Appendix K Hydrology and Hydraulic Assessment

Beryl BESS
Hydrology and Hydraulic Assessment

Version: Rev01

Ratch-Australia Corporation
SSD-61460977

Beryl BESS
4 March 2024

Executive summary

Ratch-Australia Corporation (RAC) is proposing to develop the Beryl Battery Energy Storage System (BESS) including associated infrastructure for network connection (the Project) in Gulgong, New South Wales (NSW) (the Project). The BESS would have a capacity of up to 100 megawatts (MW) with two hours of storage (100 MW/200 megawatt hours (MWh)). The Project would connect to the National Energy Market (NEM) via a 132 kilovolt (kV) underground cable to the existing Transgrid Beryl 132/66 kV Substation (Beryl Substation) located adjacent to the southern boundary of the Project area.

The Project is considered State Significant Development (SSD) under Section 2.6(b) and Schedule 1(20) of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP), and so requires assessment in accordance with Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The consent authority for Project would be the Independent Planning Commission or the Minister for Planning and Public Spaces under Division 4.7 of the EP&A Act.

This flooding and hydrology assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) relating to flooding and hydrology impacts and will assist the Minister for Planning and Public Spaces to make a determination on whether or not to approve the Project.

Assessment methodology

This assessment assesses potential flooding and hydrology impacts from the construction and operation of the Project on flooding behaviour and sensitive receivers, such as nearby dwellings and roads. The assessment also investigates the existing flood risk to the proposed Project infrastructure.

The assessment used TUFLOW (version 2020-10-AF-iSP-w64) to model the 1% Annual Exceedance Probability (AEP) event for the existing case flooding at the Project area and surrounds.

Given the generally low flood risk to the Project area, a qualitative flood impact assessment was conducted.

Potential impacts were also assessed on the natural hydrology of the local environment. The hydrological factors considered include:

- Protecting natural low flows and natural rises in water levels
- Maintaining natural drying and flow variability
- Maintaining natural rates of change in water levels.

Existing environment

The Project is located within the lower Wialdra Creek Catchment, which is a tributary of the Cudgegong River in central NSW. The Project is 600 metres (m) southeast of Wialdra Creek, which flows in a south-westerly direction from its headwaters west of Gulgong, in the Munghorn Gap Nature Reserve.

Within the Project area (approximately 100 m downstream of the proposed Project infrastructure) there is a farm dam, which is fed by an ephemeral flow path that crosses the Project area. Beryl Road is situated immediately upstream of the site and is crossed by two box culverts, situated downstream of a small farm dam.

The topography of the Project area where the proposed Project infrastructure would be located is flat with the elevation (410m AHD to 408m AHD) changing over 2 m.

Flooding within the Project area is generally characterised by sheet flow originating from small local catchments. In the areas with proposed infrastructure the flood depths are shallow (up to 0.3m) in the 1% AEP event.

Overview of flooding impacts

The assessment identified the following key findings:

- The Project is not anticipated to have significant potential impacts on flooding and hydrology within the Project area or surrounding areas. Impacts around BESS, filled hardstand areas and watercourse crossings are expected to be minor and localised and would not affect nearby dwellings
- During Project construction, the potential for increased risk of flood impact due to stockpiling of materials and construction of the internal access road would be managed by environmental management measures such as siting these outside the regional 1% AEP flood extent and directing the overland flow paths around the stockpiling.
- There would be negligible impacts on any hydrological factors, as the increase in impervious areas on a catchment scale would be negligible. The Project would be designed so as not to impede flows paths or impact on surface flow regimes
- There would be a minor risk of localised erosion and scouring of ground surfaces at drainage discharge areas and at the toe of hardstand fill areas during flood events.

Management measures

Various environmental management measures have been identified to mitigate potential flooding and hydrology impacts., including:

- Design of the Project for the construction and operational phases to minimise flooding impacts, hydrology, surface flow regimes and erosion/scour risks
- Raising BESS and switchyard sites and providing flow diversion drains to provide adequate flood immunity
- Monitoring of impacts such as scouring and implementation of appropriate remedial works if necessary.

Conclusion

Overall, with the implementation of the proposed controls and management measures, the Project would have minimal potential impacts on flooding and hydrology. Further, there would be negligible impacts on any hydrological factors and only minor risk of localised erosion and scouring of ground surfaces.

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Glossary and terms

Term	Definition
ARR	Australian Rainfall and Runoff. Guidelines prepared by the Institute of Engineers Australia for the estimation of design floods. Reference is made to the 1987 or the 2019 versions of ARR, as specified.
AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding.
Catchment	The land area draining through the mainstream, as well as tributary streams, to a particular Project area. It always relates to an area above a specific location.
EIS	Environmental Impact Statement
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this technical paper the hazard is flooding which has the potential to cause damage to the community.
Hydraulics	The study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Overland flow path	The path that floodwaters can follow as they are conveyed towards the main flow channel or if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads.
Project	100 MW/ 200 MWh battery energy storage system including associated infrastructure for network connection and site access
Project area	5 Holleys Lane, Gulgong, NSW (Lot 297 DP 755434), a portion of Beryl Road and a section of Beryl Substation in the Transgrid managed landholding (Lot 1, DP 523876).
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
TUFLOW	TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation (hydraulics). It provides coupled 1D and 2D hydraulic

Term	Definition
	solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia.

1. Introduction

1.1 Background

Ratch-Australia Corporation (RAC) is proposing to develop the Beryl Battery Energy Storage System (BESS) including associated infrastructure for network connection in Gulgong, New South Wales (NSW) (the Project). The BESS would have a capacity of up to 100 megawatts (MW) with two hours of storage (100 MW/ 200 megawatt hours (MWh)). The Project would connect to the National Energy Market (NEM) via a 132 kilovolt (kV) underground cable to the existing Transgrid Beryl 132/66 kV Substation (Beryl Substation) located adjacent to the southern boundary of the Project area.

The Project would store variable renewable energy from the NEM in periods where supply exceeds demand such that it can be dispatched at times of greater need, providing network stability and grid forming capabilities.

The Project would primarily be located at 5 Holleys Lane, Gulgong (Lot 297 DP755434) approximately 6.3 kilometres (km) west of the Gulgong township, in the Mid-Western Regional Council (MWRC) local government area (LGA) and Central-West Orana Renewable Energy Zone (CWO REZ). The Project would also include upgrade works to the existing Beryl Substation in the Transgrid managed landholding (Lot 1, DP523876) and the provision of site access off Beryl Road.

The Project would be located about 100 metres (m) north of the Beryl Solar Farm, which is operational. The location and regional context of the Project is shown in **Figure 1-1**. The local context of the Project is shown in **Figure 1-2**.

The Project description and proposed layout is presented in **Chapter 2**.

The Project is considered State Significant Development (SSD) under Section 2.6 (b) and Schedule 1(20) of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP), and so requires assessment in accordance with Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The consent authority for Project would be the Independent Planning Commission or the Minister for Planning and Public Spaces under Division 4.7 of the EP&A Act.

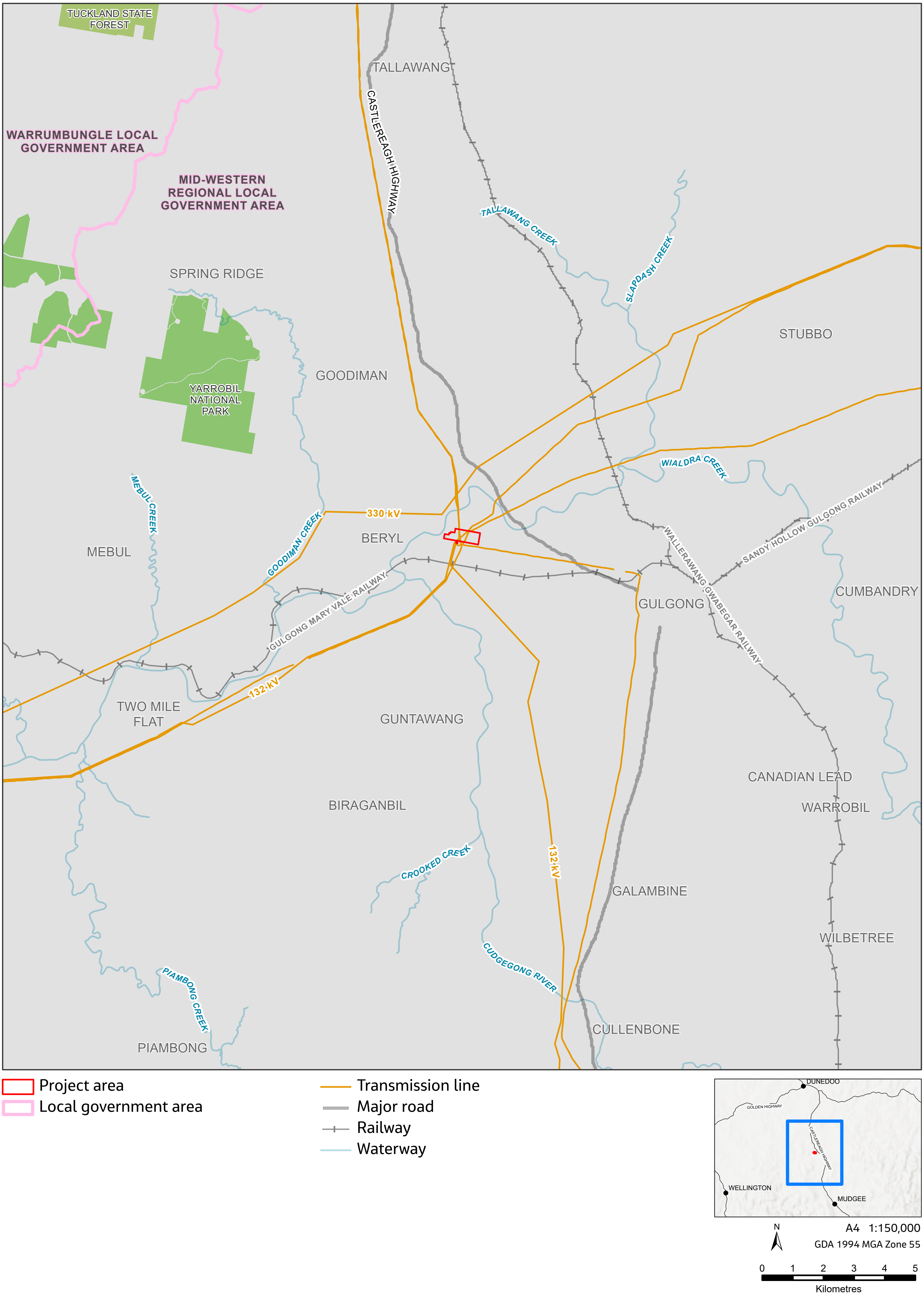

Figure 1-1: Project location and regional context

Data Sources: NSW Department of Planning and Environment (2024); Imagery Sources: ESRI Online Imagery Services; Geoscience Australia (2006); JACOBS (2024), Australian Bureau of Statistics (2021); EnergyCo (2024); TransGrid (2024)

Figure 1-2: Local context

Data Sources: NSW Department of Planning and Environment (2023); Imagery Sources: ESRI Online Imagery Services; Geoscience Australia (2006); JACOBS (2023), Australian Bureau of Statistics (2021), TransGrid (2023)

1.2 Secretary's Environmental Assessment Requirements

This assessment forms part of the environmental impact statement (EIS) for the Project. The EIS has been prepared under Division 4.7 of the EP&A Act. This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSD-61460977) issued by Department of Planning, Housing and Infrastructure (DPHI) on 28 September 2023 relating to flooding and hydrology impacts and will assist the consent authority to make a determination on whether or not to approve the Project.

Table 1-1 outlines the SEARs relevant to this assessment along with a reference to where these are addressed.

Table 1-1 SEARs relevant to flooding and hydrology impacts

Secretary's requirement	Where addressed in this report
Water – the EIS must:	
• a detailed and consolidated site water balance and an assessment of the likely impacts of the development (including flooding) on surrounding watercourses (including their Strahler Stream Order) and groundwater resources and measures proposed to monitor, reduce and mitigate these impacts including water management issues;	Potential flooding impacts during construction and operation of the Project are discussed in **Chapter 6** and **Chapter 7** respectively. A site water balance memo has been prepared separately for the Project. Refer to the 'Water' chapter in Section 7.8 of the Project EIS for potential impacts to surrounding watercourses (including Strahler Stream Order) and groundwater resources.
• details of water requirements and supply arrangements for construction and operation (including consideration of Council's comments on the SEARs);	Details of water requirements and supply arrangements are discussed in the EIS for the Project.
• 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);	Erosion and sediment control measures are described in the EIS for the Project.
• assessing the impacts of the development, including any changes to flood risk and overland flows on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required;	Potential flooding impacts during construction and operation of the Project are discussed in **Chapter 6** and **Chapter 7** respectively.

2. Project description

2.1 Overview

The Project would involve the development, construction, operation and decommissioning of a grid-scale BESS with a discharge capacity of 100 MW and a storage capacity of 200MWh. A summary of the key elements of the Project are provided in **Table 2-1**.

Table 2-1 Key aspects of the project

Key aspects	Description
Site context	
Address	5 Holleys Lane, Gulgong, NSW (Lot 297 DP 755434), a portion of Beryl Road and a section of Beryl Substation in the Transgrid managed landholding (Lot 1, DP 523876).
Project area	The Project area is 38 ha and includes (refer to **Figure 1-2**): • 5 Holleys Lane, Gulgong owned by an Associated Landowner of the Project. The rural residence includes two residential dwellings and sheds in the eastern section of the property. There is one mapped (Strahler 1st order) ephemeral watercourse that traverses the property and is dammed at the centre. An additional an unmapped drainage line associated with a culvert on Beryl Rd also extends into the property. The rest of the farm property consists of large grass paddocks with some remnant vegetation • A portion of Beryl Road (sealed road) managed by the MWRC • Western portion of Beryl Substation (Lot 1, DP 523876), owned by the Electricity Transmission Ministerial Holding Corporation (ETMHC), and managed by Transgrid • Four existing 66kv transmission lines and easement corridors owned by Essential Energy spanning across the property in a general north-south direction, connecting to the Beryl Substation.
Development area	The development area required to facilitate construction of the Project is 4.2 hectares (ha). The operational footprint of the project would be 2.5 ha, where permanent project infrastructure would be located.
Site access	Access to the Project area would be via Castlereagh Highway then Beryl Road. An internal access track off Beryl Road is proposed to facilitate the transport of equipment and materials to the Project area during construction.
Specifications	
Discharge capacity	Up to 100MW.
Storage capacity	Up to 200 MWh or 2 hours at maximum discharge capacity.
BESS technology	Lithium-iron phosphate
Typical operating cycle	One cycle per day is expected. The actual frequency of charge / discharge cycles will depend on market conditions in the National Electricity Market.
BESS compound	The BESS compound would include: ▪ Battery enclosures (nominally 3.4 m height x 1.5 m long x 2.4 m wide) containing lithium-iron phosphate type batteries, internal cooling and safety management systems

Key aspects	Description
	▪ Cabling (Direct Current (DC) electrical, communications and earthing), underground cable pits and conduits ▪ Power Conversion Systems (PCS) including inverters, 33kV transformers and switchgear ▪ Underground power and communications cables to switch rooms and control room ▪ Stormwater retention bund. The exact number of battery enclosures and inverter stations and their dimensions and arrangement as well as overall electrical connection and facility layout would be determined by the battery supplier once selected.
Switchroom and transformer	The switch room and transformer area would include: ▪ Two switch rooms including the auxiliaries (such as heating ventilation and air conditioning and fire suppression) ▪ A 132/33 kV 125 megavolt-amperes step-up transformer ▪ Two 33/0.415 kV auxiliary transformer ▪ Harmonic filter (if required) ▪ 33 kV underground cables from 33 kV switch room to the step up transformer and from switch room to the PCS ring main unit. ▪ Emergency diesel generator including the housing and interconnection with the low voltage network (if required) ▪ Two dedicated fire water tanks with total 500 megalitres (ML) storage and pumps. The connection infrastructure would include a 132 kV underground cable connecting the switch room and transformer to Beryl Substation.
Beryl Substation upgrade works	An extension of the existing Beryl Substation, including a new 132 kV bay with disconnector and switchgear and extension of 132 kV busbars.
Construction power and utilities	Power and communications would be established during construction including a transformer to provide auxiliary power and a portable emergency diesel generator in the case of any sustained grid outage event.
Laydown area	The construction laydown area would include: ▪ Temporary construction compound ▪ Temporary workers carpark ▪ Stockpiles and laydown areas for equipment and materials.
Permanent ancillary infrastructure	Permanent ancillary infrastructure would include: ▪ Operation and maintenance facility ▪ Security fencing, lighting, lightning protection, closed-circuit television cameras (CCTV) and safety and security signage ▪ Asset Protection Zone (APZ) with a minimum 10 m width.
Proposed road upgrades	Based on this traffic and transport impact assessment outcomes, no road upgrades are proposed.
Construction	
General activities	Construction would be carried out in four key stages: ▪ Enabling works, including installation of environmental controls, temporary facilities, construction of site access and vegetation clearing

Key aspects	Description
	▪ Construction of the Project including cut and fill, structural works and delivery, installation and electrical fit-out components ▪ Testing and commissioning ▪ Demobilisation.
Construction hours	Construction work would generally be limited to standard construction with some exceptions for low impact works.
Workforce	Up to 40 people per day.
Program	Approximately 12 months with construction scheduled to begin in early 2025 (subject to approval).
Vehicle movements	The following vehicle movements are anticipated during construction: ▪ Light vehicles: - Average of 15 light vehicle trips per day (15 in and 15 out) - Peak of 40 light vehicle trips per day (40 in and 40 out) ▪ Heavy vehicles: - Average of 5 heavy vehicle trips per day (5 in and 5 out) - Peak of 10 heavy vehicle trips per day (10 in and 10 out) ▪ Two oversize overmass vehicles during construction.
Operation	
Design life	Up to 30 years and this may be extended subject to replacement of components.
Operational hours	The BESS will operate remotely 24 hours per day, 7 days per week, depending on demand/supply.
Workforce	Up to two people per day shift for maintenance.
Vehicle movements	Staff light vehicles up to 2 per day (2 in and 2 out). Ad hoc deliveries of replacement parts would be unlikely to exceed one delivery per day on average.
Decommissioning	
Timing	Decommissioning would be subject to a decision that the BESS was past its useful life and not able to be life extended.
Works	Decommissioning would remove above-ground infrastructure and return the Project area to its original state, in consultation with the Associated Landowner. Decommissioning would not exceed the intensity associated with construction.

