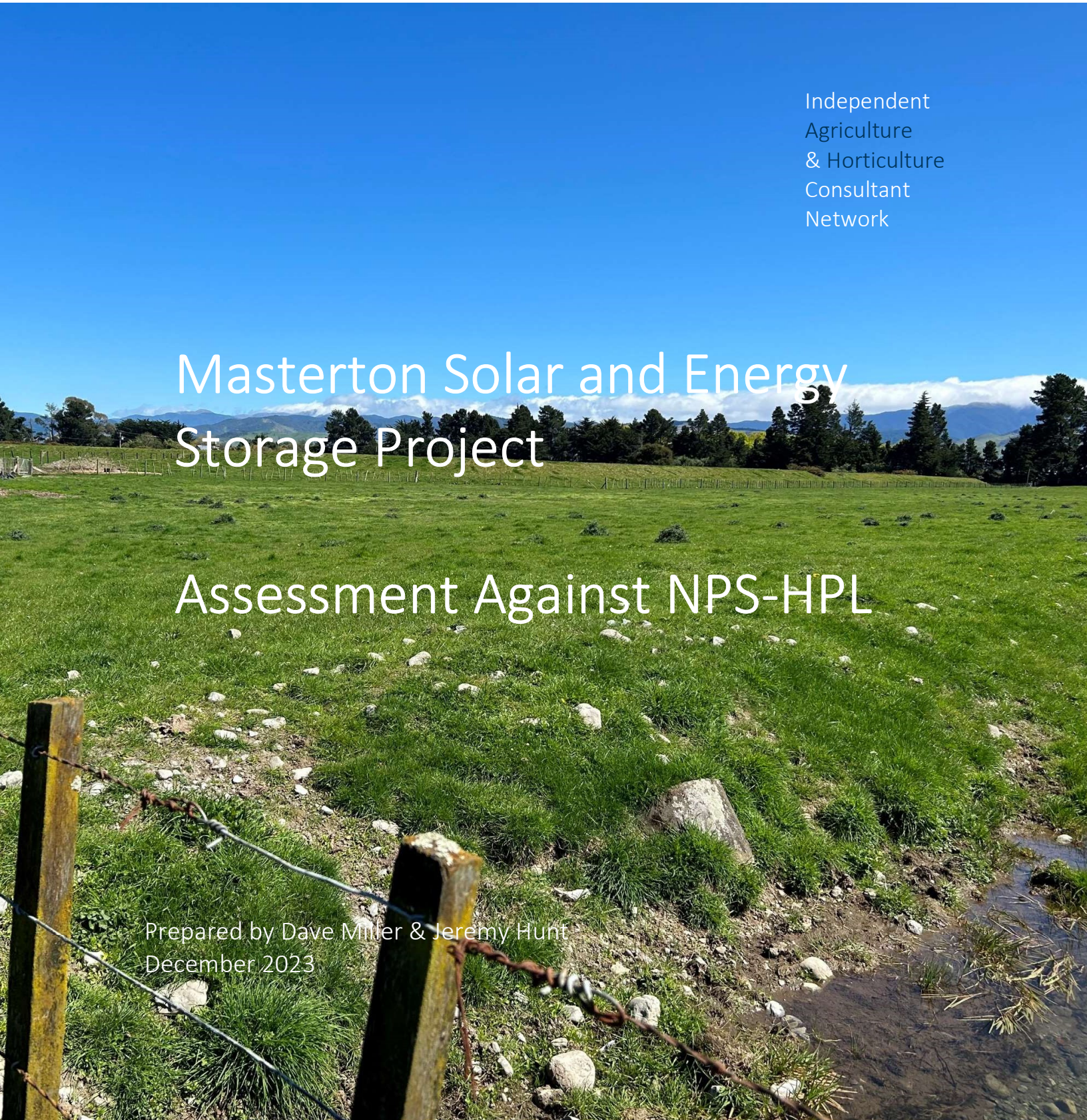
APPENDIX 9 LAND USE CAPABILITY ASSESSMENT

AGFIRST

Independent
Agriculture
& Horticulture
Consultant
Network

Masterton Solar and Energy Storage Project

Assessment Against NPS-HPL



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DOCUMENT QUALITY ASSURANCE

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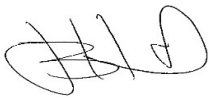
Reviewed by:	Jeremy Hunt B.Sc(Env), MNZIPIM Agribusiness Consultant	
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1.0 EXECUTIVE SUMMARY

Masterton Solar and Energy Storage Ltd, trading as NZ Clean Energy (**NZCE**), is proposing to construct and operate a solar panel farm near Masterton with an operational life of 40 years (the **Project**), which will generate and deliver power to the National Grid via a connection at Transpower's nearby Masterton substation.

AgFirst Waikato (**AgFirst**) has been engaged by NZCE to provide:

(i) An assessment of the proposed use of the land for the Project against the provisions of the National Policy Statement – Highly Productive Land (**NPS-HPL**); and

(ii) Advice on how to manage a sheep operation within the Project, taking into account the land type and environmental conditions in the Masterton area.

The project will be located on a 147.0 ha Rural Zoned property which is largely square in shape. The Project is bordered to the north by an Industrial Zone and State Highway 2. Cornwall Road and Hughes Line form the Project boundary to the East and South respectively, while adjacent to the West is an 85 ha pastoral block. Also located within the Site (covering an estimated 28.2 ha) is a Contaminated Site[1].

The solar panels will be installed on pile driven steel posts which also support a mechanism for rotating the panels (the Tracking System). The installation system means minimal disruption to the soil's physical properties, and ensures a straightforward reinstatement of the land at the end of the project if required.

At the time of the day when the panels are positioned horizontal to the ground (and approximately 1.8m above the ground), the temporary footprint of the panels and other solar infrastructure equates to approximately 40% of the site. This fully horizontal position occurs temporarily in the middle of the day, but the shading impact from the panels will be considerably less than this for the majority of the day, dropping to under 10% of the site. This is due to the gradual movement of the panels and their height above the ground.

Once the solar panels are installed, NZCE plans to graze sheep amongst the panels to maintain an agricultural land application in addition to the generation of clean renewable electricity. The practice of grazing sheep under solar panels and within solar farms has been successfully implemented overseas in Australia, the United Kingdom, Europe and America.

The site has approximately 67.1 ha of Land Use Capability (**LUC**) 3s2 land. This qualifies as Highly Productive Land (**HPL**) and is subject to the provisions of the NPS-HPL as a national order policy document considered during the Carterton District Council decision-making process for a district resource consent NZ Clean Energy has applied for. The remaining land is LUC 4s1 and is not subject to the NPS-HPL.

[1] Wairarapa Planning Maps

The block currently runs around 150 Perendale ewes and lambs, and up to 30 rising one year old (R1yr) cattle. Currently the property is farmed sub optimally as it is a support block for a larger farming operation some distance away.

Of the total area, 32 ha is currently able to be irrigated however, it is not currently being fully utilised. This is because current low returns for sheep meat make the cost of pumping and managing the irrigation infrastructure economically marginal. Furthermore, the current groundwater take consent is up for review in 2025 and given water is over allocated in the area, it may not be renewed.

The NPS-HPL, provides a number of "tests" which proposed developments on HPL must satisfy. The proposal outlined satisfies sub-clause 3.9(2)(g) and 3.92(j)(i) in particular:

(2) A use or development of highly productive land is inappropriate except where at least one of the following applies to the use or development, and the measures in subclause (3) are applied:

- *(a) it provides for supporting activities on the land:*
- *(b) it addresses a high risk to public health and safety:*
- *(c) it is, or is for a purpose associated with, a matter of national importance under section 6 of the Act:*
- *(d) it is on specified Māori land:*
- *(e) it is for the purpose of protecting, maintaining, restoring, or enhancing indigenous biodiversity:*
- *(f) it provides for the retirement of land from land-based primary production for the purpose of improving water quality:*
- ***(g) it is a small-scale or temporary land-use activity that has no impact on the productive capacity of the land:***
- *(h) it is for an activity by a requiring authority in relation to a designation or notice of requirement under the Act:*
- *(i) it provides for public access:*
- ***(j) it is associated with one of the following, and there is a functional or operational need for the use or development to be on the highly productive land:***
  - ***(i) the maintenance, operation, upgrade, or expansion of specified infrastructure:***
  - *(ii) the maintenance, operation, upgrade, or expansion of defence facilities operated by the New Zealand Defence Force to meet its obligations under the Defence Act 1990:*
  - *(iii) mineral extraction that provides significant national public benefit that could not otherwise be achieved using resources within New Zealand:*
  - *(iv) aggregate extraction that provides significant national or regional public benefit that could not otherwise be achieved using resources within New Zealand.*

(3) Territorial authorities must take measures to ensure that any use or development on highly productive land:

(a) minimises or mitigates any actual loss or potential cumulative loss of the availability and productive capacity of highly productive land in their district; and

(b) avoids if possible, or otherwise mitigates, any actual or potential reverse sensitivity effects on land-based primary production activities from the use or development.

(4) Territorial authorities must include objectives, policies, and rules in their district plans to give effect to this clause.

Sub-clause 3.9(2)(j)(i) is the primary avenue for consideration in this case, and is summarised below:

- The NPS specifically identifies energy projects as lifeline utilities. Developing a suite of different renewable energy sources is understood to be necessary to enhance energy security.
- NZCE satisfies the definition of a lifeline utility
- The need to develop, operate, maintain and upgrade renewable electricity generation activities throughout New Zealand is recognised as being nationally significant under the NPS for Renewable Electricity Generation 2011.
- Solar operations require land with less than 5 degree slope for optimal efficiency
- Solar operations are ideally located in close proximity to suitable substations to avoid transmission losses.
- Solar operations require scale in order to be commercially viable
- Solar operations require reliable sunshine hours
- The proposed sheep grazing operation minimises loss of agricultural productivity.

