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Report on

Flooding and Drainage Assessment

Proposed Solar Panel Farm @ Carisbrook

For

Carisbrook Solar Farm

Version: B

18/08/2018

Document Control

Version	Date	Author		Reviewer	
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B	18/08/2018	Colin Findlay	CF		

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1. Flooding and Drainage Assessment

1.1 Site Description

The proposed solar area comprises approximately 300 hectares of land that currently supports dryland cropping. There are areas of agroforestry where trees have been planted in rectangular fenced blocks, whilst outside the fenced agroforestry areas there are varieties of remnant eucalyptus trees and single trees scattered across the property. The land has been developed for dryland cropping amongst areas of scattered volcanic rock. The rocks vary in size and in recent years the rocks have been gathered off the paddocks and stockpiled toward the north east and south east corners of the property.

Land bordering the property to the west supports vineyards on the elevated soils which indicates the versatility of the soil types. The soils comprise of light to medium clay loams with small to medium sized rocks scattered through the profile.

The property is aligned in a catchment where rainfall induced runoff meanders through the system from south to north and eventually small tributaries feed into the Loddon River to the north.

1.1.1 Solar Panel Sites

The site selected for the solar panel array is moderately undulating with a defined natural depression aligned from the south, beginning at the boundary fence at the Pyrenees Highway, falling to the north east direction in a sweeping meandering alignment. The surface drainage on the western section of the site occurs across the natural topography, where water flows naturally to the west, out falling into a shallow depression. Another small defined depression is located centrally and extends south from the northern boundary close to the main two pipes, that form a subway under the railway line. To enable surface water to be removed effectively a drainage scheme is proposed to direct water to the two subway under the Castlemaine – Dunolly railway on the northern boundary.

1.1.2 Topographical & Feature Survey

The topographical and feature survey was completed to Australian Height Datum in April 2018 where natural surface levels vary from 243.51m AHD on the south east corner to 236.16 m AHD on the south west corner of the property. The northern end of the property is 219.19 m AHD at the discharge point at the northern end of the property. Overall there is 24 m fall from South to North with considerable side fall feeding the drainage lines.

1.1.3 Property Features

The property is generally arid apart from existing agroforestry sites, remnant vegetation, scattered trees and stock water dam sites. The soils types vary from the elevated soils through to the natural depressions and lower wetland dam sites are classified as medium clay loams to lighter clay loams.The combined soil types and sloping terrain is ideal for shedding water during high rainfall events.

The properties surrounding the proposed solar panel site support annual cereal cropping and sheep, whilst areas within close proximity to the Cairn Curran Reservoir are irrigated with Permanent Pastures.

The proposed Solar Panel layout has been designed across the property avoiding the natural depressions (refer attached solar panel layout), where as the proposed main arterial surface drains have been designed to be aligned within the centre of the depressions. Lateral surface drains designed across the bottom of the proposed blocks of solar panels will outfall into the main arterial drains. Other onsite infrastructure for the proposed solar farm will include access tracks, inverters, battery units and transformer station presented on the overall design plan.

Solar panels will not occupy land beyond the proposed treed landscape buffer zones and native remnant vegetation located to the south east position on the property will remain in its current state. The temporary compound area comprising approximately 30,000 m2 will be free of solar panels as the compounds function is to receive freight via transport and containers entering from the Pyrenees Highway.

The Pyrenees Highway is a main traffic route for transportation for fuel, wool, grain, fertilizer, livestock and general community and public transport. The Highway extends from the west of Victoria to reach Central Rural Cities and connects with major transport routes extending to NSW and South Australia.

1.2 Surface Water Mapping

The North Central Catchment Management Authority (NCCMA) has advised there is no issues in relation to flooding over the proposed solar farm site, however there are existing structures in place allowing surface water to flow through the catchment, including the entry and exit points to the subject property assessment site.

Surface water enters the property via an existing 300 mm road culvert under the Pyrenees Highway. Surface water enters the southern end of the property into a defined depression and is contained within the depression as surface run off water continue to follow the depression to the north east of the property. Surface water exits the assessment site at the north east boundary via large bluestone box culvert located under the Castlemaine – Dunolly Railway Line.

When high rainfall events occur in the Carisbrook area, the study area also experiences natural runoff across relatively steep slopes toward the western boundary of the assessment site. It continues to flow north to eventually reach the two 600 mm diameter piped culverts under the Castlemaine – Dunolly Railway.

The two existing structures under the railway line are placed correctly on line with the depression at the lowest point on the property, allowing surface water to continue unobstructed through the catchment.

CAF Consulting adopted a 20 metre grid survey to establish the drainage lines and surveyed the position and elevations of critical existing structures that allow surface water to flow through the catchment.

The existing 300 mm pipe located on the Pyrenees Highway is a small pipe that experiences flow rates between 8 ml to 10 ml per day based on the head of water over the pipe. This flow rate will not impact the property with flooding as the flow will be contained across the natural depression to a depth of approximately 100 mm.

1.3 Flooding Conditions

Minor flooding will occur on the proposed solar farm site during extreme storm activities when rainfall events exceed 25 mm in 24 hours. Rain fall events across the property experiencing 25 mm of rain over short duration will see approximately 100 megalitres of surface water run

off, if the soil profile is wet. This amount of water is insignificant and will see sheet flow entering the depressions and flowing toward the exit points of the property.

