APPENDIX B CONSULTATION

B.1 AGENCY CONSULTATION

B.1.1 Greater Hume Shire Council subdivision consent

Greater Hume Council

All correspondence
PO Box 99 Holbrook NSW 2644

P 02 6036 0100 or 1300 653 538
E mail@greaterhume.nsw.gov.au
greaterhume.nsw.gov.au

ABN 44 970 341 154

Lizzie Olesen – Jensen
NGH Environmental Pty Ltd
PO Box 5464
WAGGA WAGGA NSW 2650

C/- lizzie.oj@nghenvironmental.com.au

Dear Lizzie

SUBDIVISION ENQUIRY ASSOCIATED WITH STATE SIGNFICANT SOLAR FARM DEVELOPMENT (WALLA WALLA SOLAR FARM) – LOT 1 DP 1069452, LOT 1 DP 933189 LOT A DP 376389, BENAMBRA AND SCHNEIDERS ROADS WALLA WALLA

I refer to your enquiry wherein you sought an indication as to whether Council would object to the subdivision of the abovementioned allotments to facilitate the development of a proposed solar farm development.

In response to your enquiry it is advised that Council is not the determining authority for the proposed development and a final decision concerning the subdivision component of the proposed development would be a matter for the determining authority.

As the configuration of the land is not permanently altered by the subdivision of land for leasehold purposes, Council does not apply the provision of the Greater Hume Local Environment Plan 2012 (the LEP) and in this instance would not be concerned by subdivision for leasehold purposes.

In addition Council would not be concerned with subdivision being undertaken in conjunction with the development as Clause 4.2AA of the LEP can be applied concurrently with a development consent for a permissible use.

Should you require further information please contact Colin Kane, Director Environment & Planning, on 6044 8928 or email ckane@greaterhume.nsw.gov.au.

Yours faithfully

Colin Kane
Director Environment & Planning
GREATER HUME COUNCIL

26 September 2019

Our Ref: CK:P10112969

B.1.2 Email from Geographical Survey of NSW

NSW GOVERNMENT | Planning & Environment

20 February 2019

Bridgette Poulton
Environmental Consultant
NGH Environmental
PO Box 5464
Wagga Wagga NSW 2650

Emailed: bridgette.p@nghenvironmental.com.au

Your Reference: Walla Walla Solar Farm
Our Reference: DOC19/125357

Dear Ms Poulton,

Re: Proposed Walla Walla Solar Farm - Clause 13 Compatibility Test

I refer to your email dated 13 February 2019 inviting NSW Department of Planning & Environment – Division of Resources & Geoscience to provide comments on the Walla Walla Solar Farm proposal.

The Division appreciates the opportunity for early consultation on this State Significant Development proposal for a solar farm in the Greater Hume LGA. The Division has provided project specific requirements to supplement the Secretary's Environmental Assessment Requirements (SEARs), issued by the Department of Planning and Environment – Planning Services, for the preparation of the Environmental Impact Statement (EIS) for the proposed Walla Walla Solar Farm.

Resource specific SEARs for renewable energy projects require an assessment of the impact of the development on existing land uses, including the compatibility of the development with the existing land uses on the site and adjacent land (e.g. operating mines, extractive industries, mineral or petroleum resources, exploration activities), during operation and after decommissioning.

This requires the proponent to identify any of the above in the EIS and consult with the operators and or titleholders to establish if the proposal is likely to have a significant impact on current or future extraction of minerals, petroleum, or extractive materials (including by limiting access to, or impeding assessment of, those resources), and any way the proposed development may be incompatible with any existing or approved uses, or current or future extraction or recovery under the land use compatibility requirements of Part 3 (13) of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive industries) 2007* (Mining SEPP).

NSW Department of Planning and Environment
DIVISION of RESOURCES & GEOSCIENCE
PO Box 344 Hunter Region Mail Centre NSW 2310
E: landuse.minerals@geoscience.nsw.gov.au
Tel: 02 4063 6500
ABN 38 755 709 681

In fulfilling these requirements, a search of current mineral, coal and petroleum titles must be undertaken through the Division's MinView application, with the results shown on a map, in drafting of the EIS. Additionally, the EIS must identify whether there are adjacent mines of quarries for land use compatibility considerations.

According to current departmental databases, the Division has identified that there are no current mineral, coal or petroleum titles over the site or adjacent lands.

The Division has identified that the 'Hurricane Hill' hard rock quarry operated by Boral Resources Pty Ltd is located approximately <1.5km to the southeast of the project site (refer to Figure 1). Consideration should be given to the impacts the projects may have on the quarry's operations under cl13 of the Mining SEPP. The Division recommends consultation with Boral during the preparation of the EIS.

Queries regarding the above information, and future requests for advice in relation to this matter, should be directed to the Division of Resources and Geoscience.
Yours sincerely

Andrew Helman
A/Manager - Land Use

for Paul Dale
Director – Land Use & Titles Advice

NSW Department of Planning and Environment
DIVISION of RESOURCES & GEOSCIENCE
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B.1.3 Email from NSW Crown Lands

Re: Crown Lands Reserves Query - Wagga Wagga

CR elly.simpson@crownland.nsw.gov.au on behalf of CL Reserves <cl.reserves@

To Bridgette Poulton

Reply | Reply All | Forward | ...

Tue 25/06/2019 1:38 PM

Hi Bridgette

Thank you for your email. From having a quick look at our mapping system I can't see any reserves near the first list of Lot and DPs, however there is a reserve near 1/1069452. It is not adjoining the Lot but close by. The reserve number is 1003019 and the Lot is 137/753764.

Kind regards,
Dubbo Business Centre | Reserves
NSW Department of Industry | Lands and Water Division
P.O. Box 2185 | DANGAR NSW 2309
T: 1300 886 235 (option 5, option 1) | E: reserves@crownland.nsw.gov.au |
W: www.crownland.nsw.gov.au

B.2 NON-AGENCY COMMUNITY ENGAGEMENT

B.2.1 Community and Stakeholder Engagement Report

Community and Stakeholder Engagement Report

WALLA WALLA SOLAR FARM

OCTOBER 2019

nghenvironmental

Document Verification

Project Title: Community and Stakeholder Engagement Report, Walla Walla Solar Farm

Project Number: 18-622

Project File Name: 18-622_Rep_Walla Walla SF CSER_DRAFT_20190829

Revision	Date	Prepared by (name)	Reviewed by (name)	Approved by (name)
Draft	21/08/19	Raina Hattingh	Erwin Budde	Erwin Budde

NGH Environmental Pty Ltd (ACN: 124 444 622. ABN: 31 124 444 622).

CONTENTS

TABLES

FIGURES

ABBREVIATIONS AND ACRONYMS

AC	alternating current
ARENA	Australian Renewable Energy Agency
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BCD	Biodiversity Conservation Division of DPIE, formerly OEH
Bison Energy	Bison Energy Pty Ltd (initiating proponent)
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CSER	Community and Stakeholder Engagement Plan
DPE	Department of Planning and Environment (NSW), now DPIE
DPIE	Department of Planning, Industry and Environment (NSW), formerly DPE
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
FRV	FRV Services Australia Pty Ltd (current proponent)
ha	hectares
km	kilometres
kV	kilovolt
LGA	Local Government Area
m	metres
MW	megawatts
NSW	New South Wales
OEH	Office of Environment and Heritage (NSW), now BCD
RET	Renewable Energy Target
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements (issued by DPE)
SSD	State Significant Development

1 INTRODUCTION

1.1 PROJECT CONTEXT

FRV Services Australia Pty Ltd (hereafter the 'proponent' or 'FRV') has undertaken a dedicated Environmental Impact Assessment (EIS) process for a proposed new 300 megawatt (MW) Alternate Current (AC) photovoltaic (PV) solar farm at Walla Walla, southern New South Wales (NSW). The development footprint would occupy around 493 hectares (ha) of the 605ha subject land. It is located on freehold rural land approximately 4.3 kilometres (km) north-east of Walla Walla and 9.2 km south-west of Culcairn. The subject land is located within the Great Hume Shire local government area (LGA).

As part of the EIA process, dedicated community engagement and consultation has taken place to build resident awareness of the proposal and to inform development of appropriate mitigation measures, where required, to be documented in the EIS.

Engagement was originally facilitated by NGH, an independent environmental consultancy based in Wagga Wagga NSW, on behalf of Bison Energy, the founding proponent of the proposal. In July 2019, Bison Energy sold the Walla Walla Solar Farm project (hereafter the 'proposal'), to FRV. Stakeholder and community engagement were thereafter facilitated by Banksia Communications, a specialist in regional community relations for large-scale renewable energy projects, along with the FRV Project Manager. Key FRV team members have also been available for the community to communicate with.

Community engagement undertaken to support preparation of the EIS aligns with the requirements of the Secretary's Environmental Assessment Requirements (SEARs) and the NSW Department of Planning and Environment's (DPE) *Community & Stakeholder Engagement Guidelines*, part of the Draft EIA Guidance Series (June 2017). Guidance has also been taken from the DPE's (2007) *Guidelines for Major Project Community Consultation* and the Australian Renewable Energy Agency's (ARENA's) *Establishing the social licence to operate large scale solar facilities in Australia: insights from social research for industry* (ARENA n.d.).

This Community and Stakeholder Engagement Report (CSER) has been prepared to:

- Document the community engagement approach followed by the Proponent before and during the EIS preparation.
- Document key concerns, issues and/or comments raised by the community during this engagement, as well as how they have been addressed in the EIS.
- Document the future, ongoing community engagement approach for the project, should the proposal be approved.

The proposal is being assessed as a State Significant Development (SSD) under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). This CSER has been developed to coincide with the planning and assessment stages of the project. If the proposal is approved, community and stakeholder engagement will continue into the construction and through the operational phases of the project. These phases will require a new or updated CSER to reflect any changes in engagement objectives, as well as capturing increasing knowledge gained about and by the community.

1.2 TERMINOLOGY USED

The following terminology is relevant for this CSER:

Community	A group of people living in a specific geographical area or with mutual interests that could be affected by the proposal.
Stakeholders	Any person or group with interests in, or the potential to be affected by the proposal.
Engagement	The act of seeking the participation of the community and other stakeholders on behalf of the proponent or regulatory agencies. Can be interchanged with the term 'consultation'.
Participation	The activity whereby the community and other stakeholders have a say and potentially influence decisions that impact on their lives.

In addition, the following EIS-related terms have also been used:

Subject land	All land within the affected lot boundaries. The subject land comprises Lots 16, 17, 20, 21, 87, 88, 89, 108, 109 118 of DP 753735, Lot 3 253113, Lot 1 DP 933189, Lot A DP 376389 and Lot 1 DP 1069452, approximately 807 ha.
Development site	The area of land that is subject to the proposal. The development site is made up of 605 ha. EIS assessment prior to identified constraints and exclusions.
Development footprint	The area of land that is directly impacted by the proposal including solar array design, perimeter fence, access roads, transmission line footprint and areas used to store construction materials. The development footprint is approximately 493 ha.
Proposal	Proposed Walla Walla Solar Farm

2 PROPOSED OVERVIEW

The proposed solar farm would have a total installed capacity of up to 300 Megawatts (MW) alternating current (AC), and would include:

- Approximately 900,000 PV solar arrays mounted on single axis tracking systems.
- Electrical cables and conduits.
- Inverter/transformer units.
- On-site substation containing transformers, associated switchgear and control and protection equipment. TransGrid access to the substation.
- Site office, compound, parking and perimeter fencing.
- Operations and maintenance buildings with associated car parking.
- Main site access via Benambra Road and two crossings on Schneiders Road
- Emergency access points across the site
- Internal access tracks.
- Lighting, CCTV system, security fencing.
- A short overhead 'dropper' powerline connecting to the existing Jindera to Wagga Wagga 330 kV power line located to the west of the site.
- Vegetative screening.

The existing TransGrid Jindera to Wagga Wagga 330 kV transmission line runs across the western side of the development site, which is part of the electricity distribution network that originates at TransGrid's North Wagga Wagga Substation. The proposal will connect directly to the transmission line where it runs parallel to the development site, with a new substation required near this location.

The development site would be accessed from Benambra Road, which runs along the northern boundary and intersects with Olympic Highway (A41) between Culcairn and Albury. The Olympic Highway provides access to the region's transport network.

The proposal will require consolidation and subdivision of Lot 1 1069452, Lot 1 DP 933189 and Lot A DP 376389 as part of this land will be leased for the life of the proposal, with the remainder retained by the landholder and used for agricultural purposes. The substation on this land will become the freehold property of TransGrid at the completion of construction.

The construction phase of the proposal is expected to take 12 to 18 months, commencing Q1 2021, if approved. The proposal is expected to operate for 30 years. A total of 21 FTE jobs will be available during the operations of this project. After the operating phase, the proposal would be decommissioned, and the site returned to its original condition for normal agricultural purposes. Alternatively, the operational phase could be extended, and the development site upgraded with new photovoltaic equipment, subject to Landholder and Planning approvals.

The capital investment value of the project is estimated at approx. $399million.

The proposed infrastructure footprint is shown in Figure 2-1. This includes all land likely to be directly impacted by the proposal, including the grid connection options.

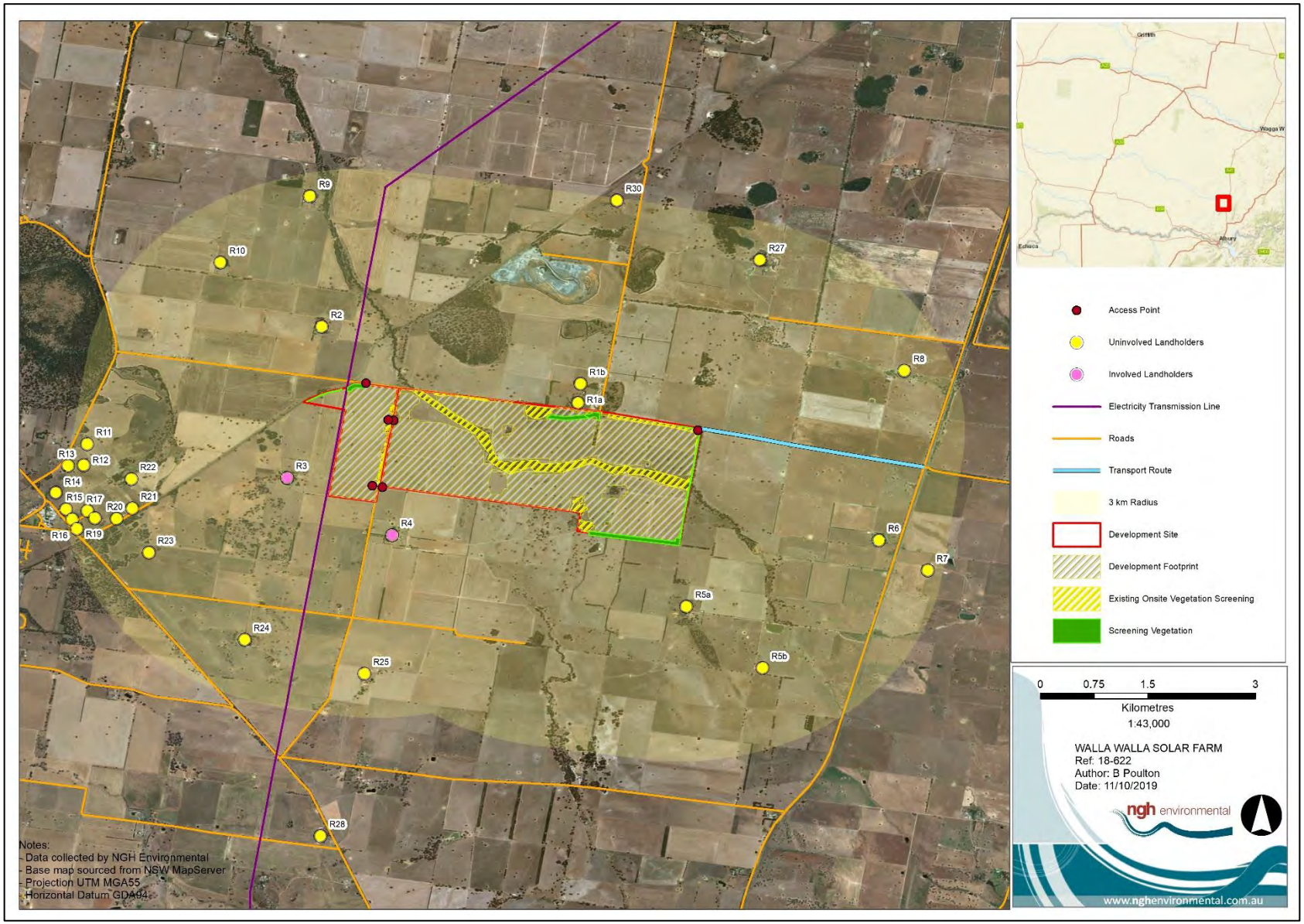


Figure 2-1 Proposed Walla Walla Solar Farm development footprint

3 COMMUNITY OVERVIEW

Understanding the makeup and values of Walla Walla and the surrounding area has been essential to finding effective ways to reach the community as well as beginning to identify ways that the project may impact people, individually and collectively.

Walla Walla is the closest town to the proposal (approximately 4.3 km south-west). During consultation it was indicated that the community affiliate not only with Walla Walla but also with Culcairn (approximately 10 km north-east) and other surrounding towns such as Gerogery and Burrumbuttock. More details on these townships are provided below.

This section provides a broad overview of the local community context for the proposal.

3.1 GREATER HUME SHIRE LOCAL GOVERNMENT AREA

Greater Hume Shire is a LGA in the Riverina region of southern NSW. The Shire was formed in 2004 amalgamating the former Culcairn Shire, the majority of Holbrook Shire and part of Hume Shire.

Greater Hume is located adjacent to the Hume, Olympic and Riverina Highways and the Sydney–Melbourne railway.

The Olympic Highway is a major regional highway servicing the communities of the central western and south-eastern Riverina. The region supports a diverse economy associated with agriculture, tourism, large commercial centres, residential facilities, health centres, railroad activities, energy generation (hydro, gas, solar), energy distribution, road freight and intermodal logistics.

In the 2016 Census, there were 10,351 people in Greater Hume Shire. Of these 50.1% were male and 49.9% were female. Aboriginal and/or Torres Strait Islander people made up 3.3% of the population. Average age of the population is 44 years. A majority of residents were born in Australia and speak English as their only language at home. Major industries of employment include Beef Cattle and Sheep Farming (specialised), Hospitals and grain growing. Internet penetration (and hence access to information) is relatively high.

3.2 WALLA WALLA

3.2.1 *Regional context*

Walla Walla's population in 2016 was recorded as 836 persons (ABS 2016). The closest regional services are in Albury, 32 km south of the proposal. Walla Walla supports two schools, two churches, a supermarket, post office, service stations, restaurants, medical services and recreation facilities.

The regional location of the proposed solar farm and its proximity to Walla Walla town are provided in Figure 3-1.

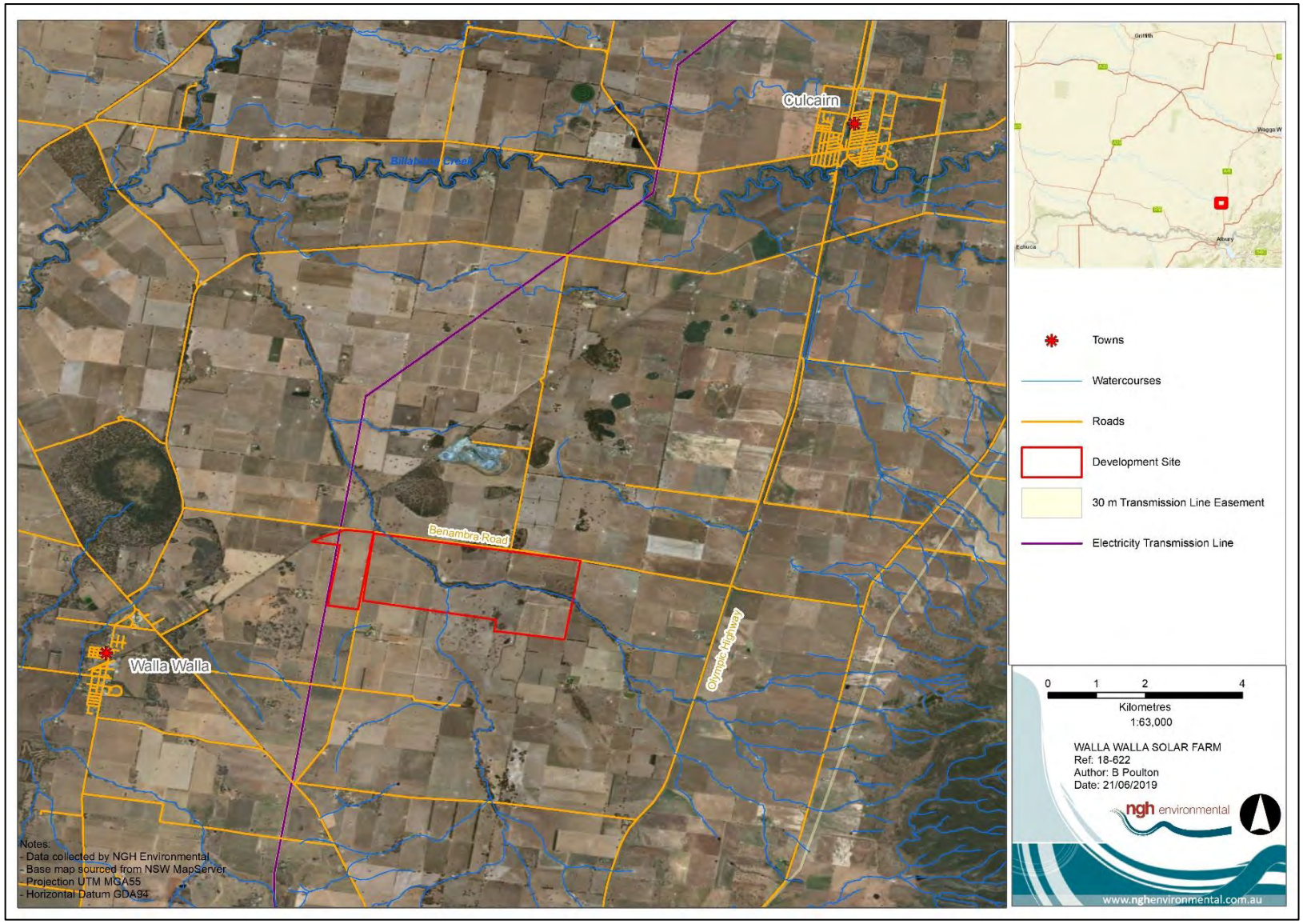


Figure 3-1 Regional location of the proposal in proximity to Walla Walla town

3.2.2 *Local industries & businesses*

Walla Walla boasts a range of industries and businesses, many supporting the surrounding agricultural district, as well as some aimed at both national and international markets. Although not exhaustive, the following have been identified as key contributors to the town (Table 3-1):

Table 3-1 Main Walla Walla industries and businesses identified during community & stakeholder engagement

Name	Details	Relevance to community understanding for the proposal
Kotzur Pty Ltd www.kotzur.com	60 Commercial St, Walla Walla NSW 2659	• Design & construction of silos and bulk handling facilities. • Family business, operating since 1962, so has historic town connection. • Large (if not biggest) contributing business for the town. • Provide services to the local area, as well as regionally and internationally. • Employs ~100 people.
PJN Steel Fabrication www.pjnsheds.com.au	104 Commercial St, Walla Walla NSW 2659	• Design & construction of sheds. • Family business, operating for ~30 years (1985), so is another long-standing business in the town. • Supplies to NSW, Victoria, South Australia, Queensland and Tasmania. • Local employer.
Weisners www.weisners.co.au	77 – 79 Commercial St, Walla Walla NSW 2659	• Supplier of agricultural equipment (tractor, combine harvester, seeder, spreader, spray equipment or hay equipment); including ongoing service and support. • Family business, operating since 1973. • Walla Walla and Wodonga facilities, operating within regional NSW and Victoria. • Already have a programme that aims to employ one new agricultural service apprentice each year, as well as participating with St Paul's College (Walla Walla) and Billabong High School (Culcairn). • Significant local employer.
Holden www.lieschkeholden.com.au	62 Commercial St, Walla Walla NSW 2659	• Family business. • Already large contributors of time and resources to local initiatives (e.g. Red Cross)
Blairs Produce Co.	3 Victoria St, Walla Walla NSW 2659	• Produce fertilizer, grain and farm supplies (operates some local silos). • Family business.

Name	Details	Relevance to community understanding for the proposal
		• Limited information but are a well-known local business.
DJ's Fine Fast Food https://www.facebook.com/djsfinefastfood/	41 Commercial Street, Walla Walla NSW 2659	• Food and beverage-focused facility in the town. • Locally owned.
Walla Walla Hotel Motel https://www.facebook.com/pages/category/Local-Business/Walla-Walla-Pub-223983410949421/	81 Commercial Street, Walla Walla NSW 2659	• Accommodation and pub. • Locally owned.
Boral Quarry	LOT 2 Weeamera Road Culcairn NSW 2660	• Local quarry

3.2.3 *Schools & education*

The co-educational Walla Walla Public School is the only kindergarten to Year 6 primary school in the town.

Walla Walla is also home of St Paul's College, the only Lutheran secondary school in NSW. The school was founded in 1948, and currently has approximately 269 students. The school offers an equine program, with many students keeping horses in the adjacent equine centre, as well as agricultural studies. Boarding students are drawn from communities within the Greater Hume Shire, the Riverina, North Eastern Victoria and further afield from the cities of Sydney, Canberra and Melbourne.

3.2.4 *Community facilities*

The following community facilities are located in Walla Walla:

- Community swimming pool.
- Bowling & Recreational Club.
- Walla Walla sportsgrounds (football and netball).
- Parks and gardens, including: Bicentennial Park, Lions Park, Sunnyside Park.

The sportsgrounds are a pivotal part of the community, with school and sporting events taking place here during the week and on most weekends. It is considered a key meeting place for the local community.

Each Friday the kitchen at the Bowling & Recreational Club is used by a designated charity, or the local schools – meals are made by volunteers, with funds raised going directly to the associated charity or school. In this way, the Club's facilities are a key meeting point for the community.

Due to the town's long history (established in 1869), it also has numerous heritage facilities, most notably:

- Morgan's Lookout: this is a white granite outcrop located next to Billabong Creek, the longest creek in the southern hemisphere. Due to its elevation, this local geological feature was used by the bushranger Dan "Mad Dog" Morgan as a lookout for police parties. Morgan's Lookout was also used as a lookout for fires in the late 1800s, a concern that was heightened by the fear of arson due to an industrial dispute between graziers and shearers.
- Zion Lutheran Church: the original Lutheran church was built from white granite in 1872. The present Zion Lutheran Church was built in 1924 and it is the largest Lutheran Church in NSW, with

seating for almost 600 people. Nearby, the schoolhouse built in 1883 by the Zion congregation is still extant.

- Gum Swamp: this is a nationally important wetland area and it covers approximately 200 hectares. This area is home to Aboriginal (Wiradjuri) heritage sites, local flora and fauna, including at least 128 species of birdlife.

The local setting of the proposed solar farm in the Walla Walla area, and the location of facilities, are illustrated on Figure 3-2 and Figure 3-3, respectively.

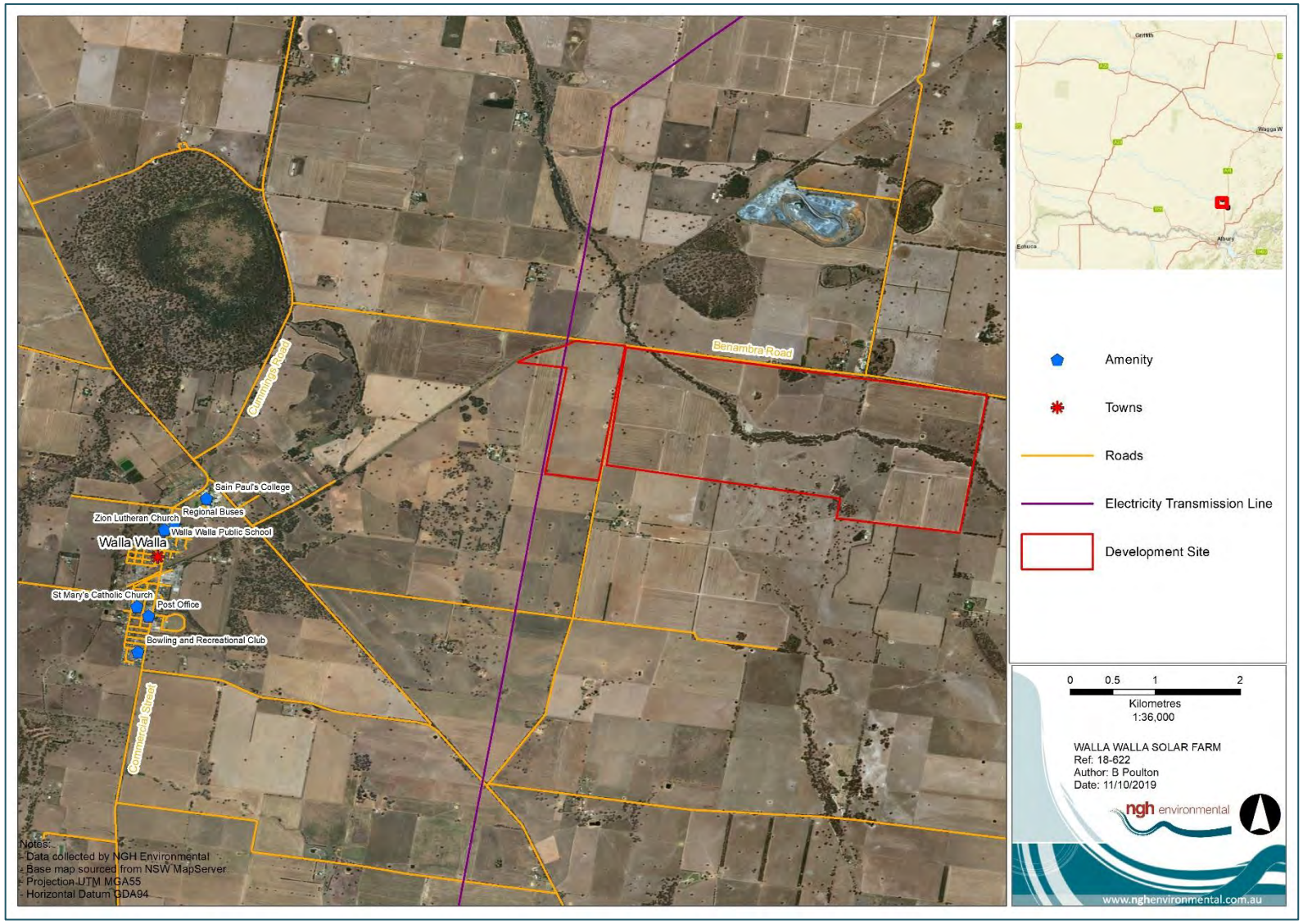


Figure 3-2 Local setting of the proposal in proximity to Walla Walla town (source: Google Earth, 6 August 2019)

Figure 3-3 Location of key facilities in Walla Walla (source: Google Earth, 6 August 2019)

3.3 CULCAIRN

Although Walla Walla was identified as being a pivotal community for the proposed solar farm, many community members also affiliate with Culcairn. This section provides a brief review of the socio-economic facilities relevant to this report.

3.3.1 *Regional context*

Located along Olympic Highway between Wagga Wagga (80 km north) and Albury (50km south), Culcairn is the centre of an agricultural district farmed for its wheat, wool and lambs. The town's population in 2016 was recorded as 1,473 people (ABS 2016). Like Walla Walla, it is situated within the Greater Hume Shire LGA.

The town is an important supply centre for nearby towns and villages including, Morven, Gerogery, Henty, Walla Walla and Pleasant Hills. Billabong Creek runs along the southern edge of town, lending its name to the local high school.

3.3.2 *Local industries & businesses*

Local industries include the Culcairn Steel Fabrication, a concrete plant, Country Energy Depot, substantial grain silos and the Wet Blue Hide facility. Council Planning Offices are located in Culcairn as well as one of the LGA's three physical libraries.

Although not in Culcairn town, the Orange Grove Gardens (https://orangegrovegardens.com.au/) is a wedding, functions and accommodation venue located 12 km south of Culcairn, along the Olympic Highway

towards Albury. This local business has relevance to this CSER as it is a direct neighbour to the proposed solar farm development site.

3.3.3 *Schools & education*

Culcairn today offers residents two primary schools – Culcairn Public School and St Joseph's Primary School, and one high school – Billabong High School.

3.3.4 *Community facilities*

The following community facilities are in Culcairn:

- Greater Southern Area Health Service;
- Football, tennis and netball courts;
- Cricket facilities;
- Public swimming pool;
- Bowling Club; and
- Parks and gardens, including Eric Thomas Park and Jubilee Park.

Due to Culcairn's long town history, it has several heritage-listed sites including the Culcairn Hotel (1891), the Memorial Hall, the Court House, the Railway Station and the Station Master's Residence (1883).

3.4 COMMUNITY GROUPS

Like many rural communities, the towns of Walla Walla and Culcairn are both largely community driven. This implies a strong community 'sense-of-place', with many town-related activities being organised, funded and/or supported by the local community.

For the purpose of the proposal's community engagement, the following community representatives/groups were identified as being relevant to the project:

- Greater Hume Shire
- NSW Farmers' Association
- NSW Rural Fire Services
- The Insurance Council of Australia
- Gum Swamp Committee
- Landcare
- Walla Walla Development Committee
- Culcairn Community Development Committee

During consultation with the Greater Hume Shire on the proposal, it was noted that the Shire supports the need for any developers to contribute financially towards the Shire's sustainable economic development.

Many of the local agricultural community are affiliated with the NSW Farmer's Association (http://www.nswfarmers.org.au/). As highlighted on their website, the '*NSW Farmers is an Association of farmers and stakeholders of the agricultural industry…members gather in branches right across NSW to discuss the issues affecting their businesses and to learn about agricultural topics*'. Furthermore, '*NSW Farmers is a lobby group for the farming sector, championing the rights of farmers and rural communities at all levels of government and with industry stakeholders. We are apolitical, independent from government, and our policy is driven from the grassroots up*'. Due to its local member base and interest shown at project-specific Information Sessions, NSW Farmers is considered a stakeholder of the proposal.

A representative from the Association was present at the original Information Sessions held by Bison; with a one-on-one meeting also held between the NGH team and the representative at the NGH offices in Wagga Wagga on 23 May 2019. After FRV acquired the project, introduction was sent via e-mail on 30 July 2019 and face-to-face introduction was completed on 2 August 2019. The representative attended the community session on 23 September 2019 and an individual meeting was also arranged on 24 September 2019.

The NSW Rural Fire Services (RFS) (https://www.rfs.nsw.gov.au/) Head Office in Sydney was engaged with following community concerns around fire management pertaining to the solar farm. Telephone and e-mail discussions were held with the Manager – Development Planning & Policy. This engagement was mainly to determine EIS-requirements needing additional consideration, such as asset protection zones, as well as operational specifications for access to the solar farm in a fire emergency. FRV engaged directly with local members of the Rural Fire Service (RFS), with recommendations being incorporated into the design of the project.

Engagement with the Insurance Council of Australia (https://www.insurancecouncil.com.au/) was undertaken regarding community concerns raised that the presence of the solar farm could result in increased public liability for natural hazards (such as unmitigated fires) on local properties. Further consultation was carried out by FRV with Willis Towers Watson, a global multinational risk management, insurance brokerage and advisory company.

FRV engaged with the Gum Swamp Committee (http://ecoportal.net.au/groups/gum-swamp-reserve-walla-walla-managment-committee/) and met for a face-to-face meeting on 2 August 2019. This meeting provided FRV with a better understanding of the local land, flora and fauna, as well as efforts to restore and preserve biodiversity in the area.

With many local recommendations, Holbrook Landcare (https://holbrooklandcare.org.au/) was engaged at the early stages of FRV acquiring the project. FRV believe it is important to engage with these local groups as they will have genuine understanding of what is appropriate for the local land. As a result, Landcare have been employed to walk over the project land and provide advice which has been incorporated into the design. The Detailed Landscape Plan is provided in Appendix E of the EIS.

Engagement occurred with the Walla Walla Development Committee on 2 August 2019. This group is pivotal to defining and delivering projects that improve the social and economic standing of the region, and a reliable means of communication regarding other developments in the area. Both the Walla Walla and Culcairn Committees produce monthly newsletters that were included in project communications during the EIS planning stage.

3.5 RELEVANT MEDIA

Local media is an important channel for community members to obtain factual, timely information about developments in their area. Subsequently, local print and broadcast media has increasingly been incorporated into community engagement practices to encourage broad scale dissemination of key project developments and factual statistics.

As a result, media coverage has appeared in the Border Mail, Channel 9 news and on ABC. FRV will continue to provide access to senior project representatives and respond to media enquiries as consultation continues.

4 COMMUNITY ENGAGEMENT APPROACH

4.1 OBJECTIVE AND AIMS OF ENGAGEMENT

The approach followed for the proposal's community engagement was aligned with the Public Participation Spectrum developed by the International Association for Public Participation (IAP2) (https://www.iap2.org.au/Resources/IAP2-Published-Resources). The IAP2 Public Participation Spectrum (Spectrum) '*is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program. The Spectrum shows that differing levels of participation are legitimate depending on the goals, timeframes, resources and levels of concern in the decision to be made. However, and most importantly, the Spectrum sets out the promise being made to the public at each participation level. The Spectrum is widely used and is quoted in most community engagement manuals.'*

Figure 4-1 illustrates this engagement Spectrum, from informing, to consulting, to involving, to collaborating, to empowering. Different levels of engagement suit varying degrees of potential impacts in the community. Where impacts are less significant, for example, the IAP2 Spectrum suggests approaches such as 'Inform' and 'Consult'. Greater impacts on communities require approaches such as 'Involve', 'Collaborate' and 'Empower'.

Although the proposal is only in the EIS stage, wherever possible, the supporting community engagement was aligned to the public participation goals of:

- *Consultation* – to partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.
- *Involvement* – to work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.

Engagement has primarily sought to 'provide meaningful avenues for FRV to involve community stakeholders in the development of key aspects of the project' and 'manage, minimise and mitigate any impacts to community stakeholders to the maximum extent possible'. Longer-term, FRV's goal is to generate community acceptance and trust for the solar farm – ensuring sustainable social and economic performance over the lifetime of the asset.

FRV's approach to engagement fits with its broader corporate values, which are:

- Pioneering spirit – becoming a role model to others
- Commitment – always fulfil promises
- Talent – professionals that are committed to responsibility and transparency
- Sustainability – applying the concept of sustainability to every action taken

Objectives of this Community Engagement Plan are as follows:

- Ensure all stakeholders have up to date information about the project, FRV and its contractors;
- Provide timely opportunity for stakeholders to have direct input into aspects of the Walla Walla Solar Farm's development;
- Ensure stakeholders and community know where and how to get information relevant to their needs.

Key Performance Indicators

The following success criteria will be used to measure the outcomes of community engagement initiatives:

1. Levels of community support for Walla Walla Solar Farm and FRV are maintained and improved.
2. No unforeseen adjustments to community engagement approach to meet community expectations.
3. Community knowledge and trust in FRV as the developers and owners of Walla Walla Solar Farm is established.

Consultation and *involvement* will continue to be key community engagement goals should the project be approved.

Figure 4-1 Spectrum of public participation (IAP2, 2014)

4.2 IDENTIFIED COMMUNITIES AND STAKEHOLDERS

4.2.1 *Specific community groups*

In order tailor the engagement strategies, it was important to identify key community and stakeholder groups for the proposed solar farm. Seven main groups were identified (Table 4-1).

Table 4-1: List of identified communities and stakeholders for the proposal's community engagement

Community and stakeholder group	Description	No. of entries
1. Residential dwelling and businesses within 1 km of the proposal or direct adjoining land (direct neighbours)	• Residential properties or businesses located within 1km of the proposal or has land directly adjoining to the property. • Referred to as development site 'direct neighbours.' • Considered key community stakeholders. • 6 stakeholders, two of whom are also the subject landowners. One of the residential properties is also being operated as a local tourism venue – weddings and eco-accommodation (map reference: R1, R2, R3, R4, R5, R6). • Identified upfront before the project's community engagement was formally initiated.	6
2. Landowners within a 3 km radius from the subject land (near neighbours)	• Residential, and/or business owner within a 3 km radius from the proposed development site (included outlying residential properties of Walla Walla). • Referred to as 'near neighbours.' • 26 community members (map reference: R7a-c to R27, R30, R37, R54, R64, R66). • Included community members registered on the project's community engagement database once identified by direct neighbours, or due to their participation in the various consultation strategies.	26
3. Landowners within a 3 - 5 km radius from the subject land (local community)	• Residential, land and/or business owner within a 3 to 5 km radius from the proposed development site. (Included outlying farming properties of Walla Walla). • Referred to as 'local community.' • 18 community members (ref: R28, R29, R31, R33, R34, R35, R44, R50, R51, R76, R77, R79, R80, R81, R82, R83). • Community members registered on the project's community database due to their participation in the various consultation platforms.	18

Community and stakeholder group	Description	No. of entries
4. Other community members (broader community)	• Community members residing or operating businesses in a radius greater than 5 km from the proposed development site. • Referred to as the 'broader community.' • 41 community members (ref: R30, R32, R36, R38 - R43, R45 – R49, R52, R53, R55 – R63, R65, R67 – R77, R78).	41
5. Regulating authorities	• DPIE, based in Sydney (State regulator) (1). • Greater Hume Shire LGA (local regulator) (2).	3
6. Community organisations	• Representative community organisations (9), including but not limited to: - NSW Farmers' Association. - NSW Rural Fire Services. - Insurance Council of Australia. - Gum Swamp Committee - Landcare - Walla Walla Development Committee	9
7. Media	• Local media outlets providing print and electronic media coverage of local issues	3
	Total Community Database entries:	**106**

4.2.2 *Community Database*

A dedicated Community Database (Microsoft Excel format) was established at the beginning of the consultation process. The details of each community and stakeholder member or group have been captured in the Community Database. Although many community members agreed to their details and associated comments being publicly available as part of the EIS, EIA protocol requires strict confidentiality on such personal details and comments. Hence, this CSER provides consolidated outcomes of the community engagement – only the NSW DPIE will have access to personal details and comments once the EIS is submitted, should they wish to clarify any comments directly.

It is noted that every effort has gone into accurately defining the precise location of residential, and/or businesses of community members contributing to the project's engagement process to date – as defined in the Community Database. This has been possible when addresses were provided as part of the various consultation media, such as Community Feedback Forms, or verbal confirmation. Where this information was not made available, precise locations could not be verified. Although these community members are all included in the Community Database, only those providing physical residential addresses could be mapped.

(The Community Database spreadsheet is provided in Appendix E of the DPIE version of CSER).

4.3 ENGAGEMENT STRATEGIES

The consultation strategies listed below formed part of the overall community engagement approach followed for the proposed solar farm.

4.3.1 *Project website, e-mail, telephone*

Aim	To provide an online platform for community information sharing on the project, allowing for regular and quick update of information, as required.
Relevant community / stakeholder group	1. Direct neighbours. 2. Near neighbours. 3. Local community. 4. Broader community. 5. Council.

