Appendix F

Surface water assessment

Orange Grove
Sun Farm

Overland Sun Farming

HYDRO ENGINEERING & CONSULTING PTY LTD

REPORT

Orange Grove Sun Farm
Surface Water Assessment

Prepared for: Orange Grove Sun Farm Pty Ltd

38a Nash Street
Rosalie QLD 4064
p (07) 3367 2388

PO Box 1575
Carindale QLD 4152
www.hecons.com
ABN 11 247 282 058

Revision	Description	Author	Reviewer	Approved	Date
a	Draft	TSM	LMG	TSM	25 Apr 2018
b	Revised following client comments	TSM	Various	TSM	4 May 2018
c	Minor formatting and text revisions	TSM	EMM	TSM	4 May 2018
d	Minor text revisions, add Executive Summary	DNF	TSM	TSM	9 May 2018
e	Minor text revisions	DNF	CB	CB	11 May 2018
f	Revise wording of Section 2.1	DNF	DR	TSM	15 May 2018
g	Revise wording of Section 2.1	DNF	DR	TSM	23 May 2018

EXECUTIVE SUMMARY

OVERLAND Sun Farming Pty Ltd (OVERLAND) on behalf of Orange Grove Sun Farm Pty Ltd (the proponent) proposes to develop the Orange Grove Sun Farm, a large-scale solar photovoltaic (PV) generation facility and associated infrastructure (the project) on a property located in New South Wales (NSW) approximately 12 kilometres (km) east of Gunnedah, 6 km west-northwest of Carroll and approximately 2.5 km north of the main Namoi River channel.

This Surface Water Assessment has been prepared in accordance with the requirements of the NSW Department of Planning and Environment (DPE) as set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project.

No water quality data are available for runoff from the site itself however an analysis of water quality data collected from regional streamflow gauging stations suggests slightly alkaline pH with varying electrical conductivity (depending on location upstream of downstream of Keepit Dam) and with turbidity slightly elevated relative to the ANZECC (2000) upper bound trigger value for protection of aquatic ecosystems.

Construction activities will require water for dust suppression as well as potable water for construction personnel which would be distributed by a water truck. Water would either be trucked to site or sourced on site via a nearby groundwater bore.

Operational activities will require water for panel cleaning and potable water for operational personnel. It is estimated that these water requirements would be in the order of 3 megalitres annually and is planned to be sourced on site via a nearby groundwater bore.

Construction activities have the potential to generate turbid or sediment-laden runoff to downslope areas. An erosion and sediment control plan would be prepared prior to construction, in accordance with Landcom (2004). Erosion and sediment controls would continue to function and be maintained during the operational life of the project.

Regarding the flood assessment, the following points are of particular note:

- Available regional 10 metre (m) contours provided only a coarse interpretation of site topography and the geometry of the Namoi River channel. Therefore a level survey of the development area (to a 0.1 m contour interval) and a cross-section of the river and adjacent areas (covering approximately 6,750 m in length) were commissioned by OVERLAND.
- Much of the described flooding characteristics of the development area are drawn from flood modelling and assessment for the Namoi and Mooki Rivers undertaken by SMEC (2003) with the model boundary capturing the development area and adjacent land.
- Based on the modelling of the 1984 flood undertaken by SMEC (2003), the level of this flood is well below the lowest development area level and therefore the proposed project should not impact on the relevant large design flood (as defined in the Floodplain Management Plan for the Upper Namoi Valley Floodplain).
- The plotted 1955 flood profile (Figure 7.3a of SMEC, 2003) appears to indicate a modelled flood level of approximately 272.3 m Australian Height Datum (AHD) in the river adjacent to the site. This is lower than the lowest surveyed surface levels across the development area and therefore the proposed project should not impact on the relevant large design flood.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 OVERVIEW

OVERLAND Sun Farming Pty Ltd (OVERLAND) on behalf of Orange Grove Sun Farm Pty Ltd (the proponent) proposes to develop the Orange Grove Sun Farm, a large-scale solar photovoltaic (PV) generation facility and associated infrastructure (the project) on a property located approximately 12 kilometres (km) east of Gunnedah in New South Wales (NSW) (Figure 1).

The project is a State significant development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). A development application (DA) for the project is required to be submitted under Part 4, Division 4.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). An environmental impact statement (EIS) is a requirement of the approval process.

This surface water assessment (SWA) has been prepared by Hydro Engineering & Consulting Pty Ltd (HEC) in support of the EIS. It provides background surface water information for the site, describes site water management during construction and operations, assesses the flood risk of the site and summarises potential surface water impacts and mitigation measures.

1.2 ASSESSMENT REQUIREMENTS

This SWA has been prepared in accordance with the requirements of the NSW Department of Planning and Environment (DPE) as set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 20 December 2017. The SEARs identify matters which must be addressed in the EIS. A copy of the SEARs is attached to the EIS as Appendix A, while Table 1.1 lists the individual requirements relevant to this SWA and where they are addressed in this report.

Table 1 Secretary's Environmental Assessment Requirements – Surface Water

Requirement	Where Addressed
Water - including:	
- an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including the Namoi River and its catchment, wetlands, riparian land, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts;	Sections 4, 5 & 6 (relating to surface water)
- details of water requirements and supply arrangements for construction and operation; and	Section 4
- a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with Managing Urban Stormwater: Soils & Construction (Landcom 2004).	Section 4

To inform preparation of the SEARs, DPE invited other government agencies to recommend matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs. These additional matters were also considered when preparing this SWA where relevant.

