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FLOOD AND STORMWATER ASSESSMENT

**5MW SOLAR FARM WITH BESS AT
742 STONEY CREEK ROAD, NARRABRI NSW
LOT 3 DP1034554**

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- Appendix A** Modelled pre-development water depth for the median 1% AEP, 2 hour storm event, climate change factor = 1
- Appendix B** Modelled post-development water depth for the median 1% AEP, 2 hour storm event, climate change factor = 1
- Appendix C** Modelled post-development water depth for the median 1% AEP, 2 hour storm event, Year 2090, SSP3-7.0 climate change scenario

1. Introduction

1.1 Background

New England Surveying and Engineering have been engaged by YES Group (SA) Pty Ltd (YES Group) to undertake a flood and stormwater assessment at the site of a proposed 5MW solar farm with Battery Energy Storage System (BESS) at 742 Stoney Creek Road, Narrabri (Lot 3 DP1034554).

This report will form part of the development application submission to Narrabri Shire Council for the solar farm with BESS.

1.2 Study Area

The grid-connected solar array and BESS is proposed within a rectangular fenced compound measuring 340.2m x 286.4m, located within the south-west corner of Lot 3 DP1034554 at 742 Stoney Creek Road. The development site is approximately 8km east of Narrabri.

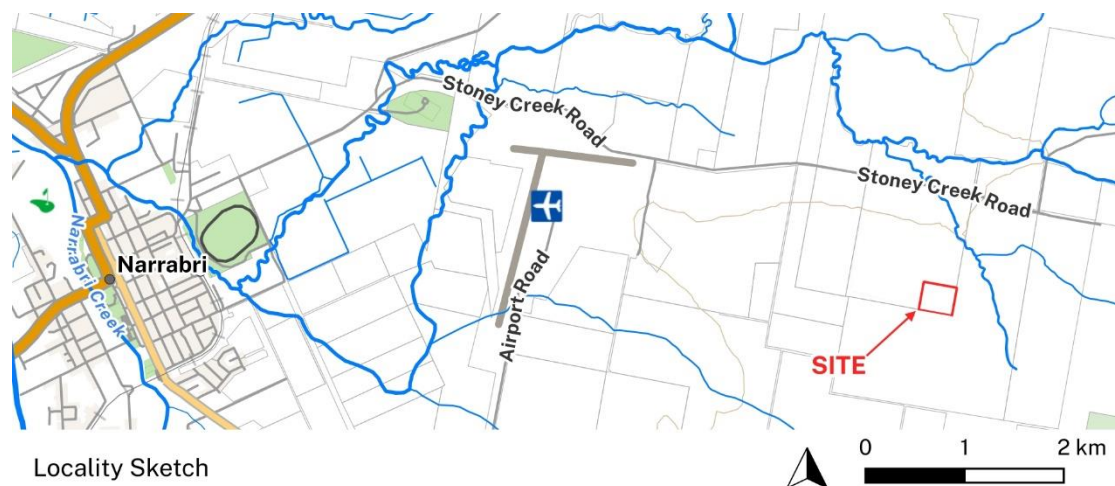


Figure 1.1 – Locality Sketch

The nearest 'hydroline' to the solar farm and BESS site is an unnamed non-perennial channel located 280m ENE of the site, which conveys surface runoff in a north-westerly direction towards Horsearm Creek.

The area around the proposed solar farm contains numerous earthen contour banks designed to intercept and channel overland flows into grassed waterways, so that overland flow velocity remains low enough to minimise soil erosion.

The modelling extent captures all runoff contributing to the hydroline at its closest location east of the solar farm site, as well as the catchment for the overland flow path west of the solar farm site.

1.3 Scope and Limitations

The scope for this report is to assess the potential flood impacts on and from the site, as well as providing recommendations for appropriate stormwater management measures during construction and operation.

