APPENDIX F:
ADDITIONAL INFORMATION

Landscape Management Strategy

BERYL SOLAR FARM

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1 INTRODUCTION

1.1 BACKGROUND

First Solar (Australia) Pty Ltd proposes to develop a solar farm approximately 4km south of the Beryl locality and 6km west of the town of Gulgong. The proposal was placed on public exhibition on 26 April 2017 to 25 May 2017, and is currently being considered for approval.

1.1.1 Environmental context

Beryl is a small rural locality, accessed from the Castlereagh Highway in the Mid-Western Regional Local Government Area (LGA). The Mid-Western Regional LGA is located in eastern NSW approximately 300km from Sydney. Nearby towns in the area include Gulgong (6km), Mudgee (45km), Rylstone (94km) and Kandos (115km). The Castlereagh Highway is an important regional transport corridor near to the site.

The proposed Beryl Solar Farm location is on the edge of a rural residential area, in an area of moderate scenic quality and in close proximity (<1km) of some residences; 31 residences have been counted from aerial imagery within 1 km, including 5 rural residential locations, and 69 residences have been counted within 5km, including 2 urban and 6 rural residential locations.

Dominant vegetation types in the locality consist of Box Gum Woodland and include Rough-barked Apple (*Angophora floribunda*), Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*E. blakelyi*). These are present as scattered paddock trees as well as woodland remnants immediately surrounding the site. Additional vegetation communities in the area include derived grasslands of this community and riparian vegetation along river corridors.

1.1.2 Visual impacts

A Visual Impact Assessment (VIA) was prepared for the Beryl Solar Farm and addressed impacts of the Project on visual amenity. A summary of the key findings of the VIA was included in the Beryl Solar Farm Environmental Impact Statement (EIS). The EIS included mitigation measures to minimise and mitigate visual impacts. This included a detailed Visual Impact Management Plan.

1.2 SCOPE

This Landscape Management Strategy is a high level document, prepared to strategically address the mitigation measures listed in the Beryl Solar Farm EIS and Submissions Report. Additionally, it considers legislation and guidelines applicable to landscaping.

A detailed Visual Impact Management Plan, including detailed landscaping measures, would be prepared and implemented to fully satisfy the project's commitments.

2 OBJECTIVES

2.1 PURPOSE

The objective of this Strategy is to ensure that landscaping is planned, established and maintained to mitigate the visual impact of the operational solar farm infrastructure.

The key objective of the Strategy is to provide onsite vegetation screening for viewpoints 17, 18, 19 and 20 of the VIA (refer Figure 2-1). This would be aimed at 'breaking up' not blocking views of onsite infrastructure. Additionally, it would address views to and from the new residence on Lot 59 DP 755434. This is likely to include some onsite planting on this block, from key recreational and view windows near the residence, in consultation with the landowners.

2.2 TARGETS

The following targets have been established for the management of the visual amenity impacts during construction and operation of the project:

1. Ensure full compliance with the relevant legislative requirements, including EIS mitigation measures and CoA[1].
2. Perimeter planting as set out in Figure 5-1 for locations 17, 18, 19 and 20, in consultation with landowners of residences closest to these locations.
3. Consider supplementary planting for the new residence on Lot 59 DP 755434, in consultation with the landowner. This would be undertaken on Lot 59 DP 755434, to assist screening from key recreational areas and house views, in consultation with the landowner.
4. Produce a post construction audit to assess the effectiveness of the screening layout and augment if required.
5. Ensure landscaping is established and maintained during operation to achieve the requirements of this strategy.

[1] The project is not yet approved and no conditions of consent currently apply.

Figure 2-1 Viewpoints with respect to the proposed Beryl Solar Farm

3 LEGISLATIVE REQUIREMENTS

3.1 RELEVANT LEGISLATION AND GUIDELINES

Legislation and guideline relevant to landscaping management include:

- NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) Part 4 (conditions of consent, if project is approved)
- *AS 4419-2003 Soils for landscaping and garden use*
- *AS 2303:2015 Tree stock for landscape use*

As the project is not yet approved, the mitigation measures proposed in the EIA and updated in the Submissions Report provide the most current requirements for this strategy. Project commitments include:

> *A Visual Impact Management Plan would address the 'as built' visual impacts of the proposed solar farm. The plan would include:*
>
> - *Onsite vegetation screening, guided by the proposed screening, provided in Appendix D of the VIA report Appendix F.*
> - *Involvement of the most affected landowners (relevant to medium impact view locations). This may include increased onsite planting density in specific locations suggested by the landowners (for example, where the proposed solar farm would be visible from outdoor recreational areas).*
> - *Verification of predicted and actual impacts. This would improve the reliability of the measures and provide a trigger to undertake additional mitigation if required.*
>
> *(Guidance regarding these measures is provided in Appendix D of the VIA report Appendix F).*

4 CONSULTATION AND VERIFICATION PROCESS

A detailed Visual Impact Management Plan, including detailed landscaping measures, would be prepared and implemented in consultation with affected landholders. Affected landholders include those closest to locations 17, 18, 19 and 20 as well as the owner of Lot 59 DP 755434.

A verification process would be undertaken as part of the detailed plan to:

- Ensure that the infrastructure view extent is properly considered in defining the extents of the onsite perimeter planting and the types of species selected.
- Notify and include an avenue for input from affected landholders (those residences closest to the medium impact view locations, as nominated above).
- Augment the extent and type of planting if required, in consultation with affected landholders where relevant. This may include limited planting on neighbouring properties if agreed with the landholders.

This process can be set out in terms of activities prior to and after the construction of the infrastructure, as set out below.

Prior to or during construction, it is proposed to:

1. Mark out the extent of screening required for onsite perimeter planting based on the predicted impacts at all medium impact locations (refer to Figures 2-1, 5-1 and Appendix A).
2. Notify affected landholders regarding the proposed planting strategy.
3. Commence planting.

Post construction, it is proposed to:

1. Verify *actual impacts* at all medium impact locations (refer to Appendix A) and augment the extent of screening required for onsite perimeter planting if required.
2. Notify affected landholders regarding the proposed planting strategy and address any additional requirement for planting on private property if required at this time.

While the extent of planting and locations would be determined in consultation with landowners, the species selection should be derived from the native vegetation community present at the site, to:

- Assist the project to blend into the existing landscape elements
- Provide additional biodiversity benefits (habitat for native species).

Refer to Section 5.2 for further information.

5 LANDSCAPE IMPLEMENTATION

5.1 AREAS OF PLANTING

The location of proposed onsite screening is provided below. (Source NGH Environmental Submissions report, 2017).

Regarding perimeter planting placement (for view points 17, 18, 19 and 20), it is noted that:

- The aim of the perimeter plant screening is to break up the view of infrastructure and not eliminate it.
- Onsite plantings would be generally 1-2 rows deep and be located on the outside of the security fence, where feasible (so that it breaks up views of the fencing as well as onsite infrastructure).
- Trees within each row and the rows themselves can be spaced 3 to 5 metres apart.
- Relatively sparse plantings, rather than a formal 'hedge' effect, is considered more appropriate to the existing environment.

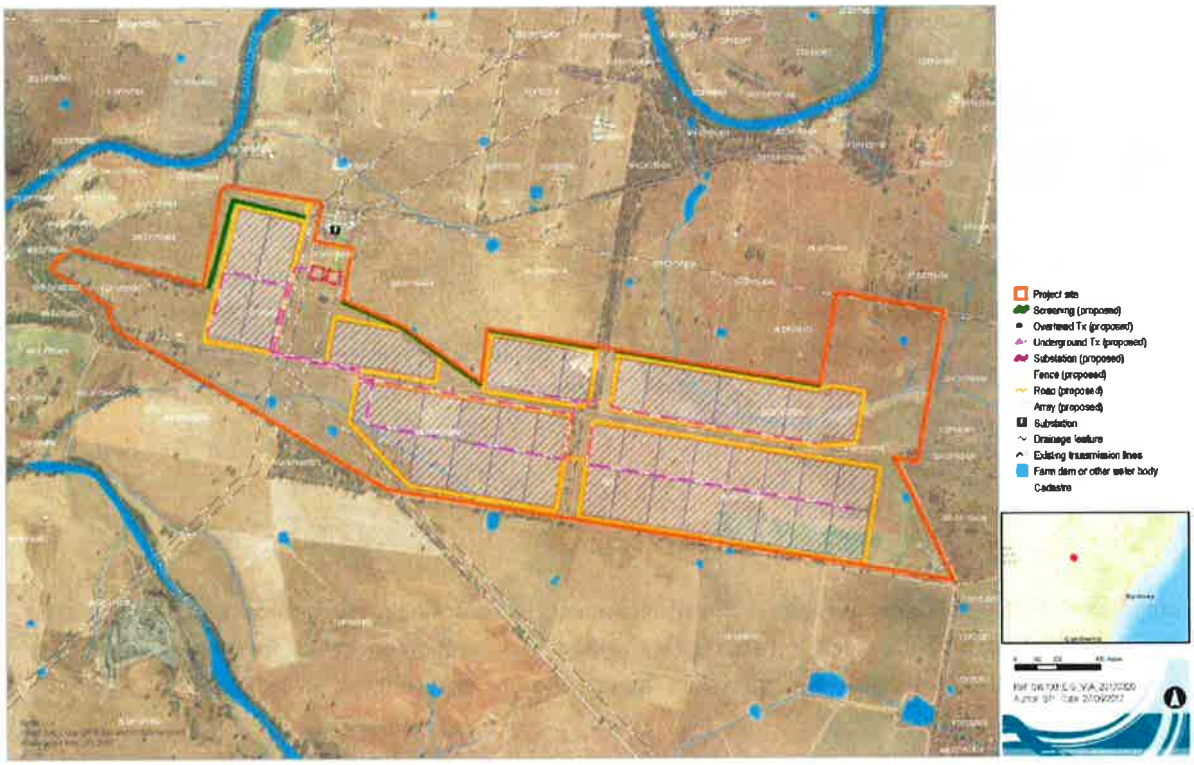

Figure 5-1 Proposed perimeter landscape planting for the proposed Beryl Solar Farm

5.2 METHODS OF PLANTING

5.2.1 *Establishment*

Planting should be undertaken as soon as practical in the construction process, as it will take time for the plants to establish and become effective as a screen. Seasonal requirements for planting should also be considered.

Tube stock will be planted in autumn with:

- Water crystals, or regularly watered until established.
- Tree guards, to provide some protection from wind and wildlife.
- Stock and herbivore fencing, if required.

Figure 5-2 Planting timing (DSE 2006)

While tube stock take longer to mitigate the visual impact than planting more mature trees, it is expected that the use of quality tube stock and assisted watering and protection during establishment will provide a more resilient and faster growing screen than the use of more mature trees.

This Strategy relies on:

- Planting as soon as possible in the construction process (the verification process may add to the extent but the main areas can be planted out as soon as the project is commenced).
- Use of quality seasoned tube stock.
- Maintenance (watering and protection from stock and other herbivores).
- Inclusion of 'pioneer species'. The species list includes pioneer species that grow rapidly and will be replaced by slower growing longer lived species over time (refer to Section 5.2.3 for further information).

5.2.2 *Sourcing of plant material*

Only hardened tube stock will be planted out.

The tube stock to be used in vegetation enhancement of the site would be grown from plant material that has been sourced from the local area (preferably within 10km of the site). Tube stock would be grown or

supplied by a reputable local nursery or supplier and would be of a sufficient size and quantity to establish successfully at the site.

When sourcing material, priority will be given to plants grown in at least 7.5 cm pots with sufficient root and shoot growth. Plants in this size pot are recommended as they are physiologically dynamic, small enough to plant, but large enough to cope with transplant shock. Tube stock would be of a good size with sufficient, healthy, root and shoot growth. Ideally a shoot:root ratio between 1 and 3 is ideal. Plants that are small, diseased or pot bound would not be accepted as they are unlikely to thrive.

5.2.3 *Species to be used*

The plant species to be used in the screen are recommended to be native, derived from the naturally occurring vegetation community in this area (Box Gum Woodland). These would most likely include the three species found onsite: Rough-barked Apple (*Angophora floribunda*), Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*E. blakelyi).*

Additional species selection would be undertaken in consultation with affected near neighbours and a botanist or landscape architect, taking into account the impact of shading on the array as well as the character of existing vegetation in the locality.

It is noted that the final species selection must be detailed with reference to a local inspection to consider surrounding vegetation character. It is noted that species diversity onsite is low due to grazing and a more extensive consideration of species that would blend into the landscape is required than is presented in this Strategy.

'Pioneer species' would be included. These species grow rapidly and will be replaced by slower growing longer lived species over time. Such species, which include wattles, can be expected to reach the maximum height of infrastructure (approximately 3m) in 2-3 years.

5.3 MAINTENANCE

Maintenance requirements would include:

- The screen would be maintained for the operational life of the solar farm.
- Dead plants would be replaced in consideration of the effectiveness of the screen (i.e. it is expected that smaller pioneers will be replaced by larger specimens. In this sense, it may not be necessary to replace every senescing tree if the screen is being effective).
- Pruning and weeding would be undertaken as required to maintain the screen's visual amenity and effectiveness in breaking up views.

6 REFERENCES

DSE (2006) Native Vegetation Revegetation planting standards – Guidelines for establishing native vegetation for net gain accounting. Victorian Government, Department of Sustainability and Environment, East Melbourne.

NGH Environmental (2017). Submissions report: Beryl Solar Farm, Report prepared for First Solar, July 2017.NGH Environmental (2017).

Visual Impact Assessment: Beryl Solar Farm, Report prepared for First Solar, March 2017.