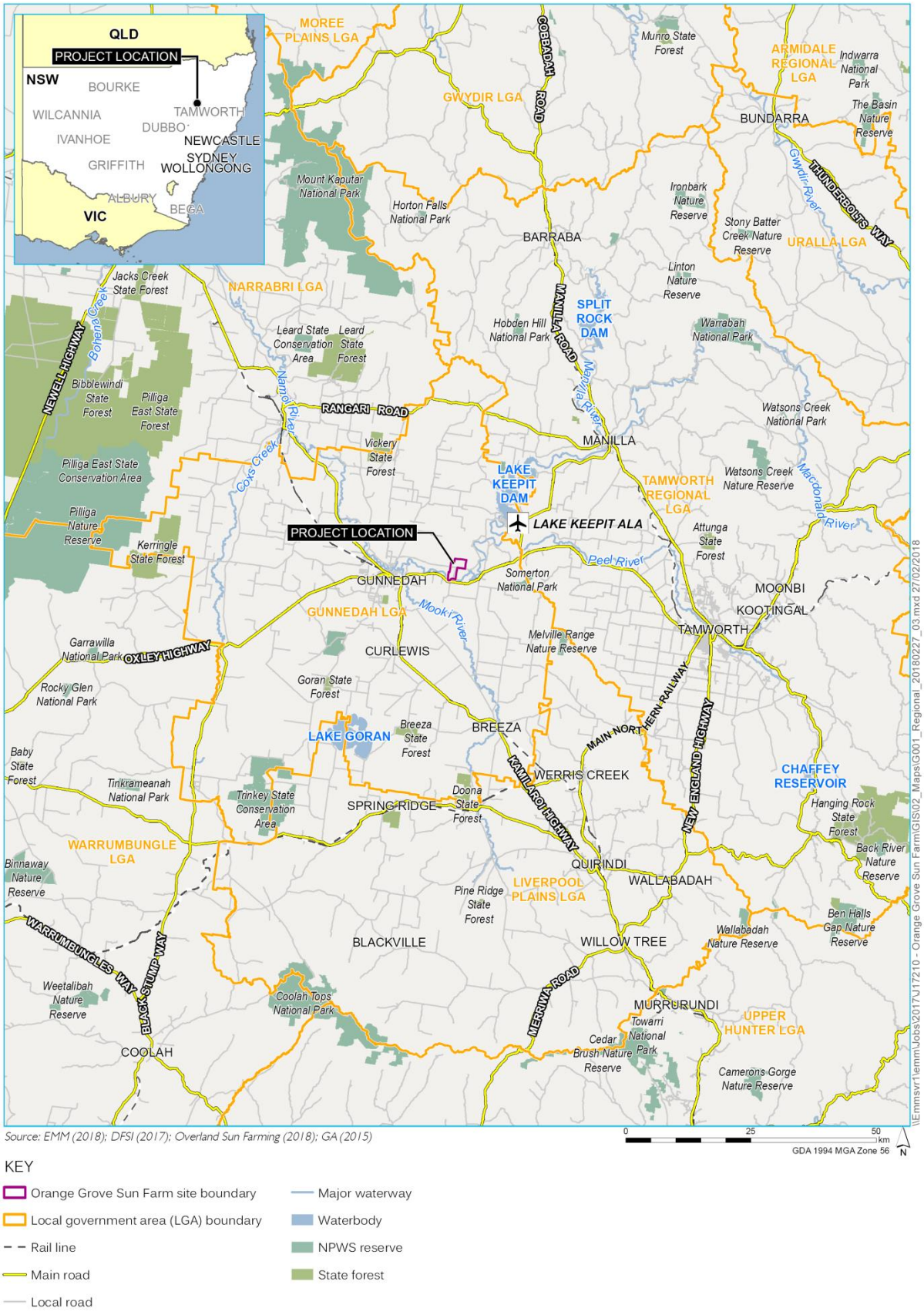

Figure 1 Regional Location

2.0 PROJECT AND SITE DESCRIPTION

2.1 PROJECT

The project includes the development, construction and operation of a solar PV electricity generation facility, which comprises the installation of PV solar panels, electrical cabling, electrical switchyard / substation, electrical connection to the TransGrid network and other associated infrastructure within the development area.

The project comprises the following key components:

- a network of PV solar panel arrays including supporting structures and tracker system;
- an internal network of electrical collection and distribution systems including electrical inverters;
- an internal network of communications and control cabling and systems;
- switchyard including electrical switching, control and monitoring equipment, electrical transformation system and operational control room;
- electrical connection and communications cabling from the on-site switchyard and transformation area to the TransGrid 132 kV electrical network;
- a management hub, including material storage areas, demountable offices, amenities and equipment sheds;
- provision of land area within the development area for possible future energy storage and network support devices; and
- fencing, access roads from adjacent public roadways, on-site parking and internal access roads.

2.2 SITE

The site straddles two neighbouring properties situated approximately 12 km east of Gunnedah within the Gunnedah Shire Local Government Area. The site is split into two separate portions by Orange Grove Road and encompasses an area of approximately 817 hectares (ha) – refer Figure 2. The development area is defined as the land area within the site where project infrastructure will be constructed and operate for the project life. The development area encompasses 253 ha. No PV solar panels are proposed for the portion of the development area that is south of Orange Grove Road.

The development area has been highly modified by past disturbances associated with land clearing, irrigation development, cropping, livestock grazing and weed invasion. It is currently used for livestock grazing and cropping, with surface vegetation of the grazing area comprising predominantly introduced grasses and herbs with scattered trees.

The village of Carroll is located approximately 6 km east-southeast of the site on the south side of the Namoi River.

