07/12/2020

Project Number: 200523

STORMWATER MANAGEMENT REPORT

at

BOGGABRI SOLAR FARM | VINE LANE BOGGABRI NSW

for

PROVIDENCE ASSET GROUP

Project No. 200523

Revision: B – Reissued for DA

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1. Introduction

DRB Consulting Engineers (DRB) were engaged by Providence Asset Group Pty Ltd to undertake a Stormwater Management Plan for the proposed Boggabri Solar Farm, located at Lot 151 DP 755475 Vine Lane, Boggabri NSW.

This report will provide commentary on the impact the proposed development will have on the existing site with regard to stormwater quantity.

It should be noted that, this report has been prepared to a level suitable for Development Application only.

This report should be read in conjunction with the Concept Stormwater Management plans 200523/CIV01-02.

2. Site Description & Proposed Development

The site is located at Vine Lane, Boggabri. The site is located on the eastern side of Vine Lane and is identified as Lot 151 DP 755475.

The proposed Boggabri Solar Farm will be located in the centre portion of the site, known as the Investigation Area (IA).

At the time of this investigation, the IA was a vacant rural parcel of land approximately 13.492 Ha in area. The IA had a good grass coverage and sloped from the northwest to the southeast at slopes of approximately 1.5 – 3.0%.

The IA had an existing watercourse passing through the south of the IA. During rainfall events, surface runoff from the IA would sheetflow towards the existing watercourse.

Figure 1 below shows the existing site and investigation area.

Figure 1 – Existing Site Boundaries

The proposed Solar Farm layout can be seen in Figure 2 below.

Figure 2 – Proposed Solar Farm

3. Council Requirements

A review of Narrabri Shire Council's Development Plan and Engineering Guidelines did not provide guidance on developments of this nature. As such, based on previous experience of design of solar farms, we understand our requirements to be:

- *The proposed development must detain stormwater runoff to ensure Post-Development flow rates are reduced to Pre-Development flow rates for all storm events up to and including the 1 in 100 year storm event.*

Furthermore, the site must discharge legally without causing nuisance flows onto neighbouring properties.

4. Water Quantity Analysis (Onsite Stormwater Detention)

4.1. Overview

The proposed development area has been split into two separate catchments for the assessment of Stormwater Quantity; the Photovoltaic Array stage and the Gravel / Hardstand catchments. Figure 3 below shows the proposed catchment boundaries.