2.2 Physical layout and design

The indicative layout and design for the Project is shown in **Figure 1-2**. The final layout and design for the Project would be determined during detailed design and is subject to change based on the selection of technology and selected contractor.

Elements which may change during detailed design of the Project include:

- The final configuration of BESS containers, inverter stations and substation infrastructure
- Dimensions, features, material, finishes
- Upgrade works at Beryl Substation associated with the network connection.

2.3 Construction overview

As discussed in previous sections, the detailed design for the Project is yet to be completed. Construction methodology may vary subject to design refinements and the selection of the construction contractor; however the likely construction activities and associated details are presented in the following sections.

2.3.1 Construction schedule

Subject to planning approval and grid connection agreement, construction of the Project is expected to commence early 2025 and construction activities to be expected for a duration of approximately 12 months with the operation of the BESS anticipated for 2026. Accordingly, the construction impact assessment has been undertaken for the peak construction year of 2025. An indicative construction schedule is shown in **Table 2-2**. The precise timing of construction activities, however, would be adapted based on construction needs.

Table 2-2. Indicative program

Construction stage	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Enabling works	■											
Cut and fill	■	■										
Construction at Beryl Substation		■	■	■	■							
Construction of switchyard		■	■	■	■	■	■	■				
Construction of BESS		■	■	■	■	■	■	■	■	■	■	
Testing and commissioning						■		■	■		■	■
Demobilisation												■

2.3.2 Construction hours

Construction activities would be undertaken during standard day time construction hours in accordance with the 'Interim Construction Noise Guideline' (DECC, 2009) (ICNG):

- Monday to Friday: 7:00 AM – 6:00 PM
- Saturday: 8:00 AM – 1:00 PM
- No work on Sundays or Public Holidays.

Construction works outside of the standard construction hours may include:

- The delivery of materials as required by the authorities for safety reasons
- Commissioning activities where the operation of the Project must align with demands on the grid
- Emergency situations to prevent the loss of lives and properties and/or to prevent environmental harm
- Work determined to comply with the relevant noise management level
- Situations where agreement is reached with affected receivers.

For the purposes of this traffic and transport impact assessment, all standard deliveries are assessed as occurring within standard construction hours while OSOM deliveries are expected to occur outside of standard hours.

2.3.3 Construction site access

Construction site access to the Project area would be via Beryl Road. The proposed site access would be able to accommodate simultaneous entry and exit of the largest design vehicle expected to access the Project area. All construction vehicles will use Castlereagh Highway and Beryl Road to access the Project area. The proposed access road would be gravelled with a 6m wide formation to facilitate the transport of equipment and materials to the Project area during construction. The access road would be retained during operation of the Project to allow for maintenance and operational activities.

3. Legislative and policy context

3.1 State legislation

3.1.1 Environmental Planning and Assessment Act 1979

The EP&A Act and Environmental Planning and Assessment Regulation 2021 establish the framework for development assessment in NSW. The EP&A Act and the Regulation include provisions to ensure that the potential environmental impacts of a development are considered in the decision-making process prior to proceeding to construction.

Part 4 of the EP&A Act establishes the framework for assessing development that is permissible with consent. The Project is State Significant Development (SSD) under the State Environmental Planning Policy (Planning Systems) 2021.

The Project is proceeding with an application for planning approval as an SSD. Under Section 4.12(8) of the EP&A Act, the application is to be accompanied by an EIS prepared by or on behalf of the applicant in the form prescribed by the Regulations.

This assessment forms part of the EIS in order to comply with the SEARs and assess flooding impacts of the Project in accordance with any relevant Government legislation, plans, policies and guidelines.

3.1.2 Water Management Act 2000

Development on floodplains is managed under the *Water Management Act 2000,* including the provisions of floodplain management plans and 'flood works' i.e. works that affect, or are likely to affect, flooding and/or floodplain functions. Given the nature of the Project and distance to the nearest watercourse (Wialdra Creek), the provisions under the *Water Management Act 2000* has been considered unapplicable. There are no current floodplain management plans applicable to the Project area (refer to **Section 3.2.5**).

The Project would not require a water use approval under section 89 of the WM Act. The Project would not involve any water management work under section 90 of the WM Act. The Project would not involve work being carried out on waterfront land and a controlled activity approval is not required under section 91(2) of the WM Act. No aquifer interference activity would occur and as such section 91(3) would not apply to the Project.

3.2 Regulatory policies/relevant guidelines

3.2.1 Australian Rainfall and Runoff 2019

Australian Rainfall and Runoff 2019 (ARR 2019) (Ball et al, 2019) provides industry guidance on technical analysis and specifies design rainfall parameters for flooding and hydrologic studies in Australia. The approaches presented in ARR are essential for policy decisions and projects involving:

- Infrastructure such as roads, rail, bridges, dams and stormwater systems
- Floodplain risk management plans for urban and rural communities
- Flood warnings and flood emergency management
- Estimation of extreme flood levels.

Reference was made to ARR 2019 (Ball et al, 2019) in developing the methodological framework for the assessment, including modeling to define existing flooding conditions and for assessing potential impacts of the Project on hydrology and flooding.

3.2.2 Floodplain Risk Management Manual and Flood Prone Land Policy

The assessment of potential flooding impacts of the proposal on existing flood regimes has been conducted in accordance with the requirements of the Floodplain Risk Management Manual (DPE, 2023), which incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation, and development of flood prone land.

This assessment has been undertaken with consideration of these objectives and provisions outlined above.

3.2.3 2021 Updated Flood Prone Land Package

The flood-prone land package, including updated Planning Circular (PS 21-006) was released by the NSW Government on 14 July 2021 and provides advice to councils on considering flooding in land-use planning. It updated and replaced the Planning Circular (PS 07-003), dated 31 January 2007, and its provisions for flood planning.

The updated guidance supports:

- Better management of flood risk beyond the 1% AEP event
- Best management practices in managing and mitigating severe to extreme flood events
- Greater resilience built into communities in floodplains and reduces potential property damage and loss of life in recognition of increasing extreme flood events throughout NSW.

The flood planning level (FPL) is the main provision in Local environmental plans (LEP) and Development control plans (DCP) to administer planning controls on development in NSW. Whilst the flood used to define the residential FPL is a decision for local councils, FRMM highlights that FPLs for typical residential development would be based around the 1% AEP, or a historic flood of similar scale, plus an appropriate freeboard (typically 0.5m).

With the 2021 flood-prone land package, Special Flood Considerations apply to sensitive and hazardous development in areas between the FPL and up to the probable maximum flood (PMF) and to land that may cause a particular risk to life and other safety considerations that require additional controls. These controls relate to the management of risk to life and the risk of hazardous industry/hazardous storage establishments to the community and the environment in the event of a flood.

Various local councils in NSW have a climate change policy in relation to flooding. As such, sea level rise and increased flooding due to rainfall may be incorporated into the design flood event used to define the FPL and Floodway areas. For example, the 1% AEP design flood in the year 2100 (with 0.9m sea level rise and 20% increase in rainfall) has been adopted as the design flood event for FPL by some local councils in NSW due to their geographic situation and susceptibility to coastal and riverine flooding. Most councils have adopted the 1% AEP event for current climate as the design flood for FPL.

3.2.4 Council planning instruments

The following council planning instruments are relevant to the Project area:

- Mid-Western Regional Council – Local Environment Plan (LEP) 2012 and Development Control Plan (DCP) 2012

Flood planning areas are defined for some parts of the area covered by the LEPs, but this excludes the Project area. In general, the FPL (minimum floor level) for standard residential development would be the 1% AEP flood event plus a freeboard (typically 0.5 m) with minimum fill levels at the 1% AEP flood level.

This report assumes the LEP guidance is referring to the regional flood risk (1% AEP flood event plus a freeboard), rather than the shallow overland flow paths.

3.2.5 Council floodplain management plans

Floodplain risk management plans are generally prepared to address the existing, continuing and future flood risk in accordance with NSW Government's Flood Prone Land Policy (refer **Section 3.2.2**). Floodplain management plans also often define the flood planning level and flood planning areas, in addition to hydraulic categorisation of the floodplain (that is, floodway and flood storage areas) which are then incorporated into relevant development controls.

There are no floodplain management plans relevant to the Project area, hence flood planning levels and areas and hydraulic categorisation of the floodplain is not defined for the Project area.

4. Assessment methodology

4.1 Study area

For the purposes of this assessment, the flooding study area in which impacts have been assessed is as shown in **Figure 4-1**.

4.2 Overall assessment approach

The objective of this hydrology and flooding assessment is to identify the existing flooding behaviour within the study area and assess the potential flooding impacts associated with the Project

The assessment methodology is summarised below:

- Desktop review of available flood study reports (refer to **Section 4.3**)
- As there is no adequate existing flood mapping in the vicinity of the Project area, flood modelling (TUFLOW) has been undertaken to determine flooding conditions for the existing case. A detailed description of the hydrological and hydraulic model development is provided in **Appendix A** and **Appendix B** respectively
- Review of council planning and policy documents to identify flood-related development controls including mitigation requirements (refer to **Section 3.2.4** and **Section 3.2.5**)
- Description of existing flooding conditions, including flood depth, velocity and hazard (refer to **Section 5**)
- Assessment of potential impacts to flooding and hydrology associated with the Project during construction and operation. A review of existing flooding conditions indicated that impacts on flooding and impacts to sensitive receivers would be minor. As such a qualitative impact assessment has been undertaken (refer to **Section 6**, **Section 7** and **Section 8**)
- Identification of appropriate measures to mitigate and manage potential flooding and hydrology impacts associated with the Project (refer to **Section 9**).

It should be noted that in the absence of detailed topographical survey data, the hydraulic assessment has relied upon relatively course 5 m DEM data. As a result, Beryl road crest and the longitudinal drainage ditches were not presented in the hydraulic model. This may lead to inaccurate overland flow paths along Beryl road and underestimate the attenuation upstream of the Beryl road.

4.3 Review of existing studies

Existing flooding studies relevant to this assessment include:

- Mudgee Flood Study, Mid-western Regional Council (WMAwater 2021)
- Proposed Solar Farm, Beryl, New South Wales (Footprint 2017)
- Beryl Solar Farm EIS (ngh Environmental 2017).

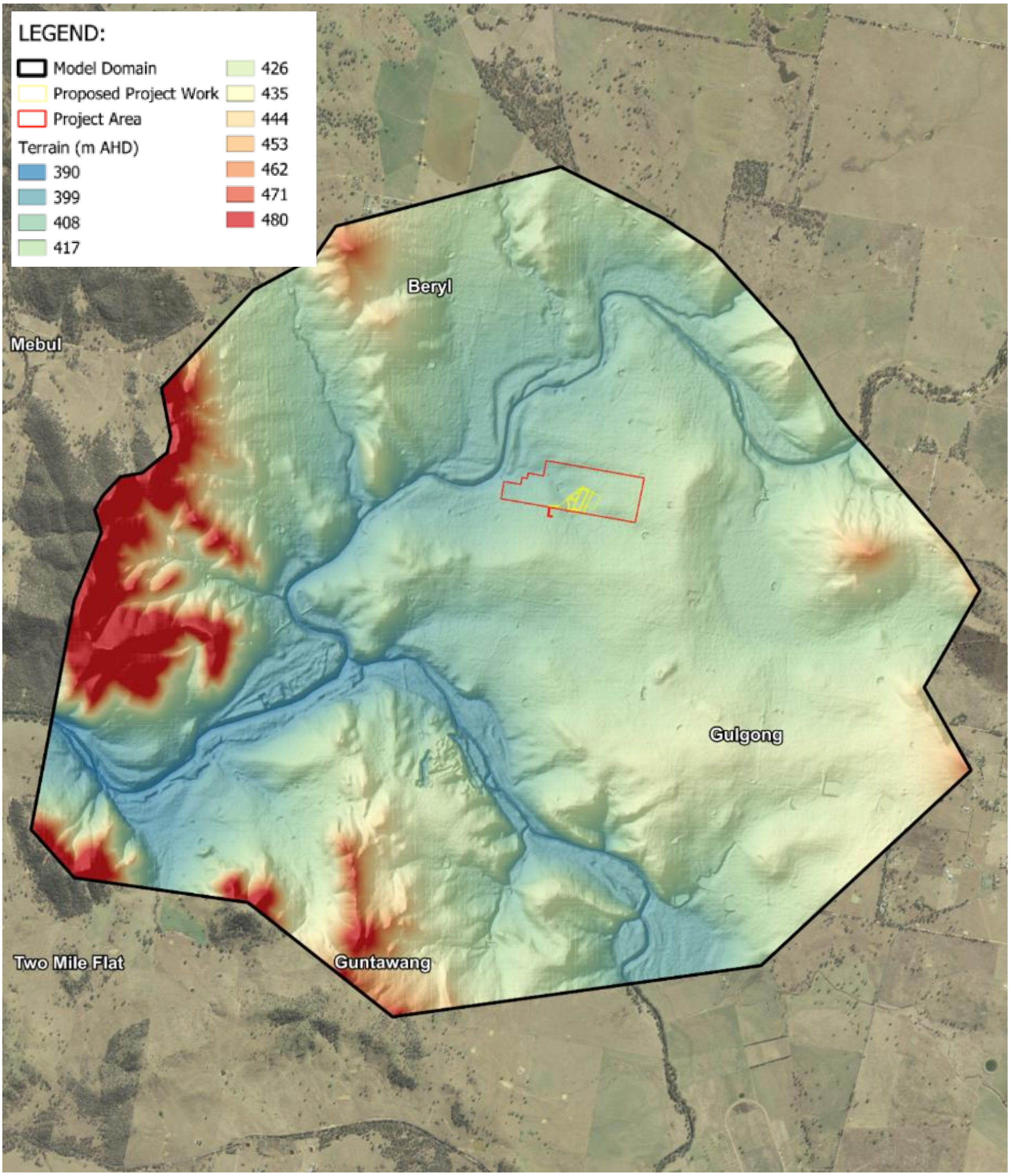

Figure 4-1 Study area

4.4 Key assumptions

Based on the description of construction activities the worst-case stage for the construction phase would be upon completion of required civil works for the Project. This would be when earthworks are being undertaken, in addition to the installation of impervious paved and roof surfaces. As such, would have the maximum potential impact on flood flow obstruction and increased Project area runoff rates. Temporary stockpiles and cabling trench works would also be included in the worst-case.

This assessment uses the following assumptions:

- The BESS and switchyard should be above the 1% AEP surface water (overland flow) flood level, preferably plus 0.5 m of freeboard. This would be achieved by filling of selected sections of the site.
- The operation and maintenance facility would be at a minimum flood protection level of 1% AEP flood level, preferably plus 0.5 m freeboard, which is consistent with typical planning controls for minimum fill levels for residential developments. Filling of the operation and maintenance facility site would be required to raise the finished ground levels where these are below the relevant flood level
- Drainage swales would be provided to convey overland flows around the BESS, hardstand areas and other Project infrastructure to prevent redirection of flows
- The model has not represented the Beryl Road crest and the longitudinal drainage ditches. This may lead to inaccurate overland flow paths along Beryl Road and underestimate the attenuation upstream of the Beryl Road.

