10/05/2021

Project Number: 210750

# STORMWATER MANAGEMENT REPORT

at

# PINE RIDGE SOLAR FARM | WYALONG

for

# PROVIDENCE ASSET GROUP

**Project No. 210750**

**Revision: A – Issued 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 Pine Ridge Solar Farm, located within Lot 219 DP 750615 & Lot 270 DP 750615 Wyalong, 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 210750/CIV01-04.

## 2. Site Description & Proposed Development

The site is located approximately 1.5 kilometres south east of the township of Wyalong. The site is located East of Wargin Road and is identified as Lot 219 DP 750615.

The proposed Pine Ridge Solar Solar Farm will be located on Lots 219 & 270 DP 750615, which will be hence forth known as the Investigation Area (IA) seen in Figure 1 below.

At the time of this investigation the IA was a vacant rural parcel of land approximately 15.00 Ha in area. The IA had grass coverage and sloped from the southwest to the northeast at slopes of approximately 1.0%.

During rainfall events, surface runoff from the IA would sheet flow towards the north eastern corner and exit the site.

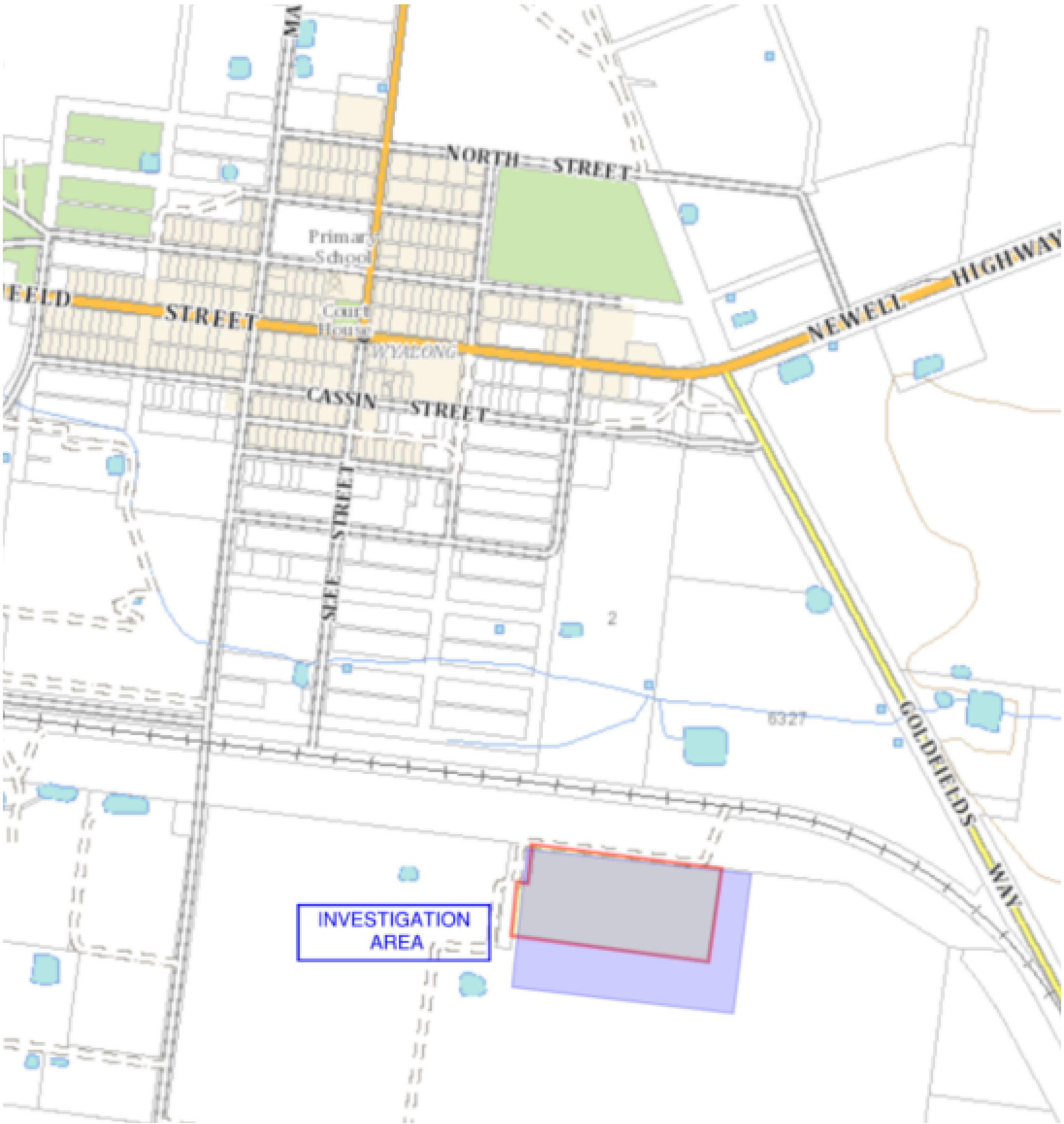


Figure 1 – Existing Site Boundaries & Investigation Area (IA)

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

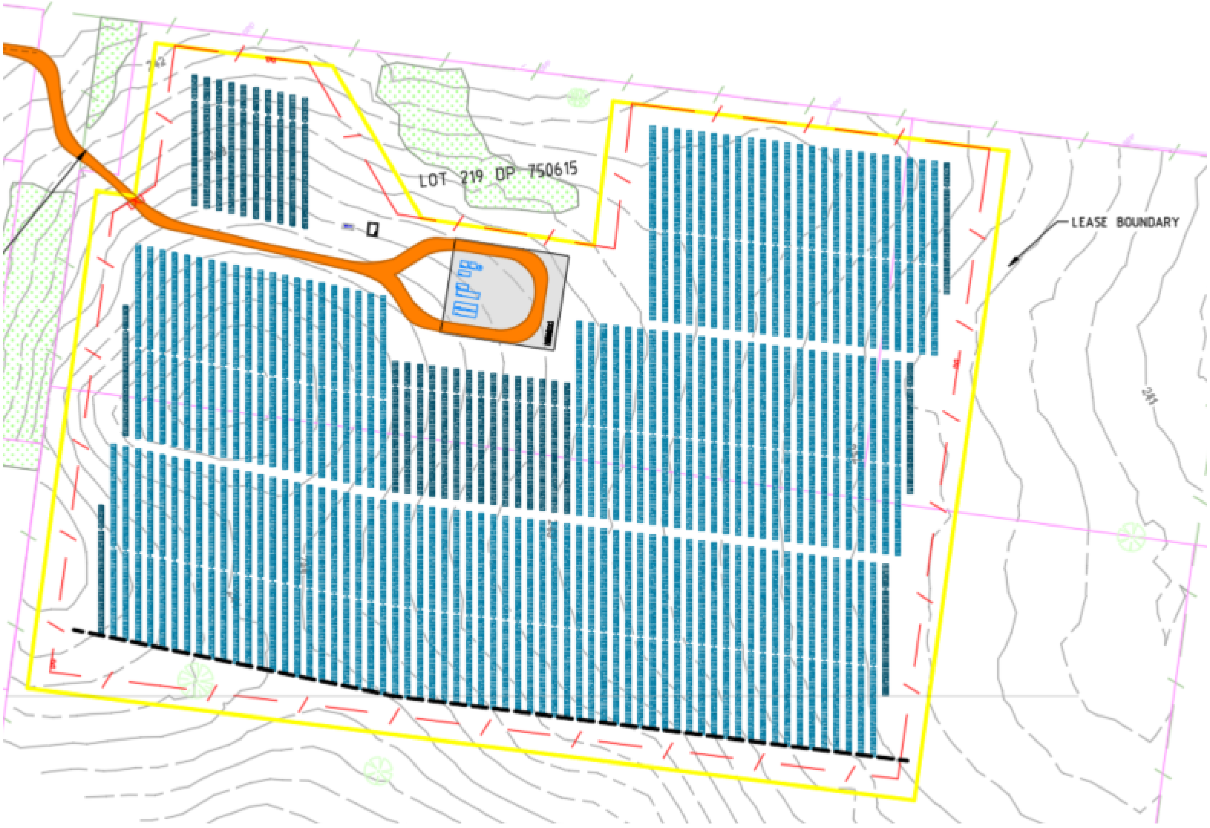


Figure 2 – Proposed Solar Farm

## 3. Council Requirements

A review of Bland Shire Council's Development Plan did not provide guidance on developments of this nature. As such, based on previous experience of design of solar farms, we propose to:

