Schwartz Family Solar Farm (SFSF)

Conclusion of Feasibility Discussion

4.93MWp DC Solar Energy Generator

November, 2018

Project Key Points / Integrated Equipment

1. 4.939MW Capacity DC / (4.940MW) / 5.000MW Capacity AC / 70,000m2, 17.29 acre, 7.0 hectare space envelope

2. 13,350 x 375w (1500v) Solar Modules Incorporated (percium split cell technology), "JA / Jinko Shortlist Suppliers"

3. 2 x MV Power Station PS-AU-2500SC Centralised SMA Inverters Incorporated, "SMA Preferred Supplier"

4. 267 x 2V25 FS2V UNO Ground Mount Tables Incorporated, "Schletter Preferred Supplier"

5. 105,600 Meters of DC "String / Array " Cable and 4,950 Meters of DC "Bus to Inverter" Cable Incorporated,

6. 3,350 Meters of HV Cable (OH) and 670 Meters of HV Cable (UG) Incorporated,

7. 55 x 40 Foot Shipping Containers comprising Solar Modules, Ground Mount Racking, Cable, Conduit etc "Logistics and Management"

Schwartz Family Solar Farm (SFSF)

Feasibility Study / Tasks and Deliverables

November, 2018

Feasibility Study / Tasks and Deliverables

(to prove bankability and constructability the following tasks were undertaken, please refer to the “Feasibility Deliverables” document suite for particulars, and further information)

1. Statement of Environmental Effects (SEE) and Associated Environmental Studies – KleinFelder

2. Development Application and Associated Activity – Cessnock City Council

3. Grid / Network Studies and Augmentation – Grid Scape

4. Application for Connection (AFC) / Design Certification / Negotiated Offer – Ausgrid

5. Geotechnical Site Investigation and Associated Studies – Valley Civilab

6a. Project Design / Modelling Package / Incorporated Equipment Specifications – earthconnect

6b. Project Procurement Schedule / Gantt Chart – earthconnect

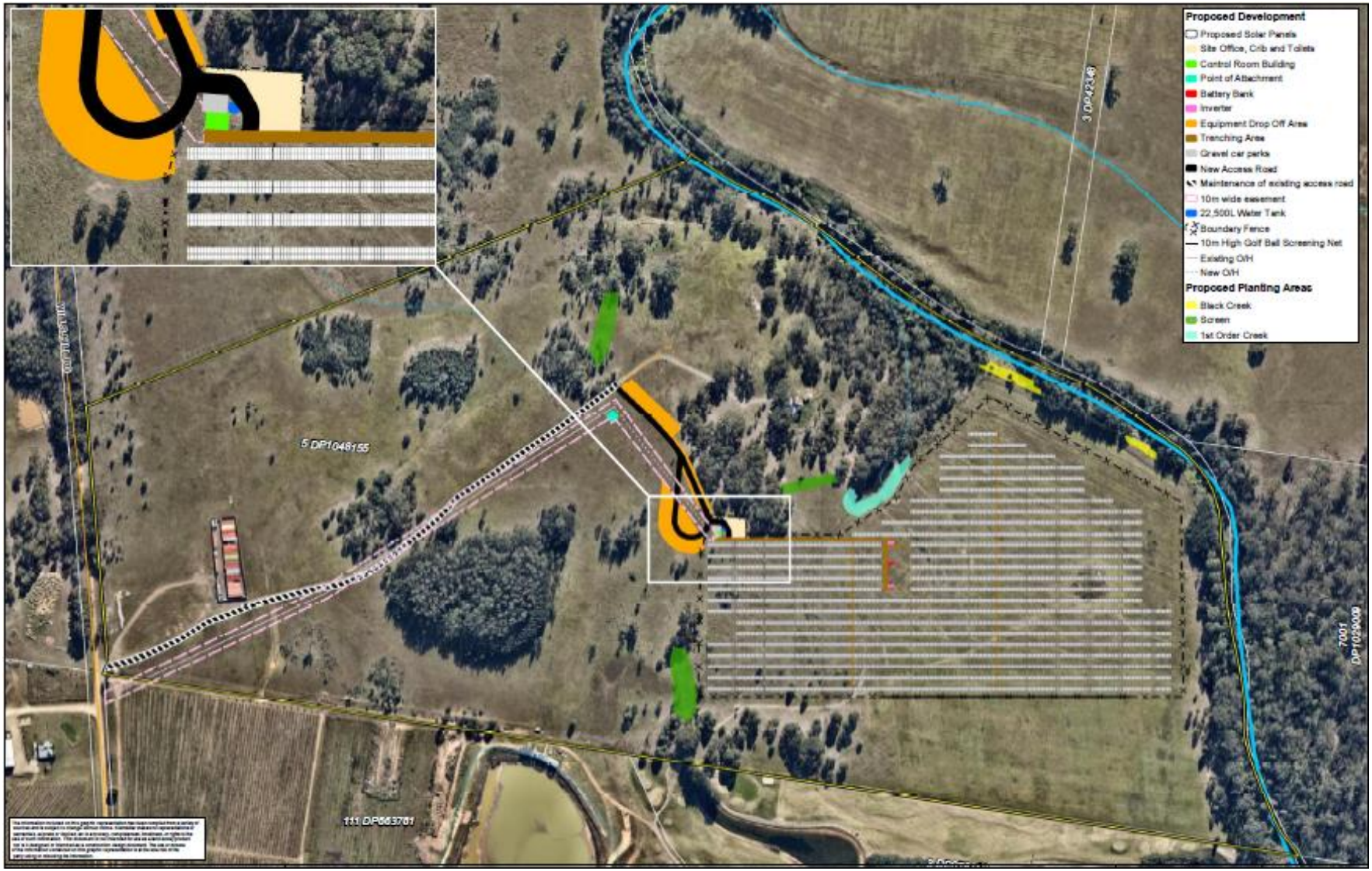
6c. Energy Utilisation / Trading Options and Returns – Flow Power / Power Ledger (consolidated by earthconnect)

