APPENDIX H

Surface water assessment

New England Solar Farm

Surface water assessment

Prepared for UPC Renewables Australia Pty Ltd | November 2018

New England Solar Farm

Surface water assessment

Prepared for UPC Renewables Australia Pty Ltd | 14 November 2018

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New England Solar Farm

Final

Report J17300RP1 | Prepared for UPC Renewables Australia Pty Ltd | 14 November 2018

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Executive Summary

ES1 Overview

UPC Renewables Australia Pty Ltd proposes to develop the New England Solar Farm; a significant grid-connected solar farm and battery energy storage system (BESS) along with associated infrastructure, approximately 6 kilometres east of the township of Uralla, which lies approximately 19 km south of Armidale in the Uralla Shire local government area (LGA) (the project).

The project is a State Significant Development under the State Environmental Planning Policy (State and Regional Development) 2011. Therefore, a development application for the project is required to be submitted under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979*. The NSW Minister for Planning (Minister), or the Minister's delegate, is the consent authority.

An environmental impact statement (EIS) is a requirement of the approval process. This surface water assessment (SWA) forms part of the EIS. It documents the surface water impact assessment methods and results; the initiatives built into the project design to avoid and minimise surface water impacts; and the additional mitigation and management measures proposed to address any residual impacts not able to be avoided. Potential impacts to groundwater resources are also addressed in this report.

ES2 Impact avoidance, minimisation and mitigation

Preliminary assessment of potential surface water impacts associated with the project identified watercourses, water quality and flooding as key areas of sensitivity. Accordingly, a project refinement process was undertaken, which included refining the extent of the development footprint for the three array areas to minimise watercourse and associated riparian corridor impacts through avoidance of higher order watercourses (i.e.3rd order and above) and to minimise the potential for adverse flooding impacts particularly within the southern array area adjacent to Salisbury Waters.

Specific outcomes from the project refinement process include exclusion of higher order watercourses (i.e. 3rd order and above) from the development footprint, with maintenance of recommended vegetated riparian zone (VRZ) buffer widths for these watercourses; reduction in the number of watercourse crossings required as part of the project's internal access track layout; and increasing the setback of the southern array area from Salisbury Waters to minimise potential interaction with floodwaters.

ES3 Residual impacts

Residual impacts to surface water and groundwater resources during both construction and operations are considered minor and manageable provided a range of proposed management measures are implemented. The following provides a summary of predicted impacts and proposed key management measures.

ES3.1 Watercourses

The development footprint includes a number of mapped 1st and 2nd order watercourses. The majority of these watercourses do not have a discernible channel and riparian zones and associated vegetation have been modified and degraded by historical land use practices. Placement of PV modules and ancillary infrastructure within 1st and 2nd order watercourses, and crossings of these watercourses for internal access tracks and electrical cabling, will be minimised to the extent practicable. Watercourse crossing plans detailing the design of proposed crossings of higher order watercourses outside of the development footprint will be prepared in consultation with NSW Department of Industry – Lands and Water Division (DoI Lands and Water). Ongoing monitoring of watercourse condition and VRZ condition for all retained watercourses where these run through or immediately adjacent to the development footprint will be undertaken during operations, with maintenance as required to minimise scouring and erosion and ensure waterway health and stability.

ES3.2 Water quality

The primary risk to water quality will occur as a result of ground disturbance during construction, and poor ground cover revegetation or stabilisation during operation. This could lead to exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses. Contamination of surface water as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemicals used to support construction and operational activities could also adversely impact water quality.

Proposed key management measures include implementation of erosion and sediment control (ESC) measures in accordance with Landcom (2004); progressive revegetation or stabilisation of disturbed areas to minimise exposed soils to the extent possible; and implementation of procedures for hazardous material storage and spill management.

ES3.3 Flooding

Prior to and throughout construction, site planning will consider flood risk and locate temporary site works, compounds, storage areas and plant/equipment away from flood prone areas where practicable. Flood modelling has been undertaken to inform project refinement, with avoidance of areas likely to be impacted to a depth of more than 300 mm in the 1% annual exceedance probability (AEP) event.

Preliminary design of permanent works has considered flooding constraints and makes appropriate responses in terms of locating heavier earthworks and flood-sensitive facilities (e.g. substations and BESSs) away from watercourses and areas of high hazard flooding and will avoid adverse flooding impacts within and downstream of the development footprint. Detailed design of the project will consider location-specific flood levels when setting floor and/or pad levels for key project infrastructure to ensure the desired level of flood protection is achieved, and will avoid flood prone areas where practicable.

ES3.4 Other potential impacts

Given the limited habitat value afforded by existing farm dams, the potential for adverse impacts associated with dam removal are considered negligible provided appropriate ESC measures are used and the disturbed areas are stabilised and rehabilitated. No other water bodies will be disturbed by the project.

Water demands during construction and operation will be satisfied by potable water imported (trucked in) to site. Any opportunistic use of water for construction sourced from farm dams to be removed would be undertaken in accordance with harvestable rights provisions. The project therefore will not impact adjacent licensed water users or basic landholder rights during construction and operations.

The project is not likely to impact groundwater during construction, operation and decommissioning due to the estimated depth to groundwater within the project boundary and the limited amount and depth of subsurface disturbance activities required during the installation and decommissioning of project infrastructure. The project will also not require access to groundwater resources.

Cumulative impacts on surface water resources as a result of the project in combination with other major developments in the locality, namely the Uralla Solar Farm, Metz Solar Farm and Tilbuster Solar Farm, have been assessed and are considered negligible.

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1 Introduction

1.1 Overview

UPC Renewables Australia Pty Ltd (UPC) proposes to develop the New England Solar Farm; a significant grid-connected solar farm and battery energy storage system (BESS) along with associated infrastructure, approximately 6 kilometres (km) east of the township of Uralla, which lies approximately 19 km south of Armidale in the Uralla Shire local government area (LGA) (the project).

The regional setting and local context of the project is presented in Figure 1.1 and Figure 1.2, respectively.

The project is a State Significant Development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Therefore, 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). The NSW Minister for Planning (Minister), or the Minister's delegate, is the consent authority.

An environmental impact statement (EIS) is a requirement of the approval process. This surface water assessment (SWA) forms part of the EIS. It documents the surface water impact assessment methods and results, the initiatives built into the project design to avoid and minimise associated surface water impacts, and the additional mitigation and management measures proposed to address any residual impacts not able to be avoided.

The scope of the SWA addresses potential impacts to:

- watercourses, water bodies and associated riparian land;
- water quality;
- flooding conditions;
- water use, licensed users and associated supply infrastructure; and
- water requirements and supply arrangements and licensing.

Potential impacts to groundwater resources are also addressed within the SWA.

The EIS for the project also includes a soil erosion assessment (SEA) (refer Appendix G of the EIS) and biodiversity development assessment report (BDAR) (refer Appendix C of the EIS), which consider erosion potential and aquatic impacts, respectively.

1.2 Site description

The project will be developed within the Uralla Shire LGA. At its closest point, the project boundary is approximately 6 km east of the township of Uralla, and the northern array area starts approximately 8.6 km south of Armidale (refer to Figure 1.1).

The project boundary, which is defined as the entirety of all the involved lots, encompasses a total area of 8,380 ha and is zoned RU1 Primary Production under the Uralla Local Environmental Plan 2012 (Uralla LEP). The project boundary encompasses 61 lots, the majority of which have been modified by historical land use practices and past disturbances associated with land clearing, cropping and intensive livestock grazing. The properties within the project boundary are currently primarily used for sheep grazing for production of wool and lambs, with some cattle grazing for beef production.

The development footprint is the area within the project boundary on which infrastructure will be located. The development footprint encompasses a total area of 2,787 ha, which includes 1,418 ha within the northern array area, 625 ha within the central array area and 653 ha within the southern array area. Within the development footprint, approximately 1,000 ha will be required for the rows of PV modules. The remaining area is associated with power conversion units (PCUs), space between the rows, internal access tracks and associated infrastructure (including substations and BESSs). The development footprint also includes land required for connection infrastructure between the three array areas as well as land required for new internal roads to enable access to the three array areas from the surrounding road network. Subject to detailed design and consultation with the project landholders, security fencing and creek crossings may be required on land outside of the development footprint, but within the project boundary.

The project is ideally located close to Transgrid's 330 kilovolt (kV) transmission line, which passes through the northern and central array areas (Figure 1.2). It also has access to the regional road network; including the New England Highway and Thunderbolts Way (Figure 1.2).

A number of local roads traverse the array areas and their surrounds, including Gostwyck Road, Salisbury Plains Road, The Gap Road, Carlon Menzies Road, Munsies Road, Saumarez War Service Road, Hillview Road, Elliots Road and Big Ridge Road, and will provide access to the three array areas from the regional road network throughout the construction and operation of the project (Figure 1.2).

The primary site access points will be from The Gap Road, Salisbury Plains Road, Hillview Road, Munsies Road and Big Ridge Road (Figure 1.2). Emergency access points may also be required.

1.3 Project boundary terms and definitions

The **project boundary** referred to in this report encompasses the 61 Lot/DPs that make up the development footprint. It is shown in Figure 1.2 and includes the involved lots beneath each of the three array areas as well as potential connection infrastructure and access corridors.

The **study area** referenced throughout this report is shown in Figure 1.2. This represents the area presented in the preliminary environment assessment (PEA) that supported the request for the Secretary's Environmental Assessment Requirements (SEARs). The study area encompasses approximately 4,244 ha.

The **development footprint** referred to in this report is shown in Figure 1.2 and represents the potential disturbance footprint of the three solar array areas and associated infrastructure. As noted in Section 1.2, the development footprint also includes land required for connection infrastructure between the three array areas (ie electricity transmission line (ETL) easements or electrical cabling), as well as land required for new internal roads to enable access to the three array areas from the surrounding road network (i.e. site access corridors). Ground disturbance will occur in these areas; however, only discrete areas of disturbance are anticipated, particularly along ETL easements namely to facilitate power pole placement.

1.4 Legislative context

The key legislative requirements for the project in terms of surface water relate to the NSW *Water Management Act 2000* (WM Act), which regulates the use and interference with surface and groundwater in NSW. Two Water Sharing Plans are relevant to the project boundary, namely:

- Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources 2016; and
- Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016.

The WM Act provides for basic landholder rights, which enable landholders to extract water from an aquifer underlying their properties for domestic and stock purposes without the need for a licence. A water use approval under Section 89 of the WM Act is not required for the project by virtue of Section 4.41 (formerly 89J) of the EP&A Act.

The WM Act also contains provisions relating to harvestable rights. Harvestable rights allow landholders to collect a proportion of the runoff from their property. Any runoff harvested from the development footprint would be within the volume permitted under harvestable rights.

As described in Section 5.5, water demands for the project during both construction and operation will be met via potable water trucked to the three array areas.

No further consideration of the WM Act is warranted on this basis.

1.5 Assessment guidelines and requirements

This SWA has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

Key guidelines, policies and plans that have been considered as part of the SWA include:

- Uralla LEP and Uralla Development Control Plan 2011 (Uralla DCP);
- *Floodplain Development Manual* (NSW Government 2005);
- *Guidelines for Controlled Activities on Waterfront Land* (NOW 2012a);
- *Guidelines for Watercourse Crossings on Waterfront Land* (NOW 2012b); and
- *Managing Urban Stormwater: Soils & Construction* (Landcom 2004).

The SWA also addresses the requirements of the NSW Department of Planning and Environment (DPE). These were set out in the SEARs for the project, issued on 8 May 2018. Revised SEARs for the project were issued on 11 October 2018; however, there were no revisions to surface water matters raised in the SEARs.