- *Limit the Post-Development flow rates from the proposed development to the Pre-Development flow rates for all storm events up to and including 1% AEP 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. The boundaries of which can be seen in Figure 3 below.

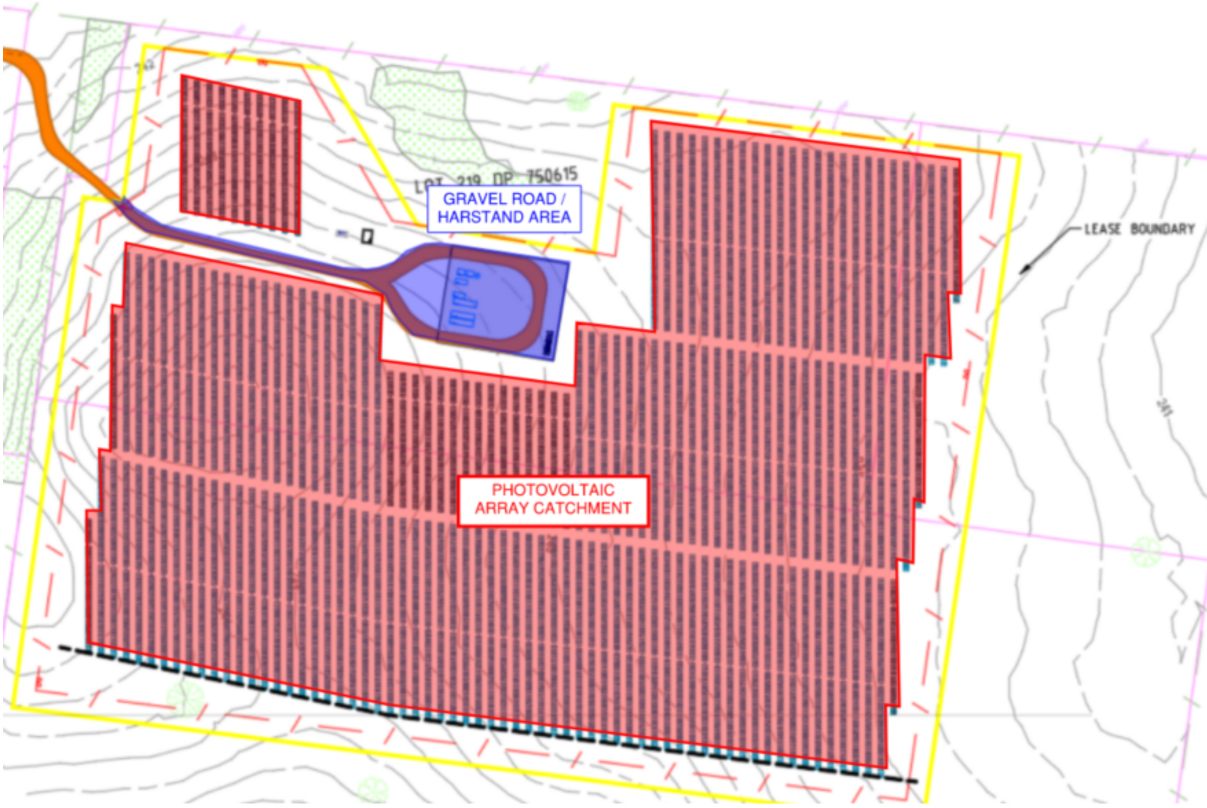


**Figure 3 – Proposed Catchment Boundaries**

### *4.2. Photovoltaic Array*

The Photovoltaic Array will consist of 165 x Ground Mounted Single Axis Trackers. The array structure will be steel pile supported and will have a minimum of 600mm ground clearance from the lowest edge of the module when the tracker is at full rotation.