APPENDIX A VIEWPOINTS REQUIRING MITIGATION

Medium impact view locates, sourced from Table 5.3 of the VIA (NGH Environmental 2017) Note: in the panorama provided:

- *Green is the estimated visible extent of arrays, excluding shielding by trees/infrastructure: this is the extent of the array most likely to be observable.*
- *Yellow areas are likely to be shielded by trees/infrastructure: infrastructure in this area is unlikely to be visible.*
- *Red is the estimated extent of the solar farm site boundary within the view field.*

ID	LCU	Viewpoint	Proximity	LMZ objective	Contrast	Visual impact	Comment
17	Rural residential	Residential	Foreground	B Protect dominant visual features	Medium	Medium	The infrastructure would be moderately dominant from this location. The horizontal view of infrastructure would be limited due to exiting vegetation. Views would be broken up to a minor extent by existing roadside vegetation. This landscape can absorb some change but dominant visual features should be protected. The contrast of the low height solar array infrastructure is considered acceptable. **Mitigation is recommended but not required.** Additional vegetation planting on the site's northern boundary would minimise visual impacts further.

ID	LCU	Viewpoint	Proximity	LMZ objective		Contrast	Visual impact	Comment
18	Rural residential	Residential	Foreground	B	Protect dominant visual features	Medium	Medium	The infrastructure would be moderately dominant from this location. The horizontal view of infrastructure would be limited due to the location of existing vegetation and placement of infrastructure. Views would be screened to a minor extent by existing roadside vegetation This landscape can absorb some change but dominant visual features should be protected. The contrast of the low height solar array infrastructure is considered acceptable. **Mitigation is recommended but not required.** Additional vegetation planting on the site's north-east corner would minimise visual impacts further.

ID	LCU	Viewpoint	Proximity	LMZ objective		Contrast	Visual impact	Comment
19	Rural residential	Residential	Foreground	B	Protect dominant visual features	Medium	Medium	The infrastructure would be moderately dominant from this location. The horizontal view of infrastructure would be limited by topography and existed vegetation. Views would be screened to a minor extent by existing roadside vegetation. This landscape can absorb some change but dominant visual features should be protected. The contrast of the low height solar array infrastructure is considered acceptable. **Mitigation is recommended but not required.** Additional vegetation planting on the site's northern boundary would minimise visual impacts further.

ID	LCU	Viewpoint	Proximity	LMZ objective		Contrast	Visual impact	Comment
20	Rural residential	Road	Foreground	B	Protect dominant visual features	Medium	Medium	The infrastructure would be moderately dominant from this location. The horizontal view of infrastructure from the closest receiver at this location (which backs onto the solar site) may be expansive. Views would be broken up to a minor extent by existing buildings and vegetation. This landscape can absorb some change but dominant visual features should be protected. The contrast of the low height solar array infrastructure is considered acceptable. **Mitigation is recommended but not required.** Additional vegetation planting on the site's northern boundary would minimise views further.

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Proposed Solar Farm, Beryl New South Wales

Hydrological and Hydraulic Analysis

Project No. 1712
Date: 31 August 2017

Prepared for: First Solar (Australia) P/L

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Flood Mapping

1.0 INTRODUCTION

Footprint (NSW) Pty. Ltd. (*Footprint*) has been engaged by First Solar (Australia) Pty. Ltd. (*First Solar*) to undertake a hydrological and hydraulic analysis over an existing ephemeral watercourse that currently traverses the north east portion of the subject site.

The purpose of the analysis is to define the flood behaviour, including depth of inundation, over the ephemeral watercourse, in order to guide the minimum design elevation of infrastructure within the subject area and to determine the potential impact of this infrastructure on the existing flood behaviour.

1.1. Scope of Works

The scope of works for the project includes:

1. Review available background information including site survey, topographic maps, proposed development plans.
2. Undertake hydrologic calculations to determine peak flows arriving at the site from the east and through the railway embankment for the 5, 10, 20, 50 and 100 year ARI events.
3. Undertake hydraulic modelling (using HEC-RAS) to determine the depth and extent of flooding over the ephemeral watercourse described above for each of the above rainfall events.
4. Preparation of a concise hydrological and hydraulic report defining the methodology and result of the above investigation, including appending of HEC-RAS output.

2.0 SUBJECT SITE

The subject site is described as Lot 20 DP1173059 and is located approximately 4 kilometers due west of the township of Gulgong and adjacent to the eastern fringe of the township of Beryl in central New South Wales. The site location in relation to Gulgong and Beryl is shown in Figure 1.

Figure 1: Location of Subject Site

The site consists of an area of approximately 300 hectares and is bisected in an east-west direction by the Gulgong to Maryvale non-operational railway line. The site is currently used for grazing and, with the exception of a number of scattered trees, is largely devoid of significant vegetation, other the pasture.

An ephemeral watercourse traverses the north eastern portion of the site which can be best described as a wide flat depression typically devoid of defined banks. Anecdotally it is understood that following periods of heavy rainfall water ponds in the watercourse to the southern side of the northern site boundary. This evidence is supported by the visible difference in vegetation cover over the wetted area.

An aerial view of the subject site showing the ephemeral watercourse described above is depicted in Figure 2.

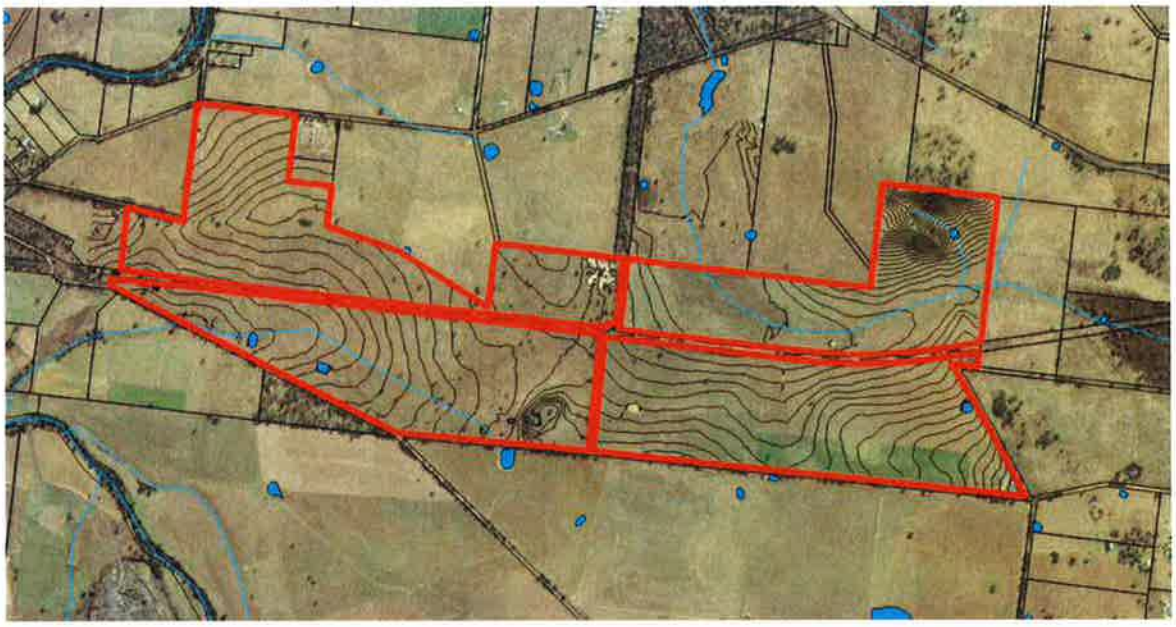

Figure 2: Aerial View of Subject Site

Elevations over the site range from RL405.8m AHD to RL447.6m AHD as depicted in Figure 3.

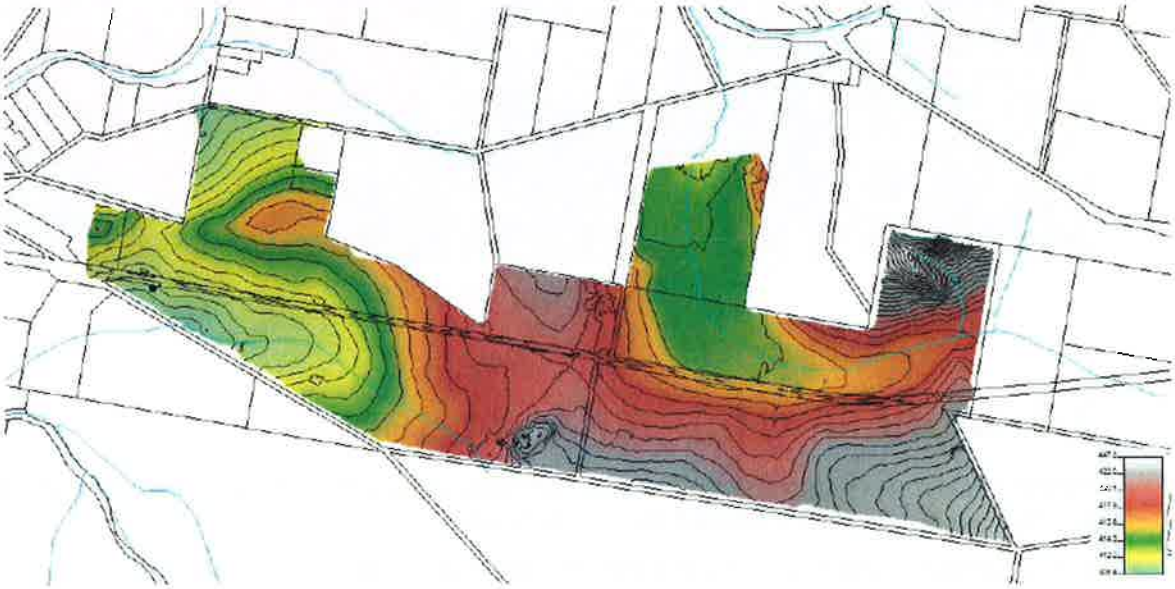

Figure 3: Terrain Analysis over Subject Site (1m contour interval)

3.0 HYDROLOGICAL MODELLING

3.1. Catchment Area

The catchment areas contributing to the ephemeral watercourse at the northern boundary of the subject site was estimated to be 11.15km^2 and was determined using 10m contour data obtained through NSW Government Spatial Services. The approximate extent of the contributing catchment is shown in Figure 4.

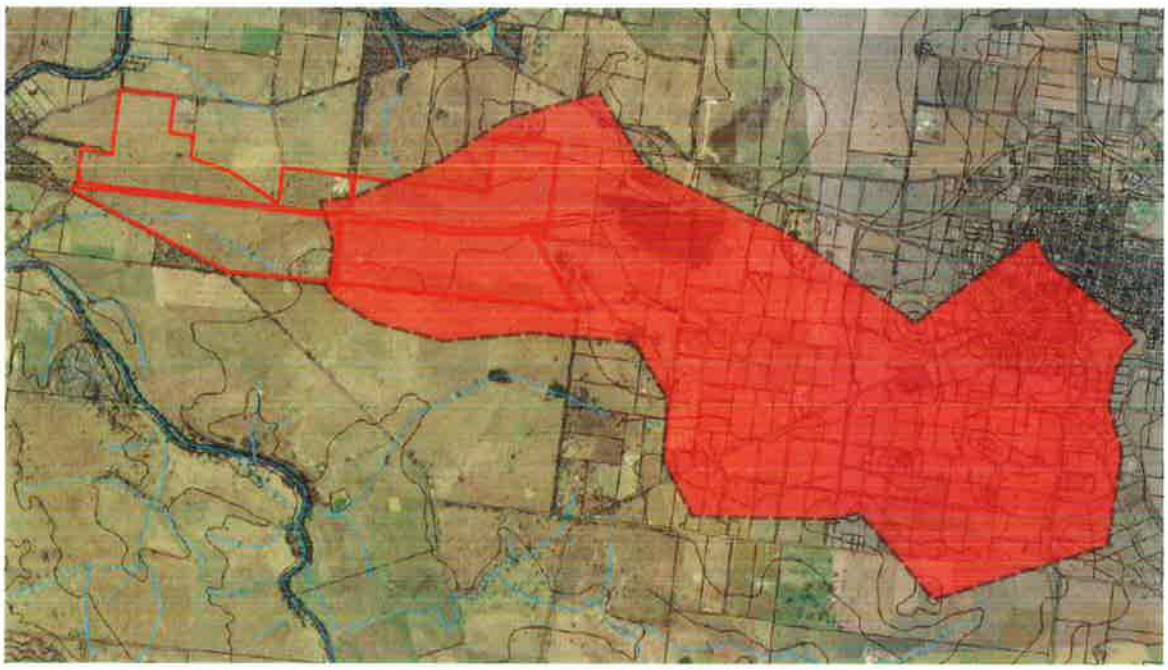

Figure 4: Catchment Plan

3.2. Modelling Input Parameters

Hydrological modelling was conducted in DRAINS using a RAFTS storage routing model, and the catchment was modelled as a single node.

The parameters adopted for hydrological modelling are shown in Table *1*.

Table 1: Hydrological Parameters Adopted

Parameter	Value Adopted	Justification/Source
Impervious Area Initial Loss (mm)	1	Typical value representative of hard paved areas and as suggested by the DRAINS manual
Impervious Area Continuing Loss (mm/h)	0	Typical value representative of hard paved areas.
Pervious Area Initial Loss (mm)	13.0	Recommended value for Central NSW obtained through ARR 2016 data hub (refer Appendix A)
Pervious Area Continuing Loss (mm/h)	2.1	Recommended value for Central NSW obtained through ARR 2016 data hub (refer Appendix A)
BX	1	RAFTS Default
Sub-catchment Area (ha)	1,150	As per Section 3.1
Impervious Area (%)	5	Value considered representative of rural lands on the urban fringe
Sub-catchment Slope (%)	1.5	Calculated from contour information and length of catchment.
Manning's n	0.025	Typical value for rural pasture lands

3.3. Rainfall Data

IFD design rainfall depth data was derived in accordance with Australian Rainfall and Runoff (2016) using the Bureau of Meteorology's 2016 Rainfall IFD on-line Data System.

A copy of the Rainfall depth for Durations, Exceedance per Year (EY) and Annual Exceedance Probabilities (AEP) table is included in Appendix B.

3.4. Results

The DRAINS Model was run for storm durations ranging from 30 minutes to 24 hours and hydrographs for the median storm for the range of events modelled are shown in Figure 5.