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 1.1 Surface water matters raised in SEARs

Requirement	Section addressed
an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including Salisbury Waters, Cook Station Creek, Saumarez Creek, Dog Trap Gully, Atchesons Gully, Julia Gully, Lambing Gully, Dangars Lagoon, Racecourse Lagoon, drainage channels, wetlands, riparian land, farm dams, 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;	Chapter 5 Requirements in **bold** are not addressed in detail in the SWA. Acid sulfate soils The project is not likely to impact acid sulfate soils as there are no known occurrences of such soils within the development footprint. Further details regarding soils within the development footprint are provided in the soil erosion assessment (Appendix G of the EIS).
details of water requirements and supply arrangements for construction and operation;	Section 5.5
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).	Chapter 6 Further discussion of erosion potential and erosion and sediment control is provided in the soil erosion assessment (Appendix G of the EIS).

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.

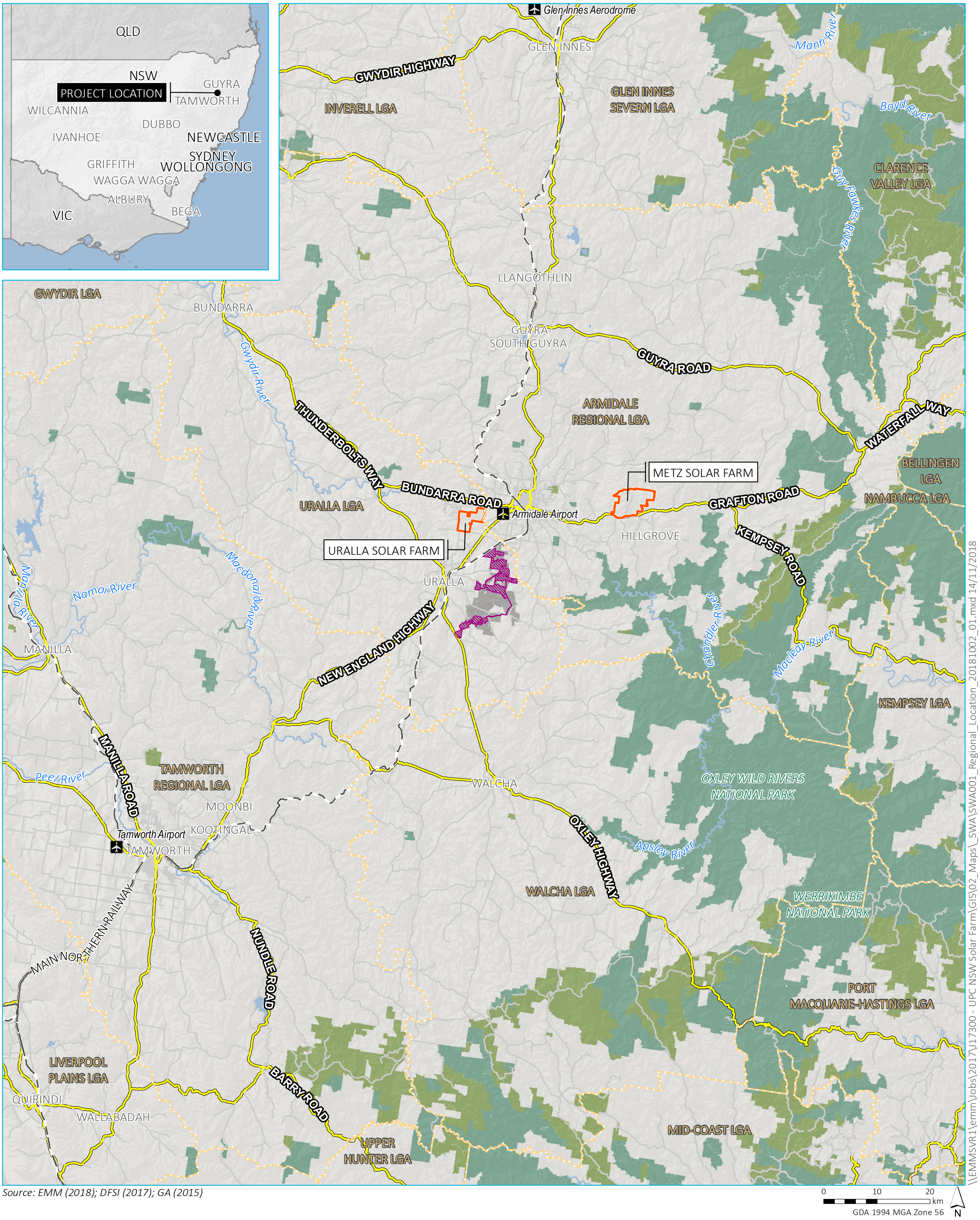
1.6 Consultation

This SWA has been prepared with consultation and contribution from the NSW Department of Industry – Lands and Water Division (DoI Lands and Water) specifically in relation to the potential interaction of the project with existing watercourses and associated riparian corridors. DoI Lands and Water highlighted several mapped watercourses of interest, with a view to consistency with the *Guidelines for Controlled Activities on Waterfront Land* (NOW 2012a), and assessment of these identified watercourses is included in this SWA (refer Section 3.3 for details).

1.7 Structure of the report

This report is structured as follows:

- Chapter 2 provides a description of the project;
- Chapter 3 outlines the broad approach and methodology used to inform the SWA;
- Chapter 4 describes existing surface water and groundwater resources;
- Chapter 5 identifies and assesses the potential impacts of the project on surface water and groundwater resources;
- Chapter 6 presents mitigation and management measures proposed to control potential adverse impacts to surface water resources; and
- Chapter 7 provides a summary and conclusions.



Source: EMM (2018); DFSI (2017); GA (2015)

KEY

- Development footprint
- Project boundary
- Other SSD solar development
- Airport
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Waterbody
- Local government area
- NPWS reserve
- State forest

Regional setting

New England Solar Farm
Surface water assessment
Figure 1.1

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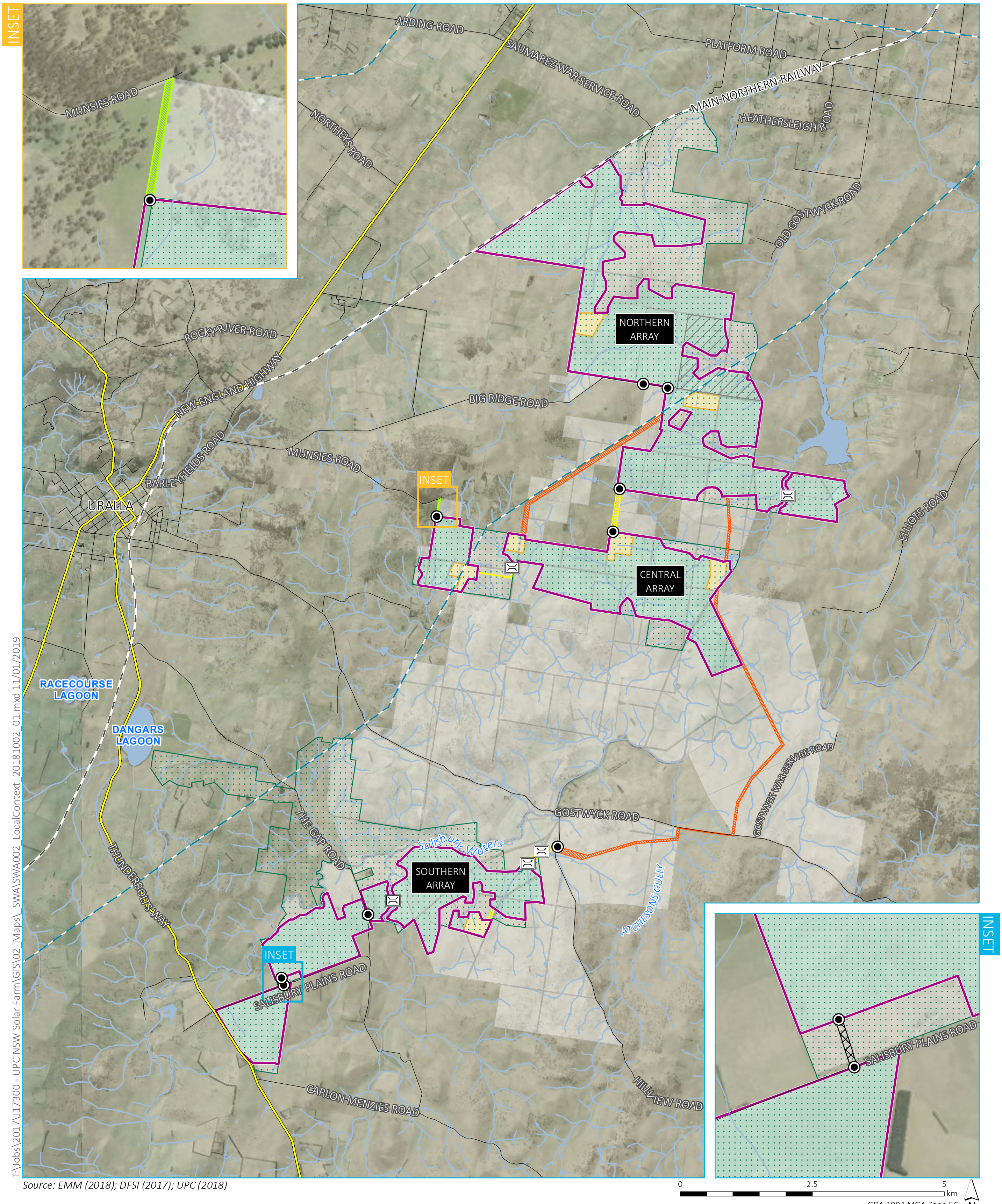

Source: EMM (2018); DFSI (2017); UPC (2018)

KEY

- 330 kV transmission line
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Waterbody
- Project boundary
- Study area

Development footprint

- Solar array
- Potential ETL easement
- Potential site access corridor
- Potential site access/ETL easement
- Potential substation/BESS footprint
- Potential electrical cabling/site access corridor
- Potential creek crossing

- Proposed primary site access point
- Potential site for construction accommodation village

Local context and study area

New England Solar Farm
Surface water assessment
Figure 1.2

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2 Project description

2.1 Overview

The project involves the development, construction and operation of a solar PV electricity generation facility and BESS, which consists of PV modules, batteries, inverters, transformers and associated infrastructure.

The development footprint provided on Figure 1.2 incorporates the land required for:

- the three solar array areas;
- up to three internal solar array substations and a single grid substation;
- associated BESS(s);
- operations and maintenance (O&M) infrastructure, including:
  - O&M buildings (namely meeting facilities, a temperature-controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure); and
  - car parking facilities;
- connection infrastructure between the three array areas (including ETLs and underground or overhead cabling); and
- a new internal road network to enable access from surrounding local roads to the three array areas during construction and operations.

In addition, security fencing and creek crossings (should they be required) will be placed within the project boundary.

The project will have a targeted 'sent out' electricity generating capacity of up to 800 MW alternating current (AC) and up to 200 MW (AC) two-hour energy storage. The final number of PV modules within the three array areas will be dependent on detailed design, availability and commercial considerations at the time of construction.

Electricity generated by the project will be injected into the grid via a new cut-in to TransGrid's 330 kV transmission line that traverses the northern and central array areas (refer Figure 1.2).

The infrastructure associated with the project will cover an area within the development footprint (Figure 1.2). During the preparation of the EIS, the development footprint within the project boundary has been refined on the basis of environmental constraints identification, stakeholder engagement, community consultation and design of project infrastructure with the objective of developing an efficient project that avoids and minimises environmental impacts to the greatest extent practicable.

2.2 Project infrastructure

2.2.1 Solar arrays, PV modules, medium voltage cable network and power conversion units

The project will involve the development of three separate arrays of PV modules and PCUs. The number of PV modules and PCUs required will be dependent on the final detailed design of the project.