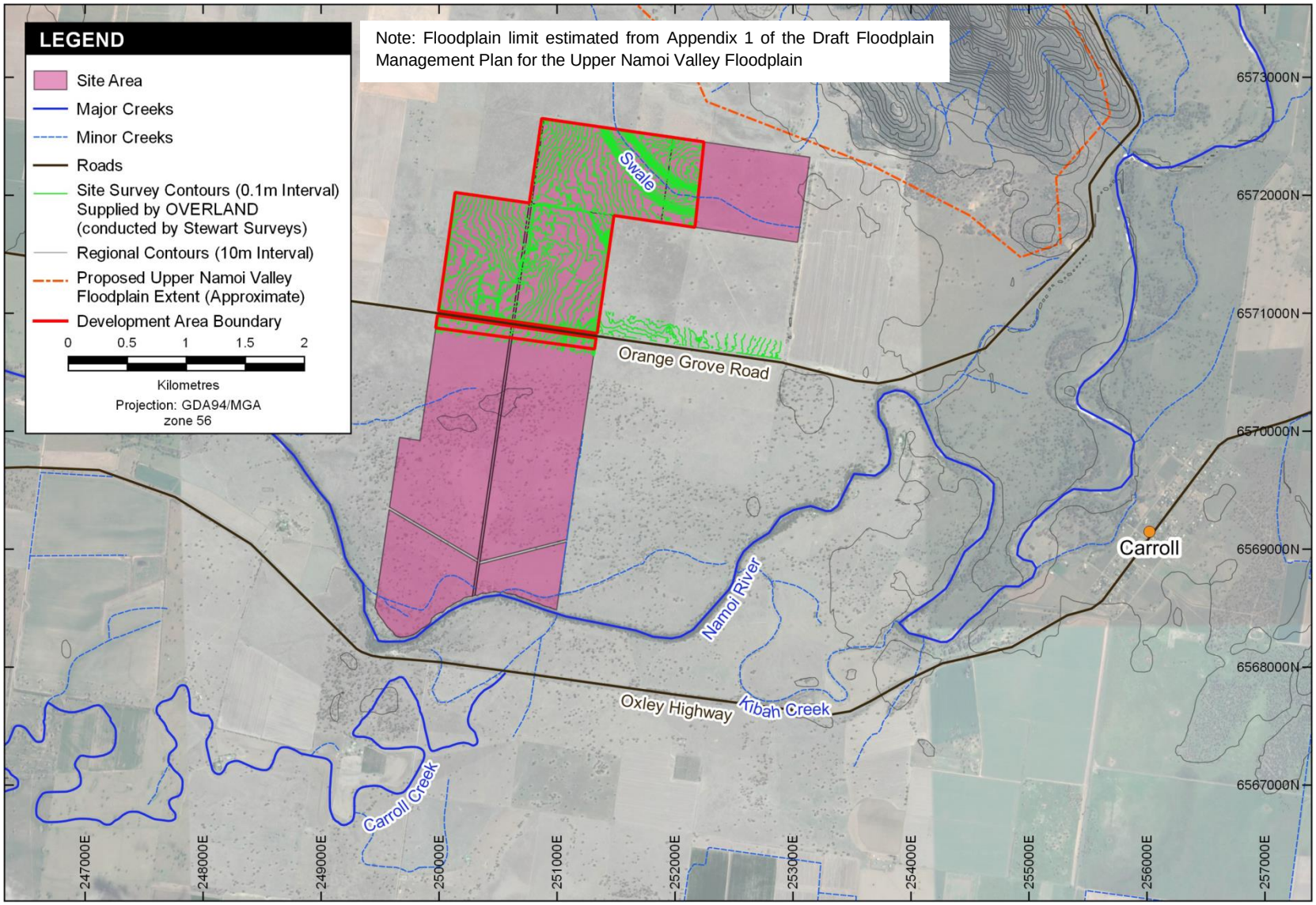

Figure 2 Site Layout, Locality and Drainage Features

3.0 HYDROMETEOROLOGICAL SETTING

3.1 REGIONAL HYDROLOGY

The site is located within the catchment of the lower Namoi Regulated River Water Source (NSW Government, 2015). The main regional drainage is the Namoi River (refer Figure 1 and Figure 2). The Namoi River catchment is located to the east of the Great Dividing Range and is a major sub-catchment of the Murray-Darling River system. The total river catchment area comprises approximately 42,000 square kilometres (km^2) at its junction with the Barwon River near Walgett.

The Namoi River rises in the New England plateau north-east of Manilla and flows generally westwards. Major headwater tributaries of the Namoi River include the Peel, Manilla and Mooki Rivers. The Manilla River joins the Namoi at Manilla, upstream of Keepit Dam, while the Peel River joins the Namoi approximately 13 km downstream of Keepit Dam and upstream of the site. The Mooki River flows from the south and joins the Namoi River just upstream of Gunnedah. The Namoi River then continues north-westwards through Gunnedah, Boggabri and Narrabri.

There are four major water storages located in the catchment of the Namoi River upstream of the site. These comprise Split Rock Dam (397 gigalitres [GL] capacity) on the Manilla River, Keepit Dam (425 GL) on the Namoi River, Chaffey Dam (100 GL) on the Peel River upstream of Tamworth and Dungowan Dam (6 GL) on a tributary of the Peel River also upstream of Tamworth. The dams provide regulated water flow downstream for irrigation, town water, stock and domestic use, while also affording flood mitigation/attenuation. The dams have a combined catchment area of 6,215 km^2 (SMEC, 2003) which comprises approximately 59% of the catchment area of the Namoi River near the site.

Several streamflow gauging stations are located on the Namoi River and its tributaries. The nearest of these with a significant period of record are located on the Namoi River at Gunnedah (GS419001), downstream of Keepit Dam (GS419007) and on the Peel River at Carroll Gap (GS419006). Streamflow at the two Namoi River gauging stations is significantly affected by releases and spills from Keepit Dam which was completed in 1960.

A flow frequency analysis was undertaken on recorded annual peak flow rates recorded in the Namoi River at Gunnedah from 1961 onwards (i.e. post Keepit Dam construction). Analysis results are plotted in Figure 3.