1.4 Flooding Considerations – Development Implications and Recommendations

The most sensitive areas of the property are the areas aligned along the depression and drainage lines. The drainage scheme proposed for the solar panel site will be most active during autumn winter and spring. It is not anticipated that rain events during this period will be a threat particularly for minor events. The solar panels will not be installed in the depressions and will not occupy the main and submain surface drainage systems. High rainfall events will naturally flow across the relatively steep terrain and enter the drainage lines, whilst shallow flooding and the proposed network of drains and structures will intercept rain fall runoff and direct the water to exit at the outfall points.

1.4.1 Position of Inverters

The inverters are located strategically across the area in a grid formation and are not expected to be subjected to flooding. The proposed solar layout is not aligned in the depressions therefore inverter stations will be located within the solar panel grid through each block

The inverter transformer stations will be seated on concrete blocks at an elevation of 300 mm above the natural surface. The site for each Inverter will be levelled off for a flat surface and the concrete blocks seated in their respective positions to allow the inverter station to be placed.

The concrete blocks raised at 300 mm allows rain fall runoff to pass under the inverter stations without obstructing sheet flow.

1.4.2 Solar Panel Elevation

Solar Panels proposed across the proposed Carisbrook Solar Farm will not be subjected to flood flows as they are not aligned in the natural depressions or over surface drains.

Solar panels will also be fixed onto a tracking device which can be raised automatically to avoid extreme flooding events, which is highly unlikely to occur on this property.

The panels can be rotated so they are placed in a horizontal position, resulting in being up to 1.5 m above the ground. The network of frames supporting the panels are not considered an issue due to the size of the framework and therefore not likely to impact to sheet flow water levels.

1.4.3 Surface Drainage Flows and Water Harvesting Storage Dam

There is a dam site located on the western boundary of the proposed Solar Farm site that harvests surface run off to store water, that is used to irrigate the adjoining vineyard.

The proposed surface drainage scheme should not disadvantage the water storage and will ensure the drainage is directed through the water harvesting storage dam that is pumped into an elevated dam.

There is no specified condition set out by NCCMA requiring storage dams to be utilised in the design of the proposed drainage scheme. There is an opportunity however to harvest water for small dams located along the drainage lines that may be useful for supplying water for fighting fires, watering any vegetation that is landscaped around the proposed solar farm and cleaning the solar panels.

1.4.4 Proposed Buildings Relevant to Operation of the Proposed Solar Panel Farm

The proposed buildings associated with Solar Park operations and connection to the power grid will be located adjacent to Bald Hill Road at the northwest corner of the property. The natural surface elevations allow the building to be sited in this location as it is above the minor flood levels, however this site should be elevated at least 400 mm above the ground as the surface drainage main drain is in close proximity.

1.5 Summary

The proposed solar farm property is currently only subject to minor flooding which is contained within the existing natural depressions. Once the proposed solar farm has been built the minor flood risk would be aided by a proposed network of surface drains that would convey water to exit the property through designated existing subways under the Castlemaine – Dunolly Railway Line

- The proposed solar panel layout design in Figure 2 presents blocks of solar panels and displays the areas that will not be occupied by solar panels. These areas are designated for surface drains, access tracks as well as buffer zones.
- The proposed Solar project will not be subjected to a 1 in a 100 year flood event and it will not be impacted by minor flooding. Minor flooding will be contained within the existing depressions and mostly within the swale drains, which have been avoided in the project design solar panel layout. The proposed solar panels will be fixed on frames and will be at least 0.5m from natural surface, therefore will not be impacted by any flood event across the property.
- Inverters are identified and numbered on the solar layout drawing and they are strategically placed in a grid formation across each block of solar panels. It is proposed that the Inverters will be elevated on 300mm concrete blocks to allow rainfall to freely run off under the inverters. ..
- It is proposed that a Security Fence will be located around the periphery of the solar project. The fence will be designed to allow flood flow and to provide security preventing kangaroos and other large animals from entering the subject site. Double gates will be provided for all entry and exit points.

Ib vogt and CAF Consulting consulted with North Central Catchment Management Authority (NCCMA) on the proposed project to ensure that the proposed project addressed any issues raised by NCCMA in relation to expected flooding conditions within the site. Following feedback from NCCMA the following conclusions are made:

- The assessment site is not subjected to 100 year ARI flood level
- Buildings (operations) will be raised above the ground but are not subjected to the 100 year ARI flood level.
- The solar panels and inverters will not impact flood flow as the property has not experienced a 100 year ARI Flood.
- Access tracks between banks of solar panels to be kept to a minimum height and tracks through depressions to be gravelled.
- Solar Panels can be raised as they are a tracking device and this will prevent any obstruction to flow in the unlikely event of a 100 year ARI

