Appendix G

Water Cycle Management Study

Prepared for
Neoen Australia Pty Ltd
ABN: N/A

AECOM

Great Western Battery Project

Water Cycle Management Study (WCMS)

08-Dec-2021

Commercial-in-Confidence

Great Western Battery Project

Water Cycle Management Study (WCMS)

Client: Neoen Australia Pty Ltd

ABN: N/A

Prepared by

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Abbreviations

Abbreviation	Description
AECOM	AECOM Australia Pty Ltd
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
BESS	Battery Energy Storage System
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
Council	Lithgow City Council
DEM	Digital Elevation Model
DCP	Development Control Plan
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
GP	Gross Pollutants
GPT	Gross Pollutant Trap
ha	hectares
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
km	kilometre
kV	kilovolt
LGA	Local Government Area
m	metres
mm	millimetres
m^2	square metres
m^3	cubic metres
mg/L	milligram per litre
ML	megalitres
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
MW	megawatts
MWh	megawatt-hour
NSW	New South Wales
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
PMF	Probable Maximum Flood
SEARs	Secretary’s Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSDA	SSD application
SWMP	Soil and Water Management Plan

Abbreviation	Description
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WM Act	Water Management Act 2000 (NSW)
WSUD	Water Sensitive Urban Design
WCMS	Water Cycle Management Study

Definitions

Term	Definition
Australian Height Datum (AHD)	The standard reference level used to express the relative height of various features. A height given in metres AHD is the height above mean sea level.
Average Recurrence Interval (ARI)	The likelihood of occurrence, expressed in terms of the long-term average number of years, between flood events as large as, or larger, than the design flood event. For example, floods with a discharge as large as or larger than the 100-year ARI flood would occur on average once every 100 years.
Annual Exceedance Probability (AEP)	The probability or likelihood of a storm event occurring or being exceeded within any given year.
Blue Book	Managing Urban Stormwater: Soils and Construction - Volume 1 (Landcom, 2004) and Volumes 2A, 2B, 2C, 2D and 2E (DECC, 2008).
Project (the)	The Project includes: • Construction and operation of a BESS of a nominal capacity of approximately 500 megawatts (MW) and approximately 1000 megawatt-hour (MWh); and • Connection of the BESS to the nearby Transgrid Wallerawang substation via a transmission line
Project Area (the)	The Project Area includes the Site, as well as the proposed location of the transmission connection between the Site and the Transgrid Wallerawang 330 kV substation, as well as the connection within the Transgrid Wallerawang 330 kV substation.
Site (the)	The proposed location of the BESS (the Site) is at one lot located at 113 Brays Lane, Wallerawang NSW, 2854 (Lot 4 Deposited Plan (DP) 751651).

Executive Summary

Neoen Australia Pty Ltd (Neoen) is seeking development consent to construct, operate and maintain a battery energy storage system (BESS) of approximately 500 megawatts (MW) and approximately 1000 megawatt-hour (MWh) at 173 Brays Lane, Wallerawang, NSW 2845 (the Site), as well as a new transmission line that would connect the BESS to the existing Transgrid 330 kilovolt (kV) substation at Wallerawang (the Project).

The Project would involve the installation of a transmission line connection between the Site and the Transgrid Wallerawang 330 kV substation.

The Project is classified as State Significant Development (SSD). As such, this Water Cycle Management Study (WCMS) for surface water, flooding and water use has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs), which would assist the Department of Planning and Environment (DPE) (formerly referred to as (Department of Planning, Industry and Environment (DPIE)) in their assessment of the Project's SSD application.

The assessment identifies the potential impacts on surface water, flooding and water use as a result of the proposed construction works and future site operations. This report outlines the regulatory framework, highlights any relevant features of the existing environment, discusses the potential impacts from the Project and proposes mitigation and management measures, where appropriate.

Existing environment

Under existing conditions, the Project Area is almost entirely pervious and undeveloped. The Lot within which the Site is located is privately owned and is currently occupied by a residential property and is used for grazing. The Site drains in an easterly direction via two ephemeral drainage lines that convey flow towards the southern part of the eastern boundary, feeding into Pipers Flat Creek offsite (approximately 50 metres (m) east of the Site), which is part of the Warragamba catchment.

The Site contains numerous farm dams that were likely constructed for water harvesting purposes.

Identified impacts

The proposed works during the construction and operational phases of the Project present some potential impacts on surface water, flooding and water use across the Project Area (the Site and the transmission line corridor connecting the BESS to the nearby Transgrid Wallerawang substation). The key potential impacts identified as part of this assessment include:

- Construction would require the diversion of existing flow paths, and construction works have the potential to disrupt the existing flow patterns to receiving waterways, such as Pipers Flat Creek
- Concentrated flows moving through and discharging from the Site that could scour the earth
- Disturbed surfaces and stockpiles during construction that could increase the risk of sediment mobilisation and transportation via surface flows
- Construction of the new underground transmission line, connecting the BESS to the Transgrid Wallerawang 330 kV substation, that could disturb soils and vegetation during the construction phase
- New pollutants introduced during both construction and operational phases of the Project, due to the soils mobilised during construction, new materials and machinery being used onsite, changes to the land use and ongoing operations at the Site
- The potential for spills and leaks from the batteries and transformers which would introduce hazardous substances that could enter water discharging to Pipers Flat Creek and neighbouring properties
- An increase in impervious area that could increase surface water pollutants and flow generated by the Site
- Flooding on the Site which could coincide with construction works presenting a safety risk to workers and the potential of floodwaters to carry construction material downstream presenting both safety and environmental concerns
- Flooding on Site which could damage buildings, inverters, transformers and batteries

- An increase in water and wastewater demands, and alterations to the water supply arrangements, as a result of increased personnel during both construction and operational phases of the Project.

Mitigation and management measures

To eliminate or minimise impacts, a number of mitigation and management measures would be implemented as part of the Project. Key measures include:

- A Construction Soil and Water Management Plan (CSWMP) would be developed, in accordance with the Blue Book (Landcom, 2004), to minimise the erosion potential and sediment production across the Project Area
- Channels are proposed to divert flows around the BESS and laydown area during the construction phase
- The rehabilitation of disturbed areas will be undertaken progressively as construction stages are completed, and in accordance with the Blue Book (Landcom, 2004), such as the transmission line
- A Spill Management Procedure will be prepared and implemented as part of the CEMP to minimise the risk to surface water quality of pollution arising from spillage or contamination on the Site and adjoining areas during the construction phase
- The battery and transformer installations would incorporate spill containment measures where appropriate to prevent spillage of toxic compounds from entering the Site drainage system or downstream waterways.
- Water sensitive urban design (WSUD) measures, such as bioretention systems, would be incorporated into the drainage design in order to treat surface water before discharging to the receiving environment
- Management measures would be in place to cease works when a severe weather warning is issued for the immediate area, and equipment would be secured accordingly, to mitigate the risks of flooding along the ephemeral drainage line during construction works
- The office buildings, inverters, transformers and batteries would be built on concrete pads at a level high enough to protect them from potential floodwater impacts during the operational phase.

With the recommended mitigation and management measures in place, negligible impacts to surface water, flooding, and water use are expected as a result of the Project.

The Project adheres to the Neutral or Beneficial Effect (NorBE) guidelines of WaterNSW as required by the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011.

For the construction phase, the protection of water quality is addressed with the requirements for a Soil and Water Management Plan, and supporting Erosion and Sediment Control Plans that are described in the mitigation measures applicable to the construction phase.

For stormwater runoff during the operation phase, the MUSIC model results conceptually show that NorBE criteria would be achieved for the Site. For the modelled proposed scenario, total suspended solids, total phosphorus, total nitrogen and gross pollutant loads are all 10% less than existing scenario conditions. The 50th to 98th percentiles of total suspended solids, total phosphorus and total nitrogen concentrations for the proposed scenario are lower than the existing scenario conditions. Achievement of an overall sustainable neutral or beneficial effect on water quality for the development can be achieved with an appropriately sized bioretention system.

Wastewater management will not impact water quality as all wastewater will be captured onsite in a holding tank and trucked to a wastewater treatment facility.

Therefore, it is expected that the development will have a neutral or beneficial effect on water quality, consistent with the ‘Neutral or Beneficial Effect on Water Quality Assessment Guideline 2015’ (WaterNSW, 2015).

1.0 Introduction

1.1 Context

Neoen Australia Pty Ltd (Neoen) is seeking development consent to construct, operate and maintain a battery energy storage system (BESS) of approximately 500 megawatts (MW) and approximately 1000 megawatt-hour (MWh) at 173 Brays Lane, Wallerawang, NSW 2845 (the Site), as well as a new transmission line that would connect the BESS to the existing Transgrid 330 kilovolt (kV) substation at Wallerawang (the Project).

The proposed location of the BESS is at Lot 4 Deposited Plan (DP) 751651. The Site is located approximately 1.25 km north west of the Transgrid Wallerawang 330 kV substation. This substation is located at James Parade, Wallerawang 2845 (Lot 91 of DP 1043967) (**Figure 1-1**).

The Project would involve the installation of a transmission line connection between the Site and the Transgrid Wallerawang substation.

The Project requires development consent under Part 4 of the Environmental Planning and Assessment Act 1979 and is considered State Significant Development. Therefore, the development application for the Project is supported by an Environmental Impact Statement (EIS).

The purpose of this report is to support the EIS in describing the surface water quality and flooding environments relative to the Site and to assess the potential impact of the Project on these environments during both the construction phase and operational phase. In particular, this report documents the assessments completed to understand how the Project would impact existing flooding, surface water drainage, and water use. Possible management and/or mitigation measures to minimise potentially adverse impacts on the surrounding environment are also identified.

*This report addresses both the Secretary's Environmental Assessment Requirements (SEARs) and the Water Cycle Management Study (WCMS) requirements of WaterNSW applicable to Sydney's drinking water catchments. These requirements are discussed further in **Section 2.1**.*

1.2 Project overview

1.2.1 Elements of the Project

The proposed elements of the Project would include (refer **Figure 1-1** and **Figure 1-2**):

- Installation of a transmission line connection between the Site and the Transgrid Wallerawang 330 kV substation
- Site establishment, including excavation and grading works
- Installation, commissioning, and operation of a large-scale BESS including battery enclosures, inverters, and transformers
- Establishment of a new driveway located at the southern boundary of the Site, providing access to the Site from Brays Lane
- Establishment of internal access roads and car parking
- Construction of permanent operations and management buildings, including staff amenities
- Construction of stormwater controls, lighting, fencing and installation of security devices around the perimeter of the BESS compound
- Establishment of noise walls, landscaping and screening vegetation
- Above ground transmission within the onsite substation, and underground transmission line connection from the BESS to the existing Transgrid Wallerawang 330 kV substation switchyard
- Ancillary upgrades to the existing Wallerawang 330 kV substation switchyard

- Subdivision of Lot 4 DP 751651 to separate the existing residence in the south eastern portion of the lot from the proposed BESS.

Figure 1-1
The Project Area

N

0 200 400 m

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Legend

- The Site
- Transgrid 330kV Wallerawang Substation
- The Project Area
- Cadastre Boundaries
- Transmission Line
- Railway
- Watercourse

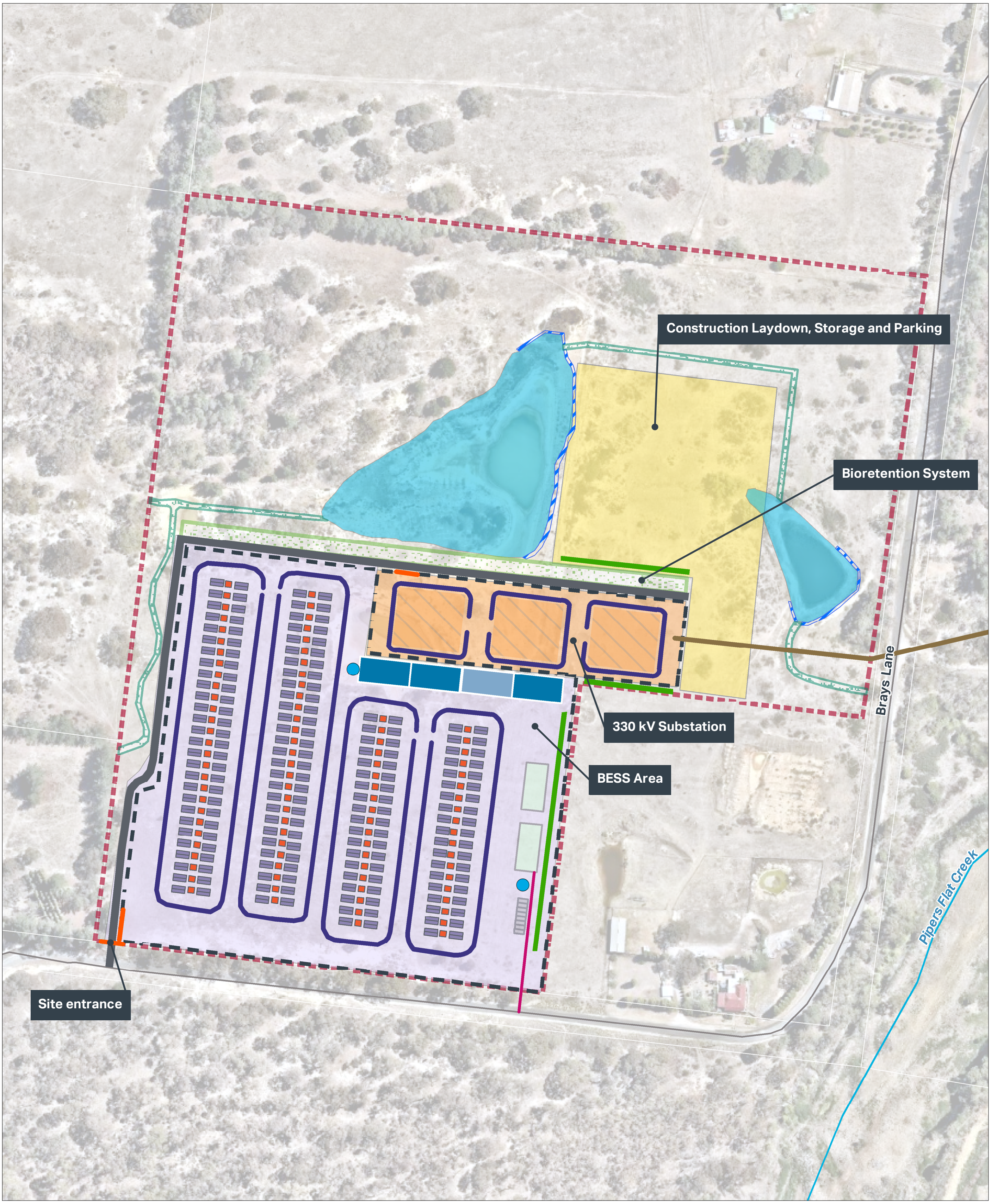

Figure 1-2
Indicative Site Layout

The Site	Local road	Control Room
Substation	Water Tank	Switch Rooms
Internal access road	Large Transformers	Landscape Planting
Noise wall	Battery and Inverter	O&M Building
Access Gate	Transformers	Carpark
Security Fencing	Bioretention System	Approx Extent Of Dam Modification
Water Connection Point	Dam Walls	Construction Laydown, Storage And Parking
Transmission Line Alignment	Swales	BESS Area
Watercourse	330 kV Substation	

N

0 30 60 m

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1.2.2 Infrastructure Services

Table 1 summarises the existing service infrastructure in proximity to the Site and the amendments required in order to service the Project for aspects relevant to the management of water.