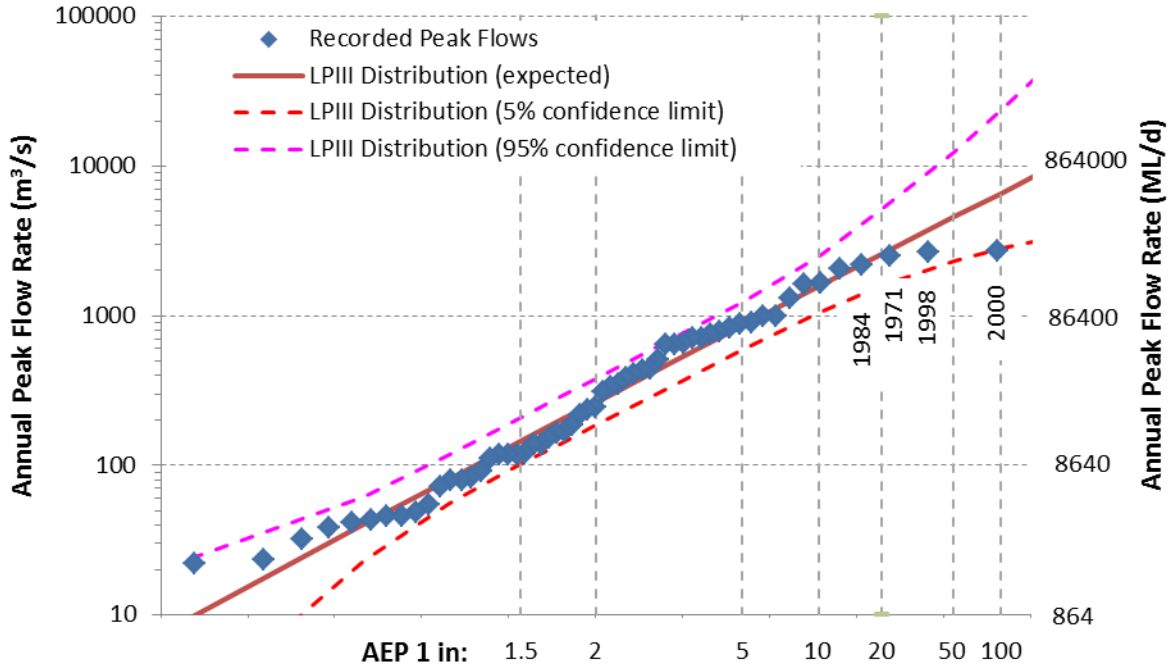

Figure 3 Annual Peak Flow Frequency Analysis – Namoi River at Gunnedah (GS419001)

The top four ranked peak annual flow years are indicated in Figure 3. The 1:100 annual exceedance probability (AEP) flow rate is estimated from this analysis to be 566,684 ML/d – this compares with the recorded peak of the 1955 flood of 800,030 ML/d which was reported to be the 1:100 AEP flow rate in SMEC (2003). The analysis in SMEC (2003) does not appear to distinguish between flow before and after Keepit dam construction. The lower 1:100 AEP peak flow derived here is likely due to the attenuating effects of the Keepit Dam reservoir.

Water quality data from the gauging stations is summarised in Section 3.4.

3.2 LOCAL DRAINAGE

The location of the project infrastructure, predominantly on the north side of Orange Grove Road, is approximately 2.5 km north of the main Namoi River channel. The river flows westwards at this point.

Available regional 10 m contours (refer Figure 2) provided only a coarse interpretation of site topography and the geometry of the Namoi River channel. Therefore a level survey of the development area (to a 0.1 m contour interval) and a cross-section of the river and adjacent areas (covering approximately 6,750 m in length) were commissioned by OVERLAND (conducted by Stewart Surveys). This information is included in Figure 2 and in cross-section in Figure 4.

The main river channel is incised with a depth of approximately 8 m below the surrounding overbank areas and a bottom of bank width of approximately 35 to 40 m - determined from the above survey and Google Earth imagery. The channel and overbank areas span a width of approximately 700 m (refer Figure 4).

The site itself slopes gently from east to west with elevations ranging from approximately 275.6 m AHD[1] in the north-east to 272.5 m AHD in the south-west. The typical east to west longitudinal surface gradient across the site is approximately 0.15%. Site survey topographic contours (0.1 m interval) for the development area are shown on Figure 2. These show a broad swale in the north-east of the development area approximately 1 m maximum depth and approximately 250 m in width, with a fall towards the northwest. This is mapped as a first order stream on NSW topographic maps[2]. The median site elevation is approximately 9 m above the surveyed Namoi River channel.