With regard to sub-clause 3.9(2)(g), AgFirst summarises:

- The project has a defined operational life.
- The development and the retirement of the project in 40 years' time will have minimal impact of physical characteristics, soil type or subsequent land use versatility of the site.
- There is already evidence of a contaminated soils across part of the site limiting future versatility

Regarding the ability to successfully graze sheep on the land within the Project, AgFirst have recommended the following guidelines:

- Self-contained system without the need to utilise external grazing
- No cattle to be grazed on the block
- Good pasture management, i.e. avoidance of long rank pastures
- Simple system minimising the number of mobs run
- Flexibility to cope with variable pasture growth

A trading stock scheme will provide maximum flexibility to adapt to difficult summer dry conditions. By implementing the system outlined above, AgFirst believes a viable sheep grazing operation can be successfully implemented on the land within the Project Site.

1.0 BACKGROUND

NZ Clean Energy (**NZCE**) is proposing to establish an agrivoltaic development, also known as a solar farm, within the subject site. This development will occupy approximately 138 ha of the subject site, as indicated in Figure 1 below and is hereon referred to as the development area. This will include erecting solar panels (photovoltaic modules), inverters, transformers, battery energy storage system (**BESS**), a substation, and a site office.

The solar panel farm located near Masterton will have an operational life of 40 years, which will generate and deliver power to the National Grid via a connection at Transpower's nearby Masterton substation. The energy generated is expected to supply approximately 35,000 homes per year. It is anticipated that it will save approximately 130,000 tonnes of CO2 per year through providing electricity from a renewable source as opposed to fossil fuels.

The Project sits within the Carterton District. AgFirst has been engaged by NZCE to provide:

(i) An assessment of the proposed use of the land for the Project against the provisions of the NPS-HPL; and

(ii) Advice on how to manage a sheep operation within the Project, taking into account the land type and environmental conditions in the Wairarapa area.

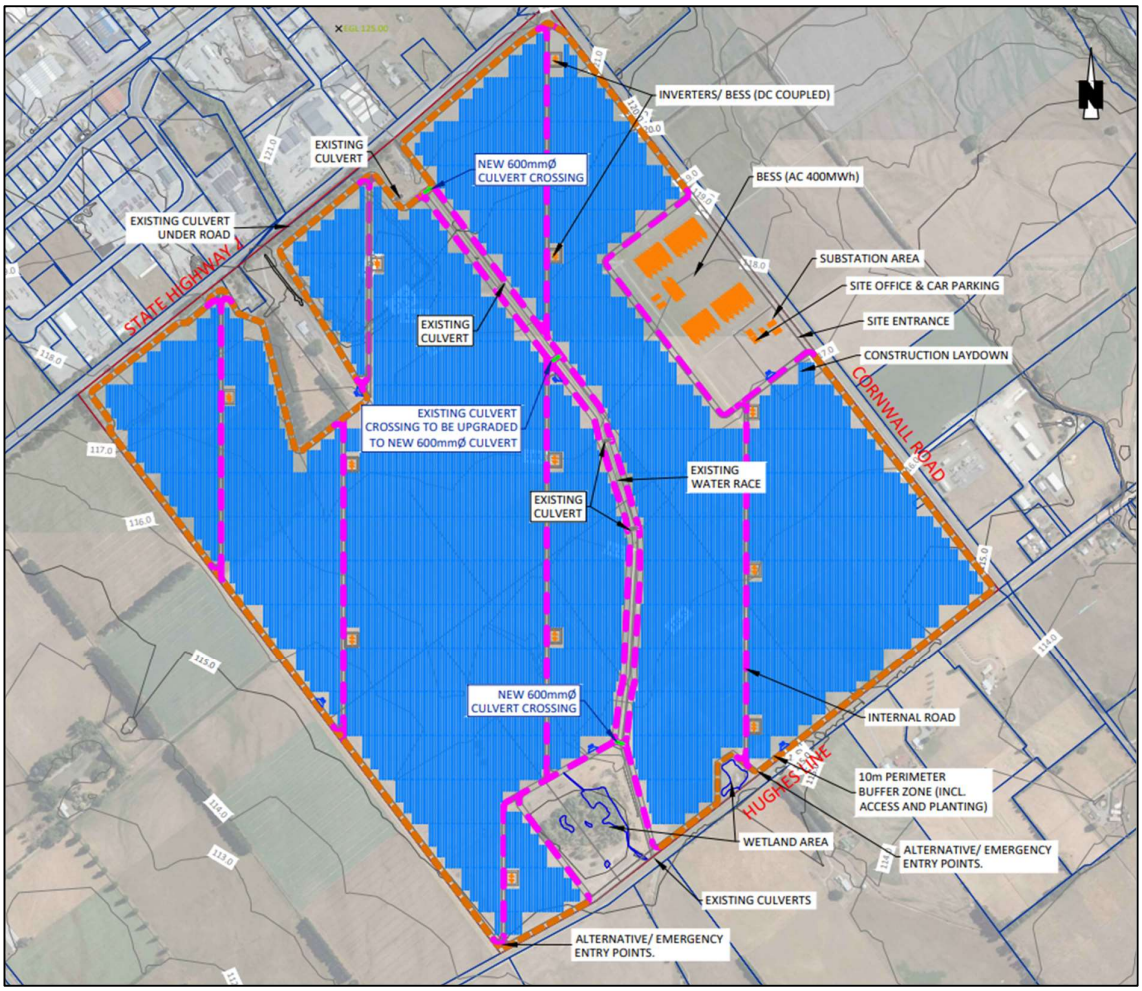

Figure 1: Proposed Site Plan

2.0 PROPERTY DESCRIPTION

2.1 Site Description

The Project will be located at 3954A State Highway 2, within the area of Waingawa. The Project is approximately 147 ha and comprises 8 records of Title (RTs) summarised in Table 1. The Project Site is roughly a square shape with flat contour. The Site is zoned rural, as is the immediately surrounding areas to the north-east, south and south-west, with industrial zone immediately to the north. The industrial area contains a composting site, container storage, several engineering firms and the Wairarapa mill. There was historically a meat works (decommissioned) in the industrial area which owned the Project Site prior to the current owner. It is unknown if the contaminated area may have had something to do with this previous use. Located adjacent to the south-eastern corner of the Project Site is the Masterton substation, which forms part of the national power transmission network. The location of the Project Site and surrounding areas is presented in Figure 2.

Table 1: Individual property Titles within the Project

#	RT Ref.	Legal Description	Area (ha)
1	WNF1/1189	Pt Lot 2 DP 2099	27.9819
2	WNF1/1188	Pt Lot 3 DP 2099	28.313
3	WN17B/749	Pt Lot 1 DP 46533	50.0816
4	WN765/45	Lot 1 DP 19148	0.0376
5	WND1/413	Pt Lot 4 DP 2099	13.8024
6	WN638/13	Lot 1 DP 17189	3.0461
7	WN248/15	Lot 1 DP 3447	9.9947
8	WN213/272	Pt Lot 4 DP 2099	13.7593
Total			147.0166

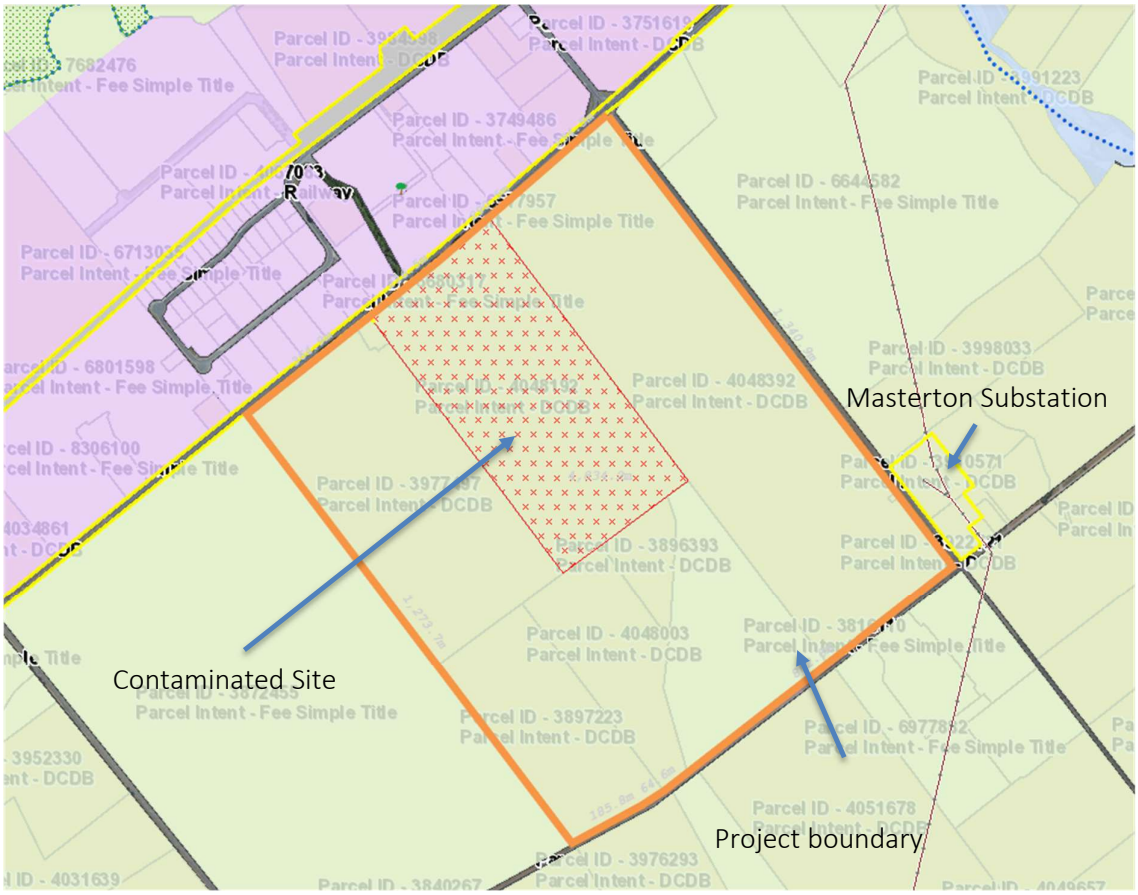

Figure 2: Property location and surrounding titles

2.2 Farming Operation

Our understanding is that historically the Project Site was farmed with a winter and summer cropping program utilised to support a livestock farm. The traditional cropping policy was a year in a winter kale crop followed by a summer crop of either rape or forage brassica and then back into permanent pasture. The cropping rotation consisted of approximately 15 to 20 ha each year. Due to the soil type, the crops needed to be direct drilled as conventional cultivation will bring stones to the surface.