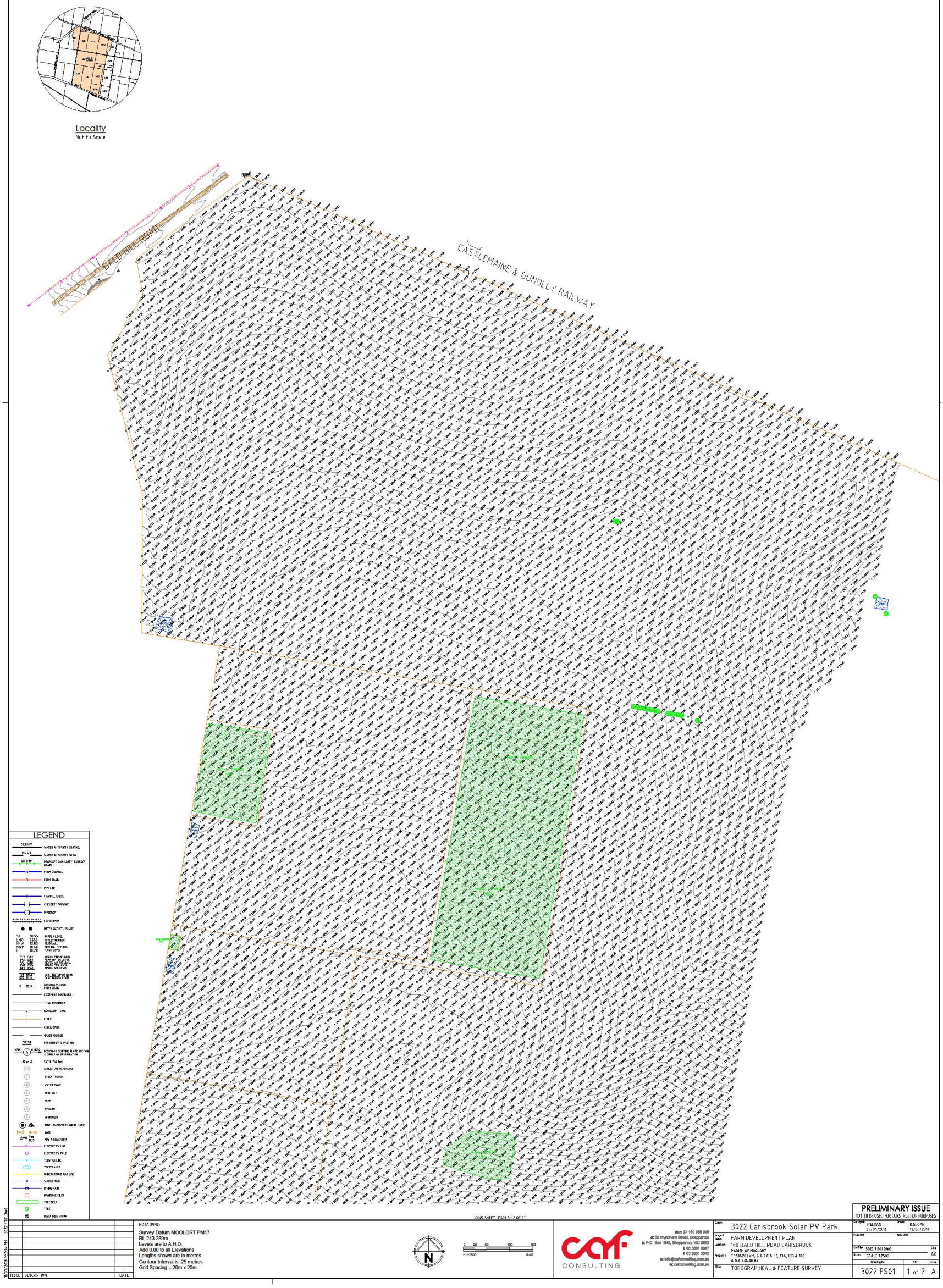


FIGURE 1 – Topographical and Feature Survey.

