Appendix I: Flood Impact Assessment - see separate report

Peninsula Solar Farm Flood Modelling

FINAL REPORT

30 August 2022

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ACCENT ENVIRONMENTAL

Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for Accent Environmental under the contract titled "Independent Contractor Agreement – Short Form".

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Cover image: abstract river image, Shutterstock

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1 Introduction

Alluvium Consulting Australia Pty Ltd (Alluvium) has been commissioned by Accent Environmental to develop a response to the flooding section of an Environmental impact study (EIS). The EIS is required as a part of the ultimate client's (Edify Energy) planned Peninsular Solar Farm located in the township of Paytens Bridge, New South Wales (Figure 1 & Figure 2).

The area of the Peninsular Solar Farm is approximately 288 ha, and it sits atop land primarily being used for agricultural purposes (a mix of cropping and grazing).

Figure 1. *Locality Plan of the proposed Peninsular Solar Farm in relation to Forbes township*

Figure 2. *Proposed site layout and design, including subject land lots*

2 Flood Modelling

2.1 Overview

Edify have requested a flood study to guide the preparation of an Environmental Impact Statement (EIS). This flood study seeks to assess several criteria in relation to the Peninsular Solar Farm. These criteria come from the need to address the Planning Secretary's Environmental Assessment Requirements (SEARs) (DPIE, 2021).

The assessment aims to address the localised flooding which originates from rainfall over the proposed Peninsular Solar Farm and its western headwaters accounting for the significant runoff above and through the study area.

The proposed Peninsular Solar Farm plus the upstream catchment has a total area of over 13.1 sq.km (1,310 ha) which is significant from a flooding perspective. The assessment methodology takes a minimalist approach to the flood study, as it is believed the Peninsular Solar Farm is of low risk (both its own internal infrastructure and impacts to neighbouring property). This status is due to the study area's generally high elevation (Figure 3) and the nature of the assets (panels mounted on posts above ground).

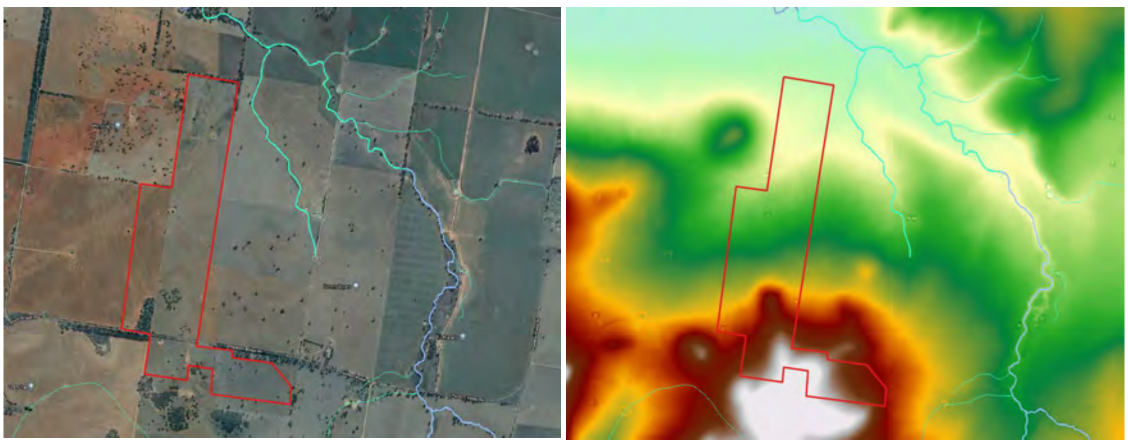

Figure 3. *(LEFT) Aerial with the extents of the Peninsular Solar Farm (red). (RIGHT) Digital Elevation Model (white and red = high; light blue = low)*

The following events were simulated in the assessment:

- 20% [1:5] AEP, 10% [1:10] AEP and 5% [1:20] AEP: to plan road and drainage / cross drainage infrastructure for the Peninsular Solar Farm
- 2% [1:50] AEP and 1% [1:100] AEP: to determine flood immune locations and levels for main buildings such as a possible Operation and Maintenance (O&M) Building and other medium risk infrastructure
- 0.1% [1:1000] AEP: to determine flood immune locations and levels for high risk infrastructure such as a possible switch yard.

Although Alluvium has not conducted a water quality analysis of the site; it is however expected that because the batteries are going to be hermatically sealed in modules that are housed within climate-controlled enclosures, therefore they will not be in direct contact with stormwater runoff.

2.2 Survey & Digital Elevation Model

Coverage of the ground surface in and around the study area was sourced from the publicly available LiDAR data acquired from ELVIS (Elevation - Foundation Spatial Data https://elevation.fsdf.org.au/). The resolution of this data was 5 m, and this Digital Elevation Model (DEM) formed the basis of the localised stormwater flood modelling (Figure 4). From a hill shade of the DEM the boundaries of the local catchment were mapped out

(Figure 5). The main study area catchment high point is RL 342 m AHD with a corresponding low point at the Mulyandry Creek downstream of the study area at RL 259 m AHD.