5. Existing environment

5.1 Catchment overview

The Project is located within the lower Wialdra Creek Catchment, which is a tributary of the Cudgegong River in central NSW. The Project is 600 m southeast of Wialdra Creek, which flows in a south-westerly direction from its headwaters west of Gulgong, in the Munghorn Gap Nature Reserve.

The Project is situated in the middle of a small lateral catchment of about one square km (km^2). The local catchment generates two distinct ephemeral watercourses that cross the Project in a westerly direction and flow down towards Wialdra Creek, shown in **Figure 5-1**.

Beryl Road is situated immediately upstream of the Project and is crossed by two box culverts, situated downstream of a small farm dam. The catchment contains four small farm dams, one of which is within the Project area, approximately 100 m downstream of the Project.

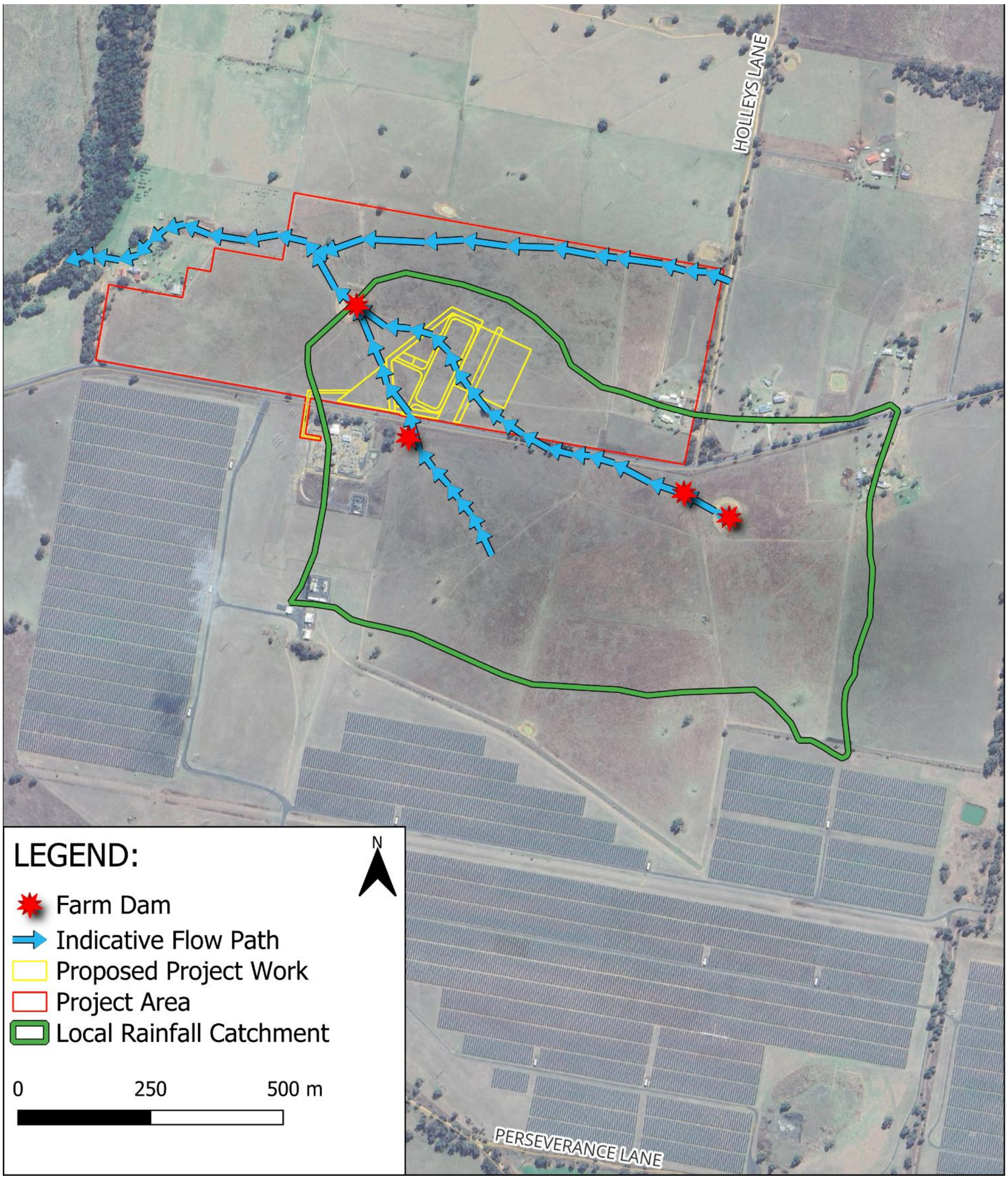

Figure 5-1 Local flow paths and farm dams

5.1.1 Topography

The Project area is largely flat with altitudes varying between 408 m and 410 m Australian Height Datum (AHD) over 200 m in length. The Project area slopes east to west, towards Wialdra Creek.

5.1.2 Land use

The Project area is zoned as RU1 – Primary Production under the Mid-Western Regional LEP, for agricultural activity. The majority of the Project area is located across a single property, which is currently used for sheep and cattle grazing, and irrigated cropping. Native vegetation also exists within parts of the Project area.

The upper portion of the catchment (south of the Project area) contains the existing Beryl Substation and Beryl Road, which are considered as hardstand.

Figure 5-2 Aerial photograph of the Project area facing north-west

5.1.3 Climate

5.1.3.1 Rainfall and temperature

Review of data available through the Bureau of Meteorology BOM) – Monthly Statistics: Climate Data Online BOM, 2022) indicates that the nearest BOM weather station for rainfall and temperature data is the Gulgong Post Office (#62013) located approximately 8 km southeast of the Project area at its nearest point.

Utilising the BOM climate database, the average total rainfall for each calendar month from 1881 to 2023 (142 years) was calculated and is summarised in **Table 5-1** shows there is only a moderate level of seasonality to rainfall within the study area, and that rainfall is typically low in most months. Lowest average rainfall is recorded in April (44.2 mm) and May (44.3 mm), followed by August. Highest monthly rainfall is recorded in January (70.2 mm) followed by December and November. Between April and October there is very little variation between monthly rainfalls.

Long term temperature data from Gulgong Post Office (#62013) was reviewed and is presented in **Table 5-1** indicates that monthly average maximum and minimum temperature ranges from 1970 to 2023. The analysis of available temperature data indicates that the Project is positioned within a temperate climatic region characterised by warm summers and cool winters. Average minimum and maximum temperature range from approximately 15 to 30ºC (December to March) and 5 to13ºC (June to August) seasonally, with predominately mild to moderate autumn and spring months.

Table 5-1 Summary of climate recorded at Gulgong Post Office (#62013)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Average Total Rainfall (mm)	70.2	61.7	57.1	44.2	44.3	50.3	49.0	45.6	46.9	55.6	60.9	66.9
Monthly Lowest Total Rainfall (mm)	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	1.5	0.0	0.0
Monthly Highest Total Rainfall (mm)	238.5	354.3	265.9	212.9	172.2	188.1	168.6	171.2	198.7	199.9	217.0	240.6
Minimum temperature (°C)	18.0	16.0	14.9	12.0	7.2	5.5	5.1	7.4	9.0	11.0	11.8	18.0
Maximum temperature (°C)	29.5	27.0	25.0	21.7	16.2	13.3	13.0	17.0	18.2	21.1	23.2	25.0

5.2 Sensitive receivers

Residential dwellings and the Beryl Substation are the main sensitive receivers in proximity to the Project. **Figure 5-3** shows that there is one dwelling and one shed (R01, R02) within the Project area, which are located approximately 400 m upstream of the Project. The spatial and vertical distance of the dwelling from the Project would prevent any changes to the existing flood conditions near the buildings.

Two dwellings (R03, R05) and two structures (R04, R06) to the west of the Project area are situated 100 m away from Wialdra Creek. The overland flow path which crosses the Project area flows north of the four dwellings. The existing Beryl Substation to the south of the Project is situated on high ground (411m AHD) and is situated outside of the existing overland flow path.

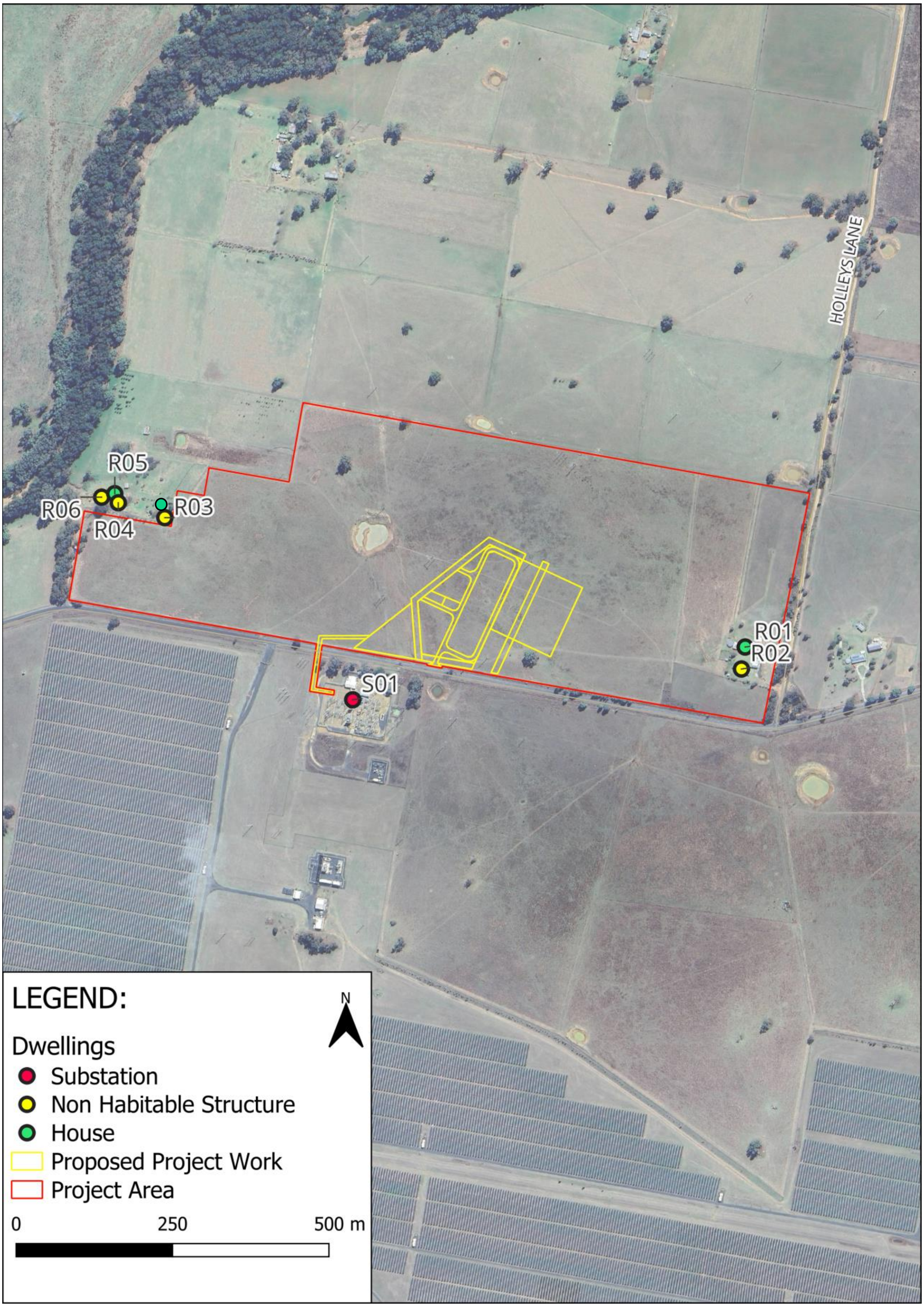

Figure 5-3 Sensitive receivers

5.3 Existing flood behaviour

Flooding across the Project is caused by runoff from small catchments to the southwest of the Project area The total external catchment area is approximately 0.5 km^2. The flow path discharges into Wialdra Creek to the west of the Project area, as seen in the Flood Maps in **Appendix C**. As stated in **Section 4.2**, there was no detailed topographical survey data available and therefore the hydraulic assessment relied upon relatively course 5m DEM data. The model has not represented the Beryl Road crest and the longitudinal drainage ditches. This may lead to inaccurate overland flow paths along Beryl Road and underestimate the attenuation upstream of the Beryl Road.

The results reported in this section and illustrated in **Appendix C**, contain the enveloped (regional and overland flow) modelling results.

The hydraulic model estimates the peak water level within Wialdra Creek (at the confluence with the ephemeral overland flow path) would be 405.1 m AHD in the 1% AEP event. As previously discussed in **Section 4.1.1**, the proposed infrastructure will be built on ground elevations between 408 m and 410 m AHD. This indicates the proposed infrastructure will be at least 3 metres above the maximum regional (i.e Wialdra Creek) water level. This demonstrates the Project is not at risk from regional flooding for events up to and including the 1% AEP event.

5.3.1 Flood depths

Mapping of the modelled flood depths are presented in **Figure 5-4** for the 1% AEP event. In the 1% AEP event, the western section of the Project (where infrastructure is proposed) experiences a maximum flood depth of 0.34 m. The BESS location has an average flood depth of approximately 0.2 m. The flood depth map is contained in **Appendix C**. **Figure 5-5** shows the flood depth for the overland flow path across the Project area.

