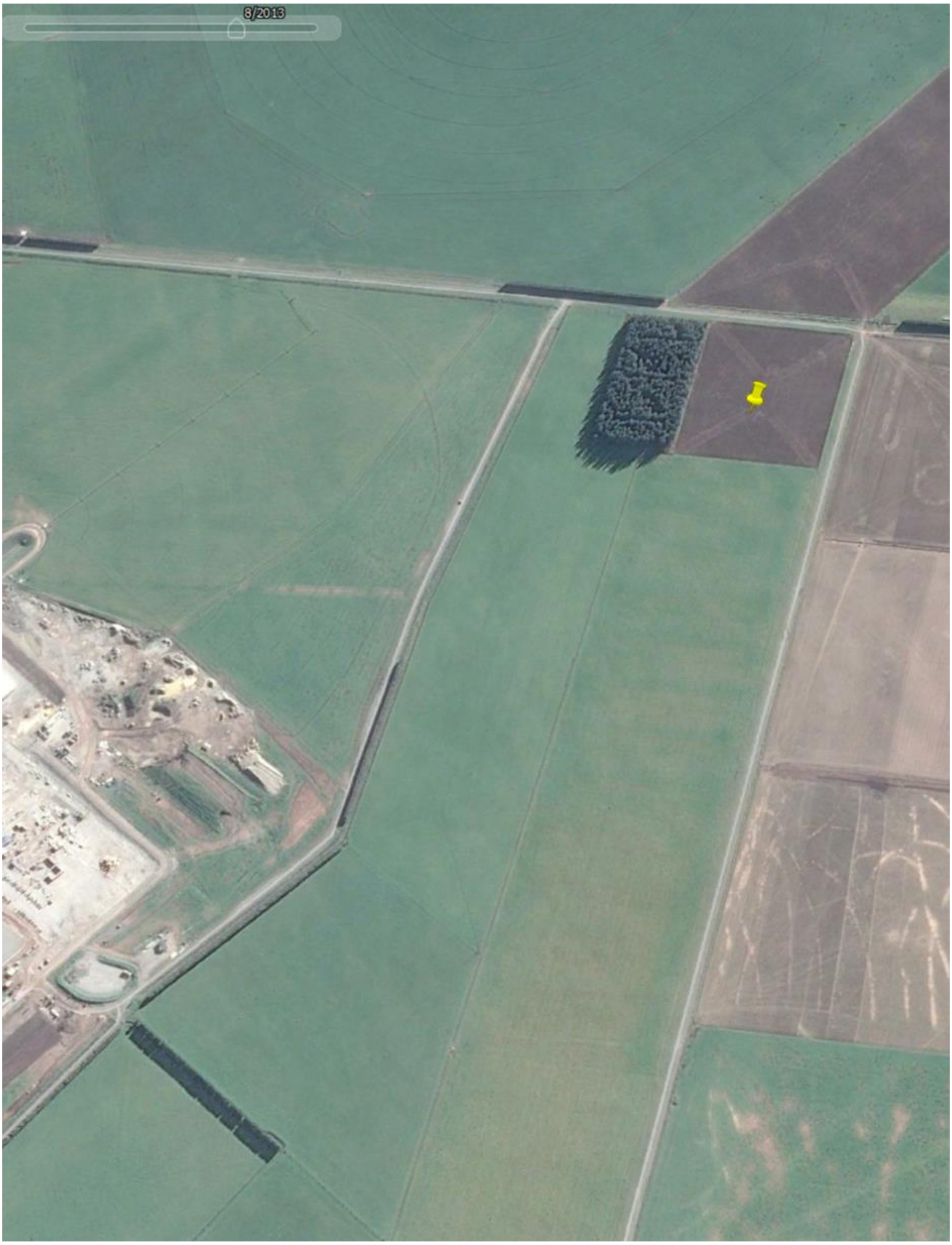
The yellow markers indicate cropped paddocks and the red markers show paddocks that have been mown, probably for silage or hay.

*March 2023*

*March 2021*

*October 2015*

*March 2013*



*February 2011*

## Appendix II: Literature Review Sources

American Solar Grazing Association
National Renewable Energy Laboratory (NREL)
Climate Energy Council (CEC) - Australian Guide to Agrisolar for Large-Scale Solar
Solar Power Europe
University of Sheffield, UK
Oregon State University study (Andrew, Higgins, Smallman, Graham, & Ates, 2021)
Cornell University Study (Kochendoerfer, C. E. McMillan, M. A. Zaman, S. H. Morris, A. DiTommaso)
Fraunhofer Institute for Solar Energy Systems (ISE) 2020 - Agrivoltaics: Opportunities for agriculture and the energy transition - A guideline for Germany
Massey University,NZ