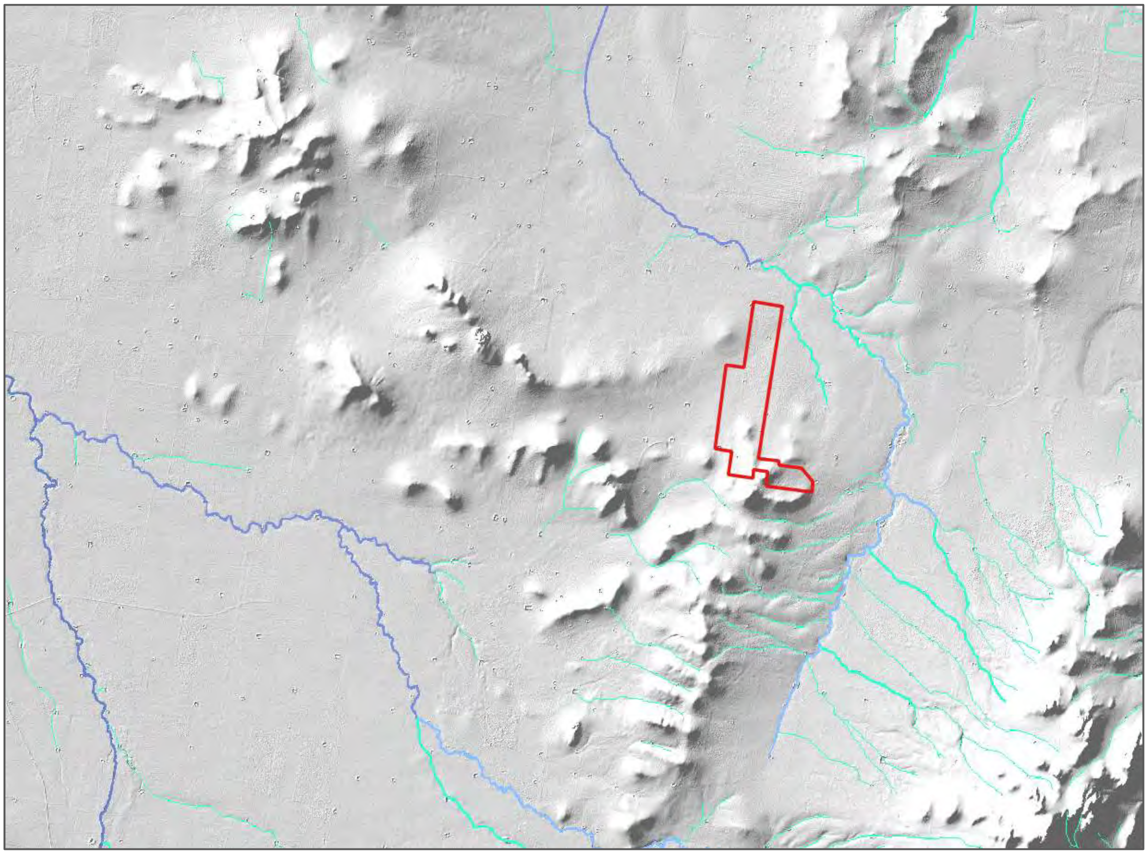

Figure 4. *Overview of the Peninsular Solar Farm and local flow paths*

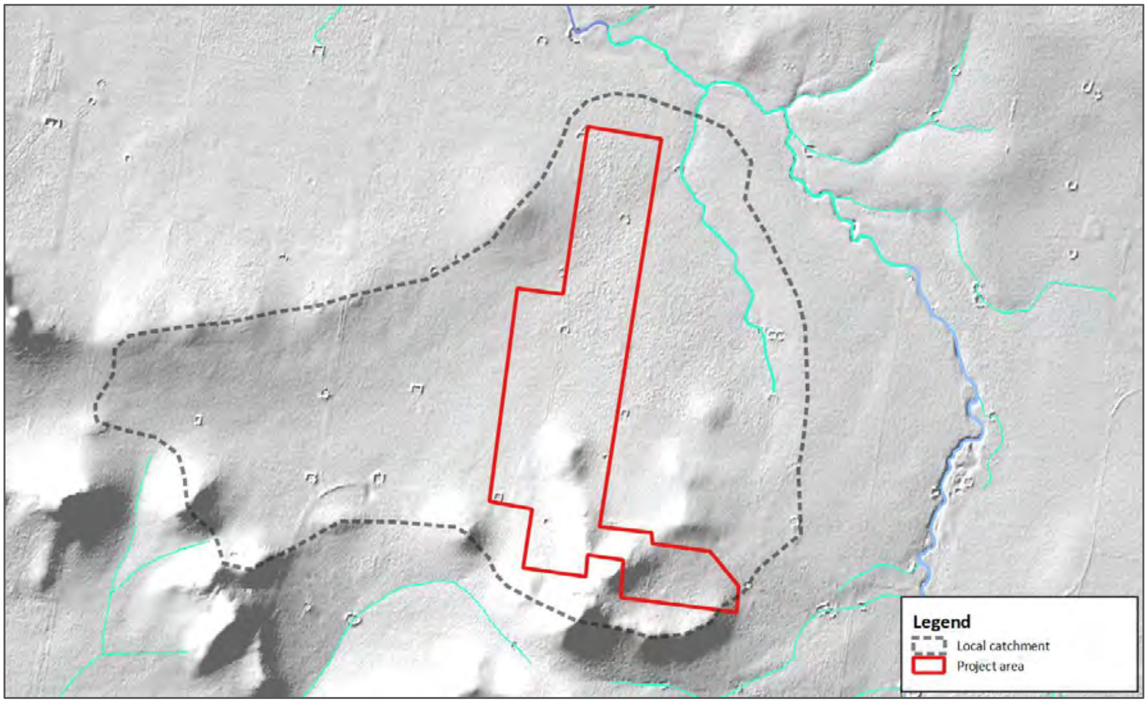

Figure 5. *Local catchment in and around the Peninsular Solar Farm with local flow paths*

2.3 Localised Flooding

Existing flood studies

The nearest known flood study to the Peninsular Solar Farm project site was the Forbes Flood Study Review (Lyall & Associates (2020)). This study focussed on large regional flood events of the Lachlan River and did not cover the Peninsular Solar Farm project site. As such, this study was conducted without reference to the previous flood study.

Hydraulic Model Build

The flood model was built using the TUFLOW software. The Direct Rainfall Approach was employed for the flood modelling where a rainfall hyetograph is applied to every model cell within the catchment contributing to drainage through the Peninsular Solar Farm. A 20 m cell resolution was considered adequate for the purposes of the 2D flood model and flood maps (Figure 6). The TUFLOW model includes sub-grid scaling which samples the underlying terrain DEM at the full resolution to increase the accuracy of the overland flow modelling.

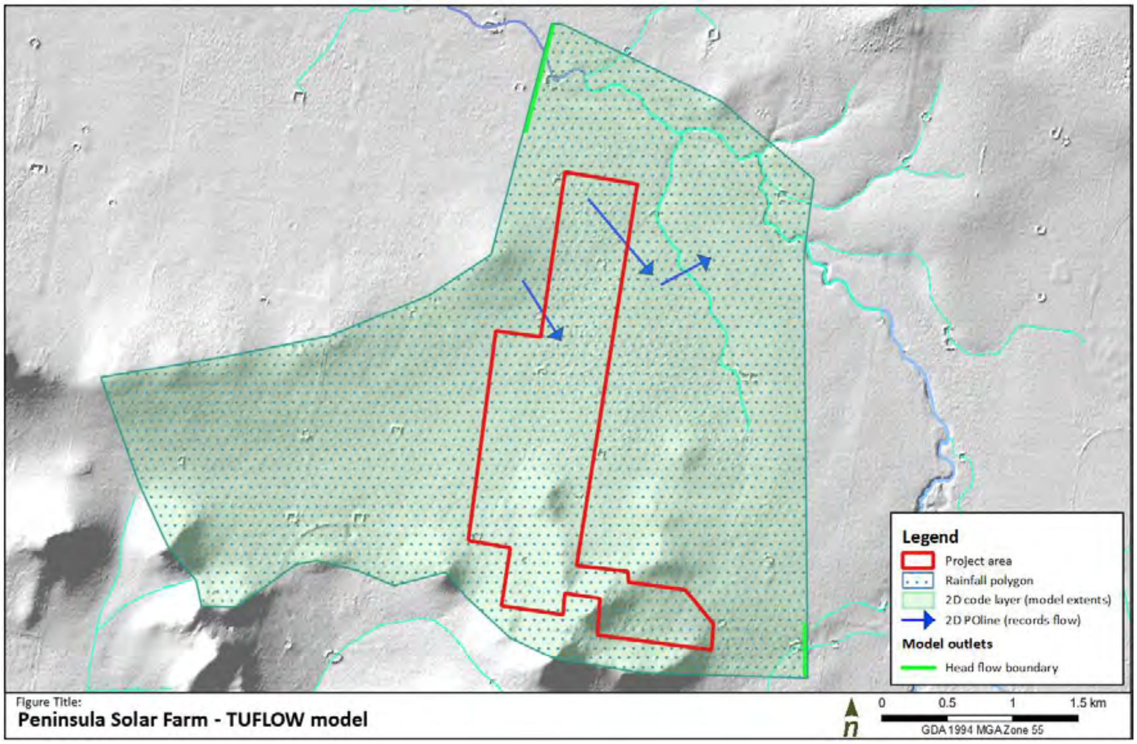

Figure 6. *Extent of the 2D TUFLOW model with flow paths*

Hydrological Simulation

Rainstorms were applied to the model for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.1% AEP events for a wide range of storm durations. For small-sized catchments a typical critical duration can be 60-minute storm duration. As such, the range of durations selected to run was the 10, 15, 20, 25, 30, 45, 60, 90, 120, 180, 270 and 360 minute storms. As the critical duration was not known prior to the TUFLOW modelling all ten temporal patterns for each storm duration were also run. With the ten temporal pattern results the median result was calculated for each event and then the maximum of these medians used as the final flood results.

The resulting critical durations and temporal patterns varied significantly. The 1% AEP event illustrates that the durations are not uniform across the Peninsular Solar Farm (Figure 8), necessitating the need to run all of the storm durations and temporal patterns to capture the hydrological complexity. Overall, 720 TUFLOW model runs were conducted.

A constant Manning’s n roughness coefficient was assumed for the whole catchment, though the value varied with depth. For water depths less than 0.05 metres the roughness value was 0.1 is applied to represent the slow velocities for very shallow overland flow. For a water depth between 0.05 and 0.1 metres the Manning’s n value was interpolated between a value of 0.045 and 0.1. When the water depth exceeded 0.1 metres the Manning’s n value became a constant value of 0.045.

The site includes a substation that was originally proposed to be located along the western boundary and later relocated to the eastern boundary out of the flood zone (refer Figure 7). Due to the small footprint of the sub-station, it was not included in the hydrologic model as an impervious area. Edify Energy have also advised that the Peninsular Solar Farm may include 100 or more power station enclosures distributed around the site with a combined storage capacity of 80 MW/160 MWh. The location and final number of battery energy storage systems is currently unknown however it is not expected to have an impact on the modelling.