In recent years a lower intervention style of farming has been adopted with no cropping. Stock numbers have been typically 150 Perendale ewes and lambs, and up to 30 rising one year old (R1yr) cattle. The property is now used in conjunction with a larger 3,500 ha hill country farm, Manahau Station, on the East Coast of Wairarapa. As such it is used to provide a feed buffer and is stocked to a level that allows flexibility.

Moving forward there will be no cattle grazing. The sheep system will be dominated by a trading enterprise that allows for maximum stock numbers through winter spring and the ability to offload as the summer dry begins.

The pattern of pasture growth is very seasonal with more reliable winter and spring growth rates. Summer and autumn growth rates are determined by the impact of any summer dry.

Stock numbers over winter are expected to be 10-12 SU/ha and may drop down to 5-6 SU/ha over summer months and match the stocking policy with seasonal growth rates.
The farm has an irrigation system on approximately 32 ha but this is currently not being used to its full potential.

2.3 Irrigation

Currently the property holds a water consent for irrigation purposes. The consent expires in September 2025.

Given the region is currently overallocated for ground water takes, there is some concern that this consent may not be renewed in its entirety at that time.

Accordingly, planning for future stock numbers is on the basis that the groundwater take consent application is unsuccessful. The Consent is Provided in Figure 3.

The current irrigation infrastructure allows for 32 ha to be irrigated, and if the system was run at 100% efficiency and for 100% of the time this allows for 430 mm of water to be applied to those 32 ha.

The LUC 3 land to the east of the Project Site is estimated to grow 7-9 tDM/ha without irrigation and 10-12 tDM/ha with irrigation. The location of the irrigation block is presented in Figure 4.

Consent No. WAR150207 [33429] **Category: Water permit Groundwater take**

Pursuant to sections 104B and 108, and subject to all the relevant provisions of the Resource Management Act 1991 and any regulations made thereunder, a consent in respect of a natural resource is hereby granted to:

Name	Old Waingawa Trust No. 2, Raymond Owen Busby and Independent Trust Company (2021) Limited as trustees (transferred from RO and JD Busby effective 28 July 2022)	
Address	C/- RO Busby, 301 East Taratahi Road, East Taratahi, RD 7, Masterton 5887	
Duration of consent	Granted: 24 April 2015	Expires: 30 September 2025
Purpose for which right is granted	To take and use groundwater from bore S26/0218 (3I/106/41(61)/I) for irrigation purposes	
Location	State Highway 2, Waingawa, Carterton At or about map reference NZTM 1808188. 5432916	
Legal description of land	Part Lots 2, 3, 4 DP 20991 Lot 1 DP 3447 Lot 1 DP 17189 Part Lot 1 DP 46533 Lot 1 DP 19148 Blocks VII, VIII Tiffin SD Valuation Reference No. 18160-012-00	
Water meter ID number	S26/0218	
Volume/Quantity/Rate	To take up to 142,560m³/year, at 950.4m³/day, at a maximum pumping rate of 11 litres/second	
Conditions	1-9 as attached	

For and on behalf of
WELLINGTON REGIONAL COUNCIL

Figure 3: Water take consent for irrigation

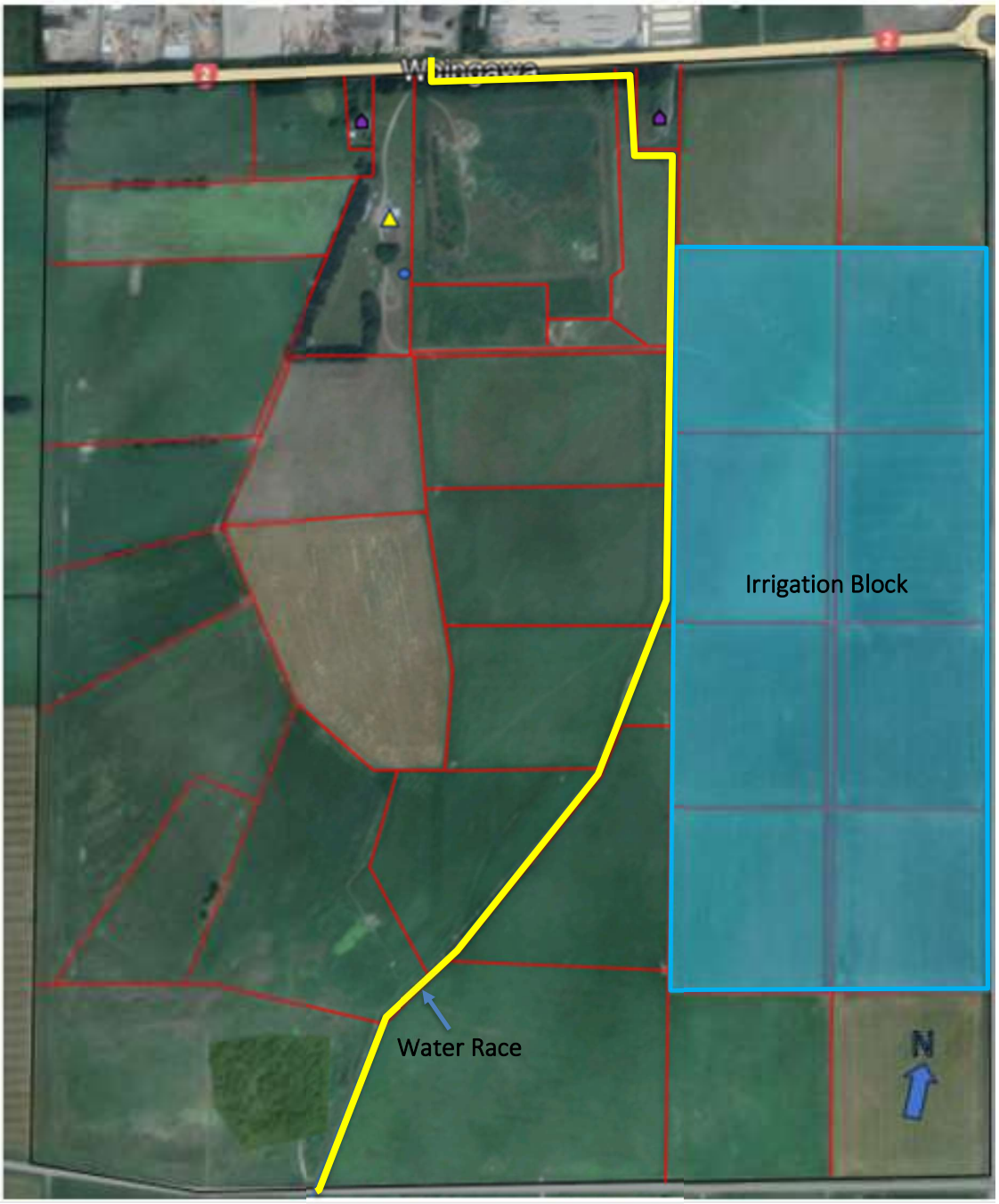

Figure 4: Irrigated block (blue shading) and water race (yellow line) on Project Site

2.4 Soils

Soils on the farm are varied, with the soils on the eastern side of the water race being predominantly poorly drained recent alluvial soils over a clay subsoil with stones and a few rocks. The depth of the soil ranges from 20-40 cm, and there is evidence of considerable mottling in the subsoils This indicates that wetness being a limiting factor over the winter months. On the western side of the water race the soils are considerably shallower (5 cm) with gravel subsoils. These soils are well drained, but as a result dry off considerably faster. There is evidence that some of the gravel has been removed from some paddocks (de-gravelled) and

put into piles. While the land to the east of the water race is the most productive area of the property, in this environment it is reliant on both drainage and irrigation to grow acceptable pasture yields.

The soil depiction from the Site visit closely aligns with the Manaaki Whenua Landcare Research S-Map (S-Map) drainage representation (Figure 5).