Immediately after acquiring the project, FRV provided direct mobile and e-mail addresses for both the FRV Project Manager and the Lead Community Engagement Officer from Banksia Communications within Introduction Letters and posters, sending a clear message that direct contact could be made with the FRV development team at any time.

Bison Energy commissioned the development of a project-specific website: http://www.wallawallasolarfarm.com.au/ . This website was initiated 1 March 2018. After acquiring the project, FRV obtained this domain and substantially updated the website for the project. There is a dedicated 'Community' tab along with a 'Contact Us' tab allowing individuals to get in direct contact. Within the 'Contact Us' tab, there is a number of drop-down options which also facilitates for suppliers and potential workers to log their interest in the project.

As part of the website, an e-mail was also provided: infoaustralia@frv.com, along with direct mobile numbers as a mechanism for ongoing feedback. Telephone correspondence was held mainly via the NGH Wagga Wagga office when Bison Energy was the project developer, however FRV prefer direct neighbour correspondence between stakeholders and the developer. Engagement information is continually updated on the project website. This includes website links to give the user access to further detail, including;

- project 'Frequently Asked Questions'
- project 'Factsheet'
- NSW Government website to review further detail on 'State Significant Developments'

Figure 4-3 FRV: As illustrated on the main page pf the project website

FRV wish to give individuals clear indication of the process and what stage we are at within the process.

Figure 4-4 FRV: As illustrated on the project website

The website and e-mail resources will remain active throughout the decision-making stage of the project, as well as during construction and operation, should the project be approved.

4.3.2 *Face-to-face meetings*

Aim	To develop a relationship with direct and near neighbours (and other stakeholders that could be directly impacted by the solar farm development), and to capture and understand key concerns that required dedicated mitigation focus as part of the EIS preparation.
Relevant community / stakeholder group	1. Direct neighbours. 2. Near neighbours. 5. Council. 6. Community Groups

Numerous face-to-face meetings were held as part of the Scoping and EIS preparation stages. Key meetings are documented below:

- On 10 January 2019, Bison Energy and NGH met with the DPE to discuss the content of the Scoping Report, and identify any specific aspects needing to be included in the EIS preparation stage (Appendix A_1).
- Engagement with those community members residing directly adjacent to the subject land was initiated on 21 January 2019, via introductory telephone calls. These telephone calls were undertaken by Bison Energy, aimed at introducing the proposed solar farm to directly adjacent landowners (R1, R2, R3, R4, R5).
- Following receipt of the SEARs in March 2019, NGH began dedicated community consultation with one-on-one face-to-face meetings with the direct neighbours and other residents located within a 3 km radius of the project. The team for these meetings comprised Mr Simon Zhang - Managing Director of Bison and Ms Raina Hattingh –independent Community Liaison Officer from NGH. These initial meetings were held on 15 March 2019. All the direct neighbours (R1, R2, R3, R4, R5, R6) were met with, the proposed project was explained in more detail, and any initial key comments captured. An introductory information flyer providing an overview of the solar farm development and the planned community consultation approach was distributed at the same time (Appendix A). In between meeting with direct neighbours, other homesteads within 3 km of the proposal were also visited. Where residents were at home, similar conversations as those with the direct neighbours were held, and comments captured. When residents were not home, the introductory flyers were left in locations where they would be found.
- On 15 March 2019, a meeting was held with the Greater Hume Shire. The purpose of this face-to-face discussion was to formally introduce the project to the Shire and identify areas for additional assessment as part of the EIS stage.
- Following the Information Session No. 1, and prior to Information Session No. 2, a face-to-face project update was provided to direct neighbours (R1, R2, R5) – this was undertaken on 11 June 2019. The project update included information on how community concerns were being addressed as part of the project development and EIS mitigations. It also provided direct neighbours with an opportunity to see project updates prior to these being provided to the broader community at Information Session No. 2, and to provide further input, as required.

  It is noted that R6 was contacted for inclusion as part of this information dissemination. Unfortunately, due to one of the landowners being unwell, they could not be engaged with on this date.
- On 11 June 2019, a meeting was held with the near neighbour R26 at his land – although there is no residence on this property, the working land abuts the westerly boundary of the development site.
- Following FRV acquiring the project, an announcement was made via letter and e-mail to the community and relevant stakeholders on Monday 29 July 2019. In the same week, FRV simultaneously, got in direct contact with direct neighbours and stakeholders to arrange suitable meetings from Wednesday 31 July to Saturday 3 August 2019. Meetings were offered on times that would suit the individuals including Saturday and in evening times, to provide flexibility. Meetings sought to understand concerns, document unresolved issues and gather more detailed information about the land and local community.
- On 31 July 2019, the FRV Project Manager and Lead Community Engagement Officer from Banksia Communications met with both R5 and R6.
- On 01 August 2019, the FRV Project Manager and Lead Community Engagement Officer met with Greater Hume Council and R2.

- On 02 August 2019, the FRV Project Manager and Lead Community Engagement Officer met with R1, the Gum Swamp Committee, Walla Walla Development Committee Chair and the NSW Farmers Association.
- On 02 August 2019, the FRV Project Manager met with near neighbour (R27), who previously requested a one-on-one meeting with the previous developer, and R7 and R30.
- After these meetings, follow up e-mails were provided to the individuals, thanking them for their time and providing update on how FRV would approach the project in the coming weeks, along with clear indication that they could make direct contact with FRV at any point in the process.
- On 19 August, the FRV Project Manager and FRV Senior Developer met with R31.
- From 10 September to 11 September further meetings were held with direct neighbours and stakeholders, to provide update on how FRV had been taking their concerns into consideration and detail on the extensive changes which had been made to the design of the project.
- On 10 September, the FRV Project Manager and FRV Head of Development met with R1.
- On 11 September, the FRV Project Manager and FRV Head of Development met with representatives from Greater Hume Council, R2, R27, R5 and R7.
- On 11 September, FRV Senior Developer met with Holbrook Landcare on site.
- On 24 September, FRV Senior Developer met with a member of the Rural Fire Service.
- On 24 September, FRV Project Manager, Head of Development, Head of Construction and Lead Community Engagement Officer from Banksia Communications met with NSW Farmers Association.

4.3.3 *Community Drop In Information Sessions*

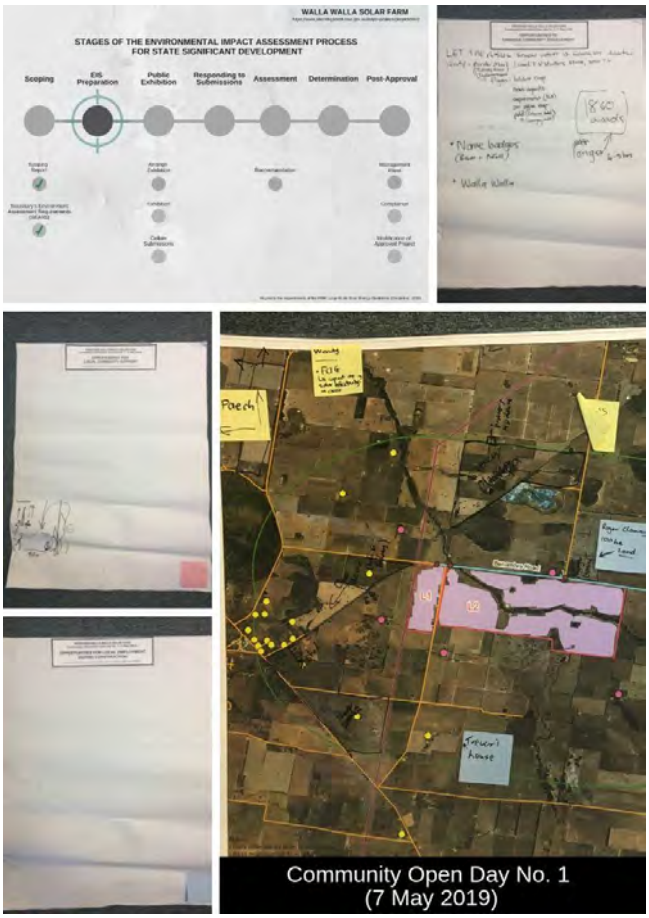
Aim	To provide project information to the broader community and other stakeholders who may have an interest in the project.
Relevant community / stakeholder group	1. Direct neighbours. 2. Near neighbours. 3. Local community. 4. Broader community. 5. Council 6. Media

Community Drop in Information Sessions were used as a forum to reach the broader Walla Walla and Culcairn communities, as well as other stakeholders interested in the project. Four Information Sessions were held for the proposal in total by both Bison & FRV:

- Information Session (No. 1): 7 May 2019 (Culcairn Bowling Club, 11:00 to 14:00).

- This Information Session was used to introduce the broader community to the project, explain the EIA process, where community engagement fits into the EIS process, and to summarise the results of specialist studies available at the time.
- 42 people registered their attendance at this session (see Appendix B_1).

- Bison Energy was represented by Mr Simon Zhang (Managing Director), Mr Patrick Lau (Technical Manager), Mr Brendan Murphy (Property Executive); NGH staff included Ms Raina Hattingh (community liaison) and Ms Bridgette Poulton (EIS project manager). Mr David Brown of JLL Consulting facilitated the discussions and captured community comments.
- The Information Session was held as an informal 'question-and-answer' session, with A0 maps and flow diagrams prompting discussion. Flip charts were used to obtain the community member input on '*enhancing community engagement*', '*local employment opportunities*' and '*opportunities for community support*'.



- Community Information Session (No. 2): 9 July 2019 (Walla Walla Bowling Club, 18:00 to 20:00).
  - This Information Session was used to summarise the results of completed specialist studies, summarise community feedback obtained on the project to date, provide responses to common queries raised on and since the Information Session No. 1.
  - 45 people registered their attendance at this event (see Appendix C_1).
  - Bison Energy was represented by Mr Simon Zhang and Mr Patrick Lau; and the NGH team included Ms Raina Hattingh and Ms Bridgette Poulton. Mr David Brown of JLL Consulting facilitated discussions and captured comments made by community members.
  - The event was a 'presentation' session – during the first hour, the project team provided an overview of the proposal design including how the proposal had changed in response to community feedback (see Appendix C_2 for the presentation); the second hour was a question and answer session to enable discussion and capture additional questions and concerns.
- Community Information Session (No. 3): 23 September 2019 (Walla Walla Bowling Club, 17:30 to 19:30).
  - This Session was held by FRV, to provide the wider community further detail on FRV as a company, their experience and approach, along with details on the proposal and the changes in which FRV had implemented to the proposal. Key FRV team members also attended the session to provide the community with an opportunity to engage with experts in their individual areas, including the 'FRV Head of Construction' and the 'FRV Head of Development'. A presentation was provided at 6pm by the FRV Project Manager. Detailed presentation

boards were provided around the room, along with videos of existing FRV operational projects.

- Community Information Session (No. 4): 24 September 2019 (Walla Walla Bowling Club, 09:00 to 11:00).
  This Session was provided to allow flexibility and a second opportunity for individuals to meet and ask questions with the FRV project team. The same personnel and material in Session 3, including information boards and videos were also provided during this session. Channel 9 and the Border Mail attended this session and provided resulting coverage of the presented materials.

4.3.4 *Community Feedback Forms*

Aim	To provide a consistent, easily accessible tool on which community members and stakeholders could document their concerns or queries.
Relevant community / stakeholder group	1. Direct neighbours. 2. Near neighbours. 3. Local community. 4. Broader community.

A standard Community Feedback Form was compiled for the project. These forms were made available on the Bison website, during face-to-face discussions, at the first two Community Drop In Sessions, and via e-mail correspondence (see Appendix D).

These forms were used as the main tool to capture neighbour and broader community inputs.

In total 50 Community Feedback Forms were received, and the input captured on the Community Database. After receipt of Feedback Forms, a personalised email was sent back to the relevant community member noting their comments and how they would be addressed by the project.

If a community member was not already on the database, receipt of their Feedback Form was used as an opportunity to capture their details. General correspondence to interested parties was sent to all contacts listed on the database as they were registered. FRV used these feedback forms as a basis to understand concerns and therefore make positive and practical changes to the design. They also helped form the basis of the FRV project 'Frequently Asked Questions' document, with the aim to inform and address concerns in a clear and consolidated manner.

4.3.5 *Ongoing community correspondence and media*

Aim	To maintain continual engagement with community members and stakeholders, addressing concerns or queries as they arise.
Relevant community / stakeholder group	1. Direct neighbours. 2. Near neighbours. 3. Local community. 4. Broader community. 5. Council. 6. Media.

Throughout the EIS stage, there was ongoing community correspondence to provide a consistent source of information as the project's studies and community engagement progressed.

Information was collated and distributed as flyers, pamphlets and posters at various locations across Walla Walla and Culcairn (see Table 4-2). Local newspapers and community newsletters were also used to advertise the four Community Sessions.

Table 4-2 provides a list of the type of communication tools used for this ongoing community engagement, the information shared and corresponding distribution dates.

Table 4-2: List of community engagement platforms used

Type of communication (tools)	Information shared	Date
Project information / updates		
Project information flyer (A4): • Direct and near neighbours (personally). • Walla Walla x1 (Post Office window). • Culcairn x1 (community noticeboard-Railway parade).	Project Information as at 15 March 2019 (Appendix A_2)	15 March 2019
Follow-up supporting guidelines, studies, research, to help empower the community with information around existing solar farms: • Emailed to key stakeholders engaged with during March 2019 (direct & near neighbours, and Greater Hume Shire).	Available NSW Guidelines and existing global supporting scientific and specialist studies on key questions raised during upfront engagement (Appendix A_3).	12 April 2019
Solar farm 'Frequently Asked Questions' (FAQs) • Emailed to Community Database.	Summary of responses to FAQs on solar farm planning, development, construction, operation and decommissioning (Appendix A_4).	From 30 April 2019
Information pamphlet (A4): • Walla Walla x1 (Post Office window). • Culcairn x2 (community notice board-Railway parade; Culcairn Bowling Club noticeboard).	Project Information as at 6 May 2019 (Appendix A_5)	7 May 2019
Posters (A2): • Walla Walla x3 (community noticeboard, Post Office window, Pub – all along Commercial Street). • Culcairn x2 (community notice board-Railway Parade; Foodworks noticeboard).	Project 'Quick Answers' as at 11 June 2019 (Appendix A_6)	Placed 11 June 2019
Walla Walla town maildrop (282), included: • 220 residences. • 27 businesses. • 35 PO Boxes. (Distributed via Walla Walla Post Office).	Project 'Quick Answers' as at 11 June 2019 (included Invitation to Information Session No. 2)	19 June 2019
Introduction Letters distributed via; • Mail • E-mail	FRV Introduction Letters (Appendix A_7)	29 July 2019

Type of communication (tools)	Information shared	Date
Project information / updates		
Posters (A4): • Walla Walla x3 (community noticeboard, Post Office window, Bowling Club). • Culcairn x3 (community notice board, Greater Hume Shire Council noticeboard, Bowling Club).	FRV New Developer Poster (Appendix A7)	3 August 2019
Email to Community Database	Follow-up e-mail after Community Sessions providing link to website and FRV Project FAQ (A8)	27 September 2019
Information Sessions		
Community Information Session (No. 1)		
E-mail to key stakeholders (immediately adjacent landowners and Greater Hume Shire)	Invitation to Community Information Session No. 1 (Appendix B_2)	12 April 2019 (four weeks before meeting)
Eastern Riverina Chronicle	Invitation to Community Information Session No. 1 (Appendix B_3)	• 24 April 2019 (two weeks before meeting). • 1 May 2019 (one week before meeting).
Email to Community Database	Summary of key community aspects raised to date (pie chart), after most feedback was received from the Information Session No. 1 (Appendix B_4). (E-mail included Information Session No.2 Invitation)	17 June 2019
Community Information Session (No. 2)		
E-mails to key stakeholders, Community Database and Greater Hume Shire	Invitation to Community Information Session No. 2 (Appendix C_3)	17 June 2019 (three weeks before meeting)
Border Mail (Saturday edition)	Invitation to Community Information Session No. 2 (Appendix C_4)	22 June 2019 (2 ½ weeks before meeting)
• Walla Walla x6 (community noticeboard, post office window, Pub, chemist, WAW Rural Transaction Centre; bowling club – all along Commercial Street). • Culcairn x 7 (community noticeboard-Railway Parade; bowling club noticeboard; post office noticeboard; Greater Hume Shire noticeboard;	Invitation to Community Information Session No. 2	18 June 2019

Type of communication (tools)	Information shared	Date
Project information / updates		
Foodworks' notices; Newspower newsagency; pharmacy notices).		
Walla Walla town maildrop (282), included: • 220 residences. • 27 businesses. • 35 PO Boxes. (Distributed via local post office).	Invitation to Information Session No. 2 (As part of mail drop with project 'Quick Answers' as at 11 June 2019)	19 June 2019
Walla Walla newsletter	Invitation to Community Information Session No. 2	26 June 2019
E-mails to registered attendees of Information Session No. 2 (as at 18 July 2019)	Presentation from Information Session No. 2.	18 July 2019
Information Session (No. 3 & 4)		
Phone-calls directly to neighbours (R1, R2 & R5) to determine the most appropriate dates for the FRV Community Sessions	Consultation on the date of the FRV community sessions	29 August 2019
Community Session Letter distributed via; • E-mail to Community Database	Invitation to FRV Community Sessions - Letter	09 September 2019
Posters (A4): • Walla Walla x5 (community noticeboard, Post Office x2, Chemist, Bowling Club). • Culcairn x7 (community notice board, Greater Hume Shire Council noticeboard, Bowling Club, Post Office, Pharmacy, Foodworks, Newspower Newsagency).	Invitation to FRV Community Sessions - Poster	10 September 2019
Border Mail advertisement	Invitation to FRV Community Sessions	09 September 2019 16 September 2019 23 September 2019
Frequently Asked Questions • Print outs provided at each session. • Electronic copy provided via e-mail after the sessions to those in attendance and on the Database.	Extensive Q and A on key topics of interest	23, 24 & 27 September 2019

Type of communication (tools)	Information shared	Date
Project information / updates		
EIS Public Notification		
E-mails to Community Database notifying that proposal is on Public Notification	Link to EIS	TBC

In addition to the above, there were numerous ongoing written (letter and e-mail) responses to face-to-face, telephone and e-mail queries raised mainly by near neighbours.

Various other media articles (written and broadcast) were available to the community during the project's consultation and engagement process. Although these publications were not instigated by Bison Energy or FRV, they had bearing on the community's access to information.

5 DOCUMENTING COMMUNITY COMMENTS

5.1 CONCERNS AND BENEFITS CAPTURED

From the Community Database, captured and documented comments can be summarised into cumulative response areas, defined as follows:

- Main community concerns and queries including:

  Environmental-related:

  - Loss of agricultural land use (food security & farmer livelihoods).
  - Incorrect classification of regional land capabilities.
  - Loss of- or impact on local biodiversity.
  - Presence of chemical/hazardous materials in panels.
  - Visual impact.
  - Glare/reflectivity impact.
  - Night lighting impact.
  - Noise and vibration impact.
  - Thermal heating (PVHI – photovoltaic heat island effect).
  - Increased/uncontrolled water use.
  - Changes to surface water runoff (incl. flood pattern changes).
  - Increased fire threats & risks.
  - Increased/uncontrolled pests and weeds.
  - Unmitigated dust from construction.

  Health and safety-related:

  - Unmitigated site access.
  - Increased traffic movements (mainly around school bus routes).

  Socio-economic-related:

  - Loss of agricultural 'sense-of-place.'
  - Financial devaluation of adjacent properties.
  - Created community anguish (dividing community; future uncertainties).
  - Increased insurance/public liability for adjacent properties.
  - Loss of secondary agriculture and tourism-related job streams.
  - Cumulative impact of many solar farms in the region.

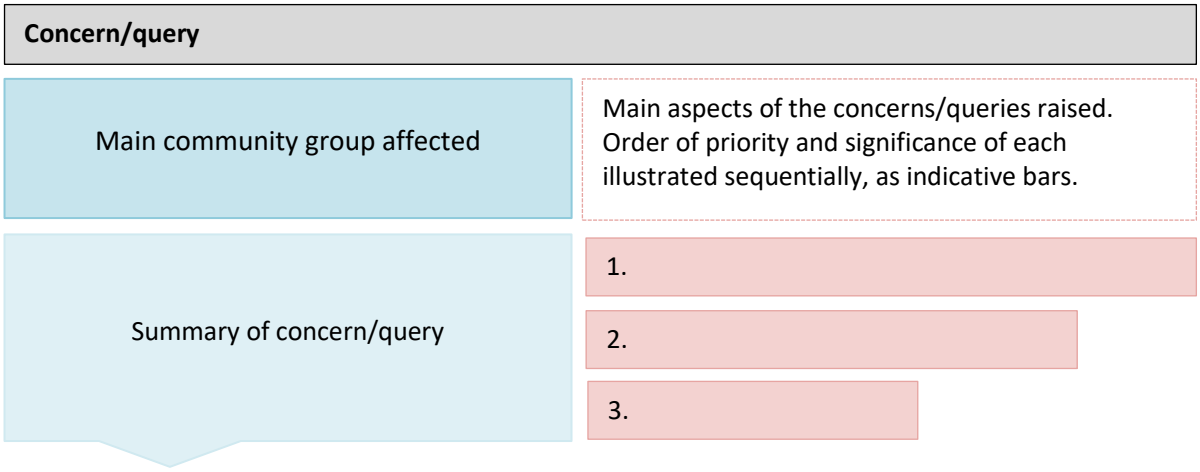
- Main community benefits, including:

  - Enhanced regional land use & income diversification.
  - Environmental benefits of renewable energy resources.
  - Availability of local jobs.
  - Socio-economic contribution for local towns, specifically Walla Walla.

5.2 MAIN COMMUNITY CONCERNS / QUERIES IDENTIFIED

From the summarised responses, the environmental and socio-economic concerns/queries raised on a continuous basis throughout the engagement process from all identified community groups are highlighted in this section (identified as being raised by 5% or more of respondents). These concerns/queries were also priority issues raised by direct neighbours.

For ease of reference, each concern/query has been summarised as follows:



- Detailed description of each of the main aspects of the concerns/queries raised.

Discussions held- and responses provided during the community engagement on raised concerns/queries; to be taken forward in EIS

Where is this considered in the EIS? Relevant EIS section

The concerns/queries have been addressed in the order of priority as gauged during the community consultation, as follows:

- No. 1 Visual impact.
- No. 2 Loss of agricultural land.
- No. 3 Financial devaluation of adjacent properties.
- No. 4 Loss of – or impact on biodiversity.
- No. 5 Loss of agricultural 'sense of place.'
- No. 6 Loss of secondary agriculture and tourism-related job streams.
- No. 7 Changes to surface water flow patterns.

Furthermore, where a concern/query is directly relevant to specific community members or groups, their specific comments have been highlighted. Conversely, if a concern/query was more general to the broader community, the main aspects have been summarised in general.

5.2.1 *No. 1: Visual impact*

This concern was captured from 8% of the respondents – together with the loss of agricultural land impact, this was deemed one of two of the proposed solar farm's largest community impacts.

Main community group affected:
DIRECT NEIGHBOURS
(specifically R1, R2, R3, R4, R5, and R6)

Four direct neighbours (R1, R2, R5 and R6) (and the two subject landowners – R3 and R4) have houses and/or working land with a direct outlook on the subject land.

Hence, the greatest visual impacts were raised from direct neighbours whose outlook from their homesteads and businesses is towards the proposed subject land. However, there was also a general broader community concern around the visual impact of the solar farm within an historically rural agricultural community.

1. Direct visual impact
2. Location of substation
3. Design of vegetation screening
4. Glare/reflectivity, and night lighting
5. Indirect (local/regional) visual impact

The following main concerns were identified:

- <u>1. Direct visual impact</u>
  - R1 owns two investment-focused rental houses next to each other (R1a & R1b), both of which are within 100 m from the northern boundary of the solar farm, along Benambra Road. Their main residence and working land are approximately 5 km north-east of the subject land. They also work the land associated with these houses (~188 ha), a portion of which is adjacent to the northern boundary of the subject land. Concern raised as to the future rental loss on this property, should prospective tenants not wish to have the solar farm as their view. This was of significance to this family as the rental properties are considered an important aspect of their long-term family investments.
  - R2's homestead is approximately 800 m from the north-western boundary of the subject land. Located on slightly elevated land, their outlook (including the bedroom, living area, balcony, front yard) is directly on to the subject land and, specifically, the sub-station. They are concerned that their rural views will be the most affected by the project. Concerns about the glare and reflectivity from the panels, as well as possible night lighting around the sub-station have been expressed. They consider that this would greatly reduce their agricultural views and associated rural sense-of place.
  - Associated landholder R3's homestead is approximately 350 m to the west of the subject land, with their working land located adjacent to the western boundary of the solar farm.
  - Associated landholder R4's homestead in located approximately 580 m south of the subject land. A portion of the southern subject land boundary is adjacent to their working land.
  - The solar farm would be a distant but direct view of the main lookout point for the adjacent business (R5) which functions as a wedding venue and also hosts and advertises eco-based

accommodation (approximately 800 m south-east of the subject land). This venue (R5a) is located on a topographical high point in the surrounding landscape. These landowners also work the land that abuts a portion of the southern boundary of the subject land. The main lookout point and working land is often used as focal points for wedding photographs. Significant concern was raised as to the negative impact the presence of the solar farm would have on the business' long-term viability.

- R6's homestead is approximately 2.2 km from the subject land, to the east. A portion of their working land – predominantly cattle farming, abuts the eastern boundary of the subject land.

- 2. Location of the substation
  - The proposed location of the substation has been raised as a significant concern by the landowners – R2. As mentioned above, their homestead's living area has distant views from an elevated, double-storey house towards the direction of the sub-station. Within this view there are existing pylons. There are deciduous trees planted along their driveway – although this may act as an additional screening in summer, in winter when the trees are bare, the visual impact could be apparent. Significant concern was raised as to the need to relocate the sub-station.
- 3. Location and design of the vegetation screening
  - Uncertainties as to whether or not the proposed vegetation screening width and species composition (landscaping design) would be adequate to reduce the perceived significant visual impacts for direct neighbours. This concern included queries as to the 'sequence of layout' of the screening – for example, location and type of fence, depth of screening in sensitive areas and location of screening in proximity to neighbouring boundaries; as well as the adequacy of the screening to reduce possible PV heat island effects.
  - The predominant wind flow is in a westerly direction across the subject land, towards R6. Their main concern is the possible transfer of heat (especially in summer) from the solar farm to their land and whether this would affect the productivity of their cattle (sensitive to temperature fluctuations). It was noted that provision and maintenance of water supply for their livestock is a constant challenge, and increased temperatures could result in them needing to invest further to supply enough water along subject land's western boundary. The vegetation screening allows for in-filling of the mid-canopy of the existing vegetation along the subject land's eastern boundary, but R6 has raised concern about whether this would be adequate to limit heat transfer from the solar farm to their adjacent land.
  - The timeframe for growth and establishment of the trees and shrubs would not reduce the visual impact for the first few years. FRV have not disputed that vegetation takes time to mature but ensures that landscaping plans use a mixture of species to ensure effective and efficient screening.
- 4. Glare and reflectivity solar panels and night lighting
  - Although the broader community raised queries as to the solar farm's glare and reflectivity, this – together with the facility's night lighting was the biggest concern for R2 who would overlook the substation.
  - Night lighting was also perceived to contribute to a loss of the rural setting. It has since been explained at night the solar farm only has reactive security lighting.
- 5. Indirect visual impact
  - The main residence of R27 is approximately 2.5 km north-west of the solar farm and is surrounded by mature vegetation. However, a portion of their working land is located directly north-west of the subject land, with current clear visibility of the subject land.

- Most respondents, even if not directly affected themselves, or even those supportive of the project, expressed the need for the Proponent to try and mitigate the above visual impacts on direct neighbours.
- The visual impact of the solar farm on local viewpoints such as Morgan's Lookout and Gum Swamp was also raised. Similarly, residences located along the range east of Olympic Highway noted their view of the subject land - one resident located over 5km from the proposal highlighted that they had plans to establish an accommodation venue which would no longer be feasible should the solar farm be developed.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	<u>1. Direct visual impact</u> • A visual impact assessment (VIA) has been included within the EIS, which provides indicative views from nearby residential receivers and public transport routes (including Olympic Highway, Benambra Road and Schneiders Road). Screening of these areas with a vegetation barrier is the main mitigation measure identified to limit visual impacts. <u>2. Location of sub-station</u> • After further engagement with R2 on 11 June 2019, they lodged a direct online enquiry with TransGrid (no. 2019-265; dated 12 June 2019. The enquiry was forwarded to Bison Energy from the project manager at TransGrid which resulted in subsequent discussions about the proposed substation site. The information was reviewed by the Bison Energy and an alternative location provided to TransGrid, situated towards the centre of the property along the western boundary. Bison Energy requested that TransGrid review both the proposed and alternative sites as part of their site visit (undertaken on 1 July 2019), and the potential to relocate the proposed site. Subsequently TransGrid advised that the existing proposed location is where they would like to establish their 33/330kV substation due to the suitability of terrain, access, engineering designs and location of infrastructure. They have also advised that the alternative location is higher and would be more visible to the neighbouring properties (R2 specifically). • However, after FRV visited R2 in early August 2019, re-location of the sub-station was re-investigated. This resulted in a change to the initial sub-station layout, relocating the sub-station footprint 100 m to the south of the initial design location, further from the homestead's line of view and the ability to retain existing mature boundary vegetation and providing additional area to implement also an extensive 50m vegetation screening buffer. To further accommodate R2, FRV have implemented a 50 m vegetation screening along the north-western subject land boundary. (With the initial design layout, this was not possible due to the sub-station being located within the powerline easement). FRV have also implemented screening along the disused railway boundary to protect view travelling from the West and also screening at the 'T' junction of Schneider's Road to facilitate views travelling from the East.

3. Location of other Infrastructure and Design of the vegetation screening

- FRV have substantially altered the original design which had been completed by the previous developer (Bison Energy) to accommodate and address concerns, with specific focus on the uninvolved direct neighbours - R1, R2, R5 and R6:

R1a & R1b:

- As R1 is the closest resident to the proposal, approx. 80m north from R1a and the property boundary. FRV have provided the following mitigation measures;
  - Changed the site access. Originally, 3 main access points were proposed along the Benambra Road, with traffic travelling past these residences, creating unnecessary dust and noise impacts. FRV have closed these proposed access points and created one single main access point to the North-East of the project, now approx. 1.4km away from these residences, therefore dramatically reducing the impact.
  - Existing, mature boundary vegetation will now be retained.
  - Altered the solar array design layout, setting-back solar panels directly opposite the R1a&b homesteads. This is referred to as a 'visual set-back' and will be undeveloped and left as grazing paddocks.
  - After this setback an extensive 50m vegetation buffer will be implemented. A detailed landscaping plan has been created;
    - Specific species that would effectively develop across the understory, mid- and top-canopy structures;
    - Specific species (shrubs and trees) that encourage foraging, pollination and habitat creation for local insects, birds and fauna; and
    - Erecting nesting and faunal boxes to encourage wildlife use of the area.
    - Connect to existing vegetation to create an ecological corridor for local and seasonal wildlife.
  - From this vegetation buffer, a further 10m setback will occur for the Asset Protection Zone (APZ).
  - After the APZ, only then will the Solar Farm security fence be installed.
  - An additional 5m minimum setback will occur before the solar array will occur.
  - From R1a, a 400m radius 'Inverter Exclusion Zone' has been implemented. Therefore, the design has been altered so no inverters will be installed within 400m, to further reduce visuals.

R2:

- R2 is located approx. 800m north-west from the proposal. FRV have provided the following mitigation measures;
  - Changed the site access. Originally, 3 main access points were proposed along the Benambra Road, with traffic travelling in close proximity to their driveway, creating unnecessary dust and noise impacts. FRV have closed these proposed access points and created one single main access point to the North-

East of the project, now approx. 4.4km away from these residences, therefore dramatically reducing the impact.

- FRV have also changed the location of the proposed Operations and Maintenance facilities which was originally proposed beside the substation. It will now be located at the main access point, 4.4km away from R2, therefore reducing any impact in the long-term for this resident.
- As stated in point 2, FRV reinvestigated the location of the substation and have moved this piece of infrastructure 100m South to accommodate the views of R2. This involved detailed and lengthy technical analysis at substantial cost to FRV.
- By altering the location of the substation, existing, mature boundary vegetation can now be retained, further protecting the views of R2.
- Solar Panels have not been proposed in the most north-western section of the development site.
- Along with FRV moving the sub-station, an extensive 50m vegetation buffer will also be implemented. A detailed landscaping plan has been created;
  - Specific species that would effectively develop across the understory, mid- and top-canopy structures;
  - Specific species (shrubs and trees) that encourage foraging, pollination and habitat creation for local insects, birds and fauna; and
  - Erecting nesting and faunal boxes to encourage wildlife use of the area.
  - Connect to existing vegetation to create an ecological corridor for local and seasonal wildlife.
- Additional screening has also been implemented in the north-west boundaries including 5m and 10m buffers which will also help facilitate views of the project from R2.
- From the substation, a further 10m setback will occur for the Asset Protection Zone (APZ).
- After the APZ, only then will the Solar Farm security fence be installed. FRV decided to not implement the security fence around the property boundary, which will help R2 retain a sense of the rural landscape.
- An additional 5m minimum setback will occur before the solar array will occur.

R5:

- R5a is located approx. 800m south-east from the proposal. FRV have provided the following mitigation measures;
  - Altered the solar array design layout, setting-back solar panels at least 65m from the property boundary.
  - Implementing this setback, has allowed FRV to therefore utilise this area and implement further mitigation by offering an extensive 50m vegetation buffer along the southern boundary and also 100m north along the eastern boundary. A detailed landscaping plan has been created;
    - Specific species that would effectively develop across the understory, mid- and top-canopy structures;

- Specific species (shrubs and trees) that encourage foraging, pollination and habitat creation for local insects, birds and fauna; and
- Erecting nesting and faunal boxes to encourage wildlife use of the area.
- Connect to existing vegetation to create an ecological corridor for local and seasonal wildlife.

- From this vegetation buffer, a further 10m setback will occur for the Asset Protection Zone (APZ).
- After the APZ, only then will the Solar Farm security fence be installed.
- An additional 5m minimum setback will occur before the solar array will occur.

R6:

- R6 is located approx. 2.2km east from the proposal, with their dwelling surrounded by mature vegetation and therefore will have no views of the proposal from their dwelling itself. FRV have provided the following mitigation measures;
  - Altered the solar array design layout, setting-back solar panels, committing to at least 30m from the adjoining property boundary to any solar infrastructure.
  - Implementing this setback, has allowed FRV to therefore utilise this area and implement further mitigation by offering an 5m vegetation buffer along the eastern boundary. This will complement the mature vegetation which already exists along this eastern boundary. A detailed landscaping plan has been created;
    - Specific species that would effectively develop across the understory, mid- and top-canopy structures;
    - Specific species (shrubs and trees) that encourage foraging, pollination and habitat creation for local insects, birds and fauna; and
    - Erecting nesting and faunal boxes to encourage wildlife use of the area.
    - Connect to existing vegetation to create an ecological corridor for local and seasonal wildlife.
  - From this vegetation buffer, a further 10m setback will occur for the Asset Protection Zone (APZ).
  - After the APZ, only then will the Solar Farm security fence be installed.
  - An additional 5m minimum setback will occur before the solar array will occur.

- Trees selected would be native, fast-growing species (mixed eucalypts and acacias representative of the Grey Box and Yellow Box communities).
- Planting of trees would commence as soon practicable, subject to seasonal suitability.
- Development and maintenance of the vegetation barrier would remain the responsibility of the solar farm operator, throughout the project's life. This includes replacing dead trees after planting. Ensuring that the vegetation screening is maintained for the entire

duration of the lease would be a legally binding commitment of the EIS, condition of approval, and commitment of the post-approval Landscaping Plan.

4. Glare and reflectivity of the solar panels; and night lighting

- The purpose of solar panels is to absorb light and convert it into electrical energy, not reflect it. The use of vegetation is intended to screen the adjoining rural residential dwellings and limit potential glint, glare (limited) and ameliorate visual impacts.
- The solar panels would be coated with a non-reflective coating. The solar panels are expected to reflect less than 2-4% of light that hits them. Reflected light from solar panels would have a significantly lower intensity than glare from direct sunlight hitting farm dams (see below graph from a Spaven Consulting assessment of solar PV glare, 2011).
- There would be no lighting on solar panels themselves. There would be no night-time lighting, only reactive and used for security/emergency. Lighting on the main substation would be for security only, in alignment with Australian Standard 4282. Mitigation measures for the solar farm lights have already been identified – be reactive, directly light downwards to reduce upward light spill and use of shielding light fixtures.

5. Indirect visual impact

- See above comments.

Where is this considered in the EIS? Section 6.4

5.2.2 *No. 2: Loss of agricultural land use (food security & farmer livelihoods)*

This concern was captured from 8% respondents.

Main community group affected:
BROADER COMMUNITY,
DIRECT & NEAR NEIGHBOURS

Many community members and stakeholders noted an objection to the project not because they are against renewable energy generation, but only because of the proposed solar farm location on productive agricultural land.

1. Loss of regional, productive agricultural land
2. Incorrect classification of local land capability
3. Reduced land productivity due to PV heat island effect
4. Increased soil salinity (due to tree removal)

The following main concerns and queries have been captured:

- 1. Loss of regional, productive agricultural land

- The entire broader community raised concerns that development of solar farms and similar projects is contributing to an unmitigated wider regional loss of productive agricultural land.
- Many queries focused on how the subject land was selected, and the possibility of using alternative sites that contribute less to maintaining food security and supporting rural livelihoods.
- Further concerns that the State's ambitious renewable energy development targets are not taking into consideration the impact of this development on established agricultural communities and their contribution to the country's food security. Concern that there is a lack of integrated cross-department planning to support decision-making on these types of developments.

- 2. Incorrect classification of local land capability
  - The project's Scoping Report used available NSW mapping data on regional land capability. Most of the community was concerned that the defined land capability of Class 4 & 6 is inaccurate for both the subject land and adjacent local farmland. This raised concern that the productivity of the land was underestimated and may also influence future land buyers.
- 3. Reduced land productivity due to PV heat island effect
  - Queries were raised as to the heat generated from solar panels, especially during summer, and how this could result in changes to local microclimates (captured from 2% of respondents). This was also a key concern for landowners - R6, whose cattle graze right up against their eastern boundary (western boundary of the subject land). As the prevailing wind direction is from the west, they had concern that heat generated from the solar panels could move, predominantly, in the direction of their land.
- 3. Increased soil salinity due to removal of trees
  - A query was raised as to whether the removal of established paddock trees would affect localised soil salinity should their removal result in raised groundwater tables.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	1. Loss of regional, productive agricultural land • There is currently no restriction regarding developing solar farms on agricultural land, regardless of their land capability classification. Agricultural lands – including Biophysical Strategic Land (BSAL), irrigated cropping land and land and capability classes 1, 2 and 3, are considered key site constraints but do not preclude large-scale solar energy development. • Approx. 85% of agriculture-related land use would still occur. This would be in the form of grazing sheep, which would have a multitude of additional benefits including controlling weeds, managing erosion and reducing fire fuel load. 2. Incorrect classification of local land capability • Discussion was held around the use of region-wide geographic information system (GIS) data that is not necessarily based on data specific to the local area. • Outcomes from the site-specific soil survey (30 representative survey sites by McMahon Earth Science (2019)) was used to infer specific land capability results for the subject land. The soil was analysed for topsoil and subsoil pH, electrical conductivity (EC), dispersion, nutrients and cations. Slight variations in profiles exist due to remnant parent formations, drainage plains and the

complex soil sequences that are associated with such. Soil moisture contents varied between soil types but were generally found to be moderately moist in the topsoil and usually drier with depth. Free groundwater was not encountered to the investigated depth. Also, as existing land capability mapping is under review, adjacent land use is also used as a guide to indicate capability.

3. Reduced land productivity due to PV heat island effect

- Several international studies have been completed for utility scale solar farms to determine the presence of PVHI, highlighting the following:
  - Identified temperature change may be linked to other changes noted in vegetation and moisture level.
  - The degree of temperature change appears to be marginal, as well as spatially (distance from panel) and temporally (time lapse after sunset) limited.
  - PVHI effect was indistinguishable from air temperatures over native vegetation when measured at a distance of 30 m from the edge of a photovoltaic array.
  - A dense vegetation buffer, from ground level to higher than the top of the highest point of the array, helps to mitigate.
- The planned vegetation screening and clear setbacks implemented into the design by FRV would mitigate these concerns.

4. Increased soil salinity due to tree removal

- The soil assessment report by independent specialist DM McMahon rated soil as “low to very low” salinity from 30 samples across the property. As subsoils across on the site are not saline, any rise in the groundwater due to removal of paddock trees would not cause dryland salinity in the area.

Where is this considered in the EIS? Section 6.6

5.2.3 *No. 3: Financial devaluation of adjacent properties (and increased public liabilities)*

These two concerns – considering the financial implications of the solar farm's presence within the Walla Walla community, were captured from 7% and 2% of respondents, respectively. From a cumulative financial impact perspective, these were a close 'second concern' to visual and loss of agricultural land impacts.

Main community group affected:
DIRECT & NEAR NEIGHBOURS

The presence of the solar farm is perceived to have a direct & long-term negative financial impact on direct- & near neighbours - either from reduced land & homestead values, or the need to increase existing personal insurance policies.

1. Reduced land value: no buyers or tenants for land and/or homesteads
2. Increased insurance-related public liabilities
3. Loss of rental income

The following main concerns and queries have been captured:

- 1. Reduced land values
  - Most direct and near neighbours to the subject land are concerned that should the solar farm be developed, the value of their properties – homesteads and land, would significantly decline. This is based on the perception that new buyers would not want to purchase agricultural and/or residential land near a solar farm.
  - In addition, R1 highlighted their concern that the current lease of their two homesteads (R1a and R1b) along Benambra Road could be impacted should the solar farm be developed.
- 2. Increased insurance-related public liabilities
  - Surrounding landowners currently have up to a $20 million public liability to cover unforeseen/unmitigated natural or other events generated on their properties. The concern raised, mainly by community members with working land in proximity to the subject land where concerned their public liability would not cover the worth of a solar farm.

	1. Reduced land value
Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	• There is no evidence of devaluation of properties located next to solar farm developments, with those specialist studies available indicating no devaluation (some of these studies were distributed). However, the event of this perceived risk for the Walla Walla area cannot be confirmed or negated. • JLL AgriBusiness was commissioned by Bison Energy to understand the influence of solar projects on surrounding landowners. This report, dated 28 June 2019, used the nearby Coleambally Solar Farm as a relevant case study. Analysis from this case study at broad and targeted levels indicated that the solar project has not had an adverse impact on the local property market and in fact the market has increased considerably in recent years due to high level of demand from agricultural land users.

- 2. Increased insurance-related public liabilities

- The Insurance Council of Australia was contacted to provide clarity on this query, highlighting the following (see Section 5.4.3):
- "*The majority of underwriters signalled that the proximity of the solar farm would, on present understanding, not influence a decision to underwrite, nor would it impact the quantum of the risk premium. A minority of underwriters suggested that in the interests of prudent risk management, some brokers may suggest to the policyholder that they should increase their liability coverage to address the possibility that an event originating on the policyholders causes damage to the solar farm, resulting in an action from the solar farm operator against the policyholder.*

  The Insurance Council noted that they are unaware of any mandated requirement for a rural policyholder to increase liability coverage in these instances.