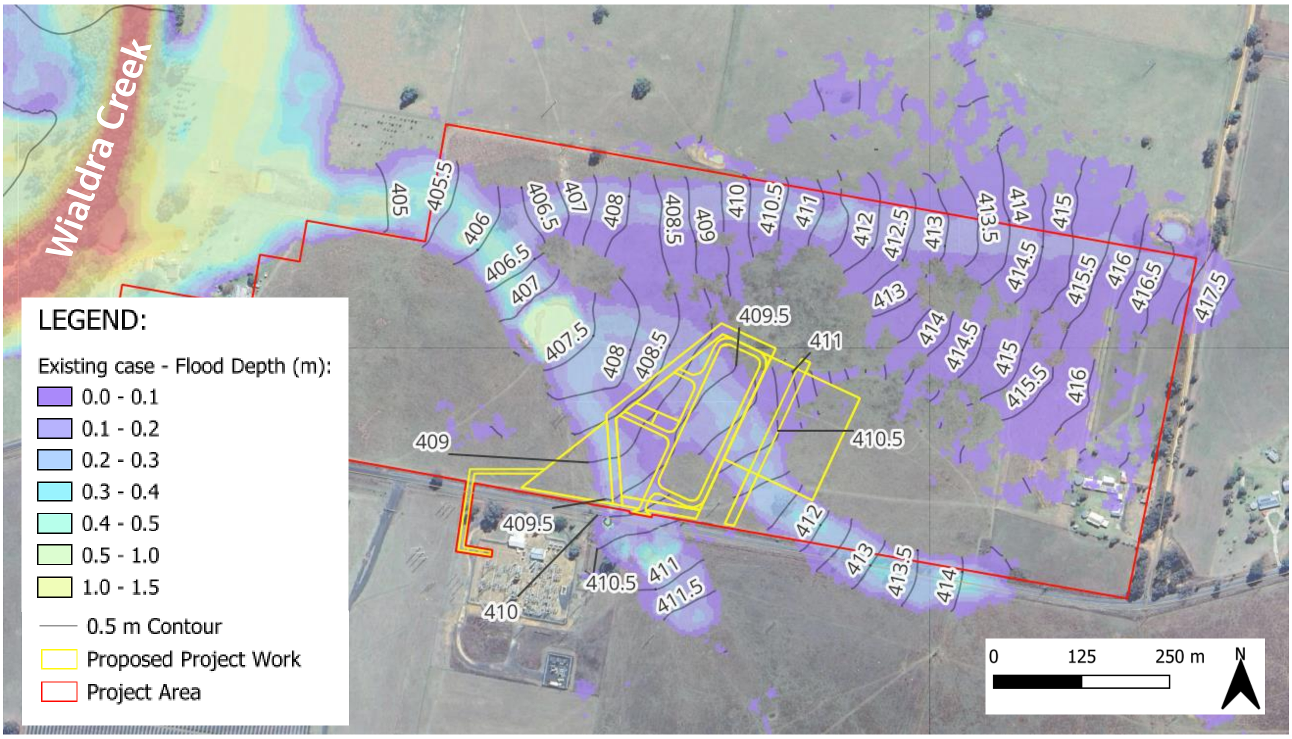

Figure 5-4 Existing flood depth (regional combined with overland) - 1% AEP event

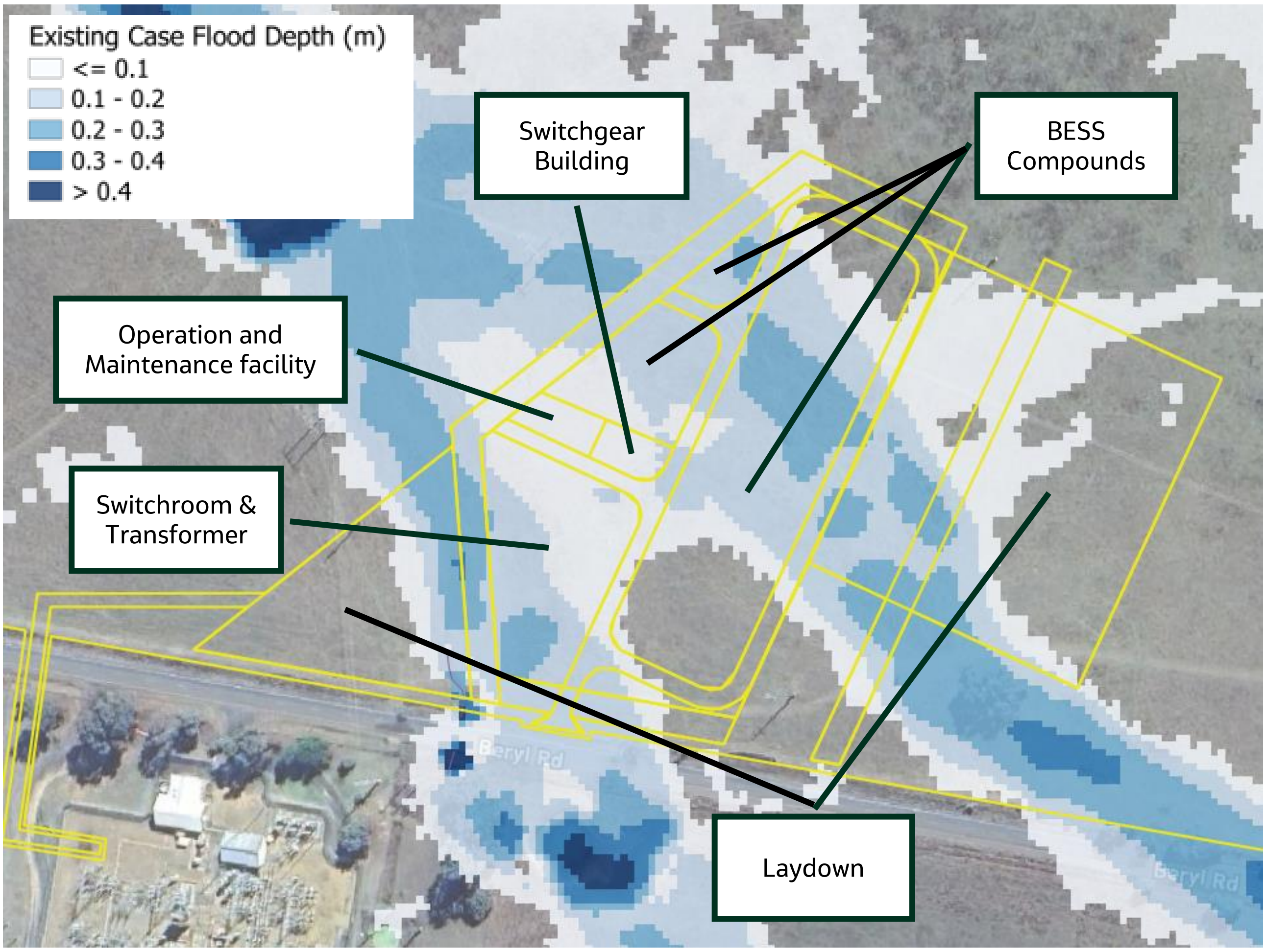

Figure 5-5 1% AEP depth of overland flow within the Project

5.3.2 Flood hazard

Recent research has been undertaken into the hazard that flooding poses and the vulnerability of the public and assets when interacting with floodwaters. A combined flood hazard classification based on this research is presented in *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017a) and *Guideline 7-3 Flood Hazard* (AIDR, 2017b), and is illustrated in **Figure 5-6**. This recent flood hazard method has been adopted in *Book 6: Flood Hydraulics of the Australian Rainfall and Runoff 2019* guidelines. The flood hazard categories according to the AIDR definition are:

- H1 – Generally safe for people, vehicles and buildings
- H2 – Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special engineering design and construction
- H6 – Unsafe for people or vehicles. All building types considered vulnerable to failure.

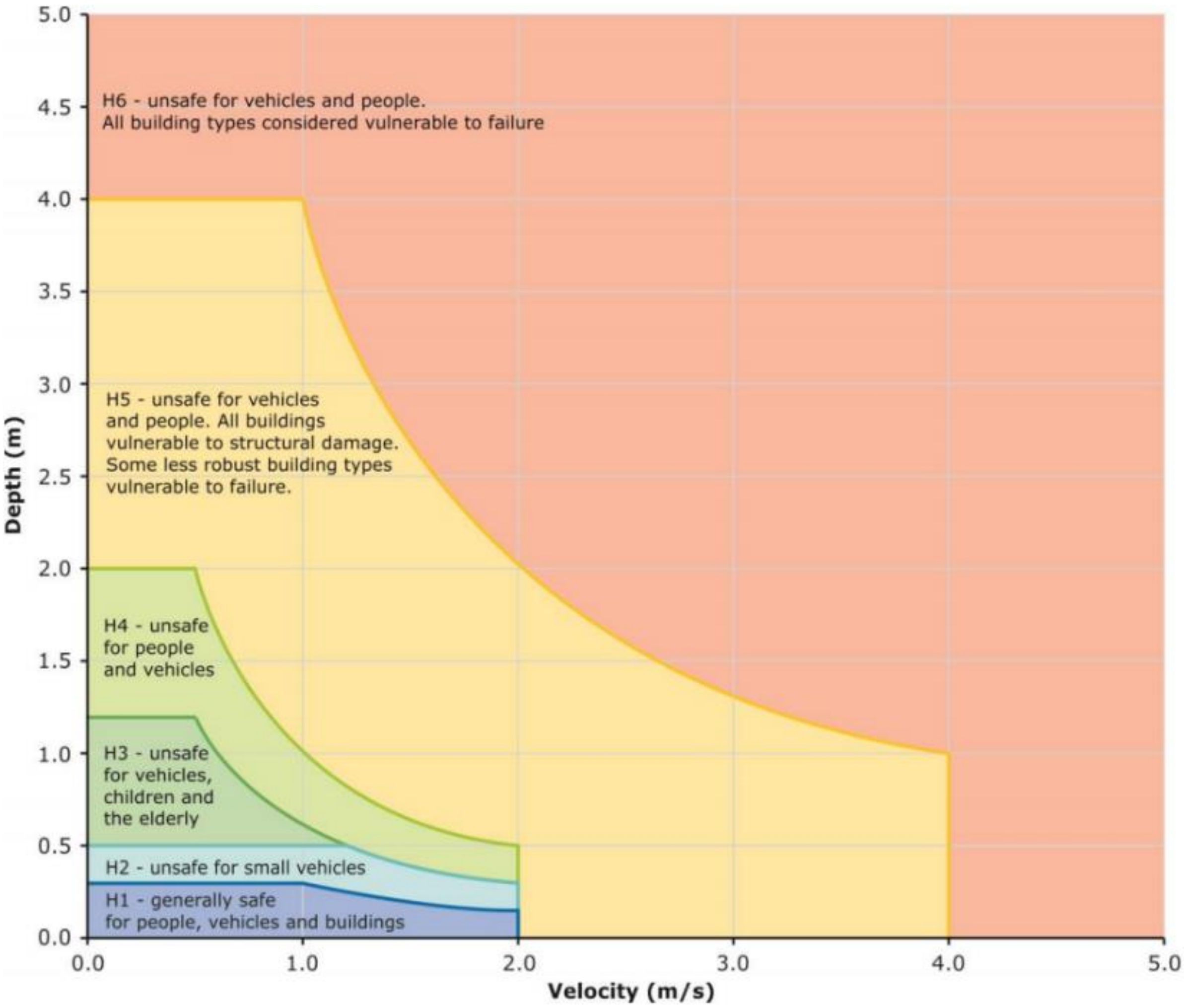

Figure 5-6 General flood hazard vulnerability curves, Australian Institute for Disaster Resilience (AIDR) definition. *Reproduced from Figure 6 in Guideline 7-3: Flood Hazard (AIDR, 2017b)*

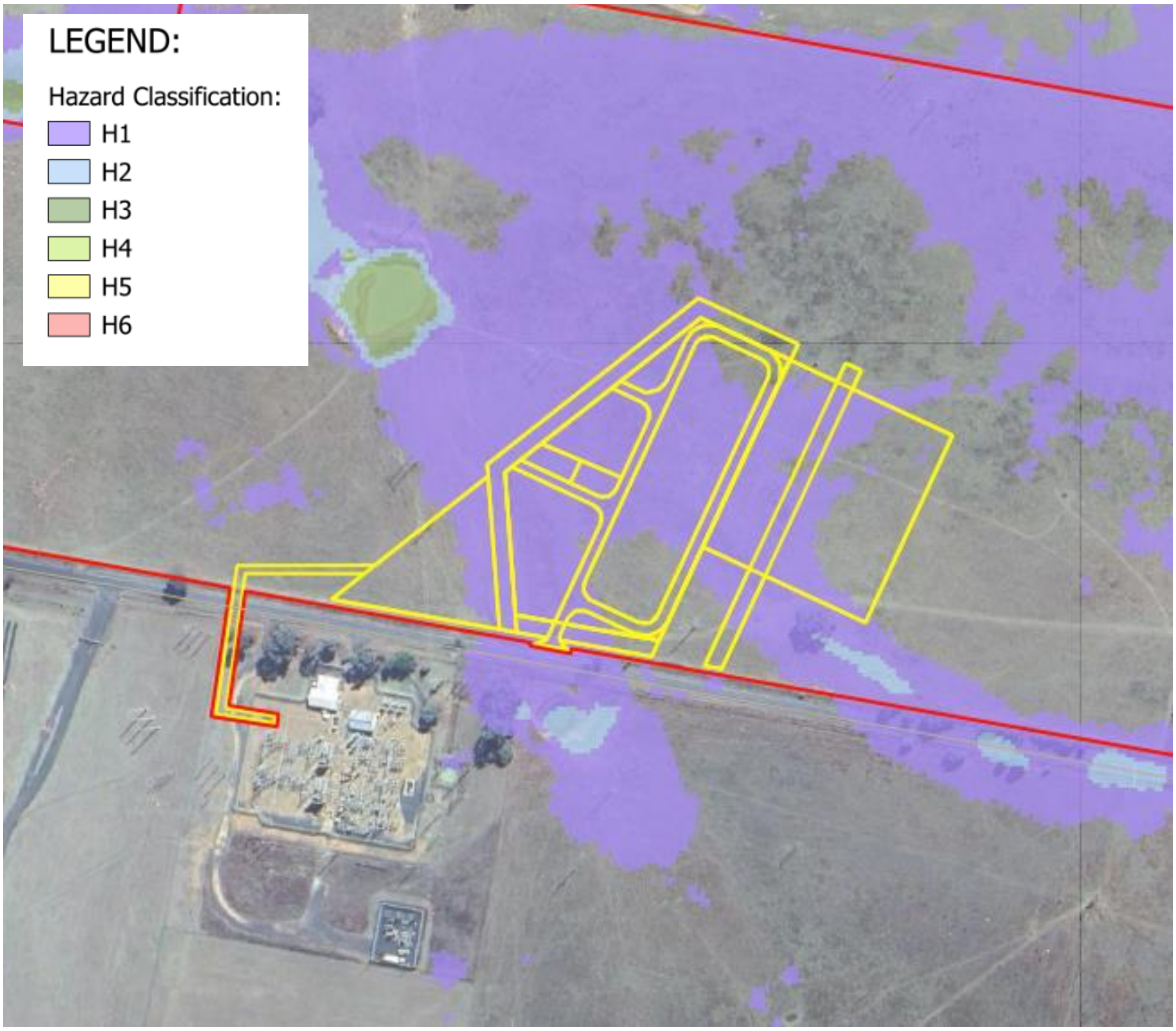

Figure 5-7 Existing flood hazard in the 1% AEP event

Mapping of flood hazard is presented in **Figure 5-7** for the 1% AEP event. The results show that the hazard classification in the 1% AEP event across the site only reaches category H1, which indicates the existing conditions is generally safe for people, vehicles and buildings.

5.3.3 Velocities

Mapping of the flood velocities is presented in **Figure 5-8** for the 1% AEP event. The maximum flow velocity is 1.1 m/s and 0.9 m/s (1% AEP event) for flow path 1 and 2 respectively. The relatively low velocity is caused by the flat grade and moderate roughness (short grass).

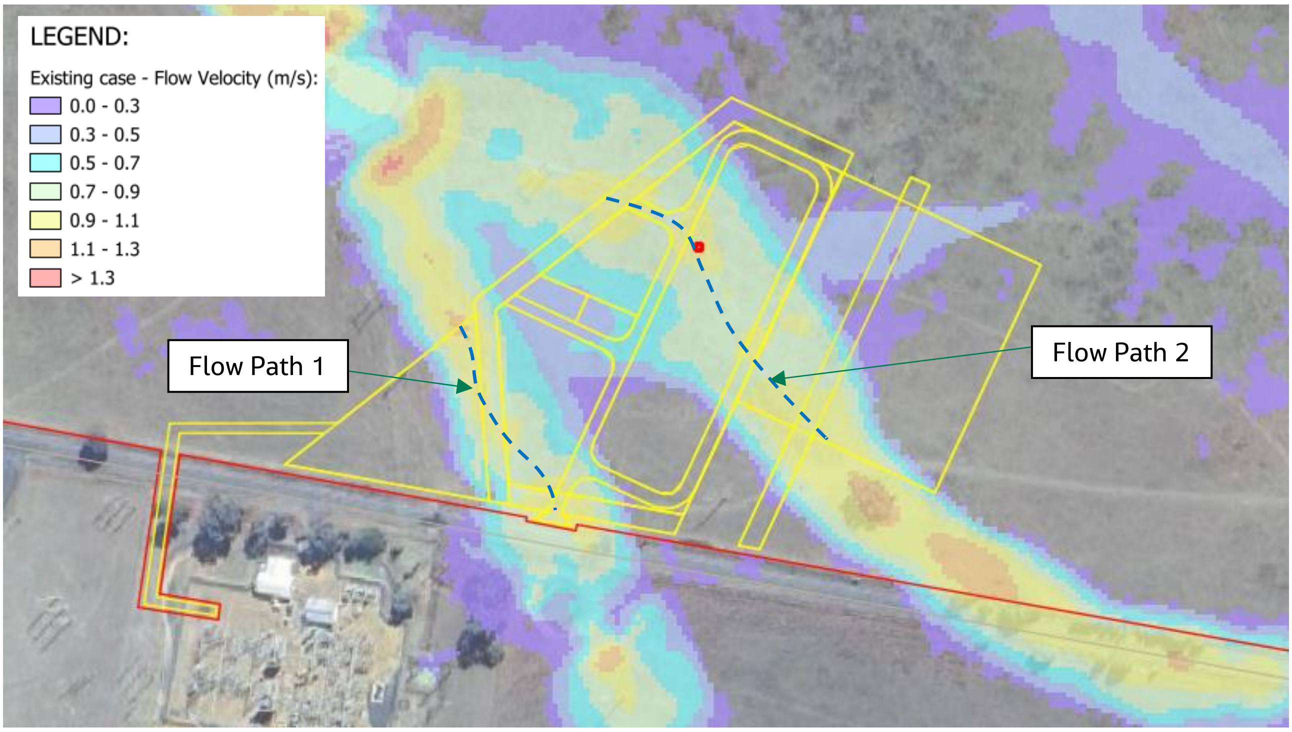

Figure 5-8 1% AEP velocities in the overland flow paths

6. Potential construction impacts

The construction elements of the Project, would involve a range of activities, including vegetation clearing and subsequent mulching, earthworks, trenching, concrete work materials stockpiling, trenching of cable routes and backfilling, and the establishment of a construction compound.

These construction activities present a potential risk to flooding and hydrology if appropriate management measures are not implemented, monitored, and maintained throughout construction. There are two unnamed ephemeral drainage lines (overland flow paths) within the Project area that would need to be considered.

Potential impacts of flooding and hydrology on the Project and potential Project impacts to flooding and hydrology during construction, and the risk of their occurrence are described in the sections below. The risks of flooding and impacts to flooding are described in relation to the regional (i.e. riverine) flooding from Wialdra Creek, and to local overland flow flooding. The local overland flooding is generally of smaller scale and nature compared to the riverine flooding.

6.1 Potential impacts of flooding on the Project

6.1.1 Earthworks

Earthworks will be required to raise the proposed BESS and switchyard infrastructure above the 1% AEP water level. The unnamed drainage lines (ephemeral) generate shallow flood depths of less than 0.3 m. The shallow overland flow paths will need to be directed around the raised platforms and discharged at the same location as existing.