PV modules will be installed in a series of rows to maximise the energy yield that is achievable given the solar resource and the ground area available within the three array areas. The modules will be fixed to, and supported by, a ground-mounted framing structure, aligned in rows. Assuming single axis tracking technology is used, the rows of PV modules will be aligned in a north-south direction and spaced out approximately 5-8 m apart. The use of single axis tracking technology would enable the PV modules to rotate from east to west during the day tracking the sun's movement.

An alternative configuration for the PV modules may be considered for the project, namely a fixed tilt system, with the rows aligned east-west and the PV modules facing north. However, it is noted that single axis tracking is considered more likely due to the recent fall in technology costs and the superior energy yield associated with this technology.

The PV modules will be supported on mounting frames consisting of vertical posts ('piles') and horizontal rails ('tracking tubes'). Rows of piles will be driven or screwed into the ground, depending on the geotechnical conditions, and the supporting racking framework will be mounted on top. Pre-drilling and/or cementing of foundations will be avoided if allowed by the geotechnical conditions.

The height of the PV modules at their maximum tilt angle (typically up to 60 degrees) will be up to 4 m. Additional site-specific clearance of up to around 300 mm may be required to avoid flooding risk or to allow sheep to graze underneath the PV modules.

Direct current (DC) cables will connect the PV modules to the PCUs.

The PCUs consist of three key components, namely inverter(s), transformer(s) and a ring main unit. The purpose of each PCU is to convert the DC electricity generated by the PV modules into AC, compatible with the electricity network. PCUs also increase the voltage of the electricity to 11-33 kV. The exact dimensions of the PCUs will be determined during detailed design; however, it is anticipated that each PCU will be approximately 8 m in length by 2.6 m wide by 2.7 m high.

A medium voltage (MV) cable reticulation network will be required to transport the electricity around each of the three arrays. If underground, cables of either 11 kV, 22 kV or 33 kV will be installed at a depth of at least 600 millimetres (mm) and will be designed and fitted in accordance with relevant Australian industry standards. Electricity from the MV cable network will be stepped up to high voltage (HV) at each of the internal solar array substations (up to three in total).

A small corridor for MV cabling may be required between two land parcels in the southern array area. The indicative alignment of this cabling is presented in Figure 1.2. The exact alignment will be determined during detailed design.

2.2.2 Solar array substations

Up to three substations will be required (potentially one within each of the three solar arrays) to step the MV up to HV. Based on preliminary designs, each substation will require transformers to step up from 33 kV to 132 kV. Each substation will likely consist of an indoor switch room, to house MV circuit breakers, and an outdoor switch yard to house the transformer(s), gantries and associated infrastructure. The total pad area for each solar array substation is likely to be in the order of approximately 3-4 ha. Indicative locations for the solar array substations are provided in Figure 1.2. A larger footprint than what will likely be required has been provided at each location to allow for flexibility for placement of this infrastructure during the detailed design stage of the project.

2.2.3 Collector network and grid substation

Up to three new overhead transmission lines will transport electricity from each of the internal solar array substations to the grid substation. Based on preliminary designs, the anticipated voltage is 132 kV.

The alignment of the overhead transmission lines and design, height and style of the structures required to support them will be determined during the detailed design stage of the project; however, it is unlikely that the height of the structures will exceed 45 m. Based on preliminary designs, single concrete, wood, or steel poles are anticipated rather than steel lattice towers. The easement required for the overhead transmission lines will be dependent on the type of structure selected but is likely to be approximately 45 m in width. The distance between each structure will also be dependent on the type of structure selected. Where possible, structures will avoid identified constraints on the land parcels between the three array areas. Complete clearance of vegetation within each of the proposed easements may be required.

Indicative alignments for each of the overhead transmission lines are presented in Figure 1.2. As illustrated in Figure 1.2, three options are being considered for the transmission line between the northern and central array areas.

The indicative alignment to connect the southern array area to the central array area extends over approximately 9.5 km and covers land owned by two of the project landholders, as well as the southern road easement of a 1 km section of Gostwyck Road. Each of the indicative alignments presented in Figure 1.2 have been surveyed as part of this ACHA.

The grid substation will be adjacent to TransGrid's 330 kV transmission line, which traverses the northern and central array areas (Figure 1.2). At the grid substation, the electricity generated by the three solar arrays will be stepped up to 330 kV and injected into the electricity grid via TransGrid's 330 kV transmission line. The grid substation will require a pad area of up to 10 ha.

Three separate areas, one in the northern array and two in the central array, are currently being considered as options for the grid substation. Footprints providing adequate flexibility for design and siting of the grid substation at these three locations are provided on Figure 1.2. The exact dimensions will be refined during the detailed design stage of the project and in consultation with TransGrid.

2.2.4 Battery energy storage system

The purpose of the BESS will be to support the network, introduce a dispatchable capability to the project's energy generation profile and allow for revenue diversification.

The BESS will be adjacent to one or more substations within the development footprint and will be housed within either a number of small enclosures/cabinets or larger battery buildings. The specific design details for the BESS and their respective enclosure types have not been confirmed; however, it is anticipated that the BESS for the project will consist of either one BESS facility at the grid substation or three BESS facilities (one at the grid substation and two at the internal solar array substations).

2.2.5 Construction accommodation village

A construction accommodation village for non-local construction employees (where skills cannot be sourced locally) may be established as part of the early stages of the project's construction.

The construction accommodation village will be on part of Lot 2 of DP 174053 in the northern array area (refer Figure 1.2).

To build the construction accommodation village, topsoil will be stripped where necessary, hardstand constructed and walkways and car parks constructed.

The construction accommodation village is expected to be dismantled and its footprint rehabilitated once the project is built and it moves into the operational stage. Lot 2 of DP 174053 may also be utilised for PV modules and supporting infrastructure following the removal of the construction accommodation village.

2.2.6 Supporting infrastructure

In addition to the infrastructure described above, the project will also require:

- one or more O&M buildings (namely meeting facilities, a temperature-controlled spare parts storage facility, SCADA facilities, a workshop and associated infrastructure);
- a number of new internal roads to enable access to the three array areas from the surrounding road network including The Gap Road, Salisbury Plains Road, Hillview Road, Munsies Road and Big Ridge Road (refer Figure 1.2);
- emergency access points to enable access to the three array areas from the surrounding road network in the case of an emergency (e.g. fire or flood);
- parking and internal access roads/tracks within the three areas to allow for construction and ongoing maintenance; and
- fencing and landscaping around the solar arrays, substations and BESSs.

O&M buildings and associated infrastructure will likely be constructed within the footprints nominated for the substations and BESSs; however, their exact location will be determined during detailed design (refer Figure 1.2). The locations for the emergency access points will be identified as part of the project's emergency response plan during detailed design.

Temporary infrastructure during the construction stage of the project including laydown and storage areas and a site compound are also likely to be required in each of the three solar array areas. Laydown areas will likely be in close proximity to the primary site access points and will be placed away from environmentally sensitive areas, where possible.

Chain mesh security fencing will be installed within the project boundary to a height of up to 2.4 m high. The location of the security fencing will be determined in consultation with the project landholders. Fencing will restrict public access to the development footprint. Where possible, fencing will be positioned to minimise disruption to ongoing agricultural operations on land adjacent to the development footprint.

2.3 Construction

2.3.1 Site preparation

The need for heavy civil works such as grading/levelling and compaction will be minimised as much as practicable, as the flattest land areas within the three array areas which are already mostly cleared of vegetation have been selected. Civil works will be required to prepare the three array areas by installing fencing, internal access tracks, digging MV cable trenches and other minor earth works.

Some heavier earth moving will likely be required for certain project infrastructure (e.g. substations and BESSs) in those instances where a level pad is necessary. In addition, grading around lower order streams and drainage channels within the three array areas may also be required in order to manage erosion during construction.

As part of site establishment works, management measures will be introduced to mitigate potential impacts on the environment and receptors within close proximity of the development footprint. Where required, additional or improved drainage channels, sediment control ponds and dust control measures will be implemented. Further, laydown areas and waste handling, fuel and chemical storage areas will be strategically placed to minimise potential environmental impacts during the construction stage of the project.

Site establishment works and preparation for construction may include:

- the establishment of a temporary construction site compound in a fenced-off area within the development footprint including:
    - a site office;
    - containers for storage;
    - parking areas; and
    - temporary laydown areas.
- construction of access tracks and installation of boundary fencing;
- site survey to confirm infrastructure positioning and placement; and
- geotechnical investigations to confirm the ground condition.

2.3.2 Construction stages

Upon completion of the site establishment and pre-construction activities described above, construction will typically be as follows:

- drive or screw piles;
- install mounting structures and tracker tubes;
- secure PV modules to tracker tubes;
- installation of medium voltage and high voltage cables;
- installation of PCUs;
- complete substation augmentation;
- establishment of the BESS compound; and
- test and commission project infrastructure.

2.3.3 Construction plant and equipment

The plant and equipment required for the construction of the project will include:

- earthmoving machinery and equipment for site preparation;
- cable trenching and laying equipment;
- pile-driving equipment;
- assisted material handling equipment (forklifts and cranes);
- machinery and equipment for connection infrastructure establishment and installation of battery and energy storage devices; and
- water trucks for dust suppression.

2.3.4 Delivery of construction materials and infrastructure

Construction materials and infrastructure will be transported to the three array areas via road. Heavy vehicles up to 25 m in length will require access to the three array areas. Construction materials and infrastructure delivered to the three array areas will include:

- PV modules;
- piles;
- tracking tubes and associated tracker equipment (e.g. motors, bearings, drivetrains, etc);
- electrical infrastructure including cabling and PCUs;
- construction and permanent O&M buildings and associated infrastructure; and

- earthworks and lifting machinery and equipment.

Oversized vehicle movements may be required for the delivery of the 33 kV/ 132 kV transformers that will be located at the solar array substations and the 33 kV/132 kV/330 kV transformers that will be located at the grid substation.

2.3.5 Construction duration, workforce and hours

Construction of the project will take approximately 36 months from the commencement of site establishment works to commissioning of the three array areas.

The project will require a peak construction workforce of up to 700 people.

Construction activities will be undertaken from 6am–6pm Monday to Sunday. Exceptions to these hours may be required on limited occasions. Uralla Shire Council and surrounding landholders will be notified of any exceptions.

2.4 Services

The project may require connections to the electricity, telecommunications, water and sewer networks. During construction, electricity requirements will be met by backup generators.

2.5 Operation

The operational lifespan of the project will be in the order of 30 years, unless the facility is re-powered at the end of the PV modules' technical life. The decision to re-power the plant will depend on the economics of solar PV technology and energy market conditions at that time. Should the PV modules be replaced during operations, the lifespan of the project may extend to up to 50 years. Throughout operations, a workforce of up to 15 full time equivalents (FTEs) will be required.

It is anticipated that the facility will require regular maintenance throughout its operational life. This will include the following ongoing tasks:

- site maintenance including:
  - vegetation maintenance;
  - weed and pest management;
  - fence and access road management;
  - upgrading drainage channels; and
  - landscaping;
- infrastructure maintenance including:
  - PV module cleaning;
  - PV module, inverter and tracker system repair (if required); and
  - equipment, cabling, substation and communications system inspection and maintenance.

Regular light vehicle access will be required throughout operations. Heavy vehicles may be required occasionally for replacing larger components of project infrastructure including inverters, transformers or components of the BESS. O&M activities will typically be undertaken by specialist subcontractors and/or equipment manufacturers.

UPC is currently in discussions with a number of the landholders to enable sheep grazing to resume on portions of the three array areas following the completion of the construction of the project. A detailed protocol will be developed to ensure biosecurity is maintained and that grazing does not impact on the safe and efficient operation of the project or result in injury to farm workers or O&M staff.

To ensure the optimal electricity production output for the project is maintained, the PV modules may need to be washed periodically to remove dirt, dust and other matter. Water for PV module cleaning will be transported to the three array areas via water trucks. Washing will not require any detergent or cleaning agents.