  FRV have operational solar farms across Australia and globally and implement into their design of the project and management plans careful consideration on ensuring the protection of the asset.

Where is this considered in the EIS? Section 6.4

5.2.4 *No. 4: Loss of- or impact on biodiversity*

This concern was captured from 6% of the respondents.

Main community group affected:
BROADER COMMUNITY

1. Removal of mature paddock trees
2. Ecological integrity of Back Creek
3. Effect of infrastructure on wildlife

The mature scattered paddock trees and Back Creek are considered key components of the local area's ecological corridors.

The following main concerns and queries have been captured:

- 1. Removal of mature paddock trees
  - Although the number of mature scattered paddock trees identified for removal (53) was discussed with community members, concern was raised that this number does not accurately reflect all of the trees to be removed across the site.
  - Some dissatisfaction was raised at the 'ease' of which large developments can identify and remove mature paddock trees, in comparison to farmers not being able to remove trees; and if they do, having to replace these twofold.
- 2. Ecological integrity of Back Creek
  - The creek line is a wildlife corridor with a variety of native animals nesting, hunting and grazing across these and neighbouring properties. Queries were raised as to what measures will be put in place to protect the wildlife in the area.

- 3. Effect of solar farm infrastructure on local wildlife
  - Further concerns were raised as to how the solar farm's surface and associated infrastructure could affect the movement of local wildlife, specifically smaller mammals, reptiles and birds such as the Wedge-tailed Eagle.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	1. Removal of mature paddock trees • All communication has included discussions around the removal isolated paddock trees as well as trees within woodland patches that have been identified for removal, as part of a site-specific biodiversity assessment. • Removal of vegetation for major projects in NSW is governed by the *Biodiversity Conservation Act 2016*. Under this legislation, FRV would need to offset the impacts of the project on biodiversity, including paddock trees, through several available mechanisms including providing funds to the NSW Biodiversity Conservation Trust. • From acquiring the, FRV wanted to clear up the confusion regarding how the tree removal process worked and during conversations explained; 'Biodiversity surveys follow the Biodiversity Assessment Methodology (BAM) developed and approved by State Government regulators (formerly OEH, now the Biodiversity Conservation Division of DPIE). The Biodiversity Development Assessment Report (BDAR) and the EIS use terminology defined in the BAM, which may be confusing to members of the public. "Paddock trees" are trees separated from other trees by 50 metres or more. Three or more trees within 50 metres are not defined as "paddock trees" but are called a "patch." Patches of trees are not assessed by the individual number of trees they contain but by the hectare (so the number of trees are not counted). This is because plant communities are weighted differently to individual trees, as they can meet the specific habitat requirements of many threatened plants and animals that can't live anywhere else. For example, the vegetation running along Back Creek contains trees that also provide habitat for Squirrel Gliders, whereas isolated paddock trees are not suitable habitat for them. The Federal Government legislation (Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)) also protects plant community types with certain characteristics.' 2. Ecological integrity of Back Creek • All natural surface water resources including the vegetation lining Back Creek have been excluded from infrastructure development to retain the integrity of the creek and other water resources. Standard construction exclusion measures would be adopted where there is a risk of impact. • Land management activities to control faunal pests and floral weeds will also be implemented, to limit the chance for these species to outcompete native species. 3. Effect of infrastructure on wildlife

- A clear Wildlife Management Plan would be implemented prior to construction.
- Fences would be inspected regularly, and FRV have committed to not having barbed wire on the top wire of their security fence or stock fences.

4. Biodiversity enhancement

- FRV are committed to enhancing biodiversity measures such as;
  - Installing 120 nesting boxes across the site suitable for small birds, owls, squirrel guilders;
  - Retaining 15 of the 17 dams on site and enhancing 10 of them for biodiversity;
  - Planting extensive native vegetation buffers which will connect to existing vegetation which will create biodiversity corridors and provide habitat, shelter and food from selected plant species.

Where is this considered in the EIS? Section 6.2

5.2.5 *No. 5: Loss of agricultural 'sense-of-place' & community anguish*

Loss of the agricultural 'sense-of-place' was captured from 5% of the respondents, with community anguish captured from 4% of respondents.

Main community group affected:
BROADER COMMUNITY

Walla Walla and Culcairn have a high level of agricultural 'sense of place' for the local community. Many of the families have lived in the local area for generations and plan to retain their land into the future. The community depends on each other – locals are concerned that solar farm developments are dividing the community and creating uncertainty for the future of the area.

1. Loss of agricultural community feel

2. Division of community and damage to personal/business relationships

The following main concerns and queries have been captured:

- 1. Loss of agricultural community feel
  - This concern was raised by members of the broader community who feel that development of a solar farm within a rural community with 150 years of agricultural history would greatly affect the area's sense-of-place. Much of the community within and around Walla Walla and Culcairn are 3rd to 5th generation living in the area, with ambitions for their families to continue their traditions and inherited culture.

- It is often this community 'sense-of-place' that builds community respect, coherence and a sense of belonging. Hence, concern was raised as to how the solar farm could impact on this sense-of-place into the future.

- 2. Division of community and general project anguish
  - Based on this community sense-of-place in the local area, the varying personal perspectives on the development of the solar farm – either supportive or against the development, has resulted in division of the community.
  - This conflict in perspectives has resulted in long-standing friendships and group dependencies being tested and, in some instances, broken. Direct neighbours are worried about their long-term agricultural and tourism-based livelihoods. Much of this anguish is based on the uncertainties of whether or not identified impacts can be mitigated; and whether or not the project would be approved.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	Due to the sensitive, personal nature of this concern, all perspectives and viewpoints have been excluded from this report.

Where is this considered in the EIS? Sections 7.6 and 7.9

5.2.6 *No. 6: Loss of secondary agriculture and tourism-related job streams*

This concern was captured from 5% of the respondents.

Main community group affected:
DIRECT & NEAR NEIGHBOURS;
BROADER COMMUNITY

1. Loss of secondary agriculture-related jobs

2. Loss of tourism-related jobs

Focus on the economic contribution of the proposal compared to current, existing direct and indirect agriculture- and tourism-related jobs / income.

The following main concerns and queries have been captured:

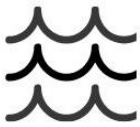
- 1. Loss of secondary agriculture-related jobs
  - As the subject land is currently operated as a farming landscape, various secondary agricultural-related services contribute to its maintenance and management i.e. secondary costs/ha such as actual crop value, hay-making, pest control, fertilisers, etc. Queries were raised as to how the loss of these services – many provided by members of the local (and regional) communities, would be mitigated.
  - Community members were concerned that the regional economic multiplier effect of removing the subject land from agricultural production are not being considered. Not only would secondary jobs and services be reduced, but local supply or agricultural produce would also be reduced e.g. wheat and livestock.
- 2. Loss of tourism-related jobs

- Based on discussions with the owners, Orange Grove Gardens (R5 – wedding and accommodation venue) (https://orangegrovegardens.com.au/) employs up to 19 local people on a casual basis. A key wedding venue facility (internal seating and external patio) where guests gather during the events look out on to the subject land. This facility slightly elevated within the surrounding landscape, emphasising the visual vantage point across the subject land. Concern was raised that the proposal could result in decline in the interest of the venue as a wedding or accommodation destination, resulting in:
  - Possible reduction in the financial viability of the business which has been successfully built up over the past few years. Although the family is also involved in farming activities on the surrounding land, they depend on the Orange Grove Gardens' business as a significant part of their future financial planning.
  - Inability to support the existing casual employment opportunities.
- In addition to the above, based on the area's historic rural agricultural setting, broader community concern was raised as to how the proposal would impact Greater Hume-related tourism by reducing the area's agricultural/rural appeal.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	<u>1. Loss of secondary agriculture-related jobs</u> • As land productivity would still occur at approx. 85% capacity (sheep grazing) as part of the solar farm's land management, many existing secondary services would still be required. Many have the view that sheep grazing is more beneficial than grain due to the higher ratio of related services e.g shearing, drenching, vets etc • Based on this community concern, a specialist study was undertaken by Ernst & Young 2019 (EY) to provide an understanding of the potential economic costs and benefits of the proposal in southern NSW. The report considered Greater Hume regional economic profiling, as well as employment profiling. EY estimate the total indirect contribution to the regional economy from the construction of proposal at approx. $203 million. <u>2. Loss of tourism-related jobs</u> • For existing tourism-related facilities, this issue is mainly relevant to R5, Orange Grove Gardens. Undeniably, this is an unquantifiable impact for the proposal as views for any clients from the venue are a personal and individual perception. Significant one-on-one conversations have been held with these landowners to try and provide feasible safeguards or mitigations. Mitigation measures include; - 50 m wide vegetation screening; - ensuring the security fence is behind the vegetation buffer within the project land and not on the property boundary; - APZ and perimeter access setbacks put in place. - FRV are open to working with R5 throughout the process and have requested a list of the future bookings of the venue to complete a review. • The proposal will not be in view from regional tourism locations such as Morgan's Lookout. • Across Australia, renewable energy projects are attracting tourists through particular events e.g 'Run with the Wind' fun run held

	through Woodlawn Wind Farm in Tarago (https://www.runwiththewind.com.au/)
Where is this considered in the EIS?	Sections 7.6 and 7.9

5.2.7 *No. 7: Changes to surface water runoff (incl. flood pattern changes)*



This concern was captured from 5% of the respondents.

Main community group affected:
DIRECT NEIGHBOURS

Back Creek flows directly through the subject land. This creek, together with numerous upstream seasonal tributaries contributes to how surface water, specifically local storm events is controlled by local land users.

1. Alterations to subject land surface landform resulting in increased / altered stormwater events to downstream properties

2. Management of stormwater events by the solar farm

The following concerns and queries have been captured:

- 1. Changes to landform resulting in increased/enhanced stormwater events for downstream properties:
  - Direct and near neighbours highlighted that the subject and surrounding land is prone to flooding. This results in regular ponding along Back Creek. Back Creek is also fed by additional flow from ephemeral drainage line Middle Creek located to the south of the subject land, in high rainfall conditions. It was noted that the disused rail line to the west of the subject land is a topographical high point - this acts as a barrier to downstream catchment flow, which originates in the mountains to the east. Due to this natural flood risk, direct neighbours were concerned that changes to landform beneath the solar panels would increase the risk of downstream flooding and/or damage during extreme rain events.
  - Landowners highlighted the movement of large debris (trees, logs, etc.) downstream during high rainfall events, resulting in damage and destruction to fences and other infrastructure.
  - The swampy area along Benambra Road, on the property of R1 is fed from surface runoff and an existing diversion trench/channel from the northern section of the subject land above the creek. Should this flow be altered due to solar panel layout, the swampy area could dry out, limiting water availability for R1's land use purposes.

Discussions held- and responses provided during the community engagement on raised concern / query; to be taken forward in EIS	1. Changes to landform resulting in increased / enhanced stormwater events • The shape of the land beneath solar infrastructure directing surface water flows would not be altered. Groundcover would largely be retained, as would 15 (of 17) existing farm dams within the subject land. As there will be no altering of existing landform or surface

	runoff conditions for the solar farm development, neighbouring properties will experience similar conditions as at present. • A hydrology and flooding report has been compiled using flood levels for the 5% annual exceedance probability (AEP) (which is the 1 in 20-year flood level) – as per independent hydrologist advice. • Setback from R1 has been included and Indicative Landscaping Plan. • As an EIS mitigation measure, a Surface Water Management Plan and Erosion and Sediment Control Plan would need to be compiled to ensure no ongoing negative flood and/or erosion-related impacts on local public roads. • Suitable fencing and flood gates for the creeks has been considered at Back Creek and tributary entry and exit points along the solar farm boundary. An existing creek crossing has anecdotally blocked the free passage of water along back creek during flood. FRV intend to upgrade this crossing point un to include correctly sized pipes to allow for the free passage of flood waters.
Where is this considered in the EIS?	Section 6.5

5.2.8 *Other key concerns*

In addition to the above, Table 5-1 provides other key concerns/queries captured during the community engagement that have been considered in the development of the project and the EIS. It is noted that these concerns are those most often raised by the community and are not exhaustive of every concern/query documented.

Table 5-1: Other key concerns / queries captured during the community engagement

Concern / query	Discussions held- and responses provided during the community engagement
Land management	
All aspects of ongoing care and maintenance of the solar farm, with specific focus on pest control (notably deadly nightshade and roly poly)	• The solar farm would be managed like other parcels of farming land in the area. This includes localised and district wide pest control (including fox populations), weed management (including removal of Priority Weeds (WeedWise) and control of area-specific high threat weeds), groundcover fertilisation, grazing (if occurring), fire control, etc. • This will be documented as part of the Land Management Plan required if the project is approved. Adjacent landowners would also have input to this plan to ensure management principles are aligned to the local area's principles. • In the preparation of relevant construction and operation management plans, community consultation with affected landowners will occur.
Fire management	
The area is a high fire risk area, especially in summer.	• The local area has experienced a few significant fires in the past, all of which have resulted in loss of farming-related income and personal livelihoods. These incidents include the following:

Concern / query	Discussions held- and responses provided during the community engagement
	- December 2009: loss of more than 17,000 acres of farmland between Glenellen and Gerogery (bushfire breakout at a council rubbish tip site in Walla Walla) • A Bushfire Management Plan and Weed and Pest Management Plan are both commitments made within the EIS. As part of the Bushfire Management Plan, a 10 m asset protection zone (fire break) would be installed around the perimeter of the proposal, with care-and-maintenance criteria of this zone provided. • Through consultation with the RFS, numerous emergency access points, water tanks, standpipes and other access to water have been implemented into the design and would significantly improve the firefighting capability around the site.
Health and safety of the Rural Fire Services (RFS) in the event of a fire within the solar farm.	• Based on this query, which was only raised at Information Session No. 2, the NSE RFS in Sydney was contacted for an official response. The following is noted: *Unless the solar farm operator is onsite and can declare the facility de-energised, the RFS would expect their Incident Controllers to undertake defensive operations and not enter a perimeter around electricity infrastructure – i.e. they would protect the facility from an encroaching bush or grass fire, or if the facility is on fire, protect exposures so that it doesn't spread outside the facility. This approach is the same as currently followed for electrical substations in the path of a fire, or one that was alight. Access to the solar farm would likely be limited to areas not involved in generation/storage/transmission of power, until/unless the on-site operator could confirm de-energisation of this infrastructure* (See Section 5.4.4). • FRV have consulted with multiple members of the RFS and as a result have made fire provisions within the design. This detail can be viewed within the Fire management section of the EIS.

Figure 5-1 summarises the main concerns/queries captured during the community engagement for the proposal, as described above.

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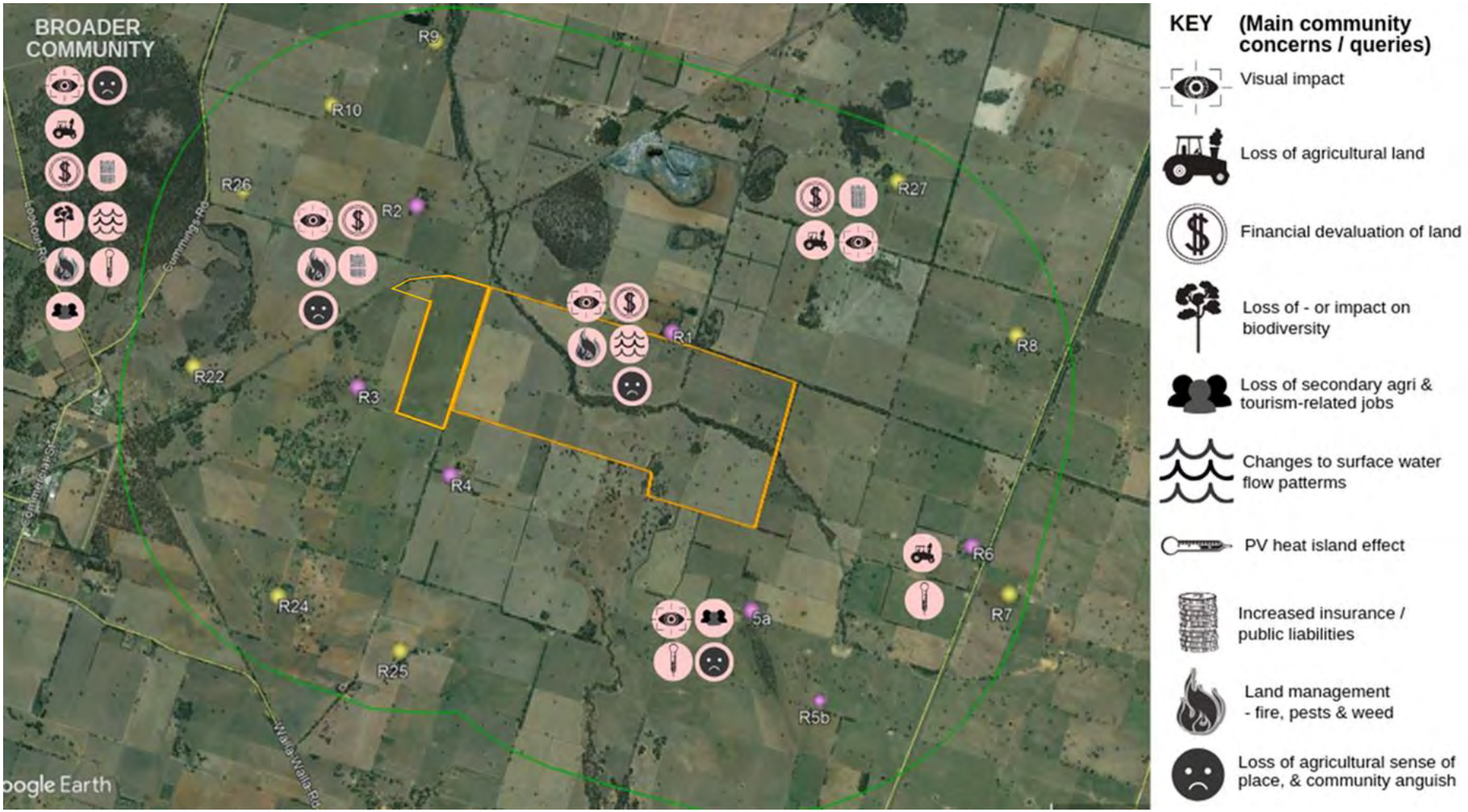


Figure 5-1 : Summary of main concerns and queries captured during the community engagement for the proposal

5.3 MAIN COMMUNITY BENEFITS IDENTIFIED

Numerous regional and community benefits were identified as part of the engagement process. Those received from 5% or more of respondents are detailed below.

5.3.1 *Enhanced regional land use & income diversification*

This benefit was captured from 5% of respondents.

Main community group that could benefit: **BROADER COMMUNITY, SUBJECT LANDOWNERS, STATE**

1. Diversification of local land uses and associated income dependencies

2. Australian energy use and contribution to economic development

The proposal would contribute to diversifying the incomes of local farmers and the community by providing jobs outside the agricultural sector.

The following main benefits were captured:

- 1. Diversification of local land uses and associated income dependencies
  - Diversification of incomes for landholders can improve resilience to agriculture commodity market fluctuations and drought. Income from solar farms can help to offset agriculture impact costs such as water, fertiliser and supplementary feeding for livestock.
  - Diversifying a community's source of income from multiple industries can increase economic resilience to markets fluctuations. For example, when agribusinesses struggle with drought, people employed in other sectors retain stable incomes and can continue to support retail and hospitality businesses.
- 2. Australian energy use and contribution to economic development
  - The Proponent would own and operate the solar farm that directly captures energy generated from the solar panels. TransGrid, an Australian operator and manager of the NSW high voltage transmission network, would own and operate the 3.2 ha sub-station connected to the existing transmission lines (for distribution within eastern Australia).
  - The proponent would endeavour to source equipment such as cables, transformers, etc., locally wherever practical.

Where is this considered in the EIS? Section 7.6

5.3.2 *Environmental benefits of renewable energy resources*

This benefit was captured from 6% of respondents.

Main community group that could benefit:
BROADER COMMUNITY

1. Education opportunities for future generations
2. Local contribution to renewable energy

The proposal would contribute approximately 300 MW of renewable energy, saving around 520,000 tonnes of CO_2 entering the atmosphere per year (compared to brown coal).

The following main benefits were captured:

- Providing a much needed 'cleaner energy' alternative to coal-powered fire stations – reduced harmful carbon dioxide and methane emissions (air quality improvements and minimised contribution to climate change); less water use for energy generation. Solar power could significantly reduce Australia's future dependence on fossil fuels, providing a reliable, more sustainable energy source.
- There is the opportunity to not only educate local school children about the merits of clean energy but also include schools from surrounding areas between Albury and Wagga to Information Sessions and guided tours.
- Some proposal supporters were excited at the prospect of being associated with a regional community that could be contributing to Australia's long-term 'sustainable development'.

Where is this considered in the EIS?	Section 2.2

5.3.3 *Availability of local jobs (construction and operation)*

This benefit was captured from 6% of respondents.

Main community group that could benefit:
DIRECT & NEAR NEIGHBOURS;
BROADER COMMUNITY

1. Temporary construction jobs
2. Permanent operation jobs

The proposal would employ approximately 250 people during construction and up to 21 people full time equivalent once operational.

The following main benefits were captured:

- Sourcing of contractors for the construction stage. Where will workforce be sourced from? Would there be temporary worker camps on-site? FRV intends to source as much of its workforce as possible locally, noting Walla Walla and Culcairn are small towns with a limited workforce. This assumes local contractors would tender for work they can cope with as part of their existing workload. There would not be a temporary worker camp on-site – workers would be based in Culcairn and Walla where possible, or in neighbouring towns.

- Although certain workforce skills and materials would need to be sourced from larger cities, FRV intends to engage local workers where possible during construction and operational stages. For construction, the bulk of the workforce would be required for panel installation – which required only on the job training and limited technical skills. Panel installation lends well to local contractor employment. Skills required during operations are estimated to include fencing, road maintenance, electrical maintenance, land management (pest control, fertilisation, grass/crop management, etc.) culminating in approximately 21 FTE positions. A detailed O&M plan can be viewed in the EIS.
- FRV have a project 'Supplier Register' where local individuals and companies who have expressed their interest in participating in the proposal if it proceeds, are added. This list will be supplied and utilised by the contractor.

Throughout the community engagement process, both Bison Energy and FRV have emphasised the desire to use local skills and services wherever possible. This message was conveyed during all engagement events and was highlighted in project information posters. The following was noted:

- Construction would require the use of nontrained, trained, technically skilled employees. These people would be sourced by the project's engineering, procurement and construction contractor, as would the remainder of the workforce. Employment during construction would include at least following:
    - Land planners and surveyors.
    - Engineers (electrical and other).
    - Electricians.
    - Metal manufacturers.
    - Fencing specialists.
    - Vegetation management (clearing, mulching, rehabilitation, screening, etc.).
    - General civil work (grader, dozer, excavator operators, etc.).
    - Logistics.
    - Builders.
    - General labourers.
    - Security.
    - Telecommunications.
    - Traffic management.

A number of locals have already expressed interest in potential labour and supplier opportunities for the proposal. These individuals have been added to the project Supplier Register which would be passed to the EPC.

FRV expects the Operations and Maintenance team would comprise 21 full time equivalent staff over the 30-year life of the proposal.

Where is this considered in the EIS?	Section 7.6

5.3.4 *Socio-economic contribution for local towns, specifically Walla Walla*

This benefit was captured from 5% of respondents.

Main community group that could benefit: **BROADER COMMUNITY**	1. Community Investment Programme

The Community Investment Programme would benefit the Walla Walla community priorities.

Based on the ongoing community engagement, FRV have committed to a dedicated Community Investment Programme (CIP) for the proposal. The aim of this CIP would be to conceptualise and develop a strategy for possible projects and/or financial contribution for the local community as part of the solar farm operational period. This would be over-and-above the commitments made in the EIS.

A CIP-based strengths, weaknesses, opportunities and threats' (SWOT) analysis has been completed to investigate opportunities for the proponent to:

- Give back to the Walla Walla community.
- Support and build a stronger, cohesive and more resilient community by diversifying local land use.
- Collaborate with and empower communities to identify their priorities.
- Encourage and support innovative solutions and approaches to local issues.
- Promote positive, long-term local outcomes and capabilities.
- Promote awareness of and commitment to the sustainable community ideal.

Should the EIS be approved, opportunities identified in the SWOT would be taken forward with community input to develop the most suitable and beneficial projects going forward. The proposed CIP has been included as an appendix.

Where is this considered in the EIS?	Appendix B.2

5.4 SUMMARY OF DISCUSSIONS WITH OTHER REPRESENTATIVE COMMUNITY BODIES

The following is a summary of key discussion points raised during engagement with identified representative community bodies.

5.4.1 *Greater Hume Shire*

Bison met with Council on 15 March 2019 and FRV had meetings on 01 August 2019 and 11 September 2019 at the Shire's Holbrook office.

Discussions included;

Opportunities for water use required during construction and operation focused on use of Shire standpipes supplies via the town line running north-west of the site and/or discussing the use of excess pit water from the Hurricane Hill Quarry.

Waste generation and disposal at the local landfill was raised. Similar projects are known to generate significant volumes of landfill waste and the Shire stated its preference was for the proposal to re-use and recycling materials wherever possible. For example, Albury City landfill has a permit to deconstruct wooden pallets for re-processing at the local papermill. Plastic wrap can be sent to Holbrook Landcare, which has an arrangement with a Culcairn businessman to reuse it locally. FRV have committed to using biodegradable packaging.

Land management would need to include weed control and ensure existing local surface runoff volumes and flow conditions are maintained around Back Creek.

The Shire recognised there had been a large community interest in the proposal along with others proposed in surrounding areas and encouraged focused engagement along with clear information to be provided to the community.

The Shire reiterated that they would like solar farm developers to commit stable, long-term financial contributions to the Shire. The available vehicle proposed by the Shire was a Voluntary Planning Agreement (VPA). However, it was noted that the Shire would prefer contribution via the Section 94A Fixed Development Contribution Plans (Section 7.12). It is noted that neither of these vehicles are legislatively mandatory or required by the Approval Authority. However, FRV have clearly considered the Council within the Community Investment Program.

5.4.2 *NSW Farmers' Association*

Bison Energy had meetings with the NSW Farmers' Association South Region Manager at the Information Session No. 1 and the one-on-one meeting held at the NGH Offices in Wagga Wagga on 23 May 2019. Following this FRV had meetings on 02 August 2019 and 24 September 2019.

Numerous members had raised concern with the NSW Farmers' Association about the location of solar farm developments on productive agricultural land. The lack of detail on available State land capability mapping data does not currently provide sufficiently accurate and precise information for project scoping and constraints analysis.

FRV have appreciated the feedback and communication received from NSW Farmers Association, which has helped shape the changes within the design of the proposal.

5.4.3 *Insurance Council of Australia*

The following is the outcome of telephone and e-mail correspondence with the General Manager – Risk, of the Insurance Council of Australia in Sydney, between April and June 2019. This engagement was initiated in response to community comments raised from numerous stakeholders during face-to-face discussions, Feedback Forms, and the Information Session No. 1. Specific comments related to the risk of increased public liability insurance premiums of adjacent landowners (to account for events such as unmanageable fires), in proximity of an operational solar farm.

It is noted that the Insurance Council of Australia highlighted that this was a new issue for them, and they needed to consult widely before providing a final response.

Specifically, they raised the following query:

'*Are there availability, risk premium or sum-insured issues that present themselves for a rural policyholder by virtue of having a solar farm installation constructed on adjacent land?'*

The majority of underwriters signalled that the proximity of the solar farm would, on present understanding, not influence a decision to underwrite, nor would it impact the quantum of the risk premium.

The Insurance Council noted that they are unaware of any mandated requirement for a rural policyholder to increase liability coverage in these instances.

It was further noted that the insurance industry is supportive of PV initiatives and if beneficial they would be prepared to address any forum or group convened to discuss the issue.

FRV are a global company with operating projects across the world and Australia and have the experience and knowledge to operate and maintenance their assets to ensure they are safeguarded.

5.4.4 *NSW Rural Fire Services*

The following is the outcome of telephone and e-mail correspondence with the Manager – development Planning & Policy of the NSW RFS, Sydney, during July 2019. As for the Insurance Council of Australia, this engagement was initiated in response to community comments raised during the Information Session No. 2 around emergency fire management for the proposal.

<u>From an EIS process perspective:</u>

DPIE generally refer proposals to NSW RFS for comment. The usual requirements from NSW RFS are a minimum asset protection zone (APZ) of 10 m and a post-approval Bushfire Management Plan specific to the proposal. This Bushfire Management Plan would need to include assessment of all hazards and associated risks and specify related prevention and mitigation measures, including response.

<u>From an operational emergency response perspective:</u>

Should a fire originating from neighbouring land spread across a solar farm, would RFS access the solar farm to fight the fire. NSW FRS stated that this would be unlikely due to the presence of electrical current inside the facility, however, crews could access any structure on fire, such as offices, buildings, carparks, etc. that are not actual electricity generation/storage infrastructure.

Unless the solar farm operator is onsite to declare the facility de-energised, the RFS would expect their Incident Controllers to undertake defensive operations and not enter a perimeter around electricity infrastructure – i.e. they would protect the facility from an encroaching bush or grass fire, or if the solar

farm is on fire, attempt to prevent the spread of fire from the solar farm. This approach is the same as currently followed for electrical substations in the path of a fire, or one that was alight.

FRV have consulted directly with members of the local RFS. A dedicated meeting occurring on 24 September 2019, who provided feedback which has helped shape the design and enhance the safety of the project from a Fire Management prospective.

Boral Resources

Formal email correspondence, including a map of the development site, was sent to the Boral Resources' Hurricane Hill Quarry (dated 26 June 2019). In response to the email, the Manager – Quarries (Culcairn) requested a face-to-face meeting with Bison Energy, which was held on 9 July 2019 to discuss the proposal. At this meeting Bison Energy provided an overview of the proposal including construction and operation timeframes, access and transport along Benambra Road during the construction period and anticipated environmental impacts such as visual, noise and dust.

During the meeting the use of surface water in the pit and the deterring dam on Weeamera Road by Bison Energy for ad hoc construction-related needs was discussed. The quarry currently also uses the quarry water for dust control on its site. It was noted that during dry years, the water on-site is not enough for dust suppression activities; additional water is obtained from a permitted Riverina Water standpipe. However, Boral Resources agreed to supply water for construction-related activities for the proposal, if available.

5.4.5 *Other local community groups*

FRV also undertook to engage with the following local community groups:

- Walla Walla Community Development Committee
- Gum Swamp Committee.
- Holbrook Landcare

Walla Walla Community Development Committee

The Development Committee is a volunteer organisation with reporting responsibilities back into Greater Hume Council. It is primarily working on advocacy into Council for priority expenditure projects and delivery of key economic development initiatives, i.e. Refugee resettlement program.

Committee Chair, Daniel Nadebaum was happy for factual information to be presented to the committee and offered to distribute this as appropriate via Community Newsletter and Facebook page.

Specific questions, discussions:

- Project has caused significant concern and divide within the community.
- Walla Walla town only viable due to agricultural businesses servicing local farmers – with removal of this demand potential for Walla Walla support businesses to suffer reduced business and trade.
- Intent of Committee is to attract a supermarket – realise this is not realistic without the population (and population growth) to support this.
- Some success with introduction of new long-day childcare and new housing estate with approx. 50 houses.
- Rental properties not currently available in Walla Walla.

Gum Swamp Committee

A volunteer organisation, with reporting responsibilities back into Greater Hume Council. The aims of Committee program are to preserve wetland area and local river catchments.

Points raised directly in FRV's meeting with John Seidel, Gum Swamp Committee, related to planning considerations (in no particular order):

HYDROLOGY

Interested in impact to river flows (quantity and quality) from Back Creek offsite as this will reach Gum Swamp – Billabong Creek is also a tributary. Potential for any negative impacts to conflict with birdlife and environmental health of Gum Swamp area. No current known issues with swamp runoff catchment areas (testing is conducted) – this includes nitrates from farming activities.

THREATENED SPECIES

Potential for site to host squirrel gliders, plains wanderer. Area surveys have been done and are publicly available.

OFFSET PLANTINGS AND VEGETATION REMOVAL

Existing Landcare biodiversity corridor projects in region that would benefit with offset investments being targeted towards local brokers/ventures to ensure that the 'considerable' vegetation removal at the SF site is offset within the local area.

Further questions, discussions

- Potential for Petaurus Education Group (local) to assist with species awareness and input to management plans.
- Additional Landcare group in Holbrook that is working with endangered species.
- Will communicate outcomes of meeting back to Group.

Holbrook Landcare

Holbrook Landcare is a Not for Profit community group. This group was engaged by FRV at an early stage as they believe local Landcare advice and knowledge can be invaluable to a project and its design.

FRV have worked with a member of Holbrook Landcare and engaged their services. A member of Holbrook Landcare completed a site visit on 11 September 2019 and subsequently completed a report providing advice and technical guidance regarding revegetation and restoration.

The advice within this report has been greatly considered, with many design changes having been implemented as a result of this consultation.

6 WAY FORWARD

6.1 ONGOING COMMUNITY AND STAKEHOLDER ENGAGEMENT

To ensure continuing community engagement is effective capturing and addressing community queries and concerns throughout the remainder of the approval process and into construction, the following actions would be undertaken alongside project design and implementation:

- Appoint and maintain a consultation manager to implement engagement activities and review this CSER regularly.
- Keep an accurate record of all feedback from consultation activities and correspondence with the community.
- Monitor regularly and respond promptly to email and phone queries.
- Ensure information and participation opportunities reach a representative section of the Greater Hume Region and all interested and affected parties.
- Updates to the project website as the primary channel of information for the project.
- Respond to media enquiries as required.

6.2 MONITORING AND EVALUATION

FRV has plans in place to conduct regular monitoring and evaluation of its community and stakeholder engagement strategy throughout the development, construction and operations of Walla Walla Solar Farm. These appraisals are crucial to identify emerging issues, concerns and opportunities early, providing optimum response time for the project team to act and respond.

Evaluation and monitoring findings will also be used to guide the ongoing delivery of community engagement and the overall development of the project.

Objectives of monitoring and evaluation

- Demonstrate FRV's ability to deliver commitments made to the community throughout each phase of the project.
- Measure anecdotal levels of community and stakeholder support for Walla Walla Solar Farm and the project team with the view to improving this over time.
- Demonstrate the level of involvement of key stakeholders in aspects of the project's development to ensure all stakeholder groups are provided with opportunity to participate and at a minimum, are adequately informed.
- Monitor the number of complaints made in relation to the project, and specifically, the number of complaints that are escalated to third parties.
- (When available) evaluate the outcomes of any community partnerships or investments provided during later lifecycles of the solar farm.

APPENDIX A COMMUNITY INFORMATION

A.1 INTRODUCTORY PROJECT INFORMATION (JANUARY 2019)

BISON ENERGY GROUP

WALLA WALLA SOLAR FARM

BE PRO W PTY LTD

Project Description | January 2019

Prepared by:

BE PRO W PTY LTD

CJ Cai

0423 261 282 | cj@bisonenergy.net

TABLE OF CONTENT

BE PRO W PYT LTD
Level 14, 380 St. Kilda Road
Melbourne VIC 3004

1. INTRODUCTION

BE Pro W Pty Ltd (BE Pro W) is developing a Solar Farm (Project) which is up to 300MWac in capacity in in Walla Walla, Wagga Wagga City New South Wales. The Project will use solar photovoltaic (PV) technology with trackers and ancillary equipment. It will connect to the 330 KV network through a switched ring bus connection. The preferred point of supply is through a newly established 200m by 200m switching station through a switched ring bus connection on the TransGrid's 330kV transmission line 62.

The Walla Walla solar farm site in Wagga Wagga has an area of about 700 hectares, which currently belongs to one single private landholder. Options deed to lease contract have been consented by the Landholder.

The Proponent, BE Pro W belongs to Bison Energy Group, who is an international leading large-scale renewable energy developer and investor with a portfolio of projects across Europe and Japan. The company identifies sites, negotiates land arrangements, network connection and arranges all key commercial contracts including construction, Power Purchase Agreements (PPAs) and financing.

The company partners with the world's best and experienced suppliers and investors to fund, design, construct and operate the solar farm. BE Pro W and Bison Energy Group are well placed with its specialist knowledge, experience and partners to be able to successfully develop, construct and operate solar farms.

2. SITE DESCRIPTION

2.1 SITE DETAILS

Address: Walla Walla Solar Farm

116 Schneiders Road Walla Walla

NSW, 2659

Area: Approximately 700 Hectares.

Local Authority: Wagga Wagga City Council

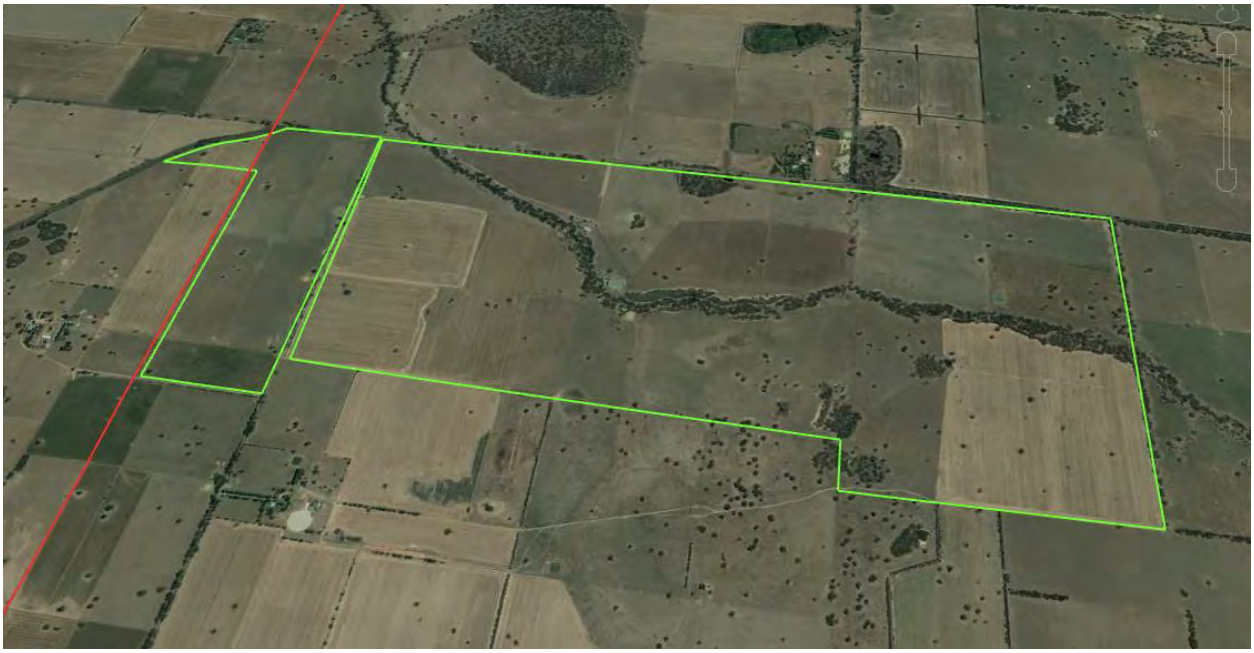
Current Use: Farming zone

Project Owners: BE PRO W Pty Ltd.

The Property is legally described as follows:

LOTS 13, DP253113 & LOTS 1517,2021,8795,108109,118, DP753735

Lot 1 in DP1069452, Lot 1 in DP933189 and Lot A in DP376389



2.2 CONNECTION POSSIBLILITIES

It is possible to connect into TransGrid's 330kV transmission line 62 running outside the west border of the target site.

3. PROJECT DESCRIPTION

3.1 MAIN FIGURES AND GENERATING UNITS

AC Capacity: 300MW

DC Capacity: 360MW

PV Module: JAM 72S01-385/PR

Tracker: Soltec SF7 sigle axis

Inverter: SMA 5000 SC-EV

Production in the first year: 392,397 MWh

3.2 PROJECT SCHEDULE

Solar farm development and construction are scheduled for 24 months from January 2019. Commencement of construction is expected in April 2020, and grids connection and commissioning is planned at the beginning of 2021. Detailed schedule has been presented in separated attachments.

4. DEVELOPMENT AND PLANNING

BE PRO W is planning to engage NGH to complete planning and assessment tasks to be included as part of the Development Application and of the proposed Walla Walla Solar Farm project. Connection enquiry and application will be supported by GHD.

A.2 UPFRONT FLYER (MARCH 2019)

15 March 2019

PROPOSED DEVELOPMENT

WALLA WALLA SOLAR FARM

Benambra Road, Walla Walla - NSW

BISON ENERGY COMPANY

ngh environmental

PROJECT OVERVIEW

LOCATION & MOTIVATION

Location

- ~4.3 km north-east of Walla Walla, Greater Hume Council area, NSW
- 614 ha on Lots 16, 17, 20, 21, 87, 88, 89, 108, 109 118 of DP 753735, and Lot 1 DP 1069452. Site access is off of Benambra Road
- Existing agricultural land (paddocks with mainly exotic ground covers); some native vegetation mainly along waterways. (Back Creek runs west-east and south-east through proposed development land)

Motivation (for location)

- Low regional visibility (no prominent or high topography)
- Not located within a residential zone or urbanised area, nor is it located on Strategic Agricultural Land
- Excellent solar exposure
- Excellent access to local and major roads
- Excellent access to the grid transmission network
- Likely low level of environmental impact (site already cleared and disturbed)

KEY INFRASTRUCTURE

- 935,000 steel frame-mounted photovoltaic (PV) solar panels, generating approximately 300 MW (AC) of renewable energy
- Inverters, a transformer and electrical conduits
- On-site sub-station
- Site office, site compound, vehicle parking areas, access tracks and perimeter fencing
- 330 kV electrical transmission line, connecting solar farm to the existing Jindera-Wagga Wagga transmission line

POSSIBLE ENVIRONMENTAL IMPACTS

A preliminary environmental risk assessment has been conducted, highlighting key environmental and social matters that would require detailed assessment. These include:

- Biodiversity
- Aboriginal heritage
- Visual amenity
- Construction noise
- Land use and resources
- Watercourses and hydrology

POSSIBLE SOCIAL BENEFITS

- 300+ direct jobs and indirect supply chain jobs during construction
- 1 - 2 full-time staff during operation
- Contribution to future possible reduced energy prices
- Diversification of local land use - additional / alternative source of income and economic activity, and indirect support industry growth
- Alignment with NSW Renewable Energy Action Plan - promoting energy security through diversified sources, reducing coal dependence, lowering emission energy sources

TIME LINES

- Construction: 12 - 18 months
- Operation: 30 years
- Decommissioned, or upgraded; depending on regional planning needs at that time.

15 March 2019

PROPOSED DEVELOPMENT

WALLA WALLA SOLAR FARM

Benambra Road, Walla Walla - NSW

COMMUNITY CONSULTATION

INTERESTED & AFFECTED PARTIES (I&APs)

Regulatory authorities

FEDERAL GOVERNMENT
Department of Planning & Environment

LOCAL GOVERNMENT AREA (LGA)
Greater Hume Council

Landowners / Lessees

OF PROPOSED DEVELOPMENT SITE

ADJACENT TO DEVELOPMENT SITE

3KM FROM DEVELOPMENT SITE

COMMUNITY CONSULTATION APPROACH

2019 time frames

One-on-one discussions
PROJECT INTRODUCTION & OVERVIEW
Regulatory Authorities
Landowners / lessees of development site
January - March

Information letters / flyers
PROJECT INTRODUCTION & OVERVIEW
All I&APs
March

Community meetings
MEETING NO. 1 → **MEETING NO. 2**
May / June

I&AP Register & Feedback
E-MAIL COMMUNICATION → **POST-CONSULTATION 'NEWSLETTER'**
REGISTER OF I&APs & COMMENTS RAISED / ADDRESSED
March - July

Input to Environmental Impact Statement
COMMUNITY CONSULTATION PLAN
July - August

HOW CAN YOU GET INVOLVED?