Table 1 Infrastructure Services

Infrastructure	Amendment/connection requirement
Stormwater	A concept level stormwater design has been developed, including drainage arrangements directing water to the dams on the Site, this is included in this report.
Potable water	The Project would be connected to the existing potable water reticulated service available on Brays Lane. This would service the site office and the operation of the Project.
Sewer	The Project would not be connected to an existing sewer network. A wastewater holding system would be installed to collect sewer waste at the Site during operation.
Fire services	Fire detection devices would be installed inside the enclosures. A gas suppression system would be installed within the control room and switch rooms if required by Australian standards and through a safety in design review. Connection to existing potable water would be established. Two 45 kL metal water tanks.

1.2.3 Operation Activities

Operational activities

The operation of the Project would involve but not be limited to the following:

- Maintenance and management of equipment
- General office activities
- Receipt of goods
- Waste removal.

Operational workforce and hours

The Project would operate 24 hours a day, 7 days a week.

The Project would be an unmanned facility that is managed remotely by Neoen. It is anticipated that five to six employees would be required periodically for maintenance activities.

Operational plant and equipment

Chapter 4 Project description of the EIS provides an indicative list of the plant and equipment that would be used to maintain the Project.

1.3 Project construction

1.3.1 Construction works

It is estimated that construction of the Project would take approximately 12 months to complete, starting in late 2022.

The construction of the Project would be likely to include the following:

- Enabling works
  - Site preparation: establishing site access, establishing erosion and sediment controls, establishing marked no go areas, site clearing, installing security fencing, establishing laydown areas, establishing construction amenities (including temporary offices, lunchrooms, storage areas and washrooms)
  - Transportation of plant, equipment, materials and workforce to and from the Site as required

  - Provision of construction power: installing on site generators until power can be sourced from the existing distribution network.
- Civil, structural, mechanical and electrical works
  - Earthworks to form a level and benched BESS pad and new substation area, as well as to infill certain dams and expand retained dams. These works would include potential import or export of fill as required
  - Rearrangement of existing dams on the Site to ultimately comprise two dams. One larger dam to the north west of the site and one smaller dam to the east of the Site. For each dam, the required dam walls and spillways would be provided
  - Installation of Site drainage, stormwater management measures, including swales and bioretention basin, and underground utilities installation
  - Transport of project elements including but not limited to the battery enclosures, transformers, water tanks, O&M buildings and switch rooms
  - Connections to surrounding utilities
  - Installation of noise walls
  - Hardstand foundations in the form of compressed gravel or concrete slab would be laid to support BESS battery enclosures, site facilities and ancillary components (including the new substation and water tank)
  - Construction, installation and connection of aboveground civil, mechanical and electrical plant equipment and structures, including battery enclosures, invertors, transformers, substation infrastructure and connection infrastructure
  - Construction of supporting structures, e.g. office building and associated amenities, workshop, formal access, permanent fencing and internal roads
  - Construction of transmission connection between the Site and the Transgrid Wallerawang 330 kV substation including installation of supporting infrastructure, laying and connecting the transmission line, and minor enabling works at the Wallerawang 330 kV substation.
- Commissioning
  - Testing and commissioning activities. Commissioning would include the operation of all elements of the Project ensuring the Project is operating safely and in accordance with quality and environmental management systems and processes.
- Finishes and demobilisation
  - Installation of landscaping and rehabilitation of disturbed areas (e.g. laydown areas)
  - Removal of construction equipment and construction facilities.

1.3.2 Materials, stockpiling and laydown areas

The location at the Site for construction laydown, storage and parking is shown on **Figure 1-2**, and would provide for:

- Spoil handling and storage
- Dangerous goods storage
- Equipment storage
- Onsite construction parking
- Construction compounds with site offices and staff amenities.

The location of where each of these specific elements would occur would be outlined within the Construction Environmental Management Plan (CEMP). The CEMP would be prepared prior to the commencement of construction.

Construction laydown, storage and parking areas would be compacted and sheeted (for example with asphalt), as required. All areas would have adequate drainage and erosion and sediment controls installed.

2.0 Assessment methodology

2.1 Legislation, policies and guidelines

2.1.1 Relevant legislation

The following NSW legislation and statutory requirements apply to surface water assessment and were considered for the Project. Those that were directly applicable to the Project, and this assessment are summarised in more detail herein:

- *Environmental Planning and Assessment Act 1979 (EP&A Act), Environment Planning and Assessment Regulation 2000 (EP&A Regulation) and supporting environmental planning instruments:*
  - *State Environmental Planning Policy (Infrastructure) 2007*
  - *State Environmental Planning Policy (State and Regional Development) 2011*
  - *Lithgow Local Environment Plan 2014*
- *Protection of the Environment Operations Act 1997 (POEO Act)*
- *Protection of the Environment Administration Act 1991*
- *Local Government Act 1993*
- *Fisheries Management Act 1994*
- *Water Management Act 2000 and the Water Management (General) Regulation 2011*
- *NSW Government – Natural Resources Access Regulator – Guidelines for controlled activities on waterfront land – Riparian Corridors (2018)*

In addition to this the following Commonwealth policy has been considered:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *National Environment Protection (Assessment of Site Contamination) Measure 2013.*

2.1.2 Secretary's Environmental Assessment Requirements (SEARS)

This EIS has been prepared to address the environmental assessment requirements for the Project provided under Division 4.7 of the EP&A Act. The EIS provides a detailed understanding of the environmental constraints, opportunities, impacts and mitigation measures associated with the Project.

In December 2020 Neoen made a request for SEARs to the NSW DPIE (now DPE). SEARs were issued on 04 February 2021 in accordance with Schedule 2 of the EP&A Regulation. **Table 2** sets out the SEARs relevant to the assessment of surface water considerations and identifies where the requirements have been addressed in this report.

Table 2 SEARs relevant to this Report

SEARs requirement	Addressed
An assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including watercourses traversing the site and surrounding watercourses, 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	Surface water considerations (including watercourses, drainage channels, wetlands, riparian land, farm dams and acid sulfate soils etc.) are addressed in the following sections of this report: - Section 3.0 provides a description of the existing surface water environment. - Section 4.1 provides an impact assessment of the construction phase - Section 4.2 provides an impact assessment of the operational phase

SEARs requirement	Addressed
	• **Section 5.0** outlines relevant mitigation and management measures that address the identified potential impacts Groundwater and groundwater dependent ecosystems are addressed in Chapter 12 Geology, soils contamination and groundwater and Chapter 9 Biodiversity, of the EIS respectively.
Details of water requirements and supply arrangements for construction and operation	Water requirements and supply arrangements are discussed in: • **Section 1.2.2** • **Section 4.1.4** Impact Assessment – Construction Phase • **Section 4.2.4** Impact Assessment – Operation Phase • **Section 5.0** Mitigation and management measures
A description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction (Landcom 2004*)	**Section 5.0** Mitigation and management measures

2.1.3 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The Project Area is within the Warragamba Catchment which is part of Sydney's Drinking Water Catchment. The Project is therefore subject to State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (SDWC SEPP). This policy requires that the Project has either a neutral or beneficial effect on the quality of water across the catchment.

In accordance with the SDWC SEPP, all development applications in the Sydney drinking water catchment should include a Water Cycle Management Study (WCMS) or equivalent information to help the consent authority and WaterNSW assess whether the development will have a Neutral or Beneficial Effect (NorBE) on water quality. The study must include information, reports and modelling appropriate to the type of development and the risks the development has for water quality. The WCMS must also include information about erosion and sediment control, and detailed information and reports about stormwater management and wastewater management in any unsewered area. The relevant WCMS requirements and where these have been addressed in this report are outlined in **Table 3**.

Water NSW Guideline: Neutral or Beneficial Effect (NorBE) on Water Quality Assessment Guideline (2021)

The Neutral or Beneficial Effect on Water Quality Assessment Guideline 2021 (WaterNSW) (the 2021 guideline) provides guidance on the requirement under SDWC SEPP for all development in the Sydney drinking water catchment to have a neutral or beneficial effect on water quality.

A neutral or beneficial effect on water quality is satisfied if the development:

a. has no identifiable potential impact on water quality, or

b. will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or

c. will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

The NorBE requirements are captured by the requirements for the Water Cycle Management Study described in **Table 3**.

WaterNSW Guideline: Developments in the Sydney Drinking Water Catchment - Water Quality Information Requirements (2020)

Developments in the Sydney drinking water catchment – Water Quality Information Requirements (WaterNSW 2020) (the 2020 guideline) describes the information required as part of the development application to demonstrate that the Project can achieve a neutral or beneficial effect (NorBE) on water quality.

All development applications in the Sydney drinking water catchment should include:

- A water cycle management study (WCMS)
- Or equivalent information depending upon the development.

This helps consent authorities and WaterNSW assess whether the development would have a NorBE on water quality.

The 2020 guideline states that the WCMS "must include information, reports and modelling appropriate to the type of development and the risks the development has for water quality. Higher risk proposals require more in-depth studies. The WCMS must also include information about erosion and sediment control, and detailed information and reports about stormwater management and wastewater management in any unsewered area."

The 2020 guideline groups types of development into different 'modules' based on their complexity and the level of potential risk that the development could present to water quality. The modules are a course approach to categorizing development types. The application of this approach means that the Project falls within 'Module 5' development which are considered "the highest risk to water quality" and typically include "major industrial developments, intensive livestock farms, extractive industries" etc. The level of risk from the Project is not commensurate with these development types, is significantly less likely to result in surface water impacts and does present the 'highest risk' to water quality in the Sydney Drinking Water Catchment.

Nevertheless Table 1 of the 2020 guideline outlines the following possible information requirements for a Module 5 WCMS.:

- Stormwater quality modelling where required using a stormwater quality modelling program like MUSIC or S3QM, depending on the size of the impervious area
- Conceptual soil and water management plan or erosion and sediment control plan
- On-site wastewater management report (if relevant)
- Development specific pre- and post-development pollutant assessment requirements.

Table 3 summarises the information requirements that are expected for the assessment of a development application that would be applicable to the Project (taken from WaterNSW 2020).

Table 3 WCMS Requirements

WCMS Requirement	Addressed
General	
An accurate description of the current situation showing the management of existing drainage in relation to contours or topography	**Section 3.0** Existing environment
The flood assessment and associated planning level for the development site, if relevant	**Section 3.0** Existing environment **Section 4.0** Impact assessment
A summary and location of the proposed onsite wastewater management as part of the development in unsewered area	**Section 4.0** Impact assessment

WCMS Requirement	Addressed
Stormwater	
That the type, design, size, location and ownership and maintenance responsibilities for all proposed stormwater quality improvement devices are in the report and can be practically implemented at the nominated locations	**Section 4.0** Impact assessment **Section 5.0** Management and mitigation measures
That the report meets all the WCMS stormwater requirements, and designs are evaluated with modelling consistent with WaterNSW's 'Using MUSIC in Sydney Drinking Water Catchment' (WaterNSW, 2019) where relevant	Referenced and discussed throughout report
Wastewater	
That the type, design, size and location of the proposed wastewater treatment and effluent management area (EMA) are in the report and can be practically implemented on the site	**Section 4.0** Impact assessment
Meets all the WCMS wastewater requirements	Referenced and discussed throughout report
Design and evaluation of systems are consistent with the guideline 'Designing and Installing On-site Wastewater Systems' (WaterNSW, 2019b).	**Section 4.2.4**

2.1.4 Lithgow Local Environmental Plan 2014

The Project is located within the Lithgow LGA, which is subject to the application of the Lithgow Local Environmental Plan 2014 (Lithgow LEP). The Lithgow LEP aims to make local environmental planning provisions for land in Lithgow in accordance with the relevant standard environmental planning instrument under section 3.20 of the EP&A Act.

According to *Clause 2.3 – Zone objectives and land use table*, the Site is located on land zoned as: RU1 Primary production. In relation to surface water and flooding, the land use objectives of RU1 Primary production, as described in the Lithgow LEP, states that the development must *maintain or improve the water quality of receiving water catchments.*

2.1.5 Water Management Act 2000

The *Water Management Act 2000* (WM Act) establishes a framework for managing water in NSW. Section 91 of the WM Act discusses activity approvals and notes that there are two types of approvals, namely controlled activity approvals and aquifer interference approvals.

The WM Act specifies certain activities as controlled activities when carried out on waterfront land. This is defined as within 40 m of the banks of a river, lake or estuary. Pipers Flat Creek is the closest waterway to the Site, located over 50 m to the east. The location of the proposed transmission line would intersect Pipers Flat Creek, however the transmission line would be installed using an underboring methodology in this area to avoid the need to work in or near the creek. Pipers Flat Creek is a tributary of the Coxs River. The Coxs River is located about 2 km north of the Site. Four farm dams are located on the Site.