The operational workforce will also be responsible for ongoing security monitoring of the three array areas and project infrastructure.

2.6 Decommissioning

Once the project reaches the end of its investment and operational life, the project infrastructure will be decommissioned and the development footprint returned to its pre-existing land use, namely suitable for grazing of sheep and cattle, or another land use as agreed by the project owner and the landholder at that time.

Project decommissioning will require disturbance of the development footprint during the removal of equipment. A significant number of FTEs, including both staff and contractors, and vehicle movements will be required during the decommissioning stage of the project.

Any underground cabling below 500 mm will remain in-situ following project decommissioning.

UPC will attempt to recycle all dismantled and decommissioned infrastructure and equipment, where possible. Structures and equipment that cannot be recycled will be disposed of at an approved waste management facility.

2.7 Potential sources of impact

Key potential sources of impact to surface water resources comprise the following:

- Construction and decommissioning stage impacts, including:
    - ground disturbance during bulk earthworks and other site activities (e.g. installation of PV modules, trenching for services, grading for new internal roads, construction of the temporary construction accommodation village if required, etc) leading to exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses;
    - contamination of surface waters as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemical used to support construction activities;
    - disturbance of watercourses (e.g. through construction of creek crossings) and associated riparian zones to support construction activities including clearing, bulk earthworks and civil works, installation of infrastructure and site establishment; and

- partial blockage or redirection of floodwaters as a result of poorly considered construction activities, fencing or storage/stockpile areas, resulting in inundation of construction areas, damage to plant and equipment, and potential risk to life.

- Operational stage impacts, including:

  - potential ongoing erosion of soils and mobilisation of sediment into receiving watercourses;

  - contamination of surface water as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemical used to support site activities, or through poor site and vegetation management practices; and

  - partial blockage or redirection of floodwaters as a result of poorly considered permanent facilities (e.g. BESSs, substations or O&M facilities) resulting in inundation of facilities, damage to plant and equipment, and potential risk to life.

It is noted that a significant project refinement process was undertaken to refine the extent of the development footprint for the three array areas to minimise watercourse and riparian corridor impacts through avoidance of higher order watercourses, and to minimise the potential for adverse flooding impacts particularly within the southern array area (adjacent to Salisbury Waters – refer Figure 1.2 for location). The project refinement process is described in more detail in Section 5.1 of this report and Chapter 1 of the EIS.

3 Assessment approach and methodology

3.1 Overview

Existing surface water resources were identified and characterised as follows:

- desktop review of existing available information, including spatial datasets, watercourse mapping and other relevant online resources;
- flood modelling to define existing flooding conditions broadly within the study area; and
- watercourse assessments as part of site investigations within the project boundary and, more specifically, the development footprint.

Section 2.7 identifies the key potential impacts to surface water resources, which were assessed on a largely qualitative basis to understand the significance of impacts and consider whether any additional mitigation and management measures were required.

3.2 Desktop review

A desktop assessment was undertaken based on available spatial datasets covering the study area (with a focus on the development footprint) including aerial imagery, terrain data and watercourse mapping sourced from NSW Department of Finance, Services and Innovation (DFSI).

This was used to:

- confirm the local topography and landforms and establish the extent of mapped watercourses within the study area;
- undertake a stream order assessment for all mapped watercourses (with a focus on watercourses identified in consultation with DoI Lands and Water – refer Section 3.3); and
- delineate catchment areas that contribute runoff to the various major watercourses, primarily as input to the flooding investigation (refer Section 3.4).

The desktop review also established the relevant legislative and regulatory context for the project.

3.3 Watercourse assessment

Stream order assessment and identification of associated riparian corridor requirements and widths were undertaken based on the Strahler system and consistent with the methodology presented in the *Guidelines for Controlled Activities on Waterfront Land* (NOW 2012a).

Consultation with DoI Lands and Water around watercourse impacts was undertaken over the period of July to September 2018, and this resulted in key watercourses of interest being identified for more detailed consideration (refer figure included in Appendix A). More detailed assessment was undertaken on the basis of drone footage and photos taken during fieldwork by EMM and UPC throughout this period. Review of drone footage and site data aimed to confirm (or otherwise) the outcomes of watercourse mapping and stream order assessment based purely on desktop review.

3.4 Flood modelling

In the absence of any existing flood data, flood modelling was undertaken as part of this SWA to understand existing flooding conditions within the study area.

Flood modelling outputs formed part of the project refinement process and informed refinements within the southern array area, which aimed to avoid areas that were subject to inundation by flood waters of a depth greater than 300 mm adjacent to Salisbury Waters for floods with an annual exceedance probability (AEP) of 1% (i.e. 1 in 100 year flood event). Further information on the project refinement process is provided in Section 5.1 of this report and Chapter 1 of the EIS.

Flood modelling outputs were also used to inform an understanding of likely impacts on flood behaviour during both the construction and operational stages of the project. This is discussed further in Section 5.6.

The scope of the flood modelling broadly comprised:

- Hydraulic modelling of major watercourses located within the study area, typically extending to all third and higher order watercourses (including Lambing Gully, Dog Trap Creek, Julia Gully, Salisbury Waters and Cook Station Creek) along with a selected number of unnamed second order watercourses located within the northern and central array areas. Hydraulic modelling was undertaken using the TUFLOW software and model extents are presented in Section 3.4 noting that four separate TUFLOW models were established to cover the required study area. Hydraulic model topography was based on available LiDAR terrain data sourced from DFSI.

- Development of a hydrologic model using the XP-RAFTS software to generate design runoff hydrographs as input to the TUFLOW modelling. Validation of the hydrologic model was achieved by comparison to flood frequency analysis (FFA) that was undertaken at stream gauge 206025 on Salisbury Waters. The gauge is located approximately 15 km downstream of the project boundary and has recorded stream flows since 1972, and therefore has 46 years of available data. FFA was based on an annual series extracted from flow records (WaterNSW 2018), with a suitable distribution fitted using the FLIKE software.

- Simulation of a range of flood events including 20%, 5%, 1% and 0.2% AEP.

- Application of methods and data from Australian Rainfall and Runoff 2016 (Geoscience Australia 2016).

- Provision of results in digital format to feed into UPC's constraints analysis and inform the project refinement process, further details of which are provided in Section 5.1 of this report and Chapter 1 of the EIS.

4 Existing surface water environment

4.1 Climate

The climate of Uralla is temperate (BoM 2001) with a mean monthly minimum and maximum temperature range between 0.4-11.8°C in winter and 12.7-26.4°C in summer (BoM 2018). The average annual rainfall is 794 mm, with the heaviest of falls occurring in the summer months.

4.2 Topography and landform

The majority of the project boundary is within the Armidale Plateau subregion, which is characterised by an undulating to hilly plateau at an elevation of approximately 1,100 metres Australian Height Datum (m AHD). The local topography can be described as a mix of low rolling hills and flatter areas that are frequently dissected by drainage networks and their adjacent floodplains, terraces and foot slopes. Elevation across the study area ranges between 986-1,149 m AHD.

4.3 Regional hydrology

The project boundary is located in the upper reaches of the Macleay River catchment, which borders the Clarence and Bellinger catchments to the north, Gwydir and Namoi catchments to the west and the Hastings and Manning catchments to the south. The catchment covers a total area of 11,450 km^2 and includes extensive areas of the northern tablelands, a sparsely populated escarpment area and a coastal area ranging from foothills to coastal plains (NSW Government n.d.). The Macleay River rises in the Northern Tablelands east of the project boundary at the confluence of the Gara River, Salisbury Waters and Bakers Creek, and flows south-east through a coastal floodplain, where it ultimately flows into the Pacific Ocean.

4.4 Local hydrology, watercourses and riparian corridors

The local hydrologic context relevant to the development footprint and broader study area is shown on Figure 4.1. Key features shown include watercourses and assessed stream order, as well as the extent of the Salisbury Waters catchment to Stream Gauge 206205. Sub-catchments contributing to runoff in Salisbury Waters and its tributaries adjacent to each of the three array areas are also identified.

As noted in Section 4.2, the landform pattern within and surrounding the project boundary can be described as low rolling hills that are frequently dissected by drainage networks and their adjacent floodplains, terraces and foot slopes. Named watercourses within the study area and surrounds are shown on Figure 4.2 and include:

- Salisbury Waters and Cook Station Creek (6^{th} and 5^{th} order streams, respectively) that traverse the study area close to the southern array area and flow generally to the north-east;
- Dog Trap Creek and Julia Gully (both 4^{th} order streams) that are to the south of the central array area and flow generally to the east; and
- Lambing Gully, Hariet Gully and Saumarez Creek (3^{rd}, 2^{nd} and 5^{th} order streams, respectively) that are close to the northern array area and flow generally to the east and then south.

Figure 4.2 shows existing watercourse alignments based on DFSI data relative to the development footprint.

Stream order based on the Strahler system and associated vegetated riparian zone (VRZ) widths recommended in NOW (2012a) are also shown on Figure 4.2. Total riparian corridor width recommended in NOW (2012a) is calculated as the channel width (measured at top of highest bank) plus twice the VRZ width (i.e. VRZ applies to each side of the watercourse).

Most watercourses within the development footprint are ephemeral and, with the exception of a small number of watercourses that are likely to be spring-fed, were dry during site investigations performed as part of the preparation of the SWA and other technical assessments. The ephemeral waterways within the development footprint are lower order streams (i.e. 1st and 2nd order only) and, in most cases, lack aquatic vegetation and are dominated by grass species prevalent across the project boundary. The majority of these mapped lower order watercourses do not have a discernible channel and therefore are considered unlikely to satisfy the definition of 'waterfront land' established within the WM Act. Furthermore, riparian zones and associated vegetation adjacent to the 1st and 2nd order watercourses that traverse the development footprint have been modified and degraded by historical land use practices and past disturbances associated with land clearing, cropping and intensive livestock grazing. Several of these lower order watercourses have been modified or flows diverted altogether by project landholders through the construction of contour banks. Based on field investigations performed as part of the preparation of the BDAR, habitat within the development footprint is considered to be unsuitable for threatened aquatic species.

Representative photographs showing the condition of mapped 1st and 2nd order watercourses within the development footprint are provided in Appendix B, which includes a selection of the watercourses of interest identified by DoI Lands and Water (refer Appendix A – Figure A.1).

4.5 Water bodies and wetlands

There are a number of existing farm dams used primarily for stock watering within the development footprint for the three array areas. Field investigations performed as part of the SWA and BDAR indicate that these man-made features have limited habitat or other environmental value. Examples of farm dams within the development footprint are provided in Photograph 4.1 and Photograph 4.2.

Other nearby water bodies include:

- Dangars Lagoon, which lies approximately 5 km west of the development footprint for the southern array area (refer Figure 1.2);
- Racecourse Lagoon, which lies further to the west of Dangars Lagoon (refer Figure 1.2); and
- a large farm dam that captures water from Saumarez Creek, approximately 200 m north-east of the northern array area at its closest point.

There are no Ramsar wetlands or other significant wetlands within or downstream of the development footprint.

Photograph 4.1 Existing farm dam within the central array area

Photograph 4.2 Existing farm dam within the northern array area

4.6 Water quality

No known water quality monitoring data was available for the watercourses within the study area, nor for downstream sites that are likely to be representative of these watercourses. It is expected that Salisbury Waters and its major tributaries are likely to be of relatively good water quality, although degraded to some extent by existing agricultural land use and management practices in the surrounding area.

4.7 Existing water use, groundwater and infrastructure

The locations of existing groundwater bores are included on Figure 4.1, which shows numerous bores within the development footprint for the three array areas and surrounds. The main use of groundwater is likely associated with stock and domestic purposes, which is typical for rural/agricultural areas.

Based on review of available groundwater level data for registered bores in the vicinity of the development footprint (DPI 2016), monitored standing water levels average approximately 20 m below ground level, to a minimum of approximately 3 m below ground level to the south-west of development footprint for the southern array area.