There will be an opportunity to find out more about the project during two upcoming community meetings. Key affected landowners will also be contacted personally. Should you wish to attend the meetings, or raise any comments before then, please contact:

Ms Raina Hattingh - Community Liaison Officer
02 6923 1564 / community@wallawallasolarfarm.com.au, or go to:
www.wallawallasolarfarm.com.au

A.3 DISTRIBUTED NSW SOLAR FARM GUIDELINES & AVAILABLE GLOBAL SOLAR FARM REPORTS OR STUDIES

BARRON-GAFFORD RESEARCH GROUP
BIOGEOGRAPHY - ECOSYSTEM SCIENCE

Response to Technical Queries Associated with Permit NO: 2017-301 for the Proposed Solar Farm at:
1190 and 1220 Cosgrove-Lemnos Road,
260 Tank Corner East Road,
875 Boundary Road and
85 Crooked Lane LEMNOS VIC 3631

STATEMENT OF EVIDENCE BY GREG BARRON-GAFFORD ON SOLAR HEAT ISLANDING ISSUES

Prepared for Neoen Australia Pty Ltd

MAY 2018

Greg Barron-Gafford, PhD
4th Floor, 1064 E. Lowell Street
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Tucson, Arizona, USA
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CONTENTS

1 INTRODUCTION: PRACTICE NOTE – EXPERT EVIDENCE

Name and Address of Expert

Greg Barron-Gafford, PhD
Associate Professor and Associate Director
School of Geography & Development;
B2 Earthscience, Biosphere 2, College of Science;
Adjunct Faculty in School of Natural Resources & the Environment
Office: ENR2 - S439; University of Arizona
Tucson, AZ 85721, USA
website: http://www.barrongafford.org/
1.520.548.0388

Qualifications of Expert

PhD, Ecosystem Ecology, University of Arizona, 2010
MS, Natural Resources & Ecology, University of Georgia, 2001
BS, Environmental Science, Texas Christian University, 1998
Member, American Geophysical Union
Member, Ecological Society of America
Member, American Association of Geographers
Refer Curriculum Vitae at Attachment 1.

I have authored or co-authored 71 peer-reviewed publications that have been cited more than 1,900 times, and I have led research in ecosystem ecology and plant-atmosphere interactions for more than 17 years. I maintain an active research program in assessing the impacts of land use and climatic change in terms of plant function, ecosystem response, and local climate conditions. My team, under my supervision, produced the first experimental and empirical examination of the presence of a heat island effect associated with PV power plants.

Any Private or Business Relationship between the Expert Witness and the Party for Whom the Report is Prepared

None.

Instructions

Written instructions from White & Case Lawyers acting on behalf of Neoen Australia Pty Ltd dated 16 April as follows:

"*We would like you to prepare an expert witness statement for the panel in which you:*

(a) set out your background and expertise relevant to this issue;

(b) provide further information in relation to the Arizona study the subject of the paper that you co-authored titled The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures published in Nature Scientific Reports on 13 October 2016. In particular, we ask that you detail the following:

(i) brief description of study methodology;

(ii) radius of the measured heat effects in that study, including those that were not outlined in the final paper. Explain the editing process that resulted in measured effects being excluded from study;

(iii) analysis of your conclusions around the measured effects, including simple descriptions of energy pathways relevant to the 'heat island effect';

(iv) outline contextual factors that may be relevant to the 'heat island effect', including environmental factors such as local landscape, humidity, cloud cover, fixed or rotating tilt panels, etc; and

(v) briefly comment, if possible, on your understanding of the possible effect of wind on the heat island effect.

(c) comment on your findings to date in other research work that you have been involved with relating to the PVHI effect and co-location of photovoltaics and agriculture;

(d) comment on the general implications of the above studies and literature for the Project and the interface between it and any established or future agricultural uses. Where possible, please include:

(i) comparative characteristics of the Arizona and Shepparton sites (e.g. presence of vegetation);

(ii) your opinion as to whether the Project would change any onsite or offsite temperature;

(iii) associated with that, your opinion as to how any change, if identified, would impact on bird and insect populations in the area;

(iv) mitigating factors or measures that exist or could be implemented.

We would also like you to consider the objections to the Project that are relevant to your area of expertise and respond to any relevant matters in your witness statement."

Facts, Matters and Assumptions

Facts, matters and assumptions on which opinions expressed in the report are based are set out in the report.

Documents and Materials Taken Into Account

The documents and any literature or other materials taken into account in preparing the report are identified in the report.

Methodology to prepare Witness Statement

In preparing this expert report I developed the following process:

(*i)* I reviewed the application and noted the submissions raising concerns about the potential negative impacts of the proposed solar farm on neighboring properties, environmental conditions, and birds, pollinators and other insects.

(*ii)* I reviewed the scientific literature on PVHI and collated the findings.

Examinations, Tests and Investigations

All examinations, tests, and investigations have been undertaken by me.

Summary of Opinion

A summary of opinion is included in the Conclusion.

Provisional Opinion

There are no provisional opinions.

Relevant Questions Outside of Expertise

There are no matters of relevance outside of my expertise.

Whether the report is incomplete or inaccurate in any respect

As far as I am aware the report is not incomplete or inaccurate in any respect.

Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance, which I regard as relevant, have to my knowledge been withheld from the Panel.

2 MY WORK ON THE PHOTOVOLTAIC HEAT ISLAND (PVHI) EFFECT

2.1 Background and Expertise Relevant to Solar Projects

I have led a team from January 2013 to present to assess the impacts of land use for renewable energy production in terms of plant function, ecosystem response, and local climate conditions. My colleagues in this work include faculty and students from the Department of Physics and Atmospheric Science and from the Department of Hydrology at the University of Arizona. We took continuous measurements (described below) for more than 18 months, and I then led a publication of the results in a co-authored, peer-reviewed manuscript entitled *The Photovoltaic Heat Island Effect (PVHI): Larger solar power plants increase local temperatures* published in ***Nature Scientific Reports*** on 13 October 2016. The paper details an objective look at the degree to which a PV power plant might alter local climate conditions. The paper is attached at Annexure 2. The study was conducted in response to requests from the Pima County (Arizona) Chief Building Official for Development Services for an assessment of the potential for a PVHI beyond the few studies previously presented in the literature.

2.2 Further Information on the Published Study of the Photovoltaic Heat Island (PVHI) Effect in Arizona

Brief description of methodology used to determine the presence of a PVHI within a solar farm

Early work on the detection of the presence of a PVHI in solar farms has been mostly theoretical or based upon simulated models. Furthermore, past empirical work had been limited in scope to a single biome. In order to determine whether or not a PV array elevated ambient air temperatures (°C) relative to native surroundings, we used shaded and aspirated temperature probes 2.5 m (manufacturer details can be found in *Barron-Gafford et al. (2016)*; Figure 1) at the following representative sites, all within a 1km^2 area:

- natural landscape (semiarid desert ecosystem);
- PV solar farm, where the probe was centrally located within the PV array; and
- within a traditional built environment (parking lot and commercial buildings).

Temperature probes were cross-validated for precision (closeness of temperature readings across all probes) at the onset and the conclusion of the experiment. We set the dataloggers to save the measurements of temperature at 30-minute intervals throughout a 24-hour day. We installed the weather stations in April 2014 and began simultaneously monitoring the three sites throughout an entire yearlong cycle to capture variations in temperatures across seasonal periods. We defined a PVHI effect as the difference in ambient air temperature between the PV solar farm and the natural landscape.

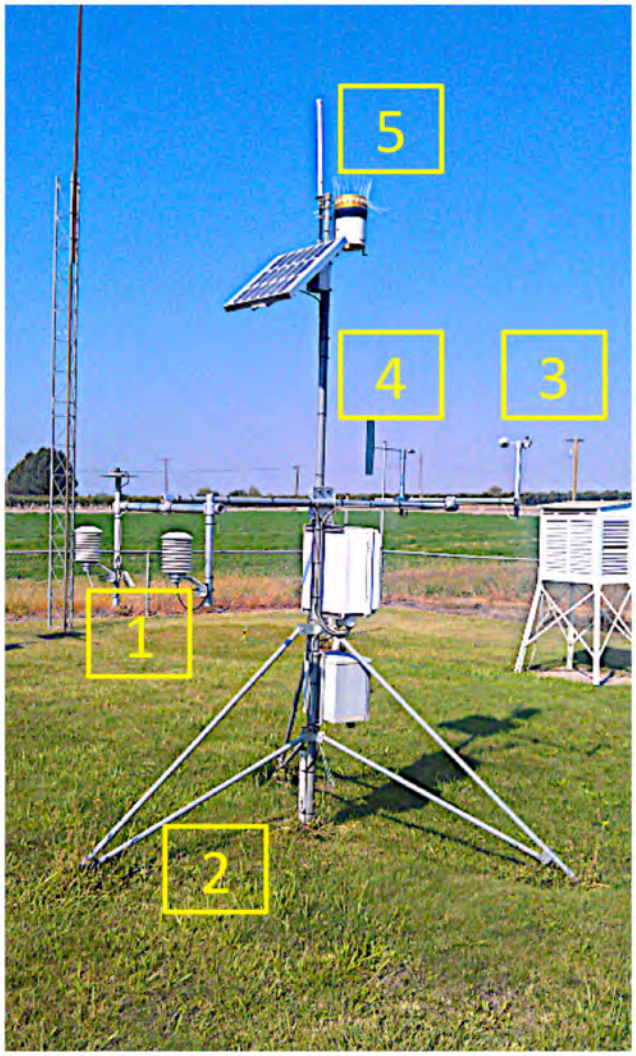

Figure 1. Weather stations were used to measure the local microclimate of an area. Each weather station used captured (1) ambient air temperature, (2) soil temperature, (3) wind speed, (4) wind direction, and (5) precipitation. All data were monitored every 30 minutes, and average conditions were saved by the datalogger. Cumulative precipitation was summed for each 30 minute period.

This type of weather station was installed at each of three sites: the photovoltaic array of a solar farm, the natural landscape, and a parking lot, to represent a typical built environment.

Photo credit: Campbell Scientific Instruments

Results illustrating the presence of a PVHI within a solar farm

Ultimately, we found that air temperatures within a PV solar farm are higher than those in nearby natural settings, and we referred to this as the PVHI effect (Figure 2). We found the PVHI effect to be much greater within the solar farm at night, with the greatest impacts being within the spring and summer months. Additionally, we found that presence of a PVHI effect to be much less significant during the day, and that the effects were least prominent in the winter and fall, regardless of time of day.

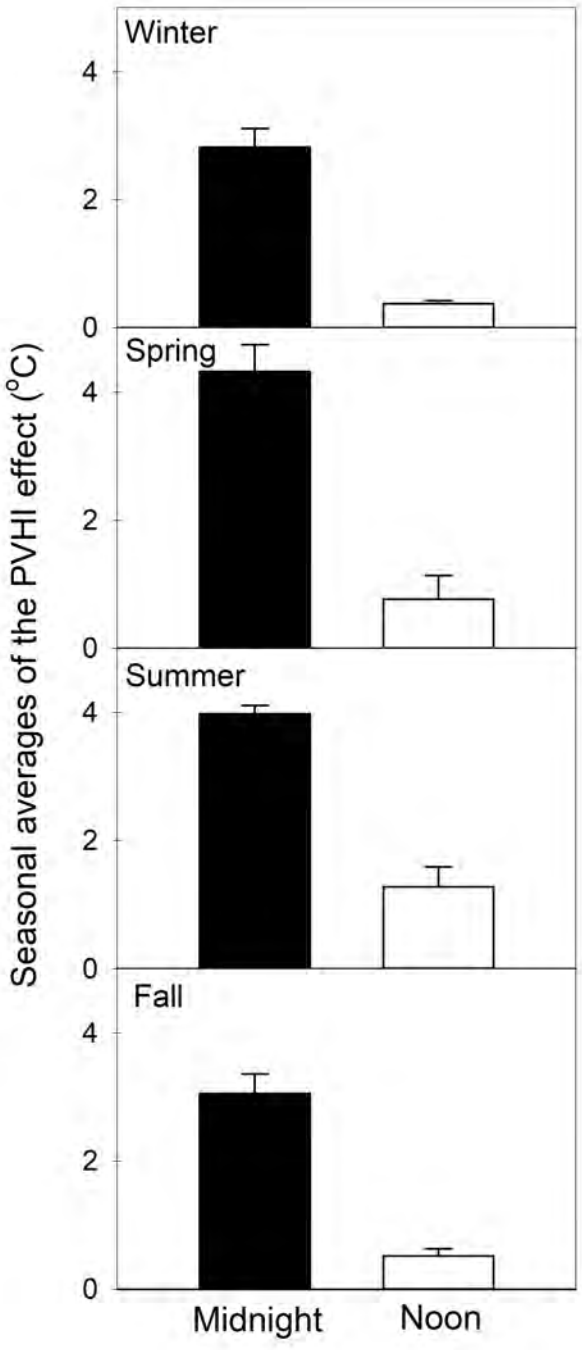

Figure 2. Through continuous monitoring of air temperatures within the center of a solar field for more than a year, we detected the presence of a PVHI effect. The effect was greatest in the nighttime hours (black bars indicate averages at midnight) and lowest during the day (white bars). The degree of the PVHI effect in the center of the solar farm was also seasonally variable with the warm season months experiencing greater impacts than the cool season months.

Figure recreated from Barron-Gafford et al. (2016).

Analysis of conclusions on the presence of a PVHI within a solar farm

As described in *Barron-Gafford et al. (2016*; in Annexure 2), incoming sun energy typically is either reflected back to the atmosphere or absorbed, stored, and later re-radiated in the form of latent or sensible heat. Within natural ecosystems, vegetation reduces heat gain and storage in soils by creating surface shading; this also occurs within PV arrays, but less so in the rows between the panels. Energy absorbed by vegetation and surface soils can be released as latent heat in the transition of liquid water to water vapor to the atmosphere through water loss from soils (evaporation) and vegetation (transpiration). This heat-dissipating latent energy exchange is dramatically reduced within a PV installation that does not have an "understory" of vegetation. PV panels convert ~20% of absorbed energy into usable electricity and also allow some light energy to pass, which, in unvegetated soils will lead to greater heat absorption. This greater sensible heat efflux from the soil becomes trapped under the PV panels, much like clouds trap the energy radiating from the Earth's surface. On cloudy nights, air temperatures do not cool off as much as they do on clear nights. This is the same principle in the PVHI, and I believe the reason that the PVHI dissipates so quickly as one moves away from the edge of the panels. Under the panels, it is analogous to a cloudy night, and away from the array, where those panels are absent, conditions are analogous to a clear night sky.

2.3 Determining the Spatial Extent of the PVHI

Methods for measuring the radius of the measured heat effects in the study

In addition to measuring the degree of the photovoltaic heat island (PVHI) effect within the solar farm, we measured the extent to which the heat island effect extended outward from the PV array (Figure 3). We installed the weather stations with the same air temperature probe described in Section 2.2 to measure temperature:

- inside the array at 20m and 40m in from the edge of the array;
- at the edge of the array (0m); and
- outside the array at 10, 20, 30, 40, and 50m out from the edge of the array.

We installed these weather stations in April 2015, and we maintained them throughout a six-month period to capture variation in the relative differences in temperatures across seasonal periods. While this was a part of our original study design once we had identified the presence of the PVHI effect, this data and associated graphic were cut from our final manuscript by the *Nature Scientific Reports* editor due to space constraints. This is quite unfortunate because the distance of the PVHI effect is one of the primary questions I continue to receive since the publication of this manuscript.

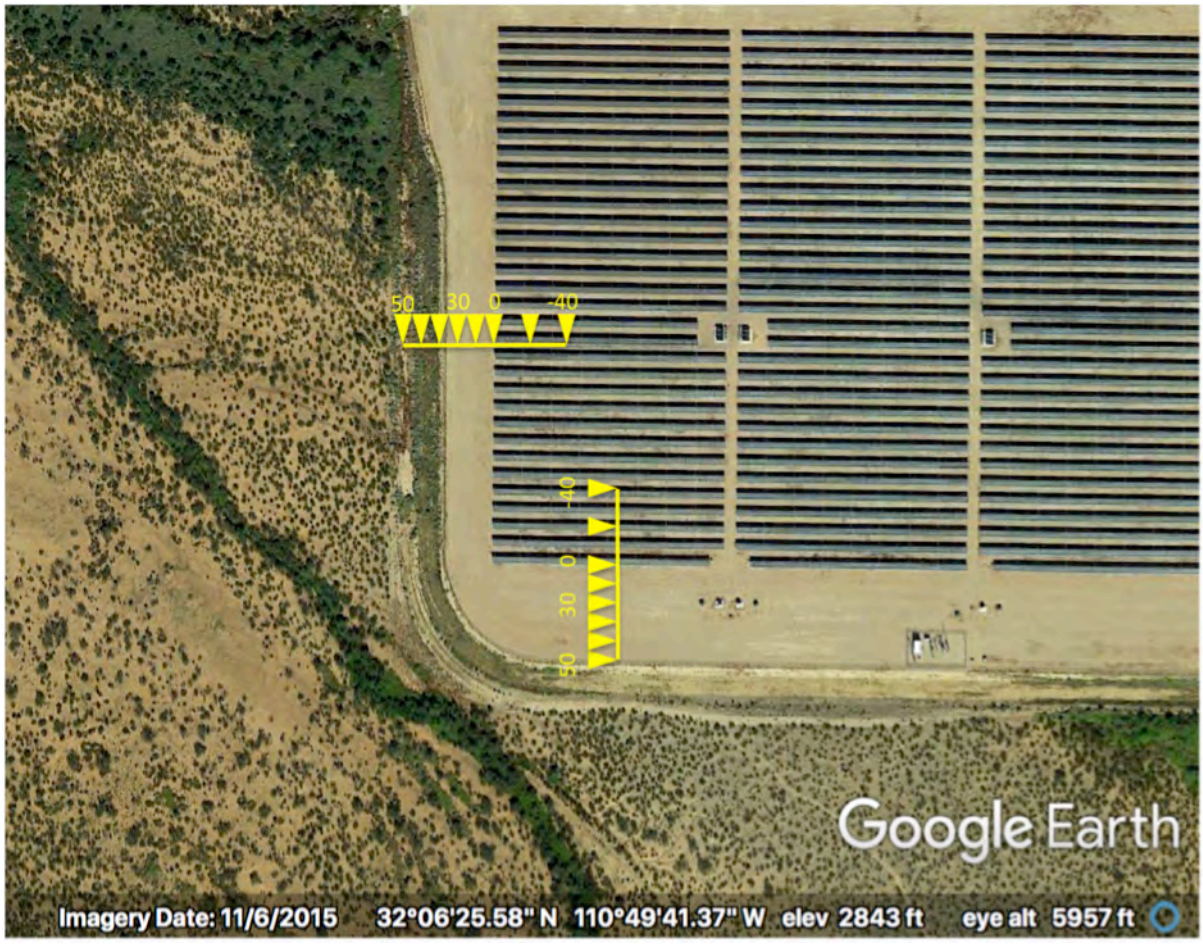

Figure 3. Locations of additional measures of air temperature are marked with yellow triangles. Stations were placed inside the array at 20m and 40m in from the edge of the array, at the edge of the array (0m), and outside the array at 10, 20, 30, 40, and 50m out from the edge of the array to quantify the spatial extent of the PVHI effect.

Results on the radius of the measured heat effects

We found that the PVHI was indistinguishable from air temperatures over native vegetation when measured at a distance of 30m from the edge of the PV array (Figure 4). This pattern held true for both daytime and nighttime conditions. Because the PV panels themselves trap the energy from diffuse sunlight that was able to reach the ground underneath them, air temperatures remain elevated within a PV array. As you leave this “overstory” of PV panels, energy is able to radiate back towards the atmosphere, as it does in a natural setting, and the PVHI quickly dissipates.

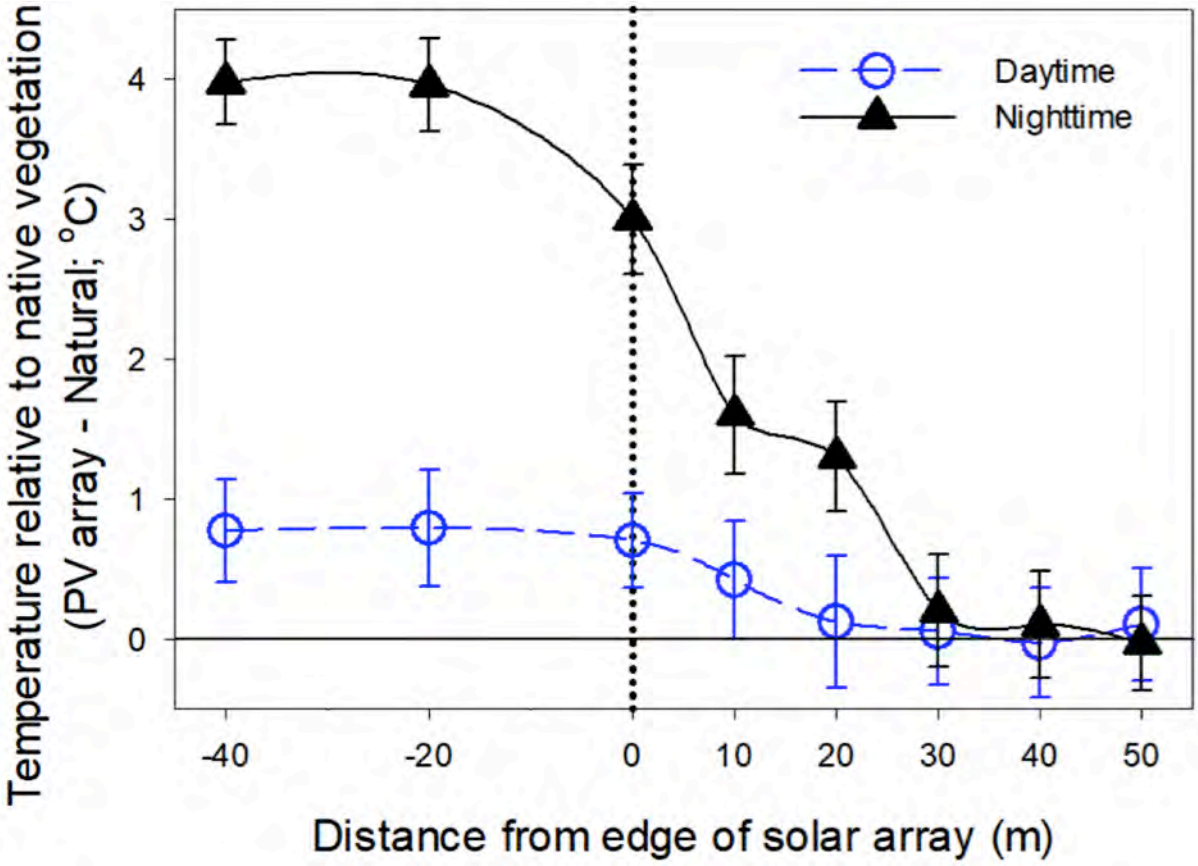

Figure 4. Measures of air temperature within (negative values on the X-axis) and outside of the PV array (positive values on the X-axis) were used to quantify the spatial extent of the PVHI effect. The dotted line represents the edge of the PV array.

The solid line at 0 on the Y-axis illustrates when there is no difference between a measurement along the transect and ambient air temperatures over native vegetation. At night, the PVHI effect of 3-4°C directly above the solar panels is reduced to 1.5 °C at 10m and to 0°C at 30m. There is a lesser PVHI effect by day. Error bars represent 1 standard error around the mean.

3 COMMENT ON THE GENERAL IMPLICATIONS OF THE ABOVE AND OTHER STUDIES IN THE LITERATURE

3.1 CONSIDERATION OF OTHER TECHNICAL PAPERS EXAMINING THE PVHI EFFECT

One of the other primary research articles in the literature on the presence and extent of the PVHI comes from *Fthenakis and Yu (2013)*. This paper links both field data and computational fluid dynamics simulations. Ultimately, *Fthenakis and Yu* found that (*i*) ambient temperatures can be up to 1.9°C greater within a solar farm, and (*ii*) temperatures dissipate rapidly with increased distance from the solar farm, with no detectable effect by at about 300m (Figure 5). In my opinion, the approach and simulations appear sound. However, my critique is tied to the accuracy of the sensors used. For the paper published by *Fthenakis and Yu (2013)*, the accuracy of the Hawk weather station air temperature probe is only ± 0.5°C, but no data on the uncertainty or variation are presented. Please see: https://www.weatherhawk.com/wp-content/uploads/2016/06/Signature-Series-Comprehensive-Manual-V7.pdf

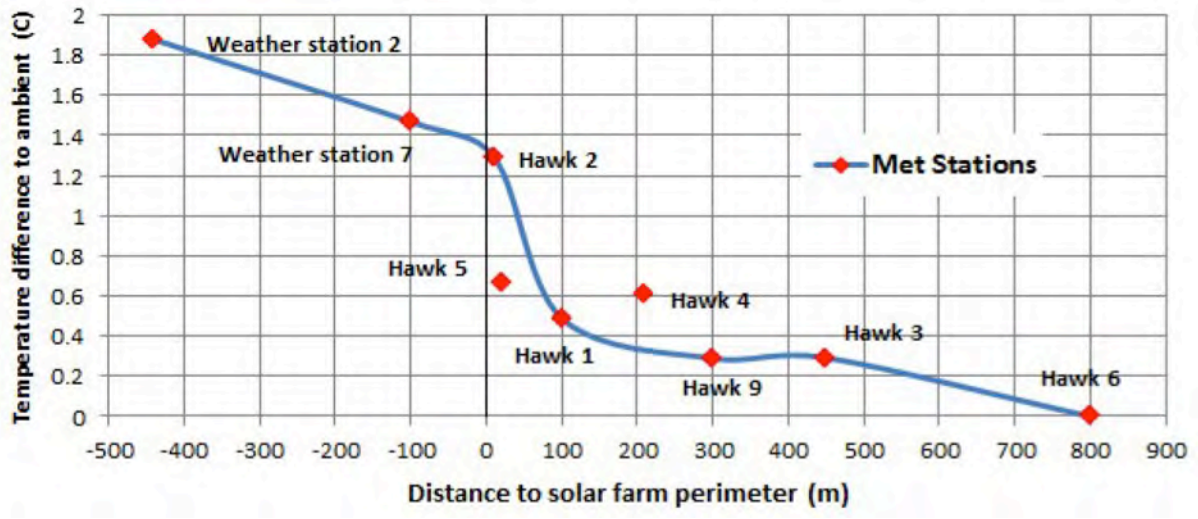

Figure 5. Measures of air temperature within (negative values on the X-axis) and outside of the PV array (positive values on the X-axis), as presented by *Fthenakis and Yu (2013)* to quantify the spatial extent of the PVHI effect. The solid line at 0 on the X-axis represents the edge of the PV array. The data illustrate that the PVHI dissipates rapidly with increasing distance away from the edge of the PV array.

In my opinion, then, if we added this uncertainty to their Figure 8 (shown here as Figure 5 within this report), all measures of air temperature beyond 200m may actually be indistinguishable from ambient air temperatures. Additionally, I do not consider “Hawk 4” to be evidence of a spike in the PVHI away from the PV array. *Fthenakis and Yu* suggest that the higher values at Hawk 4 might be due to the fact that they are on the downwind side of the solar farm. However, I interpret this more as a singular measure that is anonymously higher than those around it, which are on a downward trend as one moves away from the array. Finally, there are no measures of uncertainty on any of these measurements. From maintaining our research sites for more than a year, I know there are day-to-day variations in temperature. *Fthenakis and Yu* also dismiss another one of their sensors as showing “higher temperatures likely due to a calibration inaccuracy”, which leads me to wonder if the same might be true for Hawk 4. Taken together, I wonder if this is anything more than an anomaly.

More recently, *Yang et al.* (*2017*) have added an additional manuscript to this body of literature through a detailed suite of measurements on air and soil temperatures at depth. Ultimately, *Yang et al.* found that the degree of PVHI in terms of daytime air temperatures was nearly absent during winter, but during the other seasons the daytime air temperature in the solar farm was higher than that in areas without PV. As in our study, the maximum PVHI effect was detected during their summer. *Yang et al.* found that the PVHI was present during nighttime hours during all four seasons; again this parallels our own research, which examined the seasonal variation in daytime and nighttime PVHI effect. *Yang et al.* did not mention any data on the spatial extent and dissipation of the PVHI effect in their paper.

3.2 CONTEXTUAL FACTORS THAT MAY BE RELEVANT TO THE PVHI EFFECT

To date, no empirical or experimental studies have explicitly examined correlations between environmental factors such as local landscape, humidity, cloud cover, fixed or rotating tilt panels, and either the degree or spatial extent of a PVHI. However, we can look to literature on the analogous Urban Heat Island (UHI) effect and on Human Thermal Comfort (HTC) for potential indicators. Increases in wind speed has been shown to reduce the UHI (*Rajagopalan et al. 2014*), including work conducted

in Australia (*Santamouris et al. 2017*), however, there are less clear patterns in terms of the impacts of humidity on the UHI. Increased cloud cover is likely to exacerbate the PVHI because clouds trap any re-radiation of sun energy back towards the atmosphere, whether in a built or natural environment. Importantly, recent work has shown that the UHI effect is greater in locations with higher background temperatures (*Taha 2017).*

3.3 Possible Effect of PV Angle tilt on the PVHI Effect

To date, no empirical or experimental studies have investigated the impacts of PV panel angle on the degree of PVHI within an array. A greater degree of tilt would allow for greater loss of heat trapped under the panels, but this should be considered in concert with potential reflection from panels at the end of the day, in which a more severe angle might lead to greater horizontal reflection. Our work (*Barron-Gafford et al. 2016*) was conducted within a PV array in which panels pivoted east-to-west tracking the sun, but maximum angles only approached 45^{o}. The work of *Yang et al.* (*2017*), which found a similar contained PVHI effect within a PV array, was conducted within a PV array with panels at a fixed tilt angle of 36^{o}, and the panels within the solar farm studied by *Fthenakis & Yu* (2013) had a tilt angle of 25^{o}. I have been informed that the PV panels in the proposed Project will be single-axis tracking and could, therefore, be left at an angle to dissipate heat overnight. Together, the existing body of research suggests to me that further research on the linkage between PV angle tilt and the degree of the PVHI warrants more study, but I would predict that maintaining a PV panel angle overnight of 45-50^{o} would aid in nighttime dissipation of any PVHI effect that is created within the array.

3.4 Findings Relating to the PVHI effect and Co-Location of Photovoltaics and Restoration or Agriculture (Agrivoltaics)

Grass + Photovoltaics

The notion of “either-or” between green spaces and solar farms has been progressively more challenged in recent years as companies move towards either restoring solar farms with grasses after installation or leaving grasses in place instead of blading the soil during installation. Co-locating grasses under PV arrays

can yield multiple ecosystem services (tangible and non-tangible amenities) including continued carbon dioxide sequestration from our atmosphere, localized cooling from the transpiration of the plants, grazing forage, and storm-water regulation. In my team's own preliminary work on the effects of revegetating PV solar farms with grasses, we found significant cooling of the local atmosphere (Figure 6). In addition to illustrating the positive effect of vegetation on PV solar farm temperatures, the fact that the plants did so well in such close proximity to the PV panels (around and under the panels) suggests to me a lack of a negative impact of PV installations on local vegetation.

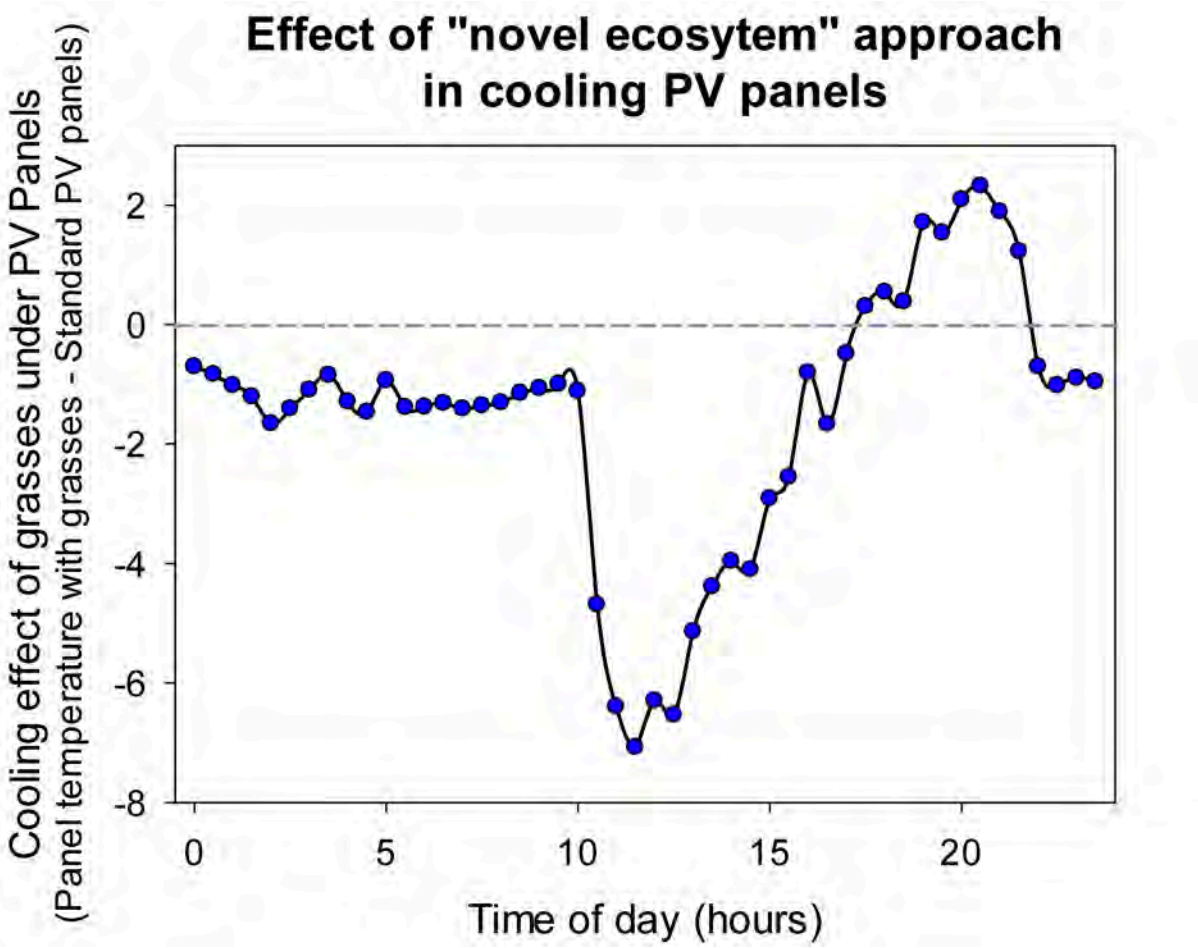

Figure 6. Measures of air temperature within a PV array restored with an understory of grasses versus a PV installation with only bare soil. The dotted line at 0 on the Y-axis illustrates when there is no difference between these measurements, and a negative value indicates the cooling effect of having a PV array restored with grasses. At night, the PVHI effect was cooled by about 1.5 ^{o}C, and the daytime PVHI effect was reduced by up to 7^{o}C within the solar array. The reduced impacts in the early evening are likely due to the vegetation being 'shut down' for the day and, therefore, not providing any transpirational cooling.

Closer to the proposed Project site, co-location of grazing of sheep beneath an overstory of PV panels have illustrated a lack of quantifiable evidence of detrimental effects on livestock:
https://parkessolarfarm.com.au/Library/sheep-grazing-under-neoen-solar-farm/

I understand that grasses will be retained at the proposed Project site. While no published research to date measures the impacts at such a large spatial footprint, I believe that leaving the grasses under the panels should greatly reduce the PVHI effect within the solar farm, which will serve to only assist in any reductions in the spatial extent of the PVHI effect outside of the array.

Agriculture + Photovoltaics

Recently, my colleagues and I have been investigating a novel approach to co-located “green” agriculture and “grey” solar PV infrastructure, where crops are grown in the shade of the PV panels within a solar farm – a practice we call ‘agrivoltaics’. We suggest that this novel energy and food generating ecosystem may become an important - but as yet under investigated - mechanism for maximizing crop yields, efficiently delivering water to plants, and generating renewable energy (Figure 7). Similar pilot studies in France and Germany have also suggested that this co-location can have beneficial effects on a balanced approach to food and renewable energy production. Beyond illustrating innovative applications in renewable energy systems, the co-location of an agriculture and PV arrays suggests that there are no ill effects of PV arrays on food production. Through our extensive measures of photosynthetic rates, transpirational water loss, and total fruit production, we have found no evidence to suggest that plants overheat or lose their potential to function by being in (extremely) close proximity to PV panels. In fact, in many cases production is increased, and water use efficiency becomes much higher because the solar panels reduced direct sunlight on the soils that drive the evaporation of irrigated waters.

Additionally, we have found that PV panels in a traditional ground-mounted array were significantly warmer in the day and experienced greater within-day variation than panels over an agrivoltaic understory, illustrating the cooling effect of vegetation. We attribute these lower daytime temperatures in PV panels in the

agrivoltaic system to the greater balance of latent heat energy exchange from plant transpiration relative to sensible heat exchange from radiation off bare soil (the typical installation method). Across the core growing season, PV panels in an agrivoltaic system were ~ 8.9+0.2^{o}C cooler in the day. These data suggest that even a vegetative barrier can significantly cool panels and the local atmosphere below those caused by the PVHI effect.

Figure 7. The co-location of agricultural under an elevated 'overstory' of PV panels has demonstrated increased production of some crop species (tomatoes, carrots, cabbages, chiltepin peppers, and kale) and increased water savings in the irrigation needed for additional spring and summer crops including red and yellow chards, purple, tepary, and cow beans, cilantro, and Japanese eggplant.

3.5 General Implications of the Above Studies and Literature for the Proposed Project

Comparative characteristics of the Arizona and Shepparton sites

Given recent work has shown that the Urban Heat Island effect is greater in locations with higher background temperatures (*Taha 2017*), it is important to consider comparative characteristics of the Arizona site, where much of my work has been conducted, and the Shepparton site under consideration here. Average climate data for Tucson (https://www.usclimatedata.com/climate/tucson/arizona/united-states/usaz0247) and Shepparton (http://www.bom.gov.au/climate/averages/tables/cw_081125.shtml) illustrate that Tucson is consistently warmer in terms of maximum and minimum temperatures in both the winter and summer seasons. Also noteworthy are vegetative differences in terms of understory vegetation. The installations in the Southwestern USA often are mechanically bladed to remove all vegetation, where as the proposed Project site will retain grasses in the understory. As noted above (Figure 6), this understory vegetation can provide significant cooling to mitigate the PVHI effect within a PV array. As such, we are working to adapt this type of practice more often here in the US installations.

Taken together with the results of *Taha 2017*, I would predict that the degree of PVHI within Shepparton might be lower than the values we measured in Tucson because of the differences in background temperatures and vegetation.

Table 1. A comparison of climatic differences between Tucson, Arizona, USA and Shepparton, Victoria, Australia, underscores the higher average temperatures of the Southwestern USA, which may lead to an elevated PVHI effect in the region.

	Summer		Winter	
	Maximum	Minimum	Maximum	Minimum
Tucson, Arizona, USA	38.1	24.7	18.9	5.5
Shepparton, Victoria, Australia	31.9	15.3	13.3	3.3

Potential for associated impact on bird and insect populations in the area

I have no experience in detecting ill effects on bird or insect populations in or around PV arrays, other than those that stem from a lack of vegetation. The fact that understory grass vegetation will be retained here should actually help to maintain local insect and bird abundances and biodiversity. Still, bolstering bird and insect populations could be achieved through either targeted revegetation efforts around the PV array or through co-location of PV and pollinator friendly vegetation, as has been carried out in multiple locations (Figure 8, for example). Multiple example stories are listed within the References section (5.2) of this report.

Beyond illustrating innovative applications in renewable energy systems, the co-location of pollinator habitat and grazing with PV arrays suggests that there are no ill effects of PV arrays on this vegetation or animals. Plants do not overheat or lose their potential to function by being in (extremely) close proximity to PV panels. Given that our research has shown that the increase in temperatures due to the PVHI effect do not extend past 30m, I do believe that off-site impacts on birds and insets are highly unlikely. Revegetating with native and locally adapted species will ensure that the solar farm does not contribute to any insect pest outbreaks that could negatively impact local agricultural areas.

Figure 8. The co-location of grasses and native or locally adapted pollinator species under an 'overstory' of PV panels has demonstrated increased abundance of bird populations and locally important pollinator species.
Photo of the Westmill Solar Park in Watchfield, England; Photo credit: Guy Parker

4 CONCLUSIONS

WILL THE PROJECT CHANGE ANY ONSITE OR OFFSITE TEMPERATURE?

In summary, both my own research and that of independent groups with which I am not affiliated have shown that solar farms can create PVHI effect, but the spatial extent of the effect is constrained. The PVHI effect is largely driven by the absence of vegetation and the vegetation's potential to cool the atmosphere through transpirational water loss. Bolstering the presence of vegetation through co-location (as described in Section 3.4) or having landscaping around the solar farm will mitigate the PVHI effect. My own research on adding grasses back into a solar farm showed the impacts of grasses on reducing the PVHI effect within a solar array. To-date, no study has published research on these patterns at such large scales, but I have no reason to believe that there will be a different outcome when extrapolated in scale. The increased practice of leaving or re-introducing vegetation within PV solar farms is acknowledging the multiple benefits that come from this practice.

Adding a vegetative buffer to the study site does not seem necessary to creating the dissipation of the PVHI effect as one moves outside of the PV array, as neither of the studies I have conducted or those described by *Fthenakis and Yu (2013)* monitored solar farms with a vegetative buffer.

I have made all of the enquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge, been withheld from the Panel.

Greg Barron-Gafford, PhD
University of Arizona
3 May 2018

5 REFERENCES

5.1 REFERENCES FOR PEER-REVIEWED MANUSCRIPTS CITED WITHIN THIS REPORT

Barron-Gafford, G. A. *et al.* The Solar Heat Island Effect: Larger solar power plants increase local temperatures. *Nature Scientific Reports* **6: 35070**, DOI: 10.1038/srep35070 (2016).

Fthenakis, V. & Yu, Y. Analysis of the potential for a heat island effect in large solar farms. *Analysis of the potential for a heat island effect in large solar farms; 2013 IEEE 39th Photovoltaic Specialists Conference*, 3362-3366 (2013).

Rajagopalan, P., Lim, K. C. & Jamei, E. Urban heat island and wind flow characteristics of a tropical city. Solar Energy 107, 159-170, doi:10.1016/j.solener.2014.05.042 (2014).

Santamouris, M. *et al.* Urban Heat Island and Overheating Characteristics in Sydney, Australia. An Analysis of Multiyear Measurements. *Sustainability* **9**, 21, doi:10.3390/su9050712 (2017).