The assessment is limited to:

- Desktop review and data compilation from various sources including supplied plans, LiDAR-sourced digital elevation models, aerial imagery, and Hydrologic Soil Groups;
- Sourcing ARR 2019 design rainfall data from the ARR Data Hub, and rainfall depths from the Bureau of Meteorology;
- Modelling the catchment in DRAINS software to determine the hyetograph (pattern of rainfall intensity over time) associated with the median ARR 2019 1% AEP design storm;
- Hydrologic assessment by way of direct rainfall (rain-on-grid) modelling in HEC-RAS using a 2D flood model of the catchment;
- Pre-development and post-development assessment of flood levels and local flows at the site.

2. Hydrologic Assessment

2.1 Topography

Two bare earth digital elevation models (DEMs) of the site area derived from LiDAR were used for a preliminary site assessment, each having a 1m cell size and vertical accuracy of 0.3m (with a 95% confidence interval):

1. Geoscience Australia (GA) 1m DEM from September 2013
2. NSW Government - Spatial Services (SS) 1m DEM from January 2014

While ground surface elevations were generally consistent across each model (being typically 0.15m lower in the GA DEM), the Spatial Services DEM was used for hydrological assessment since:

- it represents more recent surface measurements;
- it exhibits higher definition in surface water storages (since these were dry at the time of data capture);
- it covers the entire catchment area (the GA DEM does not cover the full eastern extent).

GIS analysis of the Spatial Services DEM was used to determine the location of surface flow channels, and the catchment area contributing to surface flows in those channels near the solar farm site. The model extent is shown in Figure 2.1 and covered an area of 534 hectares.

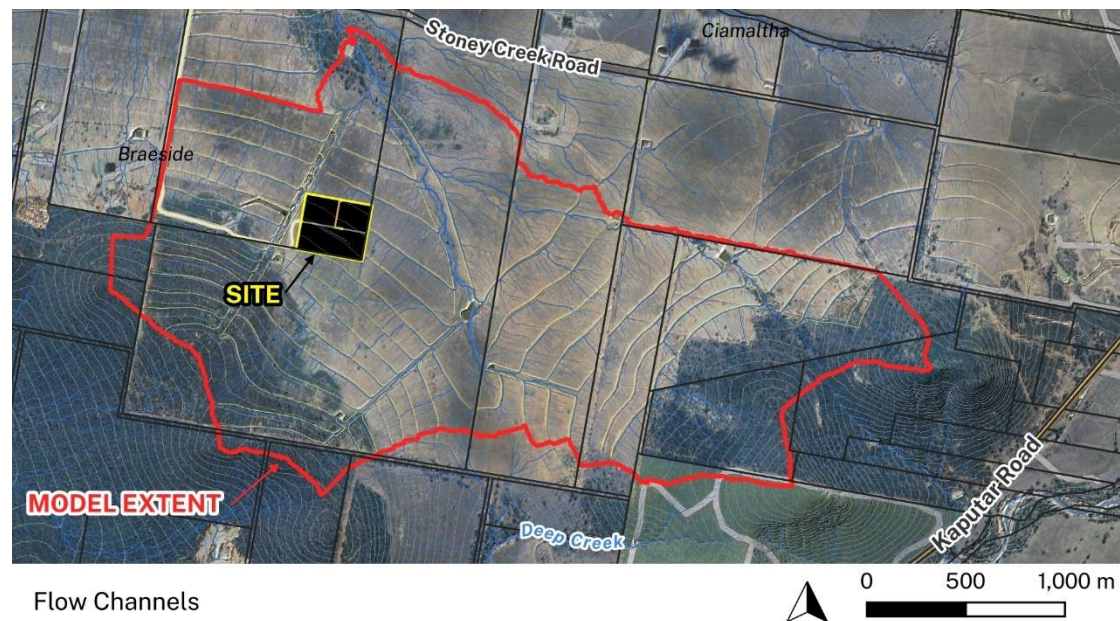


Figure 2.2 - Model Extent and Existing Banks and Overland Flow Channels

2.2 Rainfall Data

Design rainfall depths for the site were obtained from the Bureau of Meteorology (BOM) Design Rainfall Data System (2016), and temporal patterns and other rainfall data from the Australian Rainfall and Runoff (ARR) Data Hub. Site data and rainfall parameters are shown in Table 2.1.