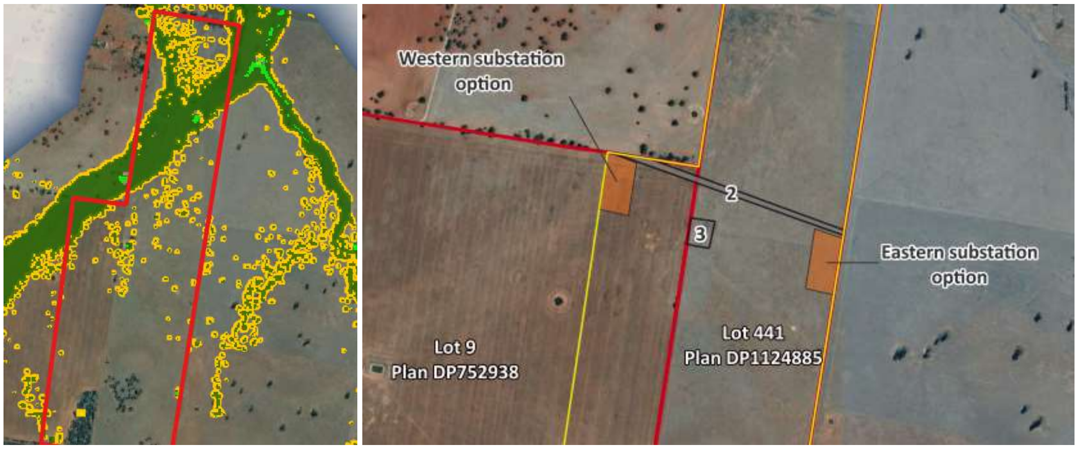

Figure 7. Left: 1% AEP flood results showing areas of the site affected by overland flow. Right: Site layout showing western and eastern substation options. The eastern substation option is out of the 1% AEP flood zone.

The results of the flood modelling are mapped in Attachment A.

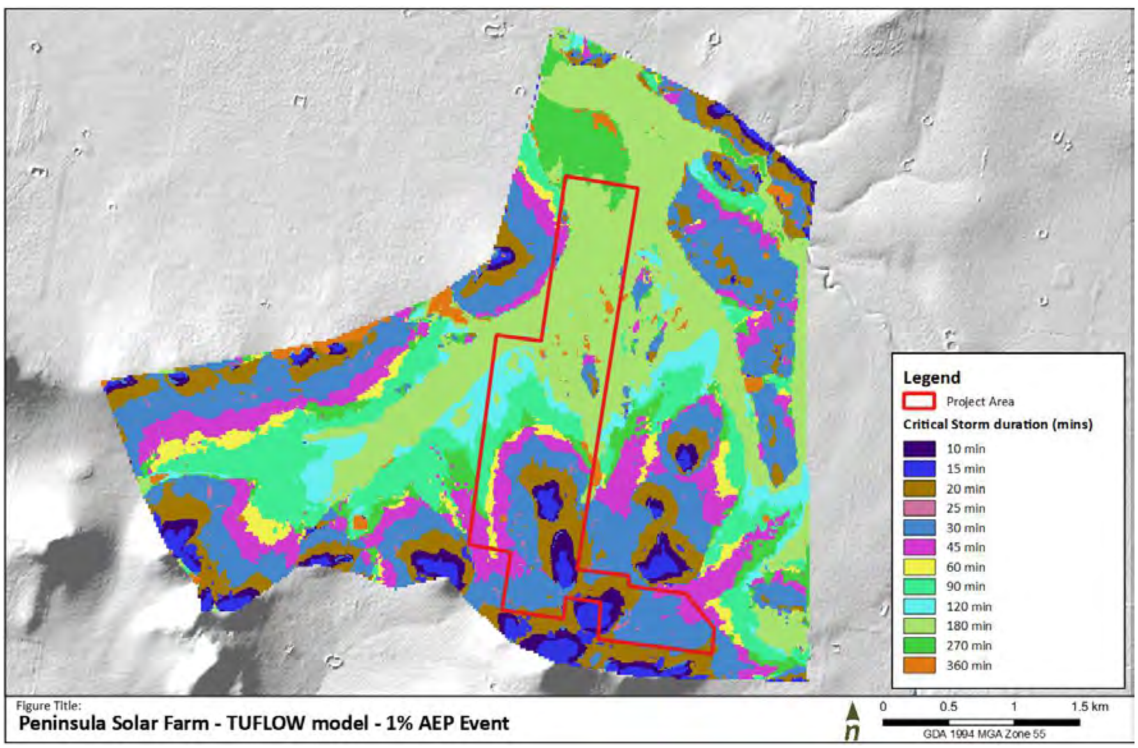

Figure 8. *1% AEP event critical storm durations*

3 Flood Impacts due to the Peninsular Solar Farm

Generally, there are two potential impacts the Peninsular Solar Farm could have on flooding and runoff external to the study area.

- Impacts on flood levels due to the Peninsular Solar Farm obstructing flow, OR
- Impacts on flood levels due the Peninsular Solar Farm producing extra runoff.

3.1 Localised flooding

In terms of the Peninsular Solar Farm and its associated solar panels generating additional local stormwater runoff a literature review was conducted on the topic. The summaries of the literature review are as follows:

Cook and McCuen, 2013. Journal of Hydrologic Engineering, ASCE. Hydrologic Response of Solar Farms.

- The solar panels themselves do not have a significant effect on catchment runoff.
- If the runoff characteristics of the final ground cover under the panels is increased (increased impervious hard-stand area, or decreased roughness) then runoff may increase.

Water Solutions, 2017. Lower Wonga Solar Q1 Renewable Energy Generation Facility Flood study.

- There are no expected changes to the runoff volumes, peaks, or times to peak for flood events in the catchment due to all the additional surface area of solar panels provided the surface coverage is maintained.
- Considered that a healthy cover of vegetation will ensure similar levels of infiltration as currently experienced at the study area.

It may be concluded that so long as the vegetation conditions are reinstated similar to pre-developed conditions following construction, and that impervious areas are not increased substantially, additional runoff from the Peninsular Solar Farm is unlikely to occur. Small increases in imperviousness are unlikely to increase peaks due to hydrograph timing effects. Therefore, the existing conditions flood modelling is likely to reflect the impact of the solar panels on the downstream runoff. As such a post-solar farm construction scenario was not required.

3.2 Localised flood modelling

The flood modelling found that the Peninsular Solar Farm becomes inundated by localised rainfall and runoff in all the events modelled (20%, 10%, 2%, 5%, 1% and 0.1% AEP events). Flood extents from a selection of storm events is presented in Figure 9. Significantly the majority of the Peninsular Solar Farm remains clear of floodwater with water depths less than 0.1m across the site with the exception of the northern area (Figure 10 and Figure 11 - 1% AEP event as an example). Typically, water depths across the north of the site averaged between 0.11m and 0.28m across the events (Table 1).

This illustrates the shallow overland flow across the Peninsular Solar Farm with one exception in the pre-existing farm dams on site where flood depths reached a maximum of 0.74m to 1.1m. The site was modelled only on the existing ground surface as no piped storm water infrastructure within or near site boundary existed to alter the flow paths.

Table 1. Maximum and average water depths in the northern region of the Peninsular Solar Farm

AEP	Maximum Water Depth (m)	Average Water Depth (m)
20%	0.74	0.11
10%	0.79	0.13
5%	0.84	0.15
2%	0.90	0.18
1%	0.95	0.20
0.1%	1.10	0.28

Edify have indicated that security fencing will be installed around the Peninsular Solar Farm site. This fence would be indicatively 1.8 – 2.7m high whilst providing sufficient access points for project maintenance, land management purposes and for emergency egress. It is understood the style of fencing will comprise plain wire installed on the top of the perimeter fence and stock fencing to reduce impacts on wildlife.

Based on the overland sheet flow that is expected to cross the perimeter fence it is expected there will be minor collection of small woody debris and grass on the fence panels. This issue is concentrated on the western perimeter of the fence where the overland flow is highest. Overall, the catchment does not contain significant debris potential since it is cleared grazing and cropping land. Moreover, the depths of flow and velocities aren't likely to carry any large woody debris to the perimeter fence.