As noted in Section 4.5, a number of existing farm dams, which are used for stock watering and are fed by surface runoff are also within the development footprint (refer Photograph 4.1 and Photograph 4.2).

4.8 Flooding

The project boundary is outside of the flood planning area as mapped under the Uralla LEP. Exclusion from the LEP does not imply that certain areas within the project boundary are not flood prone, rather that flooding has not previously been considered in this area or is not significant enough to warrant flood-related development controls.

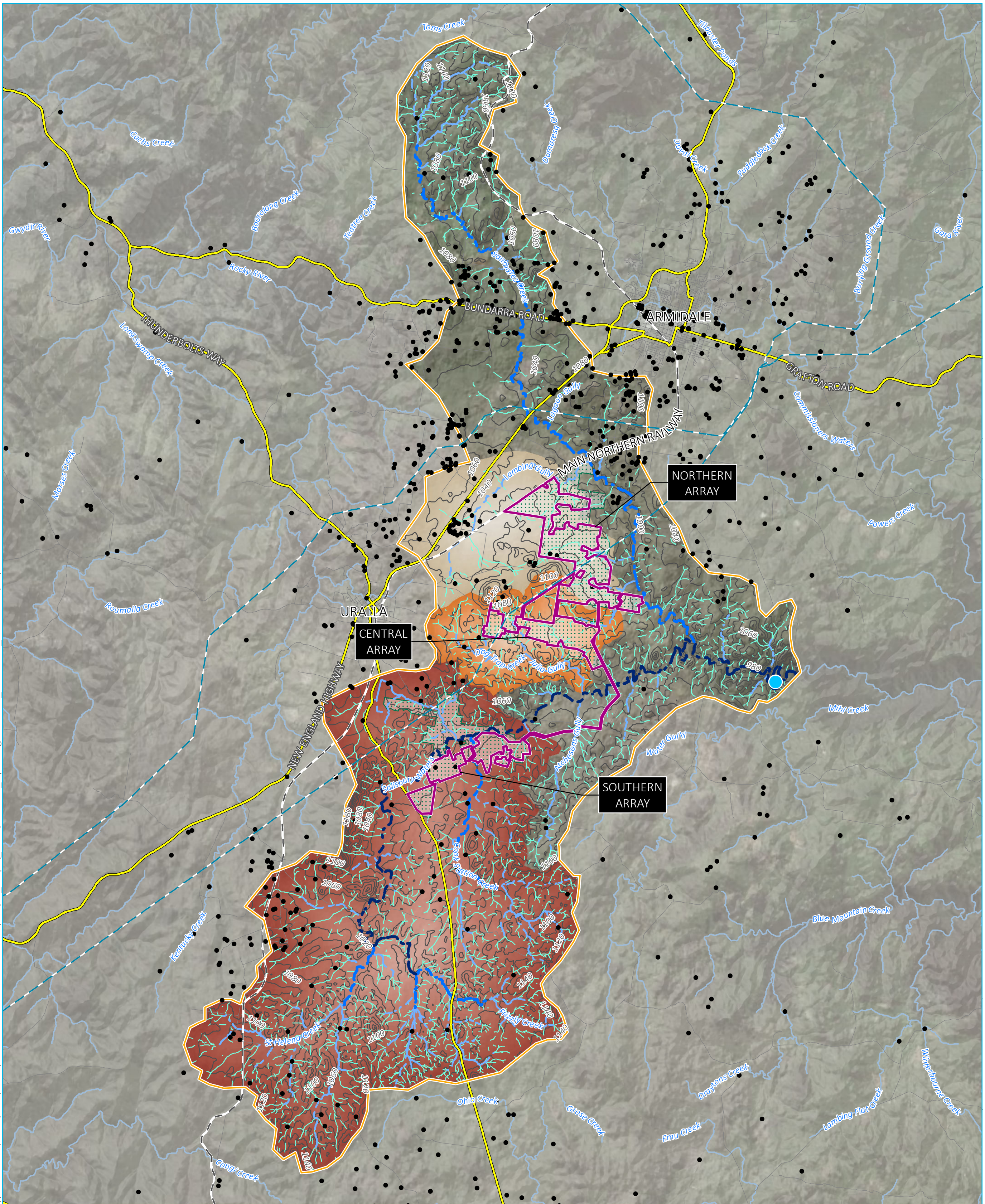
Accordingly, flood modelling has been undertaken to improve understanding of this potential constraint and to inform the project design development process. The methodology that has been adopted as part of this process is described in Section 3.4. The combined extent of the hydraulic models within which mainstream flooding along the various watercourses has been defined is shown on Figure 4.3. It is noted that overland flooding was not explicitly defined. Whilst it is anticipated that relatively shallow overland flooding affects the majority of the study area, it was not considered a major constraint nor risk to development and subsequently has not been investigated in detail.

Key findings and outcomes of the flood modelling are described below. Results are presented and discussed primarily in relation to the 1% AEP event, which has been adopted as a basis at the current stage of project development for considering flood risk to project infrastructure within the development footprint for the three array areas and the potential for adverse off-site flooding impacts to occur as a result of the project.

Figure 4.4 shows indicative extents and depths of flooding for the 1% AEP design event. The following key observations are made:

- flooding generally follows the alignment of watercourses, with no substantial overbank flooding or breakouts evident; and
- floodways and areas of higher flow velocity and flood hazard are typically confined to the in-bank section of the watercourses.

As noted in Section 3.4, flood modelling encompassed major watercourses within the study area, typically extending to all third and higher order watercourses (including Lambing Gully, Dog Trap Creek, Julia Gully, Salisbury Waters and Cook Station Creek) along with a selected number of unnamed second order watercourses (particularly within the northern and central array areas). Based on the results of the flood model (refer to Figure 4.4), within the development footprint approximately 213 ha (or 7.6%) would be subject to mainstream flooding as a result of a 1% AEP event. Within the broader project boundary, approximately 758 ha (or 9.1%) would be subject to mainstream flooding as a result of this same event.



\\EMMSVR1\emm\Jobs\2017\J17300 - UPC NSW Solar Farm\GIS\02_Maps_SWA\SWA003_HydrologicContext_20181003_02.mxd 24/10/2018

Source: DPI (2013); EMM (2018); DFSI (2017); UPC (2018)

KEY

- 330 kV transmission line
- Rail line
- Main road
- Local road
- 20 m contour
- Named watercourse
- Development footprint
- Study area
- Salisbury Waters catchment
- Northern array catchment
- Central array catchment
- Southern array catchment
- Stream gauge 206025 Salisbury waters near Dangar Falls
- Licensed groundwater bore

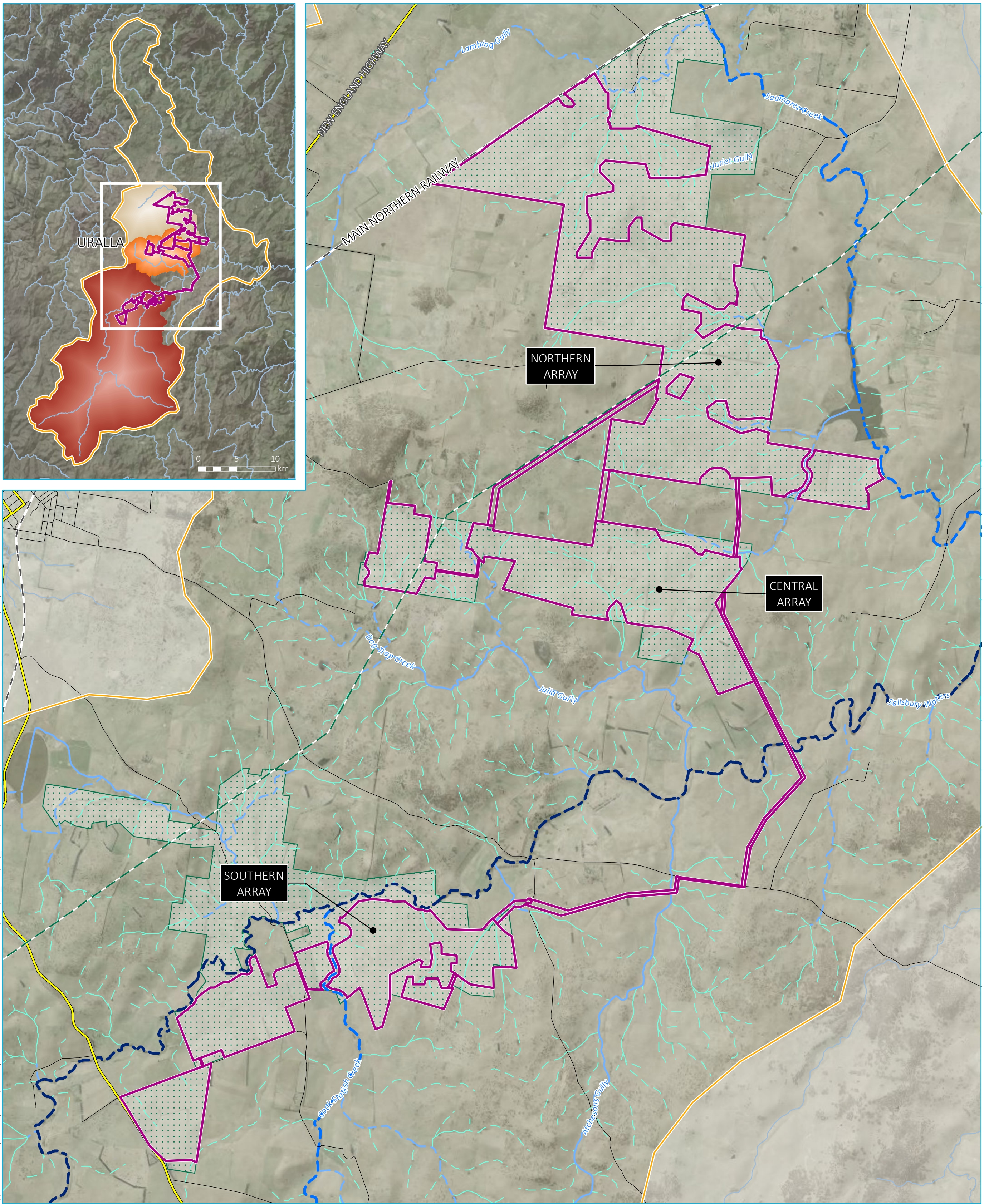
Strahler stream order (riparian buffer distance)

- 1st order (10 m)
- 2nd order (20 m)
- 3rd order (30 m)
- 4th order (40 m)
- 5th order (40 m)
- 6th order (50 m)

Hydrologic context

New England Solar Farm
Surface water assessment
Figure 4.1

EMM
creating opportunities



Source: DPI (2013); EMM (2018); DFSI (2017); UPC (2018)

0 1.5 3 km

GDA 1994 MGA Zone 56

N

\\EMMSVR1\emm\Jobs\2017\J17300 - UPC NSW Solar Farm\GIS\02_Maps_SWA\SWA006_Watercourses_20181015_01.mxd 24/10/2018

KEY

- 330 kV transmission line
- Rail line
- Main road
- Local road
- Named watercourse
- Development footprint
- Study area
- Salisbury Waters catchment