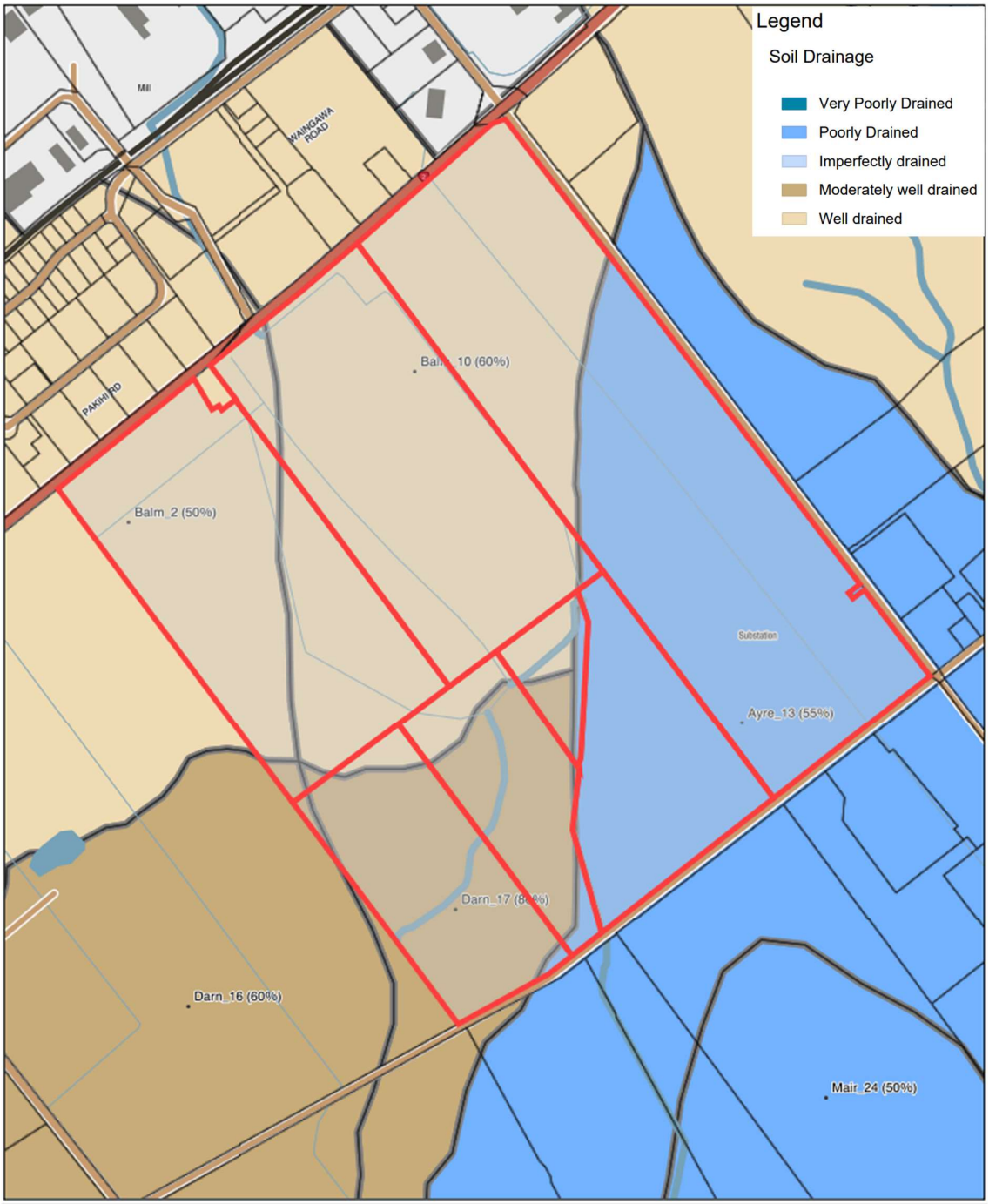

Figure 5: S-Map representation of the Project Site

3.0 CLIMATE CHANGE

A consideration for the Project with regard to the NPS-HPL is the likely impact of climate change over the life span of the 35 years.

The following data is taken from the Wellington Regional Council climate forecasting tool. Figure 6 is the projected increase in hot days (>25°C) over the next 30 years. The site is expected to experience an additional 20 to 30 hot days annually by 2050 and 50 to 60 additional hot days by 2100 (Figure 7).

While the Land Use Classification (LUC) will remain as LUC 3s2, climate change is likely to negatively impact its productive potential. Ryegrass pastures are compromised at temperatures over 25°C. There is already concern about the likelihood of the irrigation water consent being renewed in 2025 and the subsequent reduction in productivity. The increase in temperature due to climate change is likely to further reduce the productive potential of this site even further.

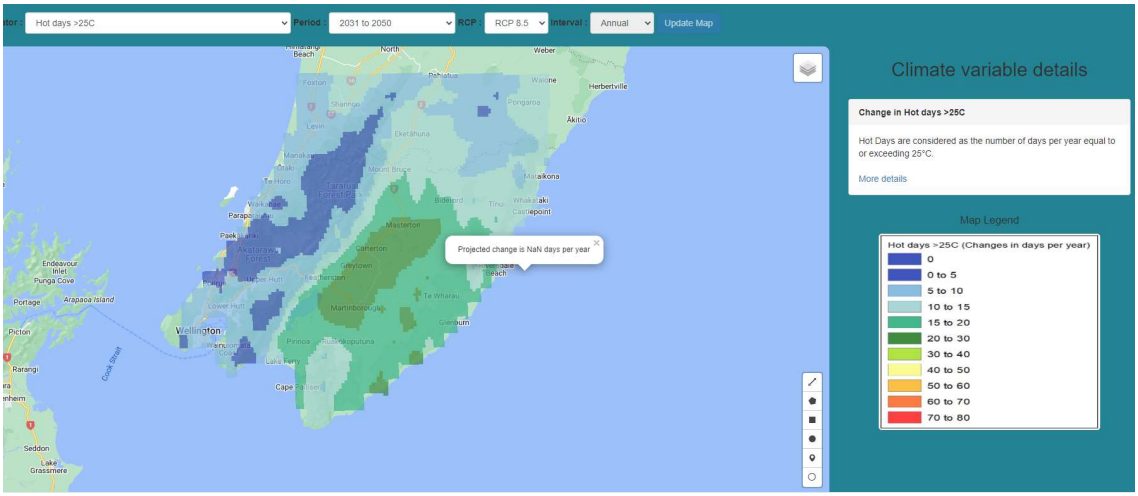

Figure 6: Increase in days over 25 degrees by 2050

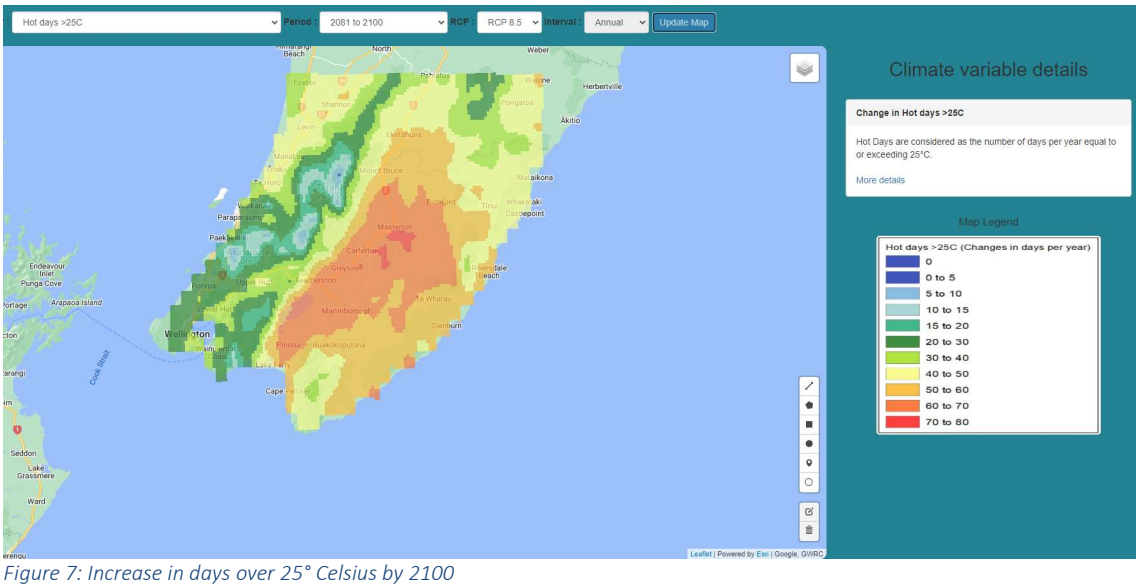

Figure 7: Increase in days over 25° Celsius by 2100

3.1 Surrounding Land

To the northwest across State Highway 2 the land is zoned for industrial purposes. The surrounding farmland is predominantly sheep and cattle grazing. Stock policies vary depending on whether there is access to irrigation water. Given the pronounced seasonal pattern of pasture production, typically trading stock operations are used because these provide flexibility to destock when the inevitable summer dry becomes pronounced.

3.2 New Proposed Land Use

NZCE are proposing to establish the Project across the full development area.

The existing woolshed, dwelling, utility sheds, stockyards, water races (including the Taratahi water race / Waikoukou Stream) and the shelterbelts along State Highway 2 and to the immediate west of the stockyards will be retained. The existing shelterbelts located along the boundary with State Highway 2, as well as those around the perimeter of the woolshed and adjacent utility sheds will be trimmed. The trimmed height of the shelterbelts will be maintained to stay between 2-3 m. All other trees and shelterbelts within the footprint of the Project Site are proposed to be removed.

The solar panels will be installed on pile driven steel posts. A Tracking System enables the panels to rotate slowly east to west over the course of the day to follow the sun and maximise solar generation. Each solar panel is approximately 2.4 m x 1.2 m and is installed in rows across the site. The height of the solar panels from the ground ranges from 0.9 m to 2.8 m depending on the time of the day (and the associated angle of the solar panels).

At the time of the day when the panels are positioned horizontally to the ground (approximately 1.8 m above the ground), the temporary footprint of the panels and other solar infrastructure equates to 40% of the ground cover across the site. This fully horizontal position occurs for a short period in the middle of the day to follow the sun and maximise solar generation, but the shading impact from the panels will be considerably less than this for the majority of the day due to the gradual movement of the panels, and their height above the ground as the panels move east to west tracking the sun. The solar module and mounting is provided in Figure 8.

Supporting infrastructure such as electrical cabling will be trenched and buried.

As discussed throughout this report, sheep grazing will be carried out on the land as a primary agricultural application.