A controlled activity approval would not be required by virtue of Section 4.41 of the EP&A Act. This section of the Act specifies certain approvals that are not required for State Significant Development , including an activity approval under section 91 of the WM Act. Despite this provision, this section of the Act does not remove the requirement for obtaining an aquifer interference approval if the identified works have the potential to impact a groundwater aquifer.

2.1.6 Specific construction phase guidelines

The following design guidelines and management procedures are relevant in identifying the appropriate water quality management and mitigation measures to be implemented during the construction phase of the Project:

- *NSW DECC 2008 'Managing Urban Stormwater-Volume 2A Installation of Services', NSW Department of Environment, Climate Change and Water (known as the Blue Book Volume 2)*
- *Landcom, 2004 'Managing Urban Stormwater- Soils and Construction, Volume 1', 4th Edition (known as the Blue Book Volume 1)*

Managing Urban Stormwater: Soils and Construction - Volume 1 and Volume 2A (the Blue Book)

The principles for the management of stormwater during the construction phase are documented in this publication, also known as 'the Blue Book'. The management principles within this document have been accounted for in the mitigation and management measures developed for the construction phase of the Project as required by the SEARs.

2.1.7 Other relevant guidelines

Other relevant guidelines guidelines referenced in this report include:

- *Australian Rainfall and Runoff 2019 (Commonwealth of Australia 2019)*
- *Using MUSIC in Sydney Drinking Water Catchment - WaterNSW Standard (2019)*
- *NSW Government – Natural Resources Access Regulator – Guidelines for controlled activities on waterfront land – Riparian Corridors (2018)*

Australian Rainfall and Runoff 2019

Australian Rainfall and Runoff (ARR) documents guidelines for estimating design flood characteristics in Australia (Commonwealth of Australia 2019). The latest issue was finalised in 2019 and was the result of several years of updates to the previous version of ARR (Engineers Australia, 1987).

Using MUSIC in Sydney Drinking Water Catchment - WaterNSW Standard (2019)

WaterNSW developed *Using MUSIC in the Sydney Drinking Water Catchment* (WaterNSW 2019) to help consultants prepare MUSIC stormwater quality models to demonstrate a neutral or beneficial effect on water quality can be achieved for proposed urban and rural land use developments. The manual includes instructions relating to setup of pre- and post- development site layouts, considering the existing site characteristics, the climatic region, drainage configuration and the configuration of post-development site layout and treatment measures in the context of NorBE.

Natural Resources Access Regulator – Guidelines for controlled activities on waterfront land – Riparian Corridors (2018)

The Natural Resources Access Regulator (NRAR) is an independent regulator established under the *Natural Resources Access Regulator Act 2017* (NSW). The NRAR administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm would be done to waterfront land as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 m of the highest bank of the river, lake or estuary. If a riparian corridor is identified on the site, then applicants must obtain a controlled activity approval from the NRAR before commencing the controlled activity.

A Biodiversity Development Assessment Report has been prepared for the Project (Biosis, 2021). During site visits undertaken for the Project, the mapped drainage lines on the Site have been observed to be ephemeral, and while some minor degree of remaining channel form is discernable in limited sections (to the north west corner of the Site), due to the level and extent of modification (vegetation clearing, dam construction, and historical land use) they no longer function as ephemeral waterways but simply as drainage lines as the lowest points in the landscape and do not sustain aquatic habitats.

The results of the Biodiversity Development Assessment find that the vegetation covering the existing drainage lines on Site comprises Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion. Where this vegetation community is located at drainage lines, it was found to be in a state of 'non-offsetable grasslands' (NOG). The poor condition of this vegetation class can be attributed to historical clearing and pasture improvement. This vegetation has been classed as NOG based on a lack of both native structural and floristic diversity within all stratums. It is to be noted that a distinguishable canopy layer was not recorded within the vegetation conditional state. The ground layer stratum was recorded to contain a reduced representation of native grass and forbs species, dominated by exotic pasture species. As such, the vegetation located within the existing drainage lines on the Site are not considered to provide diversity of habitat for terrestrial, riparian and aquatic plants and animals or provide habitat connectivity. As such, the Project is considered to not be located on waterfront land.

Additionally, major projects are exempt from requiring certain approvals under the Water Management Act 2000, because it is expected that water management considerations are included in the assessment of major projects and associated conditions of consent.

2.1.8 Dam Safety NSW

Dams Safety NSW is an independent state regulator established under the *Dams Safety Act 2015* (NSW). It is responsible for developing and implementing regulation for effective dam safety management to protect life, property and the environment from dam failures. To meet this objective, Dams Safety NSW have the authority to ‘declare’ dams deemed have a potential to threaten downstream life or cause major property, environmental, or public welfare damage.

It is anticipated that a consequence assessment (considering life safety and non-life safety consequences), and a dam break study may be required to determine if any future dam on the Site should be ‘declared’ by Dam Safety NSW. Any declared dam would be required to meet the objectives set forth in the Dam Safety NSW guidelines, which help declared dam owners comply with the requirements of the *Dams Safety Act 2015* and the *Dams Safety Regulation 2019*.

2.2 Methodology

Based on the requirements of the SEARs and other guidelines as well as the likely risk posed by the Project a number of qualitative and quantitative assessments have been completed to identify, assess and mitigate potential impacts from the Project to surface water considerations.

This assessment has applied the following methodology:

- A desktop review and analysis of existing information to characterise the existing environment, identify surface water receptors, existing flood behaviours and drainage infrastructure
- Consideration of the location of the Project Area in the context of surrounding catchment areas and potential sensitivity and influence on downstream waterways
- Identification of key topographical features such as likely overland flow paths and low/sag points around the Project Area
- Assessment of potential construction and operational impacts relating to flooding, drainage and surface water, including drainage modelling. In particular:
    - The flooding assessment involved defining the upstream catchment areas contributing to flows moving through or around the Site, estimating peak flows generated by these catchments and assessing whether the capacity of the surrounding drainage system is capable of conveying the flows without risking inundation and damage of the Site.
    - The water quality assessment included an assessment of the impervious surfaces that would be created by the Project, and the associated pollutant generation and treatment.
- Identification of appropriate mitigation and management measures to mitigate potential impacts on the environment.

The assessment draws on a number of data sources and reference documents, which included:

- Project information, including the site layout plan and contours within the area
    - Elevation data in the form of a Digital Elevation Model (DEM) at a resolution of 1 m, obtained from the NSW Government Spatial Services.

3.0 Existing environment

3.1 Context

The Lot within which the Site is located is privately owned and is currently occupied by a residential property, small-scale agricultural buildings and marginal agricultural land. The majority of the Site is used for occasional horse grazing. As a result of its use for grazing and residential purposes, the Site has undergone vegetation removal and the majority of vegetation on the Site consists of pasture grasses. A small area of mature vegetation in located in the north western corner of the Site.

A series of constructed dams are located on the Site (discussed further in **Section 3.5.2**, and shown in **Figure 3-6**). The dams are fed by two ephemeral drainage lines that enter the Site on the western boundary and generally flow to the east before entering the largest dam onsite and becoming one drainage line. This drainage line passes through one more dam before leaving the Site along the southern part of the eastern boundary before draining to Pipers Flat Creek offsite.

3.2 Climate

3.2.1 Rainfall

The Site is located in a region with a cool temperature climate. Three nearby Bureau of Meteorology (BoM) weather stations were reviewed for annual rainfall statistics. These indicated an average rainfall of between 675.7 mm and 873 mm for the region Table 4.

Table 4 Mean monthly rainfall (mm) based on records, measured at three BoM stations near the Site (current as of 23 September 2021)

Location (Site Number)	Distance from Project	Data Period	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Wallerawang Power Station (063176)	0.25 km North West	1902 - 1973	83.1	87.1	46.4	36.6	41.8	39.8	39.6	49	52.9	64.3	56.9	62.7	675.7
Lidsdale (Maddox Lane) (063132)	2.38 km North East	1959 - 2021	85.1	77	68.8	42.5	47.5	49.6	50	63.4	53	67.1	71.8	73.6	756.6
Lidsdale State Forest (063046)	5.94 km South	1938 - 1978	108.5	85.2	71.2	59	66.2	74.3	52.2	65.8	59.4	84.4	74.1	74	873

Source: BoM Website, 23 September 2021

3.2.2 Evaporation

Evaporation data has not been measured at the meteorological stations included in **Table 4**, however **Figure 3-1** indicates that the total average annual evaporation in the region is between 1400 mm and 1600 mm.

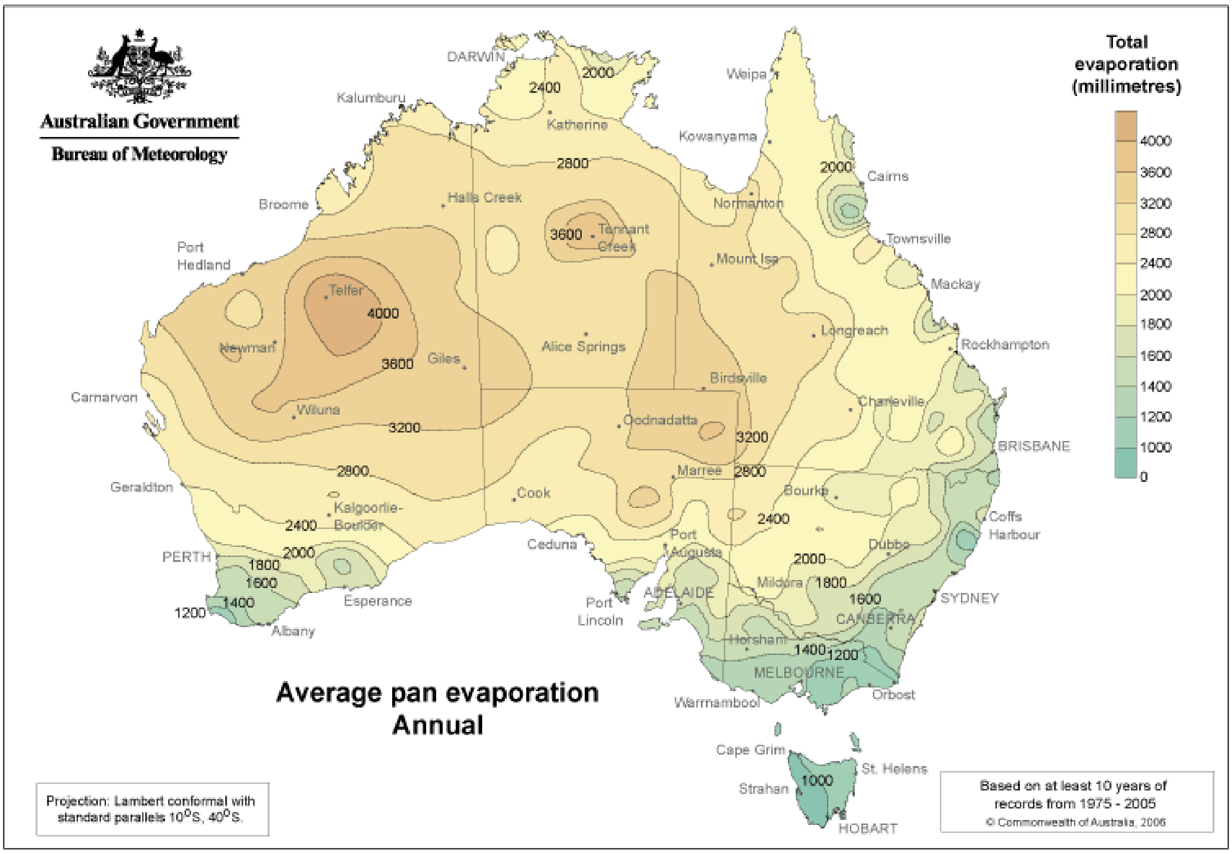

Figure 3-1 Average Annual Evaporation (BoM 2006)

3.2.3 Temperature

Lithgow (Cooerwull) Station (site number 063226) is located 10.5 km south east of the Site. January is the warmest month, with a mean monthly maximum temperature of 26.6°C, and July is the coolest month, with a mean temperature of 11.0°C (data series between 2006 and 2021) (BoM, 2021).

3.3 Catchment features

3.3.1 Sydney Drinking Water Catchment

The Site is part of the Warragamba Catchment which is located within Sydney's Drinking Water Catchment (refer to **Figure 3-2**). Warragamba is the largest of Sydney's five drinking water catchments and covers an area of 9,050 km^2. The catchment is located between north of Lithgow at the head stream of the Coxs River to the source of the Wollondilly River west of Crookwell.