Taha, H. Characterization of Urban Heat and Exacerbation: Development of a Heat Island Index for California. *Climate* **5**, doi:10.3390/cli5030059 (2017).

Yang, L. *et al.* Study on the local climatic effects of large photovoltaic solar farms in desert areas. *Solar Energy* **144**, 244-253, doi:10.1016/j.solener.2017.01.015 (2017).

5.2 REFERENCES FOR IMPACT ON BIRD AND INSECT POPULATIONS IN PV SOLAR FARMS

https://www.solarpowerworldonline.com/2017/05/pollinator-friendly-solar-vegetation/

http://eanvt.org/wp-content/uploads/2017/04/The-Effects-of-Solar-Farms-on-Local-Biodiversity-A-Comparative-Study-UK.pdf

https://www.greenbiz.com/article/pollinator-friendly-solar-sites

http://agriculture.vermont.gov/node/1507

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CHRONOLOGY OF EDUCATION

2005-2010 University of Arizona, Tucson, Arizona, USA
Ph.D. Ecology & Evolutionary Biology, 2010
Dissertation: *Temperature and precipitation controls over soil, leaf and ecosystem level CO_2 flux along a woody plant encroachment gradient*
Advisor: Travis Huxman

1998-2001 University of Georgia, Athens, Georgia, USA
M.S. Forest Ecology, 2001
Thesis: *The effects of increasing stand density on nutrient limitations to growth and nutrient budgets multi-species pine stands*
Advisors: Robert Teskey and Rodney Will

1994-1998 Texas Christian University, Ft. Worth, Texas, USA
B.S. Environmental Science, 1998
Thesis: *Analysis of forest structure and function at Huntsville State Park, Texas*
Advisors: Leo Newland and Glenn Kroh

CHRONOLOGY OF EMPLOYMENT

Aug 2017 – Present: **Tenure Track Associate Professor**, School of Geography & Development, University of Arizona, Tucson, AZ, 85721

Aug 2016 – Present: **Associate Director**, School of Geography & Development, University of Arizona, Tucson, AZ, 85721

Aug 2013 – Present: **Tenure Track Assistant Professor**, School of Geography & Development, University of Arizona, Tucson, AZ, 85721

Aug 2013 – Present: **Tenure Track Assistant Professor**, Biosphere 2, College of Science, University of Arizona, Tucson, AZ, 85721

Feb 2010 – Aug 2013: **Assistant Research Professor** and **Associate Research Scientist**, Biosphere 2, College of Science, University of Arizona, Tucson, AZ, 85721

Feb 2010 – Aug 2010: **Postdoctoral Research Associate**, Department of Botany, University of Wyoming, Laramie, WY, 82071

Dec 2003 – Feb 2010: **Research Specialist**, Department of Ecology & Evolutionary Biology, University of Arizona, Tucson, AZ, 85721

June 2001 – Dec 2003: **Senior Research Specialist**, Lamont-Doherty Earth Observatory ~ Biosphere 2, Columbia University, Palisades, NY, 10964

SERVICE / OUTREACH

Local / state outreach

2017	University of Arizona Museum of Art ~ *Art-Science Connections*
2017 – Present	Tucson Unified School District ~ *Rincon/University High Schools & Manzo Elementary School: Agrivoltaics installation and curriculum development*
2017	University of Arizona Biosphere 2 ~ *Earth Day: Agrivoltaics Hands-on Experiential learning station*
2017	University of Arizona Biosphere 2 ~ *Science Saturday: Agrivoltaics Presentations and Hands-on Experiential learning station*
2016	University of Arizona Museum of Art ~ *Fires of Change Panelist*
2013	Tumamoc Hill Public Lecture Series ~ *Lectures in the Libraries*
2013	The Santa Rita Experimental Range ~ *Discovery Saturday Public Series*
2008 – 2014	Science Saturdays (Hands-on Science activities) at Biosphere 2
2008 – Present	Informal presentations with Biosphere 2 visitors as we conduct experiments along the tour route

National / Professional

2017 – Present	Onsite Reviewer ~ U.S. National Science Foundation Environmental Biology
2017 – Present	Virtual Panel Reviewer ~ Swiss National Science Foundation, Swiss National Science Foundation Professorship
2017 – Present	Virtual Panel Reviewer ~ Israeli Science Foundation, China-Israel Research Program (CIRP) Review Panel
2017 – Present	International External Reviewer ~ University of Adelaide (Australia), External reviewer for doctoral dissertation
2017 – Present	International External Reviewer ~ Edith Cowan University (Australia), External reviewer for doctoral dissertation
2016 – Present	Onsite Reviewer ~ U.S. National Science Foundation Ecosystem Science Cluster program Doctoral Dissertation Improvement Grants (DDIG)
2013 – Present	Onsite Reviewer ~ U.S. Environmental Protection Agency (EPA) Science to Achieve Results (STAR) Graduate Fellowship

National / Professional (continued)

2013 – Present	Section Editor ~ *Annual Reviews in Plant Biology*
2013 – Present	Session Organizer for the Annual Meeting of the American Geophysical Union
2012 – Present	Section Editor ~ *Physiological Ecology of Photosynthesis* within *Oxford Bibliographies in Ecology*
2010 – Present	Oral presentation and poster judge for graduate student awards at the Annual Meeting of the American Geophysical Union
2010 – Present	Oral presentation and poster judge for Ecological Society of America's Plant Physiological Ecology section awards

2002 – Present	Journal Reviewer. (2012– 11; 2013- 12; 2014- 8; 2015- 9; 2016 – 8 so far): Representative Journals: *Journal of Biogeography, Agricultural and Forest Meteorology, Global Change Biology, Journal of Arid Environments, Nature, Nature Scientific Reports, Nature Energy, Journal of Geophysical Research-Atmospheres, Journal of Geophysical Research-Biogeosciences, New Phytologist, Methods in Ecology & Evolution, Oecologia*

University

2016 – 2017	Ecosystem Genomics Cluster Hire, Earth Sciences executive hiring committee
2015 – Present	UA Arid lands Steering Committee
2015 – Present	Art-Environment Network Governance Committee Member, Institute of the Environment
2014	University of Arizona Foundation Expo of Excellence, representing the School of Geography& Development and Biosphere 2's partnership in STEAM education programming with Manzo Elementary
2014	Water, Environmental, and Energy Solutions (WEES) Faculty Proposal Review Board
2013 – Present	National Ecological Observatory Network Regional Site Selection Committee
2013 – Present	UofA Sky School, Mt. Lemmon Sky Center – Project Organizer
2012 – Present	Institute of the Environment Faculty Exploratory Grant Referee
2011 – Present	University Representative for the Consortium of Universities Allied for Water Research (NSF sponsored program)
2011 – Present	Institute of the Environment Graduate Award Reviewer

Department

2016 – Present	SGD Associate Director
2014 – Present	SGD Undergraduate Committee
2014 – Present	SGD Curriculum and Assessment Committee

Department (continued)

2013 – 2015	SGD Graduate Committee
2013 – Present	Physical Geography Curriculum Sub-committee
2013 – Present	UC-San Diego Academic Connections, in partnership with Biosphere 2 – Project Organizer & student mentor
2013 – 2014	Association of Pacific Coast Geographers Conference Planning Committee
2013 – 2015	Biosphere 2 Earth Month Programming
2013 – 2015	Arizona Center for STEM Teachers – Presenter for weeklong program
2013 – 2014	Physical Geographer Position Hiring Committee
2010 – 2014	Advisor for Biosphere 2 Research Technicians
2011 – Present	Critical Zone Observatory – Ecohydrological Partitioning Sub-committee
2010 – Present	Specialty Tour Guide for Biosphere 2 VIP visitors

Societies

2014 – Present	Association of Pacific Coast Geographers (APCG)
2013 – Present	American Association of Geographers (AAG)
2007 – Present	American Geophysical Union (AGU)
2003 – Present	Ecological Society of America (ESA)

PUBLICATIONS / CREATIVE ACITIVITY

H-index (ISI)……22
Citations (ISI, October, 2017)……1635
Articles published in peer review journals……63
Articles in review……6
Other peer reviewed articles and book chapters……3

Chapters in scholarly books

2. Moore GW, McGuire K, Troch PA, **Barron-Gafford GA**. (2015). Ecohydrology and the Critical Zone: Processes and Patterns across Scales. *In* Principles and Dynamics of the Critical Zone, Giardino and Houser (Eds.). Elsevier.

1. Sengupta A, Pangle LA, Volkmann THM, Dontsova K, Troch PA, Meira AA, Neilson JW, Hunt EA, Chorover J, van Haren J, **Barron-Gafford GA**, Bugaj A, Abramson N, Sibayan M. (2016, *In press*). Advancing understanding of hydrological and biogeochemical interactions in evolving landscapes through controlled experimentation and monitoring at the Landscape Evolution Observatory. In Terrestrial Ecosystem Research Infrastructures: Challenges, New Developments and Perspectives. Abbad Chabbi & Hank Loescher (Eds.). Taylor and Francis Group.

Electronic publication (peer reviewed)

1. **Barron-Gafford GA (2015).** *Physiological Ecology of Photosynthesis*. Oxford Bibliographies Online Resource Library. DOI: 10.1093/OBO/9780199830060-0093

Conference Proceedings

3. **Barron-Gafford GA**, Osmond CB, Grieve KA, Lipson D, and Murthy R. (2005) Elevated CO_2 differentially effects photosynthesis and carbon balance in poplar stands, a four year study. In: van der Est, A. and Bruce, D. (eds). *Photosynthesis: Fundamental Aspects to Global Perspectives: Proceedings 13th International Congress on Photosynthesis*. ACG Publishing (Photosynthesis and Global Change, 973-976).

2. Armstrong AF, Hartley IP, Ineson P, **Barron-Gafford GA**, Murthy R and Atkin OK. (2005). Can climate driven changes in photosynthesis be used to predict changes in the rate and temperature sensitivity of ecosystem respiration? In: van der Est, A. and Bruce, D. (eds). *Photosynthesis: Fundamental Aspects to Global Perspectives: Proceedings 13th International Congress on Photosynthesis*. ACG Publishing (Photosynthesis and Global Change, 958-959).

1. Will RE, **Barron GA**, Teskey RO, and Shiver B. (2005). Within and between canopy variability of foliar nitrogen concentrations for loblolly and slash pine stands planted at different densities. *Biennial Southern Silviculture Conference Proceedings*.

Refereed journal articles

63. **Barron-Gafford GA**, Sanchez-Cañete EP, Hendryx S, Minor RL, Colella T, Murphy P, Lee E, Scott RL, Kumar P. (2017). Impacts of hydraulic redistribution on grass-tree competition versus facilitation in a semiarid savanna. *New Phytologist*, **215**: 1451-1461.

62. Potts DL, Minor RL, Braun Z, **Barron-Gafford GA**. (2017). Photosynthetic phenological variation may promote coexistence among co-dominant tree species in a Madrean sky island mixed conifer forest. *Tree Physiology*, **37**: 1229-1238.

61. Minor J, Falk DA, **Barron-Gafford GA**. (2017). Fire severity and regeneration strategy influence shrub patch size and structure following disturbance. *Forests*, **8**: DOI: 10.3390/f8070221.

60. Sanchez-Canete EP, Scott RL, van Haren J, **Barron-Gafford GA**. (2017). Improving the accuracy of the gradient method for determining soil carbon dioxide efflux. *Journal of Geophysical Research-Biogeosciences*, **122**: 50-64.

59. van Haren J, Dontsova K, **Barron-Gafford GA**, Troch PA, Chorover J, Delong SB, Breshears DD, Huxman TE, Pelletier JD, Saleska SR, et al. (2017). CO_2 diffusion into pore spaces limits weathering rate of an experimental basalt landscape. *Geology*, **45**: 203-206.

58. Villegas JC, Law DJ, Stark SC, Minor DM, Breshears DD, Saleska SR, Swann ALS, Garcia ES, Bella EM, Morton JM, Cobb NS, **Barron-Gafford GA**, Litvak ME, Kolb TE. (2017). Prototype campaign assessment of disturbance-induced tree loss effects on surface properties for atmospheric modeling. *Ecosphere*, **8**:3.

57. **Barron-Gafford GA**, Minor RL, Allen NA, Cronin AD, Brooks AE, Pavao-Zuckerman MA. (2016). The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures. *Nature Scientific Reports* **6**.

56. Scott RL, Biederman JA, Hamerlynck EP, **Barron-Gafford GA**. (2015). The carbon balance pivot point of southwestern U.S. semiarid ecosystems: Insights from the 21st century drought. *Journal of Geophysical Research-Biogeosciences*, **120**: 2612-2624, doi: 10.1002/2015JG003181.

55. Villegas JC, Dominguez F, **Barron-Gafford GA**, Adams HD, Guardiola-Claramonte M, Sommer ED, Selvey AW, Espeleta JF, Zou CB, Breshears DD, Huxman TE. (2015). Sensitivity of regional evapotranspiration partitioning to variation in woody plant cover: insights from experimental dryland tree mosaics. *Global Ecology and Biogeography*, **24**: 1040-1048.

54. Stielstra CM, Lohse KA, Chorover J, McIntosh JC, **Barron-Gafford GA**, Perdrial JN, Litvak M, Barnard HR, Brooks PD. (2015). Climatic and landscape influences on soil moisture are primary determinants of soil carbon fluxes in seasonally snow-covered forest ecosystems. *Biogeochemistry*, **123**: 447-465.

53. Pangle LA, DeLong SB, Abramson N, Adams J, **Barron-Gafford GA**, Breshears DD, Brooks PD, Chorover J, Dietrich WE, Dontsova K, Durcik M, Espeleta J, Ferre TPA, Ferriere R, Henderson W, Hunt EA, Huxman TE, Millar D, Murphy B, Niu G-Y, Pavao-Zuckerman M, Pelletier JD, Rasmussen C, Ruiz J, Saleska S, Schaap M, Sibayan M, Troch PA, Tuller M, van Haren J, Zeng X. (2015). The Landscape Evolution Observatory: A large-scale controllable infrastructure to study coupled Earth-surface processes. *Geomorphology*, **244**: 190-203.

52. Field JP, Breshears DD, Law DJ, Villegas JC, Lopez-Hoffman L, Brooks PD, Chorover J, **Barron-Gafford GA**, Gallery RE, Litvak ME, Lybrand RA, McIntosh JC, Meixner T, Niu G-Y, Papuga SA, Pelletier JD, Rasmussen CR, Troch PA. (2015). Critical Zone Services: Expanding context, constraints, and currency beyond Ecosystem Services. *Vadose Zone Journal,* **14,** doi: 10.2136/vzj2014.10.0142.

51. Ogle K, Barber JJ, **Barron-Gafford GA**, Bentley LP, Young JM, Huxman TE, Loik ME, Tissue DT. (2015). Quantifying ecological memory in plant and ecosystem processes. *Ecology Letters*, **18**: 221-235.

50. Zhang X, Niu G-Y, Elshall AS, Ye M, **Barron-Gafford GA**, Pavao-Zuckerman M. (2014). Assessing five evolving microbial enzyme models against field measurements from a semiarid savannah - What are the mechanisms of soil respiration pulses? *Geophysical Research Letters*, **41**: 6428-6434.

49. **Barron-Gafford GA**, Cable JM, Bentley LP, Scott RL, Huxman TE, Jenerette GD, Ogle K. (2014). Quantifying the timescales over which exogenous and endogenous conditions affect soil respiration. *New Phytologist,* **202**: 442–454, doi: 10.1111/nph.12675.

48. Potts DL, **Barron-Gafford GA**, Jenerette GD (2014). Metabolic acceleration quantifies biological systems' ability to up-regulate metabolism in response to episodic resource availability. *Journal of Arid Environments,* **104**: 9-16.

47. Scott RL, Huxman TE, **Barron-Gafford GA**, Jenerette GD, Young JM, Hamerlynck EP. (2014). When vegetation change alters ecosystem water availability. *Global Change Biology,* **20**: 2198-2210, doi: 10.1111/gcb.12511.

46. Nelson K, Kurc SA, John G, Minor RL, **Barron-Gafford GA**. (2014). Influence of snow cover duration on soil evaporation and respiration efflux in mixed- conifer ecosystems. *Ecohydrology*, **7**: 869-880.

45. Kimball S, Gremer JR, **Barron-Gafford GA**, Angert AL, Huxman TE, Venable DL. (2014). High water-use efficiency and growth contribute to success of non-native *Erodium cicutarium* in a Sonoran Desert winter annual community. *Conservation Physiology*, **2**: cou006, doi:10.1093/conphys/cou006.

44. Hamerlynck EP, Scott RL, Sánchez-Cañete EP, **Barron-Gafford GA**. (2013). Nocturnal soil CO_2 uptake and its relationship to subsurface soil and ecosystem carbon fluxes in a Chihuahuan Desert shrubland. *Journal of Geophysical Research-Biogeosciences*, **118**, 1593–1603, doi: 10.1002/2013JG002495.

43. **Barron-Gafford GA**, Scott RL, Jenerette GD, Hamerlynck EP, Huxman TE. (2013). Landscape and environmental controls over leaf and ecosystem carbon dioxide fluxes under woody plant expansion. *Journal of Ecology*, **101**: 1471–1483, doi: 10.1111/1365-2745.12161.

42. Hamerlynck EP, Scott RL, Cavanaugh ML, **Barron-Gafford GA**. (2013). Water use efficiency of annual- and bunchgrass-dominated savanna intercanopy space. *Ecohydrology*, **7**: 1208-1215, doi: 10.1002/eco.1452

41. Cable JM, Ogle K, **Barron-Gafford GA**, Bentley LP, Cable WL, Scott RL, Williams DG, Huxman TE. (2013). Antecedent conditions influence soil respiration differences in shrub and grass patches. *Ecosystems*, **16**: 1230-1247, doi: 10.1007/s10021-013-9679-7.

40. **Barron-Gafford GA**, Angert AL, Venable DL, Tyler AP, Gerst KL, Huxman TE. (2013). Photosynthetic temperature responses of co-occurring desert winter annuals with contrasting resource-use efficiencies and different temporal patterns of resource utilization may allow for species coexistence. *Journal of Arid Environments*, **91:** 95-103.

39. Hamerlynck EP, Scott RL, **Barron-Gafford GA**. (2013). Consequences of cool-season drought-induced plant mortality to Chihuahuan Desert grassland ecosystem and soil respiration dynamics. *Ecosystems*, **16**: 1178-1191, doi: 10.1007/s10021-013-9675-y.

38. Huxman TE, Kimball S, Angert AL, Gremer JR, **Barron-Gafford GA**, Venable DL. (2013). Understanding past, contemporary, and future dynamics of plants, populations, and communities using Sonoran Desert winter annuals. *American Journal of Botany*, **100**: 1369-80.

37. Pelletier JD, **Barron-Gafford GA**, Breshears DD, Brooks PD, Chorover J, Durcik M, Harman CJ, Huxman TE, Lohse KA, Lybrand R, Meixner T, McIntosh JC, Papuga SA, Rasmussen C, Schaap M, Swetnam TL, Troch PA. (2013). Coevolution of nonlinear trends in vegetation, soils, and topography with elevation and slope aspect: A case study in the sky islands of southern Arizona. *Journal of Geophysical Research: Earth Surface*, **118**: 741-758.

36. Adams HD, Germino MJ, Breshears DD, **Barron-Gafford GA,** Guardiola-Claramonte M, Zou CB, Huxman TE (2013). Nonstructural leaf carbohydrates dynamics during drought-induced tree mortality support role for carbon metabolism in mortality mechanism of *Pinus edulis*. *New Phytologist*, **197**: 1142-1151.

35. **Barron-Gafford GA**, Rascher U, Bronstein JL, Davidowitz G, Chaszar B, Huxman TE. (2012). Herbivory of wild *Manduca sexta* causes fast down-regulation of photosynthetic efficiency in *Datura wrightii*: an early signaling cascade visualized by chlorophyll fluorescence. *Photosynthesis Research*, **113**: 249-260, doi: 10.1007/s11120-012-9741-x

34. Jardine K, **Barron-Gafford GA**, Norman JP, Abrell L, Monson RK, Meyers KT, Pavao-Zuckerman M, Dontsova K, Kleist E, Werner C, Huxman TE. (2012). Green leaf volatiles and oxygenated metabolite emission bursts from mesquite branches following light-dark transitions. *Photosynthesis Research*, **113**: 321-333.

33. Ogle K, Lucas RW, Bentley LP, Cable JM, **Barron-Gafford GA**, Griffith A, Ignace D, Jenerette GD, Tyler A, Huxman TE, Loik ME, Smith SD, Tissue DT. (2012). Differential daytime and night-time stomatal behavior in plants from North American deserts. *New Phytologist*, **213**: 1229-1239, doi: 10.1007/s11258-012-0081-x

32. Hamerlynck EP, Scott RL, **Barron-Gafford, GA**, Cavannaugh M, Moran S, Huxman TE. (2012). Cool-season whole-plant gas exchange of exotic and native semiarid bunchgrasses. *Plant Ecology*, **213:** 1229-1239, doi: 10.1007/s11258-012-0081-x

31. Resco V, Goulden ML, Ogle K, Richardson AD, Hollinger DY, Davidson EA, Alday JG, **Barron-Gafford GA**, Carrara A, Kowalski AS, Oechel WC, Reverter BR, Scott RL, Varner RK, Moreno JM. (2012). Endogenous circadian regulation of carbon dioxide exchange in terrestrial ecosystems. *Global Change Biology*, **18**: 1956-1970.

30. **Barron-Gafford GA**, Scott RL, Jenerette GD, Hamerlynck EP, Huxman TE. (2012). *Temperature and precipitation controls over leaf- and ecosystem-level CO_2 flux of grass and woody species along a woody plant encroachment gradient. *Global Change Biology*, **18**: 1389-1400, doi:10.1111/j.1365-2486.2011.02599.x

29. Jenerette GD, **Barron-Gafford GA**, Guswa A, McDonnel J, Camilo Villegas, J. (2012). Organization of complexity in water limited ecohydrology. *Ecohydrology*, **5**: 184-189.

28. Cable JM, **Barron-Gafford GA**, Ogle K, Huxman TE, Pavao-Zuckerman MA, Scot RL, Williams DG. (2012). Shrub encroachment alters sensitivity of soil respiration to variation in temperature and moisture. *Journal of Geophysical Research-Biogeosciences*, **117**: G01001, doi: 10.1029/2011JG001757

27. **Barron-Gafford GA**, Scott RL, Jenerette GD, Huxman TE. (2011). *The relative controls of temperature, soil moisture, and plant functional group on soil CO_2 efflux at diel, seasonal, and annual scales. *Journal of Geophysical Research-Biogeosciences*, **116**: G01023, doi: 10.1029/2010JG001442.

26. Bobich EG, **Barron-Gafford GA**, Rascher KG, Murthy R. (2010). Effects of drought and changes in vapour pressure deficit on water relations of Populus deltoides growing in ambient and elevated CO_2. *Tree Physiology*, **30**: 886-875.

25. Scott, RL, Hamerlynck EP, Jenerette GD, Moran MS, **Barron-Gafford GA**. (2010). Carbon dioxide exchange in a semidesert grassland through drought-induced vegetation change. *Journal of Geophysical Research-Biogeosciences*, **115**: G03026, doi:10.1029/2010JG001348.

24. Wang L, Caylor KK, Villegas JC, **Barron-Gafford GA**, Breshears DD, Huxman TE. (2010). Partitioning evapotranspiration across gradients of woody plant cover: Assessment of a stable isotope technique, *Geophysical Research Letters*, **37**: L09401.

23. Jenerette GD, Scott RL, **Barron-Gafford GA**, Huxman TE. (2009). Gross primary production variability associated with meteorology, physiology, leaf area, and water supply in contrasting woodland and grassland semiarid riparian ecosystems. *Journal of Geophysical Research-Biogeosciences*, **114**: G04010, doi:10.1029/2009JG001074

22. Adams HD, Guardiola-Claramontea M, **Barron-Gafford GA**, Camilo-Villegas J, Breshears DD, Zou CB, Troch PA, Huxman TE. (2009). Temperature sensitivity of drought-induced tree mortality portends increased regional die-off under global-change-type drought. *Proceedings of the National Academy of Sciences USA*, **106**: 7063–7066.

21. Adams HD, Guardiola-Claramonte M, **Barron-Gafford GA**, Camilo Villegas JC, Breshears DD, Zou CB, Troch PA, Huxman TE. (2009). Reply to Leuzinger et al.: Drought-induced tree mortality temperature sensitivity requires pressing forward with best available science. *Proceedings of the National Academy of Science*, **106**: E69-E69.

20. Adams HD, Guardiola-Claramonte M, **Barron-Gafford GA**, Camilo Villegas JC, Breshears DD, Zou CB, Troch PA, Huxman TE. (2009). Reply to Sala: Temperature sensitivity in drought-induced tree mortality hastens the need to further resolve a physiological model of death. *Proceedings of the National Academy of Science*, **106**: E107-107.

19. Huxman TE, **Barron-Gafford GA**, Gerst KL, Angert AL, Tyler AP, Venable DL. (2008). Photosynthetic resource-use efficiency and demographic variability in desert winter annual plants. *Ecology*, **89**: 1554-1563.

18. Venable DL, Flores-Martinez A, Muller-Landau HC, **Barron-Gafford GA**, Becerra JX. (2008). Seed dispersal of desert annuals. *Ecology*, **89**: 2218-2227.

17. Zou CB, **Barron-Gafford GA**, Breshears DD. (2007). Effects of topography and woody plant canopy cover on near-ground solar radiation: Relevant energy inputs for ecohydrology and hydropedology. *Geophysical Research Letters*, **34**: L24S21.

16. Pegoraro E, Potosnak MJ, Monson RK, Rey A, **Barron-Gafford GA,** Osmond CB. (2007). The effect of elevated CO_2, soil and atmospheric water deficit and seasonal phenology on leaf and ecosystem isoprene emission. *Functional Plant Biology*, **34**: 774-784.

15. **Barron-Gafford GA**, KA Grieve, Murthy R. (2007). Leaf- and stand-level responses of a forested mesocosm to independent manipulations of temperature and vapor pressure deficit. *New Phytologist*, **174**: 614-625.

14. Patrick L, Cable J, Potts D, Ignace D, **Barron-Gafford GA**, Griffith A, Alpert H, Van Gestel N, Robertson T, Huxman TE, Zak J, Loik ME, Tissue D. (2007). Effects of an increase in summer precipitation on leaf, soil, and ecosystem fluxes of CO_2 and H_2O in a sotol grassland in Big Bend National Park, Texas. *Oecologia*, **151**: 704-718.

13. Angert AL, Huxman TE, **Barron-Gafford GA**, Gerst KL, Venable DL. (2007). Linking growth strategies to long-term population dynamics in a guild of desert annuals. *Journal of Ecology*, **95**: 321–331.

12. Hartley IP, Armstrong AF, Murthy R, **Barron-Gafford GA**, Ineson P, Atkin AK. (2006). The dependence of respiration on photosynthetic substrate supply and temperature: integrating leaf, soil and ecosystem measurements. *Global Change Biology*, **12**: 1954–1968.

11. Lipson DA, Blair M, **Barron-Gafford GA**, Grieve K, Murthy R (2006). Relationships between microbial community structure and soil processes under elevated atmospheric carbon dioxide. *Microbial Ecology*, **51**: 302–314.

10. Druart N, Rodríguez-Buey M, **Barron-Gafford GA**, Sjödin A, Bhalerao R, Osmond CB, Hurry V (2006). Molecular targets of elevated [CO_2] in leaves and stems of *Populus deltoides*: implications for future tree growth and carbon sequestration. *Functional Plant Biology* **33**: 121–131.

9. **Barron-Gafford GA**, Martens D, McLain JET, Grieve KA, Murthy R. (2005). Growth of eastern cottonwoods (*Populus deltoides*) in elevated CO_2 stimulates stand-level respiration and rhizodeposition of carbohydrates, accelerates soil nutrient depletion, yet stimulates above and belowground biomass production. *Global Change Biology*, **11**: 1220-1233.

8. Pegoraro E, Abrell L, van Haren J, **Barron-Gafford GA**, Grieve K, Malhi Y, Murthy R, Lin G. (2005). The effect of elevated atmospheric CO_2 and drought on sources and sinks of isoprene in a temperate and tropical rainforest mesocosm. *Global Change Biology*, **11**: 1234-1246.

7. Murthy R, **Barron-Gafford GA**, Dougherty PM , Engel VC , Grieve K, Handley L, Klimas C, Potosnak MJ, Zarnoch SJ , Zhang J. (2005). Increased leaf area dominates carbon flux response to elevated CO_2 in stands of *Populus deltoides* (Bartr.) and underlies a switch from canopy light-limited CO_2 influx in well-watered treatments to individual leaf, stomatally-limited influx under water stress. *Global Change Biology*, **11**: 716-731.

6. Pegoraro E, Rey A, **Barron-Gafford GA**, Monson R, Malhi Y, Murthy R. (2005). The interacting effects of elevated atmospheric CO_2 concentration, drought and leaf-to-air vapour pressure deficit on ecosystem isoprene fluxes. *Oecologia*, **146**: 120-129.

5. Walter A, Christ MM, **Barron-Gafford GA**, Grieve K, Paige T, Murthy R, Rascher U. (2005). The effect of elevated CO_2 on diel leaf growth cycle, leaf carbohydrate content and canopy growth performance of *Populus deltoids. Global Change Biology*, **11**: 1207-1219.

4. Pegoraro E, Rey A, Murthy R, Bobich EG, **Barron-Gafford GA,** Grieve K, Malhi YC. (2004). Effect of elevated CO_2 concentration and vapor pressure deficit on isoprene emission from leaves of *Populus deltoides* during drought. *Functional Plant Biology*, **31**: 1137-1147.

3. **Barron-Gafford GA**, RE Will, EC Burkes, B Shiver, Teskey RO. (2003). *Nutrient concentrations and contents, and their relation to stem growth, of intensively managed *Pinus taeda* and *Pinus elliottii* stands of different planting densities. *Forest Science*, **49**: 291-300.

2. Burkes, EC, Will RE, **Barron-Gafford GA**, Teskey RO, Shiver BD. (2003). Biomass partitioning and growth efficiency of intensively managed *Pinus taeda* and *Pinus elliottii* stands of different planting densities. *Forest Science*, **49**: 224-234.

1. Will, RE, **Barron GA**, Burkes EC, Shiver BD, Teskey RO. (2001). *Relationship between intercepted radiation, net photosynthesis, respiration, and rate of stem volume growth of *Pinus taeda* and *Pinus elliottii* stands of different densities. *Forest Ecology and Management*, **154**: 155-163.

WORK IN PROGRESS

Articles in peer review, final preparation, or revision

6. Adams HA, **Barron-Gafford GA**, Minor RL, Gardea AA, Bentley LP, Breshears DD, Dowell NG, Huxman TE. (*In Re-review post-revision*). Ever increasing drought-induced mortality risk for tree species with ever rising temperatures. *Environmental Research Letters.*

5. Elshall AS, Ye M, Niu G-Y, **Barron-Gafford GA**. (*In Re-review post-revision*). Impacts of Residual Models on Bayesian Inference and Predictive Performance of Soil Respiration Models. *Journal of Geophysical Research – Biogeosciences.*

4. Elshall AS, Ye M, Niu G-Y, **Barron-Gafford GA**. (*In Re-review post-revision*). Relative Model Score: A Multi-Criteria Metric for Measuring Relative Predictive Performance of Multiple Models. *Water Resources Research.*

3. Lee E, Kumar P, **Barron-Gafford GA**, Hendryx S, Sanchez-Cañete EP, Minor RL, Colella T, Scott RL. (*In Review*). Impact of hydraulic redistribution on multispecies vegetation water use in a semi-arid savanna ecosystem: An experimental and modeling synthesis. *Water Resources Research*.

2. Froend RH, Breshears DD, Law DJ, **Barron-Gafford GA**. (*In Review*). Phreatophytes in the Anthropocene: State and Transition Models for Climate Change and Land Use Pressures. *Earth's Future*.

1. Minor J, Colella TR, Barnes M, Mann S, Murphy P, Pearl J, **Barron-Gafford GA**. (*In Review*). Critical Zone Science in the Anthropocene: Opportunities for Biogeographic Theory and Praxis to Drive Earth Science Integration. *Global Ecology and Biogeography*.

MEDIA OUTREACH

2017 — UA News. *UA Researchers Plant Seeds to Make Renewable Energy More Efficient.* Interviewee discussing Agrivoltaics as an experiment in combining agriculture with energy efficiency, involves growing plants beneath solar panels, community outreach with Manzo Elementary and University High School, and the linkage between School of Geography & Development and Biosphere 2. Full online version: https://uanews.arizona.edu/story/ua-researchers-plant-seeds-make-renewable-energy-more-efficient?utm_source=uanow&utm_medium=email&utm_campaign

2016 — ResearchGate. *Solar energy is hot right now, in more ways than one.* Interviewee discussing unintended impacts of large-scale renewable energy through photovoltaics. Full online version: https://www.researchgate.net/blog/post/solar-energy-is-hot-right-now-in-more-ways-than-one

2016 — Arizona Daily Star. *Critical Zone Observatory gets grant to extend research.* Interviewee discussing the inter- and cross-disciplinary research within the context of the Critical Zone Observatory, and the linkage between School of Geography & Development and Biosphere 2. Full online version: http://tucson.com/news/science/environment/critical-zone-observatory-gets-grant-to-extend-research/article_aa4df9dc-a7a1-11e6-9f60-b341da1029a7.html

2014 — Bill Buckmaster Show. *Superstars of Science.* Interviewee discussing the Manzo Elementary project, STEAM learning (including Art in STEM education), and the linkage between School of Geography & Development and Biosphere 2. Full online version: http://www.buckmastershow.com/2014/04/24/buckmaster-show-4242014-tusd-struggles-to-keep-students/

2013 — Tucson Weekly (cover story). *Learning through Landscapes*. Interviewee on the partnership between School of Geography & Development and Biosphere

2 with Manzo Elementary to introduce a new STEM learning program. Full online version: http://www.tucsonweekly.com/tucson/learning-through-landscapes/Content?oid=3918303

2013 Arizona Public Media. Interviewee on the biogeography of woody plant expansion and the linkage between School of Geography & Development and Biosphere 2. https://ondemand.azpm.org/videoshorts/watch/2013/9/16/26865-grassland-faces-threats-from-mesquite-trees-woody-plants/

CONFERENCES AND SCHOLARLY PRESENTATIONS *(limited to period in rank)*

Invited Symposia (limited to period in rank)

Barron-Gafford GA (*Invited speaker*). Biogeography in the Critical Zone: Insights from the Mountain Tops and Valley Floor. UCLA Department of Geography Tod Spieker Colloquium Series. Tucson, Arizona. November, 2015.

Barron-Gafford GA (*Invited speaker*). Ecohydrology in our Critical Zone: Insights from Semiarid Mountain Tops to the Valley Floor. School of Natural Resources & the Environment (SNRE) Colloquium. Tucson, Arizona. October, 2015.

Barron-Gafford GA (*Invited speaker*). Sensor Technologies and Unmanned Aerial Vehicles (drones) to Measure Ecosystem Processes in Semi-arid Environments. Research Insights in Semiarid Ecosystems (RISE) Symposium. Tucson, Arizona. October, 2015.

Barron-Gafford GA (*Invited speaker*). Examining ecosystem function in space and time within the critical zone through the lenses of ecology and biogeography. Department of Ecology & Evolutionary Biology Colloquium. Tucson, Arizona. September, 2015.

Barron-Gafford GA (*Invited speaker*). Woody plant encroachment: Influence of landscape change on aboveground-belowground linkages, pulse dynamics, and ecosystem function. Soil, Water, & Environmental Science (SWES) Colloquium. Tucson, Arizona. November, 2013.

Barron-Gafford GA (*Invited speaker*). Exploring the ecology of semiarid land-cover and land-use change in anticipation of a changing climate. Department of Ecology & Evolutionary Biology Colloquium. Tucson, Arizona. March, 2013.

Invited conferences (limited to period in rank)

Barron-Gafford GA. Lags and Legacies in Ecosystem Processes: Challenges and Opportunities for Biogeographers and Ecologists. Frontiers in Experimental Ecosystem Science. Paris, France. July, 2015.

Scott RL, Huxman TE, **Barron-Gafford GA**, Jenerette GD, Young JM. The ecohydrological consequences of woody plant encroachment: How accessibility to deep soil water Resources affects ecosystem carbon and water exchange (*Invited*). American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

Submitted presentations (limited to period in rank)

Barron-Gafford GA, Allen N, Minor RL, Pavao-Zuckerman M. The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Scott RL, **Barron-Gafford GA**, Biederman JA. Insights from a network of long-term measurements of biosphere-atmospheric exchanges of water vapor and carbon dioxide in southern Arizona. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Barron-Gafford GA, Minor RL, Hendryx, S, Lee E, Sutter L, Colella T, Murphy P, Sanchez-Cañete EP, Hamerlynck EP, Kumar P, Scott RL. Impacts of hydraulic redistribution on overstory-understory interactions in a semiarid savanna. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Sanchez-Cañete EP, Scott RL, Van Haren JLM, **Barron-Gafford GA**. The Necessity of Determining the Gas Transfer Coefficient In-situ to Obtain More Accurate Soil Carbon Dioxide Effluxes Through the Gradient Method. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Elshall AS, Ye M, Niu G-Y, **Barron-Gafford GA**. Numerical Demons in Monte Carlo Estimation of Bayesian Model Evidence with Application to Soil Respiration Models. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Murphy P, Minor RL, Sanchez-Cañete EP, Potts DL, **Barron-Gafford GA**. Seasonal and Topographic Variation in Net Primary Productivity and Water Use Efficiency in a Southwest Sky Island Forest. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Lee E, Kumar P, , **Barron-Gafford GA**, Scott RL. An Experimental and Modeling Synthesis to Determine Seasonality of Hydraulic Redistribution in Semi-arid Region with Multispecies Vegetation Interaction. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Sutter L, Sanchez-Cañete EP, **Barron-Gafford GA**. Aspect as a Driver of Soil Carbon and Water Fluxes in Desert Environments. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Hingley R, Juarez S, Dontsova K, Hunt E, Le Galliard J-F, Chollet S, Cros A, Llavata M, Massol F, Barré P, Gelabert A, Daval D, Troch PA, **Barron-Gafford GA**, Van Haren JLM, Ferrière R. Effects of Climate Change and Vegetation Type on Carbon and Nitrogen Accumulation during Incipient Soil Formation. American Geophysical Union's Annual Fall Meeting, Dec. 12-16, 2016, San Francisco, CA.

Sanchez-Cañete EP, **Barron-Gafford GA**, van Haren J, Scott RL. Accurate long-term soil respiration fluxes based on the gradient method in a semiarid ecosystem. University of Arizona Arid Lands Poster Session, April, 2016, Tucson, AZ.

Murphy P, Minor RL, Potts DL, **Barron-Gafford GA**. Studying Topographic Controls on Primary Productivity. University of Arizona Arid Lands Poster Session, April, 2016, Tucson, AZ.

Sutter L, Sanchez-Cañete EP, **Barron-Gafford GA**. An important aspect of soil carbon and water fluxes in desert environments. University of Arizona Arid Lands Poster Session, April, 2016, Tucson, AZ.

Hendryx S, Minor RL, Colella T, Murphy P, Lee E, Scott RL, Kumar P, **Barron-Gafford GA**. Impacts of hydraulic redistribution on plant and soil carbon and water fluxes in a dryland savanna. University of Arizona Arid Lands Poster Session, April, 2016, Tucson, AZ.

Colella T, Mann SN, Murphy P, Minor J, Pearl J, Barnes M, Gallery R, Swetnam T, **Barron-Gafford GA**. Critical Zone Science in the Anthropocene. Association of American Geographers Annual Meeting, April, 2016, San Francisco, CA.

Elshall AS Ye M, Niu G-Y, **Barron-Gafford GA**. Bayesian multimodel inference of soil microbial respiration models: Theory, application and future prospective. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Scott RL, Biederman J, **Barron-Gafford GA**, Hamerlynck EP. The Carbon Balance Pivot Point of Southwestern U.S. Semiarid Ecosystems: Insights From the 21st Century Drought. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Barron-Gafford GA, Minor RL, Heard MM, Sutter LF, Yang J, Potts DL. Complex terrain in the Critical Zone: How topography drives ecohydrological patterns of soil and plant carbon exchange in a semiarid mountainous system. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Lee E, Kumar P, **Barron-Gafford GA**, Scott RL, Hendryx S, Sanchez-Cañete EP. Determining the Role of Hydraulic Redistribution Regimes in the Critical Zone. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Sanchez-Cañete EP, **Barron-Gafford GA**, van Haren JLM, Scott RL. Improving soil CO2 efflux estimates from in-situ soil CO2 sensors with gas transport measurements. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Parra EA, McFarland E, Minor RL, Heard MM, **Barron-Gafford GA**. Effects of isoprene production on the photosynthetic performance of Poplars (*Populus* sp.) under thermal and moisture stress. American Geophysical Union's Annual Fall Meeting, Dec. 14-18, 2014, San Francisco, CA.

Barron-Gafford GA. Examining ecosystem function in space and time within the critical zone through the lenses of ecology and biogeography. Ecological Society of America's Annual Meeting, August, 2015, Baltimore, MD.

Barron-Gafford GA. Capturing heterogeneity in carbon fluxes in space and time across a semiarid montane forest. Association of American Geographers Annual Meeting, April, 2015, Chicago, IL.

Elshall AS, Ye M, **Barron-Gafford GA**. Quantification of Model Uncertainty in Modeling Mechanisms of Soil Microbial Respiration Pulses to Simulate Birch Effect. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Pfeiffer AW, Minor RL, Heard MM, **Barron-Gafford GA**. Photosynthetic response of Poplars (*Populus*) to climatic stressors: Investigating isoprene's role in increasing tolerance to temperature and atmospheric water stress in Arizona. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Ibsen P, Van Leeuwn WJD McCorkel J, **Barron-Gafford GA**, Moore DJ. Physiology and thermal imaging of Poplar hybrids with varying temperature tolerance. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Troch PA, **Barron-Gafford GA**, Dontsova K, Fang Y, Niu G-Y, Pangle LA, Tuller M, Van Haren JLM. Monitoring and modeling water, energy and carbon fluxes at the hillslope scale in the Landscape Evolution Observatory. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Scott RL, Biederman JA, **Barron-Gafford GA**. The coupling of ecosystem productivity and water availability in dryland regions. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Ruiz J, Van Haren JLM, Dontsova K, **Barron-Gafford GA**, Troch PA, Chorover J. Rapid CO_2 consumption during incipient weathering of a granular basaltic hillslope in the Landscape Evolution Observatory, Biosphere 2. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Pavao-Zuckerman M, Knerl A, **Barron-Gafford GA**. Ecohydrology frameworks for green infrastructure design and ecosystem service provision. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Pfeiffer AW, Minor RL, Heard MM, **Barron-Gafford GA**. Photosynthetic response of Poplars (*Populus*) to climatic stressors. American Geophysical Union's Annual Fall Meeting, Dec. 15-19, 2014, San Francisco, CA.

Barron-Gafford GA, Minor RL, Heard M, Barrows J, Allen N. Using Water Smart Design and an Ecosystem Services Approach to Fight Solar Heat Islanding and Enhance Renewable Energy Production. Association of Pacific Coast Geographers Annual Meeting, Sept. 24-27, 2014, Tucson, AZ.