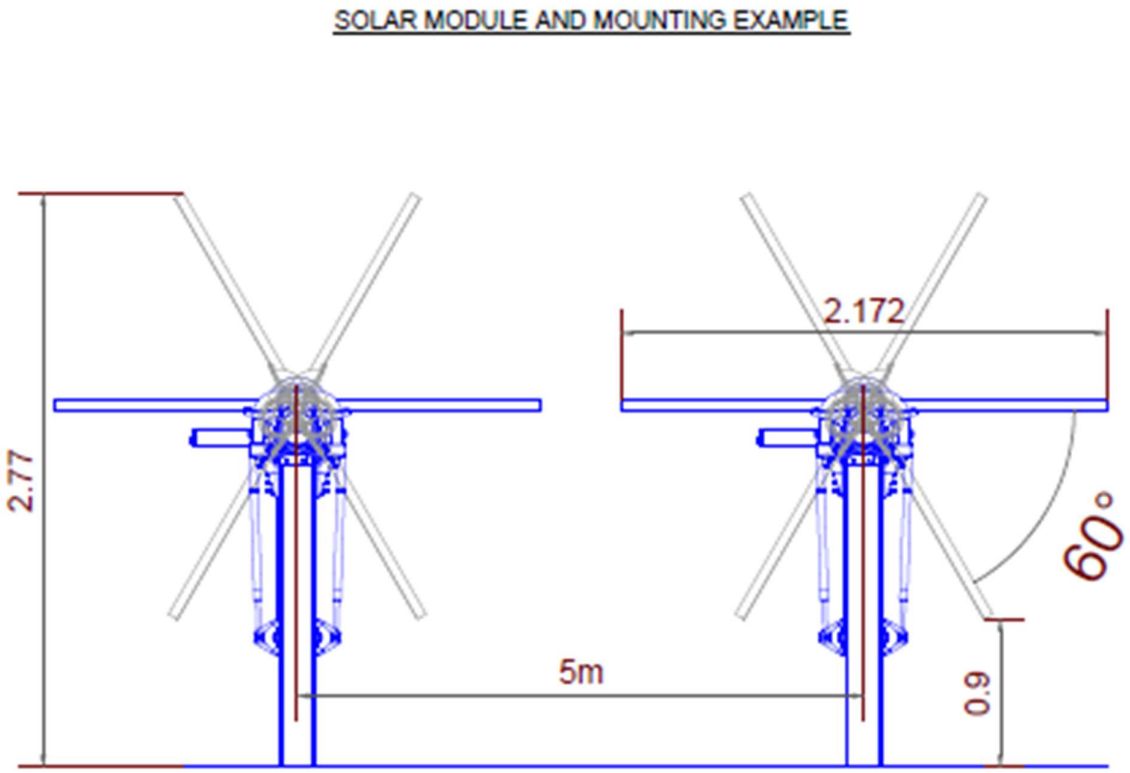

Figure 8: Typical solar panel and tracking system configuration. Source: NZ Clean Energy

3.3 Lease Agreement

NZCE has an agreement to proceed with a 40-year lease agreement for the part of the subject site proposed to be occupied by the development, should all relevant grid connection and resource consent approvals be successfully obtained. The current landowner will retain ownership of the site for the duration of the proposed operation of the solar development.

At the end of the 35-year operational period for the development, it is proposed that the site will be decommissioned to enable the site to return to its current agricultural use. Most of the plant associated with the development is not permanently affixed to the site, either just pile driven into the ground (without concrete being poured) or located on concrete piles. As such, the removal of the bulk of the development infrastructure will simply require the uplift of all of the plant via heavy vehicles.

There will be some soil disturbance associated with removal of the concrete piles and any underground wiring and cables. This will be minimal, and readily managed through implementation of appropriate sediment and erosion control measures, based on industry and council best practices and standards.

4.0 ASSESSMENT OF LAND USE CAPABILITY CLASSES

4.1 Regulatory Framework for Highly Productive Land

The property falls under the jurisdiction of the Masterton District Council and the Greater Wellington Regional Council.

The NPS-HPL came into effect on the 17th of October 2022. The statement sets out a prescriptive approach for councils to identify and protect highly productive land. Until councils have given effect to the NPS-HPL, the interim is provided:

3.5 (7) Until a regional policy statement containing maps of highly productive land in the region is operative, each relevant territorial authority and consent authority must apply this National Policy Statement as if references to highly productive land were references to land that, at the commencement date:

(a) is (i) zoned general rural or rural production; and

(ii) LUC 1, 2, or 3 land;

LUC 1, 2, or 3 land is defined as: land identified as Land Use Capability Class 1, 2, or 3, as mapped by the New Zealand Land Resource Inventory (NZLRI) or by any more detailed mapping that uses the Land Use Capability classification.

4.2 NZLRI Assessment of Soils LUC

The LUC Classification system is used in New Zealand to help achieve sustainable land development and management on farms. The LUC classification categorises land areas or polygons into classes, subclasses, and units according to the land's capability to sustain productive use. This is summarised in Figure 9 below.

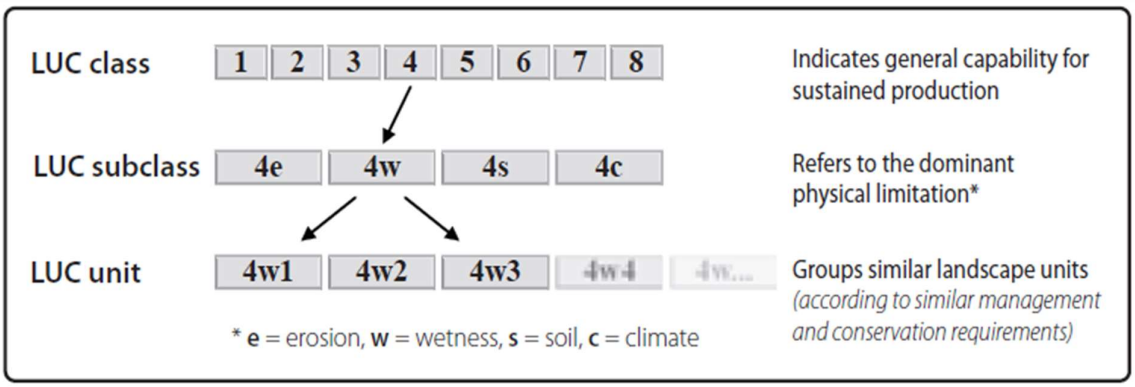

Figure 9: Components of the land use capability classification

The soils mapped at the property are classified under the NZLRI as LUC 3s2 and 4s1. The 3s2 land qualifies as highly productive land and is subject to the NPS-HPL. The location of the proposed Project in relation to the soil classifications is presented in Figure 10. Based on the NZLRI LUC map, 61.7 ha of the Project Site is LUC 3s2, with 79.3 ha being LUC 4s1.

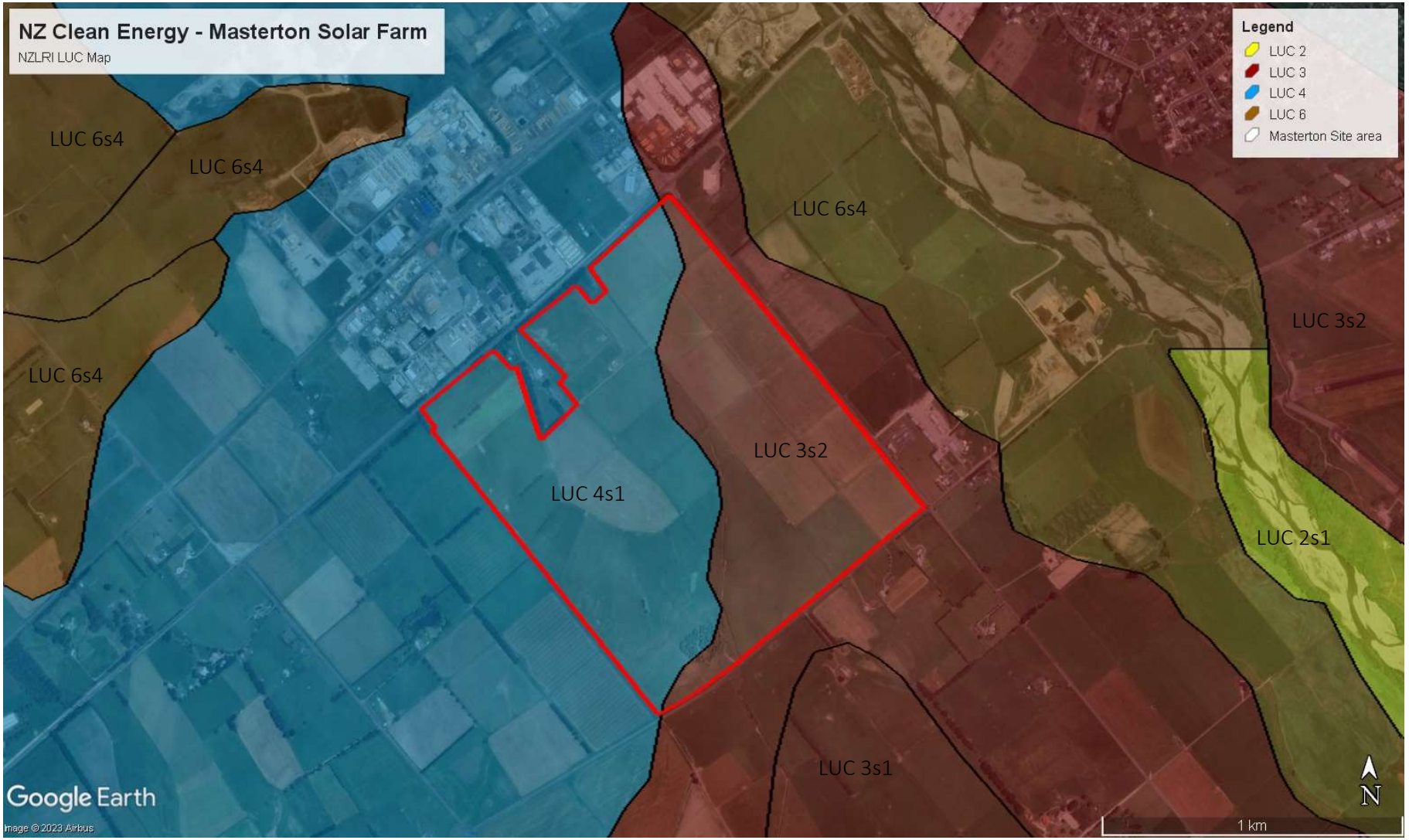

Figure 10: Land use classification for the project property

5.0 PROTECTION OF HIGHLY PRODUCTIVE LAND

The primary objective of the NPS-HPL is "*Highly productive land is protected for use in land-based primary production, both now and for future generations*". The NPS however does recognise that there are certain situations where the development of HPL is appropriate, as outlined in clause 3.9(2)(g) and 3.9(2)(j)(i).