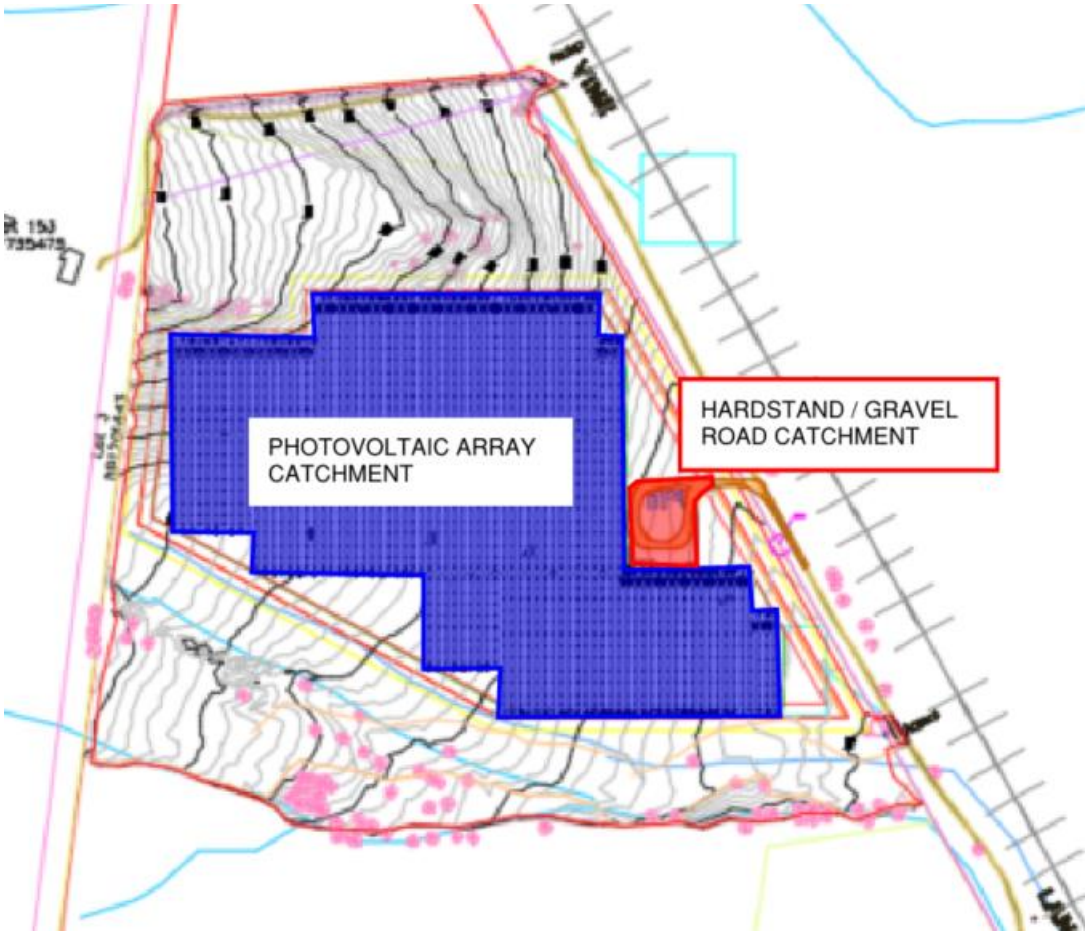

Figure 3 – Proposed Catchment Boundaries

4.2. Photovoltaic Array

The Photovoltaic Array will consist of 136 x Ground Mounted Single Axis Trackers. The array structure will be steel pile supported and will have approximately 600mm clearance above the existing ground surface.

4.2.1. Pre-Development Peak Flows

The catchment characteristics for the Pre-Development catchment area can be seen in Table 1 below:

Construction Stage	***Parameter***	
Photovoltaic Array Catchment Pre-Development	Sub-Catchment Area	88,104.70 m^2
	Percentage Impervious	0 %
	Flowpath Length	535.16 m
	Flowpath Slope	2.02 %
	Retardance Coefficient 'n'	0.075

Table 1 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The pervious area initial loss from the 2016 IFD data hub was estimated to be 60mm. This seemed to be quite a high rate for initial loss. As such, the model was developed using a more conventional, and conservative, 35mm. The Hydrological model parameters were determined using the ARR data hub and can be seen in Figure 4 below.

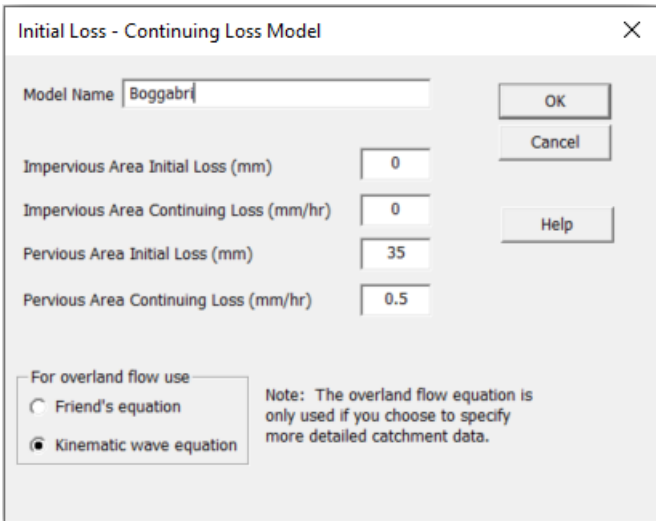

Figure 4 – Hydrological Model Parameters

The model was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events and analysed the following storm durations.

5 minutes
10 minutes
15 minutes
20 minutes
25 minutes
30 minutes
45 minutes
1 hour
2 hours
3 hours
4.5 hours
6 hours
9 hours
12 hours
18 hours
24 hours

The Results of the DRAINs model can be seen below in Table 2.