Table 2.1 – Site Information and DRAINS IL-CL Model Parameters

Parameter	Value
Latitude	-30.32968°
Longitude	149.87686°
Storm Initial Loss	40mm
Storm Continuing Losses	0.4mm (includes NSW specific reduction factor)

2.3 DRAINS Modelling

ARR2019 rainfall data was obtained from the ARR Data Hub, and rainfall depths from the Bureau of Meteorology. A DRAINS initial loss – continuing loss model was then developed and run for a variety of storm durations and using an ensemble of storm events. The median storm in the critical 1% AEP ensemble was found to be Storm 5, having a 2-hour burst.

2.4 Pre-Development Modelling

Due to the highly modified landform with multiple contour banks constructed over the property and small upstream catchment, a 2D direct rainfall ('rain-on-grid') model was developed using HEC-RAS 6.6 to model surface flows and water storages.

Existing banks were digitised in a GIS package and used to define the orientation of triangular and trapezoidal computational mesh elements, allowing greater topographical definition in critical study areas. The pre-development mesh comprising 8,875 cells is shown in Figure 2.2. No boundary inflow hydrographs were used.

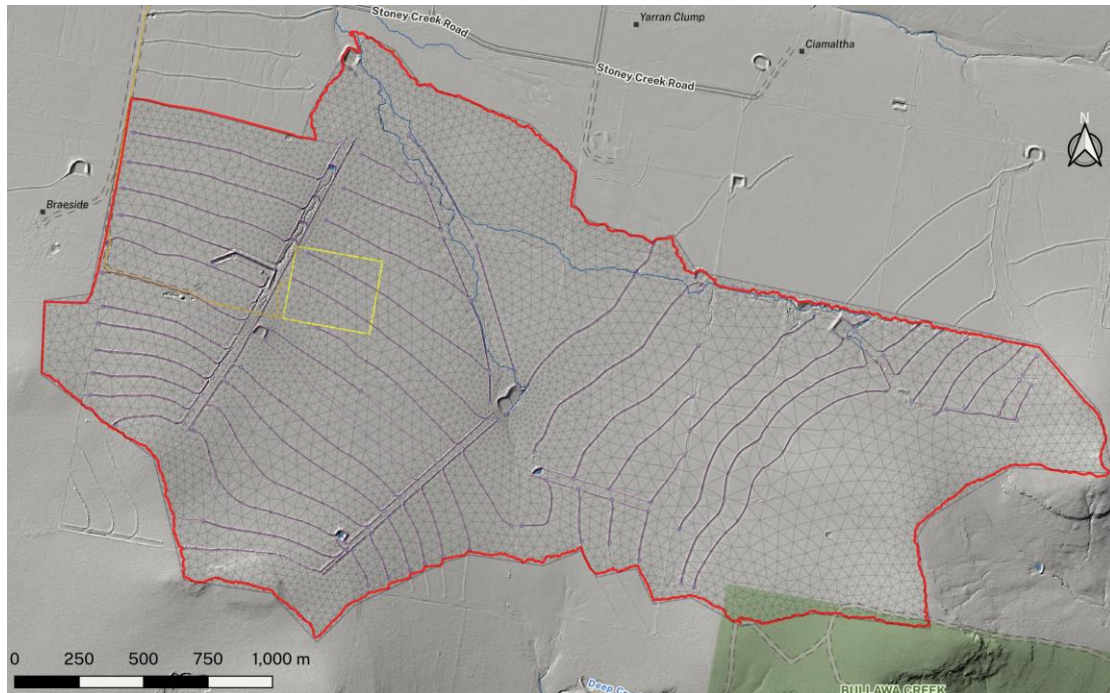


Figure 2.2 – Terrain Elevation Shading and Pre-Development Computation Mesh

Hydraulic resistance was modelled using polygon classification regions to define Manning's 'n' roughness values associated with different types of land cover. The values used are shown in Table 2.2.

Table 2.2 – Adopted Manning's 'n' Roughness Parameters

Land Use	Value
Woodland	0.100
Pasture	0.080
Flood Channel	0.045

Uniform rainfall was applied to the entire 2D catchment area based on the median Storm 5 hyetograph for the critical 1% AEP, 2 hour storm event, with a Climate Change factor of 1. Other model parameters are documented in Table 2.3.