6.1.2 Laydown areas

The laydown areas are outside of the regional (i.e. riverine) 1% AEP event. As discussed in **Section 4.3** the peak regional 1% AEP water level is 405.1 m AHD, which is approximately 3.5 m lower than the western laydown area.

The two laydown areas will be traversed by the unnamed drainage lines (ephemeral). The hydraulic assessment indicates the flood depths generated by the drainage lines will be mostly shallow (< 100 millimetres (mm), with the more defined flow paths reaching depths of 300 mm.

Approximately 20% of the eastern and western laydown areas will be inundated by the overland flow paths, exceeding 100 mm of flood depth in the 1% AEP. The construction materials will need to be located outside of the overland flow paths or alternatively the flow path will need to be re-directed around the laydown areas or manage the flow path through the site.

As discussed above, part of the laydown areas will be transversed by shallow overland flows, that would be short duration events. Based on this, a lower standard of protection could be considered during detailed design given the temporty works will only remain for a short time period.

6.2 Potential impacts of the Project on flooding

6.2.1 Impacts on riverine flooding hydraulics and flood levels

The Project area is outside of the main flow conveyance zone of Wialdra Creek, as shown in **Figure 5-4**. The Project infrastructure is 300 m away from the inundation zone and situated 3 m higher than the maximum 1% AEP regional water level.

6.2.2 Impacts on overland flooding

In the 1% AEP event, Project infrastructure would experience some degree of overland flooding. The BESS and switchyard are located in minor overland flow paths and which may result in localised impacts such as increased flood depths and velocities. The impacts are expected to be minor due to low flow velocities.

The proposed 132kV connection to Beryl Substation would be an underground cable. The transmission line would cross a single overland flow path. There is minor risk of localised impacts to the overland flow during the trenching and installation of the underground cable. Although impacts are expected to be minor due to relatively shallow flows (up to 0.2 metre depth) and low flow velocities.

Temporary construction facilities and material stockpile areas during construction will be placed away from overland flow paths (outside of the 1% AEP flood extent) and are unlikely to result in impacts to overland flooding.

6.2.3 Impacts on dwellings and roads

In the 1% AEP event there are a few dwellings and access roads that experience flooding as shown in **Figure 5-4**. However, given the large distances from dwellings, roads and the Project infrastructure, there is low risk of worsening their current flooding.

Other dwellings in and around the Project area are not flood-affected or are affected by minor overland flooding but are located downstream of Project infrastructure. Hence, these dwellings would not be affected by flooding impacts resulting from the construction of the Project.

7. Potential operational impacts

7.1 Potential impacts of flooding on the Project

The proposed switchyard and BESS configuration is flood-free from the regional (i.e. riverine) 1% AEP event. The overland flow paths (ephemeral) generate shallow flood depths of less than 0.3 m.

A flood protection level of the 1% AEP flood level would be required as a minimum, with a preference of 0.5 m freeboard, for the switchyard and BESS facilities. The existing overland flow flood depths at the operations and maintenance facilities are approximately 0.1 m, in the 1% AEP event. Road access (from Beryl Road) to evacuation centres and towns are situated on high ground and are likely to remain flood free even in large events.

There is risk of the Project being affected by flooding in extreme events (i.e. PMF). Therefore there is risk of impacts to the energy supply from the battery (during and after a flood), risk of damage to the BESS and risk of pollutant release from the BESS in extreme floods. It should be noted that in such an event, its likely other pollutant releases (i.e. sewage treatment, heavy industry etc) would pose a greater risk to the environment than the BESS.

7.2 Potential impacts of the Project on flooding

The potential hydrologic and flooding impacts of the Project operation is expected to be similar to the potential construction phase.

There are expected to be minor and localised impacts on flooding due to partial obstruction of flows and loss of floodplain storage caused by filled hardstand areas for the BESS and switchyard.

The underground 132 kV cable would have negligible impact during the operation phase, as the buried cable would not impede the overland flow path.

7.3 Potential hydrological impacts

7.3.1 Impacts on creek geomorphology and erosion

There would be negligible increases in runoff peak rates, volumes and durations of flow in Wialdra Creek resulting from increased impervious areas associated with hardstand areas for the BESS and switchyard. This is based on the assumed hardstand area of 0.02 km^2 compared to the 800 km^2 and 1 km^2 catchments upstream of the Project area for Wialdra Creek and the overland flow paths, respectively, the increase in impervious area in these watercourse catchments would be negligible. Subsequently, negligible geomorphic changes in the Wialdra creek channel are expected.

There would be a minor risk of localised erosion and scouring of ground surfaces at drainage discharge areas from the BESS and switchyard hardstand areas (subject to detailed design), without appropriate management measures. Appropriate scour protection at flow discharge areas, monitoring for erosion and implementation of remedial works such as stabilising eroded surfaces will be undertaken to minimise impacts.

There may be localised velocity increases at the toe of hardstand fill areas during flood events, although the risk of increased scour is expected to be low due to the existing low flow velocities.

7.3.2 Farm dams

There is one farm dam downstream and three upstream of the Project. Drainage swales will be provided around the hardstand areas which will maintain inflows to farm dams. As such, the farm dam downstream of the Project is unlikely to be impacted.

7.3.3 Surface water resources

The Project would not dam any or redirect any ephemeral watercourses or flow paths which may deliver surface water to properties downstream of the Project. Flows would be conveyed around Project infrastructure which will maintain the water supply to downstream properties.

The Project would not dam, redirect, or extract flows in Wialdra Creek and hence would not impact on availability of water to licensed water users along Wialdra Creek.

8. Potential decommissioning impacts

The decommissioning process for the Project would generally involve the removal of above ground infrastructure, including, electrical infrastructure and maintenance buildings unless required for the future land use of the Project area. If a future use is identified for any above ground infrastructure associated with the Project, that infrastructure may be retained in agreement with the interested stakeholders. Otherwise, all above ground electrical infrastructure would be removed during the decommissioning phase.

Filled areas and hardstand surfaces would remain in place. Drainage swales around the filled areas will be retained.

Underground infrastructure such as underground cables and footings, would generally remain in situ to avoid further disturbance. Some infrastructure, such as access tracks and laydown areas, may be of benefit to the landowners and may be retained in situ following an agreement with the landowners.

During decommissioning, existing access tracks would generally be used for equipment access and removal of materials from the Project area.

Disturbed areas would be rehabilitated to meet the intended final land use and be comparable with pre-construction conditions in consultation with landowners.

Based on the above, there would be no additional impacts to the operational flooding and hydrology impacts.

9. Environmental management measures

The following management measures detailed in **Table 9-1** have been developed to specifically manage potential flooding and hydrology impacts which have been predicted during construction, operation and decommissioning of the Project.

Table 9-1 Flooding and hydrology environmental management measures

Impact	Reference	Environmental management measure	Timing
Geomorphic impacts and scouring during flood and storm events	F1	To minimise risk of erosion and scouring the following will be implemented: • Permanent operational infrastructure and landforms will be designed where possible to minimise risk of scour and erosion associated with surface water runoff • Provision of scour protection discharge areas, drains and other at risk locations and monitoring of these locations to determine effectiveness and requirement for remedial works	Detailed design
Impacts on the Project area resulting from flooding	F2	The Project design will provide filling for any necessary infrastructure so that it is above the 1%AEP level	Detailed design
Farm dams and surface water resources	F3	Where possible, the design will: • Minimise located infrastructure in flow paths to avoid changes to runoff and natural flow regime • Constructing hardstand areas, access tracks and Project facilities to avoid reduction of inflows to farm dams and surface water resources	Detailed design
	F4	Potential impacts to flow paths associated with Project infrastructure in proximity to existing farm dams will be discussed and management measures (such as diversions) will be confirmed in consultation with landowners to avoid impacts to farm dam inflows.	Detailed design
Flood and surface water quantity impacts from temporary construction work and facilities	F5	Locating material stockpiles and construction facilities outside the 1% AEP flood extent by managing overland flow paths	Construction
	F6	Drainage swales and channels will be installed to convey runoff and flows around construction areas	Construction

10. Conclusion

This assessment has been conducted to assess any potential flooding impact from Project. The assessment has considered the available flooding studies, policies, and guidelines and flood modelling has been developed to define existing case flooding conditions for the 1% AEP event.

Review of existing flood conditions in and around the Project area indicated that the Project area is partially inundated in the 1% AEP event from surface water flow paths. Ponding and minor overland flow paths are also seen throughout other areas of the Project area. The assessment has shown the Project is flood free from regional flooding from Wialdra Creek.

An assessment of impacts of the Project on flooding was undertaken based on qualitative assessment. Construction, operational and decommissioning impacts have been considered. Potential impacts include minor and localised impacts on flood depths, levels and velocities around the switchyard and BESS due partial obstruction of flow and loss of floodplain storage. There are generally not expected to be any significant impacts on the flood behaviour as obstruction of flood flows and loss of storage would generally be minor.

Impacts to hydrology and surface flow regimes in main watercourses would be negligible as increases in impervious areas would be negligible compared to watercourse catchment areas. There is no significant expected flood impact on nearby dwellings as most are not flood-affected or are unlikely to be affected by the localised minor increases in flooding resulting from the Project.

There would be a minor risk of localised erosion and scouring of ground surfaces at drainage discharge areas and at the toe of hardstand fill areas during flood events if no mitigation measures are implemented.

Temporary construction facilities and material stockpile areas during construction will be placed away from drainage lines and waterways (outside of the regional 1% AEP flood extent) and are unlikely to result in impacts to flooding. There is the potential for impacts to flow behaviour if the power line is underground from the trenching, as it will cross an ephemeral overland flow path, as they may capture or redirect flows if appropriate management measures are not in place.

A range of mitigation and management measures have been identified to manage the potential impacts to flooding and hydrology from the Project. Management measures include design considerations to minimise flooding impacts, hydrology, surface flow regimes and erosion/scour risks, raising BESS sites to provide adequate flood immunity, potential relocation of selected elements of the Project, monitoring of impacts such as scouring and implementation of appropriate remedial works if necessary.

References

Australian Disaster Resilience Handbook Collection (2017a), 'Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia'

Australian Disaster Resilience Handbook Collection (2017b), 'Guideline 7-3 Flood Hazard'

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Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2019), 'Australian Rainfall and Runoff 2019'. Commonwealth of Australia

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Mid-Western Regional Council – Local Environment Plan (LEP) 2012 and Development Control Plan (DCP) 2012.

ngh Environmental (2017), Beryl Solar Farm EIS

Institute of Public Works Engineering Australia (2017) Queensland Urban Drainage Manual

NSW Government (2016), 'Wind Energy Framework'

NSW Government (Spatial Services) Intergovernmental Committee on Surveying and Mapping https://www.icsm.gov.au/

WMAwater (2021) Mudgee Flood Study, Mid-western Regional Council

Appendix A. Hydrological modelling

The methods and specifics for the hydrology and hydraulics modelling are outlined in Appendix A and Appendix B, respectively. This modelling characterises the existing flood behaviour for the 1% Annual Exceedance Probability (AEP) event. It includes an examination of flood depths, velocities, and associated hazards.

A.1 Methodology

RORB is one of the most widely used hydrology models of its type in Australia, and consequently, there is substantial information available on the model parameters for a wide range of catchments. The model has the capability to simulate both linear and non-linear catchment behaviour, and exhibits many desirable modelling features, such as spatially distributed inputs, flexible reservoir-routing options and the ability to model flows at a number of points throughout the catchment.

A RORB hydrology model (version 6.45) was created to assess rainfall-runoff in Wialdra Creek and its tributary catchment for design floods, incorporating streams outlined in Table A-1. The modelling process employed the runoff routing program (Laurenson et al., 2010). The total catchment size is estimated to be approximately 800 km^2.

Table A-1. Summary of streams in model

Name	Flow condition
Wialdra Creek	Perennial
Tallawang Creek	Perennial
Slapdash Creek	Non-perennial
Pine Creek	Non-perennial
Deadmans Creek	Non-perennial
Stubbo Creek	Non-perennial
Copes Creek	Non-perennial
Gum Creek	Non-perennial
Stony Creek	Non-perennial
Trefoil Creek	Non-perennial
Cooyal Creek	Non-perennial
Worobil Creek	Non-perennial
Bara Gully	Non-perennial
Garden Gully	Non-perennial
Spring Creek	Non-perennial
Abbotts Gully	Non-perennial
Chinamans Creek	Non-perennial
Back Creek	Non-perennial
King Johns Creek	Non-perennial
Lambing Yard Creek	Non-perennial
Merotherie Creek	Non-perennial

Name	Flow condition
Walfords Gully	Non-perennial
Ghost Gully	Non-perennial
Rangs Creek	Non-perennial
Unnamed	Non-perennial

A.2 Review of hydrologic study nearby

Two pertinent flood studies utilising hydrologic models were reviewed as part of the assessment. The first study focused on the hydrological and hydraulic analysis of the Beryl Solar Farm (Footprint Pty Ltd, 2017). The study used the "DRAINS" software (with RAFTS storage routing) to model the local catchments contributing to the ephemeral watercourse at the northern boundary of the site. The catchment area, covering 11.15 km^2, was modelled as a single node. The hydrological modelling parameters adopted are considered to be based on default values as recommended by ARR 2019 for the Beryl Solar Farm site.

The second study, conducted for the Mid-Western Regional Council, is the Mudgee Flood Study (WMA, 2021). This study employed the WBNM hydrologic run-off routing model to assess the hydrology of a substantial 1800 km^2 catchment area encompassing of the Cudgegong River and Lawsons Creek. The catchment for the Mudgee Flood Study is located approximately 32 km upstream along the Cudgegong River from the Beryl BESS project site.

Upon review, it was observed that the parameters and results from both studies are not directly applicable to the current study due to differences in distance and scale of the catchment areas considered. Nonetheless, the loss parameters from both studies were utilised as a reference to cross-examine the adopted values from ARR 2019 for the present study. This comparative analysis aids in ensuring the appropriateness and accuracy of the hydrological modelling parameters chosen for the current study.

A.3 Model configuration

A hydro-enforced 1-second DEM GeoTIFF, sourced from the Intergovernmental Committee on Surveying and Mapping, was utilised in ArcHydro within ArcMap. The catchment delineation and configuration of the RORB model (.catg) were performed using ArcHydro in conjunction with the RORB QGIS toolbox. Subsequently, the generated RORB catchment file underwent processing in RORB Win and Storm Injector for batch hydrograph production.

Thirty-one sub-catchments were delineated to the confluence of Wialdra Creek and Cudgegong River, situated approximately 3 km downstream from the project site. Figure A-1 illustrates the RORB catchment outlines. Of these, 29 are classified as part of the upstream routed flow area, while the remaining 2, intersecting the site, serve as local catchments for rainfall excess outputs. The RORB model outlet (node #1) is chosen for the Regional Flood Frequency Estimation (RFFE) analysis to validate the flow (as seen in Section A.4.3).