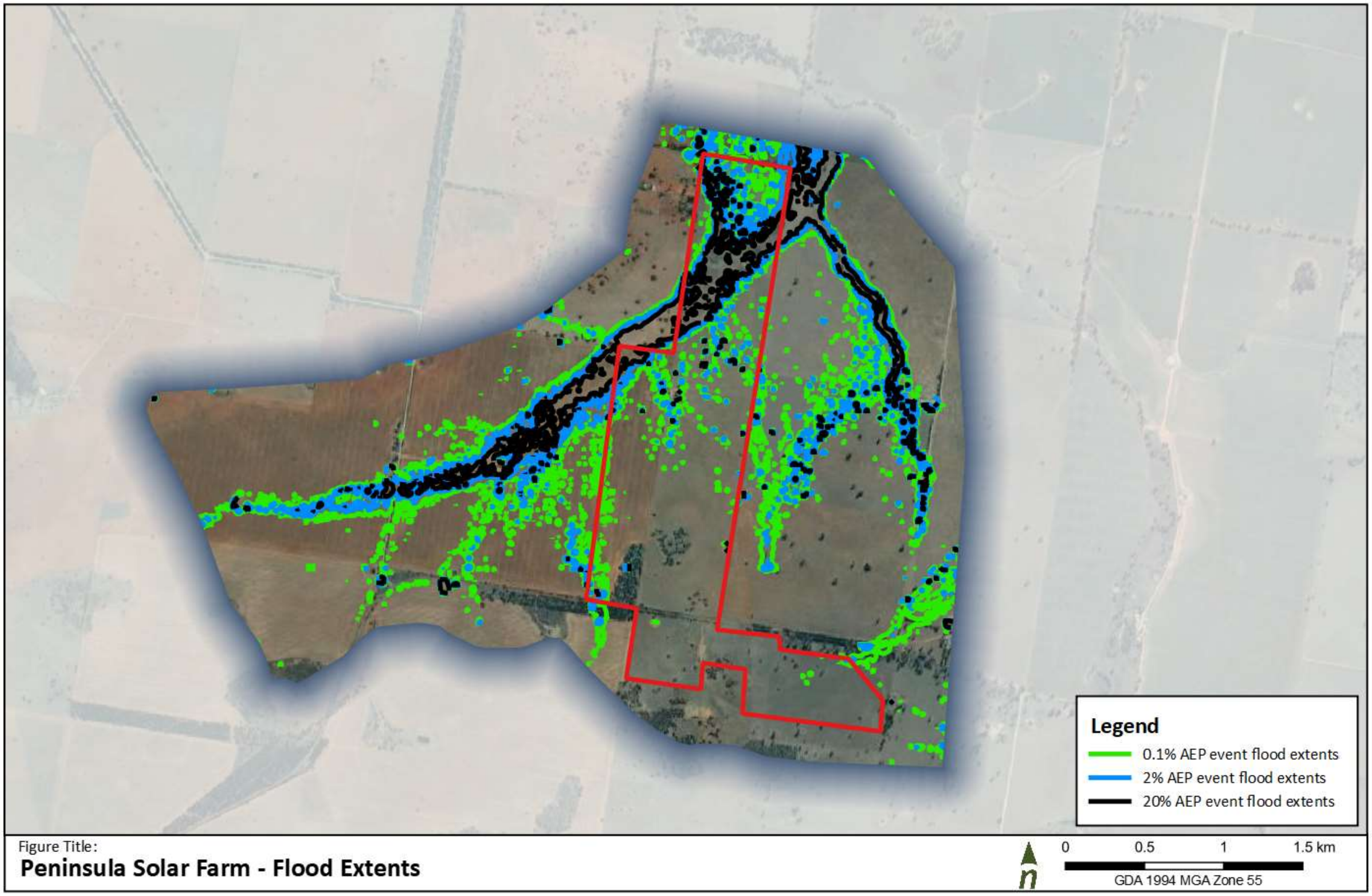

Figure 9. *Flood extents in the 20%, 2% and 0.1% AEP events*

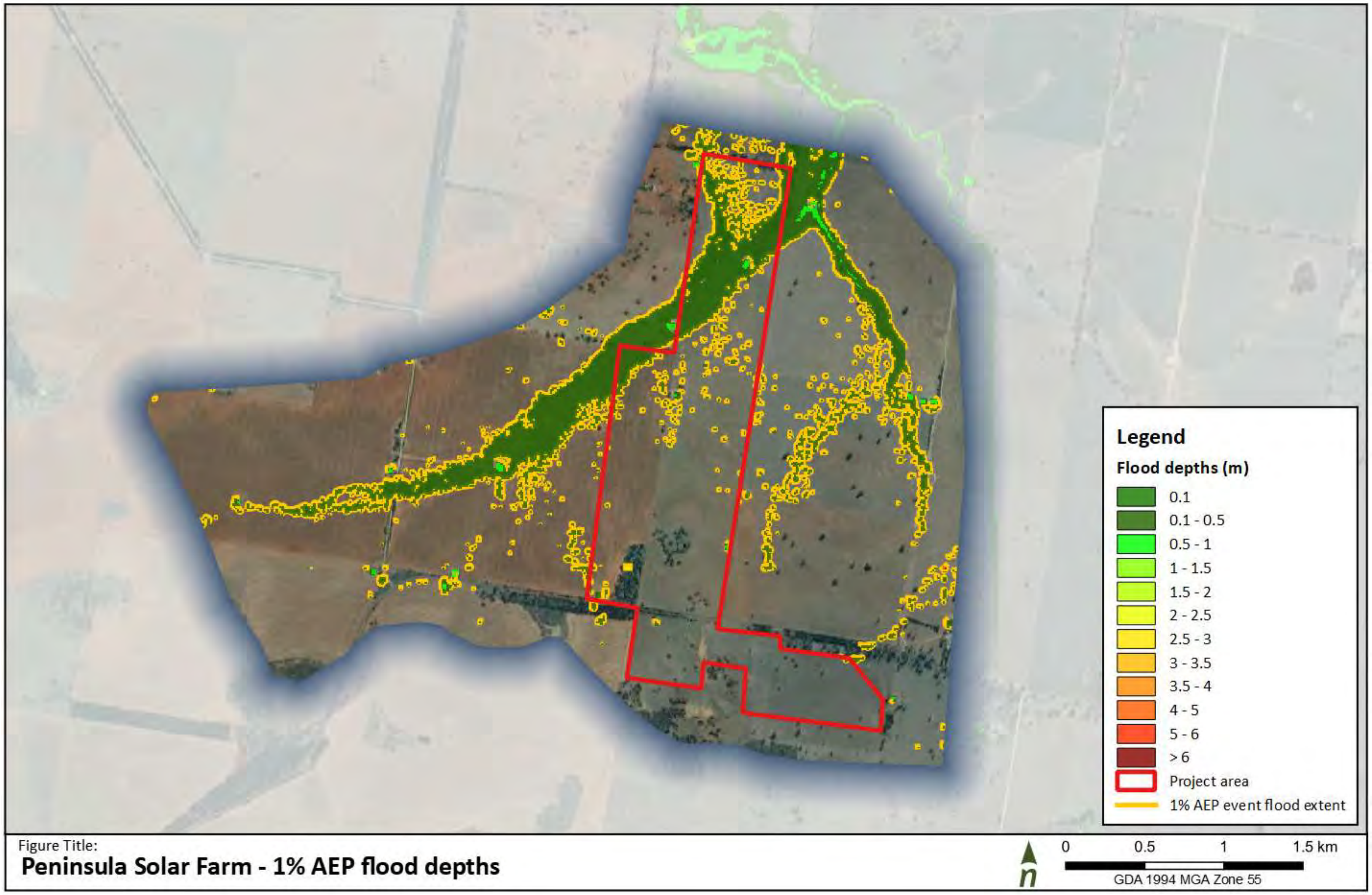

Figure 10. *1% AEP flood depths*

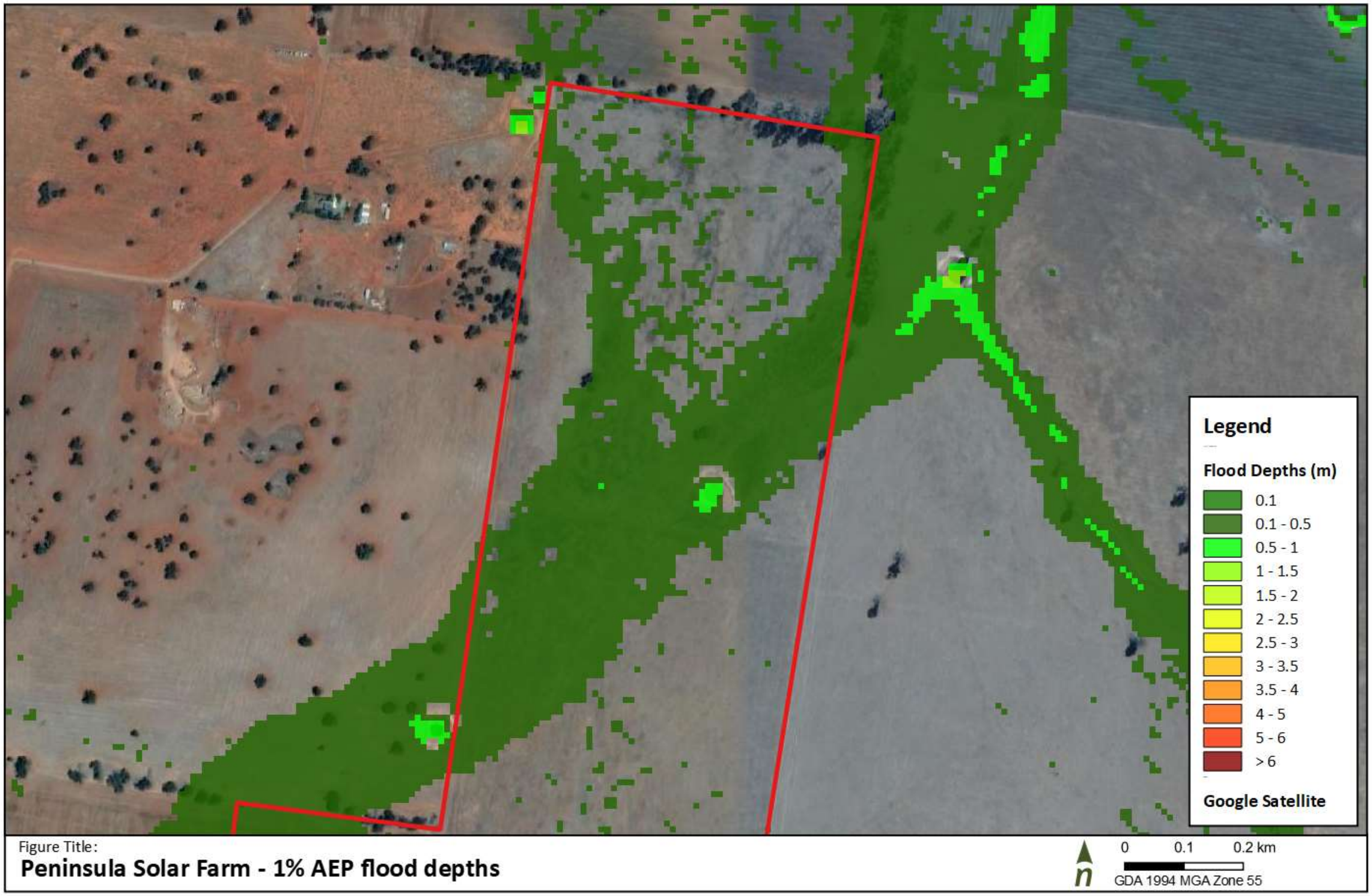

Figure 11. *1% AEP flood depths close up of the northern area of the study*

4 Conclusions & Recommendations

1. This investigation has been undertaken in order to support an EIS for the Peninsula Solar Farm, having a total precinct area of 288 ha.

2. Local catchment (stormwater runoff or overland flow) flood modelling was undertaken for the Peninsular Solar Farm in order to provide guidance on the planning of internal infrastructure and to assess the external impacts of the site development.

3. In responding to specific SEARs – Key issues "Water" flooding and surface water criteria, the following conclusions were made in general:

    a) Flood prone areas have been mapped, appropriate flood planning levels identified, and hydraulic categories on the floodplain identified. Medium to high-risk infrastructure in the Peninsular Solar Farm has a high level of flood immunity well above designated flood levels. Over the majority of the Peninsular Solar Farm there is NIL riverine flooding however in the north (adjacent to the Mulyandry Creek) extensive but shallow inundation occurred in all the events modelled.

    b) Peninsular Solar Farm will have no impact on flooding, as the footprint is located on the floodplain where velocity is low. The Peninsular Solar Farm earthworks do not include any infilling or depletion of floodplain storage. The Peninsular Solar Farm should not produce increased runoff, provided vegetation and land cover in the developed case provide similar levels of infiltration and retardance as pre-development and the development avoids extended periods where vegetation and landcover is not present.

4. RECOMMENDATION: In summary, the findings of this flood study demonstrate that the Peninsular Solar Farm should meet the SEARs's surface water assessment criteria, as impacts on the surrounding floodplain are considered to be negligible or NIL. Furthermore, risk to human life and infrastructure is considered to be low during large floods. It is recommended that the findings of this report be provided to DPIE in support of the Peninsular Solar Farm development.

5 References

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Lyall & Associates (2020), "Forbes Flood Study Review" prepared for Forbes Shire Council, May 2020.

Water Solutions, 2017, "Lower Wonga Solar Q1 Renewable Energy Generation Facility Flood Study", source: https://www.gympie.qld.gov.au/documents/40033667/0/Flood%20Study.pdf