(3) A use or development of highly productive land is inappropriate except where at least one of the following applies to the use or development, and the measures in subclause (3) are applied:

- *(a) it provides for supporting activities on the land:*
- *(b) it addresses a high risk to public health and safety:*
- *(c) it is, or is for a purpose associated with, a matter of national importance under section 6 of the Act:*
- *(d) it is on specified Māori land:*
- *(e) it is for the purpose of protecting, maintaining, restoring, or enhancing indigenous biodiversity:*
- *(f) it provides for the retirement of land from land-based primary production for the purpose of improving water quality:*
- ***(g) it is a small-scale or temporary land-use activity that has no impact on the productive capacity of the land:***
- *(h) it is for an activity by a requiring authority in relation to a designation or notice of requirement under the Act:*
- *(i) it provides for public access:*
- ***(j) it is associated with one of the following, and there is a functional or operational need for the use or development to be on the highly productive land:***
  - ***(i) the maintenance, operation, upgrade, or expansion of specified infrastructure:***
  - *(ii) the maintenance, operation, upgrade, or expansion of defence facilities operated by the New Zealand Defence Force to meet its obligations under the Defence Act 1990:*
  - *(iii) mineral extraction that provides significant national public benefit that could not otherwise be achieved using resources within New Zealand:*
  - *(iv) aggregate extraction that provides significant national or regional public benefit that could not otherwise be achieved using resources within New Zealand.*

(4) Territorial authorities must take measures to ensure that any use or development on highly productive land:

- *(a) minimises or mitigates any actual loss or potential cumulative loss of the availability and productive capacity of highly productive land in their district; and*
- *(b) avoids if possible, or otherwise mitigates, any actual or potential reverse sensitivity effects on land-based primary production activities from the use or development.*

(5) Territorial authorities must include objectives, policies, and rules in their district plans to give effect to this clause.

Clauses 3.9(2)(g) and (j)(i) are applicable to the Project and are considered further below.

5.1 Clause 3.9(2)(g) Temporary land-use activity

The exemption under clause 3.9(2)(g) is based on "a small-scale or temporary land-use activity that has no impact on the productive capacity of the land".

For context, the NPS-HPL describes productive capacity, in relation to land, as 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); and

(b) Legal constraints (such as consent notices, local authority covenants, and easements); and

(c) The size and shape of existing and proposed land parcels.

5.1.1 Temporary land use

NZCE is planning to enter a 40 year lease agreement with the landowners. Whilst this is a considerable length of time, this is not a perpetual lease, i.e. not a permanent change to the land or the landscape. This is an important distinction. At the expiration of the lease, in line with the terms of the lease agreements, all solar farm components will be removed and the soil surface will be returned to its original condition in a reasonable timeframe (approximately 12 months).

5.1.2 Impact on productive capacity of the land

The definition of productive capacity is focused on 'land based primary production over the long term'. Production can be divided into (a) the 40-year period under which the solar panels are installed; and (b) after the Project is decommissioned and the land remediated.

PRODUCTIVE CAPACITY DURING THE 35 LIFECYCLE OF THE PROJECT	
Physical characteristics	
Soil type/profile	No impact on soil type or profile. The posts supporting the solar panels will be pile driven, in a similar fashion to most fence posts or kiwifruit or grape support structures.
Soil properties	Any minor soil disturbance caused by trenching is likely to be similar to installing water pipes in a farming situation, and will not cause long-term or permanent change. Subsoil and topsoil will be separated and correctly backfilled during the trenching process in line with good solar practice internationally. Soil compaction will likely be improved through sheep grazing, by eliminating cattle and heavy machinery.
Soil fertility	Soil fertility influences pasture production. It is important to note that soil fertility is a temporary factor that does not influence the underlying land use capability status of the land.

	Key influences of soil fertility include the soil parent material, rainfall and removal of nutrient via production (e.g. meat and wool), and application of fertiliser. Nutrient removal rates are expected to be similar to the current land use. It is anticipated that soil fertility will be maintained by the landowner for the duration of the Project. This can be achieved throughout the Project via liquid foliar applications, dribble bar and modified fertiliser spreaders.
Soil nutrient leaching	May be slightly less than current farming practices due to the removal of cattle from the farming system.
Soil drainage	Existing drainage network will be retained and maintained throughout the duration of the solar farm.
Contamination	Given the nature of solar panel construction we are not expecting any contamination risk
Versatility	Throughout the duration of the Project there will be some reduction in the ability to change land use. For example, it will not be a practical option to graze cattle on the property whilst the panels are in place. However, this is no different to many other land use options. For example, if the land were to be planted into forest, this would also limit the land use options throughout the duration of the timber crop. In fact, the Project enables a dual land use opportunity, which could also be expanded to other options such as beekeeping.
Potential rooting depth	There will be no change to potential rooting depth for pastures.
Pasture production	There is limited research information available that quantifies the impact of solar panels on pasture production. A relevant research paper[2] suggested that pasture production under solar panels (not the area outside the panels) would be reduced by 38%, although animal production was not affected (due to benefits of shade in hotter temperatures). The abstract of this research has been included in Appendix A of this report. The case study in question also considered a solar farm with fixed tilt solar panels rather than those which track the sun, have wider row spacing and allow more light to hit the ground (such as proposed for the Project).

[2] Alyssa et al. 2021. Herbage yield, lamb growth and foraging behaviour in agrivoltaic production systems. Frontiers in Sustainable Food Systems. April 2021.

	Taking a conservative approach, on the assumption that the solar panels will cause some degree of temporary shading, it has been assumed that there will be some impact on the amount of solar radiation on the pastures and thus a reduction in total pasture production. Typical pasture production for farms in the area is 7-9 tDM/ha on LUC 3 land and 4-6 tDM on the LUC 4 land without irrigation. Irrigation lifts potential pasture production to an estimated 10-11 tDM/ha on the LUC 3 land. While a 38% reduction is a conservatively high figure for the reasons mentioned above, assuming this rate of reduction in pasture production, but taking into account the maximum temporary footprint of the solar array represents only 40% of the land area, annual pasture production would be temporarily reduced to 6-7 tDM/ha on the LUC 3 land and 3-4 tDM/ha/yr on the LUC 4 land. As previously noted, studies (as well as anecdotal reports from sheep grazing operations in Australia) suggest that animal production need not be reduced to the same extent, although there is insufficient evidence at this stage to provide a definitive answer.
Legal constraints	There are no anticipated legal constraints.
Size and shape of land parcels	No change.
Infrastructure	There will be some adjustment to existing farming infrastructure. Some of the sheds will remain, but others, as well as some fences, will be removed or modified.

PRODUCTIVE CAPACITY AFTER PROJECT DECOMMISSIONING AND LAND REMEDIATION	
Physical characteristics	
Soil type/profile	No impact on soil type or profile. Pile driven posts and trenched cable will be removed, this will not affect the soil profile.
Soil properties	Soil properties will be unchanged.
Soil fertility	Soil fertility can be maintained via regular fertiliser applications as it was prior to the use of the site for the Project and sheep grazing. This can be checked on a regular basis via soil testing, and if needed remediated to optimal soil nutrient levels via fertiliser applications.
Soil drainage	No change.
Versatility	The full versatility of land use options will be restored when the solar panels are removed.

Pasture production	It is possible that some regrassing of pastures may be required.
Legal constraints	No change.
Size and shape of land parcels	No change.
Infrastructure	As per the terms of the solar farm lease agreed with the landowner, all Project infrastructure will be removed, and the land returned to its original condition, which will not limit in any way future versatile productive uses of the land.

In summary:

1. During the 40 year life of the Project
   - With appropriate mitigations during construction (such as avoiding mixing of sub and topsoil):
     - Soil Type/Properties: The Project will not negatively impact the land's soil type or properties. In fact, there will be improvements to soil properties of the land due to reduced soil compaction by removing cattle from the site, and a reduction in nutrient leaching by grazing sheep as opposed to cattle. In AgFirst's opinion, impacts on soil type and properties should be given greater weighting given they are harder to reverse than a temporary loss of versatility or productivity.
     - Versatility: Throughout the duration of the Project there will be some reduction in the ability to change land use. For example, cattle farming or maize cropping will not be possible throughout the duration of the panels being in place. Regarding cattle, these animals can damage the solar infrastructure including the Tracking System. However, this is no different to other land use applications such as forestry or kiwifruit, which by nature of the crop and land coverage mean there is an (arguably greater) impact on versatility throughout the duration of that application. For example, if the land were to be planted into forest, this would also limit the land use options throughout the duration of the timber crop. The Project enables a dual land use opportunity, which could also be expanded to other applications such as beekeeping.
     - Productivity: Compared to the current use the Project will cause some degree of temporary shading, which has been assumed to have some impact on the amount of solar radiation on pasture and thus a reduction in pasture production. This assumption is based on the limited research information available. However, the solar panels also increase moisture retention and provision of shade and shelter for sheep which helps to offset this reduction in pasture growth. As previously noted it is possible that livestock production could be at higher levels than without solar, although there is insufficient research in New Zealand to make a definitive comment on this.
   - Therefore, on balance (noting expected positive impacts on soil properties from sheep grazing comparative to current land use), AgFirst believes that the Project will have a neutral impact on the overall physical characteristics of the land from which the concept of productive capacity is assessed:

- The Project will not create any legal constraints; and
- The Project will not alter the shape of existing land parcels.

2. Once the Project has been decommissioned and the land reinstated and remediated at the conclusion and decommissioning of the Project there will be no ongoing or residual impact on the productive capacity of the land with the ability to utilise the land to full productivity and versatility. Soil productivity and versatility are both temporary factors that do not influence the underlying land use capability status of the land.

5.2 Clause 3.9(2)(j)(i) Functional or operational need

The current wording of the NPS-HPL means it is unclear if new specified infrastructure is 'not inappropriate' on HPL. Specified infrastructure is defined in clause 1.3.

> **specified infrastructure** means any of the following:
>
> (a) infrastructure that delivers a service operated by a lifeline utility:
>
> (b) infrastructure that is recognised as regionally or nationally significant in a National Policy Statement, New Zealand Coastal Policy Statement, regional policy statement or regional plan:
>
> (c) any public flood control, flood protection, or drainage works carried out:
>
> (i) by or on behalf of a local authority, including works carried out for the purposes set out in section 133 of the Soil Conservation and Rivers Control Act 1941; or
>
> (ii) for the purpose of drainage, by drainage districts under the Land Drainage Act 1908

5.2.1 Potential amendments to NPS-HPL

In September 2023, the Ministry for Environment (MfE) released a discussion document relating to the unintended omission of the word 'development' in clause 3.9(j)(i) [3]. Specifically, relating to this application is the following statement:

While the ongoing maintenance, operation, upgrade or expansion of specified infrastructure is provided for under clause 3.9(2)(j)(i), the construction of new specified infrastructure is not explicitly provided for.