Schwartz Family Solar Farm (SFSF)

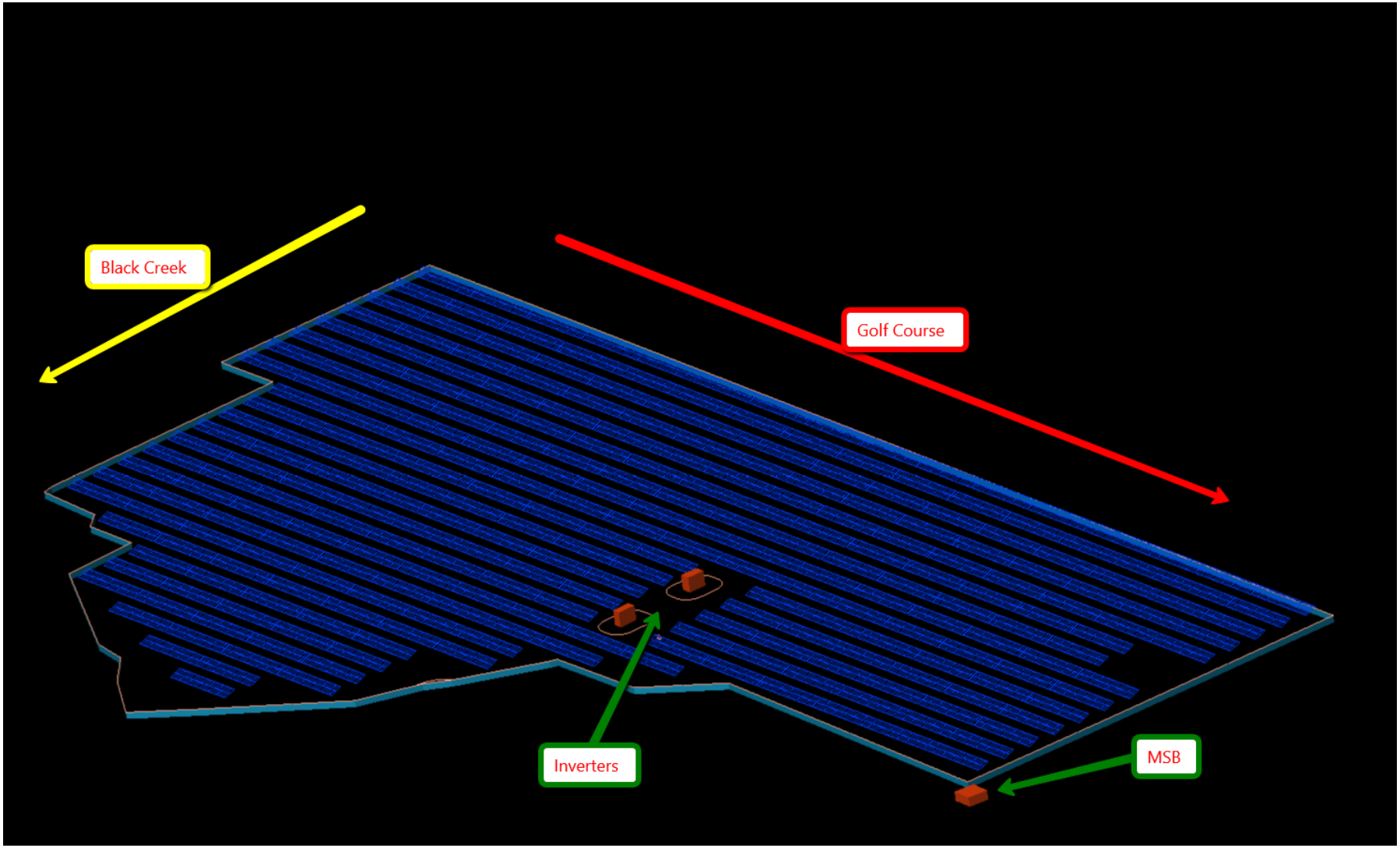
Solar Farm Layout / 3D Model / Design Analysis / Environmental Benefits