Attachment A. Flood Modelling Extent Mapping

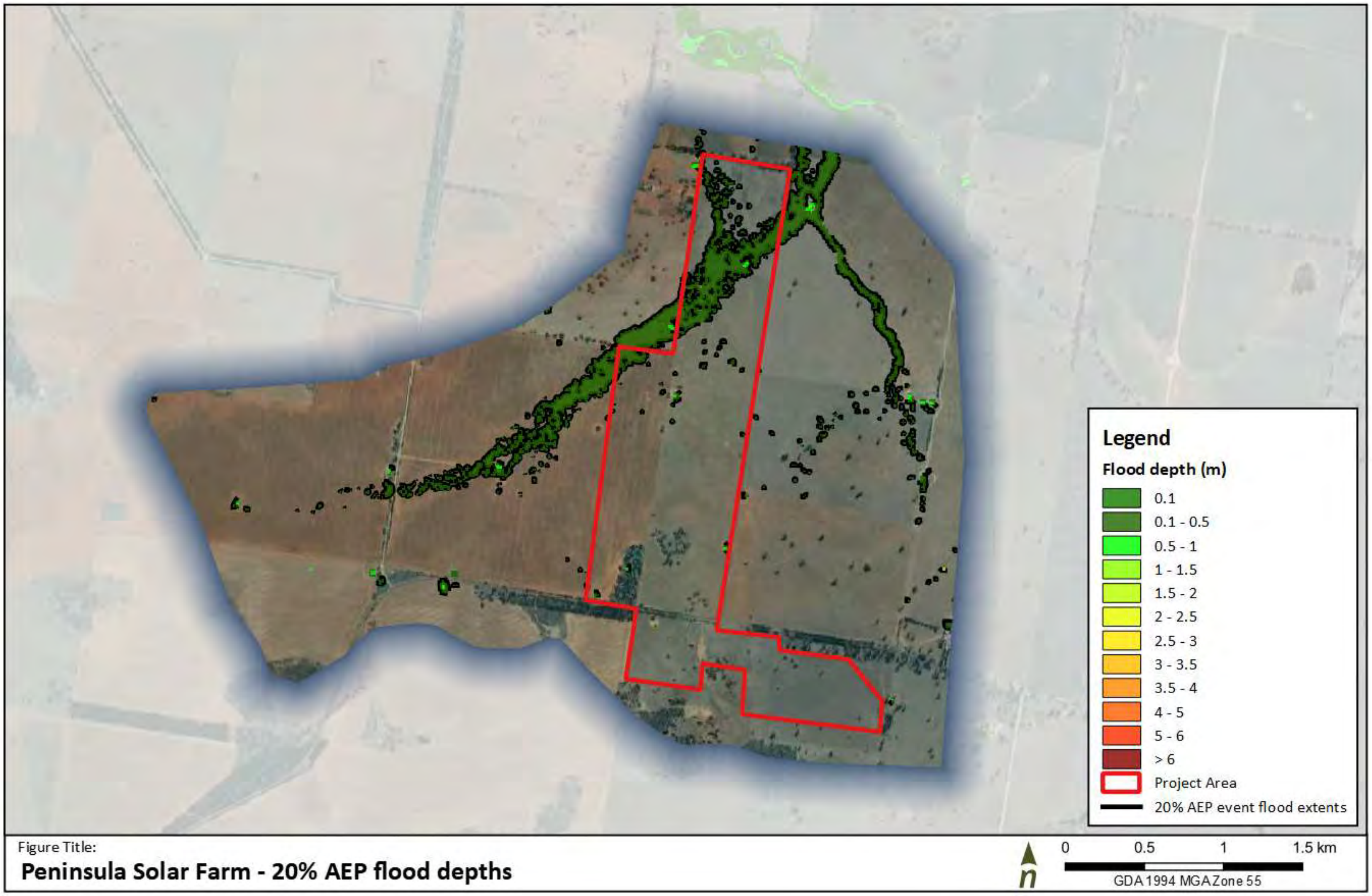

Figure 12. *20% AEP flood depths*

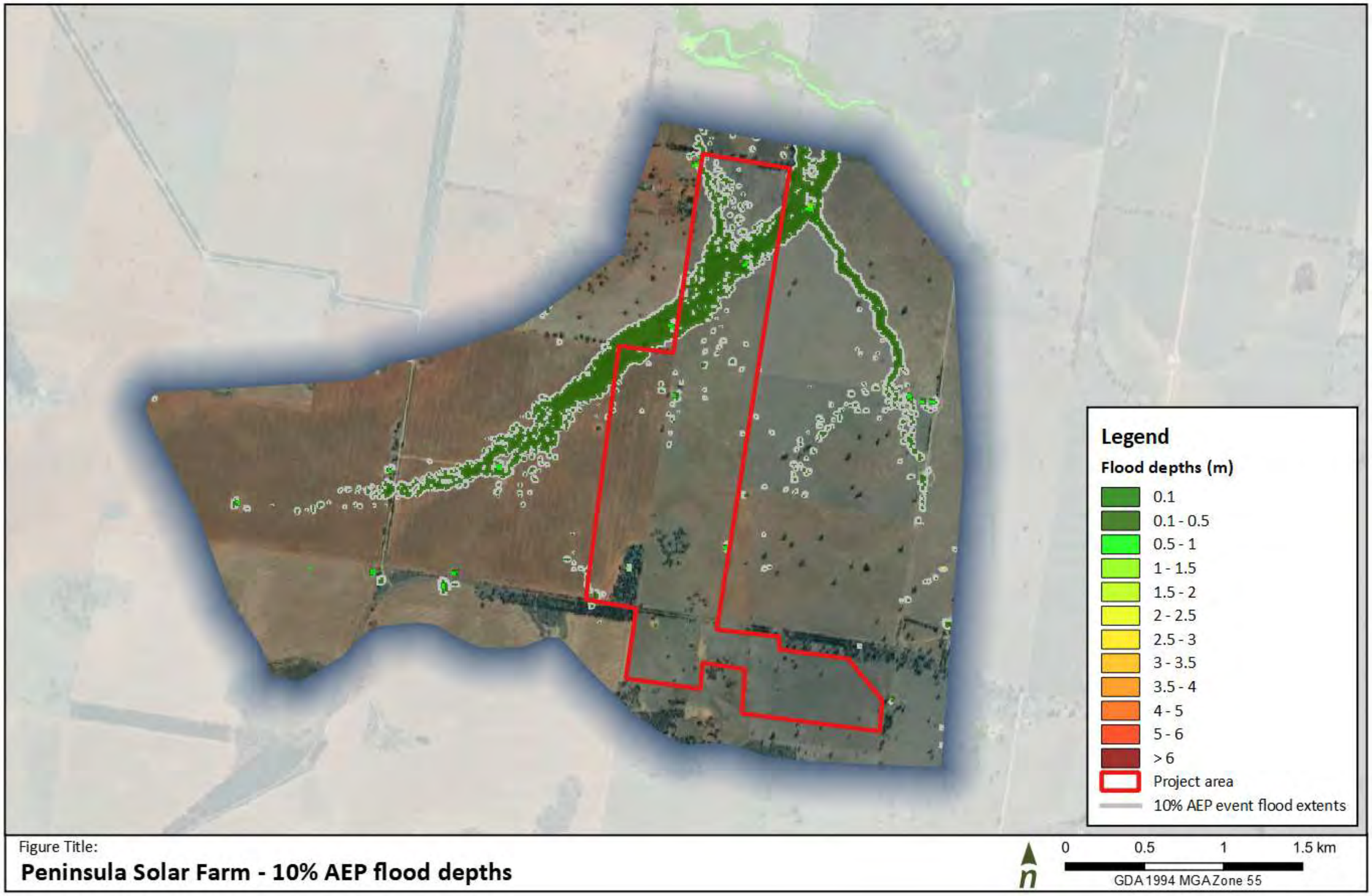

Figure 13. *10% AEP flood depths*