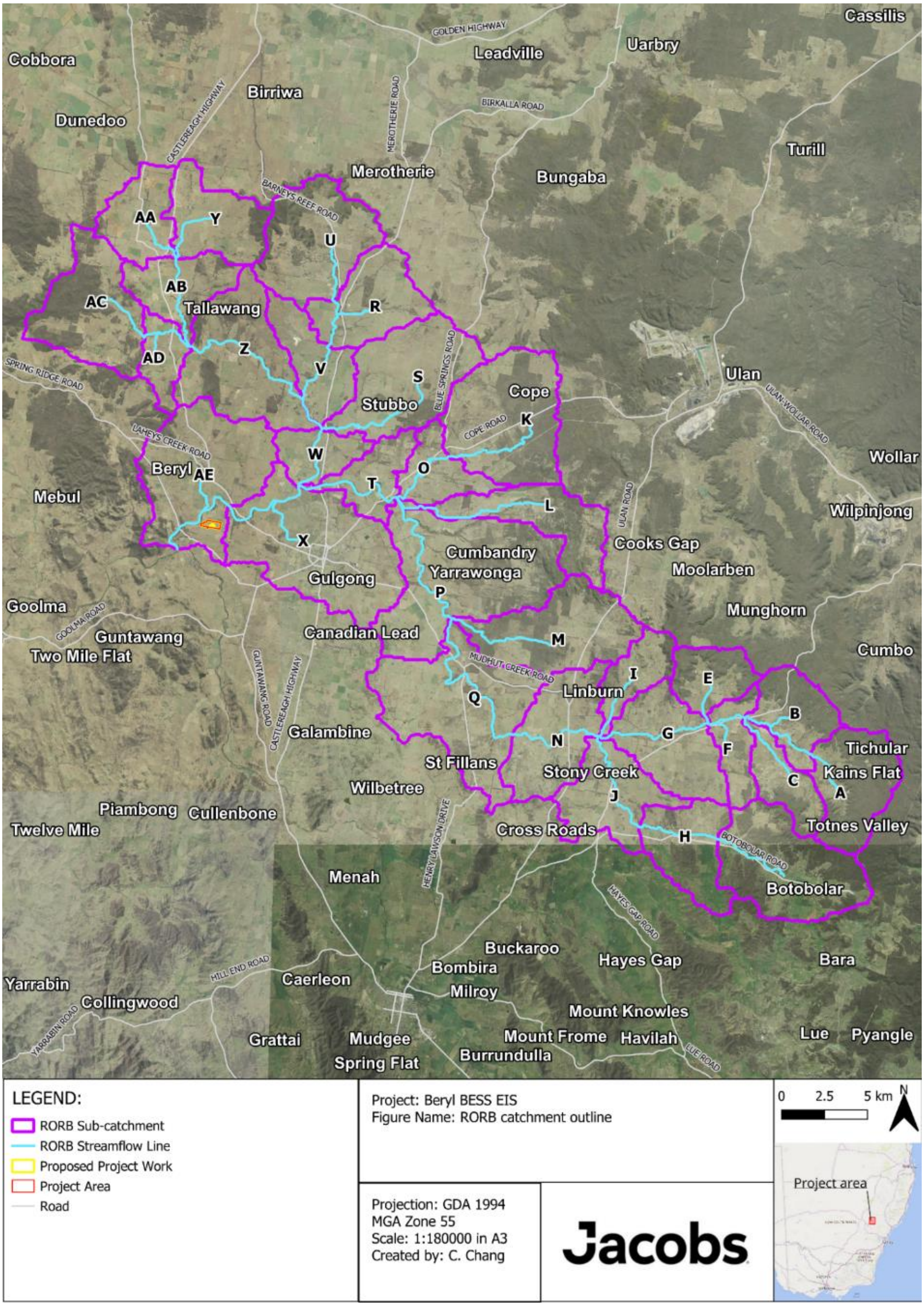


Figure A-1. RORB catchment outline

A.4 Model parameters

A.4.1 RORB model routing parameters

The site-specific parameters for the RORB model included a kc (RORB delay parameter) value of 25.48 and an m (RORB non-linearity parameter) value of 0.8, as per ARR 2019 (Ball et al., 2019). The routing parameters were implemented for all of the simulated ARR design events.

A.4.2 ARR design rainfall and losses

Design rainfall data, encompassing of ARR 2019 depths and temporal patterns for the 5%, 2%, and 1% Annual Exceedance Probability (AEP) events, was acquired from the Bureau of Meteorology's ARR Data Hub (https://data.arr-software.org). The 5% and 2% AEP events were only employed for model validation with the Regional Flood Frequency Estimation (RFFE) model. The data extraction focused on the catchment's centroid, and the corresponding design rainfall Intensity-Frequency-Duration (IFD) data is detailed in Table A-2.

For events up to and including the 1% AEP event, ensembles of 10 temporal patterns from ARR 2019 were adopted. Default areal reduction factors sourced from the Data Hub, dependent on storm duration and catchment area, were applied in this context.

The feasibility of the point temporal pattern approach was assessed, taking into account the elongated shape and size (approximately 800 km^2) of the catchment. This examination involved dividing the catchment into three partitions - north, middle, and south. The segments were of similar size as seen in Figure A-2. The temporal patterns were extracted for centroids of the three zones (refer to Figure A-2, where zone #1, #2, and #3 correspond to the north, middle, and south zone, respectively). The analysis revealed minor variations in the temporal pattern data (design rainfall depths, in mm) for the three zones (refer to Table A-3). Consequently, the design point temporal pattern was adopted from the results of the middle zone.

ARR Data Hub loss values were applied according to the hierarchy approach based on the NSW-specific guidelines. This involves the adoption of probability-neutral burst initial losses (refer to Table A-4) and storm continuous loss multiplied by a factor of 0.4. The continuous loss rate of 0.76 mm/hr is applied, calculated as 1.9 mm/hr multiplied by 0.4. The probability-neutral burst initial losses vary based on the design event and storm duration for 5%, 2%, and 1% AEP events. These values are consistent with previous studies due to the absence of other applicable studies for reference.

Table A-2 Adopted design rainfall IFD

Copyright Commonwealth of Australia 2016 Bureau of Meteorology (ABN 92 637 533 532)

All Design Rainfall Depth (mm)
Issued: 22-Nov-23
Location Label:
Requested Latitude -32.3505 Longitude 149.6109
Nearest gri Latitude 32.3625 (S) Longitude 149.6125 (E)

Exceedanc Annual Exceedance Probability (AEP)

Duration	Duration in min	12EY	6EY	4EY	3EY	2EY	63.20%	50%	0.5EY	20%	0.2EY	10%	5%	2%	1%	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	1	0.648	0.769	0.987	1.15	1.39	1.82	2.03	2.25	2.68	2.73	3.14	3.61	4.25	4.76	5.45	6.38	7.15	7.99
2 min	2	1.15	1.35	1.7	1.96	2.34	3.02	3.36	3.73	4.45	4.53	5.2	5.96	6.96	7.74	8.86	10.4	11.8	13.2
3 min	3	1.6	1.88	2.38	2.74	3.27	4.2	4.67	5.19	6.18	6.3	7.23	8.29	9.69	10.8	12.3	14.5	16.3	18.3
4 min	4	1.99	2.36	2.99	3.45	4.11	5.28	5.86	6.51	7.75	7.91	9.08	10.4	12.2	13.6	15.5	18.2	20.5	22.9
5 min	5	2.34	2.78	3.53	4.08	4.86	6.24	6.93	7.69	9.16	9.35	10.7	12.3	14.4	16.1	18.5	21.6	24.3	27.1
10 min	10	3.69	4.38	5.58	6.45	7.67	9.81	10.9	12.1	14.4	14.7	16.9	19.4	22.9	25.7	29.4	34.4	38.5	43
15 min	15	4.64	5.49	6.97	8.03	9.53	12.2	13.5	15	17.9	18.2	21	24.1	28.5	32	36.6	42.8	48	53.6
20 min	20	5.37	6.33	8	9.2	10.9	13.9	15.4	17.1	20.4	20.8	23.9	27.5	32.5	36.5	41.8	48.9	54.8	61.2
25 min	25	5.98	7.02	8.83	10.1	12	15.2	16.9	18.7	22.3	22.8	26.2	30.2	35.6	40	45.8	53.6	60.1	67.1
30 min	30	6.5	7.6	9.52	10.9	12.8	16.3	18.1	20.1	23.9	24.4	28.1	32.3	38.1	42.8	49	57.4	64.4	71.9
45 min	45	7.71	8.95	11.1	12.6	14.8	18.7	20.8	23	27.5	28	32.2	37.1	43.7	48.9	56	65.6	73.6	82.3
1 hour	60	8.63	9.96	12.3	13.9	16.3	20.4	22.7	25.2	30.1	30.7	35.2	40.5	47.6	53.2	60.9	71.4	80.2	89.7
1.5 hour	90	10	11.5	14	15.9	18.5	23.1	25.6	28.4	33.9	34.6	39.7	45.5	53.3	59.5	68.1	79.8	89.6	100
2 hour	120	11.1	12.7	15.4	17.4	20.2	25.1	27.9	30.9	36.8	37.6	43.1	49.4	57.8	64.3	73.7	86.3	96.8	108
3 hour	180	12.7	14.5	17.5	19.7	22.8	28.3	31.4	34.9	41.5	42.4	48.5	55.5	64.9	72.2	82.6	96.6	108	121
4.5 hour	270	14.5	16.5	20	22.4	26	32.1	35.6	39.6	47.1	48	55	62.9	73.5	81.7	93.5	109	122	136
6 hour	360	15.8	18.1	21.9	24.6	28.5	35.2	39.1	43.4	51.6	52.7	60.3	69	80.7	89.9	103	120	134	150
9 hour	540	17.9	20.5	24.9	28.1	32.5	40.2	44.7	49.6	59.1	60.3	69.2	79.1	93	104	119	139	155	173
12 hour	720	19.5	22.3	27.3	30.8	35.7	44.2	49.2	54.6	65.2	66.5	76.4	87.5	103	116	133	155	173	193
18 hour	1080	21.8	25.1	30.8	34.9	40.6	50.5	56.3	62.5	74.9	76.4	87.9	101	120	136	155	181	203	226
24 hour	1440	23.5	27.1	33.4	37.9	44.3	55.3	61.7	68.4	82.3	83.9	96.9	112	134	152	174	203	228	255
30 hour	1800	24.7	28.6	35.4	40.2	47.1	59.1	65.9	73.2	88.2	90	104	120	145	165	190	225	254	286
36 hour	2160	25.7	29.8	37	42.1	49.4	62.2	69.4	77.1	93.2	95	110	128	154	176	204	242	274	310
48 hour	2880	27.2	31.6	39.3	44.9	52.9	67	74.9	83.1	101	103	120	139	169	194	224	267	303	343
72 hour	4320	29	33.8	42.2	48.4	57.3	73.3	82	91	111	113	132	154	188	217	248	295	335	378
96 hour	5760	29.9	35	44	50.6	60.2	77.3	86.5	96	117	119	139	162	199	230	262	310	351	395
120 hour	7200	30.4	35.8	45.3	52.2	62.3	80.2	89.8	99.6	121	124	144	168	205	236	269	317	358	403
144 hour	8640	30.6	36.2	46.3	53.5	64	82.5	92.3	102	124	127	147	171	208	239	272	321	361	407
168 hour	10080	30.7	36.6	47.1	54.7	65.6	84.5	94.4	105	127	129	150	173	209	239	273	322	362	408

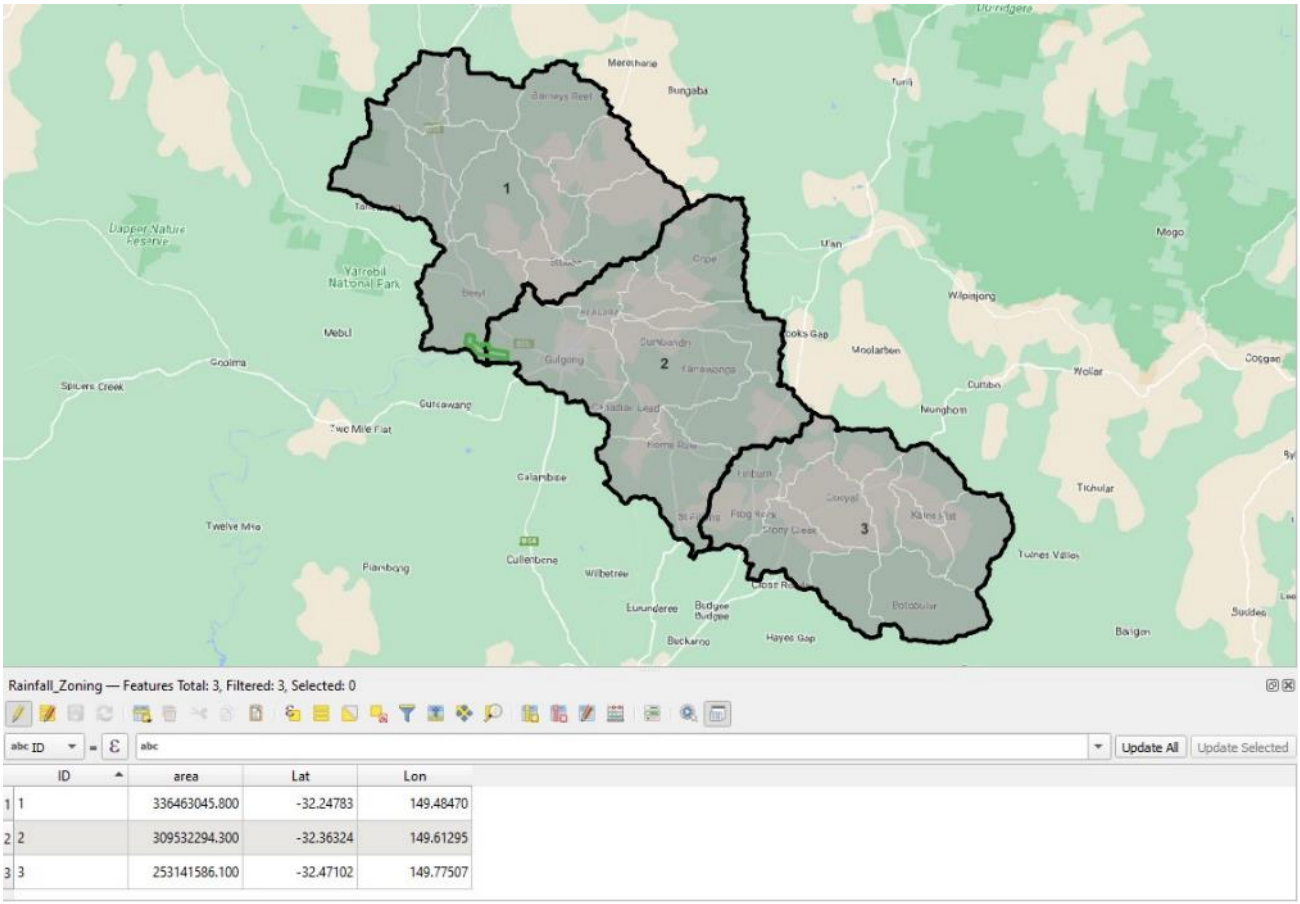


Figure A-2 Point rainfall temporal pattern zones in catchment

Table A-3 Point rainfall temporal pattern (design rainfall depths, in mm) comparison of three zones in catchment

Duration	North	Middle	South	North	Middle	South	North	Middle	South
	5%			2%			1%		
1 min	3.69	3.61	3.56	4.35	4.25	4.19	4.87	4.76	4.69
2 min	6.13	5.96	5.81	7.17	6.96	6.78	7.98	7.74	7.51
3 min	8.51	8.29	8.1	9.97	9.69	9.45	11.1	10.8	10.5
4 min	10.7	10.4	10.2	12.5	12.2	11.9	14	13.6	13.3
5 min	12.6	12.3	12.1	14.8	14.4	14.2	16.6	16.1	15.8
10 min	19.8	19.4	19.2	23.4	22.9	22.7	26.3	25.7	25.4
15 min	24.6	24.1	23.9	29.1	28.5	28.2	32.6	32	31.7
20 min	28	27.5	27.3	33.1	32.5	32.2	37.2	36.5	36.1
25 min	30.7	30.2	29.9	36.3	35.6	35.2	40.8	40	39.5
30 min	32.9	32.3	32	38.9	38.1	37.7	43.6	42.8	42.2
45 min	37.8	37.1	36.5	44.6	43.7	43	50	48.9	48.1
1 hour	41.4	40.5	39.8	48.7	47.6	46.7	54.5	53.2	52.1

Duration	North	Middle	South	North	Middle	South	North	Middle	South
	5%			2%			1%		
1.5 hour	46.7	45.5	44.5	54.8	53.3	52.1	61.2	59.5	58
2 hour	50.9	49.4	48.1	59.6	57.8	56.2	66.4	64.3	62.5
3 hour	57.5	55.5	54	67.2	64.9	62.9	74.8	72.2	69.9
4.5 hour	65.4	62.9	61	76.4	73.5	71.1	85	81.7	79
6 hour	71.9	69	66.9	84.1	80.7	78.1	93.6	89.9	86.9
9 hour	82.7	79.1	77	97.1	93	90.2	108	104	101
12 hour	91.6	87.5	85.5	108	103	101	121	116	113
18 hour	106	101	99.4	126	120	118	141	136	133
24 hour	117	112	111	140	134	132	158	152	150
30 hour	126	120	120	151	145	144	172	165	164
36 hour	133	128	128	161	154	154	183	176	176
48 hour	145	139	140	176	169	170	202	194	195
72 hour	161	154	157	196	188	191	226	217	220
96 hour	170	162	166	209	199	203	241	230	234
120 hour	177	168	172	216	205	210	249	236	242
144 hour	182	171	176	222	208	213	255	239	245
168 hour	185	173	178	225	209	214	257	239	245

Table A-4 Adopted probability-neutral burst initial losses

AEP	Duration (hour)										
	1	1.5	2	3	6	12	18	24	36	48	72
5%	9.5	8.4	9	7.9	8	8.3	9.2	11.4	13.5	18	20.2
2%	8.9	7.7	7.5	7	6.4	7.6	8.7	11.2	12.8	15.1	17.8
1%	5.6	6.5	4.7	3.4	2.5	3.5	3.2	3.7	7.9	10	11.3

A.4.3 Results and model validation

In the RORB model, a range of storm durations (1 to 72 hours) were evaluated for Wialdra Creek catchment. Table A-5 provides a summary of peak flows (refers to the maximum value among the rank 6 flows, considering all temporal patterns and selected durations), estimated by the RORB model for the 5%, 2%, and 1% AEP events. The critical (rank 6 flows) storm duration and temporal for each event are as follows:

- 5% AEP = 12-hour duration, TP6
- 2% AEP = 18-hour duration, TP2
- 1% AEP = 18-hour duration, TP2

There is a lack of suitable streamflow gauge data on Wialdra Creek to validate the estimated design flows. The two closest gauges, one located at Wilbertree Rd Cudgegong (421150), approximately 27.5 km upstream of the site along the Cudgegong River, and the other at Yamble Br Cudgegong River (421019), around 17 km downstream from the site along the Cudgegong River. Therefore, the modelled flows are compared with the RFFE model as the only means of validation for the regional watercourse flooding.