Table 2.3 – HEC-RAS Rainfall Parameters

Parameter	Value
Pre-burst rainfall depth	20.7mm
Probability neutral burst initial loss	19.1mm
Storm continuing losses	0.4mm/h
Cumulative rainfall depth (after initial & continuing losses)	62mm

Model results are shown in Appendix A, and demonstrate that the site is not at risk of flooding from any nearby waterway during the median 1% AEP storm event. The site will be subject to overland stormwater flows having low depth (up to 0.3m in the deepest sections adjacent contour banks) and slow velocity (less than 0.4m/s).

2.5 Post-Development Modelling

The digital terrain model was modified in the vicinity of the solar farm by way of:

- grading to remove existing contour banks and generally smooth the lease area suitable for the installation of a PV array;
- the construction of a gentle berm within the southern boundary of the solar farm to divert overland flow in an easterly direction around the PV array area;
- minor realignment of the north-south embankment west of the site to provide clearance around the north-west corner of the solar farm area;
- the construction of a channel west of the solar farm lease area to provide an opening for runoff which may otherwise become trapped between the solar farm and the north-south embankment separating the site from the waterway area;

The extent of proposed terrain modifications are shown in Figure 2.3. The post-development computational mesh comprised 9,556 cells and included additional breaklines to coincide with proposed terrain modifications.

No terrain modifications were undertaken for the proposed site access track, and it is assumed that earthworks and drainage associated with the track will be designed to cause no changes to the existing catchment areas during major flow events, and transverse flows will be either be allowed to flow under the access track in culverts and/or flow over the access track in a controlled manner.

An additional flow resistance classification was assigned over the extent of the proposed solar farm, and given a Manning's 'n' roughness value of 0.03 allowing for assumed ongoing vegetation control in this area.

Modelling of the post-development terrain, after completion of the solar farm, was initially undertaken using the same uniform rainfall over the catchment as for the pre-development case. The modelled maximum water depths are shown in Appendix B.