Barron-Gafford GA, Minor RL, Heard M, Yang J, Wright C, Potts DL. Aspect as a source of heterogeneity in carbon & water fluxes in space and time. National Critical Zone Observatory All-Hands Meeting, Sept. 21-24, 2014, Yosemite, CA.

Chorover J, Pelletier J, Breshears DD, McIntosh J, Rasmussen C, Brooks P, **Barron-Gafford GA**, Gallery R, Ferré T, Litvak M, Meixner T, Niu G-Y, Papuga S, Rich V, Schaap M, Troch P. The Catalina-Jemez CZO: Transformative Behavior of Energy, Water and Carbon in the Critical Zone II. Interactions between Long and Short Term Processes that Control Delivery of Critical Zone Services. National Critical Zone Observatory All-Hands Meeting, Sept. 21-24, 2014, Yosemite, CA.

Barron-Gafford GA. Heat islanding around solar energy installations ~ Valid concern or unnecessary worry about renewable energy production. Association of American Geographers Annual Meeting, April 8-12, 2014, Tampa, FL.

Barron-Gafford GA, Minor RL, van Haren J, Dontsova K, Troch PA. Precipitation pulse dynamics of carbon sequestration and efflux in highly weatherable soils. American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

Niu G, Zhang X, **Barron-Gafford GA**, Pavao-Zuckerman M. Modeling the "Birch Effect" using a microbial enzyme based soil organic carbon decomposition and gas transport model. American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

Yang J, **Barron-Gafford GA**, Minor RL, Heard M. Examining the physical drivers of photosynthetic temperature sensitivity within a sub-alpine mixed conifer forest. American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

van Haren J, **Barron-Gafford GA**, Dontsova K. CO_2 sequestration through weathering of basalt tephra in the Landscape Evolution Observatory (LEO). American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

DeMets CM, Pavao-Zuckerman M, **Barron-Gafford GA**, Jenerette GD, Young JM. Strategies for cooler cities? Ecophysiological responses of semi-arid street trees to storm water harvesting. American Geophysical Union's Annual Fall Meeting, Dec. 9-13, 2013, San Francisco, CA.

Law DJ, Ravi S, **Barron-Gafford GA**, Breshears DD, and Huxman TE. Evapotranspiration Partitioning: Competition between abiotic and biotic components of the water budget. AGU Chapman Conference on Soil-mediated Drivers of Coupled Biogeochemical and Hydrological Processes Across Scales. Tucson, AZ. October, 2013.

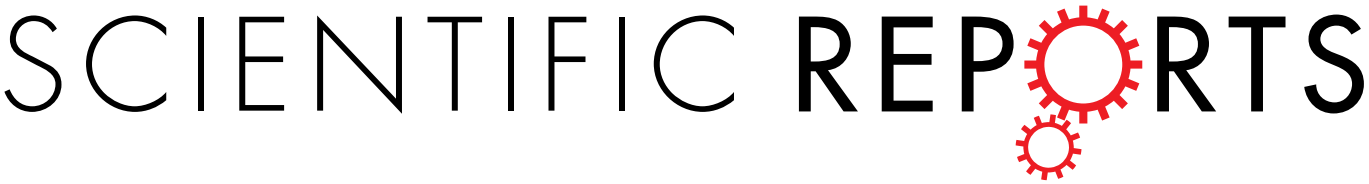
Niu GY, Zhang X, and **Barron-Gafford GA**. A microbial enzyme based Soil Organic Carbon (SOC) decomposition model for use in climate models. AGU Chapman Conference on Soil-mediated Drivers of Coupled Biogeochemical and Hydrological Processes Across Scales. Tucson, AZ. October, 2013.

Yang J and **Barron-Gafford GA**. Examining the physical drivers of photosynthetic temperature sensitivity within a sub-alpine conifer forest. Undergraduate Research Opportunities Consortium, Tucson, AZ. August, 2013.

Community Presentations (limited to period in rank)

Barron-Gafford GA. "Mesquites in the Grasslands ~ Environmental and Human Drivers of Landscape Change". Living Gently on the Land Educational Series, Appleton-Whittell Research Ranch of the National Audubon Society, Elgin, AZ. November, 2014.

Barron-Gafford GA. "Experiential Ecological Learning as a Transformative Gateway in Elementary Learning". Arizona Center for STEM Teachers (ACST) Residential Teacher Training Workshop at Biosphere 2, Tucson, AZ. July, 2013.



OPEN

The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures

Received: 26 May 2016
Accepted: 23 September 2016
Published: 13 October 2016

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While photovoltaic (PV) renewable energy production has surged, concerns remain about whether or not PV power plants induce a "heat island" (PVHI) effect, much like the increase in ambient temperatures relative to wildlands generates an Urban Heat Island effect in cities. Transitions to PV plants alter the way that incoming energy is reflected back to the atmosphere or absorbed, stored, and reradiated because PV plants change the albedo, vegetation, and structure of the terrain. Prior work on the PVHI has been mostly theoretical or based upon simulated models. Furthermore, past empirical work has been limited in scope to a single biome. Because there are still large uncertainties surrounding the potential for a PHVI effect, we examined the PVHI empirically with experiments that spanned three biomes. We found temperatures over a PV plant were regularly 3–4 °C warmer than wildlands at night, which is in direct contrast to other studies based on models that suggested that PV systems should decrease ambient temperatures. Deducing the underlying cause and scale of the PVHI effect and identifying mitigation strategies are key in supporting decision-making regarding PV development, particularly in semiarid landscapes, which are among the most likely for large-scale PV installations.

Electricity production from large-scale photovoltaic (PV) installations has increased exponentially in recent decades[1–3]. This proliferation in renewable energy portfolios and PV powerplants demonstrate an increase in the acceptance and cost-effectiveness of this technology[4,5]. Corresponding with this upsurge in installation has been an increase in the assessment of the impacts of utility-scale PV[4,6–8], including those on the efficacy of PV to offset energy needs[9,10]. A growing concern that remains understudied is whether or not PV installations cause a "heat island" (PVHI) effect that warms surrounding areas, thereby potentially influencing wildlife habitat, ecosystem function in wildlands, and human health and even home values in residential areas[11]. As with the Urban Heat Island (UHI) effect, large PV power plants induce a landscape change that reduces albedo so that the modified landscape is darker and, therefore, less reflective. Lowering the terrestrial albedo from ~20% in natural deserts[12] to ~5% over PV panels[13] alters the energy balance of absorption, storage, and release of short- and longwave radiation[14,15]. However, several differences between the UHI and potential PVHI effects confound a simple comparison and produce competing hypotheses about whether or not large-scale PV installations will create a heat island effect. These include: (*i*) PV installations shade a portion of the ground and therefore could reduce heat absorption in surface soils[16], (*ii*) PV panels are thin and have little heat capacity per unit area but PV modules emit thermal radiation both up and down, and this is particularly significant during the day when PV modules are often 20 °C warmer than ambient temperatures, (*iii*) vegetation is usually removed from PV power plants, reducing the amount of cooling due to transpiration[14], (*iv*) electric power removes energy from PV power plants, and (*v*) PV panels reflect and absorb upwelling longwave radiation, and thus can prevent the soil from cooling as much as it might under a dark sky at night.

Public concerns over a PVHI effect have, in some cases, led to resistance to large-scale solar development. By some estimates, nearly half of recently proposed energy projects have been delayed or abandoned due to local opposition[11]. Yet, there is a remarkable lack of data as to whether or not the PVHI effect is real or simply an issue

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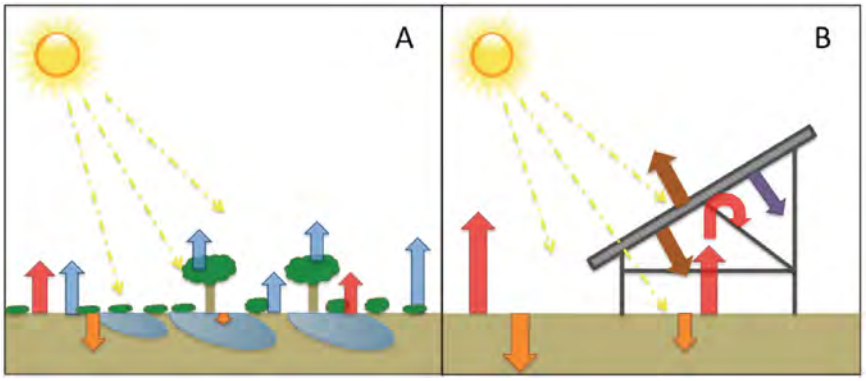

Figure 1. Illustration of midday energy exchange. Assuming equal rates of incoming energy from the sun, a transition from (**A**) a vegetated ecosystem to (**B**) a photovoltaic (PV) power plant installation will significantly alter the energy flux dynamics of the area. Within natural ecosystems, vegetation reduces heat capture and storage in soils (orange arrows), and infiltrated water and vegetation release heat-dissipating latent energy fluxes in the transition of water-to-water vapor to the atmosphere through evapotranspiration (blue arrows). These latent heat fluxes are dramatically reduced in typical PV installations, leading to greater sensible heat fluxes (red arrows). Energy re-radiation from PV panels (brown arrow) and energy transferred to electricity (purple arrow) are also shown.

associated with perceptions of environmental change caused by the installations that lead to "not in my back-yard" (NIMBY) thinking. Some models have suggested that PV systems can actually cause a cooling effect on the local environment, depending on the efficiency and placement of the PV panels[17,18]. But these studies are limited in their applicability when evaluating large-scale PV installations because they consider changes in albedo and energy exchange within an urban environment (rather than a natural ecosystem) or in European locations that are not representative of semiarid energy dynamics where large-scale PV installations are concentrated[10,19]. Most previous research, then, is based on untested theory and numerical modeling. Therefore, the potential for a PHVI effect must be examined with empirical data obtained through rigorous experimental terms.

The significance of a PVHI effect depends on energy balance. Incoming solar energy typically is either reflected back to the atmosphere or absorbed, stored, and later re-radiated in the form of latent or sensible heat (Fig. 1)[20,21]. Within natural ecosystems, vegetation reduces heat gain and storage in soils by creating surface shading, though the degree of shading varies among plant types[22]. Energy absorbed by vegetation and surface soils can be released as latent heat in the transition of liquid water to water vapor to the atmosphere through evapotranspiration – the combined water loss from soils (evaporation) and vegetation (transpiration). This heat-dissipating latent energy exchange is dramatically reduced in a typical PV installation (Fig. 1 transition from A-to-B), potentially leading to greater heat absorption by soils in PV installations. This increased absorption, in turn, could increase soil temperatures and lead to greater sensible heat efflux from the soil in the form of radiation and convection. Additionally, PV panel surfaces absorb more solar insolation due to a decreased albedo[13,23,24]. PV panels will re-radiate most of this energy as longwave sensible heat and convert a lesser amount (~20%) of this energy into usable electricity. PV panels also allow some light energy to pass, which, again, in unvegetated soils will lead to greater heat absorption. This increased absorption could lead to greater sensible heat efflux from the soil that may be trapped under the PV panels. A PVHI effect would be the result of a detectable increase in sensible heat flux (atmospheric warming) resulting from an alteration in the balance of incoming and outgoing energy fluxes due to landscape transformation. Developing a full thermal model is challenging[17,18,25], and there are large uncertainties surrounding multiple terms including variations in albedo, cloud cover, seasonality in advection, and panel efficiency, which itself is dynamic and impacted by the local environment. These uncertainties are compounded by the lack of empirical data.

We addressed the paucity of direct quantification of a PVHI effect by simultaneously monitoring three sites that represent a natural desert ecosystem, the traditional built environment (parking lot surrounded by commercial buildings), and a PV power plant. We define a PVHI effect as the difference in ambient air temperature between the PV power plant and the desert landscape. Similarly, UHI is defined as the difference in temperature between the built environment and the desert. We reduced confounding effects of variability in local incoming energy, temperature, and precipitation by utilizing sites contained within a 1 km area.

At each site, we monitored air temperature continuously for over one year using aspirated temperature probes 2.5 m above the soil surface. Average annual temperature was $22.7 + 0.5$ °C in the PV installation, while the nearby desert ecosystem was only $20.3 + 0.5$ °C, indicating a PVHI effect. Temperature differences between areas varied significantly depending on time of day and month of the year (Fig. 2), but the PV installation was always greater than or equal in temperature to other sites. As is the case with the UHI effect in dryland regions, the PVHI effect delayed the cooling of ambient temperatures in the evening, yielding the most significant difference in overnight temperatures across all seasons. Annual average midnight temperatures were $19.3 + 0.6$ °C in the PV installation, while the nearby desert ecosystem was only $15.8 + 0.6$ °C. This PVHI effect was more significant in terms of actual degrees of warming (+3.5 °C) in warm months (Spring and Summer; Fig. 3, right).

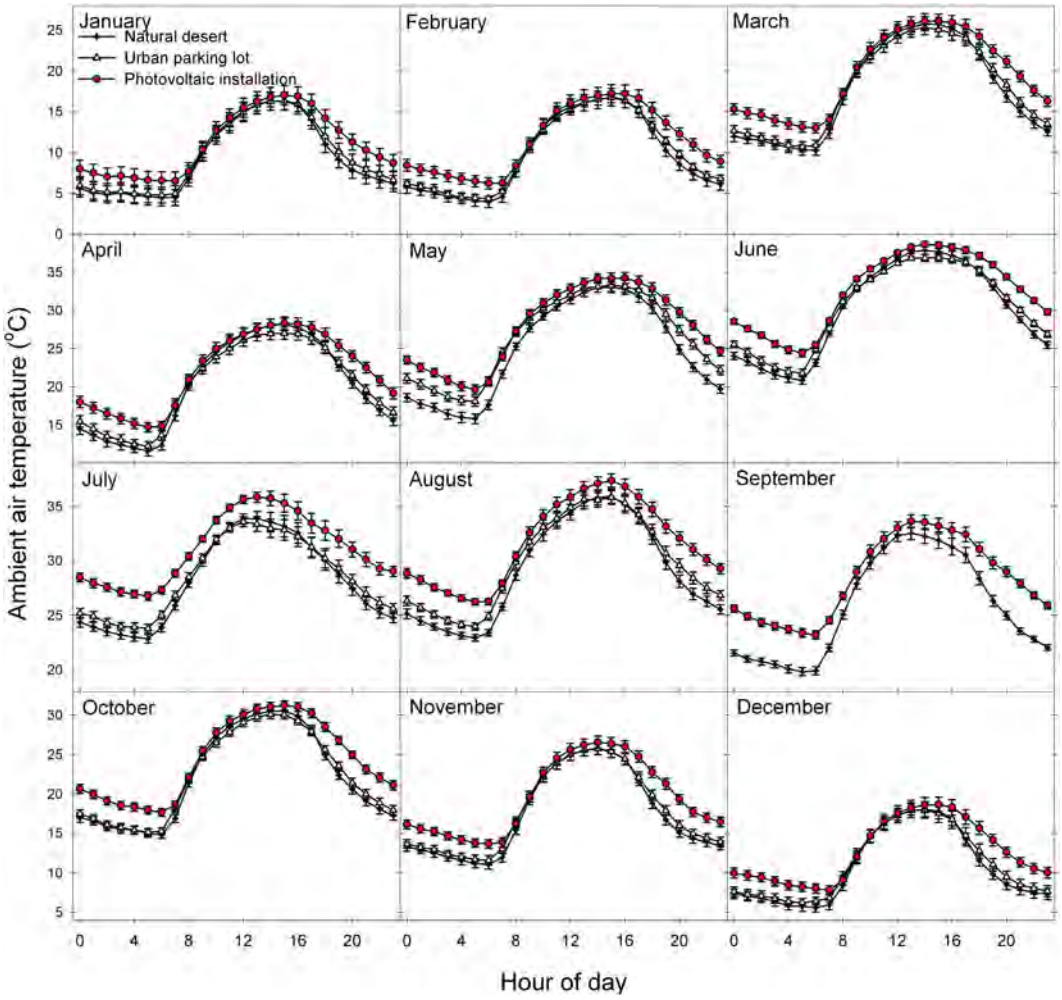

Figure 2. Average monthly ambient temperatures throughout a 24-hour period provide evidence of a photovoltaic heat island (PVHI) effect.

In both PVHI and UHI scenarios, the greater amount of exposed ground surfaces compared to natural systems absorbs a larger proportion of high-energy, shortwave solar radiation during the day. Combined with minimal rates of heat-dissipating transpiration from vegetation, a proportionally higher amount of stored energy is reradiated as longwave radiation during the night in the form of sensible heat (Fig. 1)[15]. Because PV installations introduce shading with a material that, itself, should not store much incoming radiation, one might hypothesize that the effect of a PVHI effect would be lesser than that of a UHI. Here, we found that the difference in evening ambient air temperature was consistently greater between the PV installation and the desert site than between the parking lot (UHI) and the desert site (Fig. 3). The PVHI effect caused ambient temperature to regularly approach or be in excess of 4 °C warmer than the natural desert in the evenings, essentially doubling the temperature increase due to UHI measured here. This more significant warming under the PVHI than the UHI may be due to heat trapping of re-radiated sensible heat flux under PV arrays at night. Daytime differences from the natural ecosystem were similar between the PV installation and urban parking lot areas, with the exception of the Spring and Summer months, when the PVHI effect was significantly greater than UHI in the day. During these warm seasons, average midnight temperatures were 25.5 + 0.5 °C in the PV installation and 23.2 + 0.5 °C in the parking lot, while the nearby desert ecosystem was only 21.4 + 0.5 °C.

The results presented here demonstrate that the PVHI effect is real and can significantly increase temperatures over PV power plant installations relative to nearby wildlands. More detailed measurements of the underlying causes of the PVHI effect, potential mitigation strategies, and the relative influence of PVHI in the context of the intrinsic carbon offsets from the use of this renewable energy are needed. Thus, we raise several new questions and highlight critical unknowns requiring future research.

What is the physical basis of land transformations that might cause a PVHI?

We hypothesize that the PVHI effect results from the effective transition in how energy moves in and out of a PV installation versus a natural ecosystem. However, measuring the individual components of an energy flux model remains a necessary task. These measurements are difficult and expensive but, nevertheless, are indispensable in identifying the relative influence of multiple potential drivers of the PVHI effect found here. Environmental

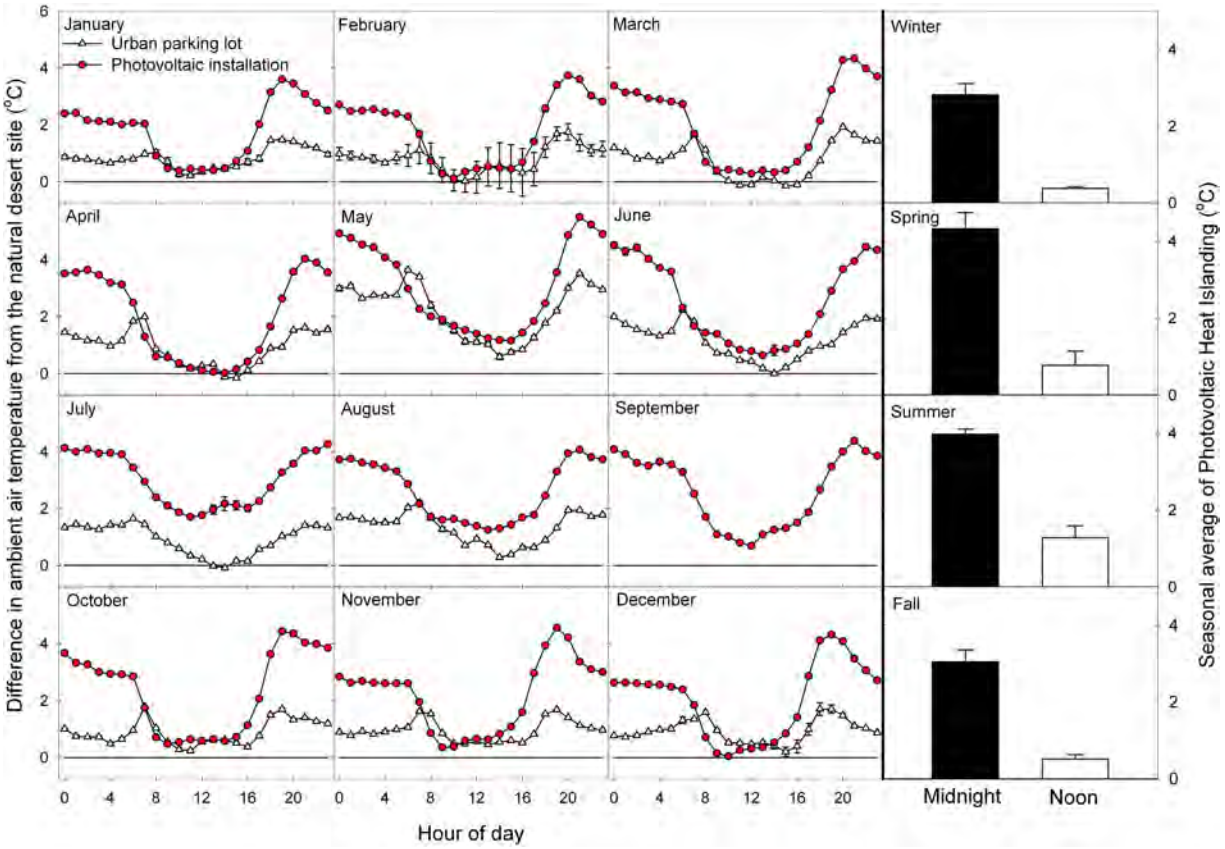

Figure 3. (Left) Average monthly levels of Photovoltaic Heat Islanding (ambient temperature difference between PV installation and desert) and Urban Heat Islanding (ambient temperature difference between the urban parking lot and the desert). (Right) Average night and day temperatures for four seasonal periods, illustrating a significant PVHI effect across all seasons, with the greatest influence on ambient temperatures at night.

conditions that determine patterns of ecosystem carbon, energy, and water dynamics are driven by the means through which incoming energy is reflected or absorbed. Because we lack fundamental knowledge of the changes in surface energy fluxes and microclimates of ecosystems undergoing this land use change, we have little ability to predict the implications in terms of carbon or water cycling[4,8].

What are the physical implications of a PVHI, and how do they vary by region?

The size of an UHI is determined by properties of the city, including total population[26–28], spatial extent, and the geographic location of that city[29–31]. We should, similarly, consider the spatial scale and geographic position of a PV installation when considering the presence and importance of the PVHI effect. Remote sensing could be coupled with ground-based measurements to determine the lateral and vertical extent of the PVHI effect. We could then determine if the size of the PVHI effect scales with some measure of the power plant (for example, panel density or spatial footprint) and whether or not a PVHI effect reaches surrounding areas like wildlands and neighborhoods. Given that different regions around the globe each have distinct background levels of vegetative ground cover and thermodynamic patterns of latent and sensible heat exchange, it is possible that a transition from a natural wildland to a typical PV power plant will have different outcomes than demonstrated here. The paucity in data on the physical effects of this important and growing land use and land cover change warrants more studies from representative ecosystems.

What are the human implications of a PVHI, and how might we mitigate these effects?

With the growing popularity of renewable energy production, the boundaries between residential areas and larger-scale PV installations are decreasing. In fact, closer proximity with residential areas is leading to increased calls for zoning and city planning codes for larger PV installations[32,33], and PVHI-based concerns over potential reductions in real estate value or health issues tied to Human Thermal Comfort (HTC)[34]. Mitigation of a PVHI effect through targeted revegetation could have synergistic effects in easing ecosystem degradation associated with development of a utility scale PV site and increasing the collective ecosystem services associated with an area[4]. But what are the best mitigation measures? What tradeoffs exist in terms of various means of revegetating degraded PV installations? Can other albedo modifications be used to moderate the severity of the PVHI?

Figure 4. Experimental sites. Monitoring a (1) natural semiarid desert ecosystem, (2) solar (PV) photovoltaic installation, and (3) an "urban" parking lot – the typical source of urban heat islanding – within a 1 km^2 area enabled relative control for the incoming solar energy, allowing us to quantify variation in the localized temperature of these three environments over a year-long time period. The Google Earth image shows the University of Arizona's Science and Technology Park's Solar Zone.

To fully contextualize these findings in terms of global warming, one needs to consider the relative significance of the (globally averaged) decrease in albedo due to PV power plants and their associated warming from the PVHI against the carbon dioxide emission reductions associated with PV power plants. The data presented here represents the first experimental and empirical examination of the presence of a heat island effect associated with PV power plants. An integrated approach to the physical and social dimensions of the PVHI is key in supporting decision-making regarding PV development.

Methods

Site Description. We simultaneously monitored a suite of sites that represent the traditional built urban environment (a parking lot) and the transformation from a natural system (undeveloped desert) to a 1 MW PV power plant (Fig. 4; Map data: Google). To minimize confounding effects of variability in local incoming energy, temperature, and precipitation, we identified sites within a 1 km area. All sites were within the boundaries of the University of Arizona Science and Technology Park Solar Zone (32.092150°N, 110.808764°W; elevation: 888 m ASL). Within a 200 m diameter of the semiarid desert site's environmental monitoring station, the area is composed of a sparse mix of semiarid grasses (*Sporobolus wrightii, Eragrostis lehmanniana*, and *Muhlenbergia porteri*), cacti (*Opuntia* spp. and *Ferocactus* spp.), and occasional woody shrubs including creosote bush (*Larrea tridentata*), whitethorn acacia (*Acacia constricta*), and velvet mesquite (*Prosopis velutina*). The remaining area is bare soil. These species commonly co-occur on low elevation desert bajadas, creosote bush flats, and semiarid grasslands. The photovoltaic installation was put in place in early 2011, three full years prior when we initiated monitoring at the site. We maintained the measurement installations for one full year to capture seasonal variation due to sun angle and extremes associated with hot and cold periods. Panels rest on a single-axis tracker system that pivot east-to-west throughout the day. A parking lot with associated building served as our "urban" site and is of comparable spatial scale as our PV site.

Monitoring Equipment & Variables Monitored. Ambient air temperature (°C) was measured with a shaded, aspirated temperature probe 2.5 m above the soil surface (Vaisala HMP60, Vaisala, Helsinki, Finland in the desert and Microdaq U23, Onset, Bourne, MA in the parking lot). Temperature probes were cross-validated for precision (closeness of temperature readings across all probes) at the onset of the experiment. Measurements of temperature were recorded at 30-minute intervals throughout a 24-hour day. Data were recorded on a data-logger (CR1000, Campbell Scientific, Logan, Utah or Microstation, Onset, Bourne, MA). Data from this

instrument array is shown for a yearlong period from April 2014 through March 2015. Data from the parking lot was lost for September 2014 because of power supply issues with the datalogger.

Statistical analysis. Monthly averages of hourly (on-the-hour) data were used to compare across the natural semiarid desert, urban, and PV sites. A Photovoltaic Heat Island (PVHI) effect was calculated as differences in these hourly averages between the PV site and the natural desert site, and estimates of Urban Heat Island (UHI) effect was calculated as differences in hourly averages between the urban parking lot site and the natural desert site. We used midnight and noon values to examine maximum and minimum, respectively, differences in temperatures among the three measurement sites and to test for significance of heat islanding at these times. Comparisons among the sites were made using Tukey's honestly significant difference (HSD) test[35]. Standard errors to calculate HSD were made using pooled midnight and noon values across seasonal periods of winter (January-March), spring (April-June), summer (July-September), and fall (October-December). Seasonal analyses allowed us to identify variation throughout a yearlong period and relate patterns of PVHI or UHI effects with seasons of high or low average temperature to examine correlations between background environmental parameters and localized heat islanding.

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Acknowledgements

The authors thank Ken Marcus for access to the University of Arizona Solar Zone and the Science and Technology Park and to Tucson Electric Power for access to their PV installation. This research was supported by the University of Arizona Institute of the Environment and the Office of Research & Development through the TRIF-funded Water, Environmental and Energy Solutions initiative.

Author Contributions

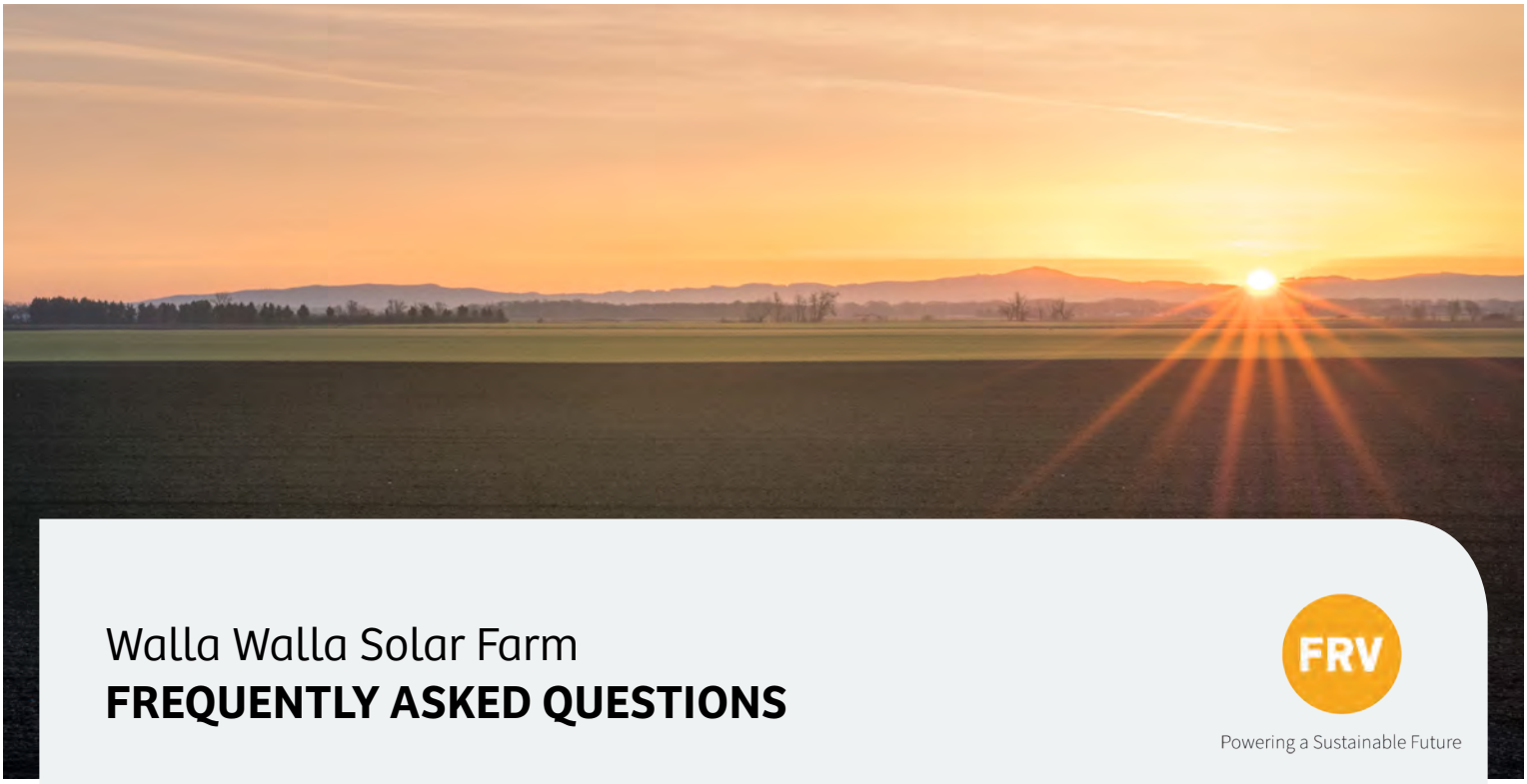
G.A.B.-G., R.L.M. and N.A.A. established research sites and installed monitoring equipment. G.A.B.-G. directed research and R.L.M. conducted most site maintenance. G.A.B.-G., N.A.A., A.D.C. and M.A.P.-Z. led efforts to secure funding for the research. All authors discussed the results and contributed to the manuscript.

Additional Information

Competing financial interests: The authors declare no competing financial interests.

How to cite this article: Barron-Gafford, G. A. *et al.* The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures. *Sci. Rep.* **6**, 35070; doi: 10.1038/srep35070 (2016).

A.4 SOLAR FARM 'FREQUENTLY ASKED QUESTIONS'



Walla Walla Solar Farm
FREQUENTLY ASKED QUESTIONS

FRV
Powering a Sustainable Future

GENERAL

Q What is proposed?

A FRV is proposing to construct and operate a 300 megawatt (MWac) solar farm for the purposes of providing a critical new source of clean energy for NSW. If approved, the solar farm will be capable of supplying 90,000 homes across the State and will reduce carbon emissions by more than 520,000 tonnes per year.

Q Why did the previous developer sell this project?

A Based on FRV's discussions with Bison they believed that it was the right time for them to exit the project. This is often the case with smaller developers as they often don't have the resources, experience or the capital to fully develop a large-scale solar project. FRV is an experienced and capable developer and has developed 1.6 gigawatts (GW) of renewable energy globally. We also have four solar farms in operation in Australia with a further project currently in construction and another which will commence construction by end of the year.

Q What stage is this project at?

A Having purchased this project after it had already commenced, FRV had initially 'stopped the clock' to do our own analysis and review of the work which has been completed to date. FRV have been working with stakeholders and local consultants to enhance the design in preparation of submitting an Environmental Impact Statement in due course.

Q Where will this project connect to?

A The project will connect to the existing 330kV transmission line, which is owned and operated by the transmission provider, TransGrid. This power line runs parallel with the western boundary of the project (Schneiders Road).

Q When will construction commence and for how long?

A The construction start date is dependent on a variety of factors, including obtaining a Development Application Approval, a Grid Connection Agreement, a Power Purchase Agreement and Financial Close. If all aspects are achieved, FRV anticipates construction could commence Q1 2021. Construction is expected to take between 16-20 months.

Q Will FRV stay on as the project owner?

A Our approach is to develop and acquire large-scale solar energy projects that we can then own and operate for the long-term. FRV have sold assets in the past but our core business model is to retain assets as this provides us with a sustainable return on investment and ensures we manage the running of our solar farms directly. For us, it is important that our assets are operated responsibly and perform well over their lifetime.

Q How long will this project operate for?

A The operational life of the project is expected to be 30 years. After this time, the site will either be rehabilitated and returned to its original purpose as freehold land or depending on future energy requirements the project may be reutilised, subject to landowner agreements and planning approvals.

DESIGN CONSIDERATIONS

Q Why has this specific site been chosen?

A As a developer there are a long list of 'conditions' which need to be analysed when choosing an appropriate site. These key conditions help narrow the search to specific geographical areas. One of the main factors is economical and low-impact access to the high voltage electricity grid network.

Typically, a developer will follow the following steps;

1. Identify parts of the electricity network with available capacity;
2. Identify land along this part of the network;
3. Review the suitability of this land – including protected ecology areas, cultural sensitivity, steep terrain etc.;
4. Define combinations of suitable land parcels that provide enough land area to make a project viable; and
5. Approach landowners of suitable land-landowners with larger, continuous land parcels are preferred.

Most suitable sites present some degree of restrictions such as creek lines, easements, etc. FRV works to incorporate these restrictions so that they can co-exist alongside the solar farm footprint. FRV have developed projects across Australia with similar restrictions to those on the proposed Walla Walla Solar Farm site.

Q What about loss of agricultural land?

A FRV have examined operational solar farms and have found that the grass growth is maintained underneath the panels thus allowing the continued grazing of the land within a solar farm.

FRV has also identified that at the Walla Walla Solar Farm, at its current design, only 14.9% of the solar farm will be unable to be grazed due to access tracks and other implemented infrastructure. This figure includes the land that will be implemented for screening and ecological enhancement. We are confident that a very small proportion of the grazing land is lost.

Allowing sheep grazing within a solar farm provides dual use of the land and further sustains the local economy through job retention in the agricultural sector. The term 'AgriSolar' is commonly used to show the symbiotic relationship between both enterprises.

Q What key changes have FRV made in the design?

A FRV have been listening to the local community and liaising with stakeholders and relevant agencies. We have been reviewing the design closely and while not all impacts can be fully mitigated, we have been making practical and positive changes to enhance the design that will help mitigate neighbours' concerns where practicable. Items include a review of site access points, location of key infrastructure, plans for biodiversity management and additional vegetation screening.

TECHNICAL

Q What type of panels will be used?

A The latest technology panels will be used on this project. These will be mounted on single axis trackers that change their orientation throughout the day to follow the sun from sunrise to sunset to maximise the energy captured.

Q How high will the panels be?

A Panels will be installed on low-lying structures expected to be around 4m in height. When the panels are stowed, they will be approx 2m in height.

Q Do solar panels cause glare?

A The purpose of solar panels is to absorb the sunlight, not reflect it. The panels are covered in an anti-reflective coating and only reflect a small amount (less than 2%) of the sunlight that falls on them compared to most other everyday objects like water surfaces and the glass windows on your home.

Q Will the site contain a battery?

A A Battery Energy Storage System (BESS) is not planned at present for this project, but if requirements change it may be required and implemented at a future date. Battery technology is very mature and has been implemented in hundreds of thousands of sites including residential, commercial and utility applications all with similar technologies.

Q Are there known health risks associated with living near solar technology?

A No. Power generation from an individual solar panel is less than that used by your vacuum cleaner, hairdryer or electric heater at home. Many Australian homes, airports, schools, hospitals etc have solar panels placed on their roofs. The operation of a solar panel generates no emissions such as CO2 or any other harmful gases. There are no situations in which being in the proximity of a solar farm can have adverse health effects and has been demonstrated by the gigawatts of solar farm installations throughout the world.

Q Will the panel design exacerbate wind from the west over neighbouring paddocks used for cropping, grazing?

A Walla Walla Solar Farm uses single axis tracking solar panel arrays, with larger row spacing than conventional fixed solar panel arrays. The increased distance between panel rows, combined with vegetation buffers, prevents any build-up of wind speed or density over the solar farm that could impact neighbouring properties. This also works to protect the solar farm infrastructure itself, which is a key consideration for FRV in its desire to preserve the performance and operating life of its asset.

ENVIRONMENTAL

Q How will you manage Hairy Panic & control weeds?

A Through community consultation, FRV have been made aware of Hairy Panic. This weed will be addressed in project development, construction and operational management stages with clear guidance on how to monitor and mitigate any issues related to Hairy Panic.

FRV have implemented a strict 'vehicle wash down procedure' for all contractors, visitors and surveyors who need to visit the site - a practise which will continue throughout the full lifecycle of the solar farm. In addition, FRV have asked local washdown facilities in Walla Walla and other locations to provide costings and details of their facilities to ensure the wash down and weed control is locally managed and local employment is supported.

During operations, a dedicated team member will be in charge of managing weeds within and around the solar farm which, when coupled with sheep grazing, will keep weeds to a minimum. FRV are also working with the landowners and local farming groups to ensure any land is sown with nitrogen rich plants such as clover and Lucerne to provide valuable food stock but that also assists with weed control.

Q Will my neighbouring livestock and crops be impacted by any 'heat island' effects?

A Around the world and within Australia, sheep graze **within** solar farms. Livestock and crops – including those proposed to be within the Walla Walla Solar Farm site during operations- will not be impacted as the design of the solar farm will ensure no significant build-up of heat at the site. Likewise, animals and crops on neighbouring properties will not be affected.

This is because the structure of the solar farm will not be thermally massive, i.e. there is no significant structure bulky enough to absorb and re-radiate an unsafe level of heat.

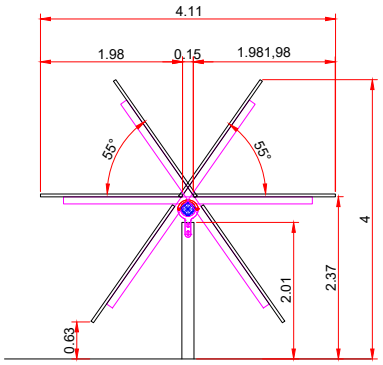
Walla Walla Solar Farm will also use single axis tracking technology, not 'fixed' panels, therefore avoiding 'trapping'

Sheep grazing at FRV's operational Lilyvale Solar Farm.

heat underneath. These solar panels are thin (< 4cm) so they do not retain heat over the long term. During the daytime, panels track the sun, moving through the positions shown right, from sunrise to sunset.

Spacing between rows will be between 8-14 metres. The tracking mount system will be programmed to store panels in stow position (i.e. facing up to the sky, approx. horizontal to the ground) at night for cooling. In the stow position panels are approx. 2 metres off the ground.

FRV will also install a meteorological station on the land to capture data of the specific site. Additionally, FRV will provide significant setbacks from the legal boundary and include vegetation screening where necessary.



Indicative profile view of a row of panels on tracking mount system. At night panels will be stowed in the horizontal position. (Dimensions in metres)

Q What is your flood analysis?

A Detailed hydrology is not a requirement during the initial planning process however FRV are being pro-active and have commissioned for this work to undertaken. This study is a site-specific in-depth analysis of the hydrology of the land and identifies flow rates and flooding depths using sophisticated LIDAR measurements taken by a Drone.

Based on this review of flood mapping, combined with the opinion of inhouse experts and information from local experience it is not considered that the site is subject to a level of flooding that would impact the project. Detailed design work will mitigate any risks associated with periods of flooding.

To ensure that the creek is able to flow freely during the unusual periods of flood FRV are installing flood gates within the solar farm fence which also assist the ingress and exit of water. These will be installed and importantly, maintained throughout the life of the solar farm. In addition, FRV intend to upgrade a section of the creek which currently inhibits water flow.

In addition, the large areas between rows of solar panels allow for normal ground absorption of rain fall and no additional run off is perceived.

During the construction phase careful attention will be paid to minimising run off from tracks and this will be conditioned by the DPIE under the Construction Management Plan.

Q Fog occurs in this area; has it been taken this into consideration?

A Seasonal weather changes including fog are considered when calculating the energy production over the life of the solar farm. We use climate data from the Bureau of meteorology, and also install our own weather stations to measure irradiance and collect other weather data throughout the year on the specific site.

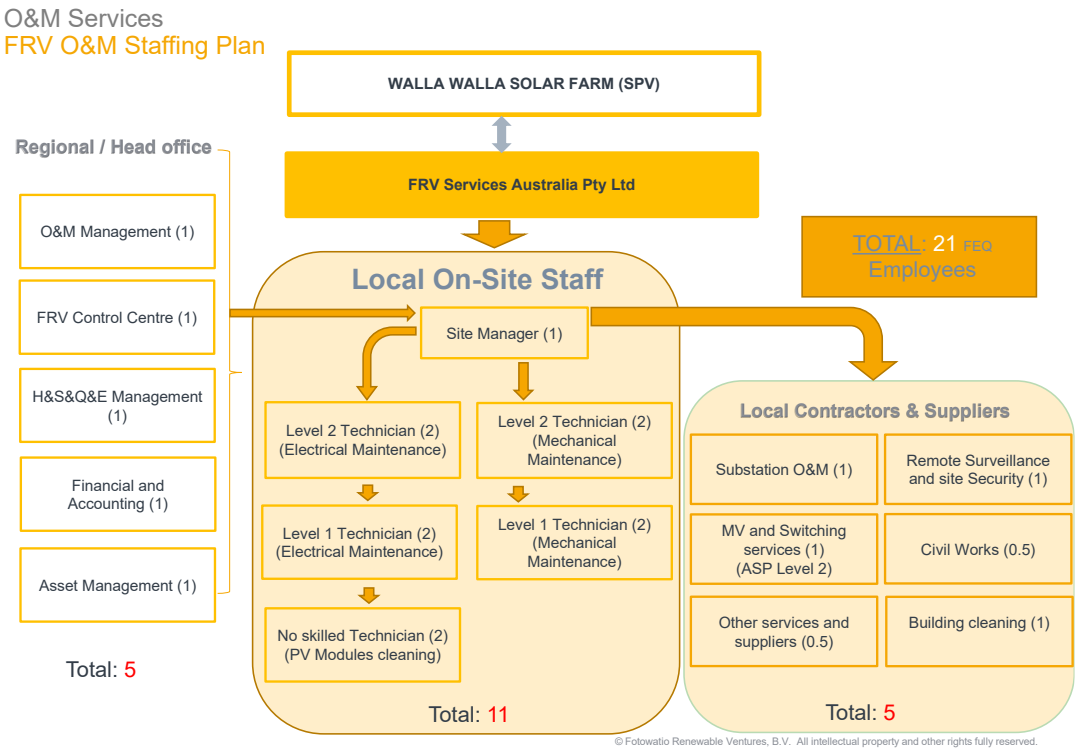
SOCIAL AND ECONOMIC

Q How many jobs will be available during construction of the Solar Farm?