### 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 | 101,912.67 $m^2$ |
| | Percentage Impervious | 0 % |
| | Flowpath Length | 309.40 m |
| | Flowpath Slope | 0.8 % |
| | 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 Hydrological model parameters were determined using the ARR data hub and can be seen in Figure 4 below.

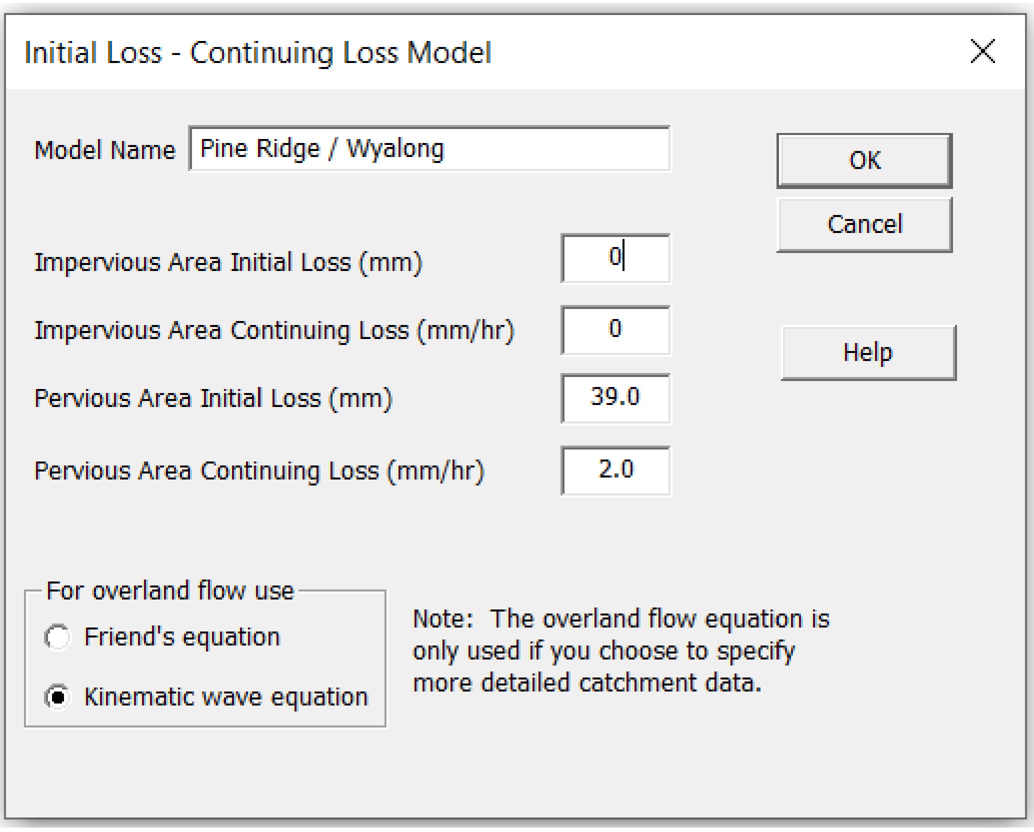


Figure 4 – Hydrological Model Parameters

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 | 45 minutes | 9 hours |
| 10 minutes | 1 hour | 12 hours |
| 15 minutes | 2 hours | 18 hours |
| 20 minutes | 3 hours | 24 hours |
| 25 minutes | 4.5 hours | |
| 30 minutes | 6 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 | 0.062 $m^3/s$ |
| | 10% AEP | 0.629 $m^3/s$ |
| | 1% AEP | 1.480 $m^3/s$ |

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 Post-Development | Sub-Catchment Area | 101,912.67 $m^2$ |
| | Percentage Impervious | 35.25 % |
| | Flowpath Length | 309.40 m |
| | Flowpath Slope | 0.8 % |
| | 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 1.55. 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.