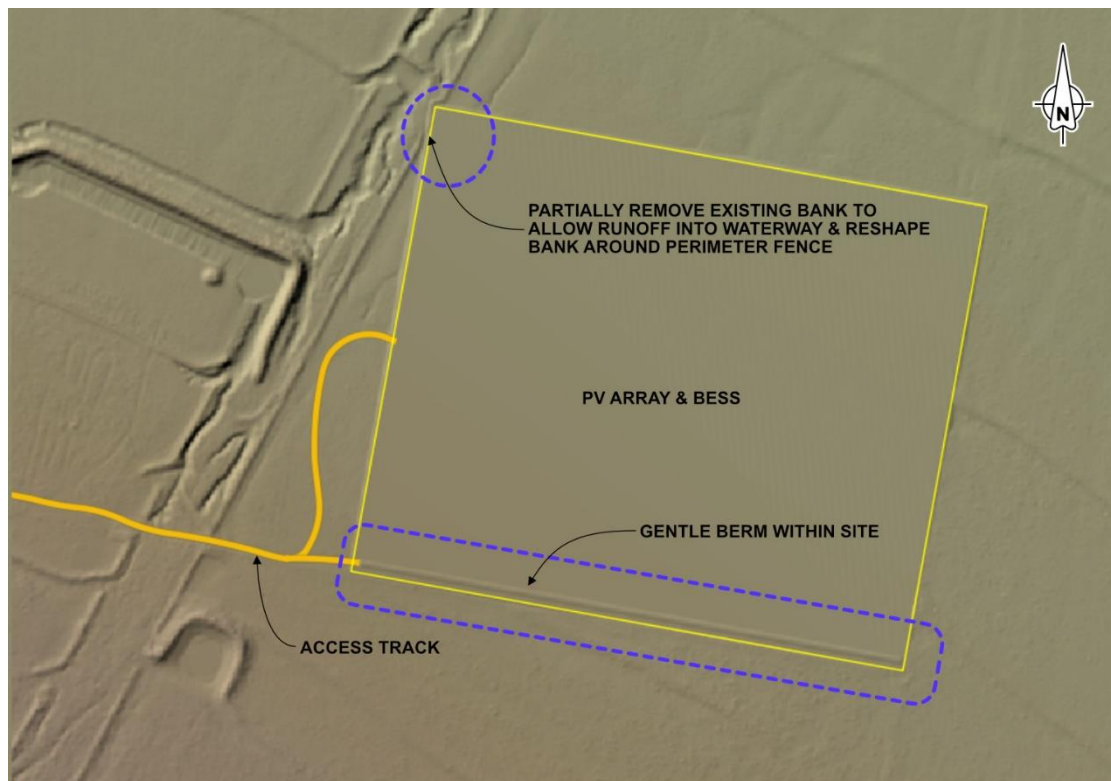


Figure 2.3 – Extent of Post-Development Terrain Modifications

The post-development modelling results indicate that the proposed minor earthworks in the vicinity of the site will be effective in minimising local stormwater flows through the proposed solar farm.

Comparison of pre-development and post-development modelling reveals no significant changes to the timing and quantity of storm flows in adjoining waterways because of the solar farm.

The effects of climate change were also reviewed for the post-development case using the Shared Socio-Economic Pathway (SSP) scenario SSP3-7.0 (High emissions, 3.3°C warming) with a target/design year of 2090 (being the midpoint of the 'long-term horizon'). A Climate Change Rainfall Modifier was applied to rainfall depths and losses in accordance with *Australian Rainfall and Runoff (ARR) v4.2 – Book 1, Chapter 6, © Commonwealth of Australia (Geoscience Australia) 2019*.

Model results under the high emissions climate change scenario SSP3-7.0 at year 2090 are shown in Appendix C and demonstrate that the site is still predicted to be clear of flood flows from adjoining waterways under this scenario.