Figure 3-2 Sydney's Drinking Water Catchments (WaterNSW, 2015)

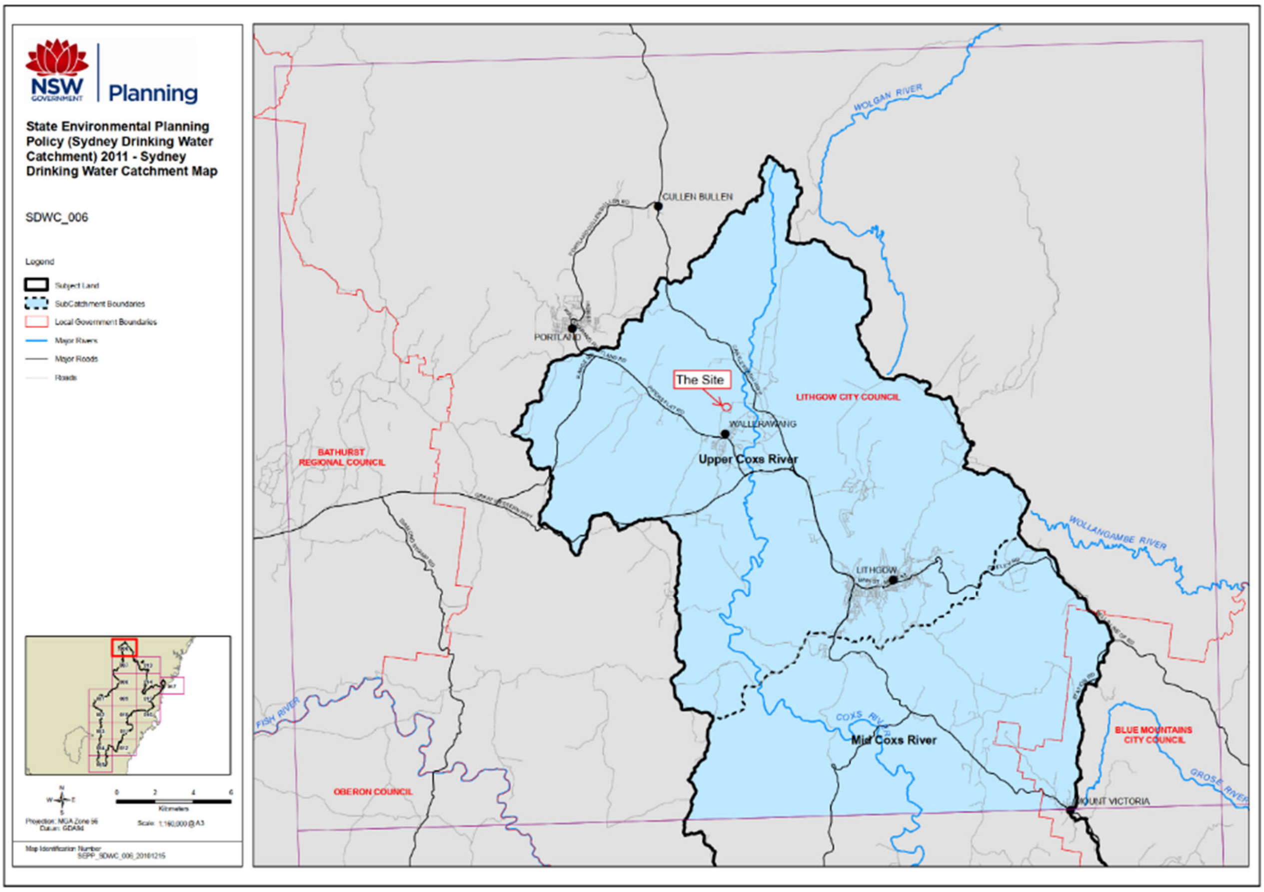

Figure 3-3 Section of Warragamba Catchment (DPIE, 2011)

3.3.2 Hawkesbury-Nepean Catchment and Water Quality Objectives

The Project Area is located within the Hawkesbury-Nepean catchment. The Hawkesbury-Nepean catchment is the longest coastal catchment in NSW. The Hawkesbury River (and its tributaries) is over 470 km long and the catchment area is 22,000 km². The Project is located towards the top of the catchment with Pipers Flat Creek joining Coxs River which flows to Lake Burragorang (refer to **Figure 3-2**). Lake Burragorang flows as Warragamba River until it eventually becomes the Hawkesbury River which flows south easterly to its mouth at Broken Bay, about 15 km from the Tasman Sea (refer to **Figure 3-4**). The main tributaries of the Hawkesbury–Nepean River commence in rural areas and national parks.

The Government-endorsed water quality objectives (WQOs) for the Hawkesbury–Nepean are contained in the final report of the Healthy Rivers Commission (HRC) on the Hawkesbury–Nepean River system (HRC 1998). The Government confirmed these objectives in its response to the Hawkesbury–Nepean Statements of Joint Intent (SOJI) (NSW Government 2001). In response to the Statements of Joint Intent, the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 was developed. This policy requires that any development within the catchment has either a neutral or beneficial effect on the quality of water across the catchment.

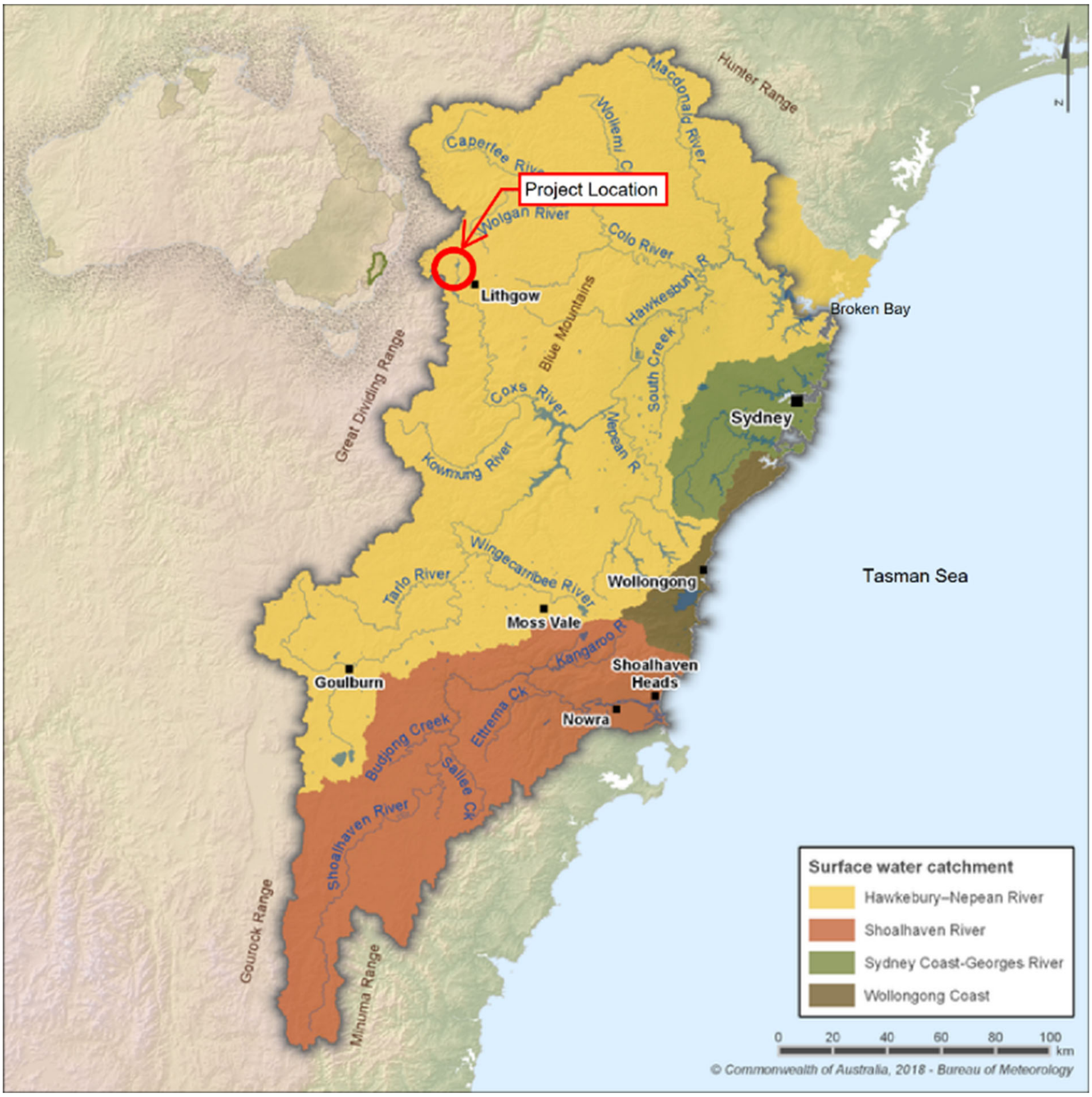

Figure 3-4 Contextual map of the Sydney region (BoM 2017)

3.4 Geology and soil landscapes

Reference to the 1:100 000 geological map sheet for the Western Coalfield (south) (Yoo,1992) indicates that the surface geology of the Project Area is of Permian to Quaternary antiquity, with rocks of the Early to Late Permian Shoalhaven Group (Ps) underlying its elevated rolling terrain and Quaternary alluvium (Qa) mantling the floodplains of both Pipers Flat Creek and the Coxs River.

The Australian Soil Classification (ASC) map identifies soil in the Site as being characterised as Cullen Bullen erosional soils (ERcb). The soils are typically dominated by shallow to moderately deep Yellow Podzolic Soils (Kurosols, Chromosols) and Yellow Leached Earths on crests; moderately deep Yellow Podzolic Soils (Kurosols, Chromosols), Yellow Leached Earths (Kandosols) and Soloths (Sodosols) on upper and midslopes; and Yellow Podzolic Soils (Kurosols, Chromosols) on lower slopes (King,1990).

The topsoil fertility is low with low to very low nutrient status and low available water holding capacity. Various Soil Essentials reports from the surrounding area record the dominant soil description as sandy clay loam to sandy loam (King,1990).

Searches were conducted for the Project to investigate the likely risk of acid sulfate soils, salinity and mine subsidence as follows:

- A review of the Environmental Planning Instrument and Lithgow LEP 2014 Acid Sulfate Soil Risk Mapping[1] (DPIE 1995) did not identify any risk of acid sulfate soil
- The NSW Department of Planning, Industry and Environment Hydrogeological Landscape and Salinity Hazard Maps[2] (DPIE 2016) did not identify any areas of inland soil salinity risk
- No risk of mine subsidence has been identified following a review of the NSW Government Mine Subsidence District Mapping[3] (NSW Government 2021). However, it is noted that the Project is located within an area that supports coal mining activities.

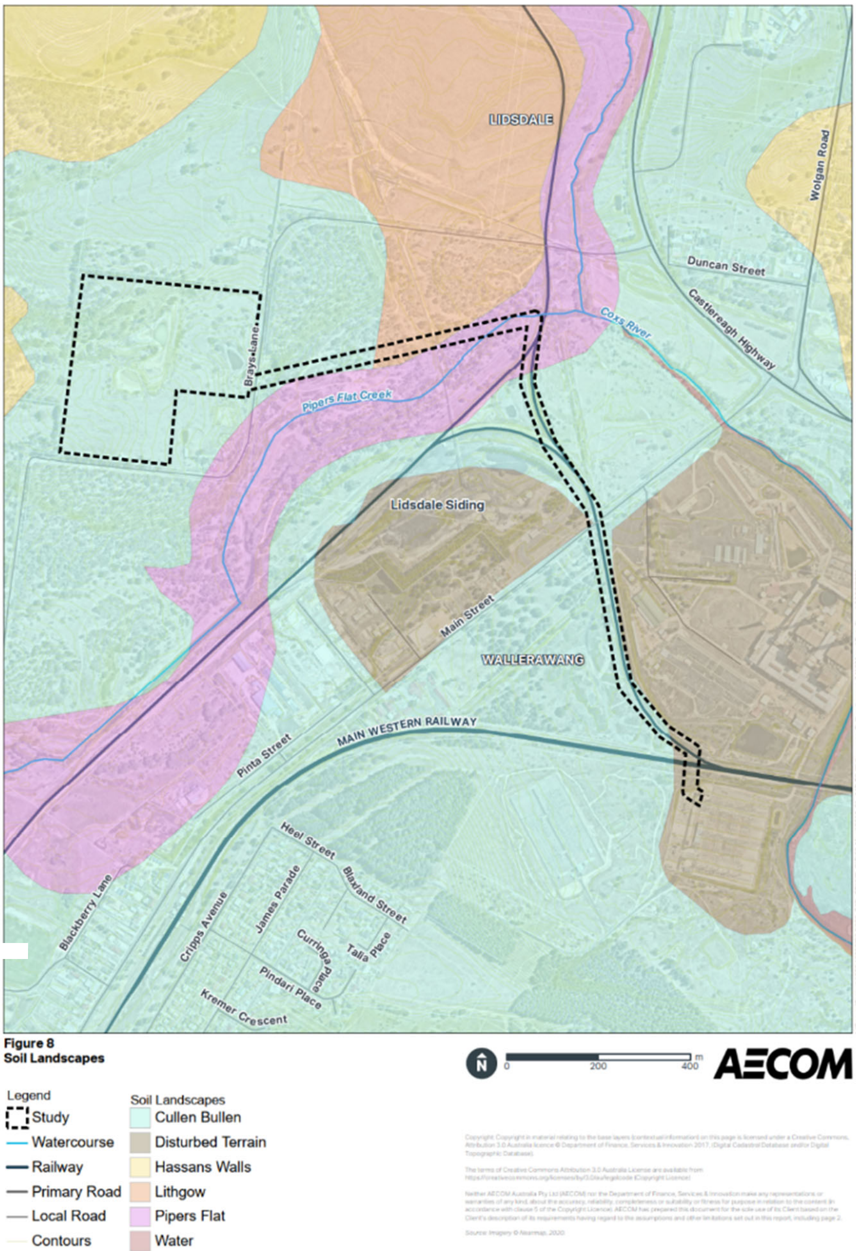

Figure 3-5 Soil Landscapes

[1] Acid Sulfate Soils Risk Mapping URL: https://www.planningportal.nsw.gov.au/opendata/dataset/epi-acid-sulfate-soils
[2] Hydrogeological Landscape Maps URL: https://datasets.seed.nsw.gov.au/dataset/hydrogeological-landscapes-nsw-act
[3] NSW Planning Portal URL: https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address

3.5 Watercourses, water bodies and site drainage

3.5.1 Named Watercourses

Pipers Flat Creek is the closest watercourse to the Project, located about 50 m to the east of the Site. Pipers Flat Creek joins the Coxs River about 700 m downstream from the Site. Other mapped and named watercourses in the vicinity of the Project include Lake Wallace (part of Coxs River, 4 km downstream from the Site). Watercourses that occur within proximity of the Project are shown on **Figure 1-1**.

3.5.2 Site Drainage Features

The existing dams influence surface water flows and flooding across the Site. The dams attenuate surface water flows as flows move through the Site, and the dams help to contain more surface water on-site, thereby reducing the volume and rate of water discharged offsite and entering Pipers Flat Creek.

The location and extent of the Site, as well as the existing flow paths and various dams scattered across the Site, are displayed in **Figure 3-6**. There are four (4) main dams that exist across the Site (dams 1, 2, 3 and 4) in addition to three (3) smaller dams located within the south-eastern residential property (dams A, B and C).

There are also two main flow paths moving through the Site:

1. Northern flow path – collecting runoff from the northern portion of the Site and running through dams 1, 3 and 4, before directing flow over Brays Lane and then discharging to Pipers Flat Creek.
2. Southern flow path – collecting runoff from the southern portion of the Site and directing it through Dam 2, before merging with the northern flow path at Dam 3, which discharges to Pipers Flat Creek via Dam 4.

These main flow paths, as well as all other flow paths across the Site, are ephemeral and only convey surface water following a rainfall event. No beds, banks or other geomorphological features are present that suggest that these flow paths are watercourses or creeks. Equally these flow paths do not support any riparian vegetation.