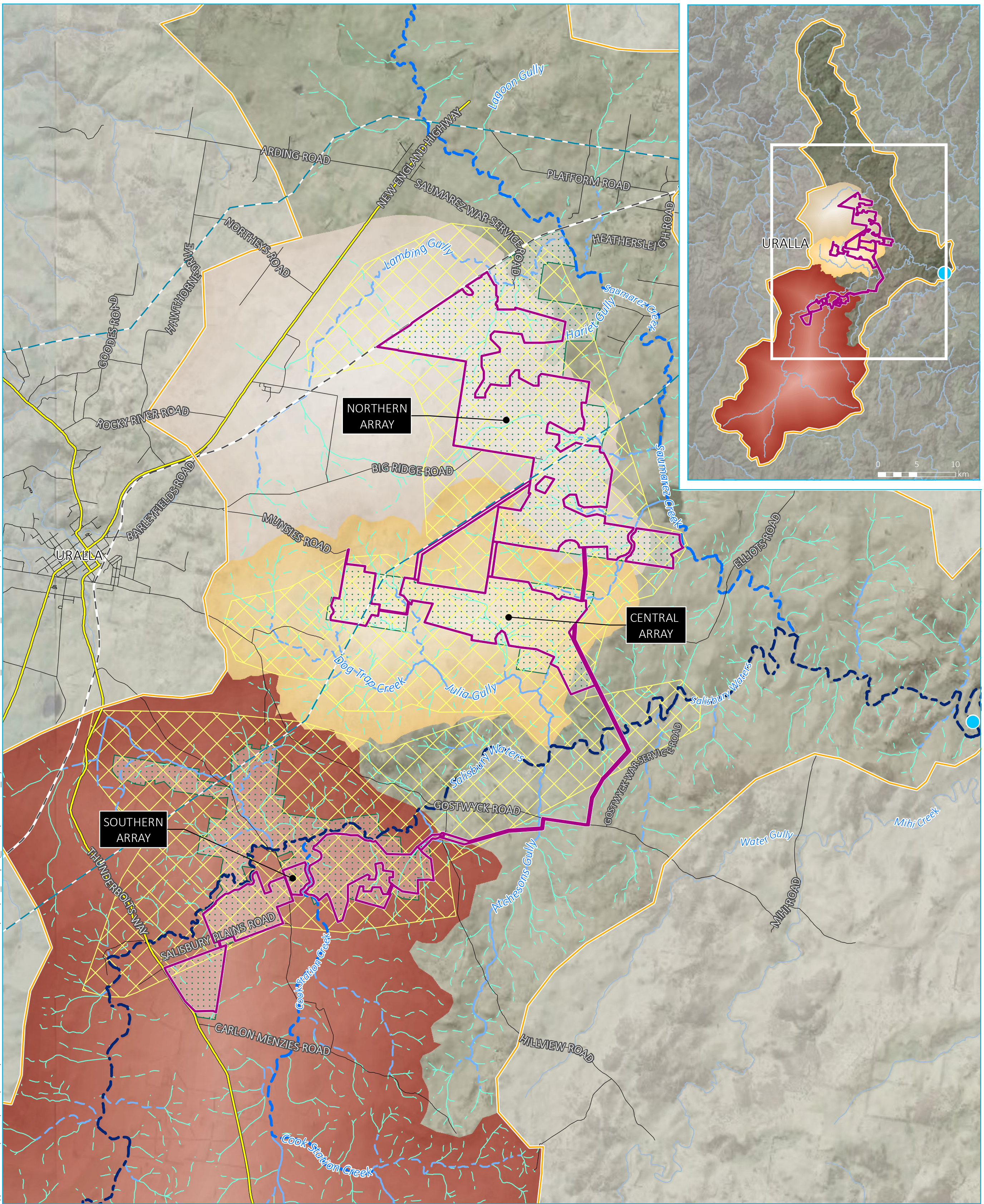
Strahler stream order (riparian buffer distance)

- 1st order (10 m)
- 2nd order (20 m)
- 3rd order (30 m)
- 4th order (40 m)
- 5th order (40 m)
- 6th order (50 m)

Watercourses and riparian corridors

New England Solar Farm
Surface water assessment
Figure 4.2

EMM
creating opportunities



Source: DPI (2013); EMM (2018); DFSI (2017); UPC (2018)

\\EMMSVR1\emm\Jobs\2017\J17300 - UPC NSW Solar Farm\GIS\02_Maps_SWA\SWA004_HydraulicModelExtents_20181003_02.mxd 24/10/2018

KEY

- 330 kV transmission line
- Rail line
- Named watercourse
- Main road
- Local road
- Development footprint
- Study area
- Salisbury Waters catchment
- Northern array catchment
- Central array catchment
- Southern array catchment
- Combined TUFLOW model extents
- Stream gauge 206025 Salisbury waters near Dangar Falls

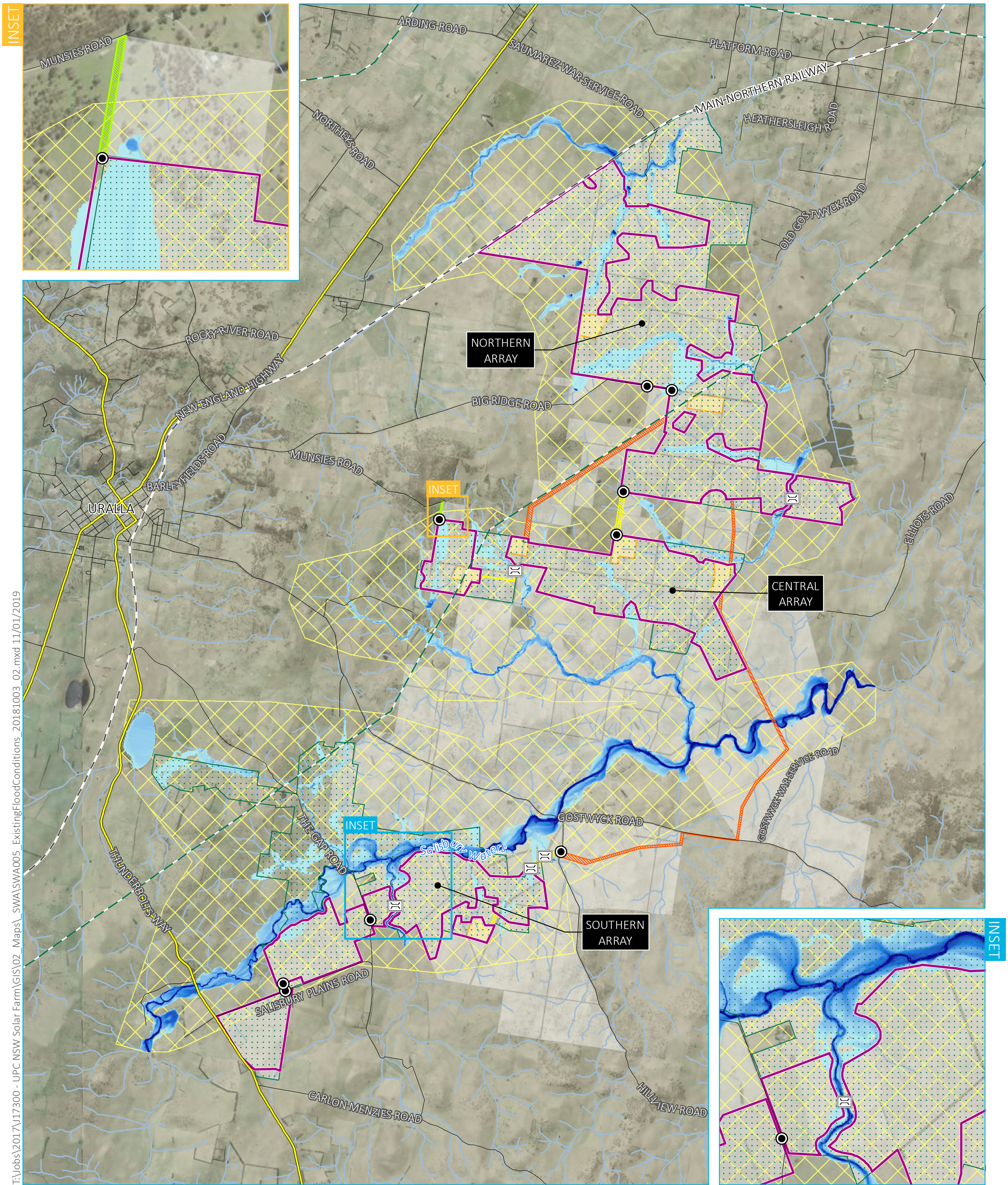
Strahler stream order (riparian buffer distance)

- 1st order (10 m)
- 2nd order (20 m)
- 3rd order (30 m)
- 4th order (40 m)
- 5th order (40 m)
- 6th order (50 m)

Hydraulic model extents

New England Solar Farm
Surface water assessment
Figure 4.3

EMM
creating opportunities



Source: EMM (2018); DFSI (2017); UPC (2018)

0 2.5 5 km

GDA 1994 MGA Zone 56

N

KEY

- 330 kV transmission line
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Project boundary
- Study area

Development footprint

- Solar array
- Potential ETL easement
- Potential site access corridor
- Potential site access/ETL easement
- Potential electrical cabling/site access coridoor
- Potential substation/BESS footprint
- Potential creek crossing

- Proposed primary site access point
- Combined TUFLOW model extents

1% AEP - indicative flood depth

10 m

0 m

Existing flooding conditions - 1% AEP indicative flood extents and depths

New England Solar Farm
Surface water assessment
Figure 4.4

EMM
creating opportunities

5 Impact assessment

5.1 Project refinement process

As mentioned, a project refinement process was undertaken during preparation of the EIS. This process resulted in considerable refinement of the development footprint within the project boundary on the basis of environmental constraints identification, stakeholder engagement, community consultation and design of project infrastructure with the objective of developing an efficient project that avoids and minimises environmental impacts (refer Chapter 1 of the EIS for more details).

From a surface water perspective, the project refinement process sought to refine the extent of the development footprint for the three array areas to minimise watercourse and riparian corridor impacts through avoidance of higher order watercourses, and to minimise the potential for adverse flooding impacts, particularly within the southern array area adjacent to Salisbury Waters. Specific outcomes from the project refinement process include the following:

- exclusion of higher order streams (i.e. 3rd order and above) from the development footprint, with maintenance of recommended VRZ buffer widths for these watercourses;
- reduction in the number of watercourse crossings required as part of the project's internal access track layout; and
- increasing the setback of the southern array area from Salisbury Waters to minimise potential interaction with floodwaters for events up to and including the 1% AEP flood.

The following sections describe residual surface water impacts.

5.2 Watercourses and riparian corridors

As described in Section 5.1, the development footprint has been refined to minimise impacts to watercourses and associated riparian corridors within the project boundary and, more specifically, the development footprint. This includes the exclusion of higher order streams (i.e. 3rd order and above) from the development footprint.

Subject to the detailed design of project infrastructure, creek crossings may be required across several higher order streams that traverse the landscape outside of the development footprint. Indicative locations for the proposed creek-crossings are identified on Figure 1.2(noting that the exact location of each crossing may change subject to detailed design) and are as follows:

- Cook Station Creek (5th order stream) adjacent to two land parcels that form part of the development footprint for the southern array area;
- two unnamed 3rd order streams that are tributaries to Salisbury Waters and intersect the proposed site access corridor and ETL easement for the southern array area within proximity of the Hillview Road site access location;
- an unnamed 3rd order stream that is a tributary to Julia Gully and intersects the proposed site access corridor and ETL easement between two land parcels that form part of the development footprint for the central array area; and
- an unnamed 3rd order stream adjacent to two land parcels that form part of the development footprint for the northern array area.

With the exception of the creek crossings described above, a minimum setback of 30 m (or greater, consistent with NOW (2012a)) from all 3rd order and higher streams will be applied across the development footprint. A watercourse crossing plan consistent with NOW (2012b) and *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI 2003) will be prepared for each creek crossing and will provide the detailed design of the proposed creek crossing for consultation with DoI Lands and Water prior to commencement of construction.

The development footprint includes a number of mapped 1st and 2nd order watercourses. As noted in Section 4.4 and is clearly shown in the photographs included in Appendix B, riparian zones and associated vegetation adjacent to the 1st and 2nd order watercourses that traverse the development footprint have been modified and degraded by historical land use practices and past disturbances associated with land clearing, cropping and intensive livestock grazing.