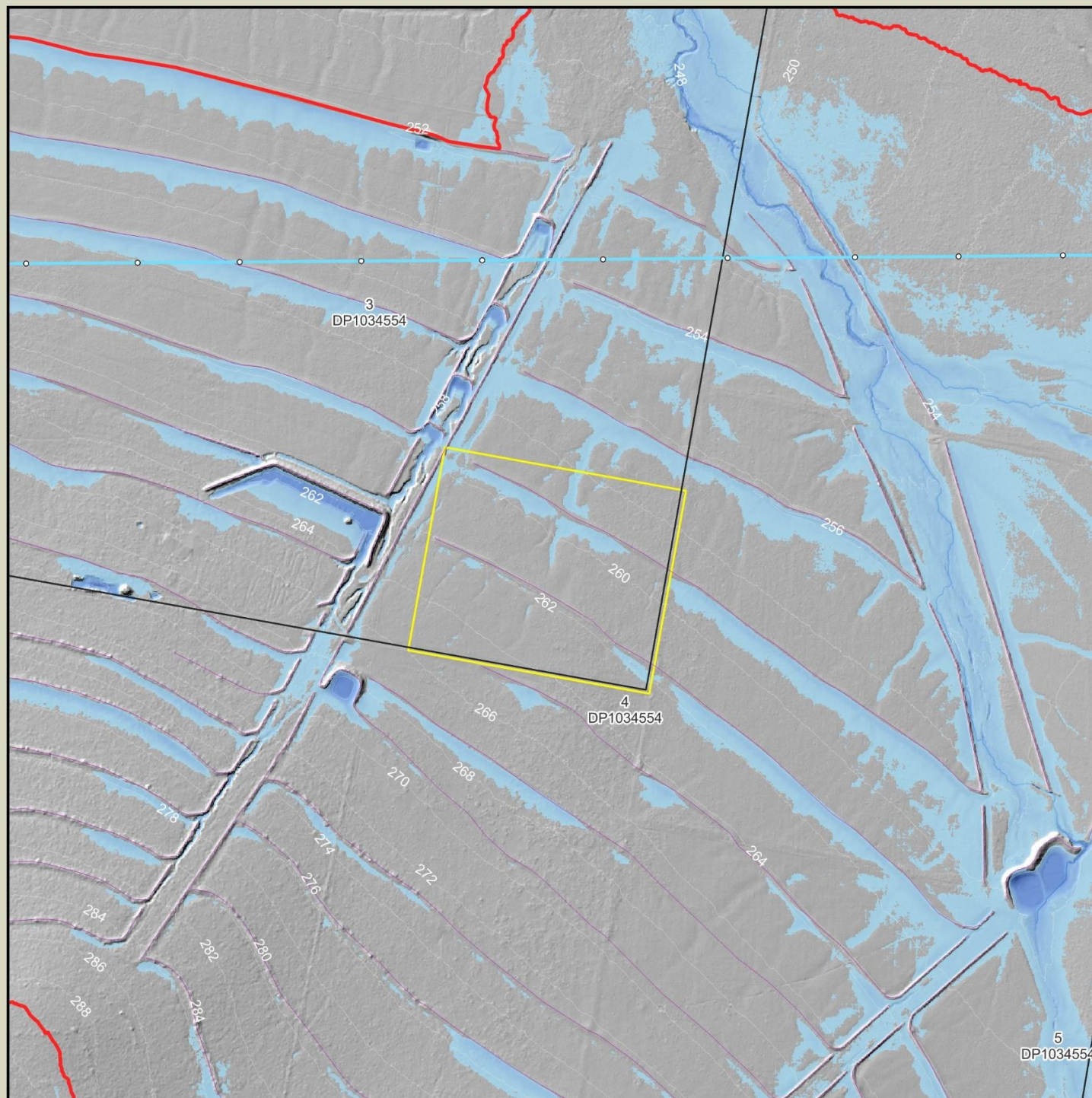
3. Conclusion

This report details the flood and stormwater assessment of a proposed 5MW solar farm with Battery Energy Storage System (BESS) at 742 Stoney Creek Road, Narrabri, within Lot 3 DP1034554.

The investigation included the development of a two-dimensional direct rainfall ('rain-on-grid') model of the site using HEC-RAS software, and applying uniform precipitation over the entire catchment to simulate the critical 1% Annual Exceedance Probability (AEP) storm event. Climate change impacts were considered based on a target year of 2090 under the Shared Socio-economic Pathway scenario SSP3-7.0, and the site will not be subjected to flooding from any nearby waterways in the critical 1% AEP storm event.

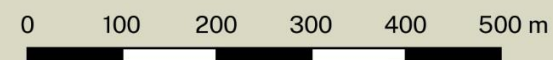
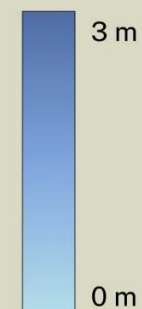
The modelling undertaken as part of this assessment demonstrates that the proposed solar farm site is not subject to flooding from either the 'hydroline' to the east of the site, nor the grassed waterway west of the site. The site has potential to be impacted by local stormwater flows, however impacts can be reduced or avoided by the use of standard site controls such as diversion banks and channels in close proximity to the site, and by culverts and/or fords where the vehicle access crosses any flow paths, as part of the detailed civil design.