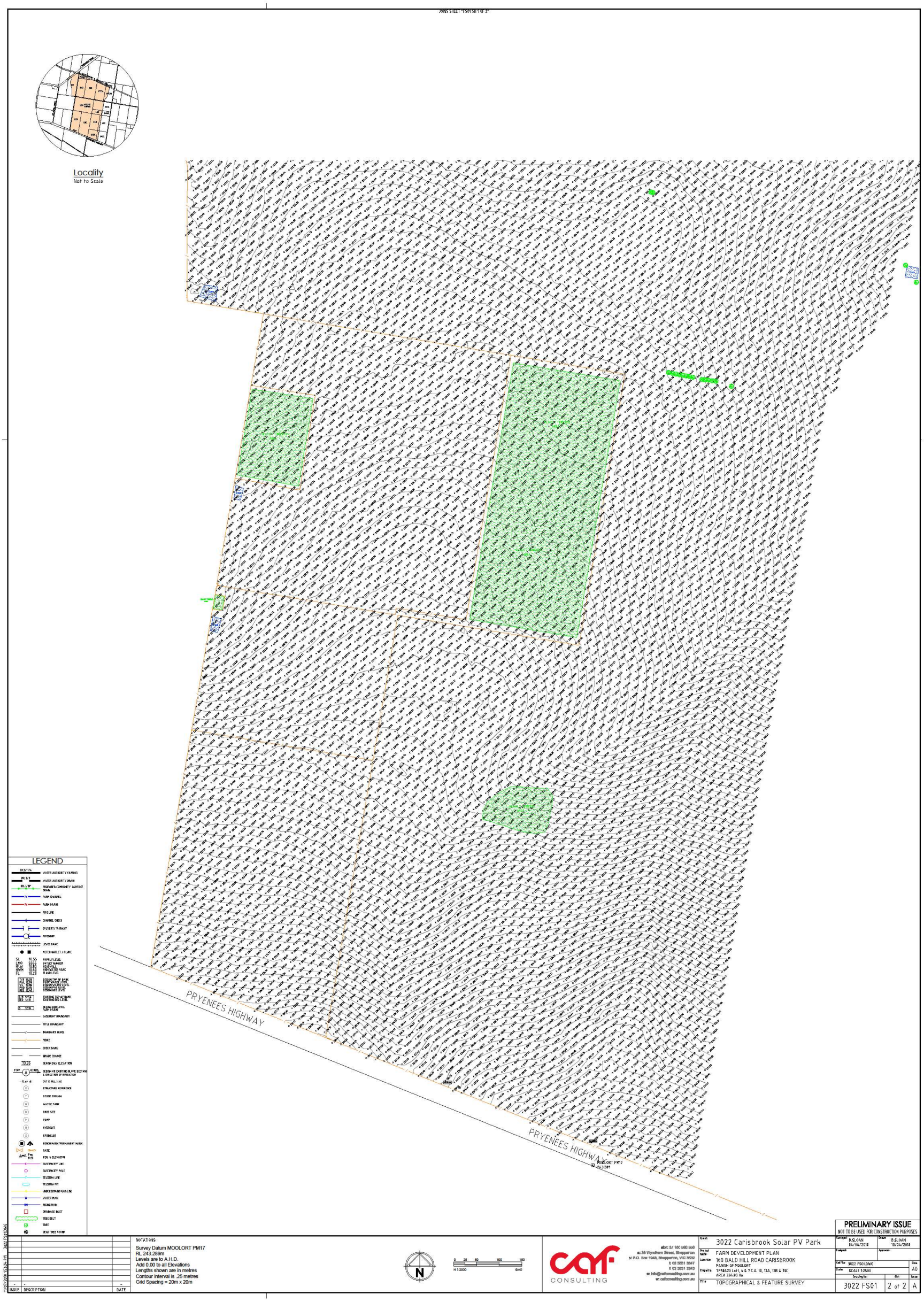
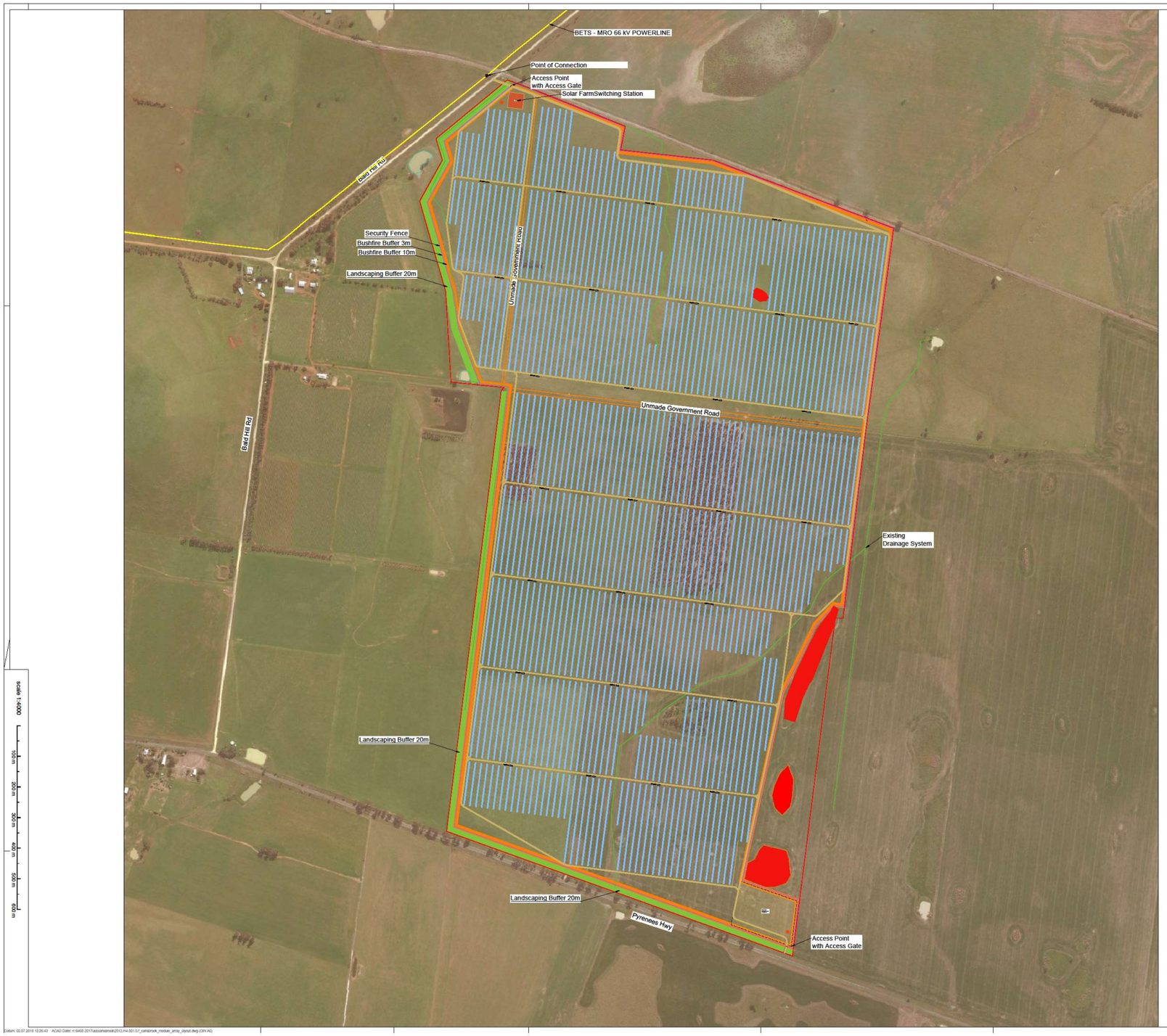


FIGURE 1 – Topographical and Feature Survey (cont'd).