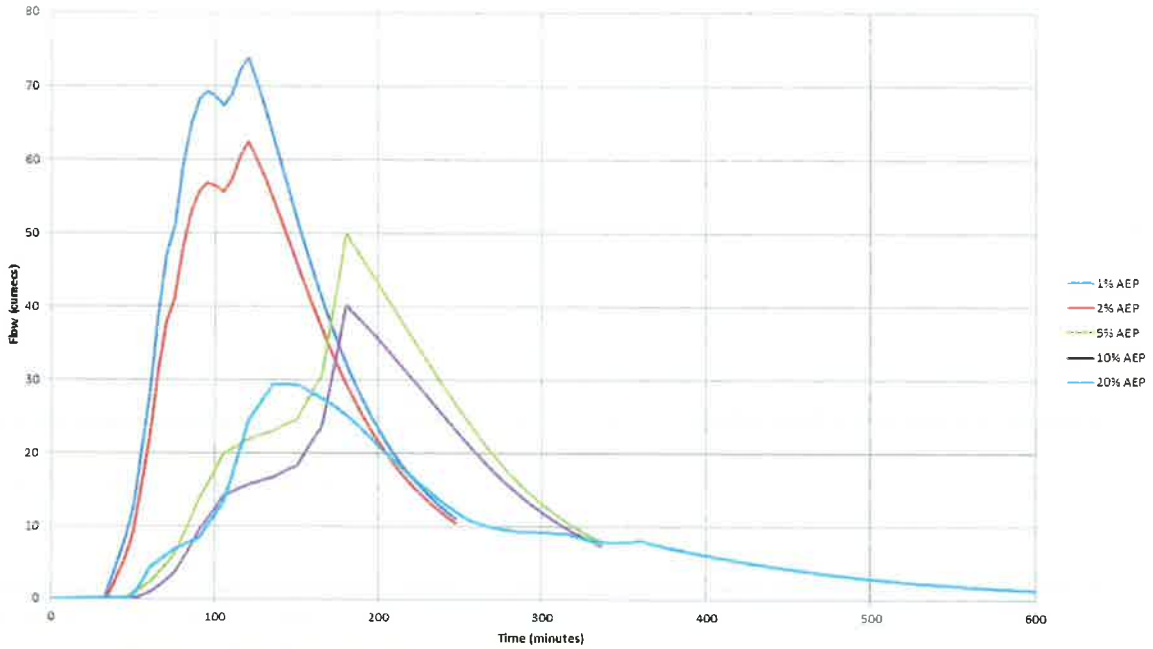

Figure 5: Median Flood Hydrographs Derived from Hydrological Model

The peak flows derived in DRAINS were compared to those derived using the Australian Rainfall and Runoff Regional Flood Frequency Estimation (RFFE) Model and the results are shown in Table 2 and Figure 6.

Table 2: Comparison of Peak Flows to Regional Flood Frequency Estimation Model

AEP	Peak Flow Rate (cumecs)			
	DRAINS	Regional Flood Frequency Estimation Model		
		Discharge	RFFE Lower (5%)	RFFE Upper (95%)
20%	29.4	22.8	9.87	52.3
10%	40.1	36.1	15.8	82.7
5%	49.8	53.1	23.1	122
2%	62.5	82.3	35.4	192
1%	73.9	111	47	262

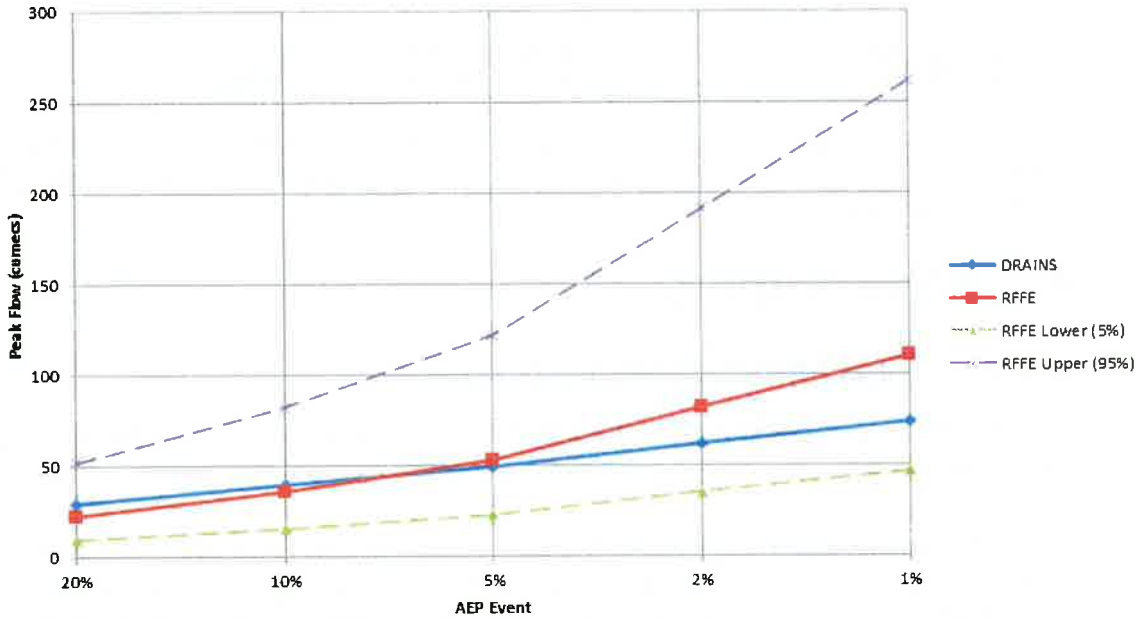

Figure 6: Comparison of Peak Flows to Regional Flood Frequency Estimation Model

The comparison of results shows a very good correlation between peak flows derived using DRAINS and the RFFE method for events up to and including the 5% AEP event, however for events in excess of the 5% AEP the peak flows derived using DRAINS are less than those derived using the RFFE method, but still well within the upper and lower confidence limits.

The difference in peak flows for events in excess of the 5% AEP are attributed to the size of the subject catchment in relation to the reference catchments used to derive flows in the RFFE, where all reference catchments were in excess of 100km^2.

The results derived using the DRAINS model are therefore considered appropriate for use in this project.

Outputs from the RFFE method are included in Appendix C.

4.0 HYDRAULIC MODELLING

Hydraulic modelling was conducted using an unsteady two-dimensional HEC-RAS model (Version 5.0.3) run in mixed flow regime to enable both subcritical and supercritical flow regimes to be assessed.

4.1. Model Inputs

4.1.1. Two Dimensional Domain

A digital elevation model (DEM) of the subject site was established using the detailed field survey compiled by de Witt Consulting. A copy of the detailed field survey is included in Appendix D.

The 5m DEM grid was imported into HEC-RAS and used as the basis for development of a 10m x 10m terrain model. Given the watercourse is a broad flat depression without defined banks a 10m x 10m grid was considered appropriate to adequately represent the existing terrain profile.

A two dimensional flow area (i.e. active cells) was defined over the subject watercourse over an extent considered large enough to accommodate the expected flows. The extent of the two-dimensional flow area is shown in Figure 7.

The entire two-dimensional flow area was assigned a Manning's n value of 0.025 which is considered representative of the current condition of the land as grazed pasture.

4.1.2. Boundary Conditions

The flow hydrographs derived using DRAINS and shown in Figure 5 were used to define the upstream boundary condition for each event. The upstream boundary was extended over the full width of the two-dimensional domain along the upstream face. This approach allows the model to appropriately distribute the flow to the cells along the boundary condition line that are wet. At any given time step, only a portion of the boundary condition line may be wet, thus only the cells in which the water surface elevation is higher than their outer boundary face terrain will receive water.

Flows leaving the two-dimensional area were defined with a normal depth downstream boundary condition with a friction slope of 0.18% which is based on the gradient of the land at the location of the boundary. The friction slope method uses the Manning's equation to compute a normal depth for each given flow, based on the cross section underneath the two-dimensional boundary condition line and is computed on a per cell basis. This boundary condition line similarly extended over the full width of the two-dimensional domain along the downstream edge.

The location and extent of the upstream and downstream boundary condition lines is shown in Figure 7.

Figure 7: Two Dimensional Flow Area and Hydraulic Boundary Conditions

4.2. Results

Results of the hydraulic modelling are included in Appendix E and include the following:

Figure 1.1 – Extent of 1% and 20% AEP Flood Events
Figure 2.1 – 1% AEP Flood Levels and Depths
Figure 2.2 – 1% AEP Flood Velocities
Figure 3.1 – 2% AEP Flood Levels and Depths
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Figure 4.2 – 5% AEP Flood Velocities
Figure 5.1 – 10% AEP Flood Levels and Depths
Figure 5.2 – 10% AEP Flood Velocities
Figure 6.1 – 20% AEP Flood Levels and Depths
Figure 6.2 – 20% AEP Flood Velocities

The results shown that in the 1% AEP flood depths over the upper, more topographically constrained, half of the watercourse are typically in the order of 400 to 500mm, whilst in the lower half the flood depths are typically in the order of 300 to 400mm with a localised increase of up to about 500mm adjacent to the northern site boundary.

The 20% AEP flood depths are typically in the order of 100 – 200mm lower than the 1% AEP flood depths.

In the 1% AEP flood velocities of between 1.0 and 2.0m/s are predicted to occur within the upper half of the watercourse reducing to around 0.7m/s at the northern site boundary.

5.0IMPACT OF PROPOSED WORKS

The proposed works consist of the construction of a 170 hectare tracker mounted solar array field with associated underground electrical collection lines, an electrical substation, and operation and maintenance building, with the latter facilities located on high ground in the north western portion of the lot adjacent to the existing Beryl substation.

It is understood the solar modules will be erected on a frame supported on piers at an approximate grid spacing of 6 x 6 metres.

Within the area of inundation the mounting height of the solar module frames should be designed such that the lower edge of the module is clear of the predicted 1% AEP flood level so as not to impact on existing flood behaviour and to prevent the infrastructure from being damaged as a result of flooding. In the event of a significant flood event the modules can be rotated to provide maximum clearance from the panels to the ground to keep them positioned well above the flood level.

The addition of the solar arrays and their associated infrastructure will result in an increase in surface roughness over the site, from grazed pasture to a regular grid of steel piers.

The change in floodplain roughness associated with the proposed development was assessed using the Modified Cowan Method for Floodplain Roughness and is shown in Table 3. It demonstrates that the roughness is anticipated to slightly increase as a result of the development.

Table 3: Modified Cowan Method for Estimation of Floodplain Roughness

Roughness Component	Existing (Grazed Pasture)	Proposed (Solar Array)
Floodplain Material (n_b)	0.020	0.020
Degree of Irregularity (n_1)	0.001	0.001
Variation in Floodplain Cross Section (n_2)	N/A	N/A
Effect of Obstructions (n_3)	0.000	0.003[1]
Amount of Vegetation (n_4)	0.004	0.004
Total (n)	0.025	0.028

[1] Based on an obstruction of 2.5% of the available flow area (i.e. 150mm piers at 6m intervals)

The hydraulic model was re-run to assess the impact of an increase in surface roughness on flood behaviour for the 1% AEP event and the results in included in Figure 7.1 in Appendix E.

The results show that the increase in floodplain roughness over the area of the proposed solar modules is anticipated to result in localised increases in flood levels of up to 30mm in the upper part of the watercourse where velocities are highest.

Importantly the modelling demonstrates that the changes in flood levels are principally isolated to the subject site, with the exception of very minor (less than 5mm) increases on the adjacent property to the north.

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APPENDIX A
BOM ARR 2016 Hub Data

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	149.517
Latitude	-32.37
Selected Regions	
Temporal Patterns	

Region Information

Data Category	Region
River Region	Macquarie-Bogan Rivers
ARF Parameters	Central NSW
Temporal Patterns	Central Slopes

Data

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are NOT FOR USE in urban areas

Storm Initial Losses (mm)	13.0
Storm Continuing Losses (mm/h)	2.1

Layer Info

Time Accessed	30 August 2017 09:21AM
Version	2016_v1

Temporal Patterns

code	CS
Label	Central Slopes

Layer Info

Time Accessed	30 August 2017 09:21AM
Version	2016_v2

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APPENDIX B
ARR 2016 IFD Data

Australian Government
Bureau of Meteorology

Location

Label: Beryl Solar Farm

Easting: 736726.871

Northing: 6415946.393

Zone: 55

Latitude: Nearest grid cell: 32.3625 (S)

Longitude: Nearest grid cell: 149.5125 (E)

IFD Design Rainfall Depth (mm)

Issued: 30 August 2017

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	1.83	2.04	2.71	3.18	3.66	4.32	4.84
2 min	3.06	3.41	4.54	5.32	6.11	7.14	7.95
3 min	4.25	4.74	6.29	7.38	8.47	9.92	11.0
4 min	5.33	5.93	7.88	9.24	10.6	12.4	13.9
5 min	6.29	7.00	9.29	10.9	12.5	14.7	16.4
10 min	9.84	10.9	14.5	17.1	19.7	23.2	26.0
15 min	12.2	13.5	18.0	21.2	24.4	28.8	32.3
30 min	16.3	18.2	24.1	28.4	32.7	38.6	43.3
1 hour	20.6	22.9	30.5	35.8	41.2	48.5	54.2
2 hour	25.4	28.3	37.6	44.1	50.5	59.2	66.0
3 hour	28.8	32.0	42.5	49.7	57.0	66.6	74.2
6 hour	35.9	39.9	52.9	61.9	70.8	82.9	92.3
12 hour	45.0	50.2	66.6	78.0	89.4	105	118
24 hour	55.9	62.3	83.2	98.0	113	135	152
48 hour	67.1	74.9	101	120	139	168	192
72 hour	73.0	81.7	110	131	153	186	214
96 hour	76.9	86.0	116	139	162	197	227
120 hour	79.7	89.2	121	144	167	204	235
144 hour	82.1	91.8	124	147	171	208	239
168 hour	84.1	94.1	127	150	174	210	241