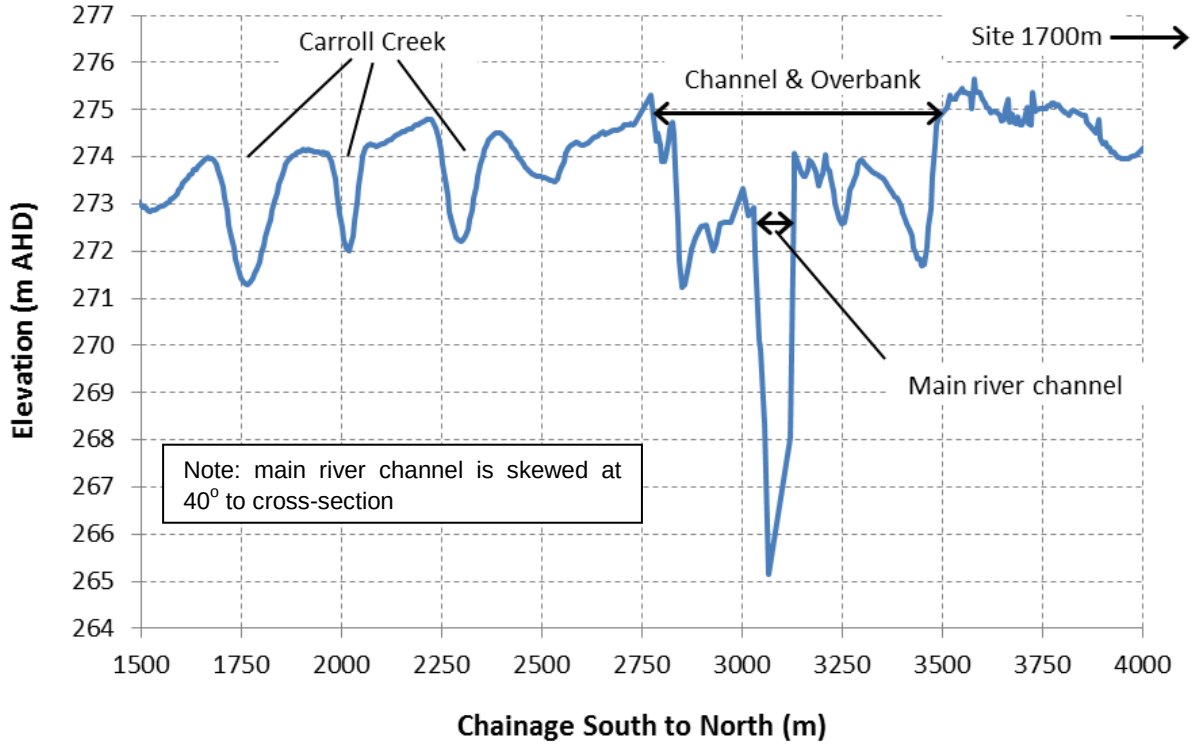

Figure 4 Namoi River Surveyed Cross-Section Looking Downstream

On the south side of the Namoi River, a flow break-out channel known as Carroll Creek exists, linking the Namoi River to the Mooki River (refer Figure 2). This channel is evident in Figure 4. At times of very high flow that is in excess of the river channel and overbank capacity, flow would pass from the Namoi River to the Mooki River along this creek (SMEC, 2003).

3.3 METEOROLOGY

The area experiences a temperate climate with variable rainfall through the year, with the majority (60%) occurring in the six months from October to March. Table 2 summarises regional monthly and annual rainfall totals from Bureau of Meteorology (BoM) stations (at Carroll and Gunnedah[3]) as well as long-term data obtained from the SILO Data Drill[4]. The highest recorded daily rainfall at the BoM Gunnedah station was 184 millimetres (mm), while

[1] Australian Height Datum (height above mean sea level).
[2] https://maps.six.nsw.gov.au/
[3] Although several other stations exist in the area, these two represent the stations with the longest period of record.
[4] The Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the BoM. Refer https://legacy.longpaddock.qld.gov.au/silo/

the highest at the Carroll station was 114.3 mm. Long-term regional rainfall averages 607 mm per year.

Regional monthly and annual pan evaporation totals from the nearest BoM pan evaporation station (Gunnedah Research Station) as well as long-term data obtained from the SILO Data Drill are summarised in Table 3. Long-term regional pan evaporation averages approximately 1,800 mm per year. Average monthly pan evaporation exceeds average rainfall in all months.

Table 2 Rainfall Data Summary

	Gunnedah Pool (55023*)		Carroll (The Ranch) (55055*)		SILO Data Drill (30.95 deg. S, 150.4 deg. E)	
	Dec-1876 – Apr-2018		Jan-1891 – Oct-2008		Jan-1889 – Apr-2018	
	Mean Total (mm)	Mean No. Raindays	Mean Total (mm)	Mean No. Raindays	Mean Total (mm)	Mean No. Raindays
Jan	69.4	6.4	76.3	6.7	74.0	11.0
Feb	64.8	6.0	63.3	5.8	63.9	9.4
Mar	45.9	4.7	45.8	4.6	48.3	7.7
Apr	35.8	4.2	35.7	4.2	36.4	6.9
May	39.7	5.0	37.3	5.0	39.4	7.8
Jun	42.5	6.2	42.7	6.4	44.9	9.7
Jul	40.8	6.1	41.8	6.4	41.4	9.6
Aug	39.7	6.0	38.5	6.3	38.0	9.4
Sep	38.3	5.6	40.5	5.7	40.0	8.8
Oct	52.0	6.6	52.9	6.9	52.7	10.6
Nov	58.6	6.5	59.4	6.8	60.0	10.8
Dec	68.3	7.0	66.7	6.9	68.0	11.6
Annual	617	77	622	78	607	113

* BoM Station Number.

Note: Statistically, the sum of monthly means does not necessarily equal the annual mean.

Table 3 Pan Evaporation Data Summary

	Gunnedah Resource Centre (55024*)	SILO Data Drill (30.95 deg. S, 150.4 deg. E)
	1948 – Apr-2018	1970 – Apr-2018
	Mean Total (mm)	Mean Total (mm)
Jan	238.7	249.4
Feb	192.1	203.0
Mar	182.9	185.7
Apr	129.0	129.9
May	83.7	84.8
Jun	57.0	58.8
Jul	58.9	64.8
Aug	86.8	92.8
Sep	120.0	130.7
Oct	167.4	180.8
Nov	201.0	211.3
Dec	241.8	251.3
Annual	1,753	1,847

* BoM Station Number.

Note: Statistically, the sum of monthly means does not necessarily equal the annual mean.

3.4 WATER QUALITY

Water quality data has been obtained for streamflow gauging stations on the Namoi and Peel Rivers[5] (refer Section 3.1). Continuous records of electrical conductivity (EC – a measure of salinity) are available for GS419001 (Namoi River at Gunnedah) from 1995 onwards. Grab sample analysis data was also sourced for pH, EC, turbidity and total dissolved solids (TDS). Note that the GS419001 site is located downstream of the junction with the Mooki River.

A summary of the water quality data is provided in Table 4. Default ANZECC (2000) trigger values for pH, EC and turbidity are also provided for comparison, for both protection of aquatic ecosystems in south-eastern Australian upland rivers and guideline values for Primary Industries water supplies (livestock drinking water quality).

[5] Continuous EC records for GS419001 were obtained from http://realtimedata.water.nsw.gov.au/water.stm?ppbm=SURFACE_WATER&rs&3&rskm_url, while grab sample data records were sourced from the NSW Department of Primary Industries Office of Water PInneena WQ Version 11.1.