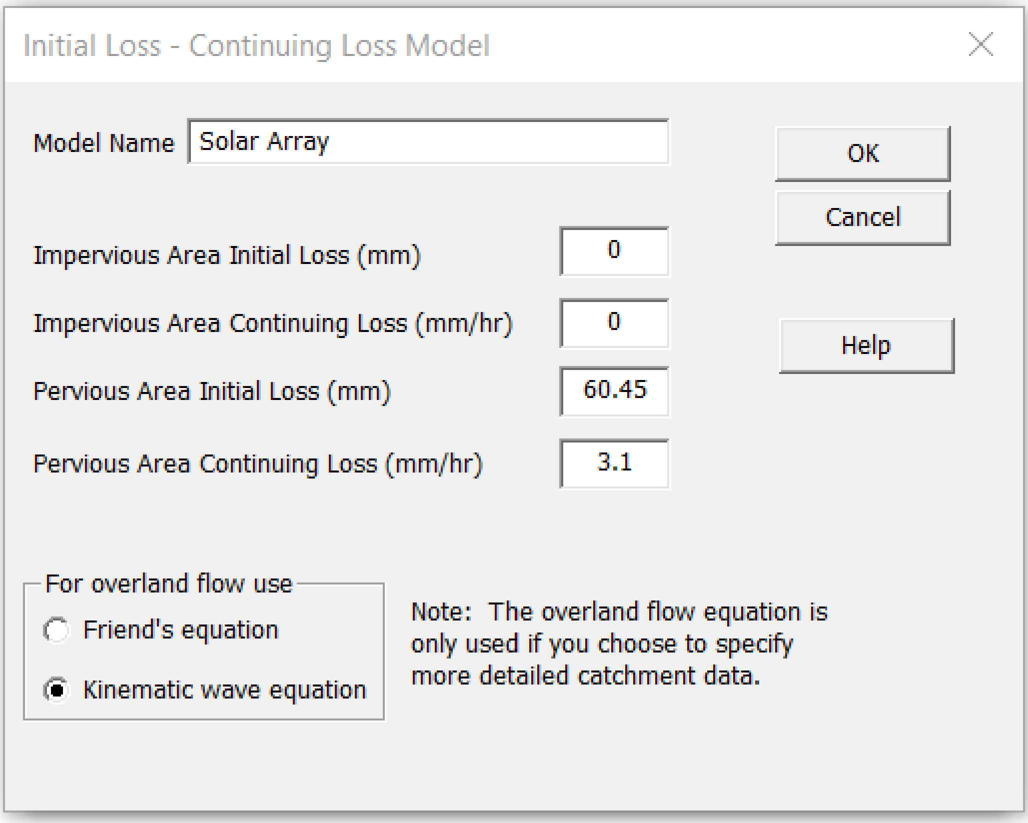


Figure 5 – Hydrological Model Parameters

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 1 Post-Development | 1EY | 0.062 $m^3/s$ | 0.033 $m^3/s$ | -0.029 $m^3/s$ |
| | 10% AEP | 0.629 $m^3/s$ | 0.391 $m^3/s$ | -0.239 $m^3/s$ |
| | 1% AEP | 1.480 $m^3/s$ | 1.030 $m^3/s$ | -0.450 $m^3/s$ |

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 in peak runoff to negligible values, and reduced the peak runoff during the 1 EY, 10% AEP and 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. For the purpose of analysis this catchment was divided into two catchments. One for the Driveway Area (Catchment 1) and the other for the Hardstand Area (Catchment 2). The two catchment areas can be seen below in figure 6.