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

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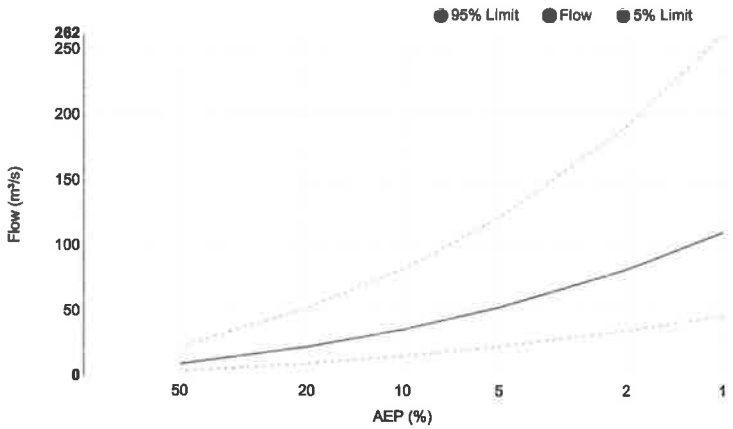
APPENDIX C
RFFE Method Results

Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	9.59	3.97	22.9
20	22.8	9.87	52.3
10	36.1	15.8	82.7
5	53.1	23.1	122
2	82.3	35.4	192
1	111	47.0	262

Statistics

Variable	Value	Standard Dev
Mean	2.271	0.526
Standard Dev	0.984	0.111
Skew	0.071	0.026

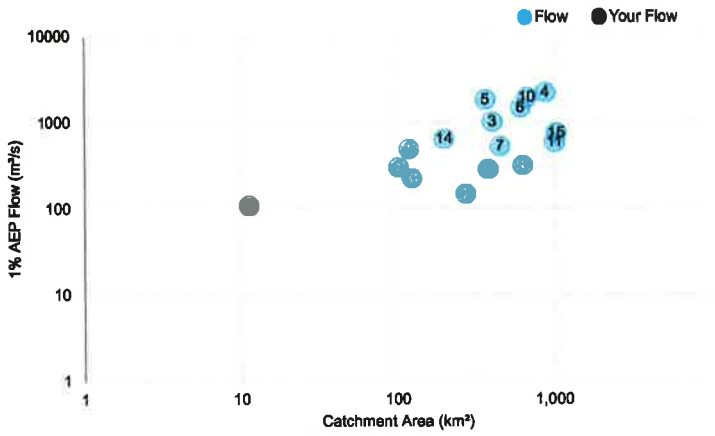
Note: These statistics come from the nearest gauged catchment. Details.

Correlation

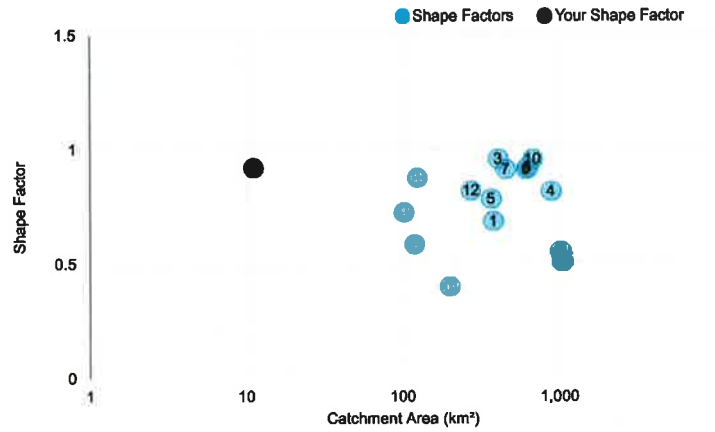
1.000		
-0.330	1.000	
0.170	-0.280	1.000

Note: These statistics are common to each region. Details.

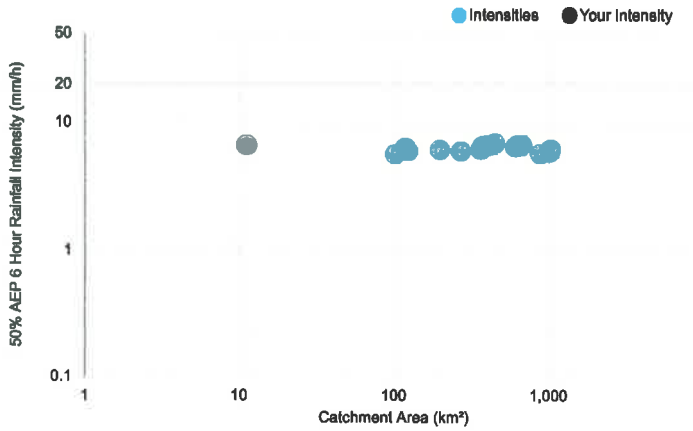
1% AEP Flow vs Catchment Area



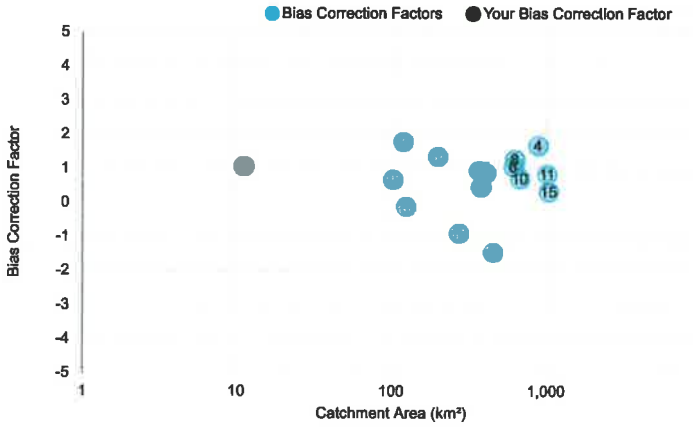
Shape Factor vs Catchment Area



Intensity vs Catchment Area



Bias Correction Factor vs Catchment Area



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TXT PDF Nearby JSON

Input Data

Date/Time	2017-08-29 09:08

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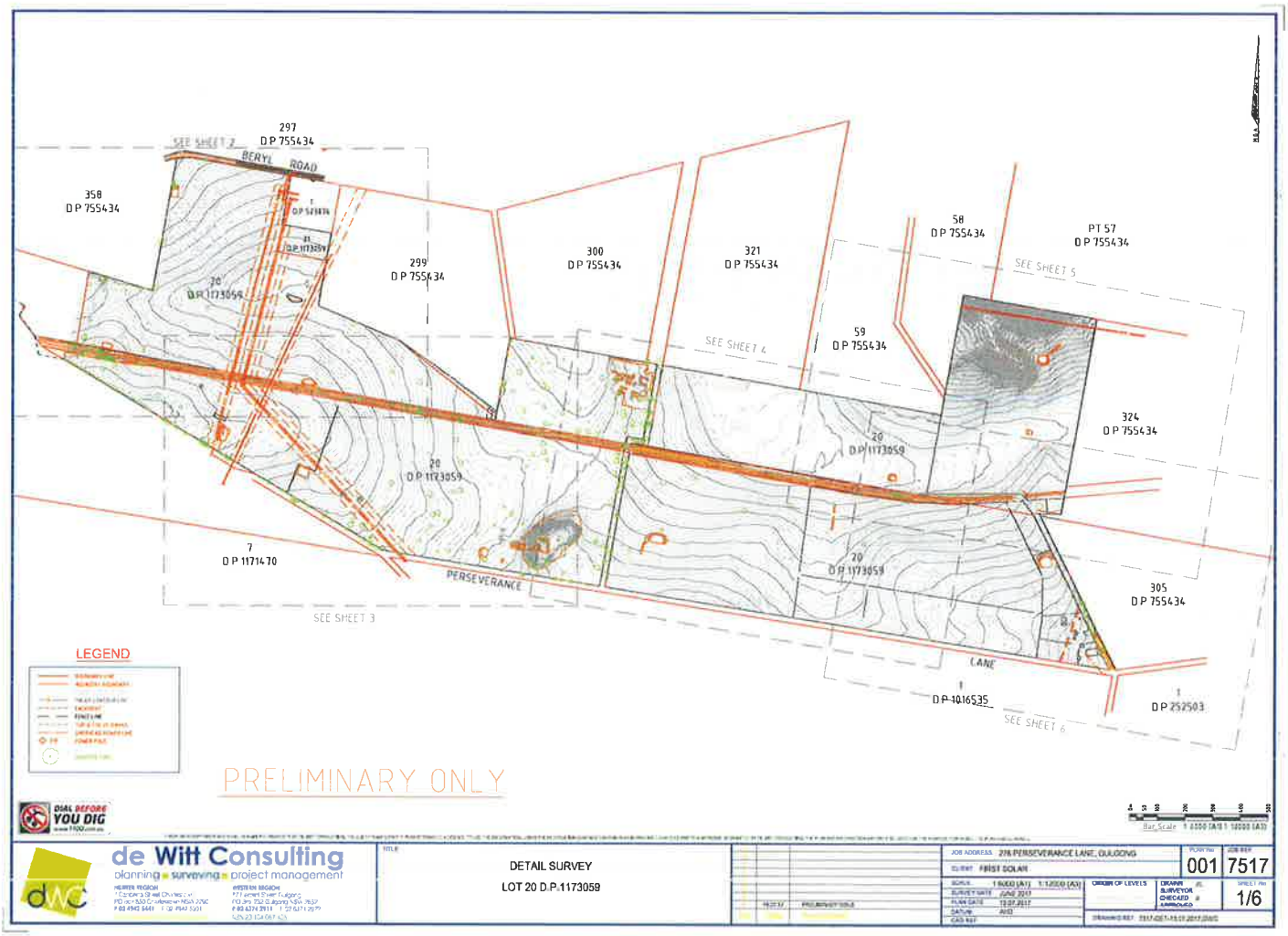
APPENDIX D
Site Survey



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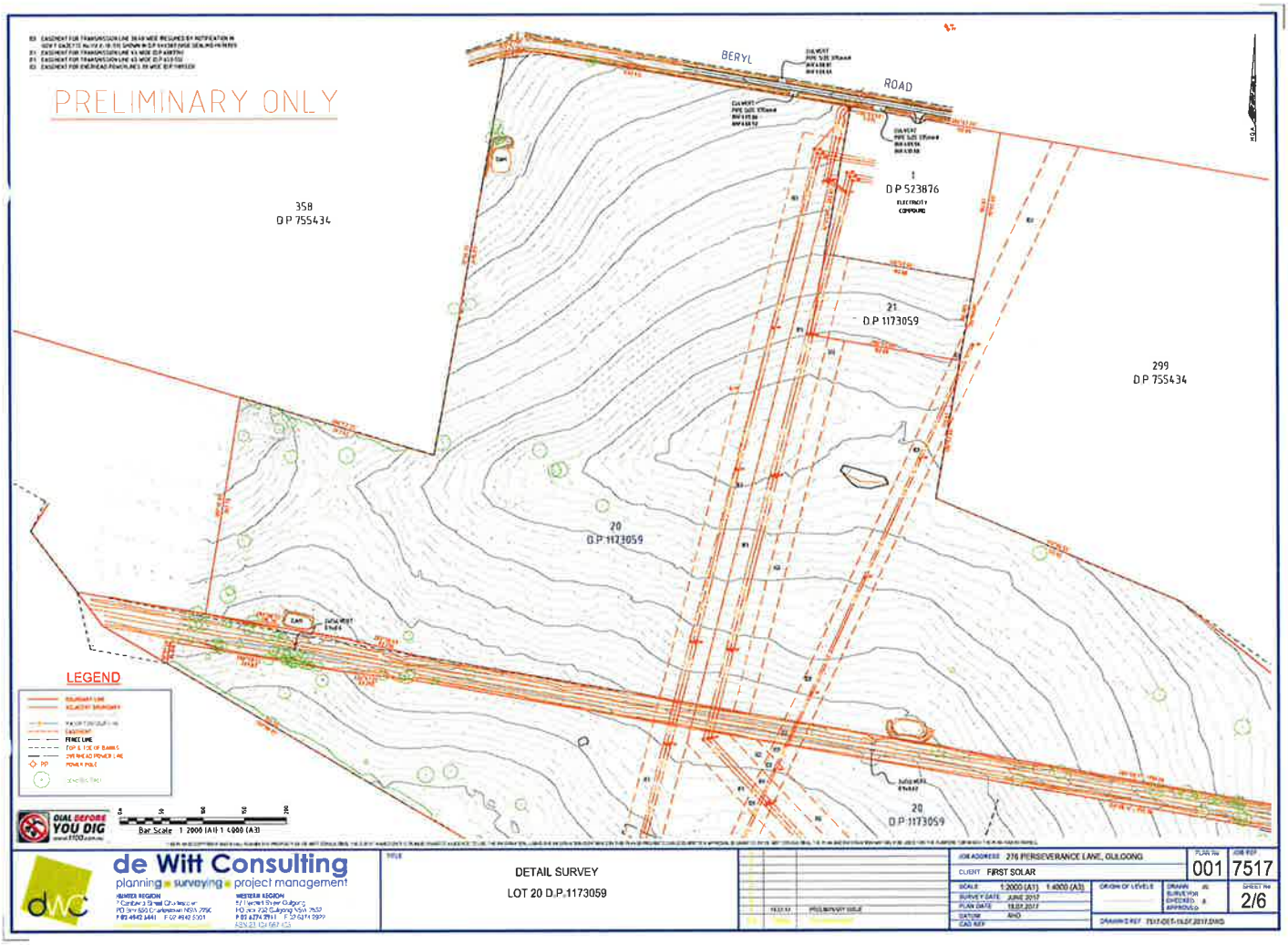
DETAIL SURVEY
LOT 20 D.P.1173059

JOB ADDRESS 276 PERSEVERANCE LANE, DULGONG
CLIENT FIRST SOLAR
SURVEY DATE JUNE 2017
PLAN DATE 12.07.2017
DATUM AHD
ORIGIN OF LEVELS
DRAWN
SURVEYOR
CHECKED
APPROVED