Construction Stage	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Peak Flow***
Photovoltaic Array Catchment Pre-Development	1EY	0.089 m^3/s
	10% AEP	0.653 m^3/s
	1% AEP	1.430 m^3/s

Table 2 – Pre-Development Peak Flow

4.2.2. Post-Development Peak Flows

The Post-Development site conditions can be summarised below:

(i) The proposed arrays will be at varying angles, however, in a worst-case runoff scenario, it is assumed the arrays are horizontal to the existing ground surface level.

(ii) Runoff from the proposed arrays will fall immediately on to the untouched natural ground surface.

(iii) The pervious area under the arrays will not receive direct rainfall, however, it will be available for both initial and continuing loss for the runoff of the array immediately upslope.

The catchment characteristics for the Post-Development catchment area can be seen in Table 3 below:

Construction Stage	***Parameter***	
Photovoltaic Array Catchment Pre-Development	Sub-Catchment Area	88,104.70 m^2
	Percentage Impervious	36.10 %
	Flowpath Length	535.16 m
	Flowpath Slope	2.02 %
	Retardance Coefficient 'n'	0.075

Table 3 – Proposed Development Catchment Parameters

To replicate the proposed site conditions and consider the available pervious areas located underneath the proposed arrays, the Pervious Area Initial and Continuing Loss was factored up by 1.565. This allowed the total pervious area to be included in the assessment.

The Hydrological model parameters used in the Post-Development model can be seen in Figure 5 below.

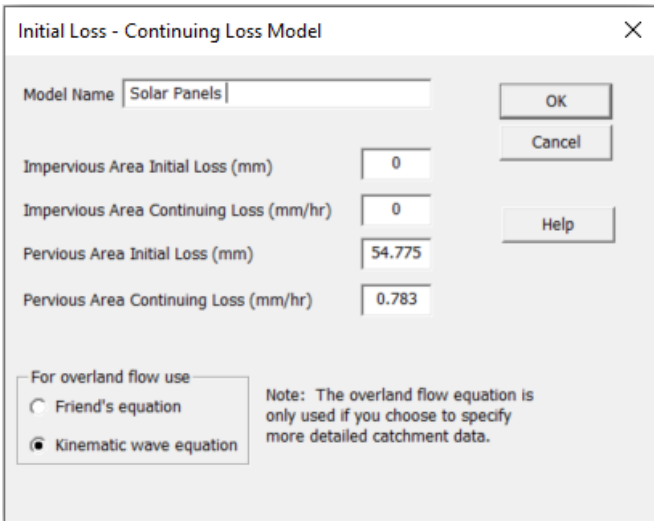

Figure 5 – Hydrological Model Parameters

The Results of the DRAINs model can be seen below in Table 4.

Construction Stage	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Pre-Development Peak Flow***	***Post-Development Peak Flow***	***Difference***
Photovoltaic Array Catchment Post-Development	1EY	0.473 m^3/s	0.198 m^3/s	- 0.275 m^3/s
	10% AEP	1.150 m^3/s	0.745 m^3/s	- 0.405 m^3/s
	1% AEP	2.150 m^3/s	1.570 m^3/s	- 0.580 m^3/s

Table 4 – Post-Development Peak Flow

4.2.3. Conclusion

By discharging the runoff from proposed Photovoltaic Array's directly to the existing ground surface and maintaining the existing natural surface levels and travel paths the proposed development area catchment limited the increase to peak runoff to negligible values, and reduced the peak runoff during the 1% AEP.

4.3. Gravel / Hardstand Area

The Gravel / Hardstand Area includes the proposed roads, gravel laydown area and temporary buildings located within the Investigation Area.

It is proposed that runoff from this area will generally follow the existing contours, with the existing swales to capture the runoff and convey these flows to a new above ground onsite stormwater detention basin. The basin will then reduce flows to the pre-development levels.