APPENDIX A - MODELLED PRE-DEVELOPMENT WATER DEPTH FOR THE MEDIAN 1% AEP, 2 HOUR STORM EVENT CLIMATE CHANGE FACTOR = 1

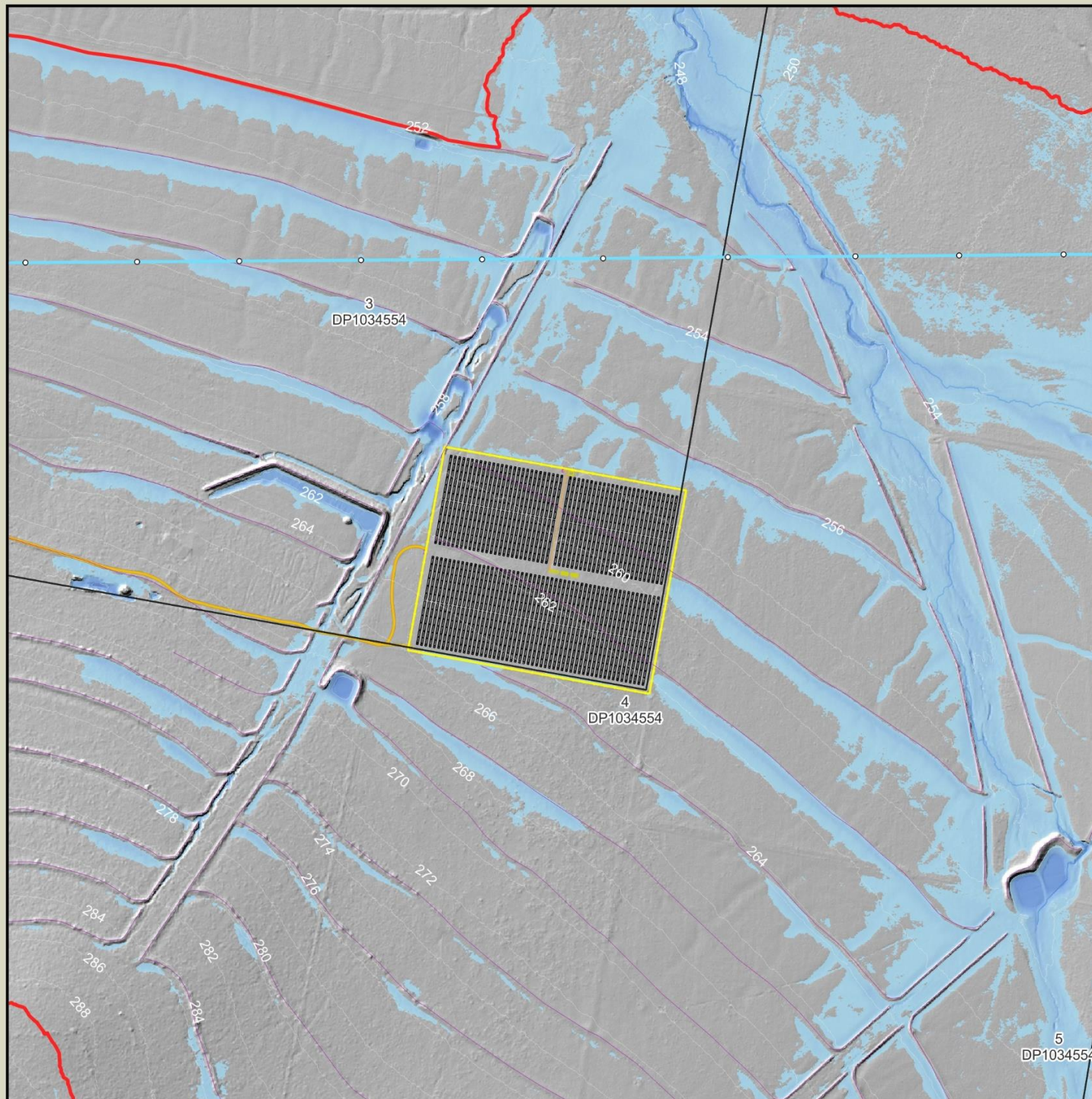


LEGEND

- ▭ Model Extent
 - ▭ Solar Farm Site
 - ▭ Lot Boundary (DCDB)
 - Contour (2m Interval)
 - Existing Contour Bank
 - Existing Power Pole
 - 22kV Overhead Conductor
- Water Depth