November, 2018

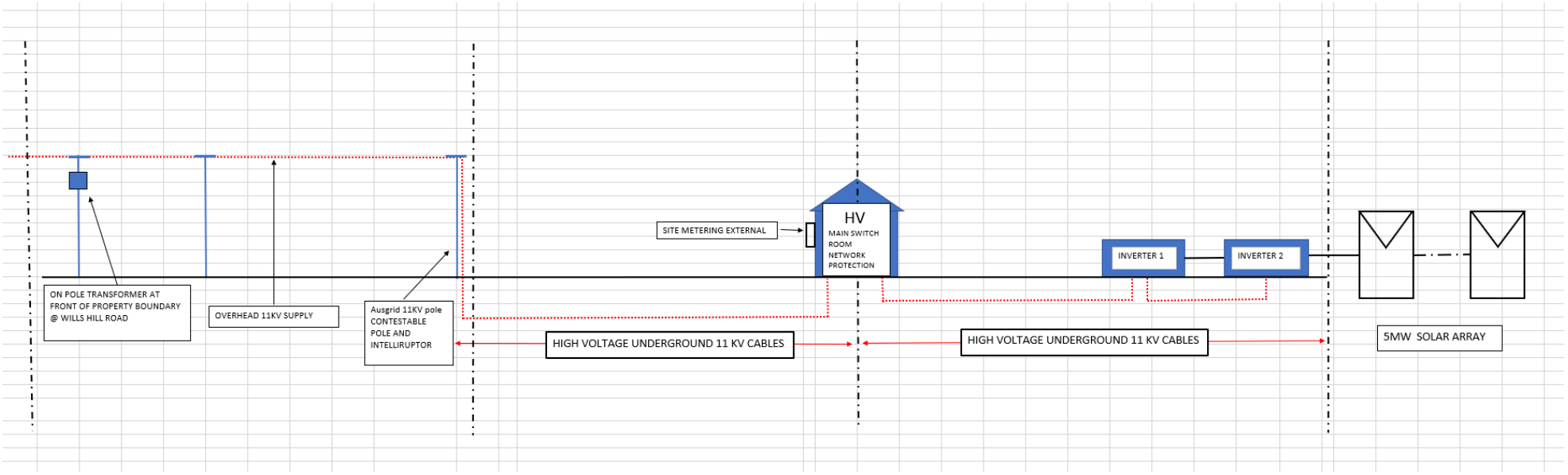
Solar Farm Layout

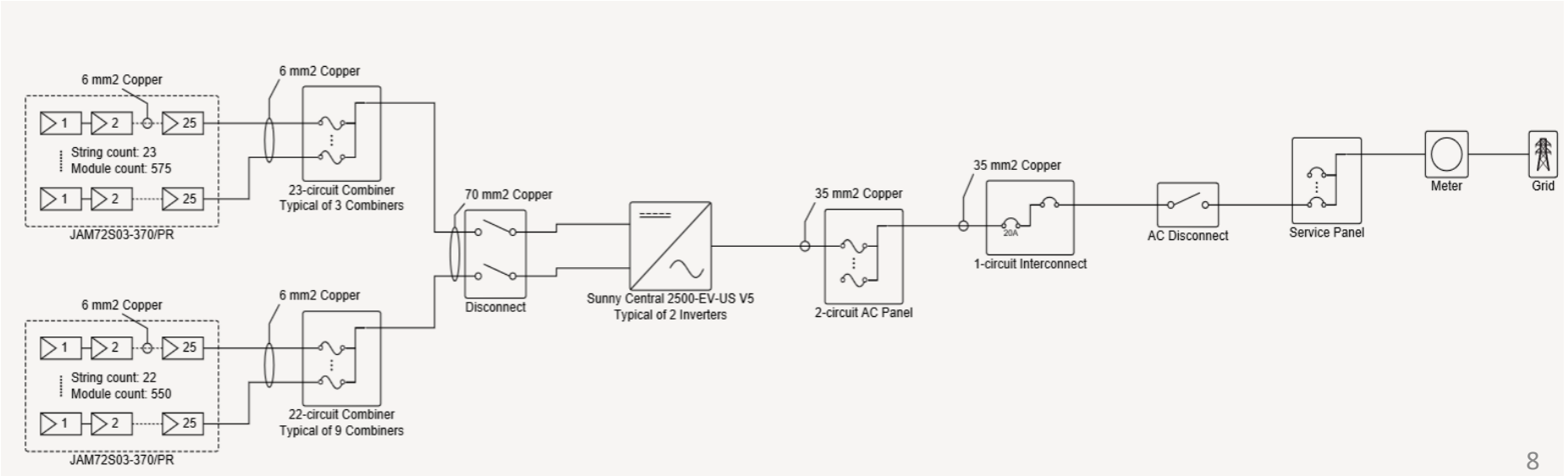


HelioScope – 3D Model



Single Line Diagram (SLD) – Preliminary Design





Design Analysis

Report

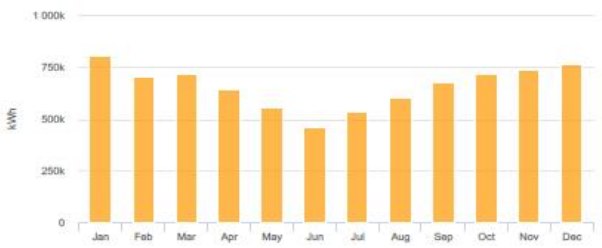
Project Name	HVSF- 5MW
Project Address	WILLS HILL ROAD CESSNOCK
Prepared By	jason marko jason.marko@earthconnect-australia.com

System Metrics

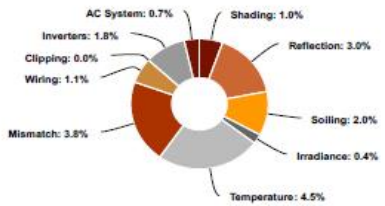
Design	25 string layout-no riperian zone enroachment
Module DC Nameplate	4.94 MW
Inverter AC Nameplate	5.00 MW Load Ratio: 0.99
Annual Production	7.928 GWh
Performance Ratio	83.2%
kWh/kWp	1,605.1
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	9b6ea3edba-740144e756-4cf1fffc4d-a6b7ed69dd