Table 4 Water Quality Data Summary

Site	Statistic	pH	EC (µS/cm)		Turbidity (NTU)	TDS (mg/L)
			Continuous†	Grab		
GS419001 (Namoi River at Gunnedah)	20th Percentile	7.8	338	337	15	260
	Median	8.1	469	462	26	300
	80th Percentile	8.3	675	647	50	392
	No. Samples	623	8,045	796	668	65
GS419006 (Peel River at Carroll Gap)	20th Percentile	8.0	521		12	-
	Median	8.2	800		29	-
	80th Percentile	8.4	980		50	-
	No. Samples	320	500		345	0
GS419007 (Namoi River at Downstream Keepit Dam)	20th Percentile	7.5	283		2.0	-
	Median	7.9	340		4.0	-
	80th Percentile	8.2	432		8.1	-
	No. Samples	231	242		207	0
ANZECC (2000) Guideline Default Trigger Values	Protection of Aquatic Ecosystems*	6.5 – 8.0	30 – 350		2 – 25	-
	Primary Industries (Livestock Drinking Water)	6.0 – 9	950		-	-

* NSW Upland Rivers

† Daily mean values used for analysis

The average recorded pH at all sites is slightly alkaline and a significant proportion of samples exceeded the ANZECC (2000) upper bound trigger value of 8.0 for protection of aquatic ecosystems. Recorded EC values for the Peel River site were notably higher than at the other sites, with 26% of samples exceeding the ANZECC (2000) upper bound trigger for livestock watering. Water from downstream of Keepit Dam was significantly less saline with the median value from this site below the ANZECC (2000) upper bound trigger value for protection of aquatic ecosystems. Recorded values at Gunnedah were between the values in the Peel River and in the Namoi River downstream of Keepit Dam. Median turbidity values for the Peel River and at Gunnedah were just above the ANZECC (2000) upper bound trigger value for protection of aquatic ecosystems, while 95% of values recorded in the Namoi River downstream of Keepit Dam were below this value (which is a likely effect of the storage reservoir).

No water quality data are available for runoff from the site itself. Runoff would contribute to flow in the Namoi River downstream and runoff water quality is expected to be similar to that shown by the above monitoring data.

4.0 SITE WATER MANAGEMENT

The proposed infrastructure layout for the project is shown in Figure 5. The key components of the operational site are given in Section 2.1.

4.1 CONSTRUCTION WATER MANAGEMENT

Construction activities have the potential to generate turbid or sediment-laden runoff to downslope areas. Construction activities which have the potential to generate such impacts include the following:

- establishment of unsealed internal access roads and parking areas;
- construction of the planned demountable offices, amenities, equipment sheds, switchyard and control room, including ground surface levelling and regrading;
- installation of the PV solar panel arrays, including installation of steel ground support posts founded below ground;
- trenching to install below ground electrical collection cabling linking the solar panel arrays to the inverters and switchyard area; and
- erection of a perimeter chain mesh fence, including supporting posts founded below ground.

Erosion and sediment controls would be employed during construction, in accordance with the requirements of Landcom (2004). An erosion and sediment control plan (ESCP) would be prepared prior to construction, in accordance with Landcom (2004) and in consultation with Gunnedah Shire Council. The plan would be implemented for the life of the project and revised as required. Erosion and sediment controls may include the following:

- sediment fence installed downslope of disturbance areas - per Standard Drawing (SD) 6-8 in Landcom (2004);
- straw bale filters installed downslope of disturbance areas – per SD 6-7 in Landcom (2004);
- minimising areas of disturbance to those areas actually needed for construction and leaving grassed areas to act as filters for runoff downslope of areas of disturbance;
- construction of a stabilised site access at the entrances to the development area from Orange Grove Road - per SD 6-14 in Landcom (2004);
- placement of rockfill at the point of discharge of roof runoff from buildings;
- separately stockpiling excavated topsoil and subsoil and replacing these materials following excavation; and
- revegetation of areas of temporary disturbance – this could include grass seeding, fertilising and watering.

Erosion and sediment controls would be regularly inspected, particularly following significant rainfall events.