4.3.1. Pre-Development Peak Flows

The catchment characteristics for the Pre-Development catchment area can be seen in Table 5 below:

Catchment	***Parameter***	
Pre-Developed	Sub-Catchment Area	46.644.82 m^2
	Percentage Impervious	0 %
	Flowpath Length	413.2 m
	Flowpath Slope	2.45 %
	Retardance Coefficient 'n'	0.075

Table 5 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The Hydrological model parameters were determined using the ARR data hub (see Figure 4 above) and was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events.

The Results of the DRAINs model can be seen below in Table 6.

Catchment	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Combined Peak Flow***
Pre-Developed	1EY	0.307 m^3/s
	10% AEP	0.735 m^3/s
	1% AEP	1.35 m^3/s

Table 6 – Pre-Development Peak Flow

4.3.2. Post-Development Peak Flows

The Post-Development site conditions can be summarised below:

(i) The proposed gravel roads and hardstand areas will be assumed to be impervious.
(ii) A retardance coefficient of 0.013 was adopted for both the proposed gravel road and hardstand area.
(iii) The runoff from the impervious area was then treated as sheet flow along the natural ground surface and conveyed to the proposed above ground onsite stormwater detention basin via sheetflow.

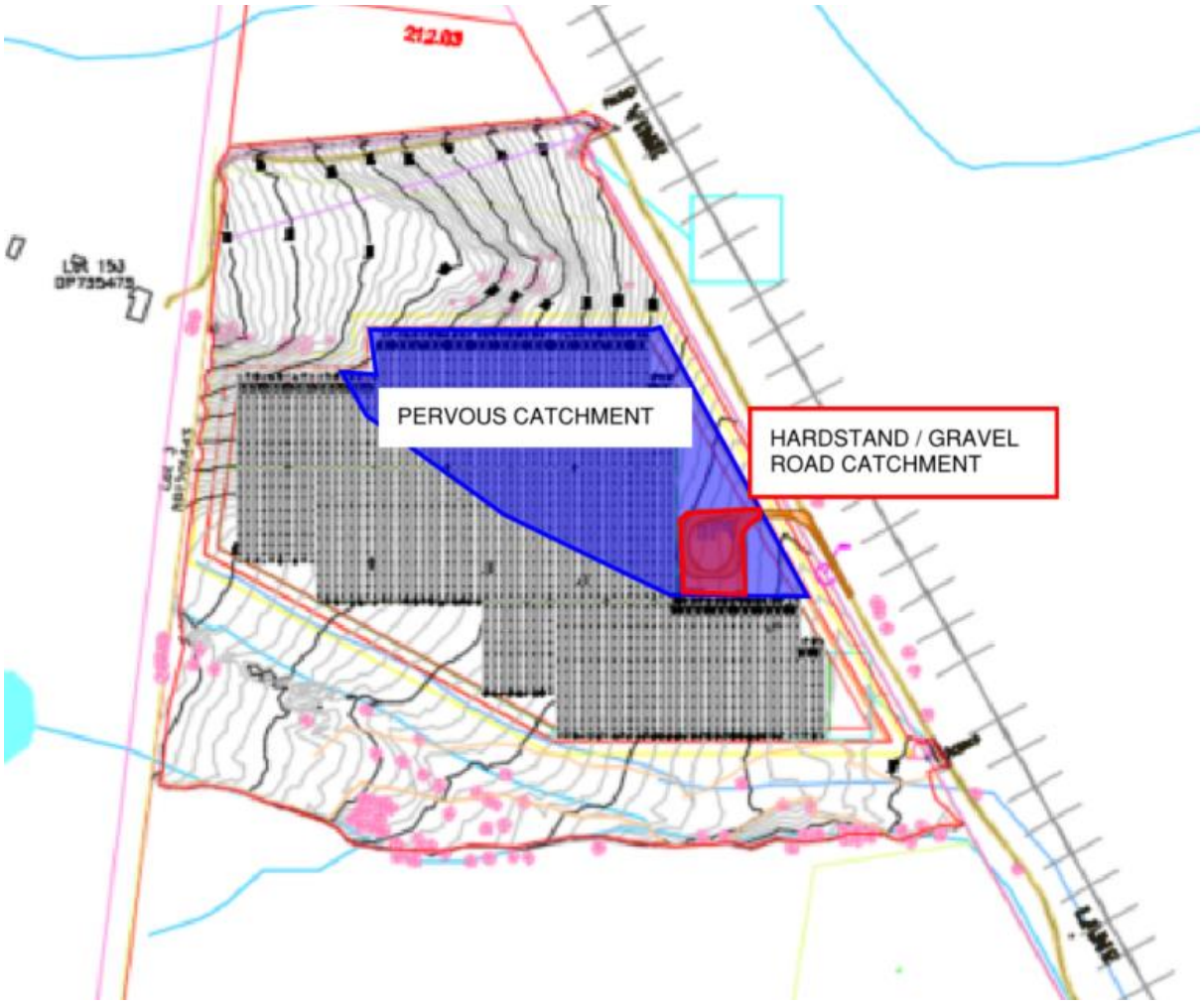

Figure 6 – Post-Development Catchment Boundaries

The catchment characteristics for the Post-Development catchment area can be seen in Table 7 below:

Catchment	***Parameter***	
Hardstand / Proposed Gravel Road	Sub-Catchment Area	3,446.14 m^2
	Percentage Impervious	100 %
	Flowpath Length	107 m
	Flowpath Slope	1.17 %
	Retardance Coefficient 'n'	0.013
Pervious	Sub-Catchment Area	43,109.70 m^2
	Percentage Impervious	0 %
	Flowpath Length	413.2 m
	Flowpath Slope	2.45 %
	Retardance Coefficient 'n'	0.075

Table 7 – Proposed Development Catchment Parameters

The Gravel / Hardstand Catchment drained directly into an above ground Onsite Stormwater Detention Basin. The Basin characteristics can be seen in Table 7 below.