A small (approximately 1.6 ha) portion of the Lot also directs runoff into the south-east residential property, draining to the dams within that property (dams A, B and C).

3.5.3 Riparian Corridors

As outlined in **Section 2.1.3**, DPE have guidelines that apply to riparian corridors, the *'Natural Resources Access Regulator – Guidelines for controlled activities on waterfront land – Riparian Corridors'* (NRAR 2018). Based on these guidelines, the two flow paths that run in an easterly direction through the Site (refer **Figure 3-6**) and discharge to Pipers Flat Creek were assessed and results reported in the Biodiversity Development Assessment Report (Biosis 2021). The assessment concluded that the flow paths within the Site were not considered to provide diversity of habitat for terrestrial, riparian and aquatic plants and animals or provide habitat connectivity. (Biosis 2021), and as such were not subject to the requirements of controlled activities on waterfront land.

The proposed underground transmission connection between the Site and the Transgrid Wallerawang 330 kV substation would cross the Pipers Flat Creek riparian corridor near the railway bridge. The transmission line is to be bored underneath the creek and as such will not impact the riparian corridor.

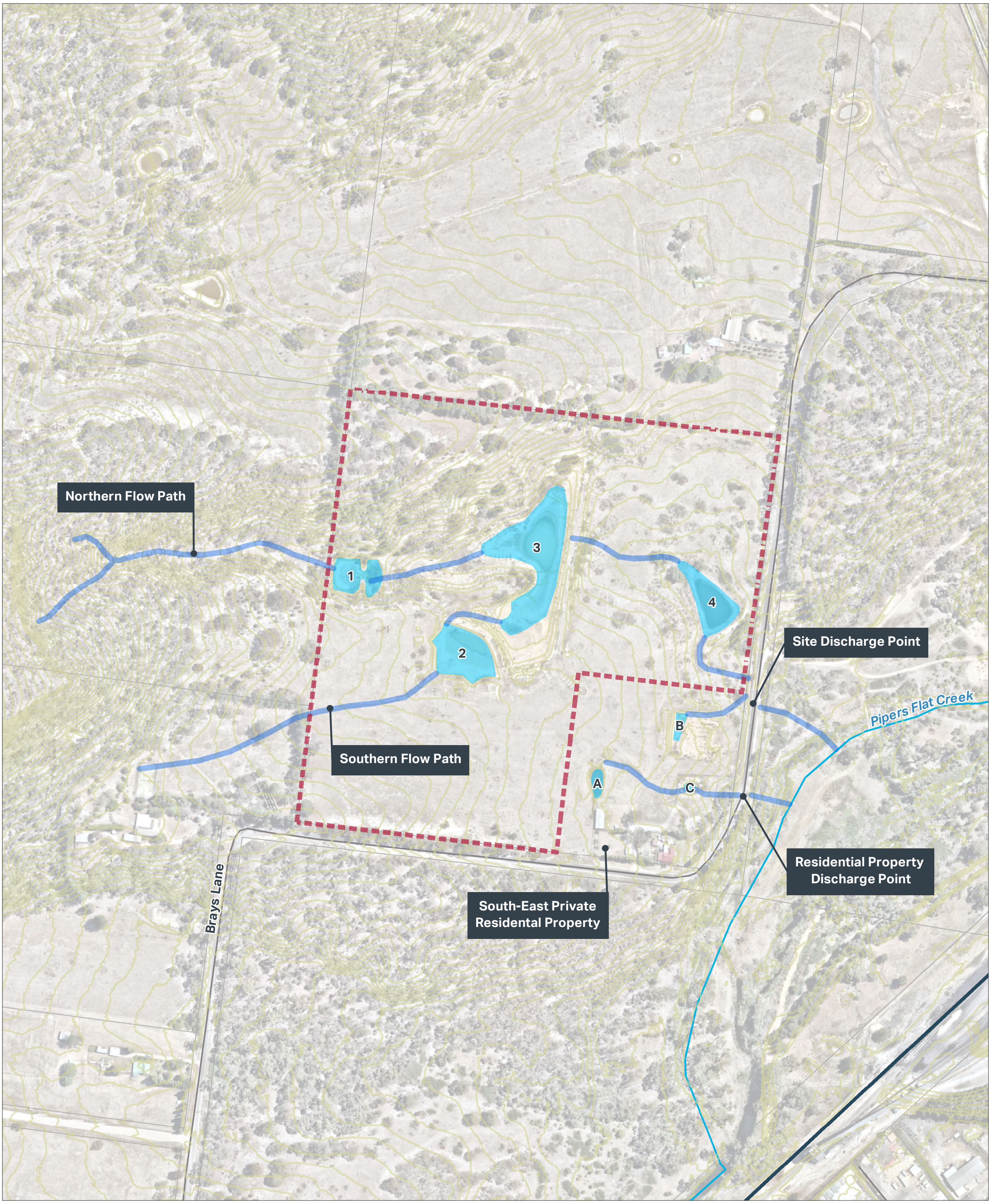

Figure 3-6
Existing Conditions on the Site

Legend

- The Site
- Dam
- Cadastre
- Flow Path
- Watercourse
- Railway

N
0 60 120 m

Source: Imagery © Nearmap, 2020.

3.5.4 Receiving Environment

Runoff from the Site discharges to Pipers Flat Creek which drains eastwards into Coxs River (about 700 m), which is part of the Hawkesbury/Nepean catchment. This is also within the Sydney Drinking Water Catchment (as discussed in **Section 3.3**). Runoff from the proposed transmission line would drain to the Coxs River.

3.6 Existing flood behaviour

A TUFLOW model was developed to assess the performance of the proposed stormwater management plan in comparison to the existing flood behaviour and existing discharge conditions. This modelling approach and results have been documented in the **Appendix A Flood Assessment**.

As shown in **Figure 3-7**, the general flood behaviour across the existing Site consists of:

- Floodwaters along the northern flow path move in an easterly direction and enter Dam 1 before eventually spilling into Dam 3.
- Floodwaters along the southern flow path move in a north-easterly direction and enter Dam 2 before eventually spilling into Dam 3.
- Flows overtopping from Dam 3 then head in an easterly direction towards Dam 4.
- Flows spilling out of Dam 4 are then directed towards Brays Lane, where flows overtop the road and head towards Pipers Flat Creek.
- A small portion (2.0 ha) of the Site directs runoff into the adjacent south-east property and feeds into their existing dams A and C. Rain falling directly on the property also helps fill these two dams, along with Dam B.
- Flow spilling out of Dam B heads towards Brays Lane and merges with flows discharging from the Site before overtopping the road and heading towards Pipers Flat Creek.
- Flow spilling out of dams A and C head towards Brays Lane, where they overtop the road and head towards Pipers Flat Creek. The point where these private property flows overtop Brays Lane is approximately 75 m south of the discharge point for the Site.

3.6.1 Site discharge

The existing dams across the Site (dams 1, 2, 3 and 4 in **Figure 3-9**) slow down and attenuate floodwaters as they move across the land. This helps to contain more surface water onsite and reduce peak discharge rates and volumes. The peak discharge rates and volumes for each Annual Exceedance Probability (AEP) modelled are discussed in **Appendix A Flood Assessment**.

3.6.2 South-eastern property

The modelled results of the existing site condition show that stormwater runoff from the site enter the south-east property at its western boundary. Estimates of the peak discharges and volumes of these flows entering the property are included in **Appendix A Flood Assessment**.

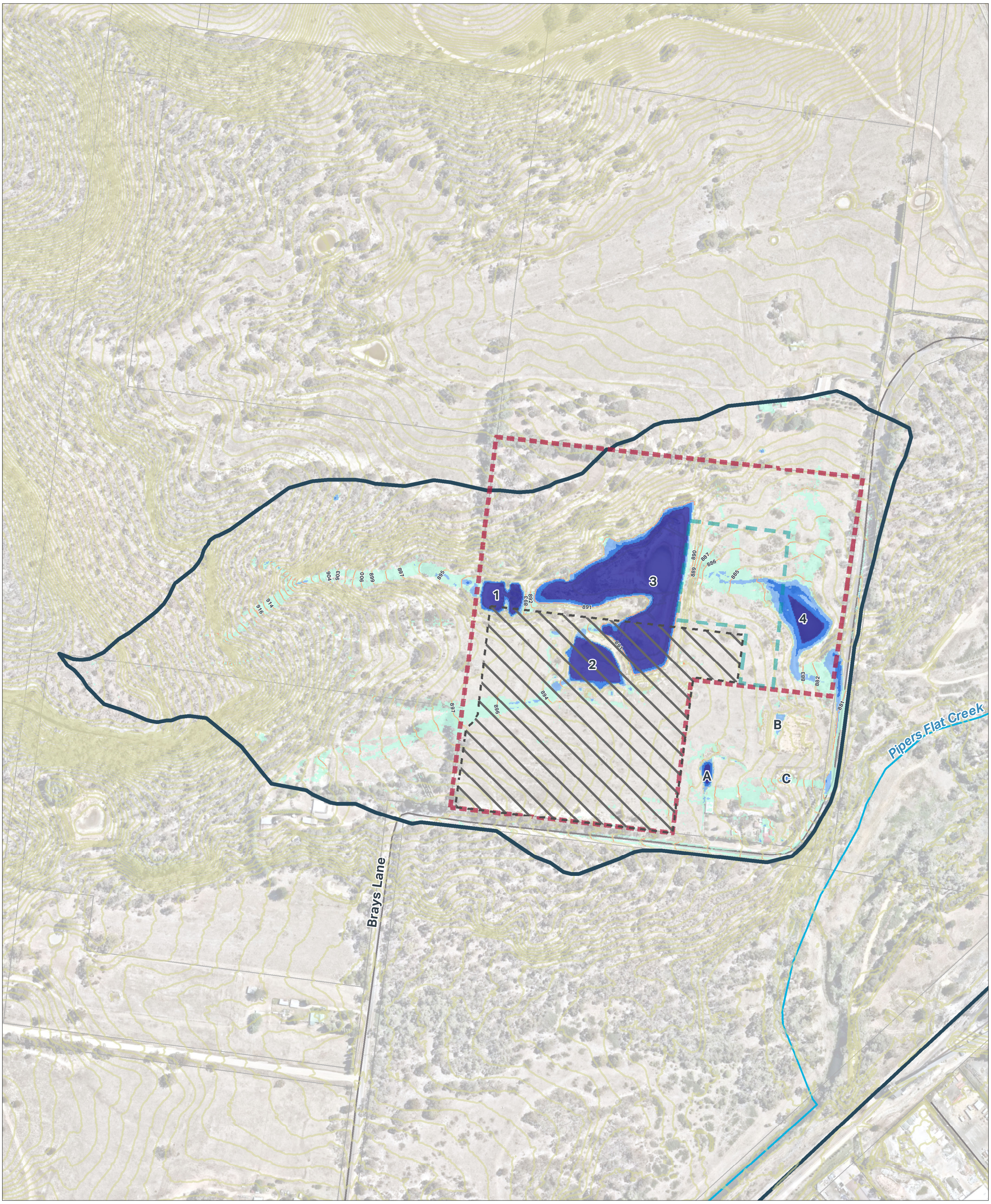

Figure
3-7 Existing Flood Behaviour Across the Site

Legend

The Site	Cadastre
Model Boundary	Railway
Development Zone	Watercourse
Construction Laydown, Storage And Parking	1m contours
	Flood Level Contours (1m interval)

Flood Depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

Source: Imagery © Nearmap, 2020.

3.7 Surface water quality

The existing Site and wider Project Area does not include any formal water quality treatment or erosion protection measures before discharging to Pipers Flat Creek. Some areas of the existing surfaces across the Site are bare and vulnerable to the effects of scouring due to rainfall and runoff.

Pasture grasses and other vegetation across the Site is likely to provide some protection against erosion. The existing dams onsite have been assumed to provide some level of pollutant removal by allowing for sediments and other potential particulate pollutants, to settle out of suspension. Vegetation within the dams would also help to remove nutrients, such as nitrogen and phosphorus. These pollutant loads have been estimated using MUSIC. **Figure 4-1** shows the water quality catchments adopted for the existing Site and contains the estimated pollutant loads. These catchments are also discussed in **Section 4.2.3** with pollutant load estimates provided in **Section 4.2.3.4**.

Any existing areas of vegetation would provide greater protection against the erosive effects of rainfall and runoff; however, there are still some areas of exposed soils that would be susceptible to erosion and contribute to the transportation of sediments in waterways.

Further information on the existing vegetation within and around the Project is provided in Chapter 8.0 of the EIS and the Biodiversity Development Assessment Report which has been prepared for the Project (Biosis, 2021) and is attached in Appendix C Biodiversity Development Assessment Report to the EIS.

3.8 Aquatic ecosystem

There are no aquatic habitat impacts relating to the Fisheries Management Act 1994 on the Site (Biosis 2021).

The location of the proposed transmission line would intersect Pipers Flat Creek, however in this location the transmission line would be underbored to avoid interaction with this waterway and any associated aquatic biodiversity values.

The drainage lines on the Site are ephemeral and due to the level and extent of modification (vegetation clearing, dam construction, and historical land use) they no longer function as ephemeral waterways but simply as drainage lines that represent the lowest points in the landscape, and do not sustain aquatic habitats.

There are no Key Fish Habitats as mapped by the NSW Department of Primary Industries (DPI) within the Project Area and no local wetlands have been identified within the Project Area.

3.9 Biodiversity

The Project is located within a mosaic of agricultural land and habitat. Within and nearby the Project Area habitat areas are situated along Pipers Flat Creek, reserves and roads. These features contain native woodland vegetation and terrestrial and aquatic fauna habitat features. These reserves are subject to edge effects and have been disturbed by past and ongoing land clearing, agricultural activities and weed invasion (Biosis, 2021).

The Project Area supports several hectares of native vegetation with varying levels of disturbance. The following plant community types (PCT) can be found within the Project Area:

- PCT 677 - Black Gum grassy woodland of damp flats and drainage lines of the eastern Southern Tablelands, South Eastern Highlands Bioregion
- PCT 732 - Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion

The highest quality patches of these PCTs in the Project Area Native vegetation (generally found in the north west corner of the Site and where the transmission line would be underbored between Brays Lane and the rail corridor) support large trees, an understorey with most of the structural components still intact and a number of species that characterise the associated PCT.

