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Re: Flood Impact Assessment – Genex Power Jemalong Solar Farm

Background and Scope

Southeast Engineering and Environmental (Southeast) have been engaged by Genex Power to undertake a technical assessment of flooding impacts for a modification to the approved Jemalong Solar photovoltaic (PV) Plant. Southeast previously prepared a Flood Impact Assessment (FIA) for the Vast Solar Pty Ltd Concentrated Solar Plant (CSP) on this site (Southeast, 2015), this assessment builds on that floodplain modelling.

The Jemalong Solar PV Plant was approved in 2018. The associated Environmental Impact Statement (EIS) included a FIA, Jemalong Solar PV Plant, Summary Technical Report (ARUP, 2017) which adddressed flood management measures for infrastructure proposed on site. Flood levels around the Jemalong Solar PV Plant for the 1990 event were established using a two dimensional (2D) TUFLOW model incorporating flow rates from the Lachlan River Floodplain Management Study (Parsons Brinckerhoff, 2009). The ARUP FIA did not consider flood impacts due to development itself.

Genex Power now have ownership of the Jemalong Solar PV development, referred to in this letter as the Genex Jemalong Solar Farm. A modification to the approved design is proposed including an expansion of the previously approved PV array footprint. This letter considers the flood impacts associated with the current proposed modification.

Floodplain Management Background

The development site is located on the Lachlan River floodplain, immediately downstream of the Jemalong Gap (**Error! Reference source not found.**), a significant hydraulic control. A number of studies have been completed over the area to assist with planning for flood controls which have been implemented primarily to manage floodwaters for agriculture.

The area immediately downstream of the Jemalog Gap is particularly sensitive to hydraulic modifications. This part of the floodplain determines how flows are distributed to the northern floodplain, southern floodplain and the Lachlan River. This part of the floodplain (Zones A and B) have the highest level of control on in-stream works, discussed further below. The development site is located around the boundary between zone A and zone B. Refer *Figure 1* **Error! Reference source not found.**

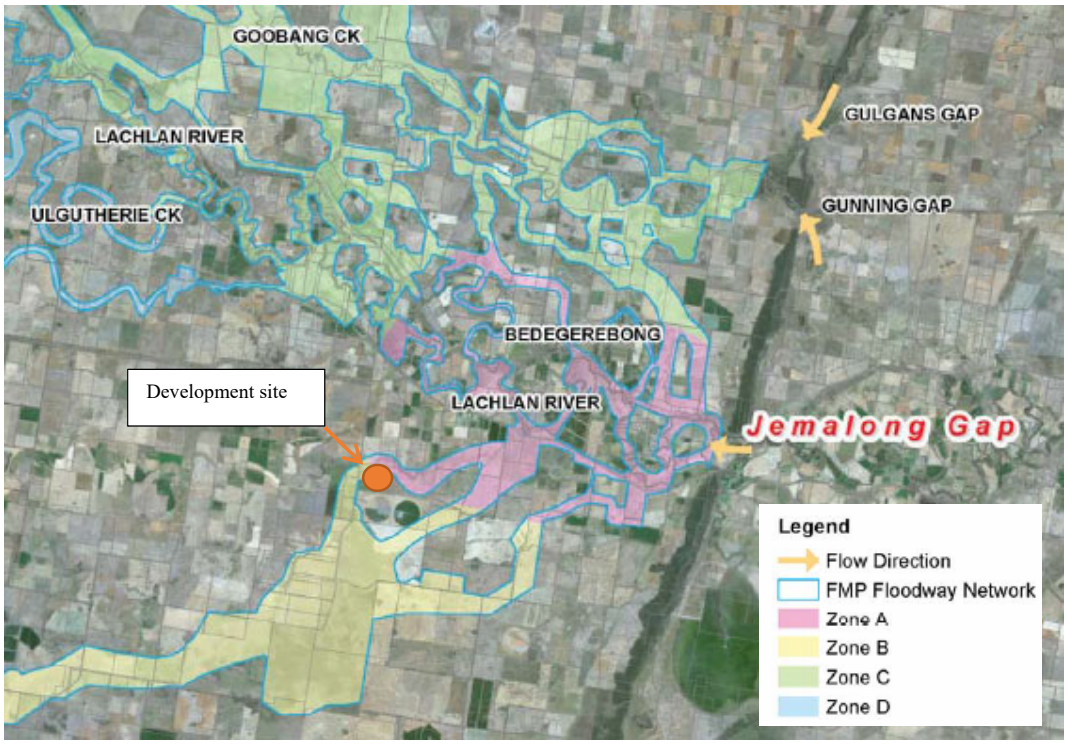

Figure 1 Floodway network and zones for management

In 1978 the Guidelines for Floodplain Development; Lachlan River Jemalong Gap to Condobolin (WRC, 1978), hereon referred to the 1978 Guidelines, determined a flood planning level based on the 25 year ARI flood. These guidelines determined levee locations and heights and outlined proposed modifications to hydraulic control structures to better manage floodwaters for economic and environmental benefit.