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,721.0	
	POA Irradiance	1,929.6	12.1%
	Shaded Irradiance	1,910.2	-1.0%
	Irradiance after Reflection	1,853.0	-3.0%
	Irradiance after Soiling	1,816.0	-2.0%
	Total Collector Irradiance	**1,816.0**	**0.0%**
Energy (kWh)	Nameplate	8,979,065.0	
	Output at Irradiance Levels	8,939,882.0	-0.4%
	Output at Cell Temperature Derate	8,540,070.1	-4.5%
	Output After Mismatch	8,218,090.5	-3.8%
	Optimal DC Output	8,123,590.9	-1.1%
	Constrained DC Output	8,123,354.0	0.0%
	Inverter Output	7,980,320.0	-1.8%
	Energy to Grid	**7,928,370.0**	**-0.7%**
Temperature Metrics			
	Avg. Operating Ambient Temp		19.8 °C
	Avg. Operating Cell Temp		29.4 °C
Simulation Metrics			
	Operating Hours		4554
	Solved Hours		4554

Condition Set

Description	Condition Set 1										
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)										
Solar Angle Location	Meteo Lat/Lng										
Transposition Model	Perez Model										
Temperature Model	Sandia Model										
Temperature Model Parameters	Rack Type	a	b	Temperature Delta							
	Fixed Tilt	-3.56	-0.075	3°C							
	Flush Mount	-2.81	-0.0455	0°C							
	East-West	-3.56	-0.075	3°C							
	Carport	-3.56	-0.075	3°C							
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	2	2	2	2	2	2	2	2	2	2	2	2
Irradiation Variance	5%											
Cell Temperature Spread	4° C											
Module Binning Range	-2.5% to 2.5%											
AC System Derate	0.50%											
Module Characterizations	Module	Characterization										
	JAM72S03-370/PR (JA Solar)	Spec Sheet Characterization, PAN										
Component Characterizations	Device	Characterization										
	Sunny Central 2500-EV-US V5 (SMA)	Default Characterization										

Components

Component	Name	Count
Inverters	Sunny Central 2500-EV-US V5 (SMA)	2 (5.00 MW)
Transformer	Primary Side: Medium Voltage (11kV) , Secondary: Medium Voltage (11kV)	1
AC Panels	2 input AC Panel	1
AC Home Runs	35 mm2 (Copper)	3 (1,427.7 m)
Home Runs	70 mm2 (Copper)	24 (5,355.2 m)
Combiners	22 input Combiner	18
Combiners	23 input Combiner	6
Strings	6 mm2 (Copper)	534 (89,981.9 m)
Module	JA Solar, JAM72S03-370/PR (370W)	13,350 (4.94 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	24	25-25	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	20°	0°	6.0 m	2x25	267	13,350	4.94 MW