Drafters intended for a consent pathway for new specified infrastructure on HPL to be provided in the NPS-HPL. The exposure draft of the NPS-HPL provided this pathway, as long as it did not represent inappropriate development. During redrafting the word 'development' was removed from the clause, restricting it to the 'maintenance, operation, upgrade, or expansion of specified infrastructure'.

The evaluation under section 32 of the RMA5 that supported the NPS-HPL anticipated that new specified infrastructure could be constructed on HPL via designation or notice of requirement, as provided for under subclause 3.9(2)(h).

[3] Ministry for the Environment. 2023. Managing the use and development of highly productive land: Potential amendments to the NPS-HPL – Discussion document. Wellington: Ministry for the Environment.

However, specified infrastructure providers that do not have designation rights under the RMA have no apparent consent pathway to develop on HPL. This restriction is also problematic when infrastructure needs to be developed at pace. One recent example is developing the infrastructure needed to support clean-up and repairs in the aftermath of Cyclone Gabrielle. There is also a significant demand for additional renewable electricity in Aotearoa. Infrastructure to meet this demand is needed to cater for a growing population and support a low-emissions economy. The demand for solar farms is growing, and HPL is often the most suitable for these developments because it is flat, has a northern aspect and receives high solar radiation.

Stakeholders in the renewable electricity generation (REG) sector, especially solar farms, have indicated that the NPS-HPL has the potential to prevent the progress of such projects, even where a functional or operational need to be located on HPL can be shown. This issue becomes apparent at the due-diligence planning stage of a development.

The lack of clarity about the consent pathway for new specified infrastructure could also lead to this clause being applied inconsistently in district plans and decision-making across the country. The clause relating to specified infrastructure in the NPS-HPL is not consistent with the way other recent national direction has provided consent pathways for new specified infrastructure. An amendment is also needed to align with work that is ongoing to amend national guidance to provide a consistent straightforward consent pathway for REG and associated electricity transmission.

As currently worded, Clause 3.9(2)(j)(i) could inadvertently constrain or prevent new specified infrastructure from being established where it is needed.

The outcome is a potential amendment of the NPS-HPL to provide for the development of new specified infrastructure:

- Option 2: Amend clause 3.9(2)(j)(i) to include the word 'construction', to make it clear that there is a potential consent pathway for new specified infrastructure on HPL, subject to the stated tests.

5.2.2 Assessment against Clause 3.9(2)(j)(i)

AgFirst considers clause 3.9(j)(i) of the NPS HPL also applies to the proposed solar farm as NZCE will be constructing, operating and maintaining specified infrastructure. The following points illustrate why clause 3.9(j)(i) also applies, thus demonstrating that the proposal is an appropriate use of productive land[4]:

- The intention of this clause is to recognise situations where the use or development of specified infrastructure may occur on HPL. The proposed solar farm development fits within the definition of 'specified infrastructure' in the NPS HPL as:
    - Solar infrastructure delivers a service operated by a lifeline utility. NZCE is considered to be a lifeline utility being an entity that will generate electricity for distribution through a network or distribute electricity through a network.

[4] Information provided to AgFirst by NZ Clean Energy

- The need to develop, operate, maintain and upgrade renewable electricity generation activities throughout New Zealand is recognised as being nationally significant under the NPS for Renewable Electricity Generation 2011.
- Renewable energy (solar farm infrastructure) is identified in the Greater Wellington Regional Council Climate Change Strategy, with Policy 1.1 that seeks to remove barriers to the use and development of renewable energy and improved energy efficiency in the region[5].

- NZCE can demonstrate that there is a 'functional and operational need' to be on HPL, and specific to the Project Site. That is:
  - Proximity to the electrical substation for a Point of Connection (POC)
    - The Project Site is located directly opposite the substation and therefore allows for a short cable run between the solar farm and the POC.
    - The closer a site is to the POC results in higher efficiencies in power generation and total export. Power is lost in electricity cables so the aim is always to keep the distance as short as possible to ensure there is reduced loss in efficiency
    - The further the site is from the POC means the greater the cost of connection. Due to the open market of the NZ electricity market, it is important that the Project is as competitive as possible to ensure its long term success and therefore cannot afford to incur significant costs due to long routes between the site and the POC
    - The further a project is from the POC, the higher the potential for disruption due to increased works and time spent on getting the power to the POC. For example, if the Project Site was further away, it would require the need to dig up road reserves to lay cables which has wider knock-on effects within the area.
  - Adequate flat land is required (less than a 5 degree slope) and free from obstacles
    - This ensures for an efficient and effective installation and allows for the Project to be designed which is suitable for the surrounding area.
    - This is of vital importance when considering other factors such as visual impact, noise, glint, glare and traffic.
    - Having a suitable topography will also enable the project to have a screening buffer around the perimeter of the Project.
  - Suitability of substation
    - Not all substations have enough capacity to accommodate scale.
    - This substation has been confirmed, via detailed studies and work with Transpower, as being able to accommodate the Project and ensure the power can be distributed to the local area when the power is exported.
    - Substations close to towns and cities have more capacity in them due to the load and demand from the area. In comparisons, small substations located remotely often can't accommodate the exported power as they are not of sufficient size due to the reduced demand requirements.
  - Sufficient area to develop a solar farm of a size which is viable and will make a meaningful impact to the generation of renewable energy

[5] https://www.gw.govt.nz/assets/Documents/2015/10/GWRCClimateChangeStrategy7-10-15.pdf

- Free of ecological, heritage or cultural constraints which would make the Project untenable by a responsible developer
- Medium to high sunshine hours / limited shading from natural features such as mountains.
- Limited disruption to agricultural land use
    - The Project Site has a long-term intention for sheep grazing.
    - This will continue over the lifetime of the Project.
    - Therefore, the landowner will not be changing their operation as a result of the Project and they will continue grazing the land at the same or similar stocking density.
    - This fits well within the NPS-HPL provisions and its purpose, with the land to be continued as per its current operation.

5.3 Clause 3.9(3)(a) Minimises or mitigates any actual loss of HPL

As discussed in Section 5.1, AgFirst has identified how the Project minimises or mitigates any actual or potential cumulative loss of the availability and productive capacity of HPL in their district. In summary this includes:

- No impact on soil type or profile. The posts supporting the solar panels will be pile driven, in a similar fashion to most fence posts or kiwifruit or grape support structures.
- Any minor soil disturbance caused by trenching is likely to be similar to installing water pipes in a farming situation, and will not cause long-term or permanent change.
- Subsoil and topsoil will be separated and correctly backfilled during the trenching process in line with good solar practice internationally.
- Soil compaction will likely be improved through sheep grazing, by eliminating large cattle and heavy machinery.
- Soil fertility influences pasture production. It is important to note that soil fertility is a temporary factor that does not influence the underlying land use capability status of the land.
- It is anticipated that soil fertility will be maintained during the project by applications of fertiliser via liquid foliar applications.
- Throughout the duration of the Project there will be some reduction in the ability to change land use. For example, it will not be a practical option to graze cattle on the property whilst the panels are in place. However, there is currently no intention to graze cattle on the property in the future.
- The Project will restrict the range and intensity of land-based production activities that can be carried out on the Project Site while the solar farm operates. However, this is a restriction of range and intensity of use of the land and not a loss of productive capacity.
- While a reduction in pasture production is mentioned in Section 5.1. However, taking into account the maximum temporary footprint of the solar array represents only 40% of the land area, annual pasture production would be temporarily reduced to 6-7 tDM/ha on the LUC 3 land and 3-4 tDM/ha/yr on the LUC 4 land. As previously noted, studies (as well as anecdotal reports from sheep grazing operations in Australia) suggest that animal production need not be reduced to the same extent, although there is insufficient evidence at this stage to provide a definitive answer.
- There are no anticipated changes expected due to legal constraints or due to the size and shape of the existing and proposed land parcels.

- There will be some adjustment to existing farming infrastructure. Some of the sheds will remain, but others, as well as some fences, will be removed or modified.
- The adjoining property to the east (surrounding the substation) contains some lower productive land (LUC 3 and LUC 6) than the Project Site. However, this has not been considered a feasible option due to the proximity to the river and flood risk for the proposed specified infrastructure.
- There are a range of potential primary productive uses that could occur if the solar farm were not located on the Project Site, and it is the landowner's prerogative to decide how to and what type of intensity productive capacity activities would take place on their HPL. In this case, the landowner currently has a desire to farm sheep, and that is in long-term farming aspiration.

Synergistic agricultural and horticultural activities within solar farms are growing rapidly globally. As an example, the concept of 'agri-solar' is an established farming technique in the USA supported by the American Solar Grazing Association (ASGA) which promotes the dual use of grazing and solar production across the USA. The ASGA website has a vast amount of information and research papers on the grazing of sheep on solar farms and a number of Universities have published research papers on the activity of grazing within solar farms (Cornell University, Oregon State University, Ohio State University) as well as additional research and private research institutions in the USA and Australia. The practice is also common across the United Kingdom where weather conditions are also similar to many parts of New Zealand.

Lincoln University through it's 'Energy Farm[6]' has developed a multi-use ground-mounted solar array. They are aiming to demonstrate that land can be used for energy production as well as agriculture, using the technology to decarbonise Lincoln University campus while validating the dual use of the land. Their research will shape the move from conventional solar farm projects towards a holistic, transformative business model by taking a scientific approach towards viable multifunctional land use.

When considering actual or potential cumulative loss within the district, AgFirst has provided an LUC mapping at a district scale[7]. Presented in Figure 11 is the LUC for the Carterton District. The total area is estimated at 117,997 ha, with 24,665 ha of HPL soils. The Project will not be removing the land from land-based primary production, therefore, AgFirst does not view this as a significant loss of HPL within the District.

In addition to the above, AgFirst has provided a livestock policy for the Project (Section 6). Based in this information, Clause 3.9(3)(a) has been met, whereby the loss off the availability and productive capacity of HPL has been both minimised and mitigated.