PLAN No 001
JOB REF 7517
SHEET No 1/6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1
D.P 523876
21
D.P 1173059
299
D.P 755434
20
D.P 1173059
20
D.P 1173059
LEGEND
FENCE LINE
DIAL BEFORE YOU DIG
Bar Scale 1 2000 (A1) 1 4000 (A3)
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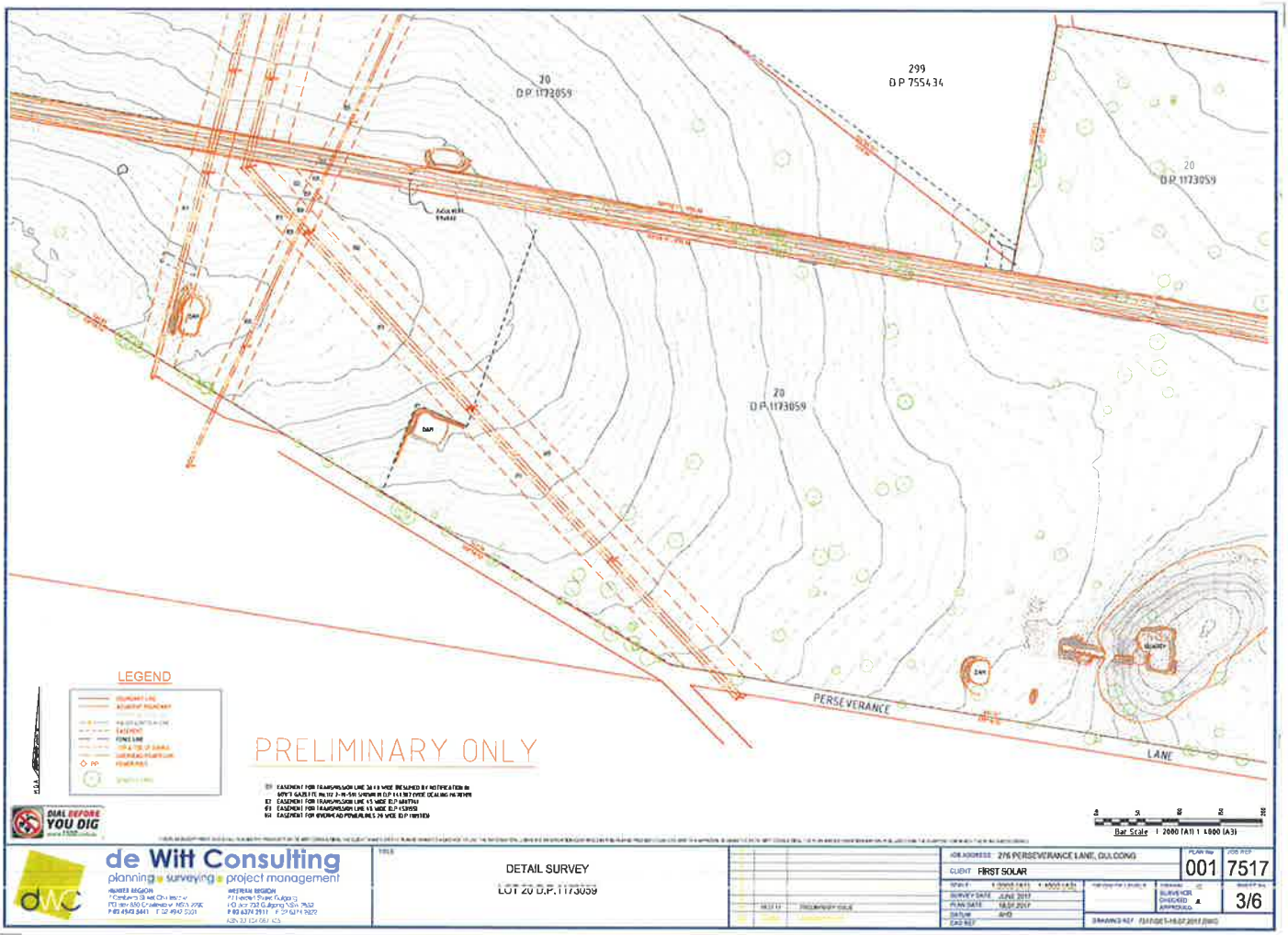
DETAIL SURVEY
LOT 20 D.P.1173059
JOB ADDRESS 276 PERSEVERANCE LANE, GULGONG
CLIENT FIRST SOLAR
SCALE 1:2000 (A1) 1:4000 (A3)
SURVEY DATE JUNE 2017
PLAN DATE 19.07.2017
DATUM AHD
CAD REF
ORIGIN OF LEVELS
DRAWN JG
SURVEY FOR
CHECKED S
APPROVED
PLAN No 001
JOB REF 7517
SHEET No 2/6



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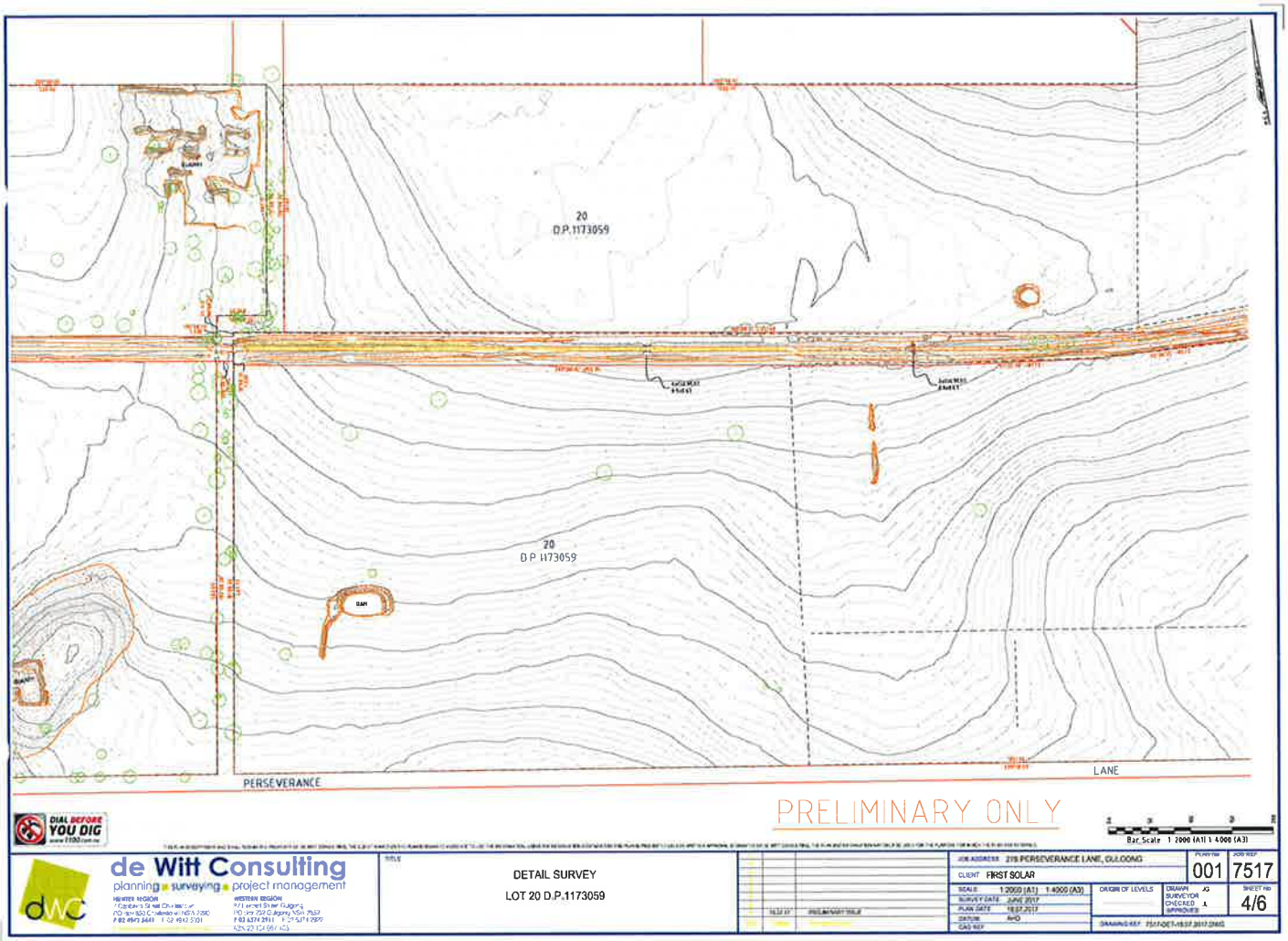
DETAIL SURVEY
LOT 20 D.P.1173059

ADDRESS: 276 PERSEVERANCE LANE, GULGONG
CLIENT: FIRST SOLAR
SURVEY DATE: JUNE 2017
PLAN DATE: MAY 2017
DATUM: AHD

PLAN No: 001
JOB REF: 7517
SHEET No: 3/6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D.P.1173059
20
D.P.1173059
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LANE
PRELIMINARY ONLY
DIAL BEFORE YOU DIG
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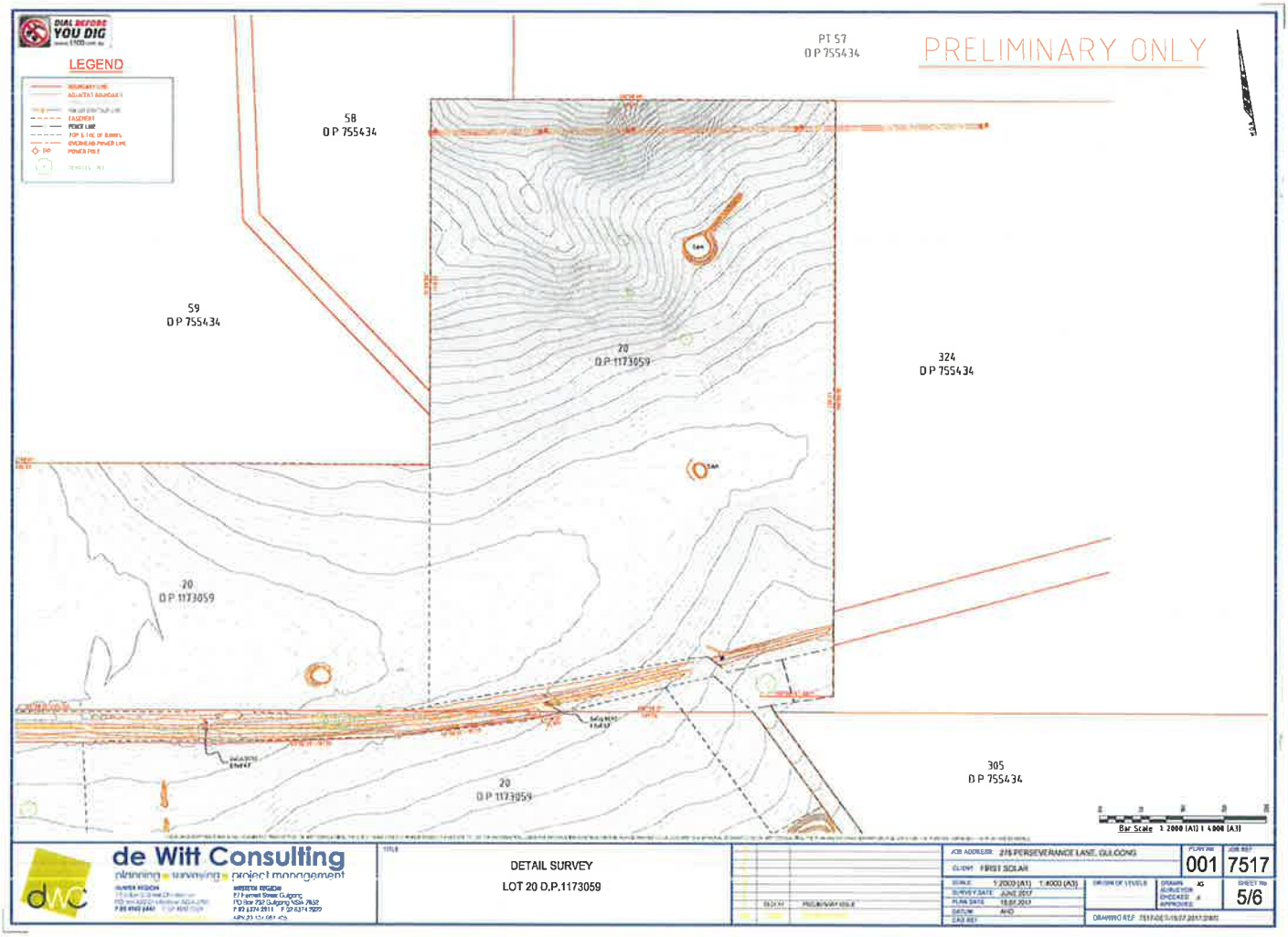
LOT 20 D.P.1173059
JOB ADDRESS 215 PERSEVERANCE LANE, GULGONG
CLIENT FIRST SOLAR
001
7517
4/6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PRELIMINARY ONLY
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D P 1173059
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Bar Scale 1 2000 (A1) 1 4000 (A3)
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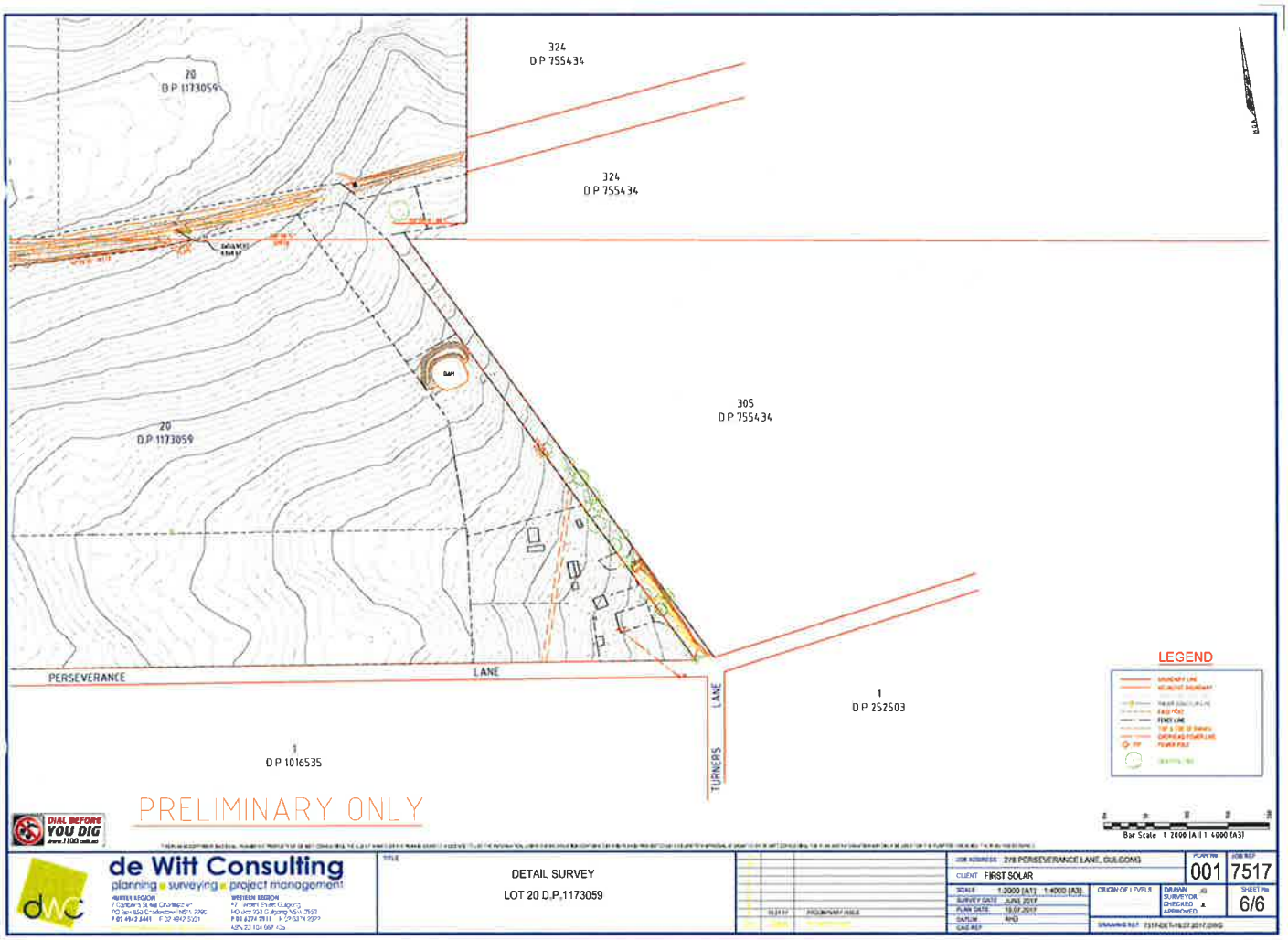