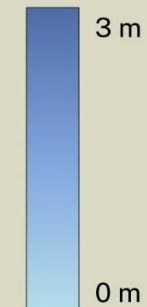


APPENDIX B - MODELLED POST-DEVELOPMENT WATER DEPTH FOR THE MEDIAN 1% AEP, 2 HOUR STORM EVENT CLIMATE CHANGE FACTOR = 1

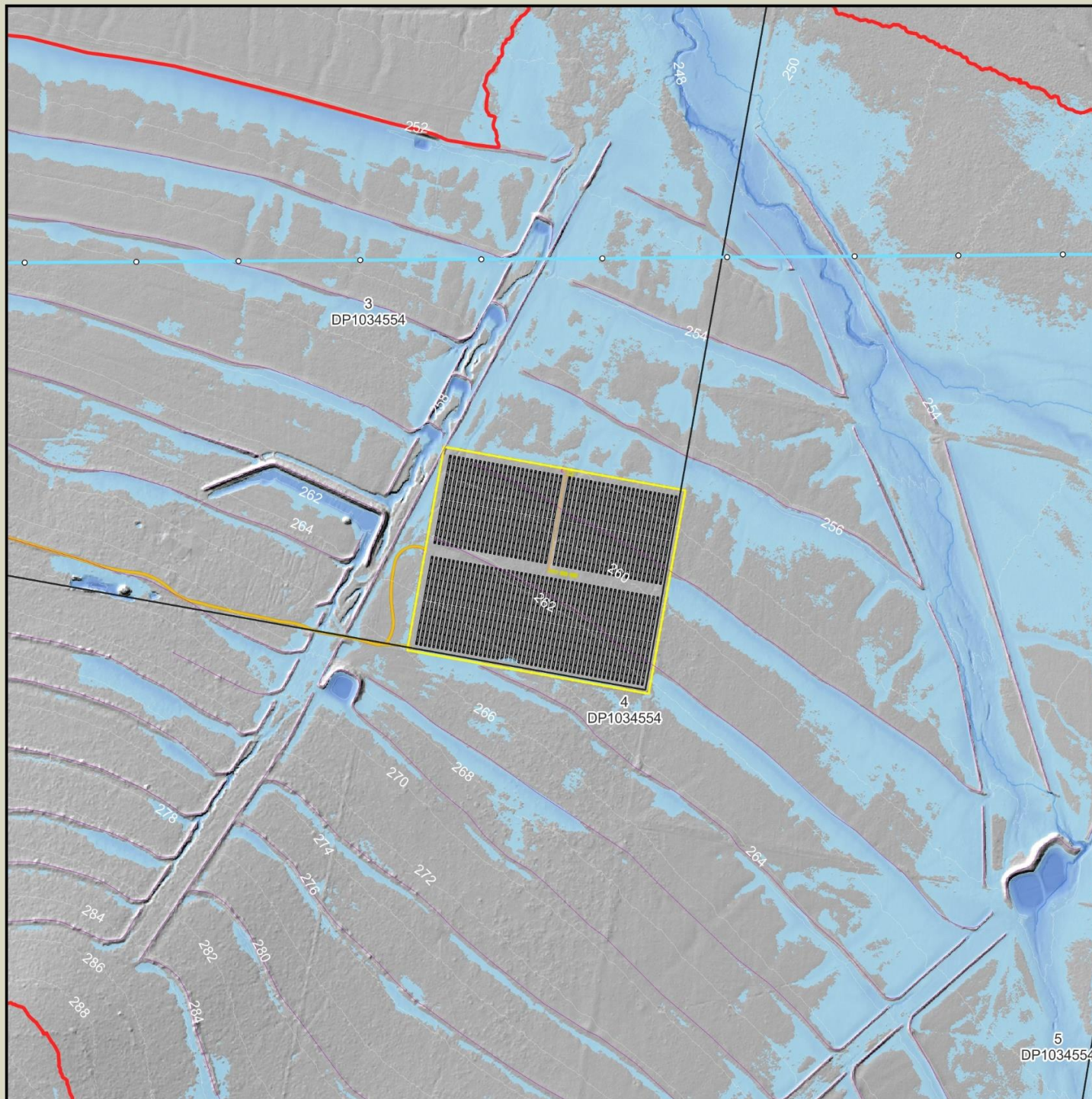


LEGEND

- Model Extent
- Solar Farm Site
- Lot Boundary (DCDB)
- Contour (2m Interval)
- Existing Contour Bank
- o Existing Power Pole
- 22kV Overhead Conductor
- Proposed Site Access
- Proposed Photovoltaic Panel



APPENDIX C - MODELLED POST-DEVELOPMENT WATER DEPTH FOR THE MEDIAN 1% AEP, 2 HOUR STORM EVENT Year 2090, SSP3-7.0



LEGEND

- Model Extent
- Solar Farm Site
- Lot Boundary (DCDB)
- Contour (2m Interval)
- Existing Contour Bank
- Existing Power Pole
- 22kV Overhead Conductor
- Proposed Site Access
- Proposed Photovoltaic Panel