Comparisons were made between the RORB design flow estimates at the model outlet and the ARR 2019 Regional Flood Frequency Estimation (RFFE). Table A-5 includes the estimated peak flow, along with the lower confidence limit (5%) and upper confidence limit (95%) for peak flow. The RFFE relies on data from 853 Australian gauged catchments, providing extensive coverage for obtaining peak flow estimates from this database.

Table A-5 Comparison between RORB and RFFE

Location	Peak flow (m^3/s)					
	RORB*			RFFE**		
Catchment outlet (node #1)	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP
	1022	1332	1550	828 (361 and 1910)	1280 (553 and 3000)	1730 (733 and 4090)

* Flows are based on RORB model results, not TUFLOW results.
** RFFE flows encompass the median peak flow estimate along with a confidence limit range. The estimated lower confidence limit (5%) and upper confidence limit (95%) for each flow are indicated in brackets following the flow

The RORB model flow estimates for the 5% and 2% AEP events are higher than the median RFFE, but fall within the 95% confidence limit. For the 1% AEP event, the RORB estimate is slightly lower than the RFFE value, with a difference of less than 10%. In summary, the RORB-modelled peak flows generally align with the RFFE results at the specified location, suggesting that the RORB flows are reasonable estimates.

Appendix B. Hydraulic modelling

B.1 Methodology

The review of previous flood studies concluded there were no suitable existing hydraulic models for the Project area. Therefore, a new two-dimensional (2D) hydrodynamic model using TUFLOW was developed for the existing case of the Project. One-dimensional features were also included to represent hydraulic structures such as culverts.

TUFLOW is an industry-standard flood modelling platform, which was selected for this assessment as it has the following:

- Capability in representing complex flow patterns on the floodplain, including dispersed channel and overland flows, flows in flow paths and watercourses.
- Capability in accurately modelling flow behaviour in bridge and culvert structures and interflows with adjacent 2D floodplain areas.
- Easy interfacing with GIS and capability to present the flood behaviour in easy-to-understand visual outputs.

The model was developed and run in TUFLOW 2020-10-AF-iSP-w64 release under the TUFLOW "Heavily Parallelised Compute (HPC)" computation scheme.

B.2 Model configuration

B.2.1 Extent

A TUFLOW hydraulic model was developed to understand the existing flood behaviour. It encompasses the Wialdra Creek from about 400 m upstream of Castlereagh Highway to 3 km downstream of the confluence with the Cudgegong River.

The model also covers the local catchments and floodplain areas situated around the proposed site. The model's extent is approximately 40 km^2, with a 5m modelling cell size. Additionally, a sub-grid sampling (SGS) distance of 2.5 m is specified to ensure a more accurate representation of the underlying topography and, consequently, more precise results. The model incorporates routed inflows, encompassing designed flows in the main watercourse, as well as rainfall excess on the local catchments and floodplain areas.

B.2.2 Terrain

The TUFLOW model consists of a 2D domain that accurately represents topography, incorporating varying roughness dictated by land use. The watercourses were modelled in 2D, and the model extent, as described earlier, covers the specified area. The extent of the TUFLOW model is shown in Figure B-1.

A five-metre digital elevation model (DEM) was used for the terrain data. The DEM was constructed using the triangular irregular network method of averaging ground heights. The terrain data was sourced from the *Intergovernmental Committee on Surveying and Mapping* where it was provided by the *NSW Government – Spatial Services*.

The terrain for the project area is shown in Figure B-1.

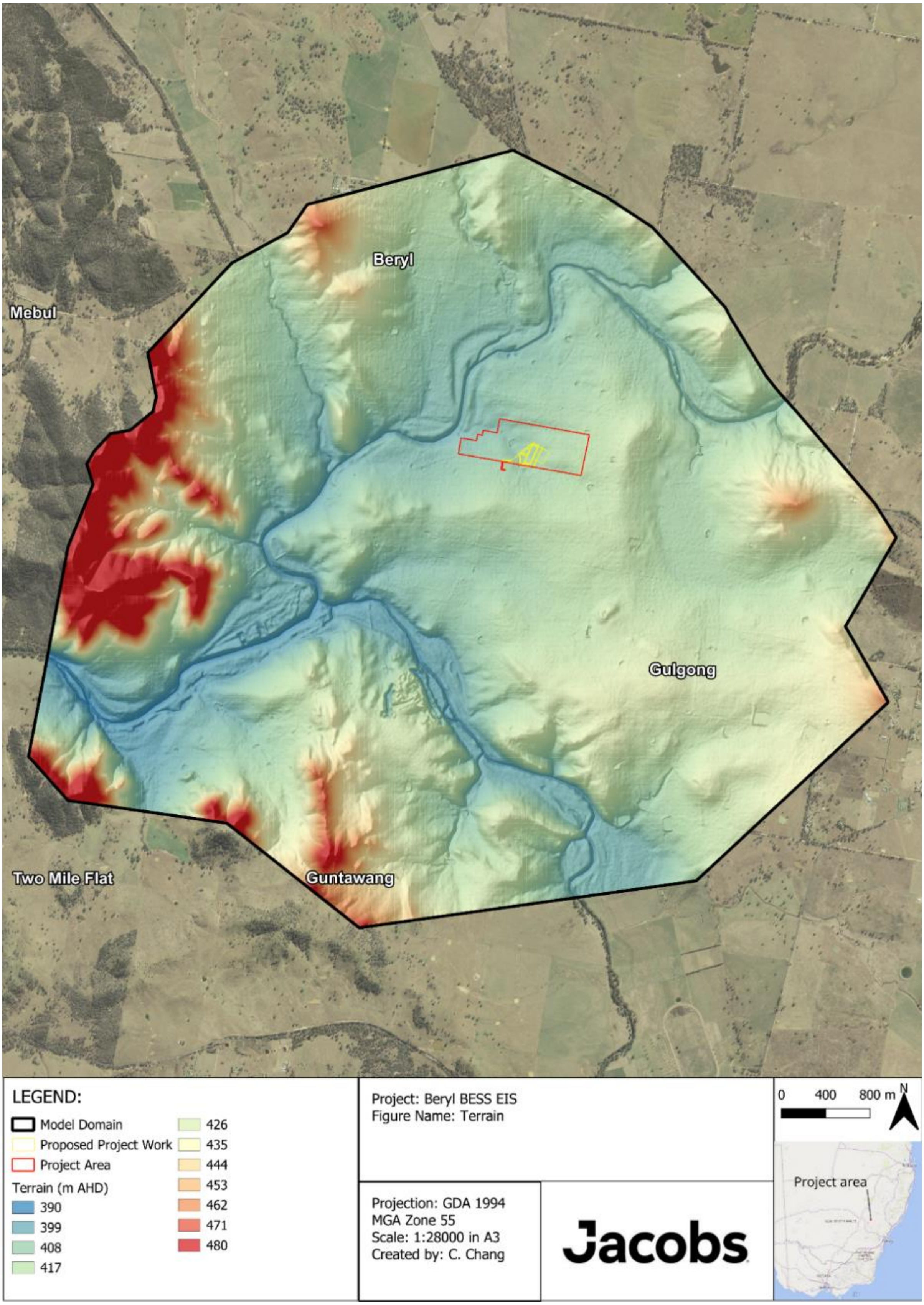


Figure B-1. Terrain and model extent

B.2.3 River inflow boundaries

The output from the RORB model was applied at the upstream limit of the 2D domain, as a QT (flow vs time) boundary.

B.2.4 Local catchment Inflows

Two minor overland flow paths traverse the project area, featuring local sub-catchment areas that are relatively small and challenging to define accurately within the RORB model, which primarily addresses regional-scale watercourse sub-catchments. Consequently, to identify minor local overland flow areas, rainfall excess (i.e., losses subtracted from rainfall) was directly applied to the TUFLOW domain. The RORB model calculated the rainfall excess over time, and the resulting flow rate was uniformly distributed across the designated direct rainfall excess area.

Various design storm durations were considered to identify the critical storm duration for local catchment flooding in the project area. For the 1% AEP event durations spanning from 15 minutes to 120 minutes appear to be critical.

B.2.5 Downstream boundaries

A single downstream boundary was applied across the Cudgegong River as a normal slope (HQ) boundary, based on the terrain slope. The 6 km distance from the downstream boundary to the site location (along the Cudgegong River) ensures the adopted boundary has no influence on the flood behaviour within the study area. Furthermore, the elevation difference between the study area and the downstream boundary is significant to prevent any influence by the boundary.

B.2.6 Hydraulic roughness

Different Manning's values were adopted to define the hydraulic roughness of different land types present in the model domain. These values can be seen in Table B-1 and are consistent with guidelines in ARR 2019. The hydraulic roughness areas are mapped in Figure B-2. Unless specified otherwise, the unclassified portions of the model domain were automatically set as grass/farmland by default.

Table B-1 Adopted Manning's n values

Land Use Type	Manning's n value
Low density residential	0.1
Industrial/commercial	0.2
Open pervious areas, minimal vegetation (grassed)	0.045 (default)
Open pervious areas, cropped	0.05
Open pervious areas, thick vegetation (trees)	0.1
Paved roads	0.02
Waterways/vegetated channels	0.05
Solar farm	0.045 (ground below solar boards) 0.2 (solar boards)
Lakes (no emergent vegetation)	0.025

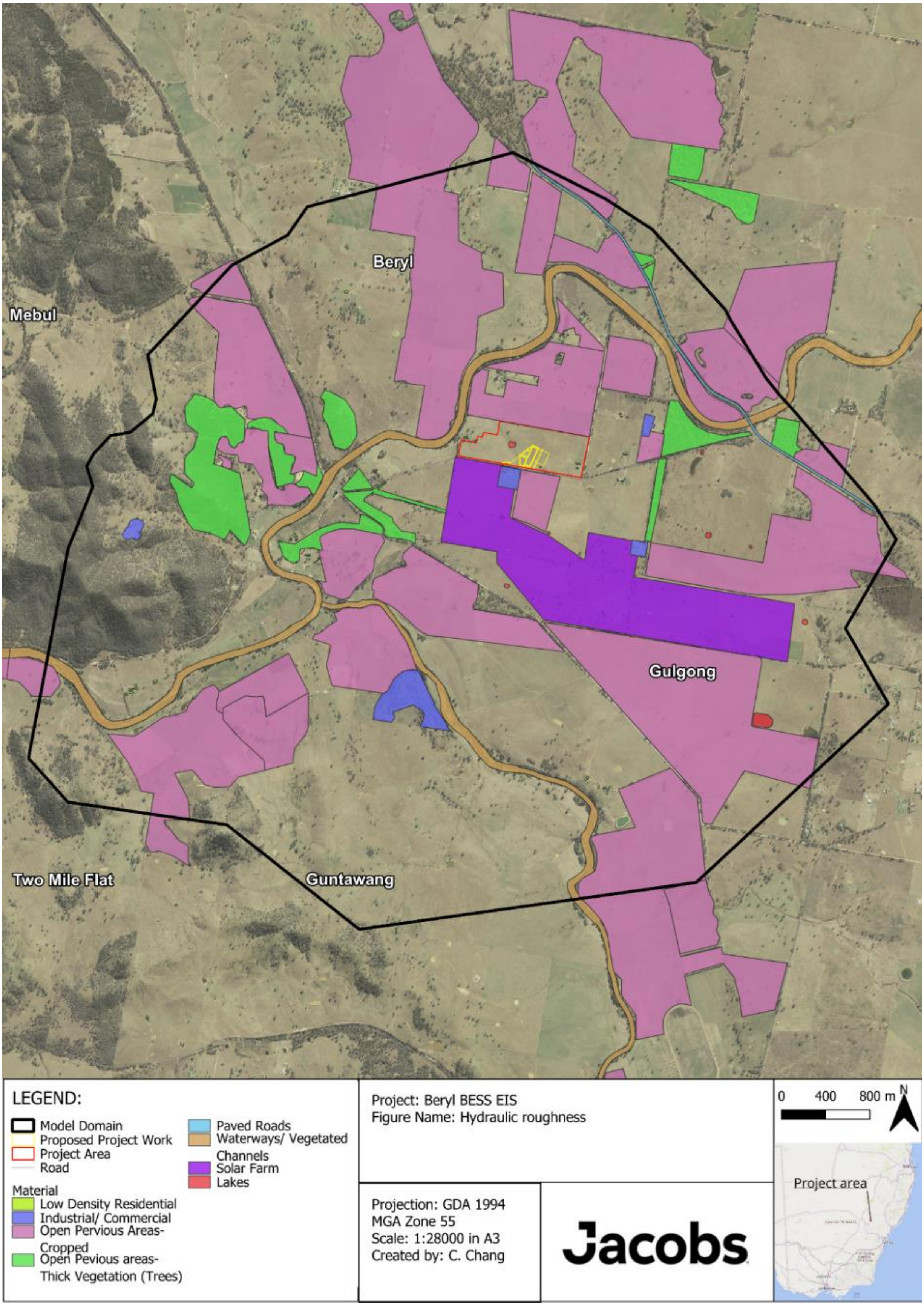


Figure B-2. Hydraulic roughness

B.2.7 Hydraulic structures

Four bridges (2d lfcsh layer) and three culverts (1d nwk layer) were considered to impact flood behaviour and where therefore included in the hydraulic model. In the absence of survey, the structural details (soffit, pier width, bridge span, skew) were estimated based on engineering judgement and site photos. The modelled bridges include:

- Castlereagh Highway (Wialdra Creek)
- Castlereagh Highway (Unnamed tributary)
- Spring Ridge Road (Wialdra Creek)
- Unnamed private road owned by Boral Quarries (Unnamed tributary)

Additionally, three culverts have been identified and assumed in the model: one under Beryl Road near Annies Rock Road, one under Spring Ridge Road, and one just at the south boundary of the site under Beryl Road.

The hydraulic structures are also shown in Figure B-3.

B.2.8 Hydraulic Results

The entire range of storm durations and temporal patterns were simulated in the TUFLOW model in the 1% AEP event. The critical storm durations and temporal patterns were identified based on hydraulic modelling results, and the final results are derived from the enveloped outcomes, which consists of the maximum values derived from all input grids.

Flooding in the Project area can be described as being regional/riverine flooding from Wialdra Creek, which is dictated by storm durations of 18 hours, and local overland flows from small local catchments around the Project area, which is dominant in storm durations of 15 to 45 minutes. The flood mapping shows the maximum envelope of flooding caused by the effects of both these flood sources.