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DETAIL SURVEY

LOT 20 D.P.1173059

2YB PERSEVERANCE LANE, GULGONG

CLIENT FIRST SOLAR

SCALE 1:2000 (A1) 1:4000 (A3)

SURVEY DATE APRIL 2017

PLAN DATE 10.07.2017

DATUM AHD

CAD REF

ORIGIN OF LEVELS

DRAWN

SURVEYOR

CHECKED

APPROVED

PLAN No 001

JOB REF 7517

SHEET No 6/6

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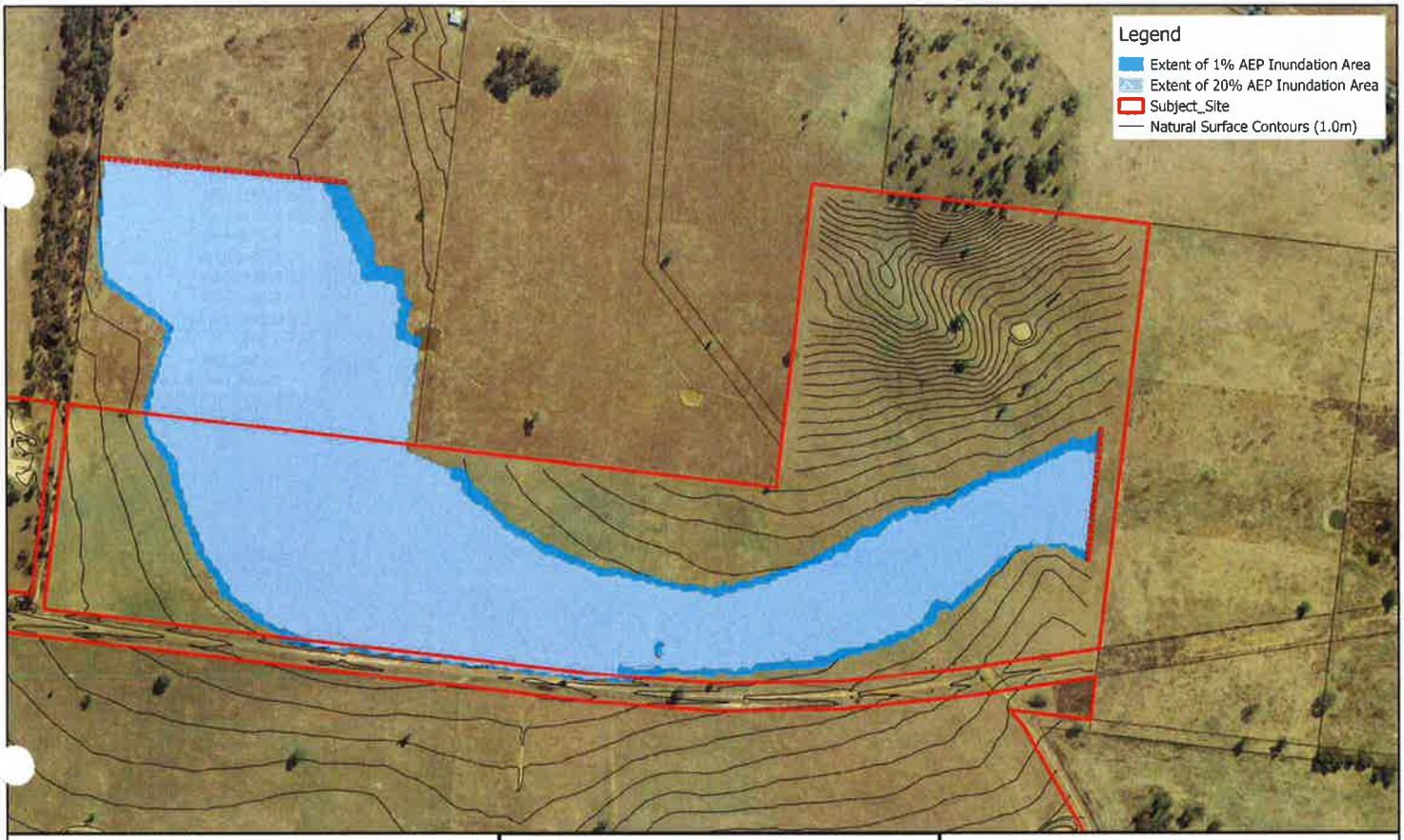
APPENDIX E
Flood Mapping



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15 meehan drive, kiama downs,
nsw 2533 p: (02) 4237 6770

First Solar.

0 100 200 m
Scale 1:5,000 at A3

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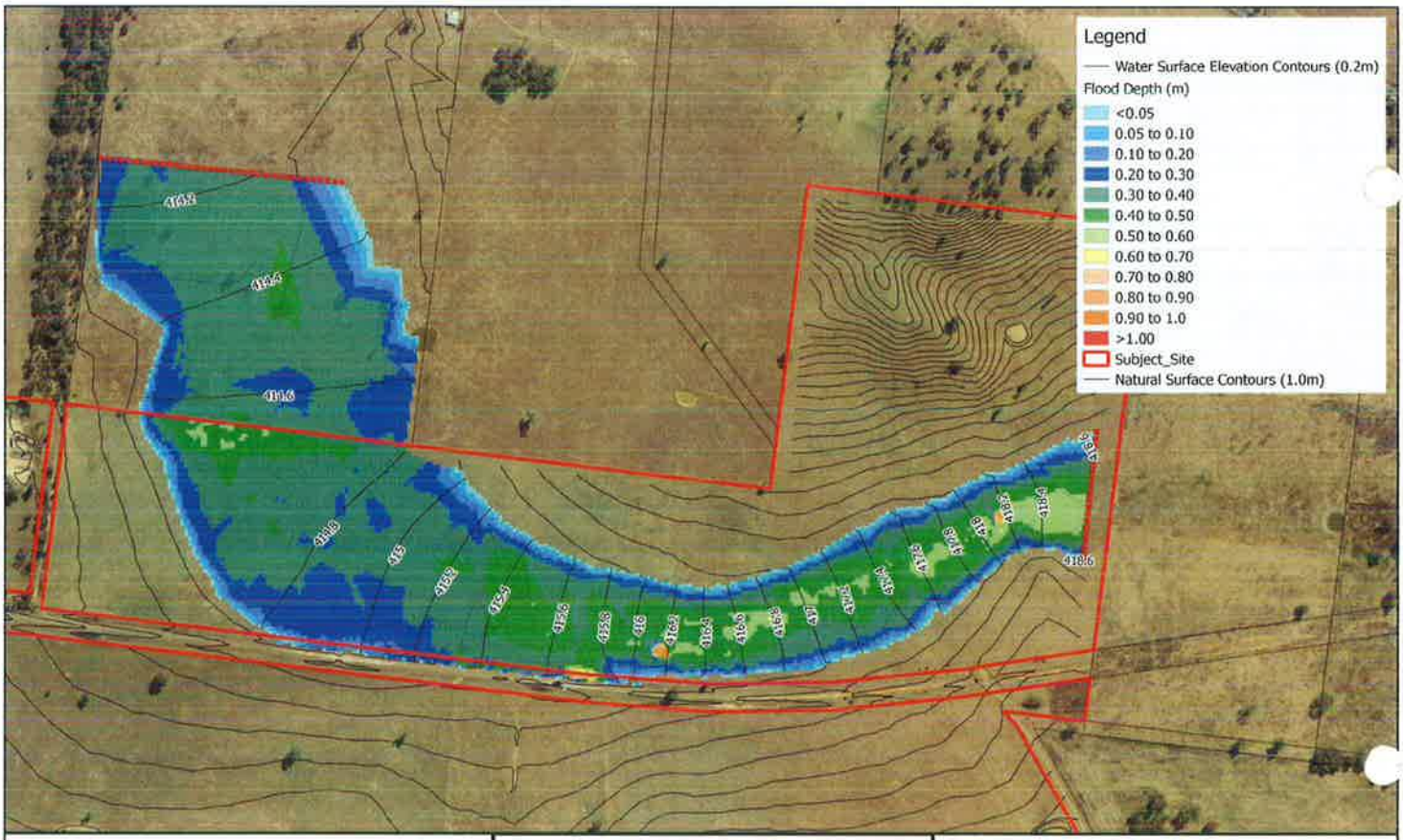
PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS
FIGURE 1.1
Extent of 1% and 20% AEP Flood Events
Rev 1 - 30 August 2017



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First Solar.

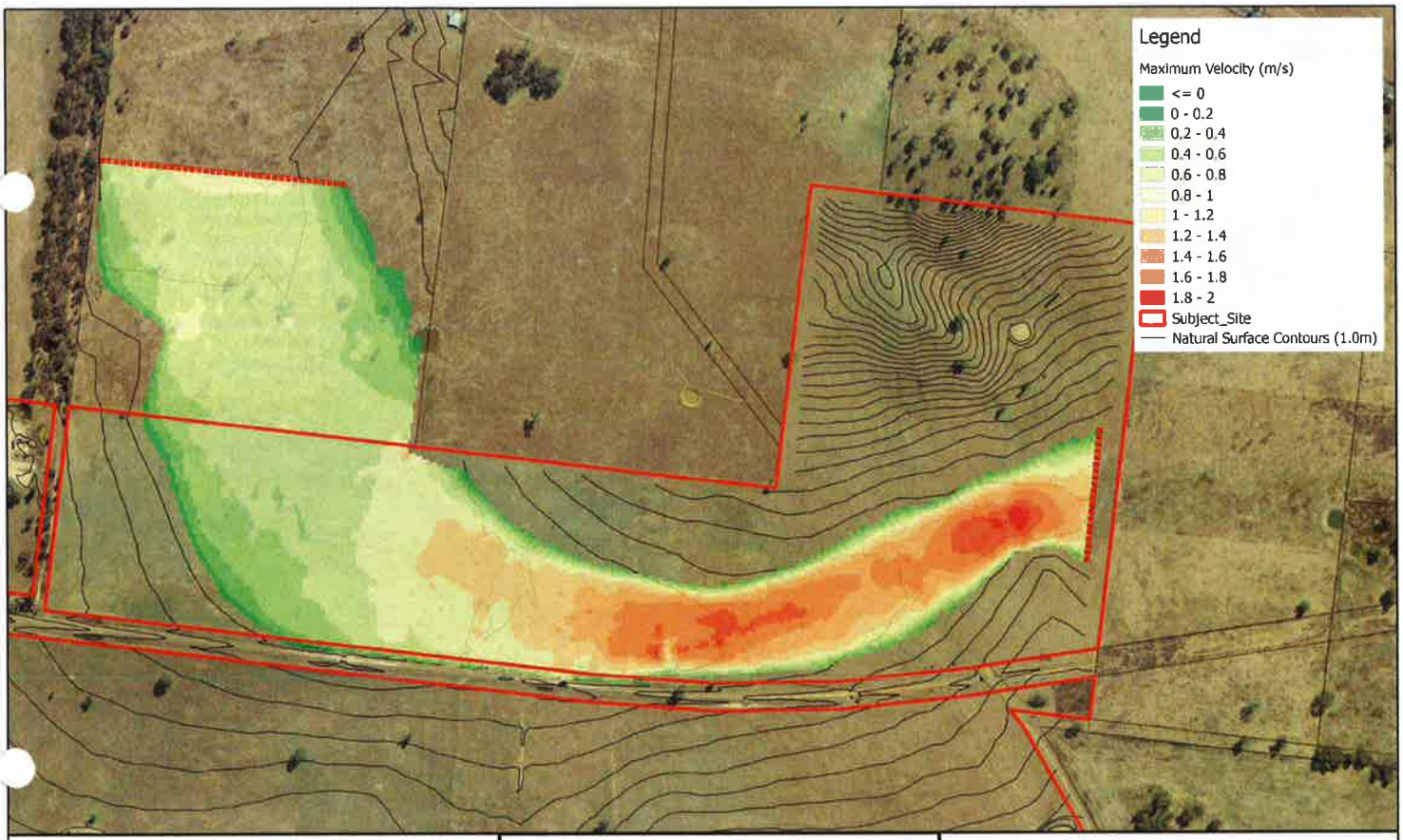
0 100 200 m

Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 2.1
1% AEP Flood Levels and Depths