Shading Analysis

Nameplate: 4.94 MWp

Energy: 8.35 GWh

Shade Losses: 0.4%

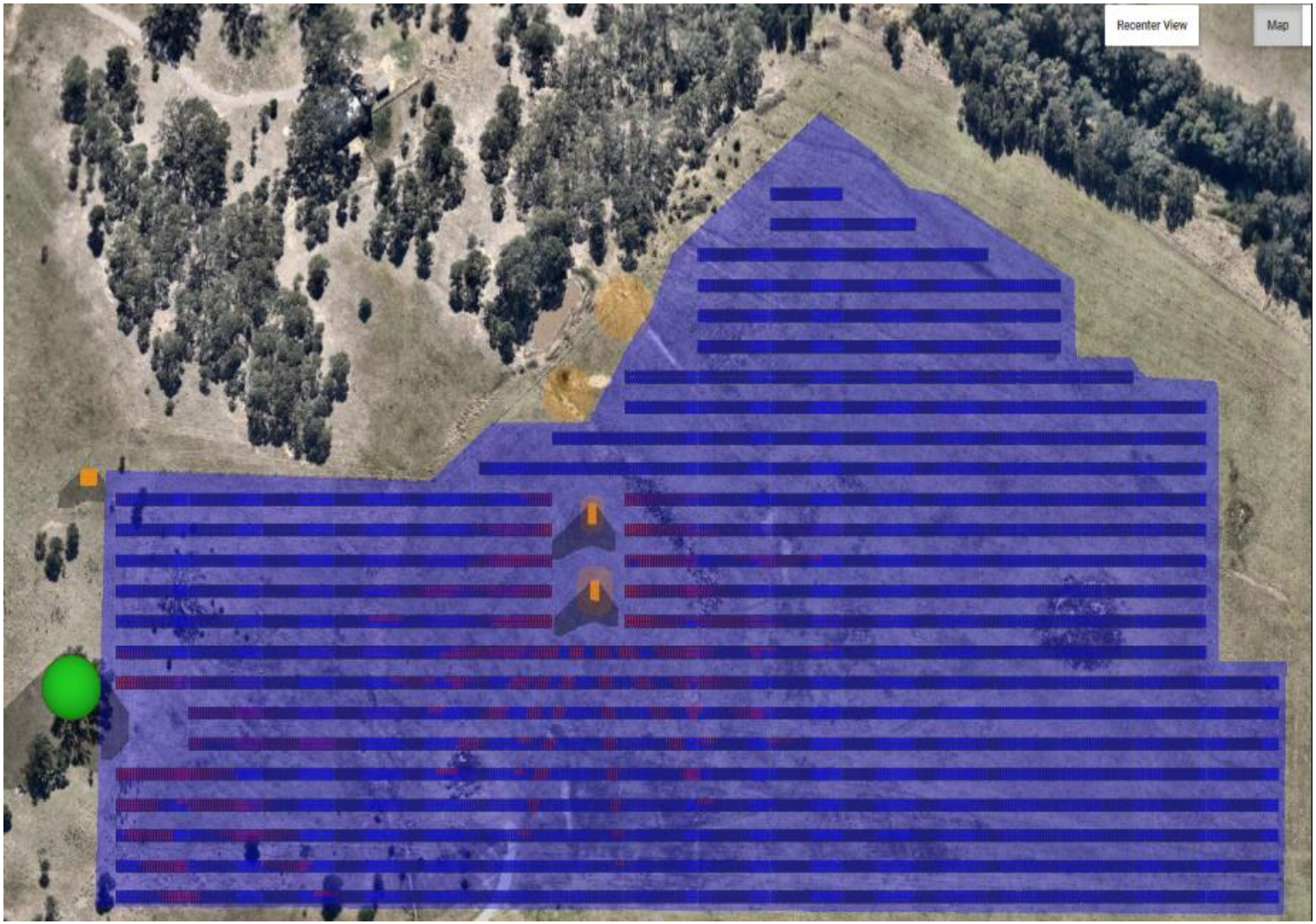
Module Shading Cutoff 3%

Nameplate Reduction 0.0% (0 modules)

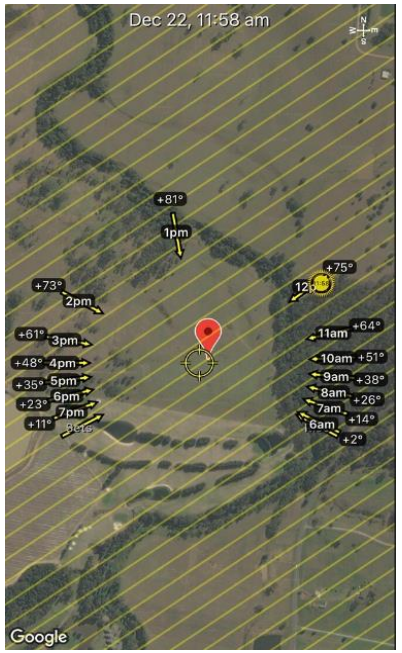
Remove 0 Shaded Modules

Show Monthly Values

	POA	Shaded POA	%
jan	2.55 GWh	2.54 GWh	99.5%
feb	2.25 GWh	2.24 GWh	99.6%
mar	2.26 GWh	2.25 GWh	99.6%
apr	2.01 GWh	2.01 GWh	99.7%
may	1.71 GWh	1.70 GWh	99.6%
jun	1.41 GWh	1.40 GWh	99.5%
jul	1.62 GWh	1.61 GWh	99.4%
aug	1.84 GWh	1.83 GWh	99.6%
sep	2.12 GWh	2.11 GWh	99.6%
oct	2.25 GWh	2.24 GWh	99.5%
nov	2.36 GWh	2.35 GWh	99.6%
dec	2.46 GWh	2.45 GWh	99.5%