[6] https://energyfarm.co.nz/
[7] https://ourenvironment.scinfo.org.nz/maps-and-tools/app/Land%20Capability/lri_luc_main

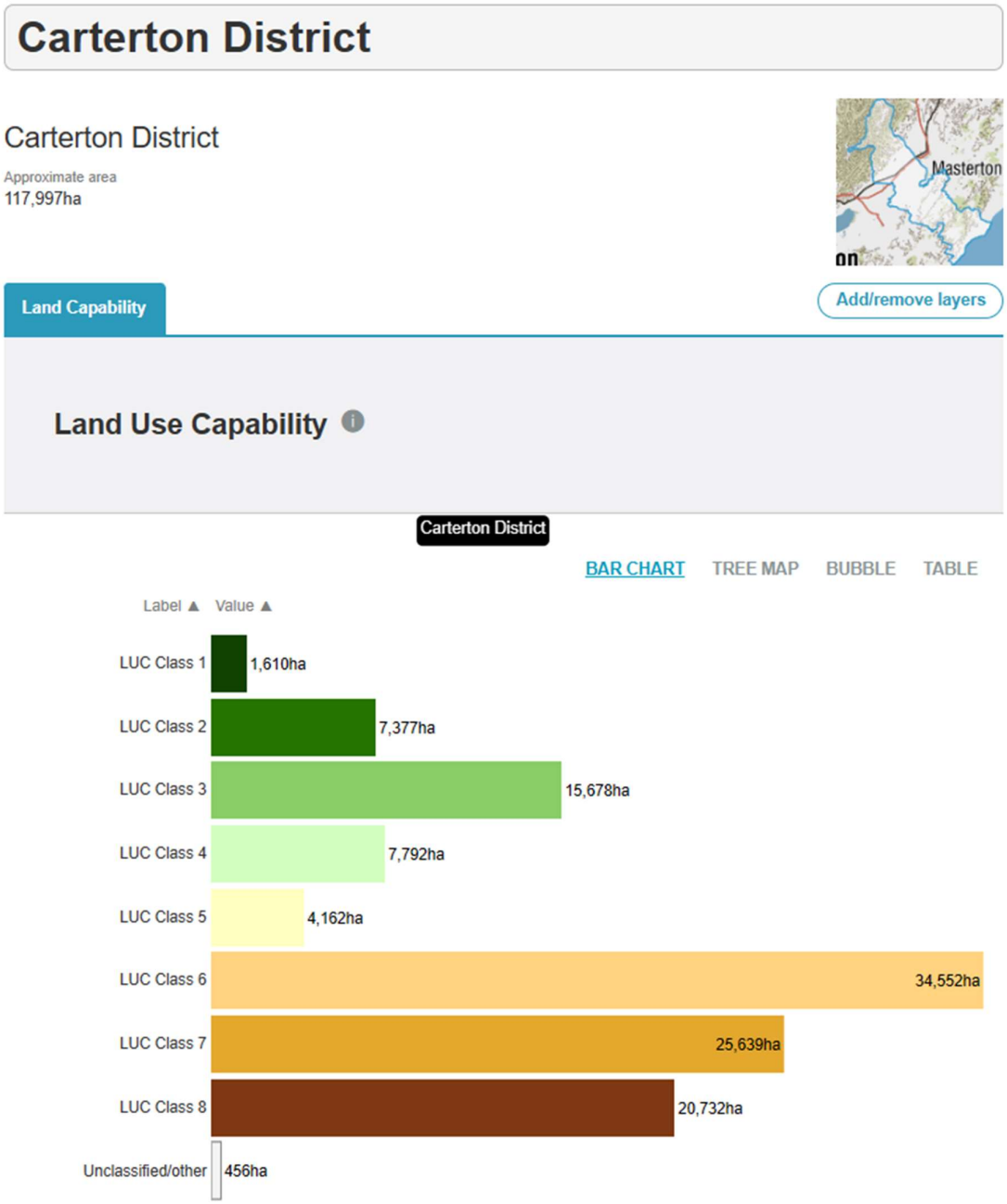

Figure 11: District LUC classification for Carterton

5.4 Clause 3.9(3)(b) Reverse sensitivity effects

AgFirst does not see any reverse sensitivity effects as a result of the Project that would not be mitigated or managed. The following are examples of reverse sensitivity effects.

- Dust on solar panels caused by normal farming practices, including seed sowing and spreading fertiliser.
    - This will only occur when nearby cropping is occurring and when the ground is fallow (bare and exposed), and as such the panels can be cleaned over these periods, which are likely to be isolated to Autumn and Spring.

- Off-site nuisance dust effects will also have to comply with district rules, as there are other receptors in the areas that could raise dust complaints.

- Shading effects on solar panels affect solar production, such as shelterbelts and shade trees.
  - There are trees along the northern boundary within the Project Site that could potentially cause shading effect. A clause could be added to the lease agreement that states trees that have been removed will be replanted at the end of the lease with fast growing Poplars or Eucalypts.
  - Additionally, a larger boundary setback can be maintained to minimise this effect.

6.0 LIVESTOCK POLICY FOR THE SOLAR FARM

This Section contains information regarding a sheep grazing scenario. AgFirst recommends that a Site-specific Livestock Policy and Management Plan for sheep grazing under Solar is prepared prior to completion of the Project.

6.1 Property

The proposed solar farm consists of an effective grazing area of approximately 132 ha.

In terms of infrastructure, there is currently one house on the block, a three-stand woolshed with an old wooden press, covered yards and cattle yards. There is an implement shed and a considerable amount of machinery and farm implements on the Project Site.

The water in the races comes from the Waingawa River. The water is pumped from the race to a tank and reticulated around the farm. There is a trough in every paddock.

The fencing on the farm is in good condition with eight wire conventional fences across most of the farm and an electric wire around the boundary. Tracks and access around the farm are good.

6.2 Pasture Growth

Pasture growth is estimated at 7-9 tDM/ha on the LUC 3 land and 4-6 tDM/ha on the LUC 4 land without irrigation.

Alyssa et al. 2021[8], evaluated herbage yield and lamb growth in an Agrivoltaic system under pastoral grazing in Oregon. The abstract of this research is shown in Appendix A. The main findings were:

- Solar pastures produced on average 38% less dry matter under fully shaded areas. Dry matter production did not differ between partially shaded or open areas.
- Pasture quality was improved under shaded areas.
- Lamb average daily liveweight gains per head were no different between solar and open pasture.
- Liveweight gains per hectare were not significantly different between solar and open pasture.
- Stocking rate was higher under solar panels and pasture cover was lower, it is unclear the reason behind the higher stocking rate.

The study suggested that the lower dry matter production under panels was offset by the higher pasture quality leading to no overall difference in livestock production.

AgFirst suggests that a conservative approach is used for interpreting this report and adopting the finding of a 38% reduction under fully shaded areas. Panels for Alyssa et al. 2021[1] were based on a 6 metre spacing, panel size was not specified, under panel areas defined as 50%

[8] Alyssa et al. 2021. Herbage yield, lamb growth and foraging behaviour in agrivoltaic production systems. Frontiers in Sustainable Food Systems. April 2021.

partially shaded and 50% full shaded. The NZCE proposal is suggesting 60% non-shaded, and a maximum of 40% temporarily shaded, and using a tilting tracking system that will have a lesser impact on pasture production.

Applying the drop in pasture production of 38% to the shaded areas, and no impact on the non-shaded areas, pasture growth is assumed under the proposed solar farm to be 5-6 tDM/ha/yr on the LUC 3 land and 4-5 tDM/ha on the LUC 4 land.

6.3 Sheep Policy

There are a number of sheep policies that could be run under the panels. The management of the livestock operation will be undertaken by the landowner, which will not be significantly different from their existing operation plan.

The following guidelines have been used for the sheep policy:

- Self contained system without the need to utilise external grazing
- No cattle to be grazed
- Good pasture management
- Simple system minimising the number of mobs run
- Flexibility to cope with reduced pasture growth during summer dry periods
- Large paddock sizing with sheep proof fencing
- Water reticulation with stock drinking water available in every paddock
- Stock yards and loading facilities to be maintained for sheep purposes

Given the propensity for summer dry we would recommend a trading policy rather than breeding ewes.

6.4 Livestock Numbers

Proposed livestock numbers are planned to mirror the seasonality of pasture production with 10-12 SU/ha through the winter and spring, dropping down to 5-6 SU/ha over summer.

APPENDIX A: LAMB GROWTH AND PASTURE PRODUCTION IN AGRIVOLTAIC PRODUCTION SYSTEM

Alyssa C. Andrew, Chad W. Higgins, Mary A. Smallman, Maggie Graham and Serkan Ates (2021). Lamb growth and pasture production in agrivoltaic production system. *AIP Conference Proceedings*, *2361.* doi:10.1063/5.0055889

Abstract

Agrivoltaic systems are designed to mutually benefit solar energy and agricultural production in the same location for dual-use of land. This study was conducted to compare lamb growth and pasture production from solar pastures in agrivoltaic systems and traditional open pastures over two years in Oregon. Weaned Polypay lambs grew at 120 and 119 g head−1 d−1 in solar and open pastures, respectively in spring 2019 (P = 0.90). The liveweight production between solar (1.5 kg ha−1 d−1) and open pastures (1.3 kg ha−1 d−1) were comparable (P = 0.67). Similarly, lamb liveweight gains and liveweight productions were comparable in both solar (89 g head−1 d−1; 4.6 kg ha−1 d−1) and open (92 g head−1 d−1; 5.0 kg ha−1 d−1) pastures (all P > 0.05) in 2020. The daily water consumption of the lambs in spring 2019 were similar during early spring, but lambs in open pastures consumed 0.72 L head−1 d−1 more water than those grazed under solar panels in the late spring period (P < 0.01). No difference was observed in water intake of the lambs in spring 2020 (P = 0.42). Over the entire period, solar pastures produced 38% lower herbage than open pastures due to low pasture density in fully shaded areas under solar panels. The results from our grazing study indicated that lower herbage mass available in solar pastures was offset by higher forage quality, resulting in similar spring lamb production to open pastures. Our findings also suggest that the land productivity could be greatly increased through combining sheep grazing and solar energy production on the same land in agrivoltaic systems.

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