The majority of vegetation found on the Site comprises Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion. Over the vast majority of the Site this vegetation type was found to be in a state of 'non-offsetable grasslands' (NOG). The poor condition of vegetation across the majority of the Site (in the location of the proposed BESS) can be attributed to historical clearing and pasture improvement. This vegetation has been classed as NOG based on a lack of both native structural and floristic diversity within all stratums. It is to be noted that a distinguishable canopy layer was not recorded, and the ground layer stratum was found to be dominated by exotic pasture species (Biosis, 2021). The rail corridor is mapped as comprising Urban Native / Exotics.

The two plant communities identified as accruing in the Project Area are known to be Groundwater Dependent Ecosystems (GDEs) (BOM 2021). These occur in the northwest corner of the Site and in the vegetated areas to the east of Brays through which it is proposed the transmission line would be underbored.

3.10 Licensed water uses

A search of registered groundwater bores from the NSW Office of Water (DPI 2021) database indicates there are eight registered groundwater bores within proximity of the Project Area.

Only three of the identified boreholes are likely to be used for the extraction of groundwater (GW053071, GW110520 and GW115261). Of these, two are for rural / residential use (GW053071 and GW115261), however, anecdotally, it is believed that the borehole at the Site is no longer in use. Water supply for the Lidsdale Siding coal loader is sourced from a licensed groundwater extraction bore (GW110520), with the allowance for 8.5 ML a year to be extracted.

Table 5 Registered groundwater users near the Project Area

Bore number	Licence status	Use	Approx. distance from Project Area	Owner type
GW053071	Unknown	Irrigation	Within the Site	Private
GW101461	Unknown	Domestic	1530 m	Private
GW110437	Unknown	Test Bore	575 m	Private
GW110520	Current	Industrial	740	Private
GW115010	Unknown	Monitoring	830 m	Private
GW115011	Unknown	Monitoring	750 m	Private
GW115260	Unknown	Nil available	830 m	Nil available
GW115261	Current	Nil available	750 m	Nil available

4.0 Impact assessment

4.1 Construction phase

This section discusses the potential impact of the construction phase activities on surface water quality, hydrology, and flooding. This assessment is based upon construction activities for the Project outlined in the EIS.

A detailed list of construction works to be undertaken have been identified in **Section 1.3.1** of this report. Relevant construction activities include:

- Earthworks to divert the ephemeral drainage lines that currently cross the Site to route flows around the proposed BESS pad
- Site preparation and temporary works: establishing site access, access roads, establishing erosion and sediment controls, site clearing, installing security fencing, establishing laydown areas, establishing construction amenities (including temporary offices, lunchrooms, storage areas and washrooms)
- Earthworks to form a level BESS pad, new substation area, and construction laydown area, and to increase the current capacity of the large dam on the Site.
- Installation of site drainage and underground utilities
- Construction of hardstand foundations in the form of compressed gravel or concrete slabs
- Construction, installation and connection of aboveground civil, mechanical and electrical plant equipment and structures
- Construction of supporting structures, e.g. buildings and associated amenities, formal access and circulation
- Concreting, asphalt, and surfacing
- Stockpiling of materials
- Construction of underground transmission connection between the Site and the Transgrid Wallerawang 330 kV substation
- Installation of landscaping and permanent security fencing
- Removal of construction equipment and rehabilitation of construction areas (i.e. construction lay down area and transmission line easement).

4.1.1 Surface water drainage

Construction works required for the Project will directly impact ephemeral drainage lines on the Site. Construction may also result in sedimentation impacts on nearby watercourses without controls.

As discussed in **Section 3**, there are two flow paths moving through the Site in an easterly direction. To allow the construction of the BESS pad, it is proposed to undertake earthworks to divert the southern flow path north once it enters the Site, joining it to the northern flow path closer to the western boundary. From this point the combined ephemeral flow paths would flow east adjacent to the northern boundary of the proposed BESS pad towards a revised Dam 3 (referred to a Dam 5). Diverting the southern ephemeral drainage line would allow surface water to flow around the BESS pad (refer to **Figure 4-2**).

Construction of the Project would also require the infilling of Dam 1, Dam 2 and the southern part of Dam 3. Dam 2 is located on the southern drainage line and both it and the southern part of Dam 3 are required for the BESS facility and associated infrastructure.

The proposed earthworks, diversion of the southern drainage line and changes to the dams have the potential to cause a minor redistribution of some surface flows generated by the Project Area. The disruption of existing flow paths and the earthworks required to build the diversion channel could result in the following surface water impacts:

- Localised ponding occurring at new areas across the Site with the potential to impact works
- Earthworks causing runoff to move as concentrated flows, as opposed to existing runoff moving as sheet flow, which has the potential to scour out the earth and mobilise sediment in runoff discharging to Pipers Flat Creek
- Earthworks directing concentrated flows into the neighbouring properties which could potentially create drainage/flooding issues within these properties and the surrounding downstream environment.

These potential impacts are discussed further in **Table 6** below.

4.1.2 Flooding

As discussed in **Section 3.0** of this report, there are two flow paths moving through the Site in an easterly direction. Whilst these flow paths are dry outside periods of rainfall events, there is potential for the two upstream catchments to generate flows during heavy rainfall events which would be directed through the Site along the drainage lines and into the existing dams before discharging to Pipers Flat Creek. The proposed construction areas are located on these existing flow paths, in a rainfall event, this could lead to floodwaters moving through the construction site.

Flooding along the ephemeral drainage line during construction works would present a safety hazard to construction personnel, could cause damage or loss of materials and equipment and could potentially lead to materials being washed offsite which could potentially block drainage infrastructure and/or have environmental impacts (for example, increased sediment flow to the receiving surface water environment).

Measures to mitigate potential impacts related to flooding are provided in **Section 5.3**. These include measures to monitor weather to identify the potential for flooding to occur and measures to reduce the likelihood that flooding would result in significant impacts or adverse impacts to the receiving surface water environment. Mitigation measures include the construction of a channel to divert flows around the proposed earthworks area.

4.1.3 Surface water quality

Potential impacts to surface water quality during construction are outlined in **Table 6**. The receiving waterways for the potential impacts stated below are Pipers Flat Creek and Coxs River.

Table 6 Potential impacts to surface water quality during construction

Construction Activity/ Source of Pollutants	Pollutants of Concern	Potential Impact
Mobilisation of sediment from exposed soils and release of sediment laden runoff from construction areas, leading to sedimentation of receiving waterways	Sediment, nutrients, contaminants, gross pollutants	• Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration • Reduced visual amenity (visible gross pollutants)
Dust, litter and other pollutants associated with building materials, earthworks and demolition waste being mobilised by wind and stormwater runoff into waterways	Sediment, gross pollutants	• Reduced visual amenity (visible gross pollutants) • Possible intake of gross pollutants by fish
Leakage or spills of petroleum hydrocarbons, lubricants, effluent, oils and greases from machinery or equipment, during refueling or accidental spill could potentially result in pollutants being conveyed to downstream waterways	Hydrocarbons, oil and grease, hydraulic fluids, other hazardous chemicals	• Oil sheen on water surface and increases in toxicant concentration which could lead to fish kills and other undesirable impacts

Construction Activity/ Source of Pollutants	Pollutants of Concern	Potential Impact
Concrete washout water being discharged into waterways	High pH, chromium	• Increases in alkalinity and toxicant concentration which could lead to fish kills and other undesirable impacts
Increase in alkalinity in waterways due to transport of chemicals used in treatment and curing of concrete and mobilisation of concrete dust to waterways through wind, runoff	High pH	• Increases in alkalinity of waterways which could lead to fish kills and other undesirable impacts
Earthworks and changes to the Site resulting in concentrated flows, as opposed to sheet flow, that have potential to scour the earth and increase sediment loads carried by surface waters	Sediment, nutrients, contaminants	• Increased risk of scour and erosion • Increased turbidity, lower dissolved oxygen levels and increased nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration • Reduced visual amenity (turbidity)
Vehicle movement across construction site areas may loosen soils and transport sediment into the waterways either by runoff carrying sediment from loosened soils or through sediments attached to the vehicles traversing drainage lines.	Sediment, nutrients, contaminants	• Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration
Dewatering open excavations following periods of rainfall, which may contain sediments and other pollutants mobilised by the rainfall.	Sediment, nutrients, contaminants	• Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration.

To avoid and minimise potential surface water quality impacts during the construction phase of this Project, management and mitigation measures would be required. These measures are described in **Section 5.3**. Key amongst these measures would be to manage surface water in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (DECCW 2008), commonly referred to as the 'Blue Book'.

Whilst a number of potential impacts could occur, these impacts are typical of the development of greenfield sites and are managed on a regular basis. With the implementation of the mitigation and management measures described in **Section 5.3**, impacts to the receiving watercourses are likely to result in no impact to the water quality of the receiving waters.

4.1.4 Water use and wastewater

The number of workers/occupants on the Site and across the Project Area would be at its largest during the construction phase of the Project. To accommodate these workers, there would likely be some temporary office facilities including amenities. This would require a temporary higher demand for potable water. It is noted that during the two months of peak of construction, up to 250 workers may attend the Site in a day, however this number would more typically be about 50 workers a day outside of the peak construction period. Potable water would initially be delivered to the Site with water trucks until such time as a potable water connection is established. It is proposed to make the connection to the potable supply network at the start of the construction process so that potable water would be available during the construction phase for worker amenity. Water for construction activities would be sourced from the on-site dams whenever possible, and where not possible would be trucked into the Site.

Wastewater generated would be kept in holding tanks and disposed offsite. Measures to mitigate potential impacts related to water use and wastewater are provided in **Section 5.3**.

4.2 Operational phase

4.2.1 Surface water drainage

Under existing conditions, the Site is almost entirely pervious. The proposed layout of the Site would increase the impervious area which would in turn, increase the runoff generated by the Site. Areas that would contribute to an increase in impervious area include:

- Office buildings
- Access/internal roads
- Hardstand areas in the form of compressed gravel or concrete slab to support battery enclosures, transformers, site facilities and ancillary components.

A conceptual site drainage and stormwater management plan is shown in **Figure 4-3**, but it is expected that these modifications would be refined and optimised during detailed design.

The impervious area across the Site would likely increase from 3% to 41% which would increase in the amount of runoff generated by developed areas. All drainage infrastructure within the development areas would be designed to safely convey runoff towards the nearest dam. This would be Dam 5 for the majority of the site.

The Site's drainage system would typically consist of minor (underground) and major (overland) drainage systems with a combined capacity capable of conveying the 1% AEP flows. Both the minor and major drainage systems would be designed during the detailed design phase, including appropriate erosion and scour protection measures.

The proposed dam modification strategy would be capable of storing site runoff and controlling/reducing the peak discharge rates. This reduction in peak flows and discharge volumes would reduce the risk of scour and associated water pollution (turbidity) in downstream environments.

4.2.2 Flooding

As shown in Figures B7 to B12 in **Appendix A Flood Assessment**, the main flood impacts resulting from the Project include:

- The proposed diversion flow path along the western boundary of the Site would be designed to divert the southern flow path around the proposed BESS. This diverts flows from the southern flow path into the northern flow path and then into Dam 5 (refer to **Figure 4-3**).
- The Project alters flow paths across the southern part of the Site, directing runoff from most of the area towards Dam 5 at the centre of the Site.
- Other areas of the site, if disturbed during the construction phase, would be rehabilitated as pasture grasses and no impacts to flows are expected in the long term.
- Following construction, the temporary hardstand area would be returned to a condition similar to the existing condition (pasture grasses). This area is the only site catchment to direct runoff into Dam 4 (refer to **Figure 4-3**). The swale used to divert flows around the construction laydown area would be removed following construction and a swale established to follow the contours of the land (refer **Figure 4-3**).
- Storage that would be lost at dams 1, 2 and 3, by partially or completely filling them to make room for the development zone, would be moved to other areas of the Site (proposed Dam 5). This alters the location and extents of flood storage across the Site. The design sought to retain a similar surface area and flood attenuation volume to the existing conditions in order to minimise impacts to flows.
- Flood extents and depths at Dam 4 would increase due to the proposed increases in imperviousness resulting from the construction of the BESS, and the associated increases in runoff.
- Flows from the Site that would previously enter the south-eastern property would be reduced to zero, as the Project would extend up to the south-eastern property boundary. Areas that currently

drain towards the south-eastern property would be directed back towards Dam 5. This would reduce the amount of flow filling up their dams and leaving the land around this property.

As discussed in the Flood Assessment (refer to **Appendix A Flood Assessment**), overall, the results show that the Project would maintain (or reduce) the peak discharge rates and volume for major design storm events. The shape of the hydrographs (refer to Figures A1 to A6 in **Appendix A Flood Assessment**) (i.e. the change in the rate of discharge over time) is also relatively similar to existing conditions. This is due to the dam configuration (layout and volume for flood storage) for the Project being very similar to existing conditions, with the total flood storage volume being maintained.

As the Project introduces a large area of newly impervious surface, the total runoff generated by the Site also increases. The modified dams are effective at attenuating these flows and reducing peak discharge rates. The flood modelling is not capable of showing a complete reduction in discharge rates (down to zero) in some of the smaller, more frequent storm events as it has been conservatively assumed that all dams are completely full at the beginning of a storm event. However, it is expected that runoff generated in some of these smaller storm events could be entirely contained within the dams as they would not always be full and would therefore have some available storage for the retention of floodwaters.

The proposed dam alterations would be able to adhere to the requirements of the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (SEPP) (**Appendix A Flood Assessment**), as the Project is not expected to result in an increase to the peak discharge rate or volumes during the major storm events and would therefore be likely to result in a neutral or beneficial flood impact on the receiving environment.

As a result of the Project, the modelled results indicate that flow entering the property south eastern via its western boundary would be effectively reduced to zero. This is due to the development zone extending all the way up to the eastern Site boundary. Runoff generated in this area is now being directed to Dam 5 as opposed to the south-eastern property.