Shading Analysis / Sun Paths



Shading by Field Segment

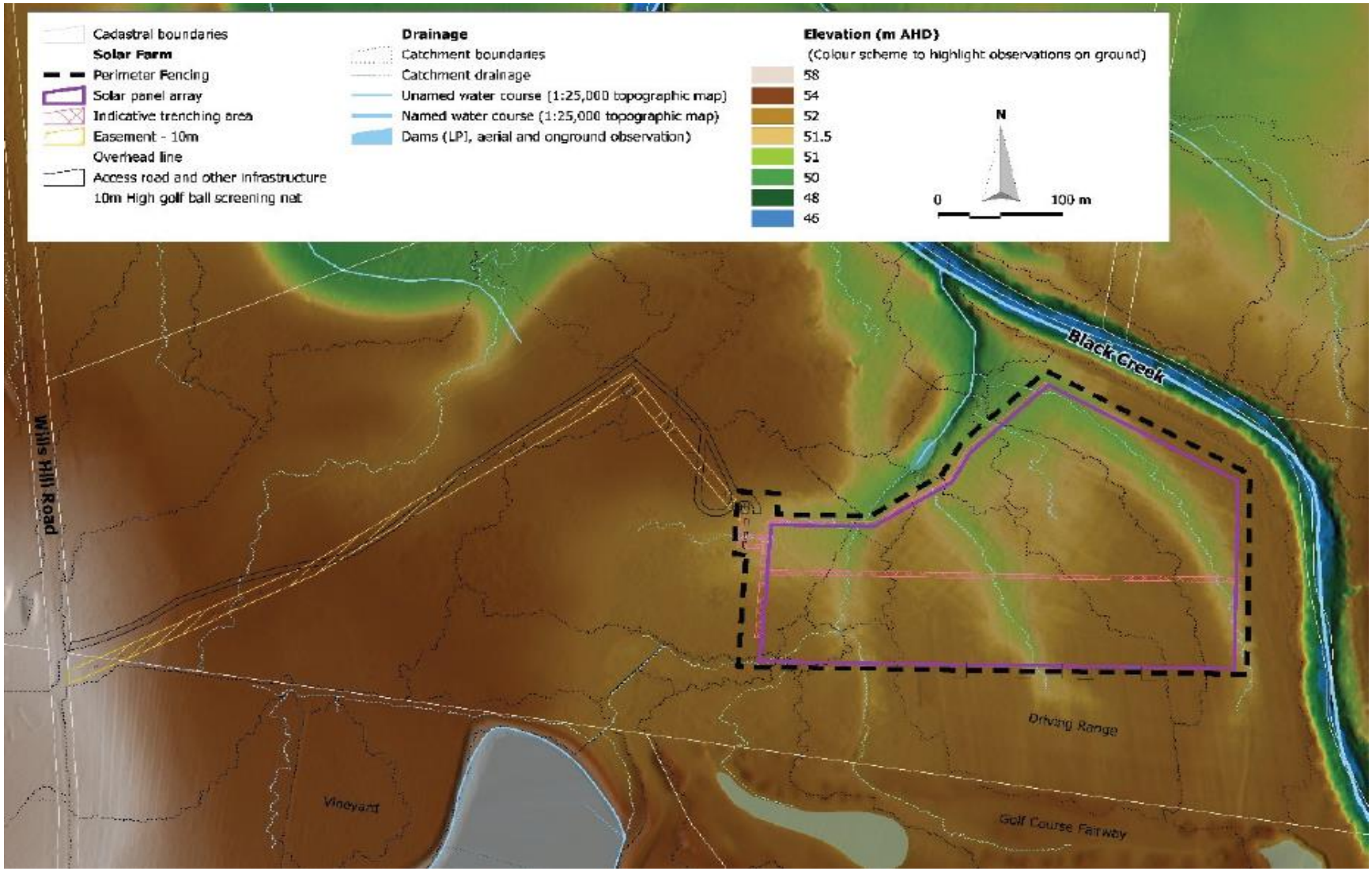
Description	Tilt	Azimuth	Modules	Nameplate	Shaded Irradiance	AC Energy	TOF[2]	Solar Access	TSRF [2]
Field Segment 1	20.0°	0.0°	13,350	4.94 MWp	1,910.2kWh/m^2	7.93 GWh[1]	98.1%	99.0%	97.1%
Totals, weighted by kWp			13,350	4.94 MWp	1,910.2kWh/m^2	7.93 GWh	98.1%	99.0%	97.1%