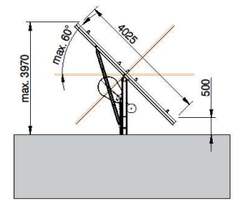


Location		Coordinates			
Country:	Australia	WGS 84		Projected	
Address:	Victoria	Latitude:	37.03° S	Eastings:	
	Carisbrook	Longitude:	143.50° E	Northings:	

Areas						
	Fenced Area		Length		Area	Length
	[m²]	[ha]	[m]		[m²]	[m]
Total	2,987,911.4	298.8	7,853	Access Road		
				Maintenance Road		
				Construction Compound		

System Configuration System Voltage @1500V							
Modules		Strings		Inverter		Substructure	
Allocation							
[Wp]	350	Mdls/String	28	Type	Central	Type	Tracker
No.		No.	9,180	Model AC [kVA]	3600	Config	2P
Total No.	257,040			No.	27	Azimuth [°]	6°East
DC [kWp]	89,964 MWp			Total AC [kVA]	75000 kVA	Pitch [m]	17.00

2 Tracker Cross Section



Legend

Planing Boundary			Single Axis Tracker for Panels
Fence			Solar Farm Switching Station
Access Gate			Point of Connection
Access Roads [Width of 4m / 6m]			Construction Compound = 30,000m²
PV Panel Area			40ft Battery Container plus spacing for DC/DC converters
Bushfire Buffer [3m / 10m]			Inverter Transformer Station
Ecological Constraints			Drainage System
Landscaping Buffer [20m]			Water Storage Tank [2 x 45,000 l]

Used Xrefs of external planners in the current drawing

Rev	Date	Xrefs(DWG) - File name / Planning expert

Please note that all drawing contents have to be checked on the contractor's own responsibility prior to construction start. Discrepancies have to be communicated to the contractual partner or to the responsible technical planners. Drawing numbers and index have to be observed. With release of new drawing, previous drawings lose their validity and will not be withdrawn.

Document-No.: 2512 M2.001.0.F

Rev	Date	Des	Chec	Appr	Revision Description
F	02 Jul 18	MAB			Number of inverter station increased (27 stations instead of 22)
E	25 Jun 18	MAB			Approval Drawing, ENV-pitch changed to 17.00m
D	06 Jun 18	MAB			Drawing updated
C	31 May 18	MAB			Drawing updated
B	24 May 18	MAB			Drawing updated
A	15 May 18	MAB			Drawing updated
0	23 Jan 18	PUD			Original drawing

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Client:

Version: Metric | European Proj
Designed by: 25 Jan 2018 | PUD
Checked by:
Approved by:
Page: 1 | 1
Drawing Scale: 1:4000
DK | Size: A0
11858541

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Title: CarisbrookSolar Farm
Module Array Layout

Supplier:

Planning Phase: A0_11858541 | Approval | Status: 02 Jul 18
Document-No.: 2512 M4.001. 0 F | Revision Index: F

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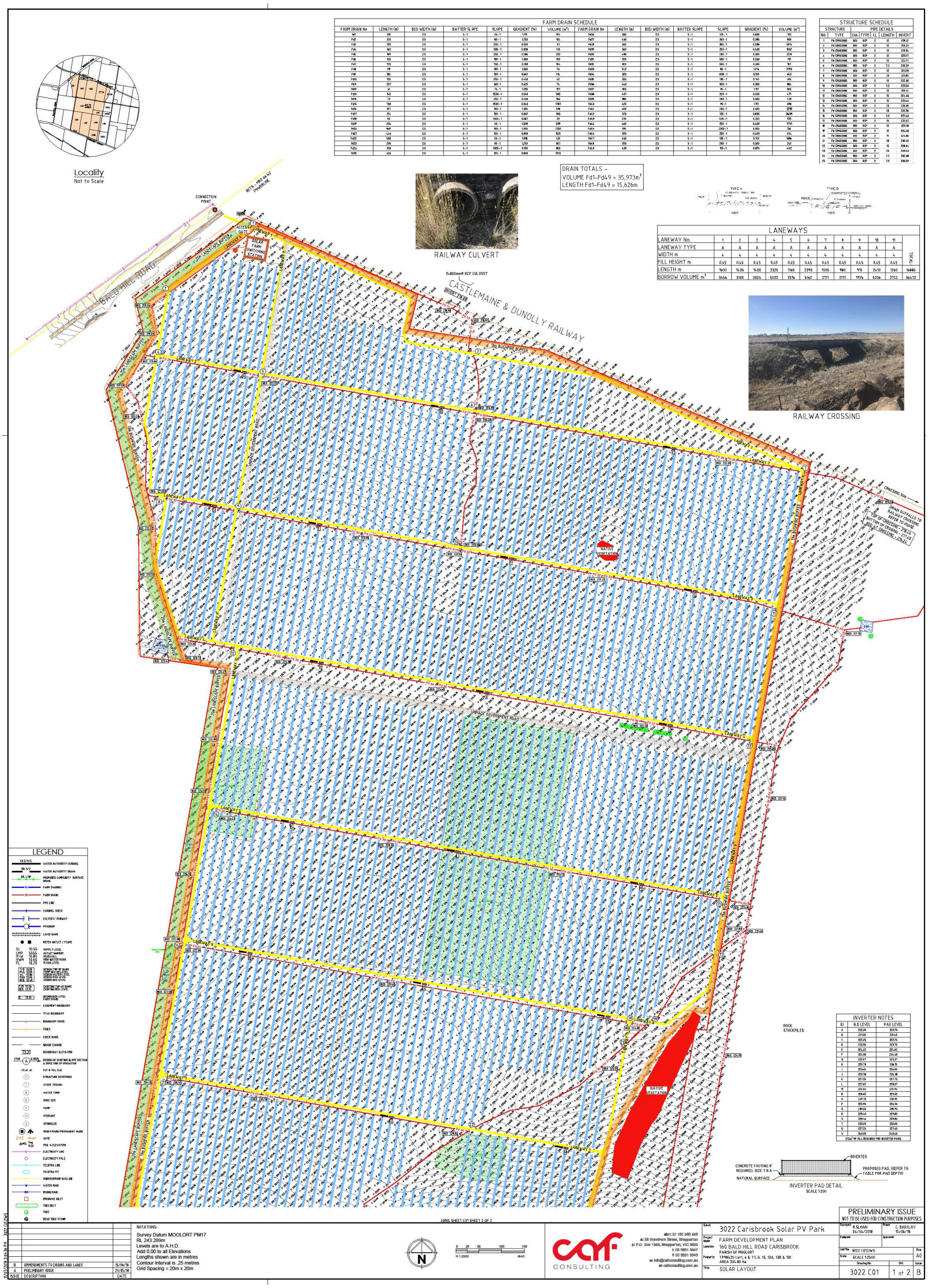
FIGURE 2 – Solar Panel Overlay.