A Employment opportunities will range from skilled to manual labour with jobs reaching 250 during the peak of construction. Utilising qualified local content is always key element for FRV when developing a project. FRV is keen to work with local service and product suppliers to simulate the local economy. We strongly encourage local individuals to put forward their interest in employment either for labouring or as a supplier via our website.

Q How many jobs will be available during operations of the Solar Farm?

A 21 jobs are likely to be required during the 30-year project. The jobs available will include the following:



Q With the exception of job creation, what other benefits will the community receive?

A As the solar farm will be operating for 30 years, FRV see ourselves as part of a community and are committed to giving back to the local community and will be working with local groups and organisations, to determine where funds can be best allocated to provide optimum benefit to the community. FRV is creating a list of potential community benefits to be contributed during the Construction and Operational lifetime of the the project.

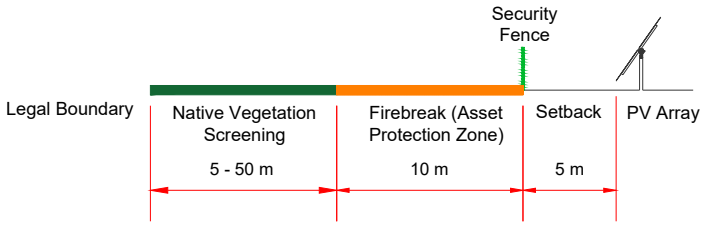
Q Will there be a contact onsite at all times in case of emergency?

A The plant is fully maintained throughout the life of the solar farm. There will be a 24/7 contact. An Operations Manager and other staff members will be based in close proximity to the solar farm. The Solar Farm will also be monitored 24/7 by remote CCTV.

Q How do you manage fire risk?

A Health and Safety is of the upmost importance for all FRV projects. FRV have solar farms operational not only across Australia but the world and are therefore highly experienced in implementing the management requirements of our projects and ensuring that our projects are designed correctly to mitigate any fire risks. Below is a simple illustration of the clear setbacks which are implemented from legal property boundaries to the positioning of the PV Array which includes a 10-metre Fire Protection Zone.

FRV will be putting forward detail of our management strategies in the Environmental Impact Statement.



Q What is a Power Purchase Agreement (PPA)?

A A power purchase agreement or a PPA is simply a contract to buy power. The contract will specify the price of which the power is bought and length of the contract. Sellers of these agreements are utility scale generators e.g. Solar and Wind Farms. Purchasers of these contracts have significant electricity requirements which allows them to purchase all or some of the output of a project. Examples of buyers include utilities, governments and major corporates. Examples of companies which have entered into PPAs across Australia include E.g. Telstra, Mars, Blue Scope Steel, Snowy Hydro, UNSW, Coles etc with many others considering this option.

SOLAR FARMS
FREQUENTLY ASKED QUESTIONS (FAQS)

Development Considerations

When determining the long-term feasibility of the proposed site of a solar farm's operations and management, the following is taken into consideration:

- Intensity and level of solar exposure;
- Proximity and direct connectivity to an existing power grid, such as transmission lines, sub-stations etc.;
- Access to an existing power grid and available capacity;
- Proximity to a road network;
- Level and uniformity of surface topography;
- Proximity to sensitive ecological, cultural or industrial sites;
- Proximity to township and urban areas;
- instability

What is the planning process when developing a solar farm?

1. Scoping Report – Secretary's Environmental Assessment Requirements (SEARs)
2. Environmental Impact Statement (EIS)
3. Public exhibition of the proposal
4. Response to submissions
5. Assessment
6. Decision, or determination (approval/refusal)
7. Post-approval (compliance reporting)

consent authority.

Is this a , and what does that mean for solar farms?

Developments due to their size, economic value or potential impacts.

Under the *Environmental Planning & Assessment Act 1979*, a solar

- has a capital investment value of more than $30 million; or
- has a capital investment value of more than $10 million and is in

Government: December, 2018)

Will the land be purchased or leased by the solar farm developer?

For most solar projects, the subject land is leased from the land owner for the entire project life-cycle, which is usually 25-30 years.

What will the solar farm look like, and how will it work?

Most solar farms are single-axis solar arrays, that track the sun in an east to west direction.

Direct current (DC) power is transferred from the solar arrays (photo voltaic/PV panels) to an inverter. The inverter changes the DC power to alternate current (AC) power, and it is then transferred to an electrical sub-station. Electricity is then distributed from the sub-station to the grid via local transmission lines.

How does the solar farm's life-cycle work, and what happens when it comes to an end?

A solar farm project has a planning, construction, operation and decommissioning stage.

For a medium to large solar development, construction can be between 9 and 18 months.

The operational life of panels is between 25 and 30 years.

At the end of its life-cycle, planning approval may be sought to extend , or decommission it.

Decommissioning involves the removal of all surface and most underground infrastructure, and rehabilitation of the footprint to the previous land use.

Who is responsible for management and maintenance of the solar farm, and how will this be guaranteed?

The developer/operator is legally bound to operate within these conditions, and is liable for all land management and operational aspects of the solar farm during the lease period.

The existing landowner may be engaged by the developer to continue land management practices on the developer's behalf.

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SOLAR FARMS
FREQUENTLY ASKED QUESTIONS (FAQS)

Environmental Considerations

Are solar farms allowed to be constructed on agricultural land?

Large scale solar projects are permissible and can be compatible with agricultural land use.

should be carefully considered when selecting a site for a large-scale solar project.

(from Large Scale Solar Energy Guideline for State Development (NSW Government: December 2018))

Are there harmful chemicals in the solar panels, or radiation emitted from the solar farm?

No. Most solar panels are constructed of glass (silicon), with common metals such as aluminium and copper wiring, and don't tend to contain heavy metals or other potentially toxic substances.

As few solar panels contain toxic chemicals, they pose little threat of site contamination.

The electromagnetic radiation produced from transformers and inverters is reduced through strict industry performance standards that apply to standard components.

How will the visual impact on neighbouring farms be managed?

Visual impact to neighbouring landholders will be assessed in a visual impact assessment (VIA) undertaken in the proposal phase of a solar project. The VIA considers visibility, distance, landscape character and viewer sensitivity, and the number of receivers proposed.

Once the outcomes of the VIA are known, possible mitigations can include:

- Screening of the solar farm, using vegetation barriers;
- Using the topography of the site to reduce visibility;
- Optimising the height, siting and layout of the panel arrays and related infrastructure; and/or
- Optimising the design of fencing and other security measures.

farm?

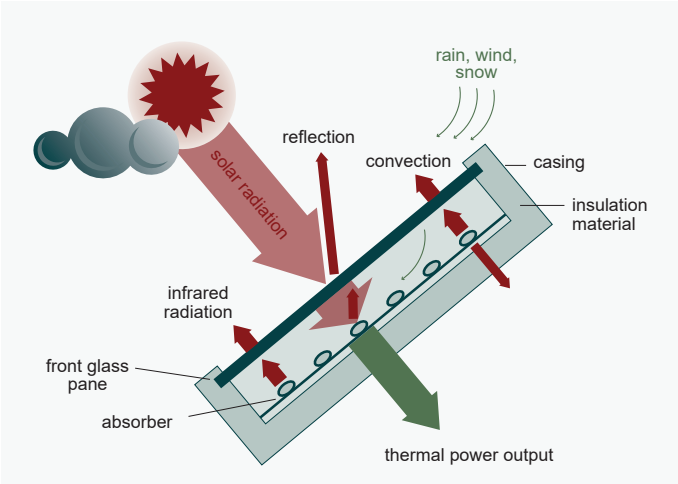
are constructed with dark-coloured materials, are covered with anti-

Typical solar

For single-axis tracking systems, there is an optimal panel tilt for solar radiation absorption (usually between 60 and 70%). This generally

operating conditions – for example, when the sun is at the lowest point,

(from Solar Photovoltaic Energy Facilities: Assessment of Potential for Impact on Aviation (Spaven Consulting: January 2011, and Solar Farm Planning Expert Witness Report (Guthrie: May 2018))



Basic structure and main components of the solar panel 'sun collector'. From Solar Thermal Technology Update (Matthias et al: 2010)

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SOLAR FARMS
FREQUENTLY ASKED QUESTIONS (FAQS)

Environmental Considerations

Will there be disturbing night lighting around the solar farm?

The main lighting related to the solar farm will be located around the

Lighting will comply with *Australian Standard 4282 – Control of Obtrusive Effects of Outdoor Lighting,* including:

- Eliminating upward light spill, directing light downwards and away from sensitive receivers;
-
- Use of asymmetric beams.

How much noise will be generated during construction and the operational stage?

Construction activities normally result in temporary and short duration increases in the noise and vibration levels at a site from earthworks, piling, site levelling, laying of concrete, installation of services etc.

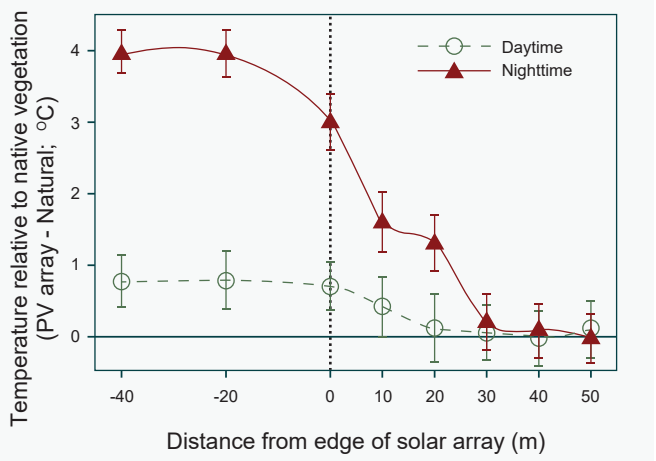
During operation, very low levels of noise are emitted from solar farms. These are usually not perceptible from adjacent land.

Noise-related management and compliance are undertaken in terms of industrial noise requirements, such as the *Australian Standard 2436 – Guide to Noise Control on Construction, Demolition and Maintenance Sites.*

Do solar farms create a 'photovoltaic heat island effect' (PHVI)?

Several studies have been completed for utility scale solar farms to determine the presence of PVHI. The following is considered important:

-
  noted in vegetation and moisture level;
- The degree of temperature change appears to be marginal, as well as spatially and temporally limited;
- PVHI effect was indistinguishable from air temperatures over native vegetation when measured at a distance of 30 metres from the edge of the photovoltaic array; and
- A dense vegetation buffer, from ground level to higher than the top of the highest point of the array, helps to mitigate potential PVHI effects.



(from Statement of Evidence on Solar Heat Islanding Issues (Barron-Gafford: May 2018))

What is the water use on solar farms, and how is this managed?

Solar farms use very little water.

During the construction stage, water will be used for dust suppression on and around the main transport routes around the site.

During operation, water will be used to wash the solar panels 1-2 times

.

Water will be accessed from the land's existing water use and delivery entitlements.

Do solar farms create changes to surface runoff?

The framing used to hold the solar arrays has a very small footprint, and so is unlikely to have an impact on surface runoff behaviour.

anything other than the pile is af

.

switch

room, storage shed) are built on concrete footings, usually 0.3 metres above ground level, on gravel or concrete hardstand areas. These areas are also unlikely to impact on surface runoff behaviour.

grazing – and who will be responsible?

The solar farm will be operated and managed in accordance with the needs of similar parcels of land in the surrounding landscape.

The developer will be responsible for implementation of a land management plan throughout the operational stage, which includes at least the following:

- Pest (fauna) control;
- W
- Maintenance of vegetation (eg. ecologically sensitive areas);
- Maintenance of access infrastructure (eg. fencing, roads, water resources);
-
- Waste management.

How will the solar farm's presence affect the value of the neighbouring land?

Due to the relatively new nature of solar farm development in Australia, the impact of the presence of solar farms on neighbouring land value is unclear.

Overseas studies have however indicated only limited impacts to land values.

(from Property Value Impact Assessment (Cohn Reznic: May, 2018))

Will insurance and public liability costs increase on neighbouring land due to the presence of the solar farm?

Two of the main factors affecting the cost of your insurance will be the type of business you run, along with the size of your business.

As with all forms of insurance, public liability is ultimately price based on the perceived risk of your business, and not that of adjacent land uses.

Like neighbouring landholders, the solar farm owners will be required to hold relevant insurance and public liability for the solar farm operations.

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SOLAR FARMS
FREQUENTLY ASKED QUESTIONS (FAQS)

Social Considerations

How will truck and other construction movements affect day-today community activities?

A T
solar farm development.

This plan will include (at a minimum):

- Pre-conditioning survey of relevant sections of the existing road network;
- Designated routes and vehicle access;
- T
- Procedures for informing the public where road access could be restricted;
- Periodic road improvements and land closures, as required;
- Carpooling/shuttle bus arrangements for site workers to minimise vehicle numbers;
- Scheduling of deliveries; and
-

How will dust from construction activities be managed?

Solar farm development will result in the removal of vegetation and possibly some reshaping of landscapes. This can create land disturbance, making soil vulnerable to erosion. Soil removed by erosion may become airborne as dust or be carried into waterways causing pollution.

Mitigations can include:

- Watering of unsealed roads during periods of heavy truck movement, as well as of temporary soil stockpiles and areas of cleared vegetation; and/or
- Planting of vegetation barrier (a dual visual mitigation function).

Will there be opportunities for employment, and what are the main job types that will be needed?

Yes, and the main employment opportunities will occur during the construction stage. During the operational stage, 1-3 full-time jobs will be available for solar farm management and maintenance.

The main job types will include:

- Landscape management;
- Fencing;
- Road maintenance/grading;
- Security;
- Electrical and mechanical engineering; and/or
- Hygiene site support.

Use of a local skilled workforce is preferred.

For people interested in possible work opportunities, they are encouraged to make direct contact with the project developer, should the project be approved.

Will the energy that is generated on the solar farm result in local electricity cost reductions?

No. The energy generated from the solar farm will connect into the State electricity network.

Electricity generated from the solar energy facility will be transported via high voltage transmission lines to large industrial energy users and to low voltage electricity distribution networks in each region, which deliver electricity to homes and businesses.

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A.5 PROJECT INFORMATION (AS AT 6 MAY 2019)

Proposed
WALLA WALLA SOLAR FARM
Benambra Road, Walla Walla - NSW

BISON ENERGY 株式会社

Project Information (as at 6 May 2019)

Project Background

Bison Energy proposes to develop a solar farm at the properties off Benambra Road at Walla Walla, New South Wales (NSW) (the project). The development site is approximately 4.3 km north-east of the town of Walla Walla and 9.2 km south-west of Culcairn. It is located within the Greater Hume Local Government Area (LGA).

The project involves the construction of a ground-mounted photovoltaic solar farm which would generate approximately 300 MW alternating current (AC) of renewable energy. The project would consist of the following components:

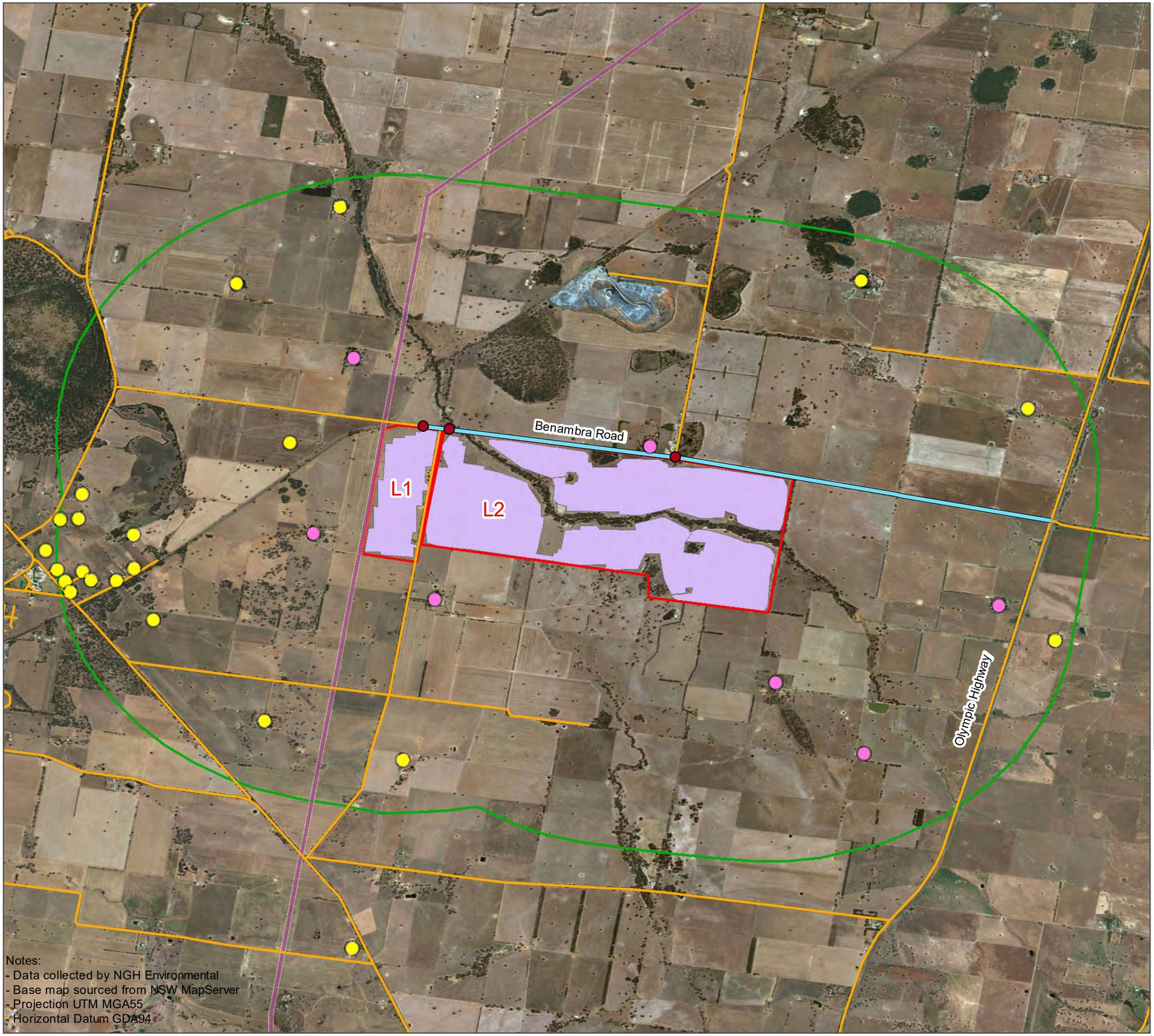
- Single-axis tracker photovoltaic solar panels mounted on steel frames (approximately 927,696 PV solar panels);
- Inverters, a transformer and electrical conduits;
- On site substation;
- Site office, site compound, vehicle parking areas, access tracks and perimeter fencing; and
- 330 kV electrical transmission line to connect the project to the existing transmission Jindera to Wagga Wagga line (located on the development site's western boundary).

At present, there is no intention to install a battery storage facility. The design is adaptable and would be refined to avoid adverse impacts where feasible, and to minimise/mitigate environmental impacts if avoidance is not possible.

The solar farm would occupy around 614 hectares of rural land currently used for primary production (cropping and grazing). The subject land is legally identified as Lots 16, 17, 20, 21, 87, 88, 89, 108, 109 118 of DP 753735, and Lot 1 DP 1069452. The land consists of large paddocks with predominantly exotic groundcovers. Back Creek runs through multiple Lots of DP 753735 and contains remnant native vegetation. Scattered trees are located primarily within Lots 20, 21, 88 and 109 of DP 753735, along the northern boundary of the development site along Benambra Road and more sparsely through the remainder of the site. Lot 1 DP 1069452 is currently undergoing subdivision, to create Lot 22, as the proponent only intends to lease part of this land. The western boundary of Lot 22 will be alongside the transmission line. The 30 m transmission line easement is excluded from the lease area. There are no building improvements on the site.

The construction phase of the project is expected to take 12 to 18 months, commencing in the second half of 2020, if approved. If commissioned, the solar farm is expected to operate for around 30 years. After the initial operating period, the solar farm would either be decommissioned, removing all above-ground infrastructure and returning the site to its existing agricultural land use, or upgraded with new PV equipment (as determined by regional planning needs at that time).

The capital investment value of the project is estimated at $330 million.



Notes:
- Data collected by NGH Environmental
- Base map sourced from NSW MapServer
- Projection UTM MGA55
- Horizontal Datum GDA94

Walla Walla Solar Farm

Community Consultation

BISON ENERGY 株式会社

- 3 km buffer
- Interested and affected parties
- Adjacent landholders
- Development site
- Development footprint
- TransGrid 330 kV transmission line
- 30 m transmission line easement
- Roads
- Transport Route
- Access Point

0 0.75 1.5 3

Kilometres

1:42,997

WALLA WALLA SOLAR FARM
Ref: 18-752
Author: B Poulton
Date: 12/03/2019

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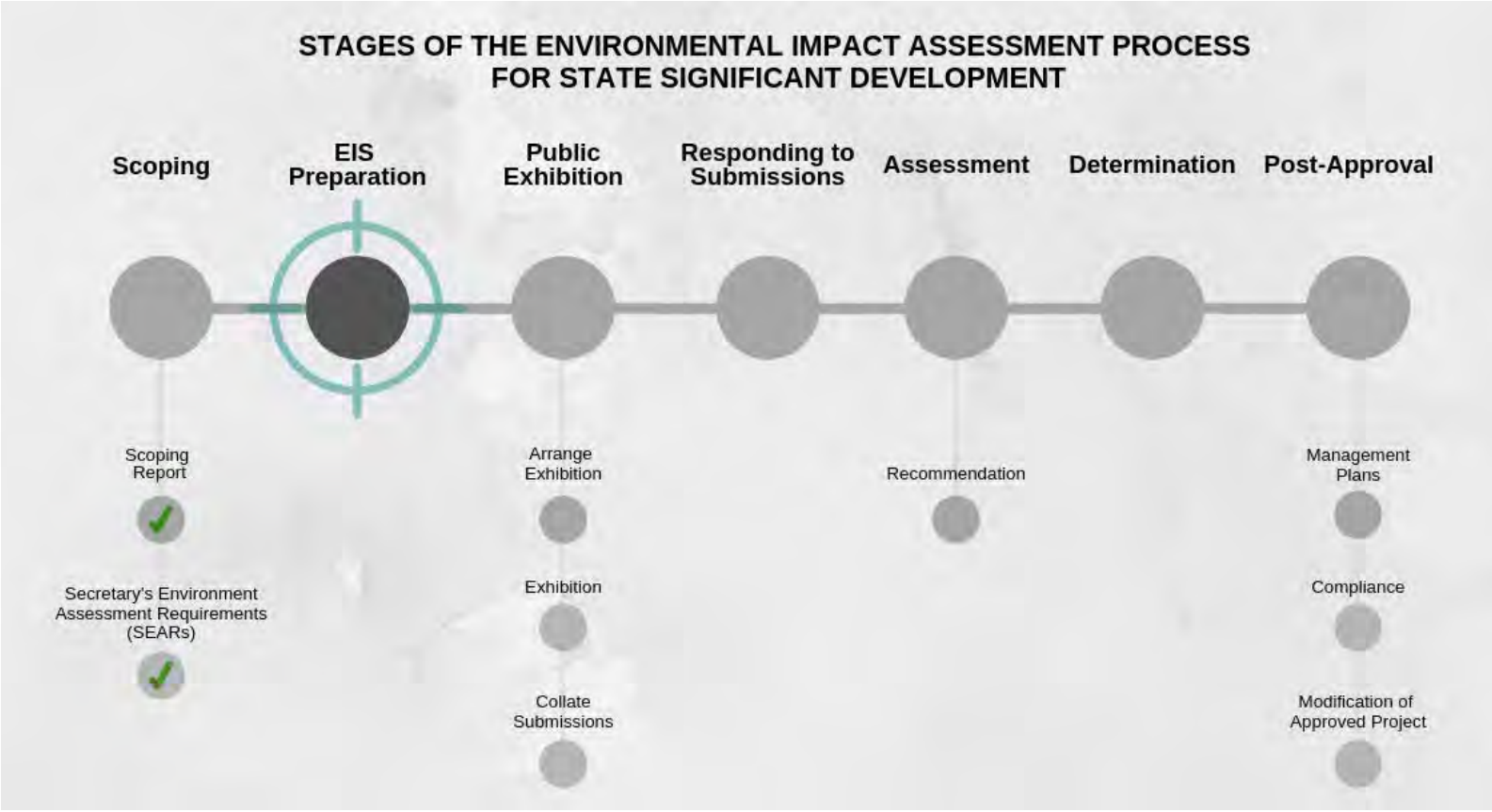
Environmental Planning Process

Being assessed as a Major Project under the NSW planning system, the project will be evaluated by the NSW Department of Planning and Environment (DPE). The first steps in that process have now occurred, including the submission of a Scoping Report and the receipt of Environmental Impact Statement (EIS) assessment guidelines (known as Secretary's Environmental Assessment Requirements (SEARs) – dated, 7 March 2019).



The conditions provided in the SEARs are now being addressed as part of the EIS preparation, in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The EIS will include a full description of the development, including details of construction, operation and decommissioning, as well as analysis of possible impacts on neighbouring residences and businesses. It will also reflect community feedback as well as technical studies which are currently underway to gain a better understanding of the development site and identify suitable mitigations where required.

The EIS is expected to be released for public exhibition in August/September 2019. This will be in an electronically accessible format via the DPE's Major Projects website (https://www.planningportal.nsw.gov.au/major-projects/project/9931), as well as a hard copy in a local public building. The exhibition period is typically 30 days; and community submissions on the EIS are welcomed.

Project Update

ENVIRONMENTAL CONSIDERATIONS

A preliminary environmental risk assessment was conducted as part of the Scoping stage to assist in the identification of key environmental matters that required detailed assessment within the EIS. Additional studies identified – as part on ongoing community, Council and Regulator engagement are in varying stages of completion.

The following summarises the key environment-related specialist studies, their current status (as at end-April 2019) and key focus areas of the studies.

Special study	Status	Key focus area
Soil survey	Complete (April)	**Considers** fertility and land capability of subject land. **Informs** erosion control recommendations.
Flood study	In progress (June/July)	**Includes** flood condition modelling and resultant impact assessment of the development on local surface water flow conditions. **Informs** final infrastructure layout design, water-induced erosion controls and mitigation measures for natural drainage lines.
Biodiversity development assessment report (BDAR)	In progress (June/July)	**Identifies** threatened ecological communities and/or species listed under State or Commonwealth legislation. **Provides** mitigation and management controls to minimise impacts, where required. Impacts on biodiversity inform off-set requirements.
Visual impact assessment	In progress (June/July)	**Assesses** visibility of the solar farm from neighbouring residential dwellings, businesses and public access sites (i.e. roads.). **Informs** development of the landscape plan, usually required prior to construction. Includes recommendations to minimise identified visual impacts, such as vegetation barriers, and is required to be developed in consultation with local community members.
Aboriginal heritage survey	In progress (May)	**Identifies** presence and cultural importance of heritage-related artefacts. **Informs** which artefacts would need to be removed and replaced at an unimpacted part of the subject land or avoided by adjusting infrastructure layout of the solar farm.
Post-colonial heritage assessment	Complete (March)	**Identifies** registered non-Aboriginal related heritage sites, as listed on the Greater Hume Council Local Environmental Plan, NSW heritage register and/or Australian Government register. **Informs** conceptualisation of mitigation measures to avoid, remove or replace these sites if required.
Noise and vibration assessment	In progress (June/July)	**Involves** noise and vibration modelling to predict possible impacts on residential dwellings in proximity to the solar farm. **Provides** mitigation measures and management controls to minimise any identified impacts.
Traffic impact assessment	In progress (May)	**Identifies** and quantifies impacts of construction and operation traffic on current traffic volumes in and around the development site. **Provides** recommendations on the most suitable access points for the site and any need to upgrade road or intersections, in consultation with Greater Hume Council (used to inform the Traffic Management Plan, which is usually required prior to construction).
Hazards assessment	In progress (June/July)	**Assesses** other possible environmental-related hazards such as fire, chemicals, electric and magnetic fields, etc. **Informs** development of suitable mitigation measures for these hazards, if identified.

COMMUNITY CONSIDERATIONS

Engagement with those community members residing directly adjacent to the subject land was initiated in January 2019, via introductory telephone calls. Once the SEARs were issued in March 2019, the project team spent time to meet one-on-one with these and other residents located within a 3 km radius of the project. Where residents were not home, introductory flyers were distributed. Meetings were also held with the Greater Hume Council. The purpose of these face-to-face discussions was to formally introduce the project to community members and identify areas for additional assessment as part of the EIS stage.

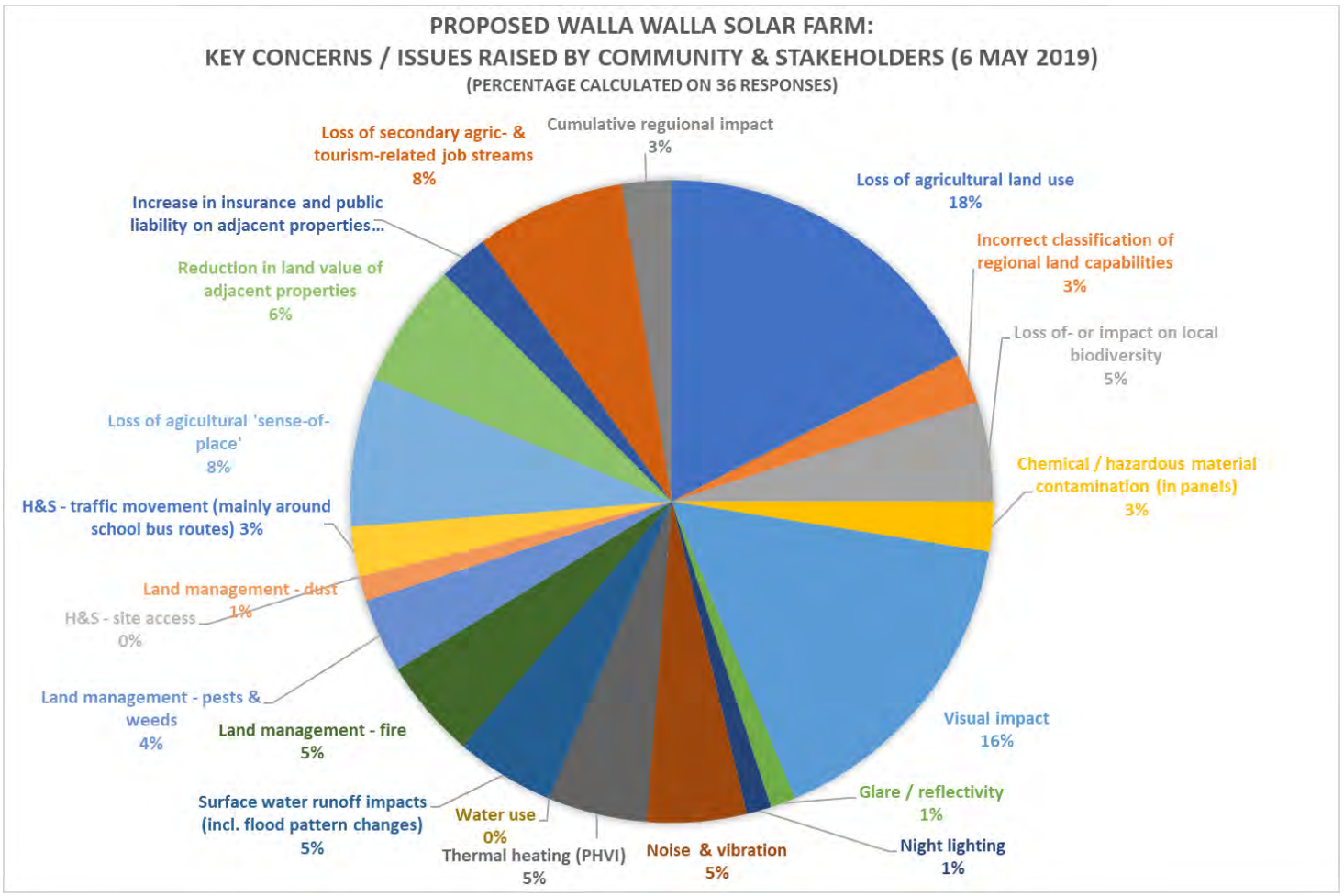
Valuable feedback was generated from this first round of engagement, which is considered key to ensure the project's design incorporates the needs of the local community where practical. Conversation topics centred largely on visual amenity, reflection, glint and glare, noise, dust and traffic, property values as well as project impacts on agricultural land, soil, flooding, the benefits to the climate, local economy, employment and other contributions.

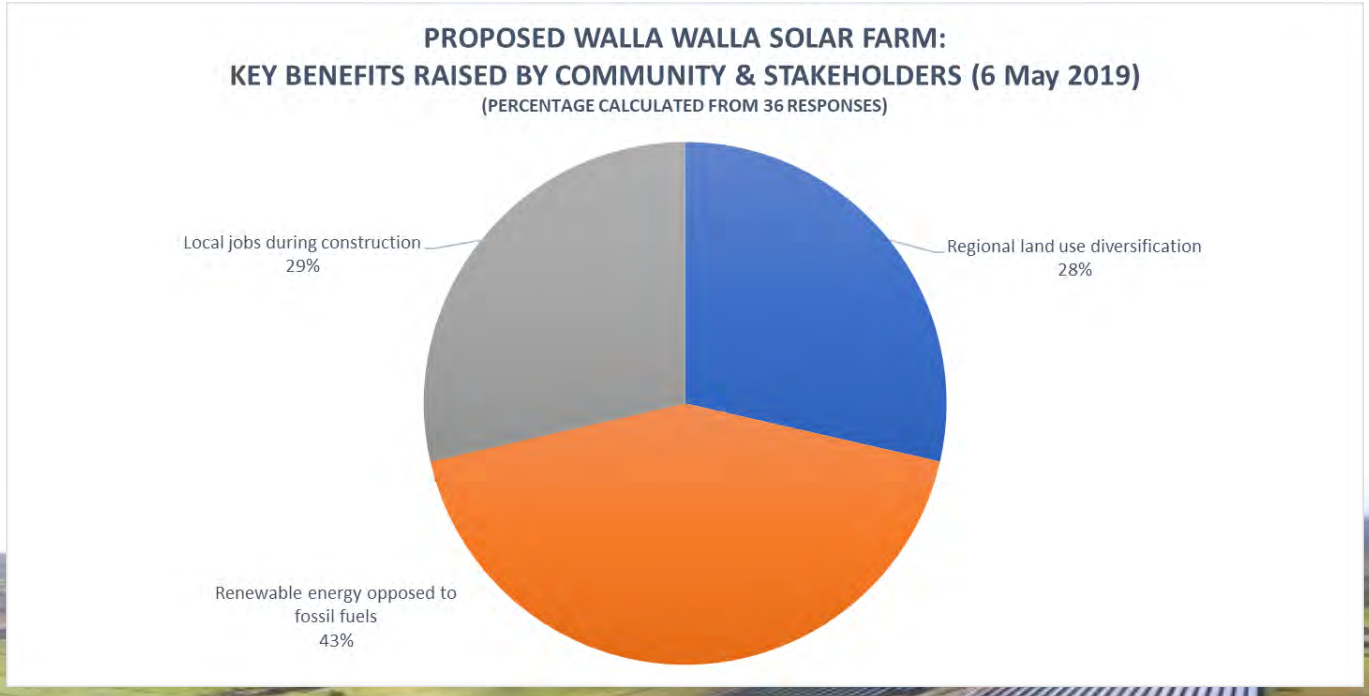
Since the one-on-one engagement, numerous e-mail and telephone discussions have also been received by the project team from members of the public. Community Feedback Forms have also been received via the project website. The two pie charts provided on the next page summarise: 1) key concerns and issues raised, and 2) key benefits identified for the project. Both pie charts have been compiled based on 36 responses received to date, as gathered through the various mechanisms for community feedback (as at 6 May 2019).

This Community Information Open Day (no. 1) is the next step in raising project awareness to a wider community audience.

A second Open Day will be held, once all specialist studies have been completed. The objective of this session will be to provide feedback to interested and affected parties on the identified, consolidated impacts and proposed mitigations, prior to submission of the EIS to DPE. As part of the EIS submission, a Community and Stakeholder Engagement Plan (CSEP) will be compiled. This CSEP will document the engagement process followed for the project, a list of registered interested and affected parties, specific concerns and queries raised and how these concerns and queries have been addressed as part of the EIS.

Bison Energy continues to welcome further feedback, as the project progresses. Importantly, should the project be approved, conditions of approval usually include the need for detailed environmental management plans to be compiled prior to construction. This includes plans around landscaping, traffic management, water management, dust and erosion control etc. Feedback received during community engagement for the project will inform the content of these environmental management plans, and nearby residents will have a further opportunity to contribute to these as they are developed.


PROPOSED WALLA WALLA SOLAR FARM:
KEY CONCERNS / ISSUES RAISED BY COMMUNITY & STAKEHOLDERS (6 MAY 2019)
(PERCENTAGE CALCULATED ON 36 RESPONSES)
Loss of secondary agric- & tourism-related job streams 8%
Cumulative reguional impact 3%
Loss of agricultural land use 18%
Increase in insurance and public liability on adjacent properties...
Incorrect classification of regional land capabilities 3%
Reduction in land value of adjacent properties 6%
Loss of- or impact on local biodiversity 5%
Loss of agicultural 'sense-of-place' 8%
Chemical / hazardous material contamination (in panels) 3%
H&S - traffic movement (mainly around school bus routes) 3%
Land management - dust 1%
H&S - site access 0%
Land management - pests & weeds 4%
Land management - fire 5%
Visual impact 16%
Glare / reflectivity 1%
Surface water runoff impacts (incl. flood pattern changes) 5%
Water use 0%
Thermal heating (PHVI) 5%
Noise & vibration 5%
Night lighting 1%


PROPOSED WALLA WALLA SOLAR FARM:
KEY BENEFITS RAISED BY COMMUNITY & STAKEHOLDERS (6 May 2019)
(PERCENTAGE CALCULATED FROM 36 RESPONSES)
Local jobs during construction 29%
Regional land use diversification 28%
Renewable energy opposed to fossil fuels 43%

About Bison Energy

Bison Energy is a professional solar farm developer established in Melbourne in 2017. Bison Energy's focus is on renewable energy power generation and, more specifically, solar projects. The company identifies sites, negotiates land arrangements, and network connection and arranges all key commercial contracts including construction, Power Purchase Agreements (PPAs), financing and investments. The company currently has approximately 600 MW of solar farm projects under development in Australia, across NSW and Victoria.

In addition to solar energy, Bison Energy has also expanded into biomass with 50 MW in preliminary development in Japan.

Stay Informed

COMMUNITY ENGAGEMENT

The project team will continue working with the community to answer questions, understand concerns and provide information as requested. Please contact us using the details provided to find out more. We also encourage you to sign up to our mailing list for you to always stay informed about the project: community@wallawallasolarfarm.com.au / www.wallawallasolarfarm.com.au .

CONTRACTOR SERVICES

Since initiating community engagement, several Walla Walla residents and local contractors have indicated their interest to be a supplier to the project, should it be approved. Bison Energy encourages local business with relevant skills to register their interest: community@wallawallasolarfarm.com.au / www.wallawallasolarfarm.com.au .

A.6 WALLA WALLA SOLAR FARM 'QUICK ANSWERS'

Proposed
WALLA WALLA SOLAR FARM
Benambra Road, Walla Walla - NSW 2659

QUICK ANSWERS

For more information, please visit:
www.wallawallasolarfarm.com.au
e-mail: community@wallawallasolarfarm.com.au
call: 02 6971 9696

Will the solar farm land be owned by Bison Energy?

No.
Bison Energy will lease the land from the current landowners. This will be for the solar farm's entire life-cycle of 25 - 30 years.

Are there opportunities for your town?

Yes!
If your school, club or group has ideas on how you can benefit, please send us a submission. We need your suggestions to ensure the solar farm adds ongoing value to your town. Tradespersons who would like to work on the solar farm should send through your details.

Is it true neighbours can't farm within 500m of a solar farm?

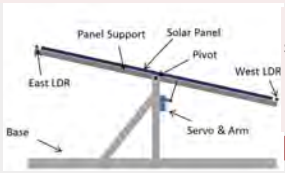
No.
Solar farm operators cannot enforce restrictive covenants on neighbouring properties. If a solar farm wanted a 500m buffer, this would need to be included within their own project boundaries.

Can solar farms co-exist with agricultural farms?

Yes.
Existing solar farms in Australia, including NSW and around the world, co-exist with rural farmland. As part of active land management, the proposed Walla Walla Solar Farm land will still be grazed by sheep, beneath the panels - so, the land will continue to be productive agriculturally, whilst adding further regional value via its renewable energy generation.

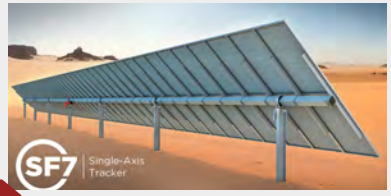
What will the solar panels & inverters look like?

Each panel is 2 x 1 m; they are placed in pairs along their narrow edge. When the panels are parallel to the ground (flat), they are 1.6 m above the ground. When they are perpendicular to the ground, they are 4 m above ground at the highest point. There will be 60 containers, each containing 2 inverters , for capture of the energy generated from the panels.



There will also be a substation to connect the inverters to the existing TransGrid transmission line.

See orange square on map for indicative substation location




Example of the inverters, within the containers

Will the roads be sealed / gravel?

Both.
Benambra Road, from the Olympic Highway to Weeamera Road, is already sealed. Benambra Road, west of Weeamera Road to Scheiders Road, is currently gravel – this portion of road will be sealed, should it be requested by Council as part of the proposal approval.

See purple circles on map for proposed solar farm access locations

How long is the construction period?

12 to 18 months.
Peak construction activities will be 4 to 8 months of this period. Construction activities will be Monday to Friday (7am to 6pm) and Saturday (8am to 1pm). If the proposal is approved, construction could commence mid-2020.

What happens to the solar farm when it reaches its end-of-life?

It will be decommissioned, removed and the land rehabilitated to an agricultural land use.
This will be the responsibility of the operating company, working in conjunction with, and to the satisfaction of the landowner. The value to decommission and rehabilitate the site is included in the project's upfront economic modelling.