[1] approximate, varies based on inverter performance
[2] based on location Optimal POA Irradiance of 1,966.7kWh/m^2 at 33.0° tilt and 0.0° azimuth

Solar Access by Month

Description	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Field Segment 1	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Solar Access, weighted by kWp	98.9%	98.9%	99.0%	99.1%	99.2%	99.0%	99.1%	99.1%	99.1%	98.9%	98.9%	98.9%
AC Power (kWh)	802,637.4	702,039.0	716,322.5	645,755.3	557,638.9	462,592.5	533,436.9	603,782.4	675,005.8	716,978.6	742,574.5	769,601.7

Topography Analysis



Environmental Benefits

1. CO2 Reduction

Approximately 7,811,000 kg per annum

Approximately 4,336 vehicles removed from the road per annum

kWh of electricity produced / saved = a 1.07 kg reduction in C02 Pollution, source: savepower.nsw.gov.au

120.1g/km x 15,000km = 1,801,500g / 1000 = 1,801.5kg/pa

2. Rejuvenation of Black Creek Riparian Zone

As past of the Statement of Environmental Effects (SEE) planting and rejuvenation of the riparian zone, which is associated with Black Creek will take effect as part of the Project, and as prescribed by the Department of Water, further details are provided throughout the Feasibility Deliverables issued.

Schwartz Family Solar Farm (SFSF)

Feasibility Study / Challenges and Constraints

November, 2018

Feasibility Study / Challenges and Constraints

1. Cessnock City Council Delays

The lack of communication and support from Cessnock City Council (CCC) has been a concern since early in the piece, and during the drawn out Development Application process, which was nine (9) months, council appeared uncertain as to how to compile the submission for review by the Joint Regional Planning Panel (JRPP).

2. Civil Aviation Safety Authority (CASA)

Although earthconnect made enquiries with CASA several years back, and it was understood that their determination was that the Solar Farm would not impact Air Traffic because the aerodrome did not have a control tower. CCC did not appear to accept this determination, and it really slowed progress.

3. Riparian Zone Interface / Management

The Department of Water requested that a Vegetation Management Plan be developed in addition to the Statement of Environmental Effects, which in turn resulted in extensive negotiations, and delays to the program.

4. Direct Connection at 11KV / Power Quality / Grid Interface

Ausgrid had concerns with a 5.0MWp Generator Connection at 11KV, and detailed network studies were conducted to prove that we would not have a detrimental impact on the Grid Infrastructure. Documents associated with this study are attached a Feasibility Deliverable 3.

5. Integration of Dual Axis Trackers

The Principle requested that we explore the integration of Dual Access Trackers at the site.

As part of this exercise, the following issues were realised … Flood Concerns on mechanical / electrical components, Space Envelope Constraints, Output Limitations “park zize reduced by approx. 50%” additional Costs to Construct, Additional Costs to Maintain, Old Technology which was introduced when module prices were high, to increase yield.

6. Alternate Solar Panel Integration

The Principle requested that we explored the integration of Bluesun Solar Modules at the site, and at the time of our review the following concerns were realised … only 350w output, park reduction of 333.75kWp, lower efficiency to top panels manufacturers (approx. 1.28%), 1000V DC Modules .. 1500V DC required, not a top ten (10) manufacturer.