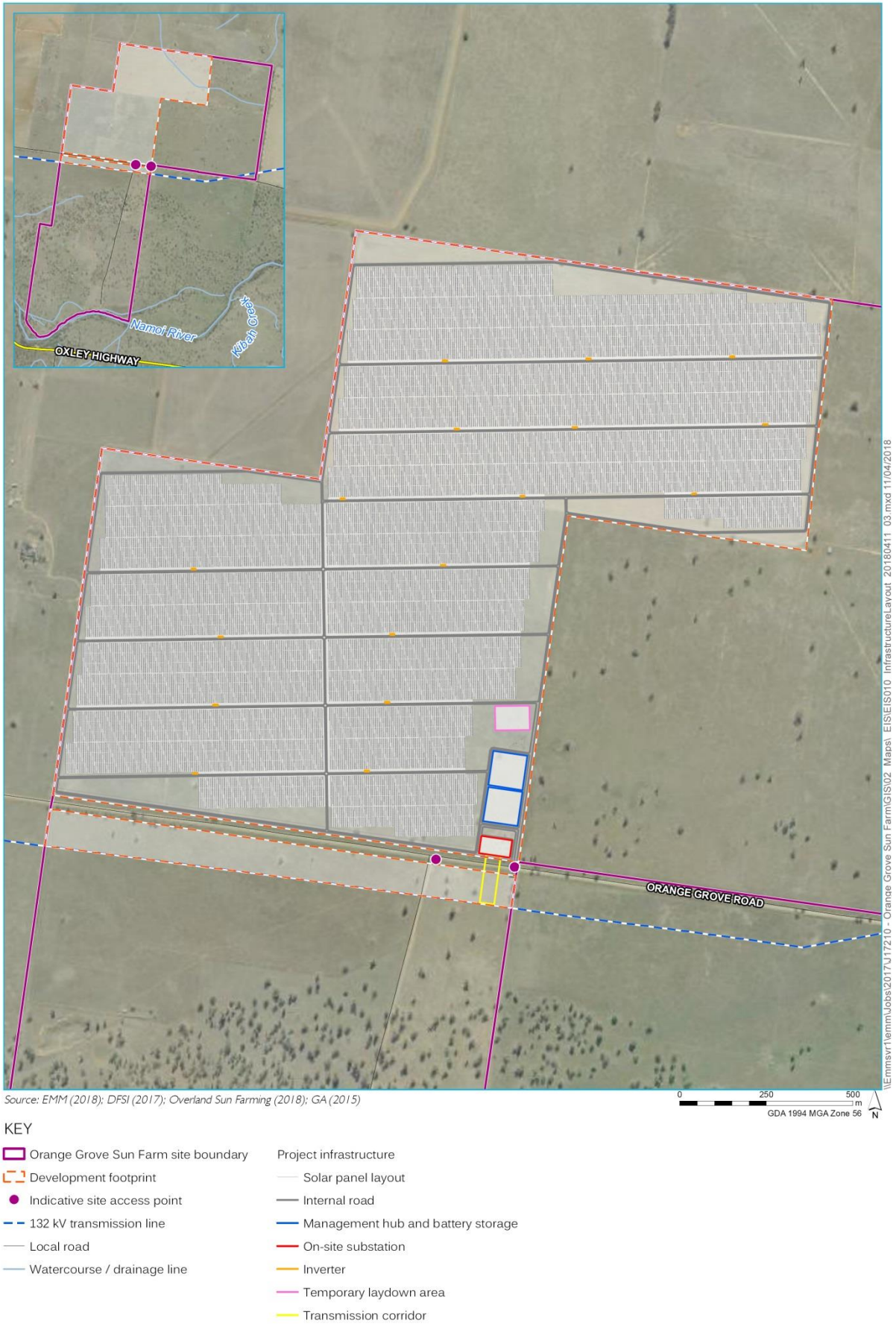

Figure 5 Proposed Infrastructure Layout Plan

Construction activities will also require water. The main requirement will be for dust suppression on access roads and excavation activities as well as potable water for construction personnel. A water truck would distribute water for construction activities. It is estimated that the water requirements for the nine to twelve months of construction would be in the order of 15 megalitres (ML). Water demands will be met via a combination of potable water trucked to the site and/or extraction from the Upper Namoi Zone 4 Namoi Valley (Keepit Dam To Gin's Leap) Groundwater Source (refer EIS). A groundwater bore within the site boundary (GW902401) has a current water access licence with an annual entitlement of 10 ML of water from the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source. Access to this water will be the subject of ongoing consultation with the landholder. In addition, during consultation about the project, a neighbouring landholder has offered to sell water to the project, should it be required. A small farm dam exists within the development area, however this would be removed as part of infrastructure establishment activities by backfilling with adjacent material and levelling.

4.2 OPERATIONAL WATER MANAGEMENT

Erosion and sediment controls would continue to function and be maintained during the operational life of the project. The ESCP may be modified to reflect the change from construction to operation.

The water requirements of the project during operation will comprise of water required for panel cleaning and potable water for operational personnel. It is estimated that these water requirements would be in the order of 3 ML annually and is planned to be sourced on site via the groundwater bore (GW902401).

5.0 FLOOD ASSESSMENT

Flood modelling and assessment for the Namoi and Mooki Rivers was undertaken by SMEC (2003). Much of the following description of the flooding characteristics of the development area is drawn from that report.

As described in Section 3.1, the main tributaries of the Namoi River upstream of the village of Carroll are the Manilla and Peel Rivers. At the junction of the Namoi and Peel Rivers, approximately 17 km upstream of Carroll, both rivers are confined within narrow valleys with little overbank areas. Upstream of Carroll, the valley widens and flood flow 'breakouts' occur from the main Namoi River channel. Downstream of Carroll, the river valley widens considerably, with wide alluvial floodplains on both sides. A major flow breakout occurs on the south side of the river downstream of Carroll – available topographic mapping (Figure 2 and Figure 4) indicates that a breakout occurs to Carroll Creek, across the Oxley Highway opposite the site. A considerable portion of the flood flow in the Namoi River would flow into the Mooki River via this path, flowing away from the development area. There is no data available that indicates a similar significant breakout to the north towards the development area.

As indicated on Figure 2 and described in Section 3.2, a broad swale is present in the north-east of the development area, with a fall towards the northwest. This is mapped as a first order stream[6]. It is not evident from available topographic mapping whether this swale represents a breakout channel from the north side of the Namoi River or whether it is a channel conveying runoff from the hills to its north.

Flood modelling was undertaken by SMEC (2003) of the Namoi and Mooki Rivers from upstream of Carroll and Breeza respectively (refer Figure 1) to downstream of Boggabri. The main focus of the modelling appears to have been to assess the effect of the development of numerous raised irrigation channels and flood levees adjacent to the Mooki River upstream of Gunnedah. Reported modelling was restricted to four historical floods which occurred in 1955, 1984, 1998 and 2000. Note that the 1955 flood (which had by far the largest flow rate in the Namoi River of the four) occurred prior to the completion of Keepit Dam (1960) and Split Rock Dam (1987). The 1984 flood was the fourth highest recorded at Gunnedah (GS419001) since the completion of Keepit Dam (refer Figure 3). Modelling relied upon recorded/reported flood water levels in the rivers for the above events. Flood levels for the 1998 and 2000 floods were reportedly obtained from surveyed flood marks, while the origin of flood level records for the 1955 and 1984 floods is unclear.

The following points are of note regarding the reported historical flood levels and flood model results undertaken by SMEC (2003):

1. For the 1955 flood, there are no flood levels recorded between Carroll and Gunnedah on the north side of the Namoi River. The nearest reported flood levels are 280.88 m AHD and 280.64 m AHD in Carroll and 267.38 m AHD located approximately 7.5 km west of the site (Figure 4.1 of SMEC, 2003). The plotted 1955 flood profile (Figure 7.3a of SMEC, 2003) appears to indicate a modelled flood level of approximately 272.3 m AHD in the river adjacent to the site. This is lower than the lowest surveyed surface levels across the development area (refer Section 3.2).