FARM DRAIN SCHEDULE

FARM DRAIN No	LENGTH (m)	BED WIDTH (m)	BATTER SLOPE	SLOPE	GRADIENT (%)	VOLUME (m³)	FARM DRAIN No	LENGTH (m)	BED WIDTH (m)	BATTER SLOPE	SLOPE	GRADIENT (%)	VOLUME (m³)
Fd1	591	2.5	5:1	98:1	1.19	194	Fd16	286	2.5	5:1	126:1	0.833	192
Fd2	310	2.5	5:1	161:1	1.250	104	Fd17	446	2.5	5:1	249:1	0.345	368
Fd3	185	2.5	5:1	200:1	0.500	41	Fd18	540	2.5	5:1	166:1	0.286	1814
Fd4	160	2.5	5:1	338:1	0.333	119	Fd19	360	2.5	5:1	256:1	0.403	1092
Fd5	190	2.5	5:1	358:1	0.286	220	Fd20	490	2.5	5:1	280:1	0.320	2210
Fd6	126	2.5	5:1	188:1	1.000	189	Fd21	220	2.5	5:1	550:1	0.200	770
Fd7	120	2.5	5:1	158:1	0.658	164	Fd22	180	2.5	5:1	585:1	0.200	907
Fd8	178	2.5	5:1	188:1	1.002	79	Fd23	542	2.5	5:1	85:1	1.176	3799
Fd9	184	2.5	5:1	158:1	0.667	174	Fd24	303	2.5	5:1	1000:1	0.100	663
Fd10	120	2.5	5:1	250:1	0.400	42	Fd25	286	2.5	5:1	185:1	0.541	615
Fd11	257	2.5	5:1	188:1	0.625	74	Fd26	446	2.5	5:1	939:1	0.103	486
Fd12	61	2.5	5:1	76:1	1.333	101	Fd27	266	2.5	5:1	91:1	1.111	306
Fd13	145	2.5	5:1	2500:1	0.063	582	Fd28	407	2.5	5:1	224:1	0.455	477
Fd14	72	2.5	5:1	250:1	0.400	166	Fd29	280	2.5	5:1	280:1	0.400	478
Fd15	780	2.5	5:1	2500:1	0.063	1782	Fd30	425	2.5	5:1	90:1	1.111	698
Fd16	317	2.5	5:1	188:1	1.000	578	Fd31	469	2.5	5:1	281:1	0.320	1240
Fd17	214	2.5	5:1	158:1	0.667	260	Fd32	570	2.5	5:1	126:1	0.893	3639
Fd18	50	2.5	5:1	1900:1	0.067	29	Fd33	234	2.5	5:1	406:1	0.250	195
Fd19	286	2.5	5:1	45:1	1.539	599	Fd34	445	2.5	5:1	254:1	0.403	1795
Fd20	869	2.5	5:1	188:1	1.000	2108	Fd35	190	2.5	5:1	2000:1	0.050	56
Fd21	444	2.5	5:1	125:1	0.800	1021	Fd36	259	2.5	5:1	259:1	0.400	614
Fd22	580	2.5	5:1	64:1	1.496	431	Fd37	446	2.5	5:1	136:1	0.741	586
Fd23	280	2.5	5:1	80:1	1.250	807	Fd38	280	2.5	5:1	280:1	0.400	261
Fd24	380	2.5	5:1	1900:1	0.053	850	Fd39	406	2.5	5:1	95:1	1.053	402
Fd25	625	2.5	5:1	125:1	0.800	1915							