Further flood investigations were undertaken from 2003 through to 2012 as part of the floodplain risk management process (NSW Government, 2005) and a flood study, floodplain risk management study and floodplain management plan were developed for this stretch of the Lachlan River.

The flood studies undertaken make use of existing gauging data and use flood frequency analysis to estimate flood recurrence. The more recent significant events of 1952, 1974 and 1990 have been modelled as these historical events have influenced floodplain management and are recent enough to be understood by landholders.

The Lachlan River Floodplain Management Study (Parsons Brinckerhoff, 2009) considered the 1952, 1974 and 1990 flood events, and established the exceedance probabilities of the 1952 event at approximately a 0.5% AEP event, and the 1990 event at approximately a 4% AEP event.

The adopted 'design flood' for the current Floodplain Management Plan (FMP) (OEH, 2012) is the 1990 historical event and is identified as the 25 year ARI event. This adopted 'design flood' is very similar to the flood planning levels developed in the 1978 guidelines.

These more recent studies have refined the floodway network and confirmed flood levee locations.

Floodplain Planning and Legislation

Modifications in and around floodways in the western rural areas of NSW is controlled through Floodplain Management Plans the Water Management Act 2000 and Water Management (general) Regulation 2018. The Floodplain Management Plan (OEH, 2012) defines a designated floodplain by the green line and shaded area as shown in *Figure 2*. Works within the designated floodplain, depending on their extent and impact are controlled through the Water Management Act 2000 as 'controlled activities', which are generally earthworks, embankments or levees or other works that are likely to affect the flow of water. This letter addresses the potential impact of the proposal and how the proposal sits within the Water Management Act 2000.

Figure 2 Designated floodplain (development site shown in orange)

In this case no works are proposed within the floodway, although works are proposed on the broader designated floodplain. In this particular case the Floodplain Management Plan (OEH, 2012) notes:

> *Development outside of the limits of the FMP floodway network would not generally cause a significant redistribution of design flood flows or a significant increase in flood levels. However, while applications for flood control works in this area will generally be assessed as complying works, the assessment may need to take into account any potential increase in flood hazard or flood damage under flood conditions larger than the design flood. Adverse impacts could result, for example, if extensive works proposed near to the floodway network are substantially higher than the corresponding design level of the floodway network.*
> *Assessment of the flood hazard will be largely qualitative, taking into consideration existing works, the extent of proposed works, and the potential for localised impacts on*

neighbouring unprotected properties. Such an assessment would not need to go into the details required for works within the floodway, unless the impact on overall flood behaviour could be significant and therefore far-reaching.

The key consideration for this development proposal is whether the possible; '*impact on overall flood behaviour could be significant and therefore far-reaching.' a*s noted in the Floodplain Management Plan.

Proposed Modification Flood Impact Assessment

Modification Description

The proposed modification increases the footprint of PV arrays from the Jemalong Solar PV proposal at the western and eastern ends and in a small area along the northern side (refer *Figure 3*).

The proposed PV field is arranged into linear trackers of either 87 or 58 modules (PV cells) that run north south to allow the tracking modules to pivot from east to west. The linear trackers are supported on piers about every 8 metres, with each row about 6.5m apart. Support piers are steel I profile supports with dimensions approximately 150x100mm. Based on the ARUP FIA and the Genex's risk assessment, the panel tilt point and associated tracking motor are set at 300mm above the 1990 flood level (4% AEP) to provide flood protection. The panels will be rotated to the horizontal plane in the event of a flood.

No adjustment to any existing levees are proposed.

Over the development site there is an average difference in flood level between the 1990 and 1952 flood level of about 350mm *(Parsons Brinkerhoff, 2009).* The MIKE 11 model used in the *Lachlan River Floodplain Management Study* (Parsons Brinckerhoff, 2009) confined all flows to within the levee areas, even though the 1952 flood would overtop the levee in some places. Allowing larger flows to extend over the floodplain in the HEC RAS model associated with this report reduces this difference to approximately 250mm. This suggests that the panel tilt axis and panel motor are at around the 0.5% AEP flood level.