Rev 1 30 August 2017



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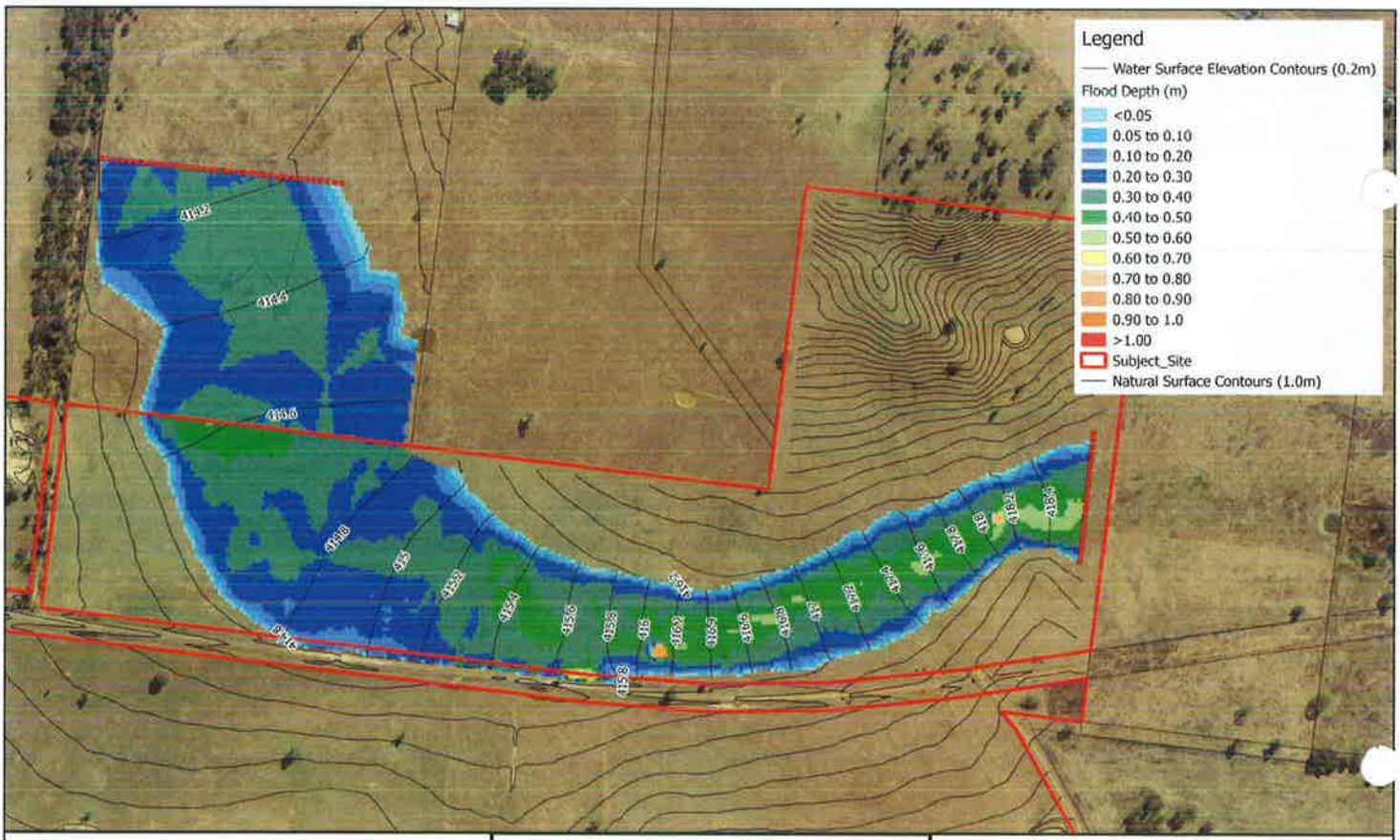
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 2.2
1% AEP Flood Velocities

Rev I 30 August 2017



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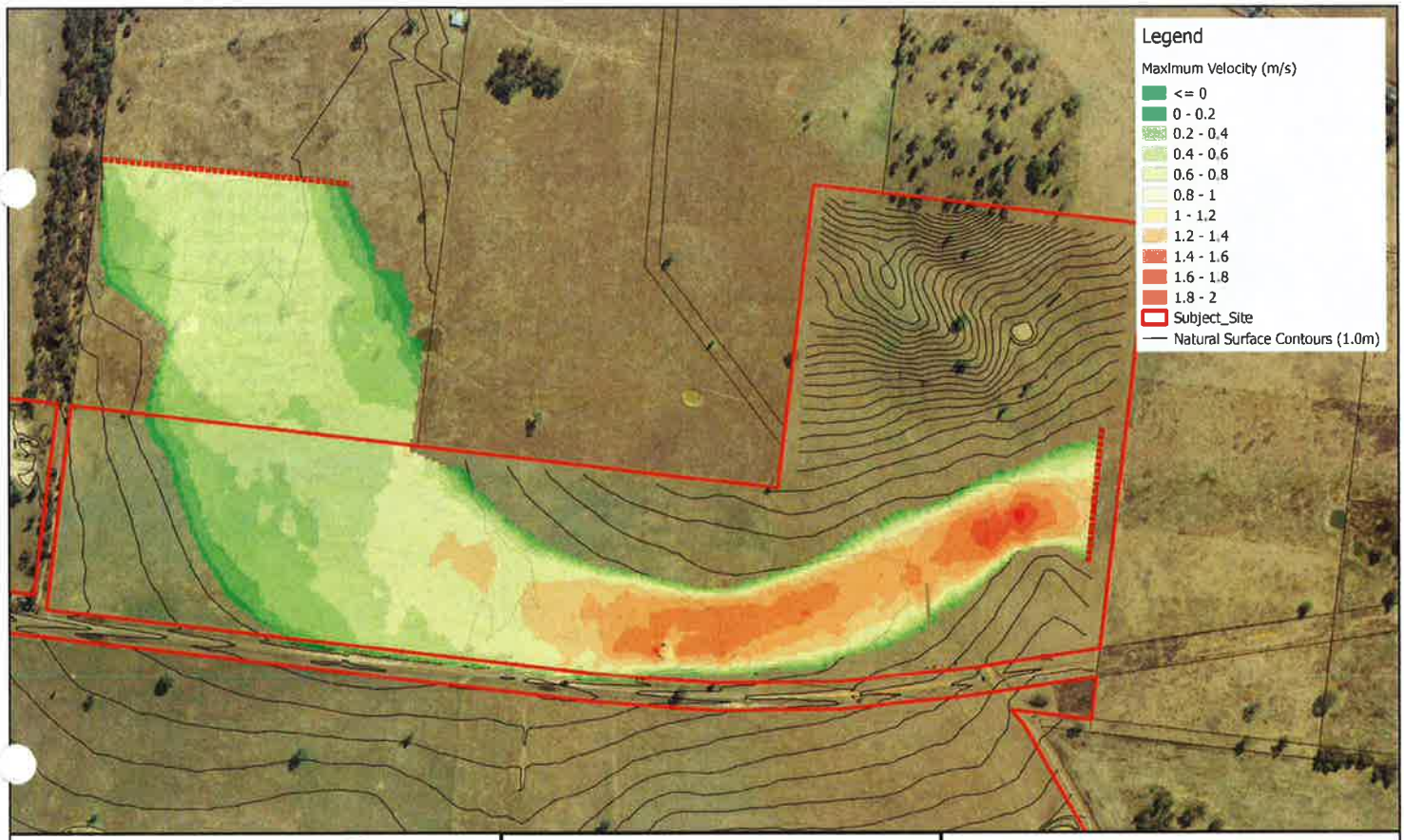
PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS
FIGURE 3.1
2% AEP Flood Levels and Depths
Rev 1 - 30 August 2017



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First Solar.

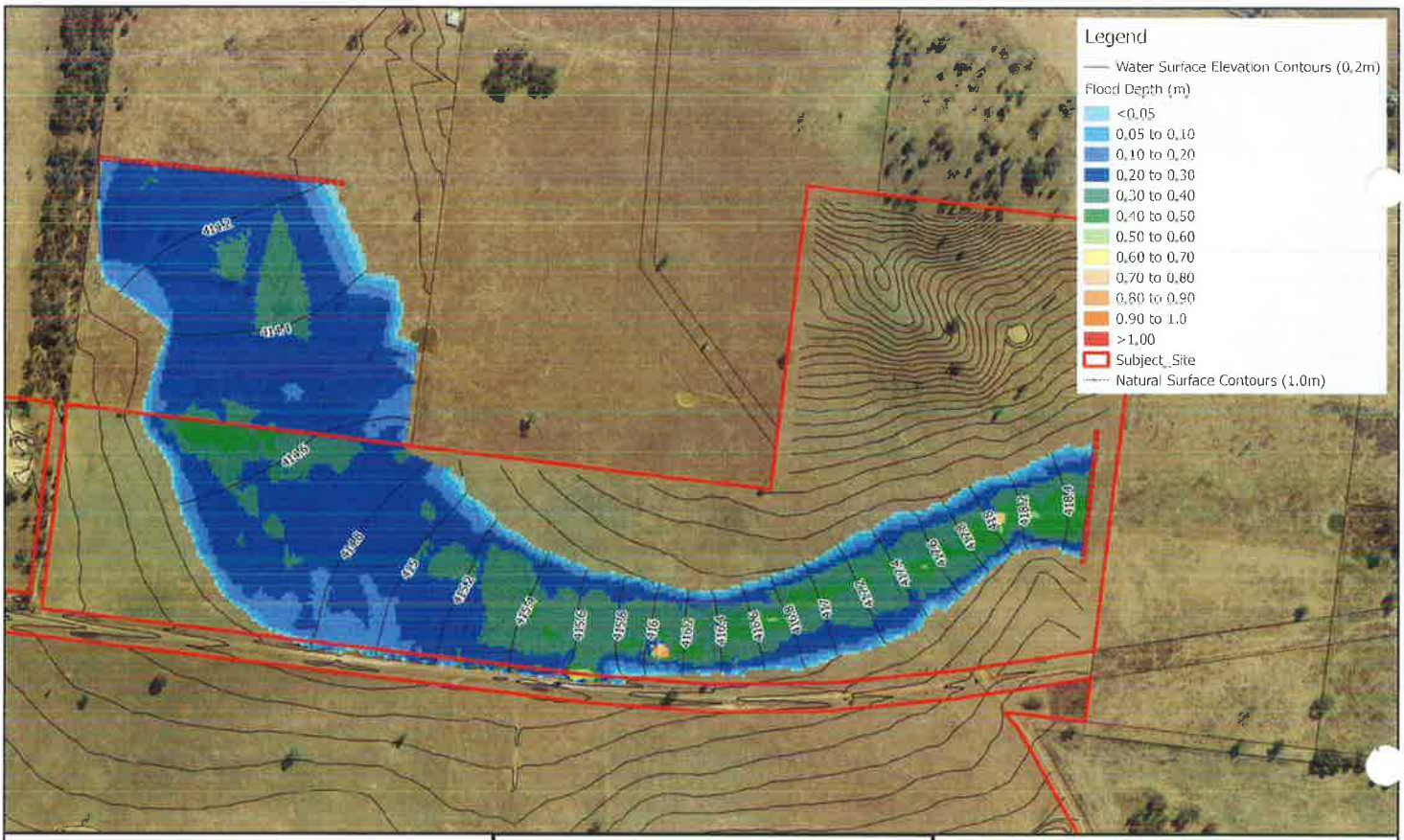
0 100 200 m

Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 3.2
2% AEP Flood Velocities

Rev 1 | 30 August 2017



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First Solar

0 100 200 m
Scale 1:5,000 at A3

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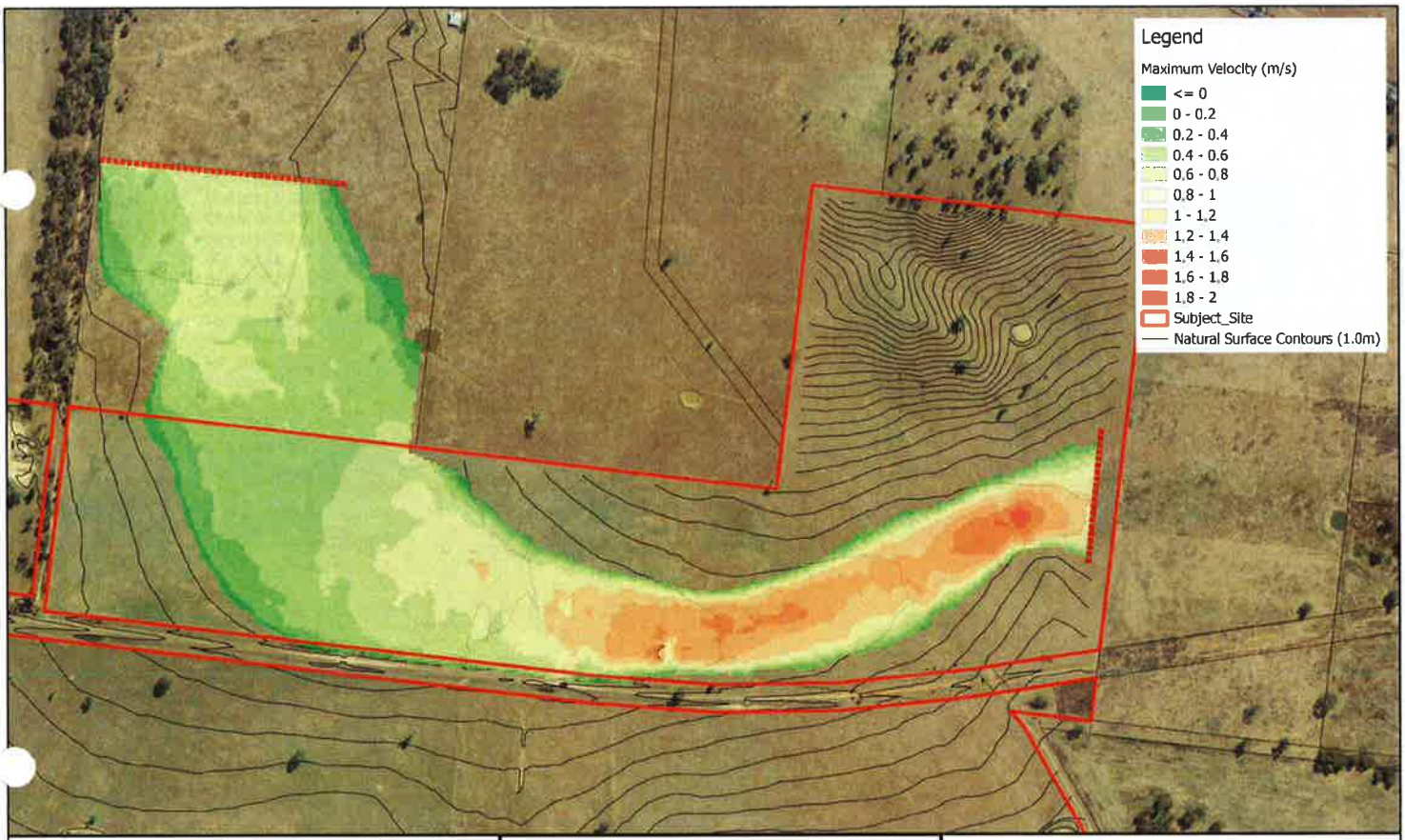
PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 4.1
5% AEP Flood Levels and Depths

SW | 10/August/2017



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First Solar.