OSD Basin	
Basin Invert	254.8m AHD
Basin – Top of Bank	255.2m AHD
Low flow pipe diameter	300mm
Low flow pipe invert	254.80m AHD
Base of Weir Width	6.4 m
Base of Weir Level	255.00m AHD
Top of Weir Width	10.4 m
Top of Weir Level	255.20 AHD
Basin Volume	150 m^3

Table 7 – Proposed OSD Basin Characteristics

The Results of the DRAINs model can be seen below in Table 8.

Storm Event	***Pre-Dev. Peak Flow***	***Post-Dev. Peak Flow***	***Post-Dev. Peak Flow - Mitigated***	***Difference***	***Top Water Level***
1EY	0.307 m^3/s	0.344 m^3/s	0.299 m^3/s	- 0.008 m^3/s	255.07m AHD
10% AEP	0.735 m^3/s	0.812 m^3/s	0.715 m^3/s	- 0.020 m^3/s	255.13m AHD
1% AEP	1.35 m^3/s	1.478 m^3/s	1.307 m^3/s	- 0.043 m^3/s	255.20m AHD

Table 8 – Post-Development Peak Flow

4.3.3. Conclusion

By discharging the runoff from proposed Gravel / Hardstand Area through the proposed OSD basin, the Post-development peak flows for the entire Investigation Area are reduced back to the Pre-development peak flow values.

5. Conclusion

The stormwater drainage strategy for the proposed Boggabri Solar Farm at Vine Lane, Boggabri can be summarised as:

(i) All impervious runoff from the proposed Photovoltaic Arrays will discharge to the existing ground surface where the natural flow regime will be maintained.

(ii) Runoff from the proposed gravel/hardstand area catchment will be conveyed via sheet flow to the proposed above ground onsite stormwater detention basin.

(iii) Discharge from the above ground onsite stormwater detention basing will be limited to the pre-development flow rates.

Provided the above stormwater drainage philosophy is adopted for the site, the proposed Boggabri Solar Farm will limit the Post-Development peak flows to Pre-Development flow rates for the 1 EY, 10% AEP and 1% AEP events.

Should you require any further advice or clarification of any of the above, please do not hesitate to contact us.

Yours faithfully
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