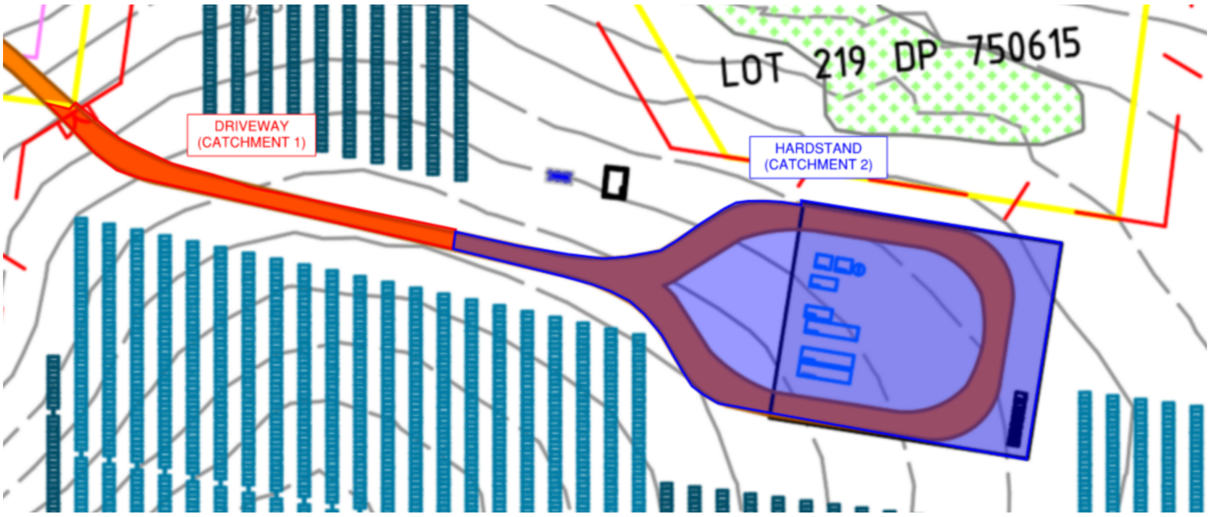


**Figure 6 – Gravel Road/Hardstand Catchment Areas.**

It is proposed that runoff from Catchment 1 will sheet flow across the hardstand and be captured by a new above ground onsite stormwater detention basin. The runoff from Catchment 2 will be allowed to sheet flow under predeveloped conditions. The new onsite stormwater detention basin will overstore flows to offset the minimal flows not captured from Catchment 2. The peak flows are to be considered where the flows will exit the site at the northern boundary.

#### 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 Catchment 1 | Sub-Catchment Area | 515.40m$^2$ |
| | Percentage Impervious | 0.0 % |
| | Flowpath Length | 74.35 m |
| | Flowpath Slope | 1.2 % |
| | Retardance Coefficient ‘n’ | 0.075 |
| Pre-Developed Catchment 2 | Sub-Catchment Area | 11,304.50 m$^2$ |
| | Percentage Impervious | 0.0 % |
| | Flowpath Length | 200 m |
| | Flowpath Slope | 1.0 % |
| | 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 Catchment 1 | 1EY | 0.000 $m^3/s$ |
| | 10% AEP | 0.011 $m^3/s$ |
| | 1% AEP | 0.021 $m^3/s$ |
| Pre-Developed Catchment 2 | 1EY | 0.009 $m^3/s$ |
| | 10% AEP | 0.094 $m^3/s$ |
| | 1% AEP | 0.212 $m^3/s$ |
| Pre-Developed Total Catchment | 1EY | 0.009 $m^3/s$ |
| | 10% AEP | 0.098 $m^3/s$ |
| | 1% AEP | 0.220 $m^3/s$ |

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 treated as sheet flow along the proposed levels before being captured within a new roadside swale and conveyed to the proposed above ground onsite detention basin.