DRAIN TOTALS –
VOLUME Fd1–Fd49 = 35,973m³
LENGTH Fd1–Fd49 = 15,626m

STRUCTURE SCHEDULE

STRUCTURE		PIPE DETAILS			
NO.	TYPE	DIA	TYPE	CL	LENGTH	INVERT
1	Fd CROSSING	900	RCP	2	12	219.13
2	Fd CROSSING	900	RCP	2	12	218.23
3	Fd CROSSING	900	RCP	2	12	219.64
4	Fd CROSSING	900	RCP	2	12	220.11
5	Fd CROSSING	900	RCP	2	12	222.17
6	Fd CROSSING	900	RCP	2	12	218.39
7	Fd CROSSING	900	RCP	2	12	221.28
8	Fd CROSSING	900	RCP	2	21	221.81
9	Fd CROSSING	900	RCP	2	12	222.46
10	Fd CROSSING	900	RCP	2	12	222.26
11	Fd CROSSING	900	RCP	2	12	218.12
12	Fd CROSSING	900	RCP	2	15	221.46
13	Fd CROSSING	900	RCP	2	15	221.46
14	Fd CROSSING	900	RCP	2	21	226.26
15	Fd CROSSING	900	RCP	2	21	222.26
16	Fd CROSSING	900	RCP	2	12	227.68
17	Fd CROSSING	900	RCP	2	15	227.82
18	Fd CROSSING	900	RCP	2	12	225.19
19	Fd CROSSING	900	RCP	2	12	226.38
20	Fd CROSSING	900	RCP	2	21	224.86
21	Fd CROSSING	900	RCP	2	21	230.31
22	Fd CROSSING	900	RCP	2	15	228.61
23	Fd CROSSING	900	RCP	2	21	233.63
24	Fd CROSSING	900	RCP	2	12	232.38
25	Fd CROSSING	900	RCP	2	12	234.69

RAILWAY CULVERT

LANEWAYS

LANEWAY No.	1	2	3	4	5	6	7	8	9	10	11	TOTAL
LANEWAY TYPE	A	A	A	A	A	A	A	A	A	A	A	
WIDTH m	4	4	4	4	4	4	4	4	4	4	4	
FILL HEIGHT m	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
LENGTH m	1600	1435	1400	2325	1165	2390	1005	980	915	2470	1260	16845
BORROW VOLUME m³	3456	3188	3024	5022	2516	5162	2171	2117	1976	5206	2722	36472