Figure 1 - 1990 event Flood depth (ARUP, 2017). Approved PV extent and proposed modification.

Client: GENEX
DATE: 10/07/19

Figure 3: PV array footprint for Vast Solar and modified Genex Power proposal

Flood Impact Assessment (Roughness Change)

The MIKE11 flood model used in the *Lachlan River Floodplain Management Study* (Parsons Brinckerhoff, 2009) was transferred to a HEC RAS 1D model to assess the impact of the Genex Jemalong Solar Farm on flood flows. Flows from both the 1990 flood (4% AEP), and the 1952 flood (0.5% AEP) were used in the model.

To assess the impact of the solar array on flooding, an adjustment to the Manning's roughness values used in the HEC RAS model was made to account for the flow impedance associated with the PV array supports. Manning's roughness estimation was based on the *Modified Cowan* method and floodplain vegetation roughness for particular tree spacing (Table 1). Doubling of roughness was also tested as a sensitivity or 'worst case' analysis. Roughness impacts were tested for both the 1990 and 1952 events.

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Roughness component	Floodplain pasture	PV field
Surface component (clay base soils)	0.020	0.020
Irregularity	0.000	0.000
Obstructions in floodplain	0.001	0.001
Vegetation height and type or PV supports*	0.015	0.050
Total	**0.037**	**0.071**

*Based on trees at 8m spacing on an even well grassed surface (BCC, 2003)

Flood Impacts

In the 1990 event the change in roughness from pasture to a PV field increases flood depths by up to 2cm over the site and upstream surrounds.

In the 1952 event the change in roughness from pasture to a PV field increases flood depths by up to 3cm over the site and upstream surrounds.

In the 1952 event, doubling of roughness to 0.142 to represent significant impedance, increases flood depths by up to 5cm.

Taking into consideration that, for the 1952 (0.5% AEP) event, the potential changes in flood depth upstream of the site is up to 5cm in a 'worst case' and 3cm in a 'realistic' case and the landscape uses adjacent to the site of broadscale agriculture, the flood impacts impact of the PV field is not significant.

The limited impact of a change in roughness is a function of the large flow extents, and the relatively slow flow velocities.

Impact Management

To ensure the impacts of the PV field on flooding is limited, the panels shall be a minimum 0.3m above the 1990 (4% AEP) event when in the horizontal position. A fail-safe mechanism or procedure will need to be incorporated into the design to ensure that panels are placed in the horizontal plane in a flood event to maximise flood protection and limit flood interaction.

Conclusions and Recommendations

The impact of the proposed PV panel supports on the floodplain, in terms of a surface roughness change is minimal. Based on a one dimensional hydraulic model, the proposed PV array and associated supports increase flood levels for the 1952 event (0.5% AEP) from 3cm to up to 5cm, and for the 1990 (4% AEP) event up to 2cm around and immediately upstream of the site. This is not considered significant given the change in depth and the land use over the impacted area and model accuracy.

No modification of existing flood control levees are proposed.

Given that the impact of the array on the floodplain is not significant and therefore far reaching, the proposal can be considered 'complying works' under the FMP (OEH, 2012). Although the impact is minor, a flood work approval may still be required under the Water Management Act 2000 and the Water Management (General) Regulation 2018.

The design of the PV arrays and associated infrastructure should ensure:

- the panels themselves are at a minimum 0.3m above the 1990 (4% AEP) flood level.
- That mechanical/electrical components for the arrays have appropriate freeboard/flood protection based on Genex's operational risk assessment.
- That grid connection infrastructure such as inverters and transformers are protected from flooding with a minimum 0.3m freeboard from the 1990 event, or higher based on Genex's operational risk assessment.

Please contact the undersigned if you have any questions.

Yours sincerely,

Lachlan Bain
Environmental Engineer BEng (Env) MEM.

REFERNCES

ARUP 2017, *Jemalong Solar PV Plant, Summary Technical Report*

BCC 2003 *Natural Channel Design Guidelines,* Brisbane City Council.

Department of Environment and Climate Change 2009, *Lachlan River Jemalong Gap to Condobolin Floodplain Risk Management Study*

Parsons Brinkerhoff 2004, *Lachlan River (Jemalong Gap to Condobolin), Lachlan, NSW, Rural Flood Study.*
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Southeast 2015, *Flood Impact Assessment: Jemalong Solar Station*