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

| ***Catchment*** | ***Parameter*** | |
|---|---|---|
| Catchment 1 | Sub-Catchment Area | 515.40 $m^2$ |
| | Percentage Impervious | 100 % |
| | Flowpath Length | 74.35 m |
| | Flowpath Slope | 1.2 % |
| | Retardance Coefficient 'n' | 0.013 |
| Catchment 2 | Sub-Catchment Area | 11,304.50$m^2$ |
| | Percentage Impervious | 38.18 % |
| | Flowpath Length | 93 m |
| | Flowpath Slope | 0.45 % |
| | Retardance Coefficient 'n' | 0.013 |

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 8 below.

| ***OSD Basin*** | ***Catchment 1*** |
|---|---|
| Basin Invert | 242.700 m AHD |
| Basin – Top of Bank | 243.100 m AHD |
| Low flow pipe diameter | 150 mm |
| Low flow pipe invert | 242.700 m AHD |
| Base of Weir Width | 3.0 m |
| Base of Weir Level | 242.950 m AHD |
| Top of Weir Width | 7.0 m |
| Top of Weir Level | 243.100 m AHD |
| Basin Volume | 165.271 $m^3$ |

Table 8 – Proposed OSD Basin Characteristics

The Results of the DRAINs model for catchments 1 & 2 can be seen below in Table 9.

| | ***Catchment 1*** | | ***Catchment 2*** | |
|---|---|---|---|---|
| ***Storm Event*** | ***Pre-Dev. Peak Flow*** | ***Post-Dev. Peak Flow*** | ***Pre-Dev. Peak Flow*** | ***Post-Dev. Peak Flow*** |
| 1EY | 0.000 $m^3/s$ | 0.009 $m^3/s$ | 0.009 $m^3/s$ | 0.059 $m^3/s$ |
| 20% AEP | 0.004 $m^3/s$ | 0.014 $m^3/s$ | 0.058 $m^3/s$ | 0.096 $m^3/s$ |
| 10% AEP | 0.007 $m^3/s$ | 0.017 $m^3/s$ | 0.094 $m^3/s$ | 0.128 $m^3/s$ |
| 1% AEP | 0.014 $m^3/s$ | 0.027 $m^3/s$ | 0.212 $m^3/s$ | 0.255 $m^3/s$ |

Table 9 – Post-Development Peak Flow Catchments 1 & 2.

The combined results of the two catchments, considering overland flow paths to the boundary, can be seen below in Table 10.

| ***Storm Event*** | ***Pre-Dev. Peak Flow*** | ***Post-Dev. Peak Flow*** | ***Post-Dev. Peak Flow - Mitigated*** | ***Difference*** | ***Top Water Level*** |
|---|---|---|---|---|---|
| 1EY | 0.009 $m^3/s$ | 0.068 $m^3/s$ | 0.020 $m^3/s$ | 0.011 $m^3/s$ | 242.87 m AHD |
| 20% AEP | 0.061 $m^3/s$ | 0.110 $m^3/s$ | 0.038 $m^3/s$ | -0.023 $m^3/s$ | 242.97 m AHD |
| 10% AEP | 0.098 $m^3/s$ | 0.145 $m^3/s$ | 0.079 $m^3/s$ | -0.019 $m^3/s$ | 242.99 m AHD |
| 1% AEP | 0.222 $m^3/s$ | 0.185 $m^3/s$ | 0.282 $m^3/s$ | -0.060 $m^3/s$ | 243.02 m AHD |

Table 10 – Post-Development Peak Flow Combined Catchments.

Note that for the 1 EY, the system does not reduce the Post-development peak flows back to the Pre-development peak flow values. For this site it is deemed impractical to reduce the post-development flow to match the pre-development flow of 0.000 $m^3/s$ in Catchment 1 seen in Table 9. Therefore, the 20% AEP storm event was added as a minor storm to be used in-lieu of the 1 EY. This ensures that the Post-Development peak flows are reduced back to Pre-Development peak flow for lower flows in minor storms.

### *4.3.3. Conclusion*

By allowing the driveway to maintain flows as per pre-development and discharging the runoff from the 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 Pine Ridge Solar Farm at Lots 219 & 270 DP 750615, 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 and the proposed roadside swale to the proposed above ground onsite stormwater detention basins.

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

Provided the above stormwater drainage philosophy is adopted for the site, the proposed Pine Ridge Solar Farm will limit the Post-Development peak flows to Pre-Development peak flow rates for the 20% AEP, 10% AEP and 1% AEP storm 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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