[6] https://maps.six.nsw.gov.au/

2. For the 1984 flood there is only one recorded Namoi River flood level upstream of the Mooki River junction – 280.34 m AHD at Carroll (Figure 4.2 of SMEC, 2003). Note that this is 0.42 m lower than the average flood level recorded in Carroll in the 1955 flood. A flood profile is not reported for the Namoi River for this flood however, with reference to the 1955 flood profile, it would appear that flood levels would have been similarly lower in the Namoi River adjacent to the site - i.e. an estimated flood level of approximately 271.9 m AHD which is again lower than the lowest surveyed surface levels across the development area.
3. For the 1998 flood, a flood level of 270.38 m AHD was recorded just north of the Namoi River channel approximately 5 km west of the site and a level of 267.35 m AHD at a location adjacent to Orange Grove Road approximately 6 km west of the site (Figure 4.3d of SMEC, 2003). No levels were reported further upstream on the Namoi River. The plotted 1998 flood profile (Figure 7.9a of SMEC, 2003) appears to indicate a modelled flood level of approximately 270.1 m AHD in the river adjacent to the site. This is lower than the lowest surveyed surface levels across the development area (refer Section 3.2).
4. There were no recorded flood levels for the 2000 flood reported for the Namoi River upstream of the Mooki River junction. A similar modelled flood level for this flood as for the 1998 flood is plotted in the 2000 flood profile (Figure 7.12a of SMEC, 2003) – i.e. approximately 270.1 m AHD in the river adjacent to the site.
5. The plotted flood network maps in the report appear to include modelling of the broad swale located in the northeast of the development area as a breakout channel, with flow appearing to enter this channel from the north side of the Namoi River both upstream and downstream of Carroll. Modelled flood discharge rates of 897 m^3/s and 211 m^3/s are reported in this swale for the 1955 and 1984 flood respectively, with no significant flows modelled for the remaining two floods. The modelled flows do not appear to be supported by the reported flood levels for the 1955 and 1984 floods (refer 1 and 2 above).

The Floodplain Management Plan (FMP) for the Upper Namoi Valley Floodplain defines management zones and sets rules and assessment criteria for all works on the floodplain. The current version of the FMP (draft) is dated September 2016[7]. The site lies within Management Zone (MZ) BL of the FMP (Appendix 3 of the FMP), with boundaries indicated on Figure 2. The FMP Floodway Network Map (Appendix 4 of the FMP) indicates that the site lies within the area defined as comprising ”flood storage and secondary flood discharge” with no “major discharge areas” mapped within or near the site.

Division 5 of the FMP sets rules for granting flood work approvals in MZ BL. The FMP states that (among other things):

> “*a flood work approval must not be granted … if construction of the flood work is likely to … increase flood levels by more than 20 cm on adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios including at a minimum the relevant large design flood*”

The proposed construction of project infrastructure (refer Sections 2.1 and 4.1) including buildings, chain mesh fence and the PV solar panel arrays themselves have the potential to

[7] Refer https://www.water.nsw.gov.au/water-management/floodplain-management/upper-namoi

affect flood levels if these developments were to occur below the level of the relevant large design flood. The relevant large design flood is given in Appendix 5 of the FMP for the site area as the 1984 flood. Based on the modelling of the 1984 flood undertaken by SMEC (2003), the level of this flood is well below the lowest development area level and therefore the proposed project should not impact on the relevant large design flood.

6.0 POTENTIAL SURFACE WATER IMPACTS AND MITIGATION MEASURES

The following potential impacts have been identified as part of this assessment:

1. The potential to generate turbid or sediment-laden runoff to downslope areas as a result of ground disturbance.
2. Accidental spills or fuel leaks from vehicles or other motorised equipment on-site.
3. Reduced catchment runoff as a result of project infrastructure.
4. Flood impacts to neighbouring properties.

Erosion and sediment generation issues would be addressed by the development of an ESCP prior to construction (refer Section 4.1), with measures employed consistent with Landcom (2004). Erosion and sediment controls would continue to function and be maintained during the operational life of the project.

Whilst not anticipated, accidental spills could also occur, which could result in transient impacts to water quality if this coincided with a period of rainfall. The development area is not adjacent to a major watercourse and therefore any spills would be immediately obvious to site personnel. A portable oil/fuel spill clean-up kit would be located on-site and employed should any spills occur. Any residual contaminated soil would be removed from site and transported to the Gunnedah Waste Management Facility for disposal.

The risks of the above impacts are likely to be highest during construction and would be limited during operations.

No interception of runoff is planned by project infrastructure (refer Section 2.1) and therefore there should be no net reduction in runoff from the development area.

Surveyed levels of the development area indicate that it is above the 1955 and 1984 flood levels as assessed from flood modelling (the 1984 flood is the relevant large design flood in terms of the Draft FMP for the Upper Namoi Valley Floodplain). Therefore the proposed project should not impact on the relevant large design flood.

7.0 REFERENCES

ANZECC (2000). "Australian Water Quality Guidelines for Fresh and Marine Water Quality", Australian and New Zealand Environment and Conservation Council, October, Paper No. 4, Canberra.

Landcom (2004). "Managing Urban Stormwater: Soils & Construction." 4th Edition, March.

NSW Government (2015). "Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016". Version 16 October 2015, https://www.legislation.nsw.gov.au/#/view/regulation/2015/631, accessed 25 April 2018.

NSW Government (2016). "Draft Floodplain Management plan for the Upper Namoi Valley Floodplain 2016".

SMEC (2003). "Carroll to Boggabri Flood Study and Compendium of Data". Report prepared by SMEC Australia Pty Ltd for Department of Land and Water Conservation, North Sydney, March.