Can the solar farm operate in extreme heat or in fog?

Yes.
Although solar panels operate optimally within a specific temperature and solar radiation range, they can also generate energy in 'extreme' weather conditions. Fluctuations in energy generation due to changing weather conditions are built into the solar farm's economic modelling.

Will there be a visual impact for neighbouring landowners?

In the short-term.
Planting vegetation barrier/screening around portions of the solar farm boundary has already been committed to by Bison Energy to minimise any visual impact to neighbouring residential landowners.

See light green lines on the map for indicative barrier/screening locations

Will trees be removed from the land ?

Yes.
57 isolated paddock trees as well as trees within 15 ha of Grey Box Woodland have been identified for removal, as part of a site-specific biodiversity assessment.
Bison Energy will need to provide funds to the Biodiversity Conservation Trust to manage the offset for vegetation removal.

See light green triangles (paddock trees) and orange (Grey Box Woodland) on the map

Does a solar farm create a micro-climate?

Yes, but only within the boundaries of the solar farm.
A 'heat island effect' can be created in the immediate area but it becomes negligible within 30 m from the solar farm boundary. The vegetation barrier will mitigate this effect on surrounding properties.

Will there be weed & pest control?

Yes.
We will work in partnership with the landowner who will spray, graze and undertake pest control - the same as current management.

Will the solar infrastructure be affected by, or influence, seasonal floods?

No.
The shape of the land beneath solar infrastructure routing surface water flows will not be altered. Groundcover would largely be retained, as would ten (of 16) existing farm dams. As there will be no alteration of existing landform or surface runoff conditions for the solar farm development, neighbouring properties will experience the same surface flow conditions as at present.

Will the solar farm have any toxicity or radiation effects?

No.
Crystalline silicon solar panels are made from silicon, glass, copper and aluminum - none of these are toxic in their design form, even if they are exposed to extreme heat such as a fire. All components of the solar farm will be made according to strict radiation-related industrial standards.

Will existing surface water infrastructure be removed?

Yes.
6 of the existing 16 farms dams will be removed. The effect of their removal has been included in the site's flood assessment report, which indicates that their removal will not impact on surface flows within the 1 in 20-year flood event.

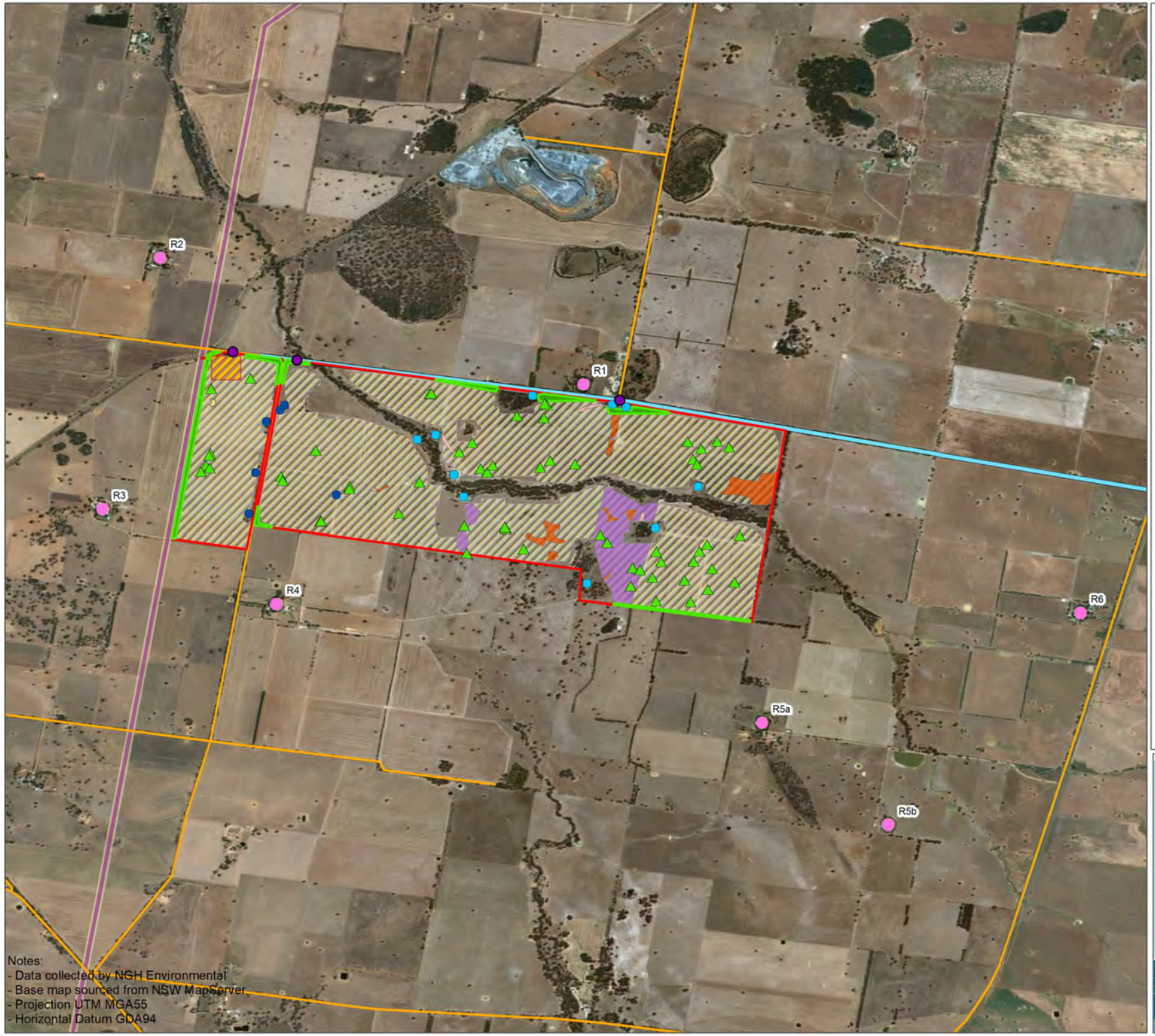
See dark blue circles on map for 6 dams to be removed. Light blue circles are dams to be retained

Will development be located in Back Creek?

No.
All natural surface water resources including the vegetation lining Back Creek have been excluded from infrastructure development to retain the integrity of the creek and other water resources.

Are there measures in place to manage bush fire?

Yes.
The site includes a 10 m asset protection zone (fire break) around the entire perimeter of the farm. There will also be a Bushfire Management Plan for the solar farm.



- Dams for Removal
- Dams for Retention
- Paddock Trees Impacted
- Adjoining Landholders
- Access Point
- Development Site
- Indicative Development Footprint
- Proposed Vegetation Screening
- Compound
- 30 m Transmission Line Easement
- TransGrid 330 kV Transmission Line
- Roads
- Transport Route

Native Vegetation Impacted

- PCT 277: Blakley's Red Gum Yellow Box Woodland
- PCT 76: Grey Box Woodland
- PCT 76: Grey Box Woodland - Derived Grassland
- PCT 5: River Red Gum Forest Wetland

0 0.5 1 2

Kilometres

1:30,000

WALLA WALLA SOLAR FARM
Ref: 18-622
Author: B Poulton
Date: 28/05/2019

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Notes:
- Data collected by NGH Environmental
- Base map sourced from NSW MapServer
- Projection UTM MGA55
- Horizontal Datum GDA94

A.7 EIS SUBMISSION PAMPHLET (AUGUST 2019)

Powering a Sustainable Future

WALLA WALLA SOLAR FARM
PROJECT UPDATE

29 July 2019

NEW PROJECT DEVELOPER

New owners have been announced for the proposed 300 megawatt (MW) Walla Walla Solar Farm, near Walla Walla. Bison Energy has transferred ownership of the proposed project to FRV Services Australia (FRV).

ROYALLA SOLAR FARM,
near Canberra, NSW.
Operating since August 2014

FRV has been active in Australia since 2010 and has a track record of developing solar farms in Australian regional areas. In its nine years in Australia, FRV has developed several successful solar projects across VIC, NSW and QLD.

FRV is committed to engaging with all stakeholders that have interest in or may be impacted by the Walla Walla solar project.

MOREE SOLAR FARM,
Moree, NSW.
Operational since 2016

WHAT ELSE IS CHANGING?

The transfer of ownership of the Walla Walla Solar Farm to FRV is the only change to the project parameters at this stage. FRV will progress development plans, strengthen community engagement and will eventually look to lodge an Environmental Impact Statement.

CLARE SOLAR FARM,
Clare, QLD.
Operational since 2017

WHAT ARE THE NEXT STEPS?

FRV will advise on intended timing for progressing with development approvals for the Walla Walla Solar Farm shortly.

LILYVALE SOLAR FARM,
NW of Emerald, QLD.
Operational since 2019

WHO CAN YOU SPEAK TO?

To speak with the
FRV Project Development Manager, Cliona Gormley
please call 0404 061 903
or 0418 142 173

Walla Walla Solar Farm is in *early stages* of development and has potential to contribute both economically & environmentally to the region as well as the State.

APPENDIX B INFORMATION SESSION NO. 1 INFORMATION

B.1 INFORMATION SESSION NO. 1 ATTENDANCE REGISTER

(CONFIDENTIAL)

B.2 INFORMATION SESSION NO. 1 INVITATION

26 March 2019

BISON ENERGY COMPANY

ngh environmental

PROPOSED DEVELOPMENT

WALLA WALLA SOLAR FARM

Benambra Road, Walla Walla - NSW

INVITATION

COMMUNITY INFORMATION OPEN DAY NO. 1

A Community Information Open Day
will be held for Interested and Affected Parties (I&APs)
about the proposed Walla Walla Solar Farm.

The project developer and environmental team
assisting with the planning approval process
will be available to discuss and capture
any queries or comments you may have.

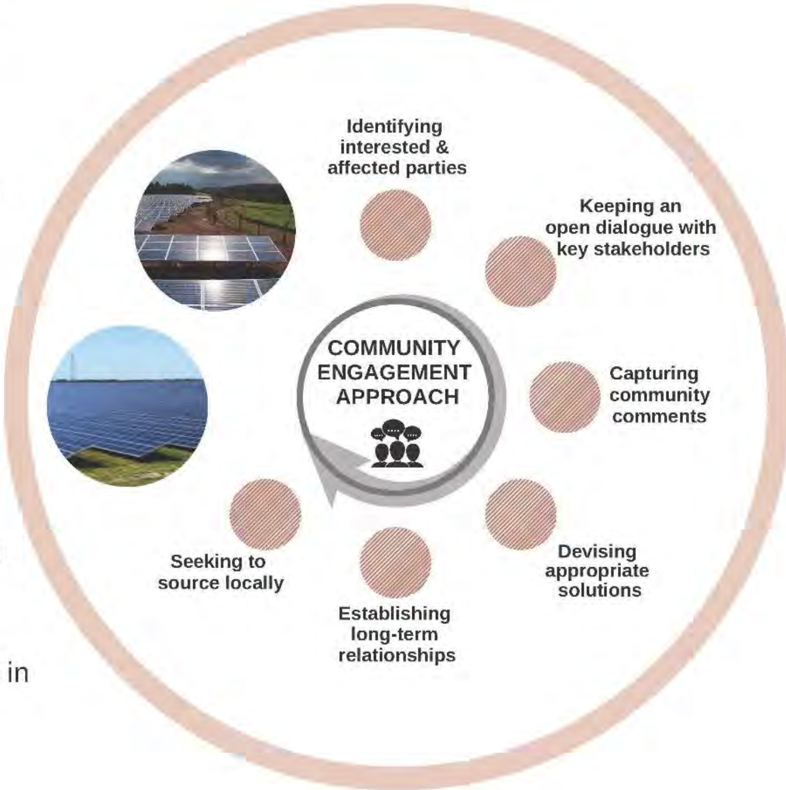
Date: Tuesday, 7 May 2019

Place: Culcairn Bowling Club
Albury Road, Culcairn NSW 2660

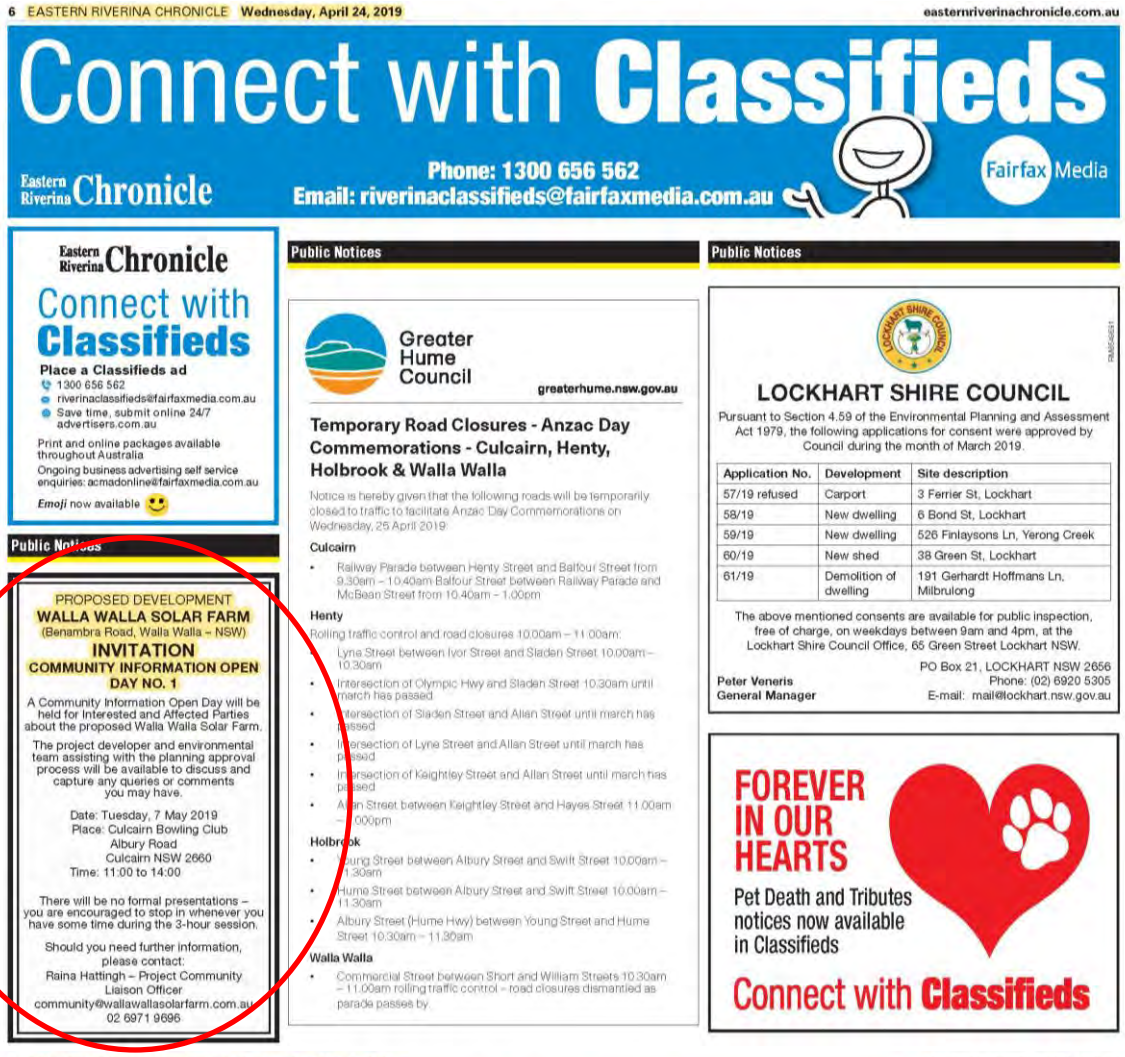
Time: 11:00 to 14:00

There will be no formal presentations - you are encouraged to stop in whenever you have some time during the 3-hour session.

Should you need further information, please contact:
Raina Hattingh - Project Community Liaison Officer
community@wallawallasolarfarm.com.au / 0488 448 023



B.3 INFORMATION SESSION NO. 1 EASTERN RIVERINA CHRONICLE ADVERTISEMENT



6 EASTERN RIVERINA CHRONICLE Wednesday, April 24, 2019 easternriverinachronicle.com.au

Connect with Classifieds

Eastern Riverina Chronicle

Phone: 1300 656 562
Email: riverinaclassifieds@fairfaxmedia.com.au

Fairfax Media

Eastern Riverina Chronicle
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Emoji now available

Public Notices

PROPOSED DEVELOPMENT
WALLA WALLA SOLAR FARM
(Benambra Road, Walla Walla – NSW)
INVITATION
COMMUNITY INFORMATION OPEN DAY NO. 1

A Community Information Open Day will be held for Interested and Affected Parties about the proposed Walla Walla Solar Farm.

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Albury Road
Culcairn NSW 2660
Time: 11:00 to 14:00

There will be no formal presentations – you are encouraged to stop in whenever you have some time during the 3-hour session.

Should you need further information, please contact:
Raina Hattingh – Project Community Liaison Officer
community@wallawallasolarfarm.com.au
02 6971 9696

Public Notices

Greater Hume Council
greaterhume.nsw.gov.au

Temporary Road Closures - Anzac Day Commemorations - Culcairn, Henty, Holbrook & Walla Walla

Notice is hereby given that the following roads will be temporarily closed to traffic to facilitate Anzac Day Commemorations on Wednesday, 25 April 2019:

Culcairn
- Railway Parade between Henty Street and Balfour Street from 9.30am – 10.40am Balfour Street between Railway Parade and McBean Street from 10.40am – 1.00pm

Henty
Rolling traffic control and road closures 10.00am – 11.00am:
- Lyne Street between Ivor Street and Sladen Street 10.00am – 10.30am
- Intersection of Olympic Hwy and Sladen Street 10.30am until march has passed
- Intersection of Sladen Street and Allan Street until march has passed
- Intersection of Lyne Street and Allan Street until march has passed
- Intersection of Keightley Street and Allan Street until march has passed
- Allan Street between Keightley Street and Hayes Street 11.00am – 1.00pm

Holbrook
- Young Street between Albury Street and Swift Street 10.00am – 11.30am
- Hume Street between Albury Street and Swift Street 10.00am – 11.30am
- Albury Street (Hume Hwy) between Young Street and Hume Street 10.30am – 11.30am

Walla Walla
- Commercial Street between Short and William Streets 10.30am – 11.00am rolling traffic control – road closures dismantled as parade passes by

Public Notices

LOCKHART SHIRE COUNCIL

Pursuant to Section 4.59 of the Environmental Planning and Assessment Act 1979, the following applications for consent were approved by Council during the month of March 2019.

Application No.	Development	Site description
57/19 refused	Carport	3 Ferrier St, Lockhart
58/19	New dwelling	6 Bond St, Lockhart
59/19	New dwelling	526 Finlaysons Ln, Yerong Creek
60/19	New shed	38 Green St, Lockhart
61/19	Demolition of dwelling	191 Gerhardt Hoffmans Ln, Milbrulong

The above mentioned consents are available for public inspection, free of charge, on weekdays between 9am and 4pm, at the Lockhart Shire Council Office, 65 Green Street Lockhart NSW.

Peter Veneris
General Manager

PO Box 21, LOCKHART NSW 2656
Phone: (02) 6920 5305
E-mail: mail@lockhart.nsw.gov.au

FOREVER IN OUR HEARTS
Pet Death and Tributes notices now available in Classifieds
Connect with Classifieds

6 EASTERN RIVERINA CHRONICLE Wednesday, May 1, 2019 easternriverinachronicle.com.au

Connect with Classifieds

Eastern Riverina Chronicle

Phone: 1300 656 562
Email: riverinaclassifieds@fairfaxmedia.com.au

Fairfax Media

Eastern Riverina Chronicle
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Place a Classifieds ad
1300 656 562
riverinaclassifieds@fairfaxmedia.com.au
Save time, submit online 24/7 advertisers.com.au
Print and online packages available throughout Australia
Ongoing business advertising self service enquiries: acmadonline@fairfaxmedia.com.au
Emoji now available

FOREVER IN OUR HEARTS
Pet Death and Tributes notices now available in Classifieds
Connect with Classifieds

Public Notices

NSW GOVERNMENT
Local Land Services

Office Closure – Albury & Corowa offices

Please note that all offices of Murray Local Land Services will be closed on **Wednesday, 8 May, 2019** to enable organisation development: to be conducted. Offices to be closed include:

Garland Avenue, Albury
Short Street, Corowa

All offices will reopen from 8.30 am on Thursday, 9 May, 2019.

For *Emergency Animal Disease* matters please call *1800 675 888*.

Gary Rodda
General Manager

Any enquiries should be directed to Colin McMahon on 0428 266 730.

Public Notices

PROPOSED DEVELOPMENT
WALLA WALLA SOLAR FARM
(Benambra Road, Walla Walla – NSW)
INVITATION
COMMUNITY INFORMATION OPEN DAY NO. 1

A Community Information Open Day will be held for Interested and Affected Parties about the proposed Walla Walla Solar Farm.

The project developer and environmental team assisting with the planning approval process will be available to discuss and capture any queries or comments you may have.

Date: Tuesday, 7 May 2019
Place: Culcairn Bowling Club
Albury Road
Culcairn NSW 2660
Time: 11:00 to 14:00

There will be no formal presentations – you are encouraged to stop in whenever you have some time during the 3-hour session.

Should you need further information, please contact:
Raina Hattingh – Project Community Liaison Officer
community@wallawallasolarfarm.com.au
02 6971 9696

SAVE TIME, SUBMIT ONLINE

By placing your classified ad through our self-service portal, advertisers.com.au

- Submit your ad at any time of the day
- Access the portal from anywhere in Australia
- Place an ad into newspaper, website and mobile with three easy steps

Connect with Classifieds

Fairfax Media

APPENDIX C INFROMATION SESSION NO. 2 INFORMATION

C.1 NO. 2 ATTENDANCE REGISTER

C.2 INFORMATION SESSION NO. 2 PRESENTATION

C.3 INFORMATION SESSION NO. 2 INVITATION

BISON ENERGY COMPANY

ngh environmental

PROPOSED DEVELOPMENT

WALLA WALLA SOLAR FARM

Benambra Road, Walla Walla - NSW

INVITATION

COMMUNITY INFORMATION OPEN DAY NO. 2

Please join the Bison Energy team for a project update on the proposed Walla Walla Solar Farm.

This session will provide a project update based on the queries raised during the first Open Day (7 May 2019), as part of ongoing community engagement. It will also provide the outcomes of the independent specialist studies completed to date.

There will be a formal presentation from 18:00 to 19:00 Thereafter, the project team will be available to answer any further queries you may have.

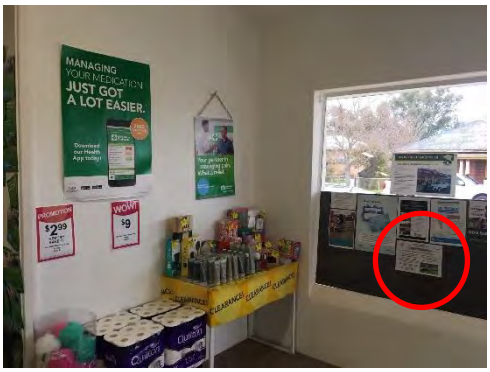
Should you need further information, please contact:
Raina Hattingh - Project Community Liaison Officer
02 6971 9696 / community@wallawallasolarfarm.com.au
www.wallawallasolarfarm.com.au

Date: Tuesday, 9 July 2019

Place: Walla Walla Bowling Club
111 Commercial Street,
Walla Walla NSW 2659

Time: 18:00 to 20:00

Walla Walla locations



Culcairn locations

C.4 INFORMATION SESSION NO. 2 BORDER MAIL ADVERTISEMENT

74 THE BORDER MAIL Saturday, June 22, 2019 bordermail.com.au

The Border Mail — Connect with Classifieds — Phone: 1300 655 666 Email: lineadverts@bordermail.com.au — Fairfax Media

Development Applications

Development Proposals — Albury City

The following development proposals are now on exhibition:

App. No.	Proposal	Address
10.2019.36886.1	Covered Alfresco Area & Pergola	368 East Street EAST ALBURY
10.2019.36888.1	Elevated Covered Deck, Spa, Demolition of Garage & Patio	704 Morningside Place ALBURY
10.2019.36891.1	Front and Side Boundary Fence & Demolition of Existing Fence	358 Tribune Street ALBURY
10.2019.36892.1	Residence & Garage	92 Strand Terrace ETTAMOGAH
10.2019.36893.1	Residence, Garage, Colorbond Shed & Tree Removal	11 Litchfield Drive THURGOONA
10.2019.36890.1	Colorbond Shed	21 Dibbler Street THURGOONA

Exhibition for the above closes 3 July 2019

10.2019.36885.1	Alterations & Additions to Residence, Outbuildings & Alteration to Front Fence	669 Holmwood Cross ALBURY

Exhibition for the above closes 10 July 2019

10.2019.36889.1	Three Storey Commercial Premise & Demolition of Existing Structures	572 Kiewa Street ALBURY
10.2019.36889.1	Planning Agreement for Car Parking Contribution	572 Kiewa Street ALBURY

Exhibition for the above closes 24 July 2019

You can view these online via 'DA Tracker' or at 553 Kiewa Street, Albury. Submissions can be made online via 'DA Tracker' or in writing to info@alburycity.nsw.gov.au or 553 Kiewa St, Albury during the exhibition period.

alburycity.nsw.gov.au/datracker

Tenders

Joss Construction

Subcontractors & suppliers are invited to submit quotations for the following tender:

Moama Multipurpose Sports Pavilion

Closes COB 5 July 2019

Enquires Ph (02) 6051 1900 Fax (02) 6021 7054

E: estimating@jjossgroup.com.au

Tender documents are available at www.jossgroup.com.au

www.jossgroup.com.au

Tenders

City of Wodonga VIC

Tender

W1699-19Q Community facilities audit and needs

This tender closes Tuesday, July 16, 2019 at noon.

Enquiries: Claire Taylor on (02) 6022 9353.

W1713-19 Rates for miscellaneous removal and replacement of kerb and channel (2019-2020 and 2020+ reseal programs)

W1715-19 Rates for reseal preparation works - Minor miscellaneous works 2019-2020

These tenders close Tuesday, July 16, 2019 at noon.

Enquiries: Conwae Knight on (02) 6022 9230.

Tender documents can now only be obtained and submissions made electronically by visiting wodonga.vic.gov.au/tenders

Tenders

Albury City

Current Tenders

Water Meter Reading Services

Submissions close at 12:00 noon on Tuesday 23 July 2019. Enquiries to Colin Bartlett.

Call 6023 8111 or go to alburycity.nsw.gov.au

Tenders

Holy Trinity Primary School Wagga Wagga

Cercol Construction Services invites subcontractors and suppliers to submit quotes to info@cercol.com.au by July 6th 2019.

For more information phone 02 6239 3735.

Public Notices

COUNCIL MEETINGS

The July Council Meeting will be held on Tuesday 2 July from 10.30am at the Corryong Council Offices.

The agenda for each meeting can be viewed online at www.towong.vic.gov.au

towongshire

adzuna

Public Notices

Greater Hume Council — greaterhume.nsw.gov.au

VendorPanel for Tradies, Contractors and Suppliers
Drop in Sessions to help you get Registered

will be held by Greater Hume Council Staff on the following dates:

Holbrook Library	Culcairn Library	Jindera Community Hub
Wednesday, 26 June 2019	Wednesday, 3 July 2019	Wednesday, 10 July 2019
4.00pm to 8.30pm	4.00pm to 8.30pm	4.00pm to 8.30pm

Vendorpanel is an online procurement process which allows councils to streamline procurement of goods and services. Council uses Vendorpanel to manage all quotations and local preferred suppliers.

Bookings Essential for the Drop in Sessions.

To book contact Susan Shanahan, at Greater Hume Council on T: 02 6036 0100 or email **VendorPanelAdmin@greaterhume.nsw.gov.au**.

Carpark Closure - WAW/Hall Carpark, Walla Walla
For Carpark Reconstruction

Contractors for Greater Hume Council are scheduled to commence reconstruction work of the carpark behind the Walla Walla Hall and WAW. Works will also include the demolition of the existing public toilet.

Notice is hereby given that public access will be closed to pedestrians and parking in this area from the week commencing Monday June 24, 2019 for a period of approximately 3 weeks.

Council apologises for any inconvenience.

Should you have any queries regarding this matter please contact Council's Director Engineering, Greg Blacke on T: 02 6036 0100.

Public Notices

MAIN SEWAGE PUMP STATION UPGRADE AND NEW SEWER RISING MAIN, ALBURY
NOTIFICATION AND REGISTRATION OF ABORIGINAL INTERESTS

Albury City Council (the proponent) is proposing a main sewage pump station upgrade and new sewer main within Albury, NSW.
The Study Area is located between Smollet Street and Waterview, West Albury in the Albury Local Government Area (LGA).
An Aboriginal Cultural Heritage Assessment will be undertaken for the proposed works to address Aboriginal cultural heritage issues.
Albury City Council invites Aboriginal people who hold cultural knowledge in determining the significance of Aboriginal object(s) and/or places in the vicinity of the above area to register their interest in a process of community consultation.
The purpose of the community consultation will be to provide sufficient information for the assessment of Aboriginal cultural heritage values, to assist and inform the Aboriginal Cultural Heritage Assessment and to assist the proponent in the preparation of an application for an Aboriginal Heritage Impact Permit (AHIP), if required.

To register in writing please contact:
Meaghan Aitchison
Biosis Pty Ltd
PO Box 3279 Albury NSW 2640
maitchison@biosis.com.au

The proponent's contact details are Albury City Council, PO Box 323, Albury NSW 2640. They can be contacted by phone on (02) 6023 8111.

REGISTRATIONS MUST BE RECEIVED BEFORE 5.00pm, Friday 12th July 2019

PROPOSED DEVELOPMENT
WALLA WALLA SOLAR FARM
(Benambra Road, Walla Walla – NSW)
INVITATION
COMMUNITY INFORMATION
OPEN DAY NO. 2

Please join the Bison Energy team for a project update on the proposed Walla Walla Solar Farm.

This session will provide a project update based on the queries raised during the first Open Day as part of ongoing community engagement.

It will also provide the outcomes of the independent specialist studies completed to date.

Date: Tuesday, 9 July 2019
Place: Walla Walla Bowling Club
111 Commercial Street
Walla Walla NSW 2659
Time: 18:00 to 20:00

There will be a formal presentation from 18:00 to 19:00. Thereafter, the project team will be available to answer any further queries you may have.

Should you need further information, please contact:
Raina Hattingh – Project Community Liaison Officer
community@wallawallasolarfarm.com.au / 02 6971 9696

INDIGO SHIRE COUNCIL

PUBLIC NOTICE

Ordinary Council Meeting

An Ordinary Meeting of the Indigo Shire Council is to be held on Tuesday 25 June commencing at 6.30pm at the Council Chambers Beechworth.

All members of the community are invited to attend.

Phone 1300 365 003
www.indigoshire.vic.gov.au

Wanted to Buy

COLLECTIONS/accumulations of pre 1980 tractor or truck brochures. — Phone Bob 0408 682 205.

WANTED: Fridges, freezers, washers, in good cond. Guinea Street Trading Centre. — Ph: (02) 6041 2388.

OLD wares, collectibles, estates, old bottles, tins, toys, military, railway, oil bottles, signs, shed stuff etc. Cash paid. — Ph: 0476 394 472.

Wanted To Lease

FARMHOUSE req for family with a clydesdale, farm knowledge, Wang, Beechworth or Myrtleford area, outstanding work refs. — Ph: Donna 0400 346 447.

C.5 INFORMATION SESSION NO. 3 & 4 ADVERTISEMENT

FRV
Powering a Sustainable Future

9 September 2019

Dear Resident,

Re: Proposed Walla Walla Solar Farm community information session

Planning for the proposed Walla Walla Solar Farm is progressing, under the project's new owners, FRV Services Australia.

FRV will host a community drop-in information session at the Walla Walla Bowls Club on Monday 23rd and Tuesday 24th September for residents interested in finding out more about FRV and the proposed project. FRV Planning and Management team members will be available at both sessions to answer any questions.

Residents are welcome to drop by during the times listed below. Additionally, a 20-minute project presentation will be provided by the FRV Project Team at **6pm** on Monday 23rd September.

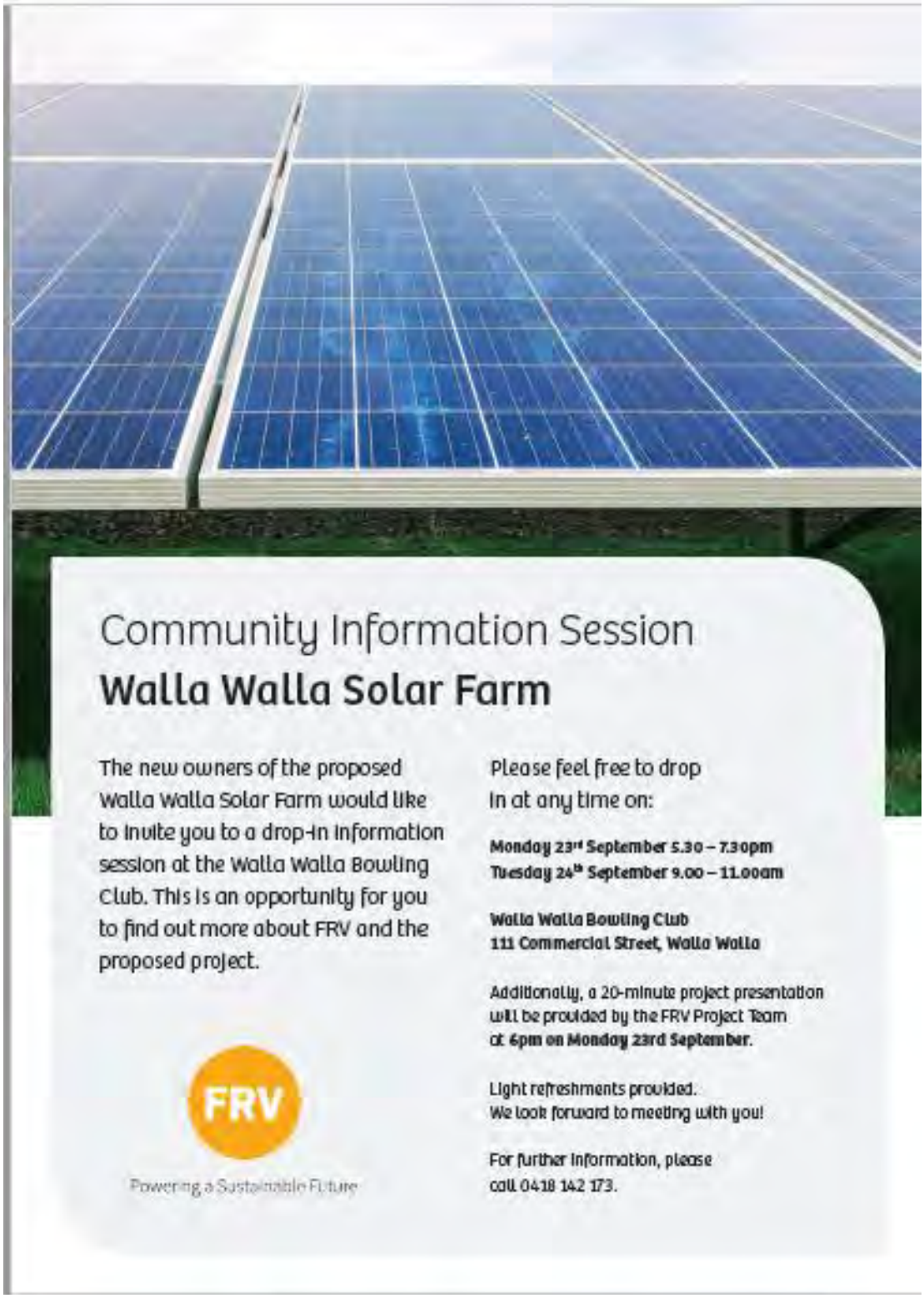
Walla Walla Solar Farm Community Drop In Session
Walla Walla Bowls Club
111 Commercial Street, Walla Walla

Monday 23rd September 5.30-7.30pm
Tuesday 24th September 9-11am

Light refreshments will be provided. We look forward to meeting with you.

Yours sincerely,

Cliona Gormley


Community Information Session
Walla Walla Solar Farm
The new owners of the proposed Walla Walla Solar Farm would like to invite you to a drop-in information session at the Walla Walla Bowling Club. This is an opportunity for you to find out more about FRV and the proposed project.
FRV
Powering a Sustainable Future
Please feel free to drop in at any time on:
Monday 23rd September 5.30 – 7.30pm
Tuesday 24th September 9.00 – 11.00am
Walla Walla Bowling Club
111 Commercial Street, Walla Walla
Additionally, a 20-minute project presentation will be provided by the FRV Project Team at 6pm on Monday 23rd September.
Light refreshments provided.
We look forward to meeting with you!
For further information, please call 0418 142 173.

APPENDIX D COMMUNITY FEEDBACK FORM

BISON ENERGY 株式会社

COMMUNITY FEEDBACK FORM: WALLA WALLA SOLAR FARM

Your feedback is important to develop a solar farm project that best suits the local area and community.

Your feedback will ensure local concerns are understood by the developers and the environmental assessment team.

Please send your feedback to (or seek further information directly, from):
community@wallawallasolarfarm.com.au

For further information about the project, please see the project website at www.wallawallasolarfarm.com.au

Your name & residential address: (this will not be printed or recorded anywhere but is to ensure that we don't double count forms)

NAME: ……

ADDRESS: ……

Tick which box best describes where you live:

- ☐ Less than 2 kilometres from the proposed solar farm
- ☐ 2-5 kilometres from the proposed solar farm
- ☐ More than 5 kilometres from the proposed solar farm
- ☐ Not a member of the local community

Tell us what you value about the local area:

What do you value most about the local area? Circle one or more.

a) Landscape and views
b) Community / family ties
c) Historic values
d) Work opportunities
e) Recreation opportunities, including sporting, nature-based, tourism, etc.
f) Natural values
g) Other

Provide more detail about your answer:

……
……
……
……

What views or landscape characteristics in the region and local area are important to you?

Provide more detail about your answer:

……
……
……
……
……

What do you like most about solar farms, generally?

a) Renewable energy generation
b) Local economic opportunities – jobs, tourism, economic stimulus
c) Diversification of land use / income streams
d) Other

Discuss:

……
……
……
……
……

What concerns do you have about solar farms, generally? Circle one or more.

a) Community impacts
b) Visual impact
c) Noise, during construction or operation
d) Traffic, during construction or operation
e) Effects on natural areas and habitats
f) Effects on water resources
g) Effects on land use or land values
h) Effects on recreation opportunities
i) Other

What specific concerns do you have about the solar farm proposed at Walla Walla?

……
……
……
……
……

Reflecting local values and character

We would like the project to fit in with the local values and character of the area. Can you suggest ways that we might achieve this? *I.e. – a competition to design the signage? Adopt a panel? Viewing platform for the solar farm?*

……
……
……
……
……

APPENDIX E COMMUNITY DATABASE

(CONFIDENTIAL)

B.2.1 Community Investment Program

(CONFIDENTIAL)

B.2.2 Email to Boral Resources regarding the proposal

发件人: "Quarry, Culcairn" <culcairn.quarry@boral.com.au>

主题: 回复: Water Providing Enquiry

日期: 2019年6月27日 GMT+8 下午12:51:35

收件人: Rebecca Wang <rebecca@bisonenergy.net>

Good afternoon Rebecca.

Can you organise a representative from your business to attend site to discuss?

Kind regards

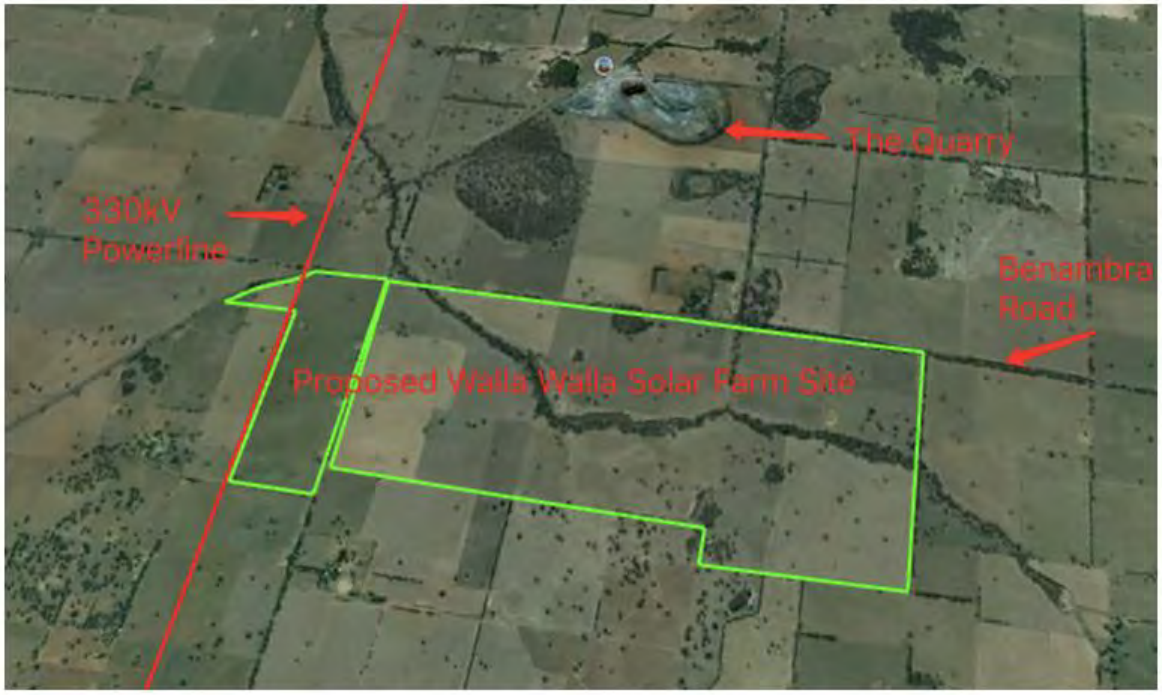
IAN FORREST
Manager - Quarries (Culcairn)

Telephone: (02) 6029 8600
Mobile: 0408609206
Fax: (02) 6029 7501
Email: Ian.Forrest@boral.com.au

Boral Quarries
P.O. Box 93, Culcairn NSW 2660
www.boral.com.au

On Wed, 26 Jun 2019 at 11:07, Rebecca Wang <rebecca@bisonenergy.net> wrote:

> Good morning Ian,
>
> This is Rebecca Wang from Bison Energy, the proponent for Walla Walla Solar Farm.
>
> There are more information about our Walla Walla solar farm project I would like to provide to you for your information.
>
> Please find attached file for our target project map, the area with green line is our project boundary. We are using Benambra Road as the access route. Our planned construction dates would start from June 2020, and end till the end of 2021. The construction site may need 47 megaliter water in total during the 1 and half years construction period.
>
> Would you please reply us an email of your water providing ability based on the information we've provided? If you need further information, please feel free to let me know.
>
> Look forward to your reply in your earliest convenience.
>
> Thank you.
>
> Best Regards,
> Rebecca
>
> Rebecca WANG
>
> Email: rebecca@bisonenergy.net
> www.bisonenergy.net


The Quarry
330kV
Powerline
Benambra
Road
Proposed Walla Walla Solar Farm Site