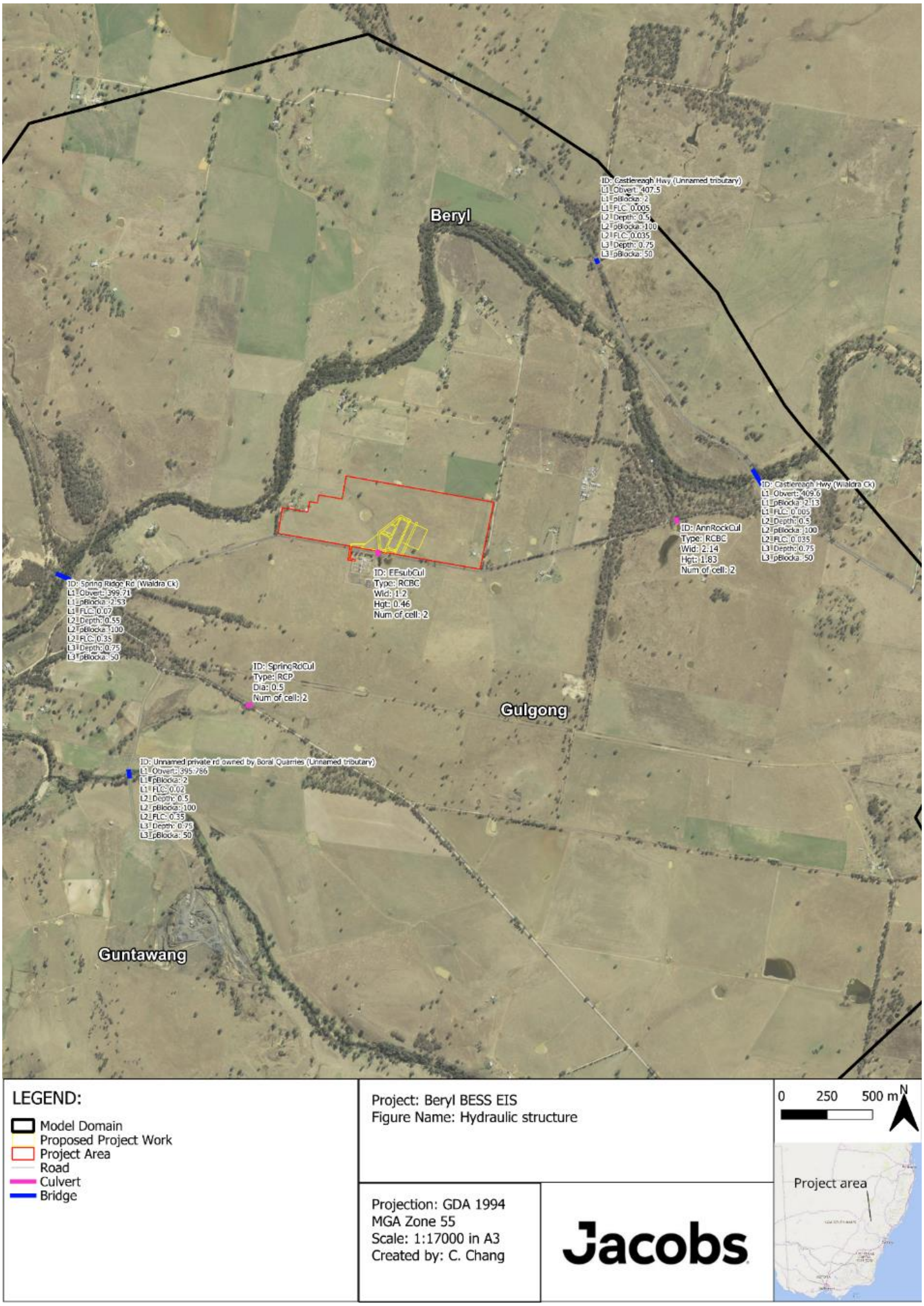


Figure B-3. Hydraulic structures

B.3 Model validation

B.3.1 Regional watercourse

As seen in Table B-2 the TUFLOW model (critical event 18-hour, TP2), generates a peak flow of 1544.57 m^3/s at the outlet for the 1% AEP. In comparison, the RFFE model estimates a value of 1730 m^3/s, with a 5% confidence limit value of 733 m^3/s and a 95% confidence limit value of 4090 m^3/s. The results show that the TUFLOW model result for peak flows in Wialdra Creek are within the confidence limits.

Table B-2 Regional flow estimate validation to RFFE

Parameter	Value
Wialdra Creek catchment area	800 km^2
RFFE 1% AEP flow estimate	1730 m^3/s
RFFE 5% confidence limit	733m^3/s
RFFE 95% confidence limit	4090m^3/s
TUFLOW 1% AEP estimate	1544 m^3/s

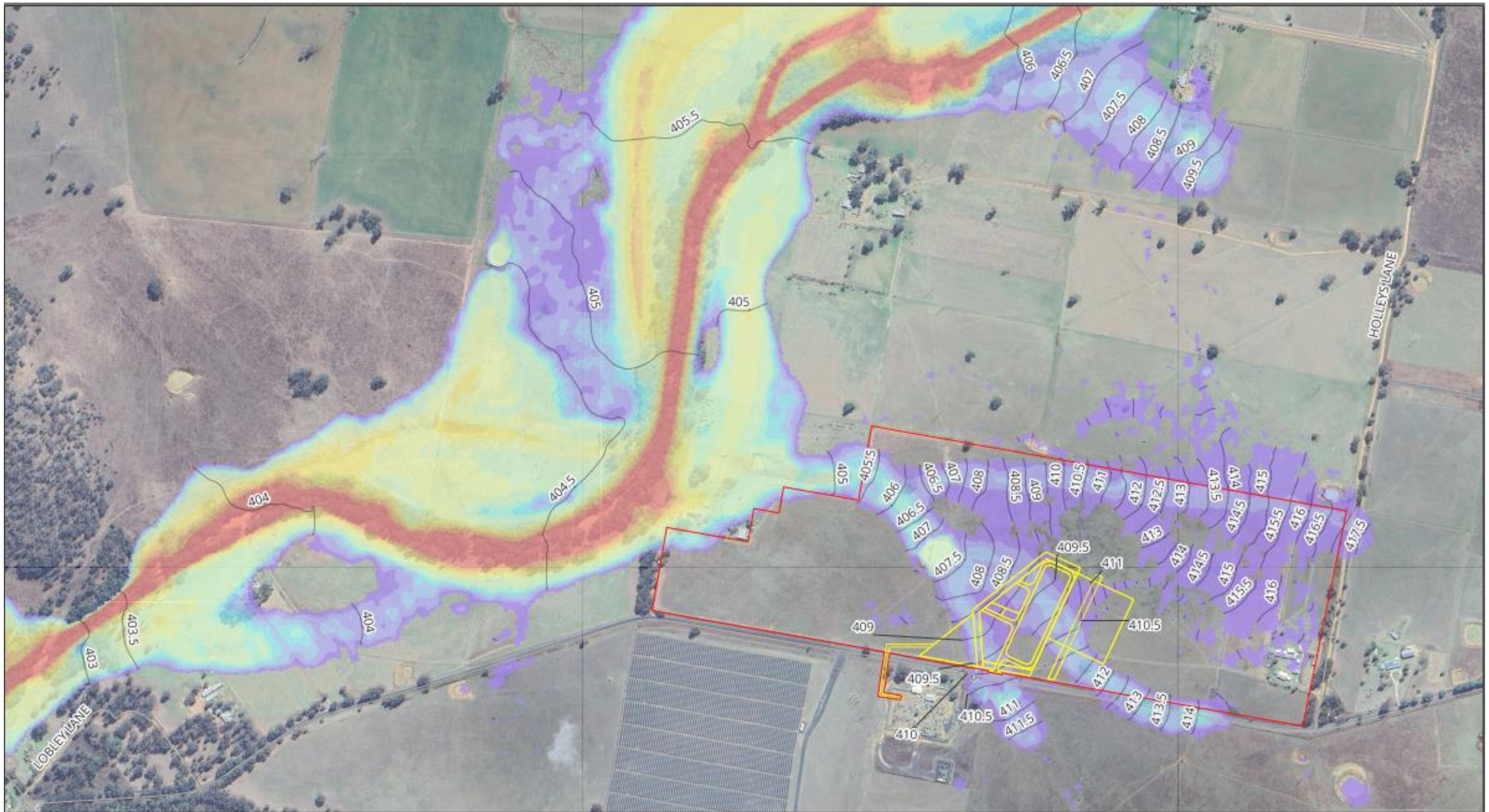
B.3.2 Local catchment flooding

The local catchments surroundings the project site are too small to be validated by the RFFE. Instead, the local catchments were validated against the Rational Method, which is a commonly used formulae used for determining peak discharges from small drainage areas. The Rational Method was also adopted for verification purposes and was applied as per QUDM (2017). Frequency factors were assigned based adjustment factors considered in AUSTROADS (2013), and time of concentration was calculated based on the catchment characteristics which used either the Bransby's-Williams Equation or standard outlet method.

The hydraulic model determined the 1% AEP critical storm duration to be either 15 or 45 minute duration with peak flows of 20.6 and 21.3 m^3/s respectively at the selected PO line (A38 in TUFLOW model). In contrast, the 1% AEP peak flow estimated by the Rational Method was around 10.5 m^3/s, considering a local catchment size of 0.98 km^2. This highlights a notable difference, with the TUFLOW model showing results about two times higher than the Rational Method estimation. The cause for the higher flows in the TUFLOW is likely due to the distribution of the large (49km^2) RORB catchment across the small drainage catchments.

The validation suggests that the current model overestimates the local catchment flows, however a conservative approach is considered appropriate at this stage of the project. This report recommends the local catchment flow estimation should be enhanced in future design phases. Possible improvements include building a new hydrologic model that covers the local catchments in software with specific strengths in local drainage analysis, such as DRAINS. Alternatively a rain-on-grid approach could be applied to the hydraulic model, if additional topographical survey is obtained.

Appendix C. Flood mapping for existing conditions



LEGEND:

Existing case - Flood Depth (m):

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- >3
- 0.5 m Contour
- Proposed Project Work
- Project Area

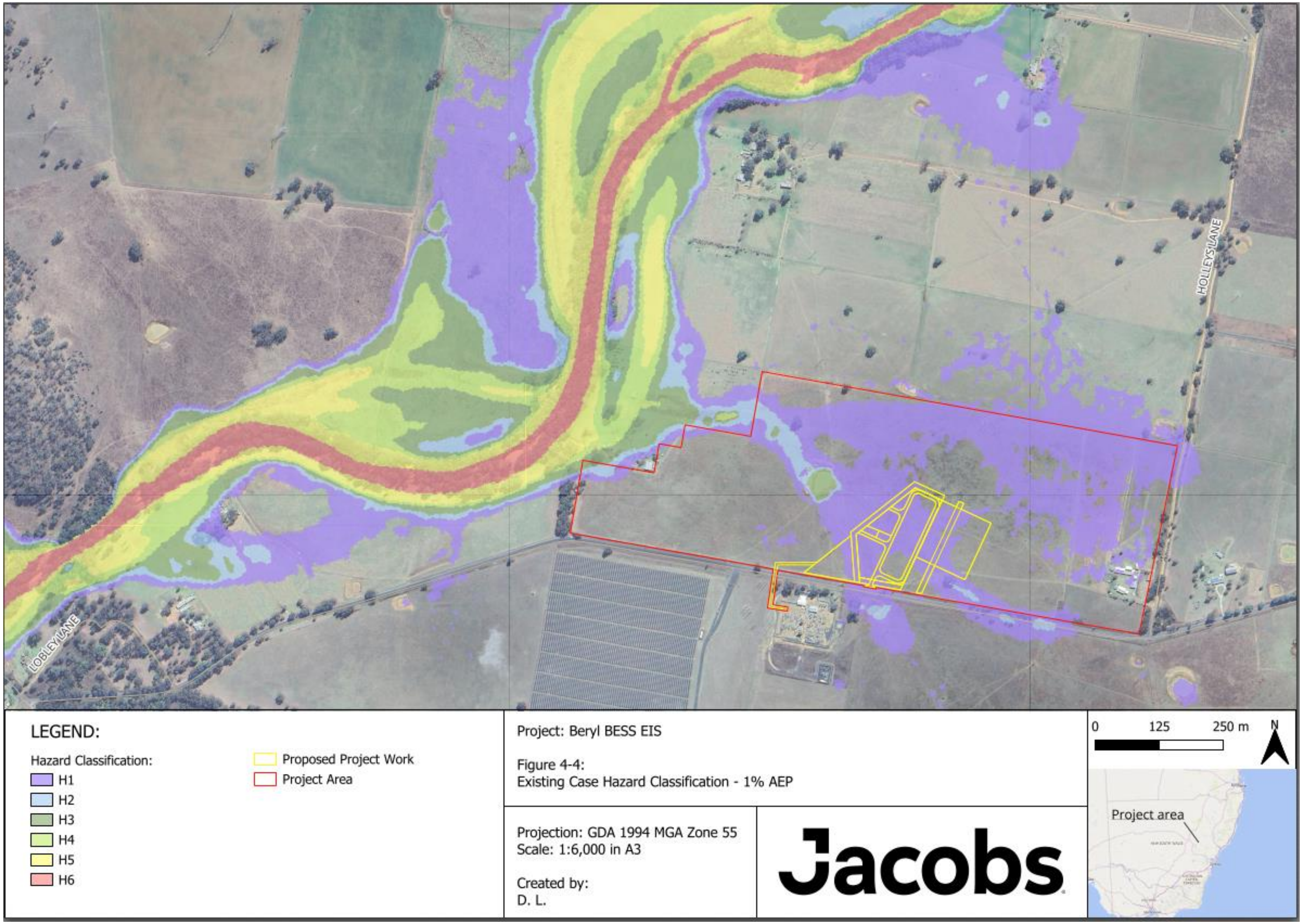
Project: Beryl BESS EIS

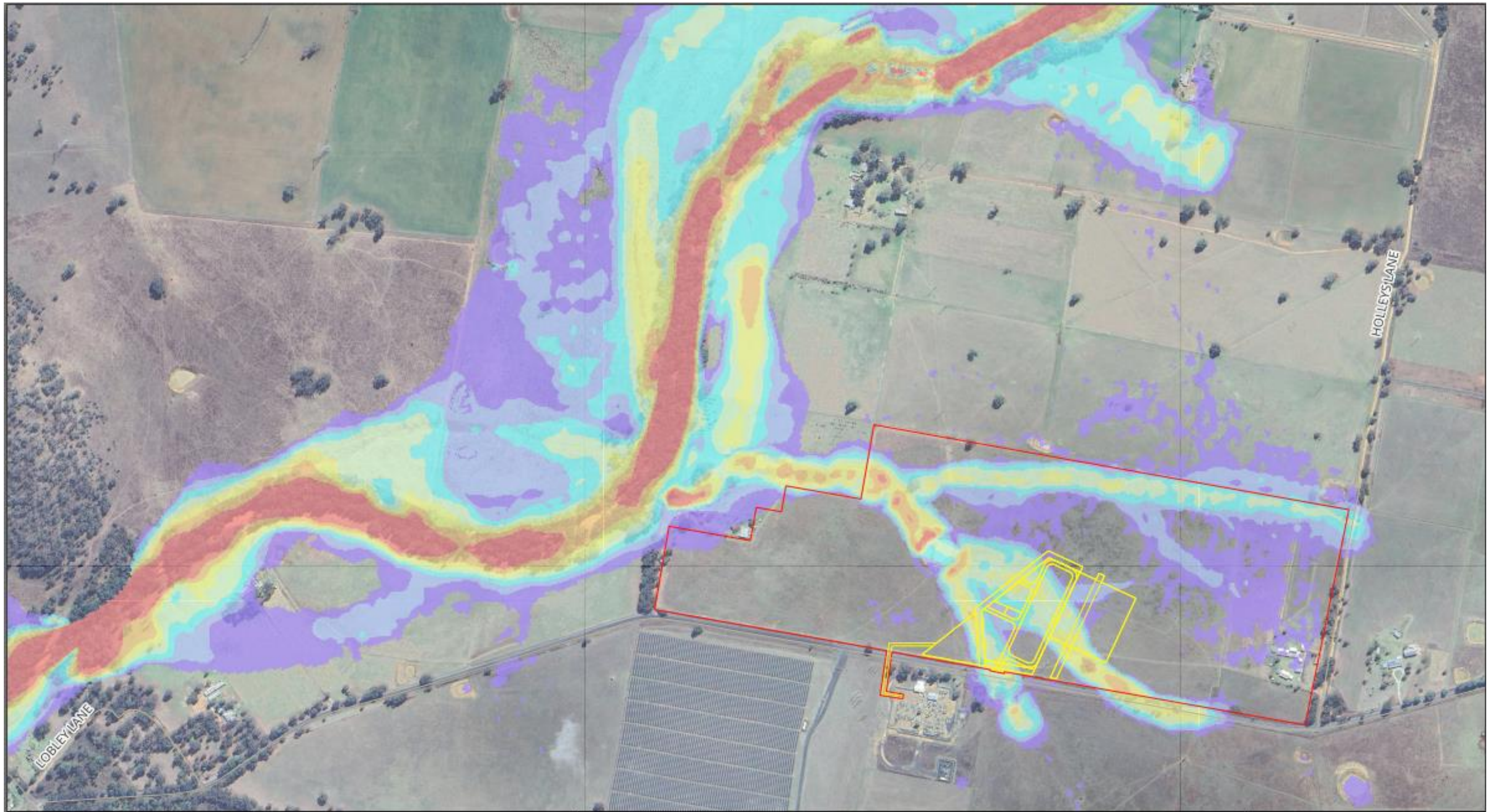
Figure 4-2:
Existing Case Flood depths and levels - 1% AEP

Projection: GDA 1994 MGA Zone 55
Scale: 1:6,000 in A3

Created by:
D. L.

0 125 250 m N


HOLLEYS LANE
LOBLEY LANE
LEGEND:
Hazard Classification:
H1
H2
H3
H4
H5
H6
Proposed Project Work
Project Area
Project: Beryl BESS EIS
Figure 4-4:
Existing Case Hazard Classification - 1% AEP
Projection: GDA 1994 MGA Zone 55
Scale: 1:6,000 in A3
Created by:
D. L.
Jacobs
0
125
250 m
N
Project area



LEGEND:

Existing case - Flow Velocity (m/s):
- 0.0 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1.1
- 1.1 - 1.3
- > 1.3

- Proposed Project Work
- Project Area

Project: Beryl BESS EIS

Figure 4-5:
Existing Case Flow Velocity - 1% AEP

Projection: GDA 1994 MGA Zone 55
Scale: 1:6,000 in A3

Created by:
D. L.

Jacobs

0 125 250 m

N