0 100 200 m
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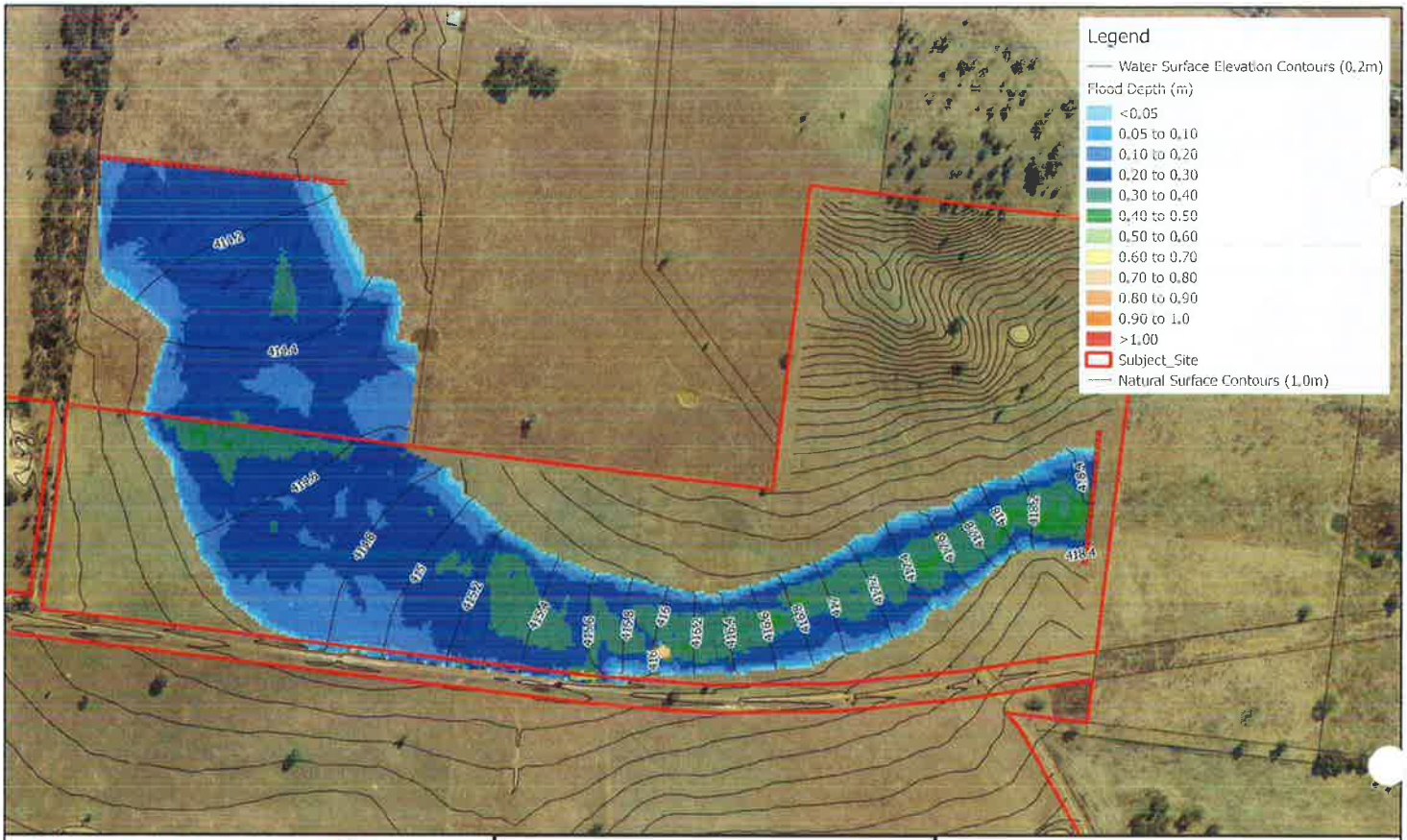
PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS
FIGURE 4.2
5% AEP Flood Velocities
Rev 1 - 30 August 2017



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First Solar

0 100 200 m
Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 5.1
10% AEP Flood Levels and Depths

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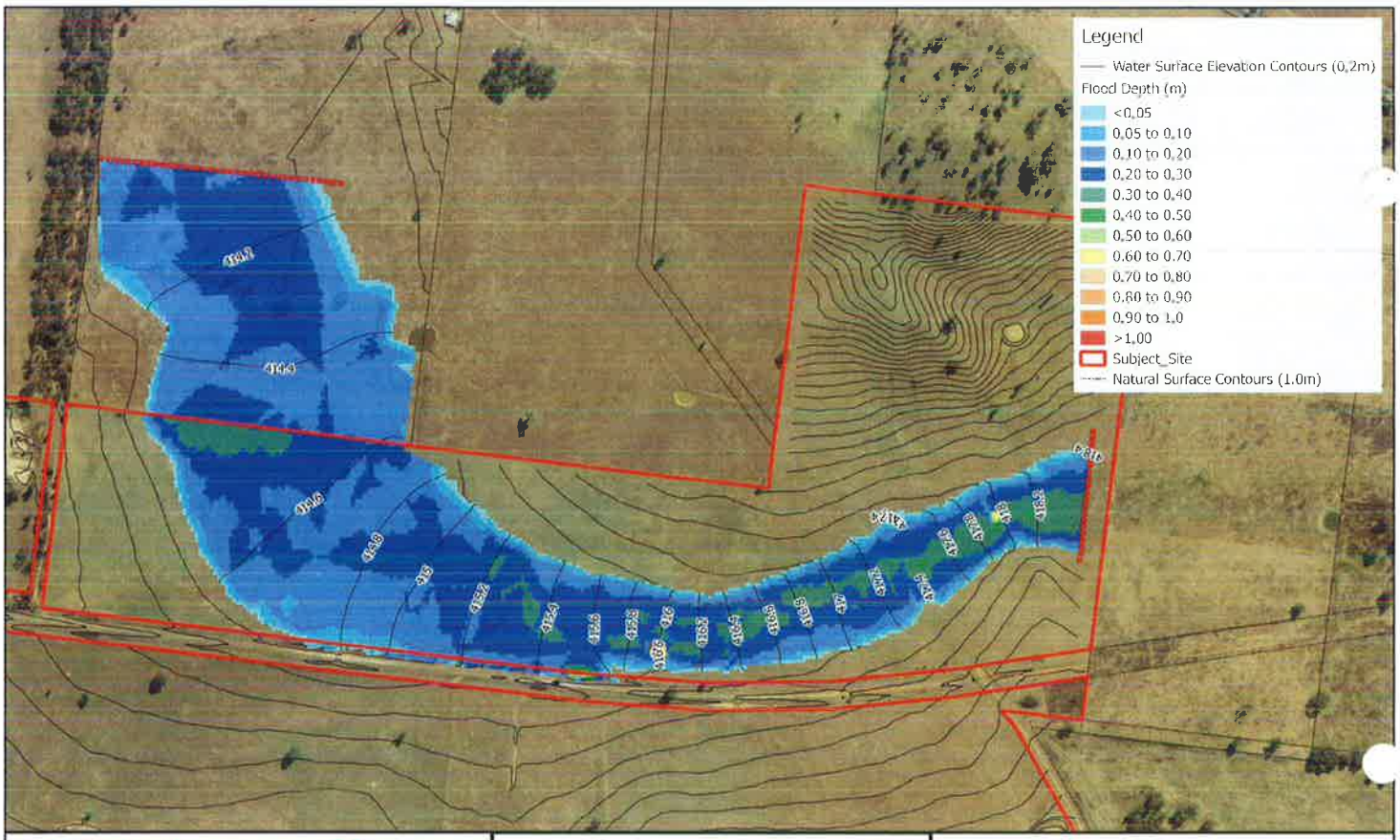
First Solar.

0 100 200 m
Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 5.2
10% AEP Flood Velocities

Rev 1 - 30 August 2017



footprint.
sustainable engineering.
15 meehan drive, kiama downs,
nsw 2533 p: (02) 4237 6770

First Solar

0 100 200 m
Scale 1:5,000 at A3

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PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS
FIGURE 6.1
20% AEP Flood Levels and Depths
Rev 1 - 10 August 2017

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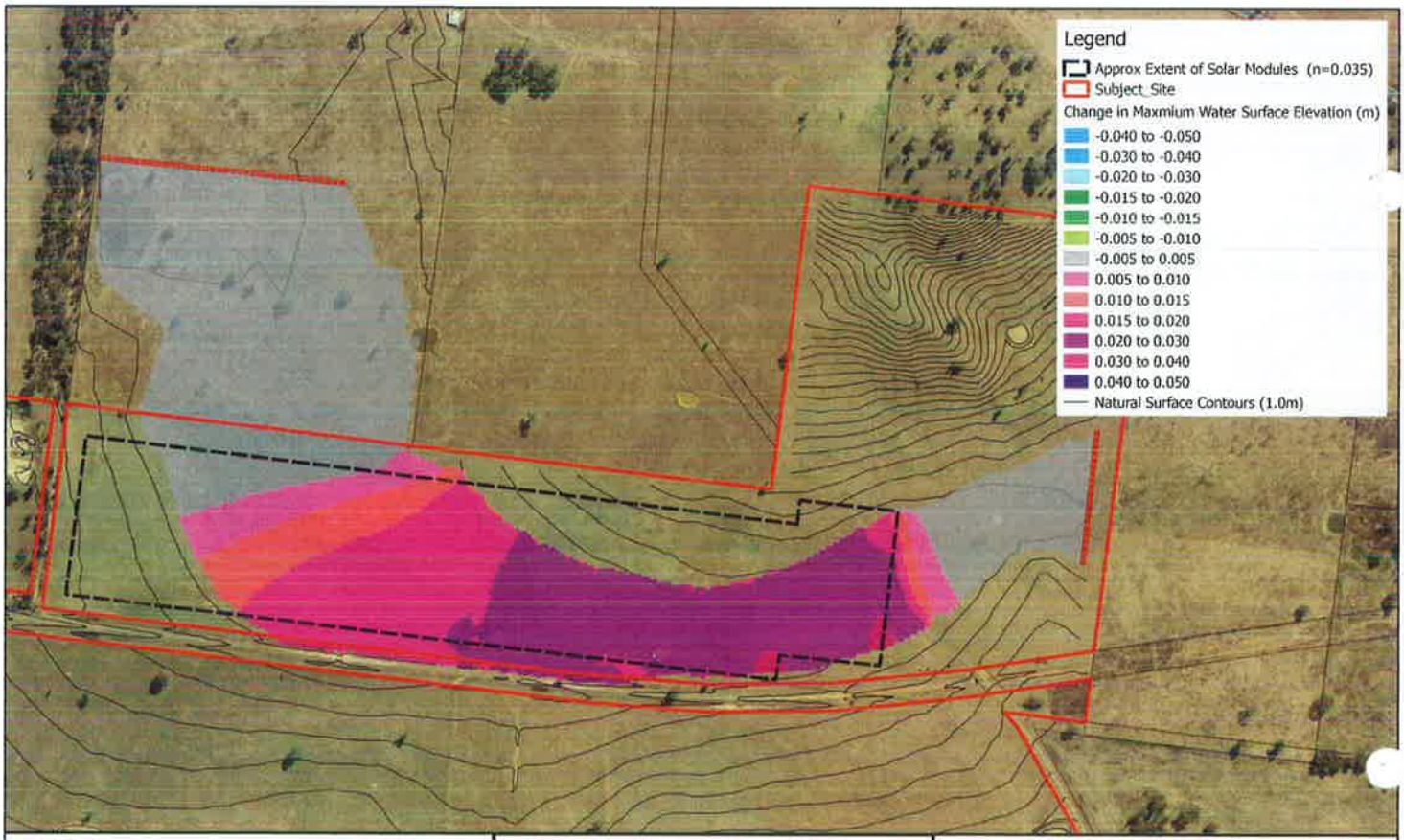
First Solar.

0 100 200 m
Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 6.2
20% AEP Flood Velocities

Rev 1 30 August 2017



footprint.
sustainable engineering.
15 meehan drive, kiama downs
nsw 2533 p: (02) 4237 6770

First Solar

0 100 200 m

Scale 1:5,000 at A3

PROPOSED BERYL SOLAR FARM
HYDROLOGICAL AND HYDRAULIC ANALYSIS

FIGURE 7.1
Impact of Increase in Surface Roughness in 1% AEP

Rev 2 - 31 August 2017