4.2.3 Surface water quality

Potential impacts to the quality of stormwater runoff during the operational phase could occur as a result of increases in the impervious surfaces within the Project Area. Pollutants build up on impervious surfaces from atmospheric washout, atmospheric deposition, spills and vehicle wear, and these can be washed off and discharged to the receiving environments.

The design of the Project would result in a 38% increase in total impervious area of the Site (from 3% to 41%). Without treatment, this could result in an increase in a commensurate increase contaminants and litter in the runoff that would discharge to Pipers Flat Creek and Coxs River. These potential impacts are outlined in **Table 7**.

To meet the requirements of the Neutral or Beneficial Effect (NorBE) on Water Quality Assessment Guideline 2021, a water quality treatment system would be designed and implemented to reduce the load of pollutants generated from impervious services so that the water quality requirements can be achieved. A bioretention system has been proposed as part of the Project to treat surface water flows from the BESS facility to a standard that meets the requirements of the NorBE Guidelines. Further information regarding the proposed bioretention system is provided below. Further details would be confirmed during detailed design.

Table 7 Potential impacts to surface water quality during operation

Activity/ Source of Pollutants	Pollutants of Concern	Potential Impact
Stormwater runoff from hard surfaces being discharged to Pipers Flat Creek and Coxs Creek	Gross pollutants, TSS, nutrients, heavy metals, oil and grease	• Increased turbidity, lower dissolved oxygen levels and nutrients • Increases in toxicant concentration • Increased alkalinity

Activity/ Source of Pollutants	Pollutants of Concern	Potential Impact
Erosion and sedimentation – Vehicle movements bring sediments into site, which may be washed off impervious areas	Gross pollutants, TSS	• Increased turbidity, lower dissolved oxygen levels and nutrients • Increases in toxicant concentration • Smothering of aquatic habitats
Accidental spill or leakage events during site operations	Oil and grease and various hazardous fuels and chemicals that may be transported by vehicles or caused by spills	• Increases in toxicant concentration
New site layout concentrating flows which may increase the risk of scour and sediment mobilisation	Sediment, nutrients, contaminants	• Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration • Reduced visual amenity (turbidity)
Raindrop and rill erosion on the pervious surfaces surrounding the batteries pervious surfaces due to the surface not having a protective cover or having insufficient compaction.	Sediment, nutrients, contaminants	• Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth • Increases in toxicant concentration • Reduced visual amenity (turbidity)

4.2.3.1 Pollutant load targets

As per the WaterNSW Guideline (WaterNSW 2019), to ensure NorBE is achieved, the modelled pollutant loads for the proposed scenario should aim to achieve 10% less than the existing scenario for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN). For gross pollutants (GP), the modelled existing scenario load only needs to be equal to or less than the existing load.

To evaluate the pollutant concentration levels generated from the Site development, eWater's MUSIC software package was used. WaterNSW sets the pollutant target loads conservatively to account for potential uncertainty in MUSIC predictions and to ensure that NorBE is satisfied despite this uncertainty.

4.2.3.2 Pollutant concentration targets

To meet NorBE, the concentration of pollutants for the proposed scenario should always be equal to or less than the concentration for the existing scenario. NorBE would be deemed to be met if the existing scenario pollutant concentrations are equal to or less than the existing scenario concentrations between the 50th and 98th frequency percentiles when runoff occurs. This is demonstrated by comparing the cumulative frequency graphs of pollutant concentrations (typically in milligrams per litre) for the existing and proposed scenarios (i.e. the existing Site and the Site following development of the BESS).

4.2.3.3 Treatment opportunities considered

Opportunities for stormwater treatment were considered during the design process. Stormwater treatment opportunities considered are described in **Table 8**. A bioretention system has been selected as the preferred option (presented in **Figure 4-3**).

Table 8 Treatment opportunities considered for stormwater runoff

Treatment Option	Description	Constraints	Outcome
Constructed Wetlands	Constructed wetlands are artificial systems that mimic functions of natural wetlands in reducing fine particulate sediments and associated pollutants such as suspended solids, total phosphorous and total nitrogen. A footprint of ~7% of the contributing catchment is typically required to meet treatment targets for stormwater runoff.	• Requires an impracticably large footprint to meet NorBE targets	Not feasible
Vegetated Swales	Vegetated swales are typically trapezoidal or dish-shaped open channels provided to convey and filter stormwater runoff through vegetation to remove coarse sediment and total suspended solids.	• Swales are proposed to convey flows across the Site, between the dams and to the offsite discharge point. • Swales alone do not provide sufficient treatment to achieve NorBE pollutant load targets.	Feasible
Bioretention Systems	Bioretention systems are vegetated filters that treat runoff as it flows vertically through a filter media. Pollutants are removed through the physical processes of screening, chemical process of adsorption and precipitation, and biological processes of uptake and transformation.	• Requires a vertical grade difference of about 1 m to allow the filter media to drain	Feasible. This is the preferred option.
Ponds	A pond is essentially a basin with a permanent water storage component and a lower vegetation coverage than constructed wetlands. The lower vegetation coverage results in less efficient treatment than constructed wetlands.	• Requires an impracticably large footprint to meet NorBE targets • Ponds are proposed for flood attenuation purposes.	Not feasible for water quality treatment
Gross Pollutant Traps (GPTs)	GPTs such as the CDS / Holcim Humeceptor /Ocean Protect Cascade are proprietary products designed to screen and settle particulates in stormwater runoff. Gross pollutant traps can be used as a pre-treatment measure for sites where large sub-catchment scale measures are proposed, such as water quality control ponds, bioretention basins, constructed wetlands or stormwater filtration devices. Clean-outs would require a vacuum truck to remove the	• GPTs alone do not provide sufficient treatment to achieve NorBE pollutant load targets. These would be considered as pre-treatment to a bioretention system.	Feasible as part of a treatment train for water quality treatment

Treatment Option	Description	Constraints	Outcome
	accumulated pollutants, and clean-out frequency would be about once per year. Clean outs are expected to take several hours.		
Filterra®	A Filterra® biofiltration system is very similar to a typical biofiltration system The key difference is that Filterra® biofiltration systems use an engineered filter media blend that can treat flows at a significantly higher flow rate than typical biofiltration filter media. Filterra biofiltration systems can achieve equivalent pollution reduction with significantly less area (typically 0.3% of upstream area) relative to typical biofiltration systems (with 'loamy-sand media, typically 1.5% to 2% of the contributing upstream catchment area). The Filterra design may be installed with other associated proprietary products to support the desired NorBE performance outcome.	• Filterra filter media is more expensive than bioretention filter media. However this expense may be offset the smaller required footprint and associated construction costs. • Filterra would be considered further in detailed design if it can provide equivalent treatment with most effective use of space.	Feasible and to be considered further in detailed design.

4.2.3.4 MUSIC modelling results for pollutant loads

The existing and proposed scenario parameters were setup based on the WaterNSW Standard *Using MUSIC in Sydney Drinking Water Catchments* (WaterNSW, 2019). The catchments for the existing scenario are shown in **Figure 4-1** and the proposed catchments are shown in **Figure 4-2**. Modelling was only completed the areas of the Site that are proposed for development. The construction laydown area was not included in the model as after the construction phase it would be returned to the existing landcover of pasture grasses.

The catchments identified outside of the Site were not included in the MUSIC models.

The NorBE guidelines require a 10% improvement in the pollutant loads for the proposed scenario compared to the existing scenario. As the existing scenario was predominately pervious and had four farm dams that treat water quality, the benchmark pollutant loads are low. This means that a significant investment in stormwater treatment systems would be required to meet the NorBE pollutant load targets for the Project.

The proposed areas to be developed include the BESS area, the 330 kV substation and building/carpark, indicated in **Figure 4-2**. To compare the development area of the proposed scenario to the existing scenario, the equivalent developed area was calculated and modelled for the existing scenario. The catchment source node summary for the existing and proposed scenarios are shown in **Table 9** and **Table 10** respectively. The terrestrial areas were ascribed an imperviousness of 5% to account for the existing unsealed road. Dam 2 and Dam 3 catchments were ascribed with a fraction imperviousness of 100% and a rainfall threshold of 0 to account for rainfall on the dam area, as per WaterNSW (2019).

Table 9 Development Area – Existing scenario catchment source node summary

Catchment	Area (ha)	Impervious (%)	Treatment Device
Terrestrial Area	4.867	5	Nil
Dam 2	0.239	100	Nil
Dam 3 (Sub catchment)	0.080	100	Nil
Total	5.186		

Table 10 Developed – Proposed scenario catchment source node summary

Catchment	Area (ha)	Impervious (%)	Treatment Device
Substation	0.908	100	Bioretention System
Management Building/Carpark	0.091	100	Bioretention System
BESS Area	4.187	100	Bioretention System
Total	5.186		