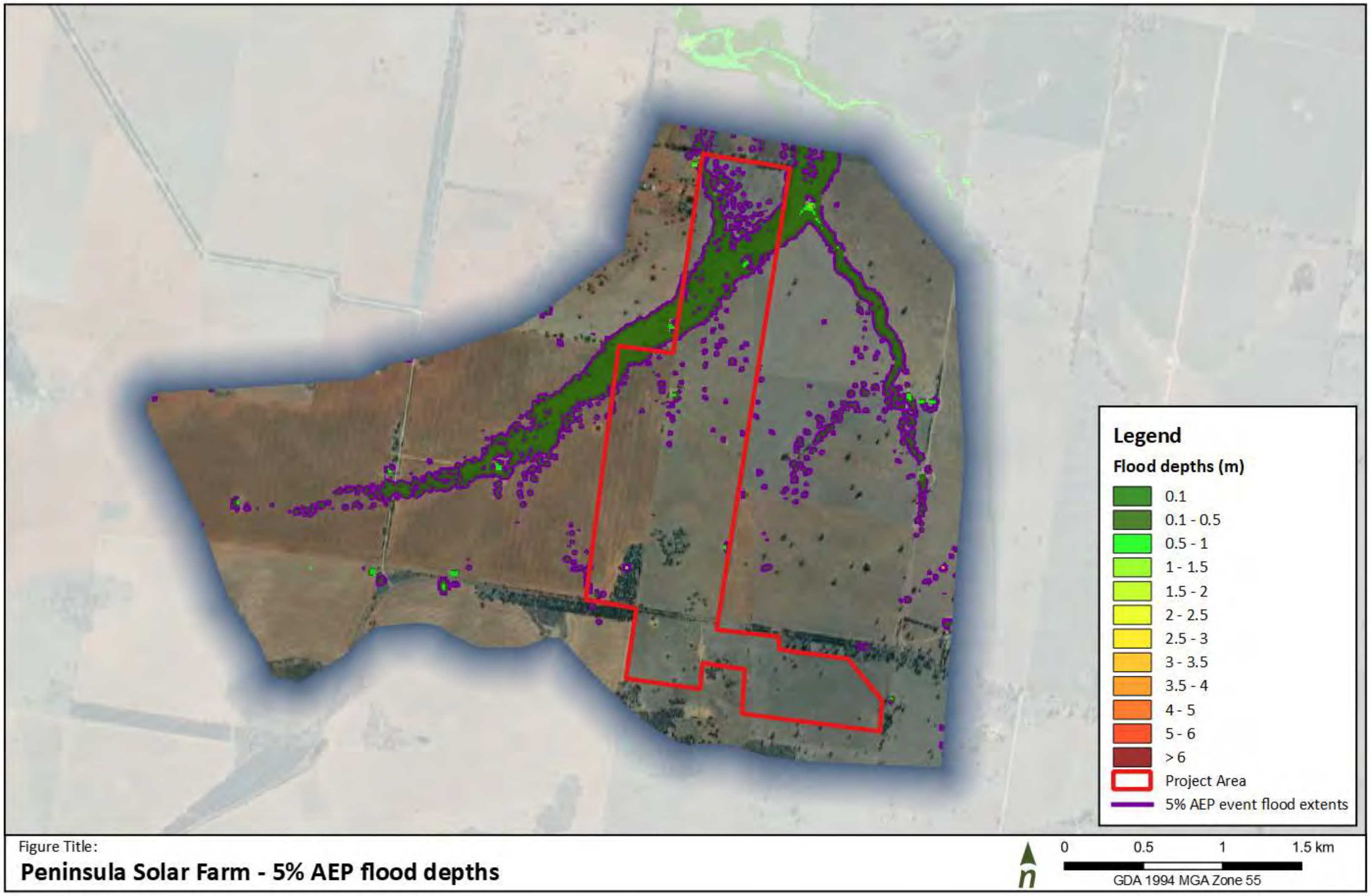

Figure 14. *5% AEP flood depths*

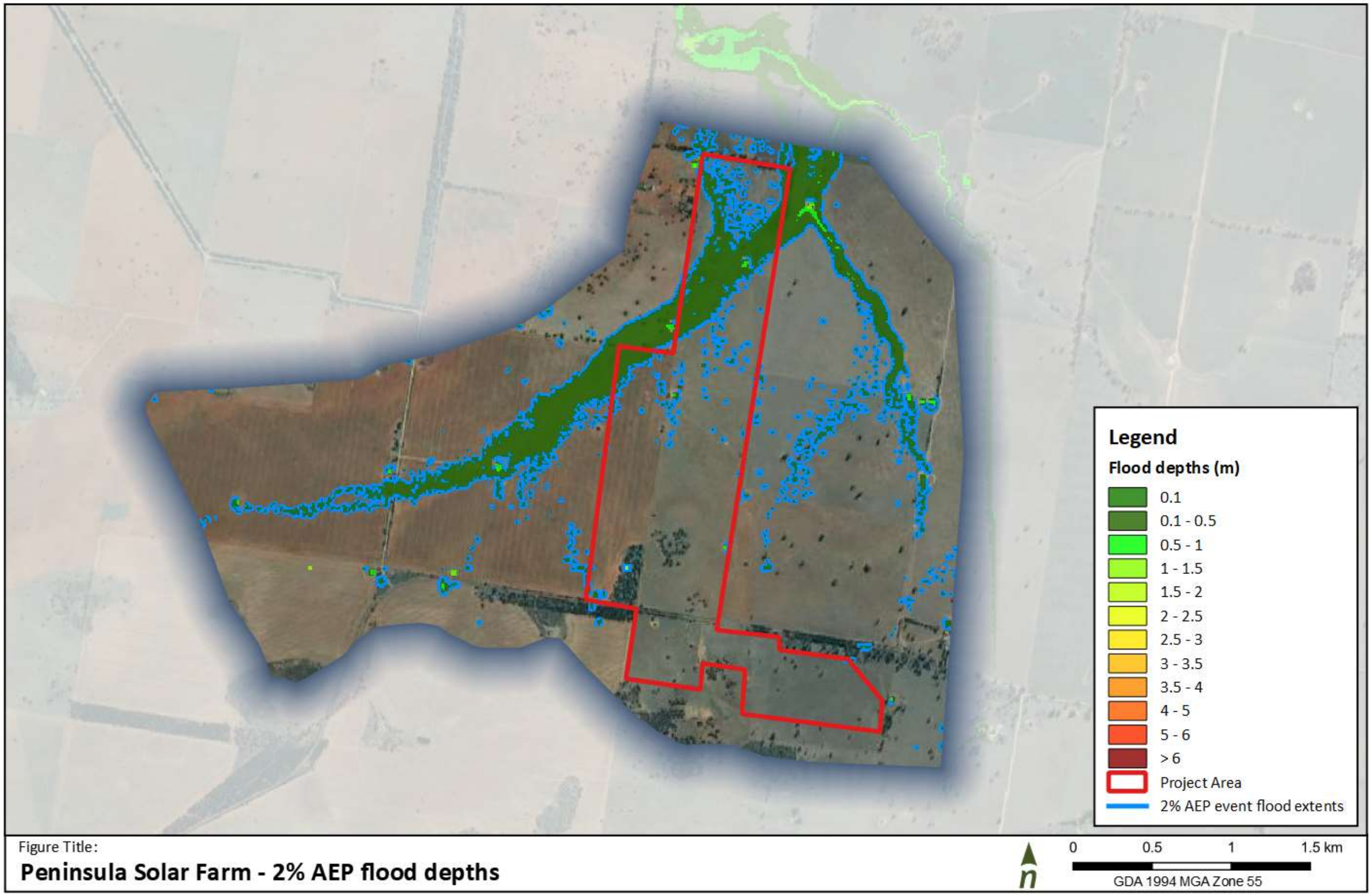

Figure 15. *2% AEP flood depths*

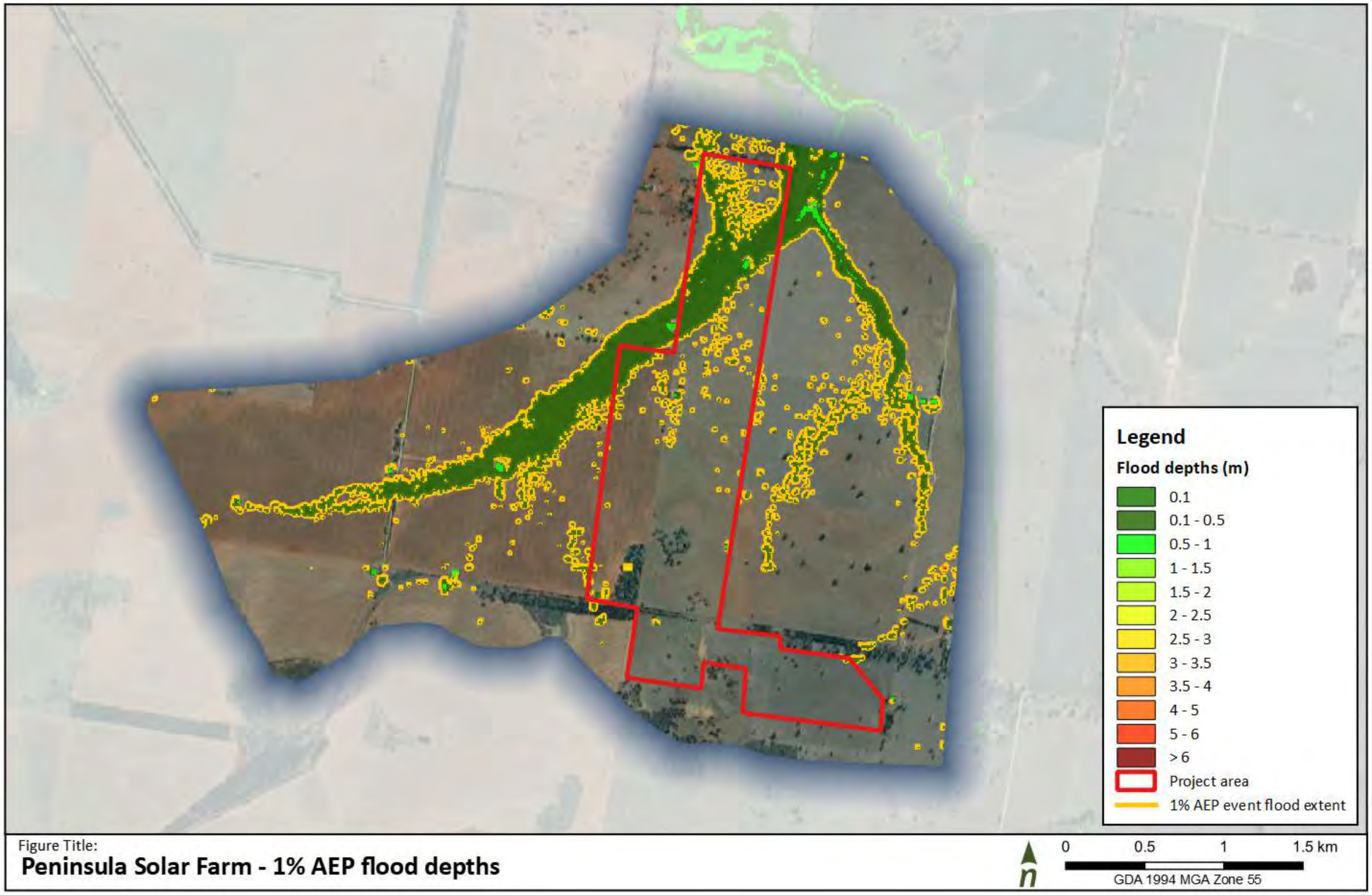