Table 5.1 provides a summary of the mapped 1st and 2nd order watercourses within the development footprint. The majority of these mapped lower order watercourses do not have a discernible channel and therefore are considered unlikely to satisfy the definition of 'waterfront land' established within the WM Act. Furthermore, these watercourses exhibit little intact riparian vegetation and poor to no aquatic habitat. On this basis and considering the existing low value of these watercourses, strict compliance with NOW (2012a) in terms of avoiding placement of PV modules and associated infrastructure within the riparian corridor for mapped 1st and 2nd order watercourses is considered to excessively constrain the project's design and construction. Rather, it is proposed that placement of PV modules and ancillary infrastructure within these watercourses be minimised to the extent practicable.

Table 5.1 Watercourses within the development footprint

Array area	Stream order	Length of mapped watercourse (km)	DoI watercourse of interest reference [1]	Representative photographs [2]	Comments
Northern	1	12.9 km	1	-	Channel evident in some cases, no intact riparian vegetation.
	2	4.34 km	1, 2, 3, 4, 5	1.1, 1.2, 1.3	No discernible channel and no intact riparian vegetation.
Central	1	9.1 km	3	1.4, 1.5	Channel evident in some cases, no intact riparian vegetation.
	2	3.08 km	1, 2	1.6, 1.7, 1.8, 1.9, 1.10, 1.11	Channel evident in some cases, no intact riparian vegetation.
Southern	1	1.87 km	-	1.12	No discernible channel and no intact riparian vegetation.
	2	2.36 km	1, 2, 3	1.13, 1.14, 1.15, 1.16, 1.17	Channel evident in some cases, no intact riparian vegetation.

Notes: 1. Refer Figure A.1 in Appendix A for DoI Lands and Water watercourse reference.
2. Refer Appendix B for representative photographs of selected watercourses.

Monitoring of watercourse and VRZ condition for all retained watercourses where these run through or immediately adjacent to the development footprint will be undertaken throughout the operational stage of the project with maintenance as required to minimise scouring and erosion and ensure waterway health and stability.

Project-related infrastructure proposed outside of the development footprint includes land required for connection infrastructure (i.e. ETLs) between the three array areas as well as land required for new internal roads to enable access to the three array areas from the surrounding road network and internal access tracks. Security fencing may also be required on land outside of the development footprint but within the project boundary. Placement of structures associated with ETLs and security fencing within 1^{st} and 2^{nd} order streams will be minimised, where practicable.

The proposed alignment for the ETL between the southern and central array areas crosses both Atchesons Gully (4^{th} order stream) and Salisbury Waters (6^{th} order stream) (Figure 1.2). Design of structures associated with this infrastructure will span these higher order streams to minimise potential impacts.

5.3 Water bodies

Existing farm dams within the development footprint may be removed as part of the construction of the project.

Given the limited habitat value afforded by these dams, the potential for adverse impact associated with dam removal is considered negligible provided appropriate erosion and sedimentation control (ESC) measures are used and the disturbed areas are stabilised and rehabilitated.

Further details of proposed ESC measures and stabilisation methods are provided in Section 5.4.

Where feasible any water contained within dams to be removed would be used for non-potable construction purposes, in accordance with harvestable rights provisions, to minimise wastage and use of imported water.

5.4 Water quality

5.4.1 Construction

The primary risk to water quality during construction will occur as a result of ground disturbance during earthworks and other site activities (e.g. installation of PV modules, trenching for the MV cable network and services if required, grading for new internal roads, construction of the temporary construction accommodation village if required, etc). There is potential that these works will lead to exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses. Contamination of surface water as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemicals used to support construction activities could also adversely impact water quality.

Potential impacts to water quality are considered minor and manageable with proposed management measures in place, further details of which are provided in Chapter 6.

5.4.2 Operation

The primary risk to water quality during operation will occur as a result of poor ground cover revegetation or stabilisation leading to exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses. Contamination of surface waters as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemicals used to support operational activities could also adversely impact water quality.

Impacts to water quality during operations are considered minor and manageable with proposed management measures in place, further details of which are provided in Chapter 6.

5.5 Water use

5.5.1 Construction

During construction, it is estimated that approximately 150 kilolitres (kL) of water per month will be required, equating to 1.8 megalitres (ML) per annum over the three year construction period. The majority of this water will be required for dust suppression, with other minor uses including site amenities, fire protection and washing of equipment and plant. The water demands during construction will be satisfied by potable water imported (trucked in) to site. Water contained within existing farm dams to be removed may be used for non-potable construction purposes, in accordance with harvestable rights provisions, to minimise use of imported water where practicable. The project therefore will not impact adjacent licensed water users or basic landholder rights during construction.

As noted in Section 2.3.5, a construction accommodation village for non-local construction employees (where skills cannot be sourced locally) may be established as part of the early stages of the project's construction. Should it be required, the construction accommodation village will include a water treatment plant (chlorine dosing) and storage tanks. Potable water for the construction accommodation village will be imported (trucked in) to site. Based on similar facilities currently operating in Australia, it is anticipated that potable water usage will be approximately 250 litres (l) per person per day.

In summary, project water requirements during construction are anticipated to be:

- assuming three year construction period and no construction accommodation village = 5.4 ML; and
- assuming three year construction period and 500 people residing in the construction accommodation village = 142.275 ML.

5.5.2 Operation

It is estimated that approximately 5 ML of water per annum will be required to sustain operations amounting to a total water demand of 150 ML over a 30 year operational life. The majority of this water will be required for washing of PV modules, which would typically occur once a year. As for construction, the water demands during operation will be satisfied by water imported (trucked in) to site. The project therefore will not impact adjacent licensed water users or basic landholder rights during ongoing operations.

5.6 Flooding

5.6.1 Construction

During construction, there is the potential for inundation of site works, compounds, storage areas and plant/equipment if these are located close to or within flood prone areas. This could present a hazard to site workers and potentially lead to plant/equipment damage and materials being washed into watercourses. However, these risks can be adequately mitigated through construction site planning giving due consideration to flood risk, which will occur as part of future detailed design.

5.6.2 Operation

Preliminary design has considered flooding constraints and makes appropriate responses in terms of locating heavier earthworks and flood-sensitive facilities (e.g. substations and BESSs) away from watercourses and areas of high hazard flooding. Array areas have also adopted appropriate setbacks from mainstream flooding, in particular for the southern array area adjacent to Salisbury Waters. Detailed design of the project will need to consider location-specific flood levels when setting floor and/or pad levels for key site infrastructure to ensure the desired level of flood protection is achieved, and will avoid flood prone areas where practicable.

Adverse flooding impacts outside of and downstream of the development footprint for the three array areas will be avoided as the development footprint has adopted appropriate setbacks from mainstream flooding, which will avoid placement of permanent works in areas that could obstruct and divert floodwaters.

The potential for surface water impacts associated with hydrologic changes due to increased runoff rates from PV modules is considered negligible. PV modules shed runoff directly to the ground, which will be stabilised and vegetated to promote retention and infiltration.

5.7 Groundwater

The typical depth of installation for piles to support PV modules is anticipated to be approximately 1.5-3 m but may be greater depending on geotechnical conditions and specific tracker design. The depth of required ground preparation works for other project infrastructure and civil works are expected to be also within this range.

Given depth to groundwater levels across the project boundary are on average approximately 20 m, to a minimum of approximately 3 m in selected areas, the project is unlikely to intersect nor impact groundwater during construction, operation and decommissioning.

The project will not require access to groundwater resources within or outside of the project boundary as water demands during construction and operation will be satisfied by water imported (trucked in) to the three array areas.

5.8 Cumulative impacts

Neoen Australia Pty Ltd (Neoen) is seeking to develop the Uralla Solar Farm (SSD 18_9534) within the Uralla Shire LGA, approximately 4.9 km north-west of the project. SEARs for the Uralla Solar Farm were not available at the time of writing; however, based on the information provided within the PEA, it is understood that if constructed, the proposed Uralla Solar Farm would cover an area of up to 1,800 ha and have a targeted capacity of around 400 MW AC (GHD 2018). The proposed site for the Uralla Solar Farm is identified on Figure 1.1.

Clenergy proposes to develop the Metz Solar Farm (SSD 16_7931), a 100 MW PV solar farm at Metz, approximately 18 km east of Armidale (Figure 1.1). The project was approved by the Minister for Planning on 18 July 2017.

In addition, Enerparc proposes to develop the Tilbuster Solar Farm (SSD 18_9619) within the Armidale Regional LGA, approximately 22 km north of the project.

On the basis of the minor nature of the surface water impacts assessed herein which are able to be readily mitigated, cumulative impacts as a result of the combined development of the project in conjunction with the Uralla Solar Farm, Metz Solar Farm and Tilbuster Solar Farm are considered negligible.

6 Mitigation and management measures

A summary of the proposed surface water mitigation and management measures is provided in Table 6.1.

Table 6.1 Summary of proposed mitigation and management measures

Aspect	Proposed mitigation measures
Construction	
Watercourses and riparian corridors	Watercourse crossing plans consistent with NOW (2012b) and DPI (2003) detailing the design of proposed crossings of any higher order stream (i.e. 3rd order and above) will be prepared in consultation with DoI Lands and Water prior to commencement of construction. Placement of PV modules and ancillary infrastructure (i.e. footings and pilings) within 1^{st} and 2^{nd} order streams will be minimised to the extent practicable. Watercourse crossings of 1^{st} and 2^{nd} order streams for internal access tracks and electrical cabling will be minimised to the extent practicable.
Water quality	Implementation of ESC measures in accordance with Landcom (2004). The SEA (Appendix G of the EIS) outlines a range of potential measures that could be adopted. Proposed measures will be considered further and formalised as part of detailed design and documented in the construction environmental management plan (CEMP). Progressive revegetation or stabilisation of disturbed areas to minimise exposed soils to the extent possible. Implementation of procedures for hazardous material storage and spill management to be prepared and documented within the CEMP.
Flooding	Construction site planning to consider flood risk and locate temporary site works, compounds, storage areas and plant/equipment away from flood prone areas where practicable. Detailed design and placement of key project infrastructure (e.g. substations and BESSs) will consider location-specific flood levels when setting floor levels and flood protection levels, and will avoid flood prone areas where practicable.
Water use	Water contained within existing farm dams to be removed will be used for non-potable construction purposes, in accordance with harvestable rights provisions, to minimise use of imported water where practicable.
Operations	
Watercourses and riparian corridors	Monitoring of watercourse and VRZ condition for all retained watercourses where these run through or immediately adjacent to the development footprint will be undertaken, with maintenance as required to minimise scouring and erosion and ensure waterway health and stability.
Water quality	Monitoring and maintenance of ground cover vegetation and other stabilised surfaces throughout operation to limit erosion and transport of sediment to watercourses. Implementation of procedures for hazardous material storage and spill management to be prepared and documented within the operational environmental management plan (OEMP).

7 Summary and conclusions

7.1 Overview

Preliminary assessment of potential surface water impacts associated with the project identified watercourses, water quality and flooding as key areas of sensitivity. Accordingly, a project refinement process was undertaken which included refining the extent of the development footprint for the three array areas to minimise watercourse and associated riparian corridor impacts through avoidance of higher order watercourses and to minimise the potential for adverse flooding impacts particularly within the southern array area adjacent to Salisbury Waters. Specific outcomes from the project refinement process include:

- exclusion of higher order streams (i.e. 3rd order and above) from the development footprint, with maintenance of recommended VRZ buffer widths for these watercourses;
- reduction in the number of watercourse crossings required as part of the project's internal access track layout; and
- increasing the setback of the southern array area from Salisbury Waters to minimise potential interaction with floodwaters for events up to and including the 1% AEP flood.

Residual impacts to watercourses, water quality and flooding during both construction and operations are considered minor and manageable provided a range of proposed management measures are implemented. The following provides a summary of predicted impacts and proposed key management measures.