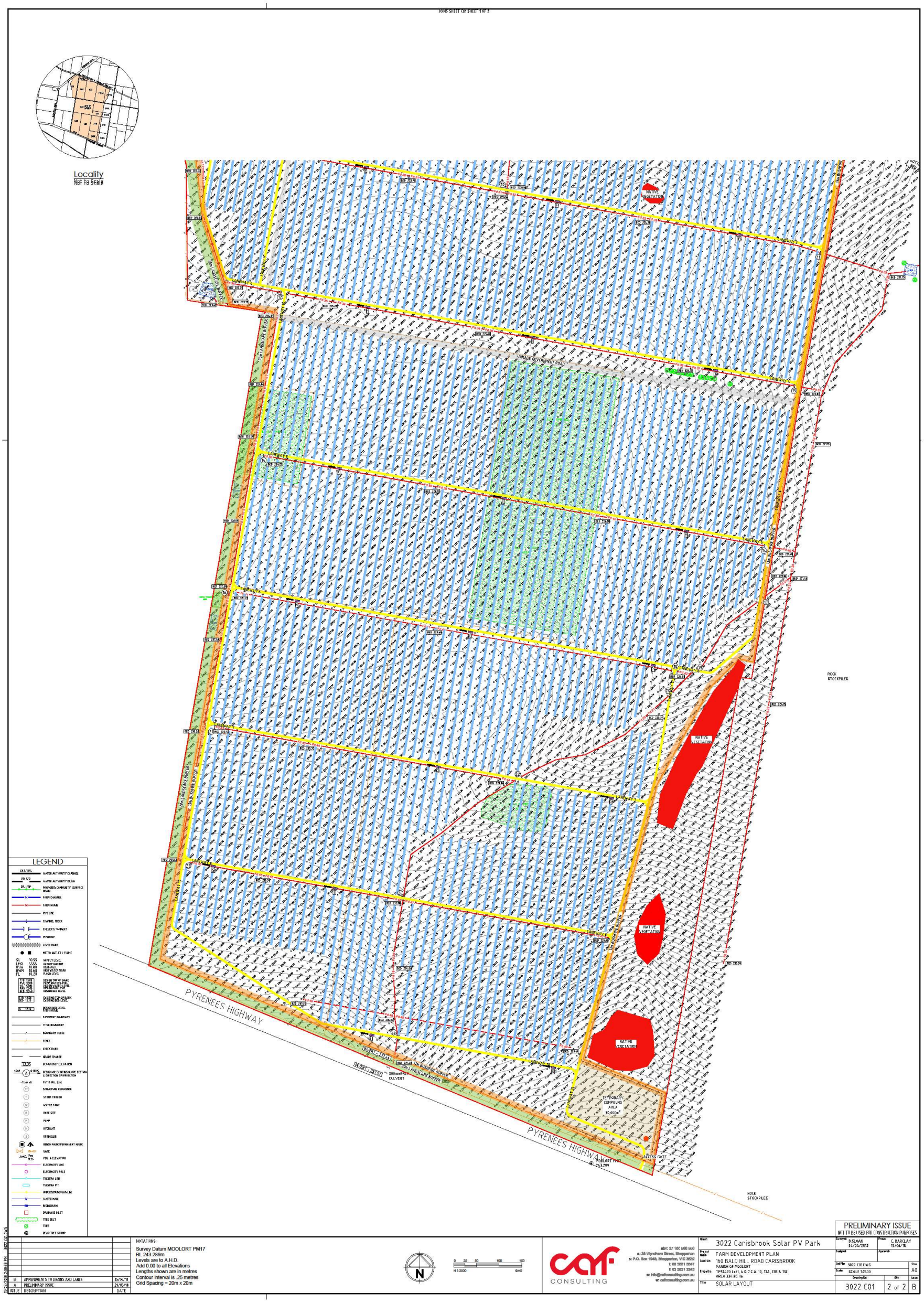
RAILWAY CROSSING

INVERTER NOTES

ID	N.G LEVEL	PAD LEVEL
A	222.39	222.79
B	221.06	221.46
C	222.25	222.75
D	223.30	223.70
E	224.22	224.62
F	224.81	225.16
G	222.97	223.37
H	225.79	226.13
I	225.66	226.06
J	223.78	224.18
K	223.35	223.75
L	223.67	224.07
M	224.24	224.74
N	224.62	224.82
O	223.76	224.16
P	225.79	226.24
Q	226.20	226.75
R	225.62	226.02
S	224.66	224.86
T	223.29	223.69
U	222.25	222.65
V	220.85	221.65

STOCK OF FILL REQUIRED PER INVERTER PADS

FIGURE 3 – Solar Panel, Access Tracks, Drainage Scheme, Structures, Solar Park Inverters & Buffer Zone.



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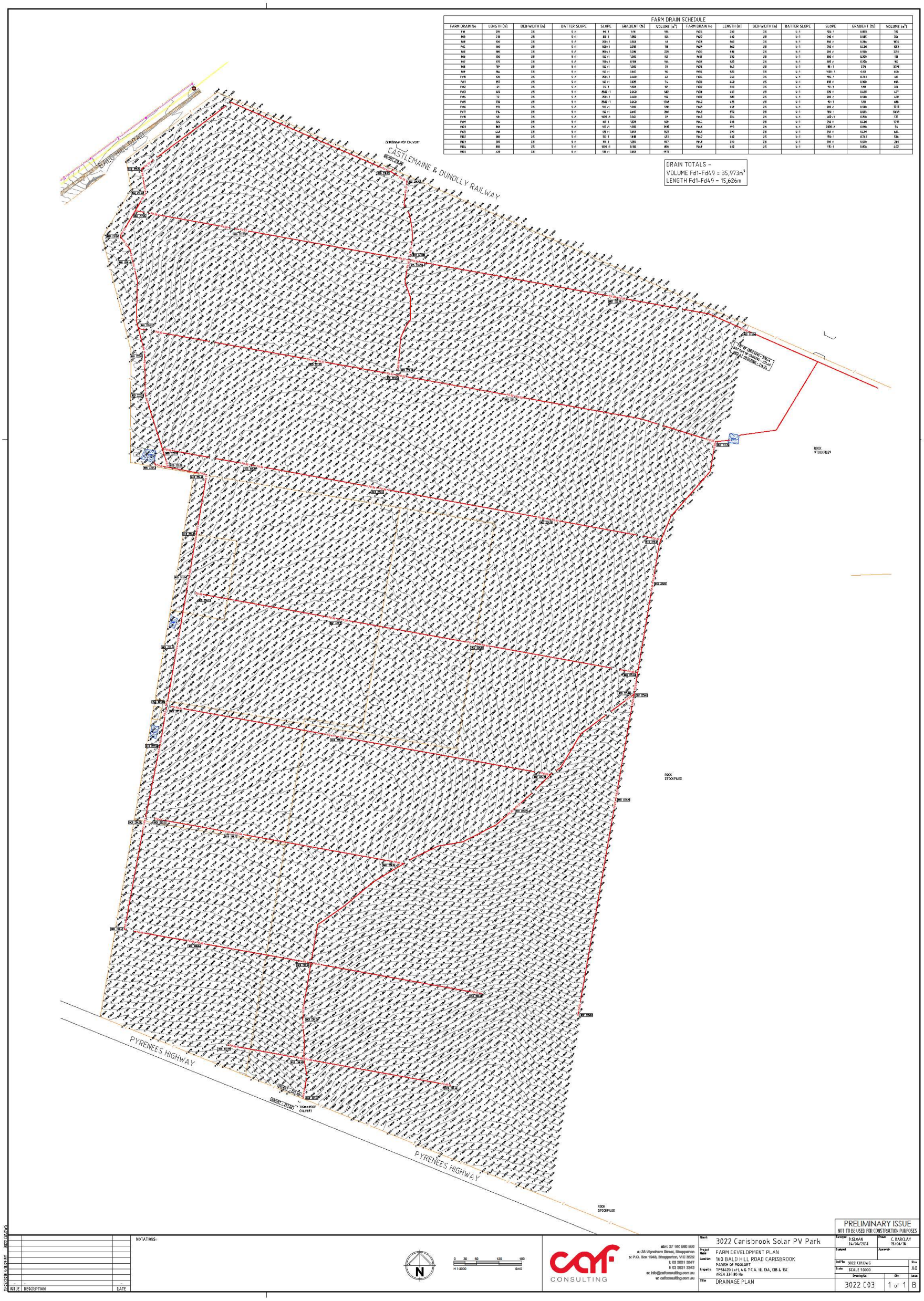

FIGURE 4 – Significant Drainage Lines.