Figure 16. *1% AEP flood depths*

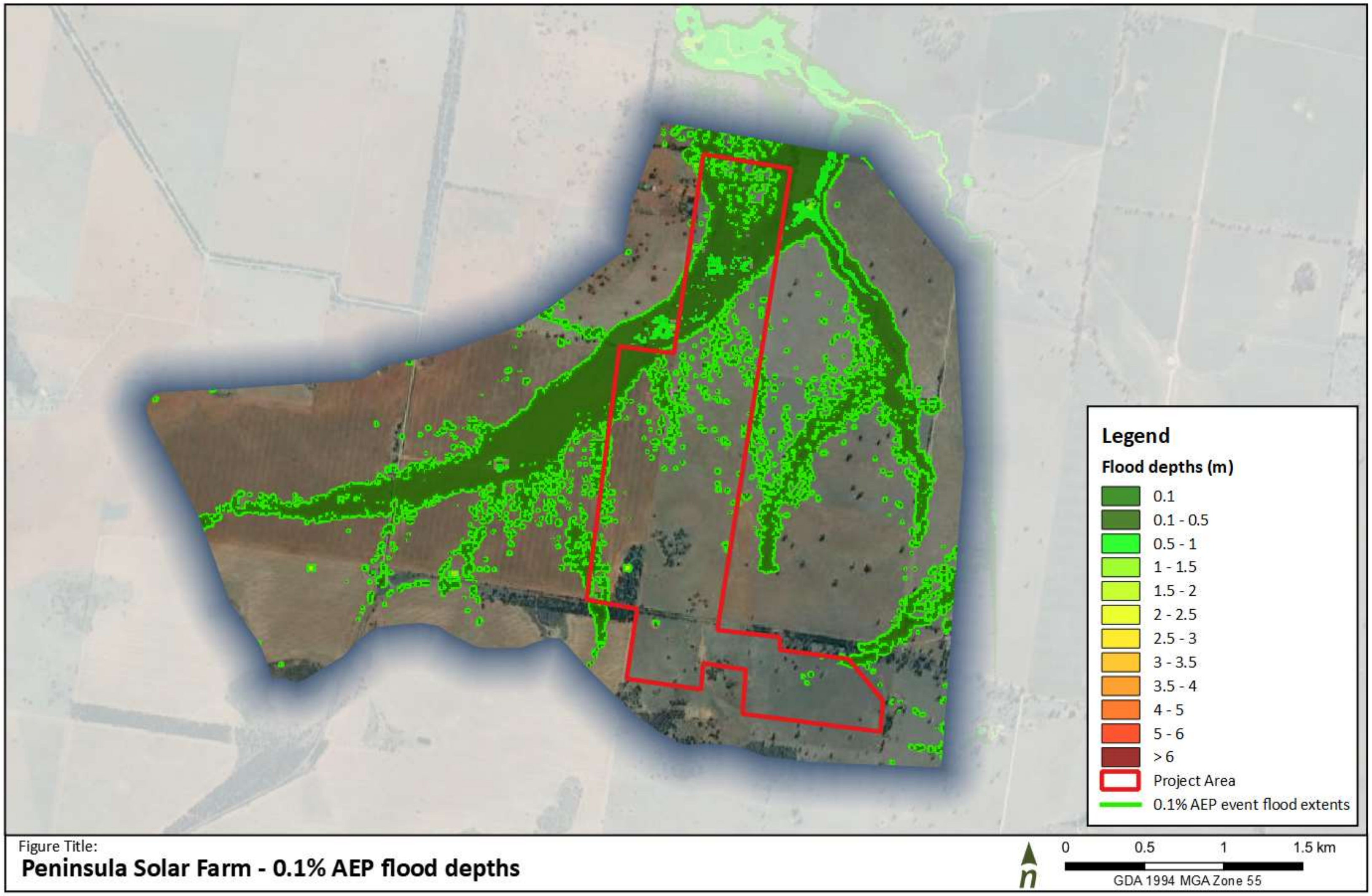

Figure 17. *0.1% AEP flood depths*

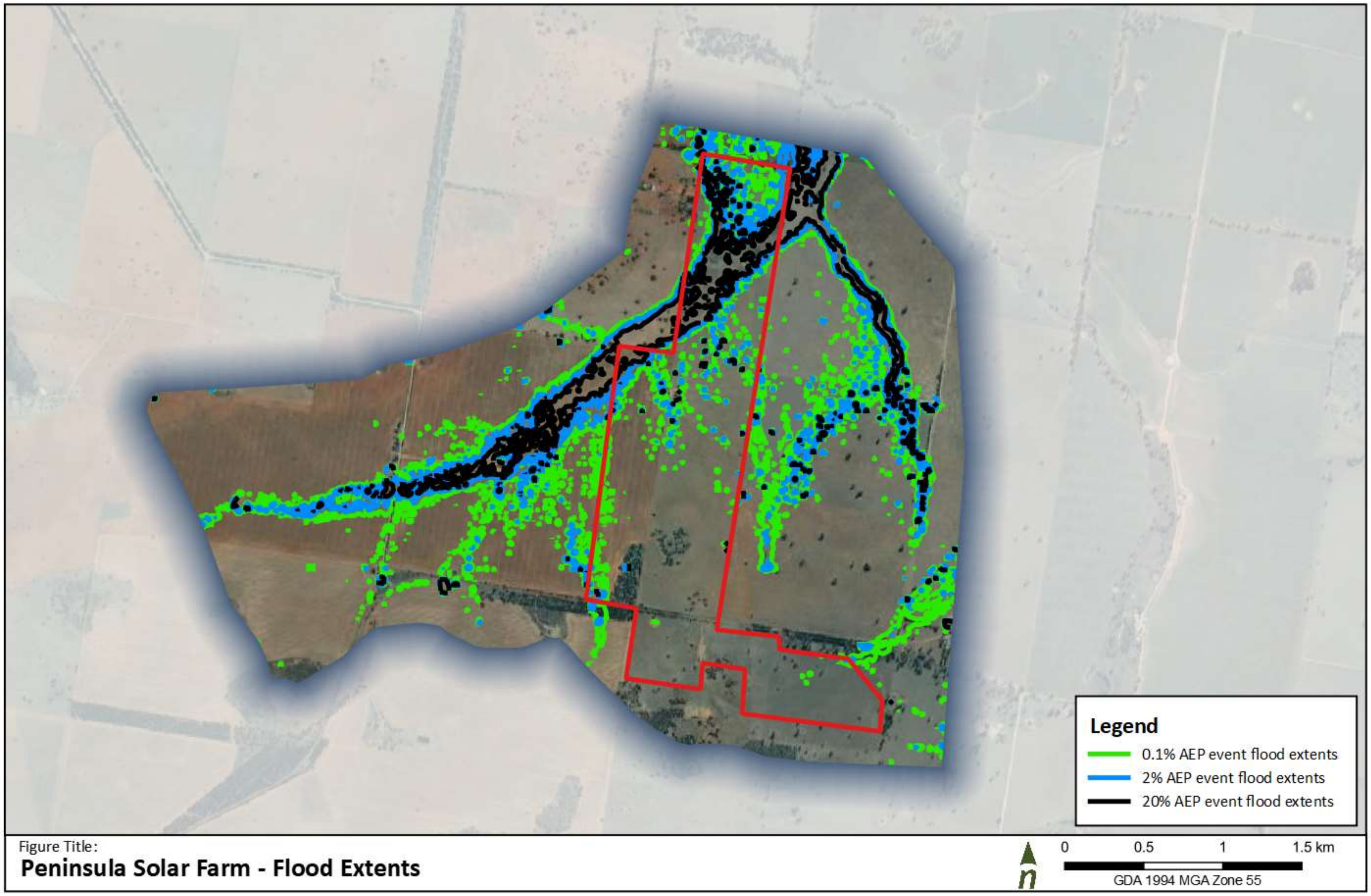

Figure 18. *Flood extents in the 20%, 2% and 0.1% AEP events*