7.2 Watercourses

The development footprint includes a number of mapped 1st and 2nd order watercourses. The majority of these watercourses do not have a discernible channel and riparian zones and associated vegetation have been modified and degraded by historical land use practices. Placement of PV modules and ancillary infrastructure within 1st and 2nd order watercourses and crossings of these watercourses for internal access tracks and electrical cabling will be minimised to the extent practicable. Watercourse crossing plans detailing the design of proposed crossings of higher order watercourses (i.e. 3rd order and higher) outside of the development footprint will be prepared in consultation with DoI Lands and Water. Ongoing monitoring of watercourse condition and VRZ condition for all retained watercourses where these run through or immediately adjacent to the development footprint, will be undertaken during operations with maintenance as required to minimise scouring and erosion and ensure waterway health and stability.

7.3 Water quality

The primary risk to water quality will occur as a result of ground disturbance during construction, and poor ground cover revegetation or stabilisation during operation, leading to exposure of soils and potential erosion and mobilisation of sediment into receiving watercourses. Contamination of surface water as a result of accidental spillage of materials such as fuel, lubricants, herbicides and other chemicals used to support construction and operational activities could also adversely impact water quality.

Proposed key management measures include implementation of ESC measures in accordance with Landcom (2004), progressive revegetation or stabilisation of disturbed areas to minimise exposed soils to the extent possible and implementation of procedures for hazardous material storage and spill management.

7.4 Flooding

Prior to and throughout construction, site planning will need to consider flood risk and locate temporary site works, compounds, storage areas and plant/equipment away from flood prone areas where practicable. Flood modelling has already been undertaken to inform project refinement by avoiding areas likely to be impacted to a depth of more than 300 mm in the 1% AEP event.

Preliminary design of permanent works has considered flooding constraints and makes appropriate responses in terms of locating heavier earthworks and flood-sensitive facilities (e.g. substations and BESSs) away from watercourses and areas of high hazard flooding and will avoid adverse flooding impacts within and downstream of the development footprint. Detailed design of the project will need to consider location-specific flood levels when setting floor and/or pad levels for key project infrastructure to ensure the desired level of flood protection is achieved, and will avoid flood prone areas where practicable.

7.5 Other potential impacts

Given the limited habitat value afforded by existing farm dams, the potential for adverse impacts associated with dam removal are considered negligible provided appropriate ESC measures are used and the disturbed areas are stabilised and rehabilitated. No other water bodies will be disturbed by the project.

Water demands during construction and operation will be satisfied by potable water imported (trucked in) to site. Any opportunistic use of water for construction sourced from farms dams to be removed would be undertaken in accordance with harvestable rights provisions. The project therefore will not impact adjacent licensed water users or basic landholder rights during construction and operations.

The project is not likely to impact groundwater during construction, operation and decommissioning due to the estimated depth to groundwater within the project boundary and the limited amount and depth of subsurface disturbance activities required during the installation and decommissioning of project infrastructure. The project will also not require access to groundwater resources.

Cumulative impacts on surface water resources as a result of the project in combination with other major developments in the locality, namely the Uralla Solar Farm, Metz Solar Farm and Tilbuster Solar Farm, have been assessed and are considered negligible.

Abbreviations

AC	alternating current
AEP	annual exceedance probability
AHD	Australian Height Datum
BDAR	biodiversity development assessment report
CEMP	construction environmental management plan
DA	development application
DC	direct current
DoI Lands and Water	NSW Department of Industry – Lands and Water Division
DFSI	NSW Department of Finance, Services and Innovation
DPE	NSW Department of Planning and Environment
EIS	environmental impact statement
EMM	EMM Consulting Pty Ltd
ESC	erosion and sediment control
ETL	electricity transmission line
FFA	flood frequency analysis
FTE	full time equivalent
HV	high voltage
LGA	local government area
MV	medium voltage
OEMP	operational environmental management plan
PEA	preliminary environmental assessment
SEA	soil erosion assessment
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SRD	State and Regional Development

SSD	State Significant Development
SWA	surface water assessment
UPC	UPC Renewables Australia Pty Ltd
VRZ	vegetated riparian zone

References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Editors) 2016, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

Bureau of Meteorology (BoM) 2018, Climate data and statistics for Uralla (Dumaresq Street) Station Number 056034, viewed 5 July 2018, http://www.bom.gov.au/climate/data/.

- 2001, *Map of Climate Zones of Australia*, viewed 8 November 2018, http://www.bom.gov.au/climate/how/newproducts/images/zones.shtml.

GHD 2018, *Neoen Uralla Solar Farm Preliminary Environmental Investigation*.

Landcom 2004, *Managing Urban Stormwater: Soils & Construction, Volume 1.*

NSW Government 2005, *Floodplain Development Manual.*

- n.d., Macleay Catchment, viewed 27 February 2018, http://www.water.nsw.gov.au/water-management/basins-and-catchments/macleay-catchment.

NSW Department of Primary Industries (DPI) 2016, *NSW Groundwater Archive – Pinneena GW 11.1*.

- 2003, Policy and Guidelines for Fish Friendly Waterway Crossings.

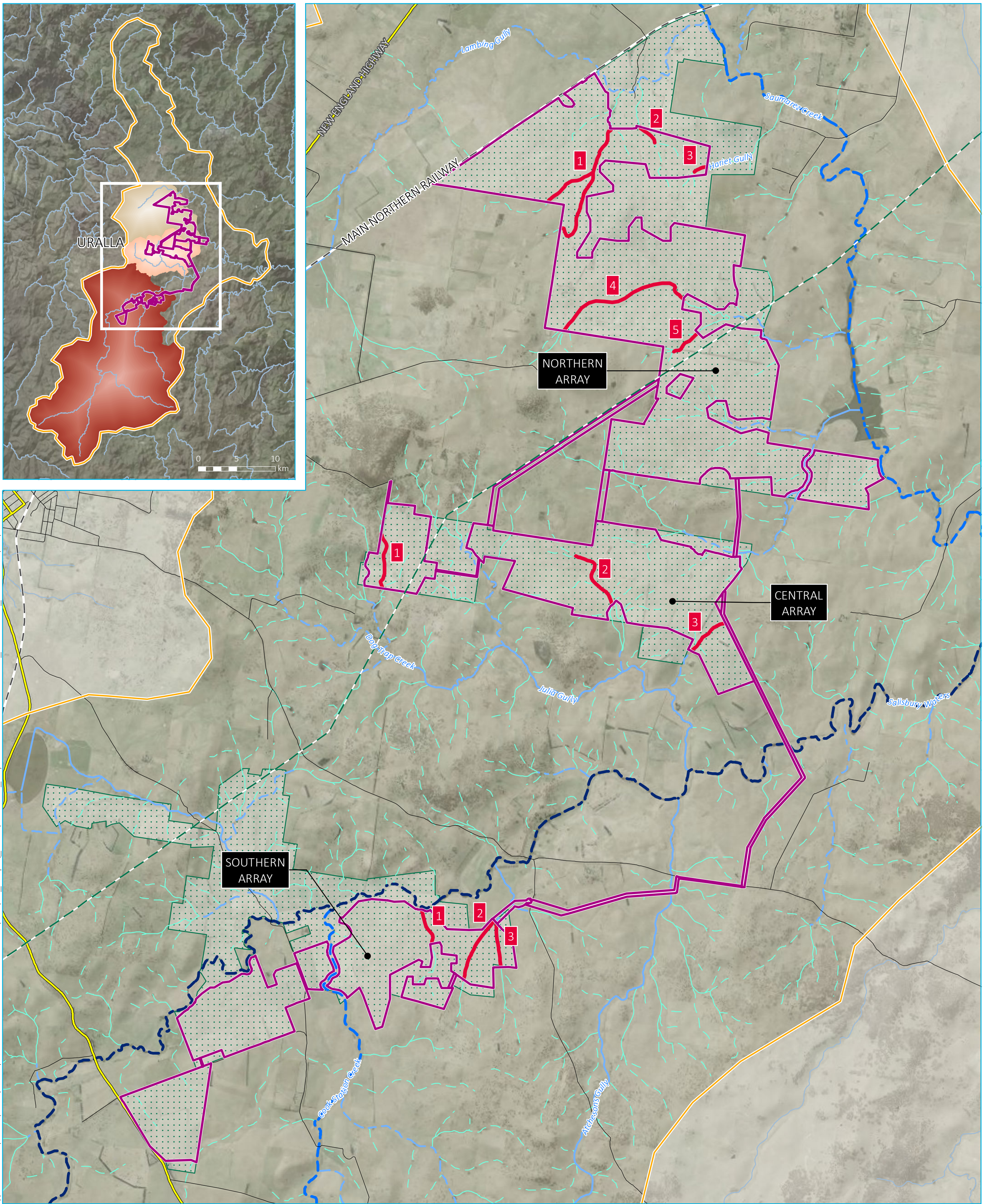
NSW Office of Water (NOW) 2012a, *Guidelines for Controlled Activities on Waterfront Land.*

- 2012b, *Guidelines for Watercourse Crossings on Waterfront Land*.

WaterNSW 2018, Streamflow records for Salisbury Waters Site Number 206025 sourced from WaterNSW real time data portal, viewed 18 June 2018, https://realtimedata.waternsw.com.au/.

Appendix A

Key watercourses of interest to DoI Lands and Water



\\EMMSVR1\emm\Jobs\2017\J17300 - UPC NSW Solar Farm\GIS\02_Maps_SWA\SWA007_KeyWatercoursesofInterest_20181024_01.mxd 24/10/2018

Source: DPI (2013); EMM (2018); DFSI (2017); UPC (2018); DoI Lands and Water (2018)

0 1.5 3 km

GDA 1994 MGA Zone 56 N

KEY

- 330 kV transmission line
- Rail line
- Main road
- Local road
- Named watercourse
- Development footprint
- Study area
- Salisbury Waters catchment

Strahler stream order (riparian buffer distance)

- 1st order (10 m)
- 2nd order (20 m)
- 3rd order (30 m)
- 4th order (40 m)
- 5th order (40 m)
- 6th order (50 m)

- Watercourse of interest to NSW Department of Industry (Lands and Water)

Key watercourses of interest to NSW Department of Industry (Lands and Water)

New England Solar Farm
Surface water assessment
Figure A.1

EMM
creating opportunities

Appendix B

Representative photographs showing lower order watercourses within the development footprint

Northern array area

Photograph B.1 2nd order - Northern array – DoI Lands and Water Reference 5

Photograph B.2 2nd order - Northern array - DoI Lands and Water Reference 4

Photograph B.3 2nd order - Northern array - DoI Lands and Water Reference 4

Central array area

Photograph B.4 1st order - Central array - tributary to DoI Lands and Water Reference 1

Photograph B.5 1st order - Central array – tributary to DoI Lands and Water Reference 1

Photograph B.6 2nd order - Central array - DoI Lands and Water Reference 1

Photograph B.7 2nd order - Central array –DoI Lands and Water Reference 1

Photograph B.8 2nd order - Central array –DoI Lands and Water Reference 1

Photograph B.9 2nd order - Central array (no DoI Lands and Water reference)

Photograph B.10 2nd order - Central array –DoI Lands and Water Reference 2

Photograph B.11 2nd order - Central array –DoI Lands and Water Reference 2

Southern array area

Photograph B.12 1st order - Southern array (no DoI Lands and Water reference)

Photograph B.13 2nd order - Southern array - DoI Lands and Water Reference 1

Photograph B.14 2nd order - Southern array - DoI Lands and Water Reference 2

Photograph B.15 **2nd order - Southern array - DoI Lands and Water Reference 2**

Photograph B.16 **2nd order - Southern array - DoI Lands and Water Reference 3**

Photograph B.17 2nd order - Southern array - DoI Lands and Water Reference 3

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