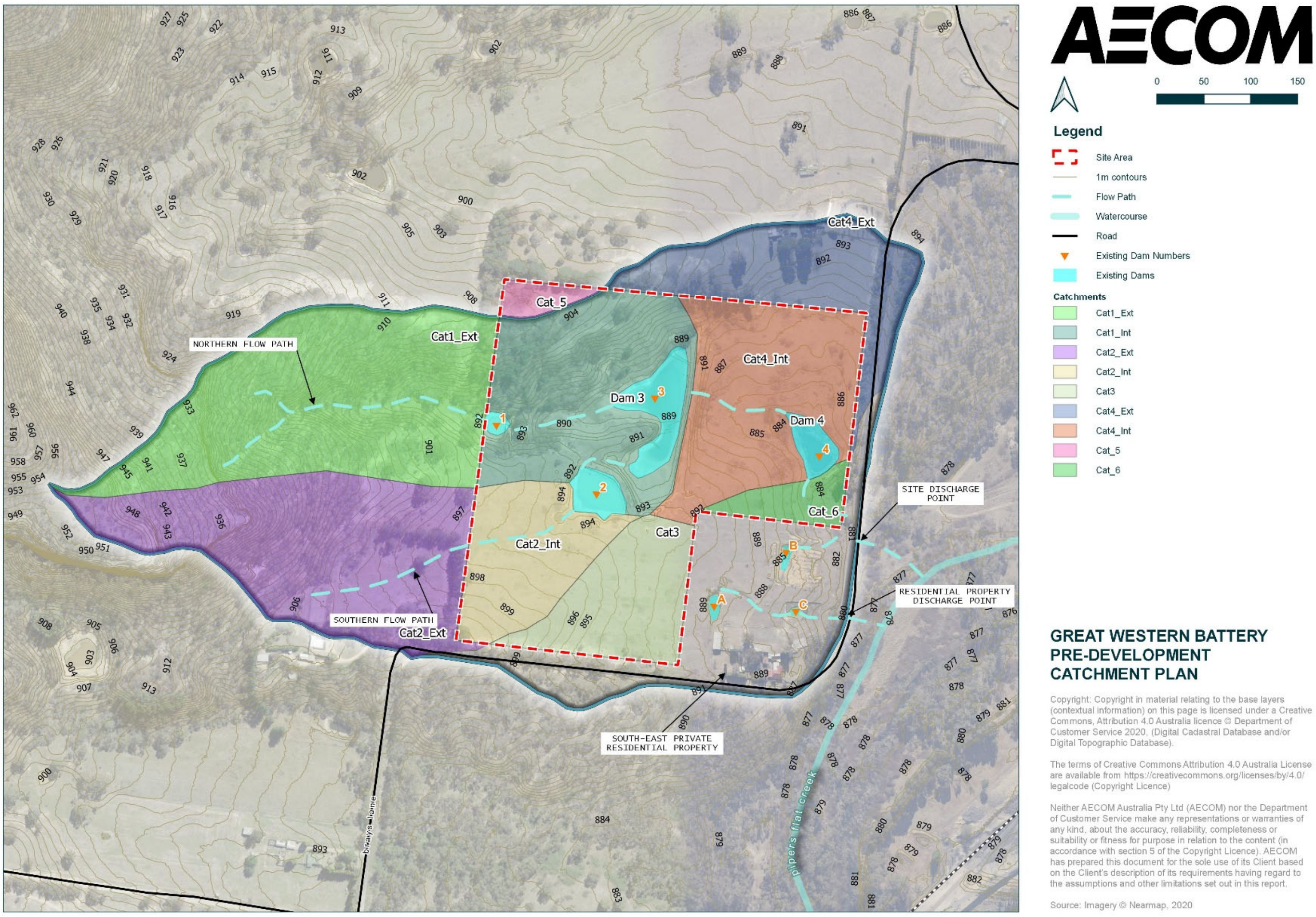

Figure 4-1 Existing scenario catchment plan

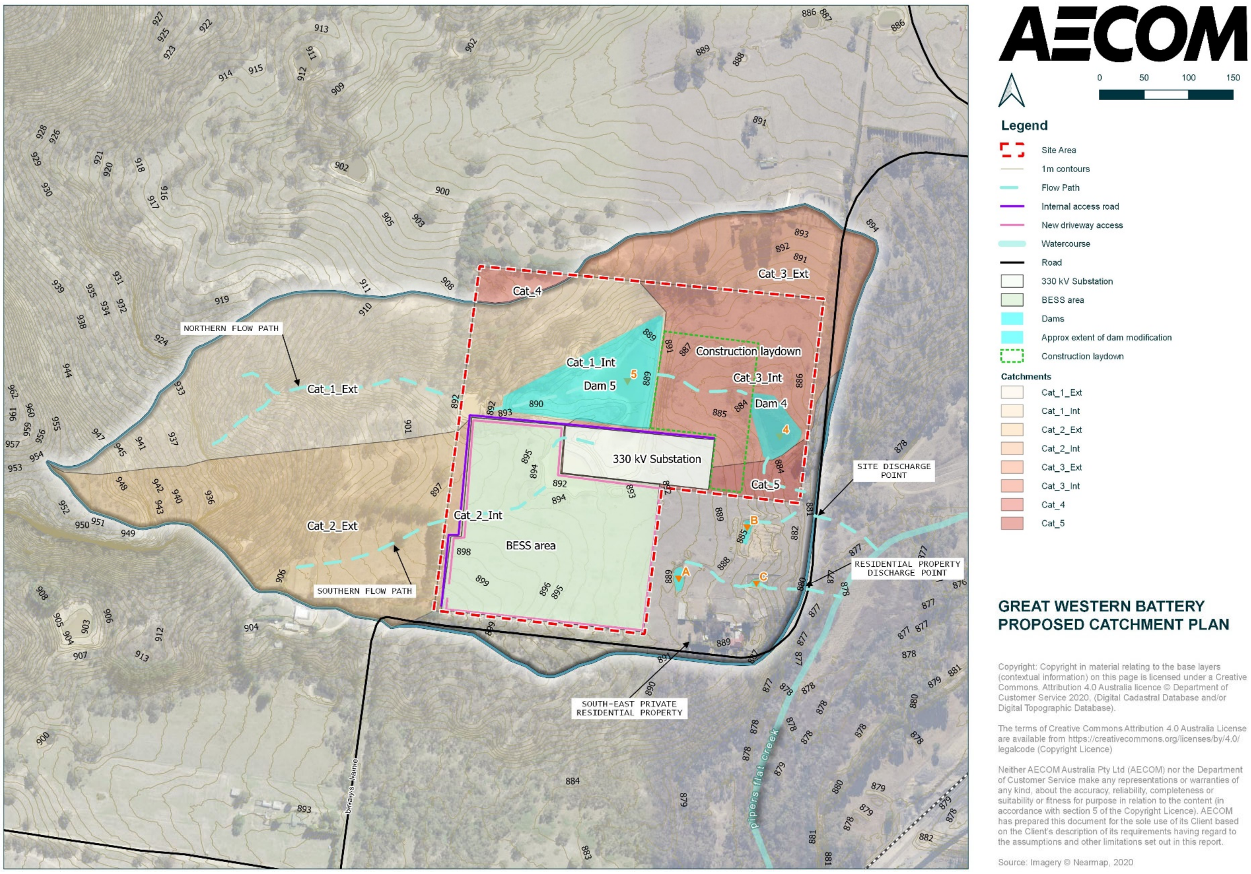

Figure 4-2 Proposed scenario catchment plan

The MUSIC Modelling results for the area to be developed are outlined in **Table 11**. These results show that the NorBE requirements for reducing pollutant loads can be achieved for the area of the Site to be developed, when compared to the existing scenario. This table shows the estimated pollutant loads for the existing and proposed scenarios. The results indicate that the inclusion of a bioretention system is sufficient to achieve a reduction of pollutant loads, such that the pollutant loads resulting from the Project would be at least 10% less than the existing scenario. The modelled dimensions and parameters of this treatment system are summarised in **Table 12** and the location of the proposed bioretention system is shown in **Figure 4-3**, with a cross section sketched in **Figure 4-4**.

Table 11 Developed Area - music modelling pollutant load results

Scenario/Catchment	Annual Pollutant Loading (kg/yr)			
	TSS	TP	TN	GP
Existing	903	2.43	25.8	138
Proposed	138	1.57	22.5	0
Difference	-765	-0.86	-3.3	-138
% Improvement	**84.7**	**35.4**	**12.8**	**100**
Neutral or beneficial effect? (Y/N)	Y	Y	Y	Y

Table 12 Bioretention system parameters modelled in MUSIC

Parameter	Value Adopted
Extended Detention Depth	0.30 m
Surface Area	2500 m^2
Filter Area	2500 m^2
Filter Depth	0.40 m
Saturated hydraulic conductivity	90 mm/hr
Submerged zone depth	0.3 m
TN content of filter media	400 mg/kg
Orthophosphate content of filter media*	20 mg/kg
Exfiltration	0 mm/hr

*Orthophosphate content of filter media is typically < 10 mg/kg, hence 20 mg/kg used as a conservative estimate.

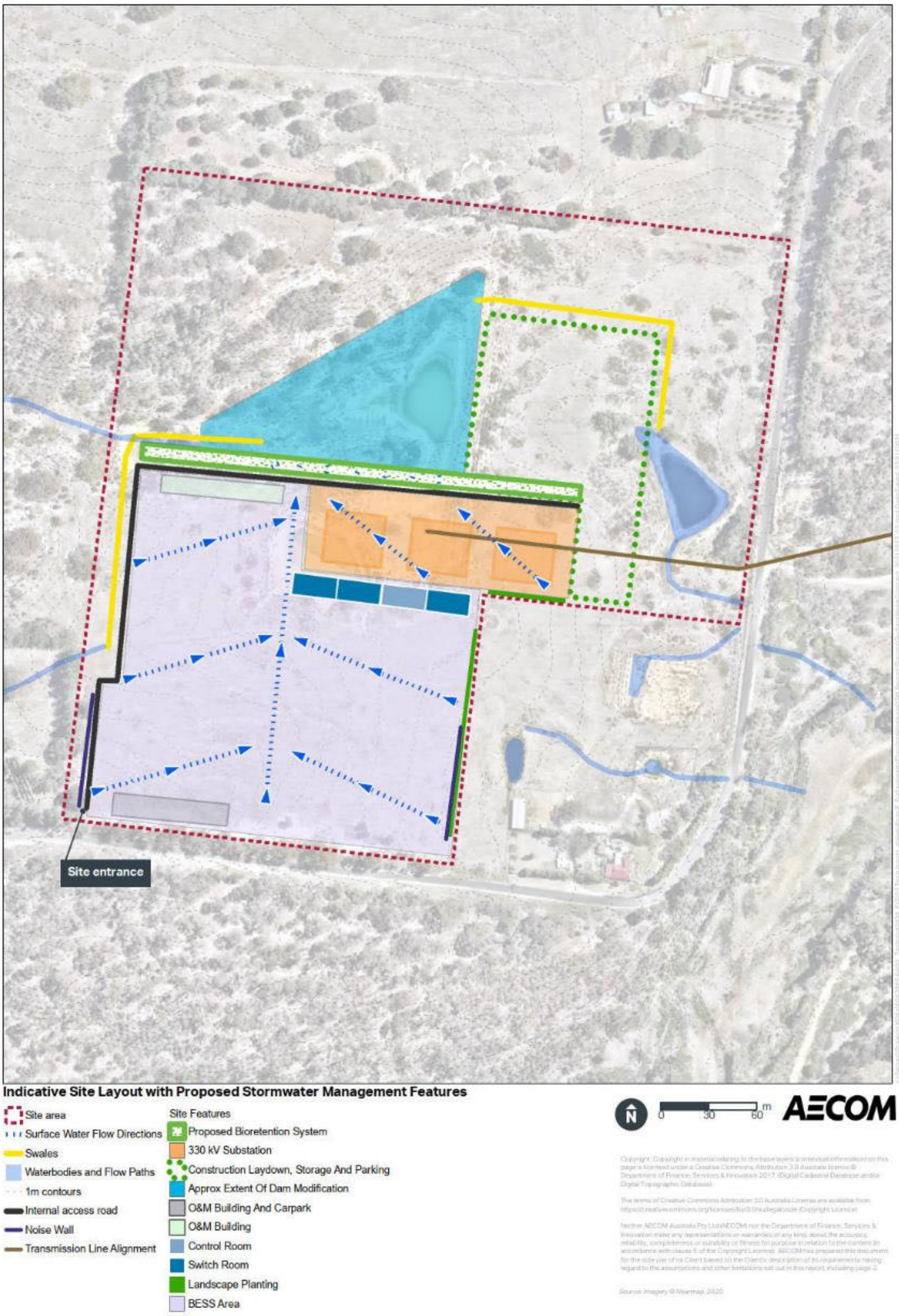

Figure 4-3 Proposed stormwater management plan with bioretention system

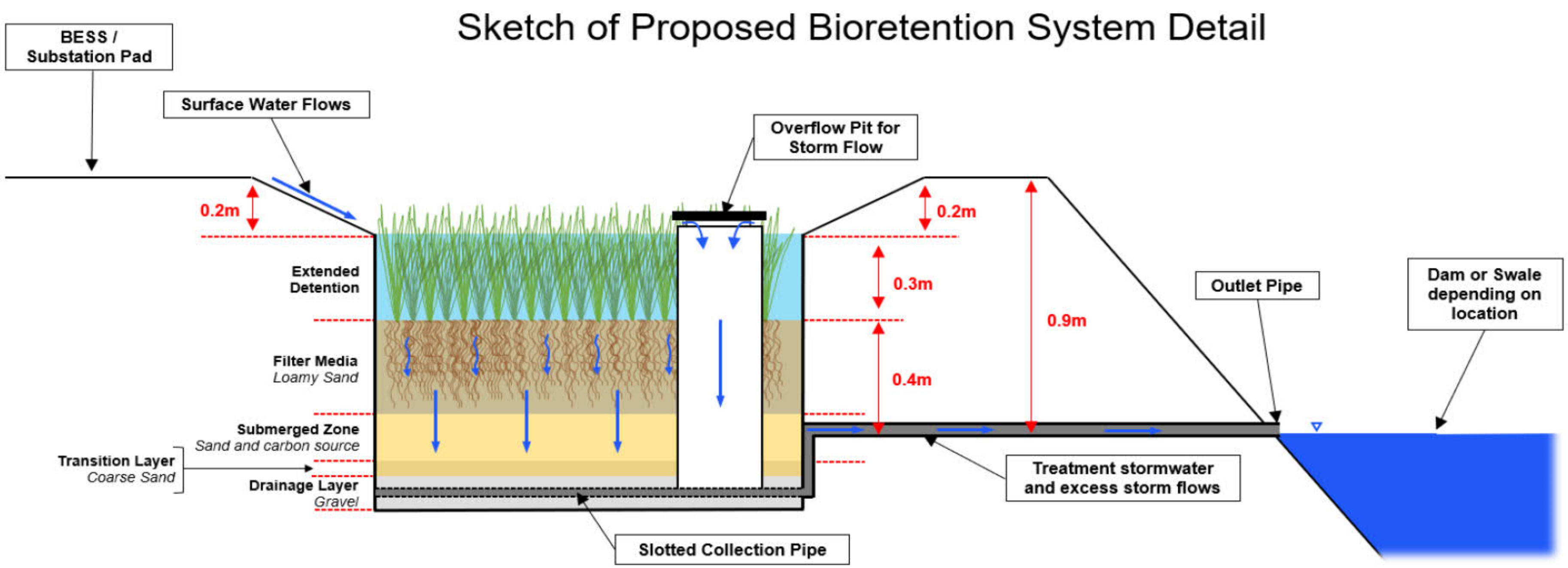

Figure 4-4 Sketch of Proposed Bioretention System Detail

4.2.3.5 MUSIC modelling results for concentrations

NorBE requirements for reducing pollutant concentrations are deemed to be met if the post-development case pollutant concentrations are equal to or less than the pre-development case concentrations between the 50th and 98th frequency percentiles when runoff occurs. This can be demonstrated by comparing the cumulative frequency graphs of pollutant concentrations for the pre- and post-development cases. The concentrations in runoff from the pre and post-development scenarios were compared using MUSIC's cumulative frequency graphs in accordance with the WaterNSW (2019) MUSIC modelling guidelines.

The combined graphs indicate that the post-development concentration is equal to or less than the pre-development level between the 50th and 98th percentiles, indicating compliance with the NorBE test.

The graph below shows that total suspended solids concentrations in runoff (refer to **Figure 4-5**) from the post development scenario are less than the pre-development scenario at the 50th and 98th percentiles.

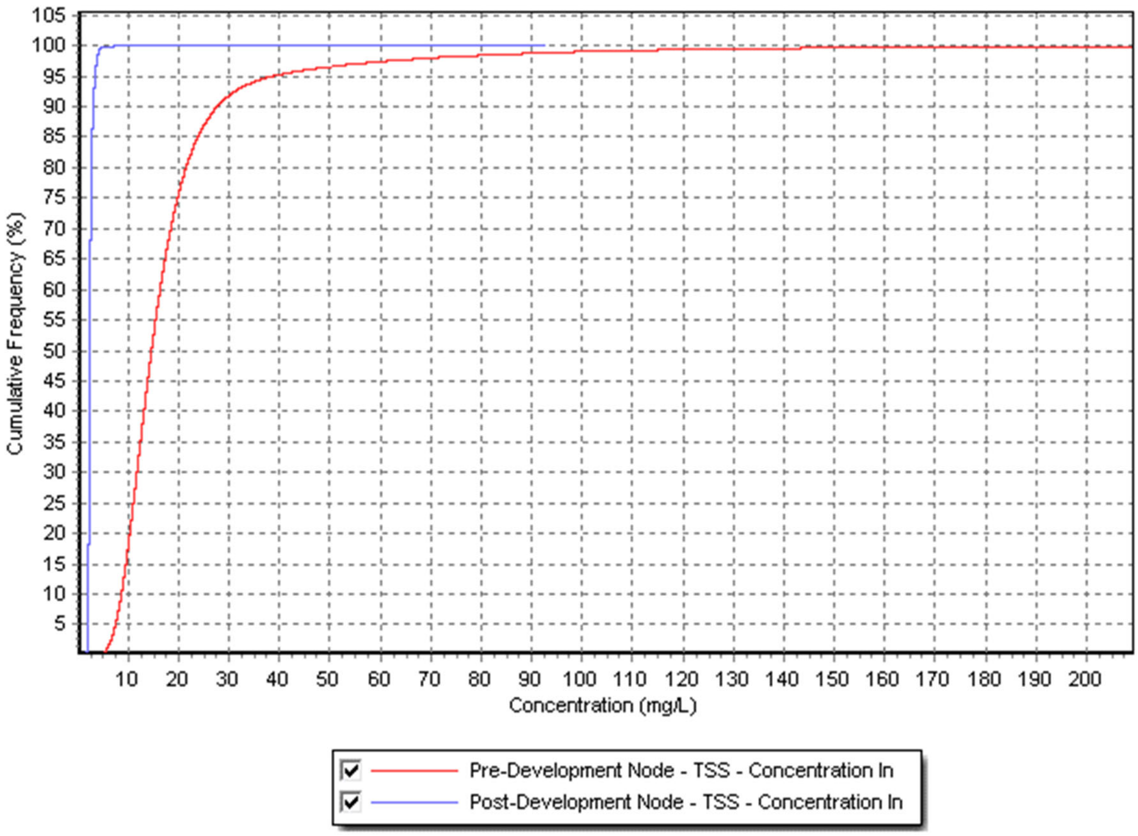

Figure 4-5 Comparative Cumulative Frequency Graph for Total Suspended Solids

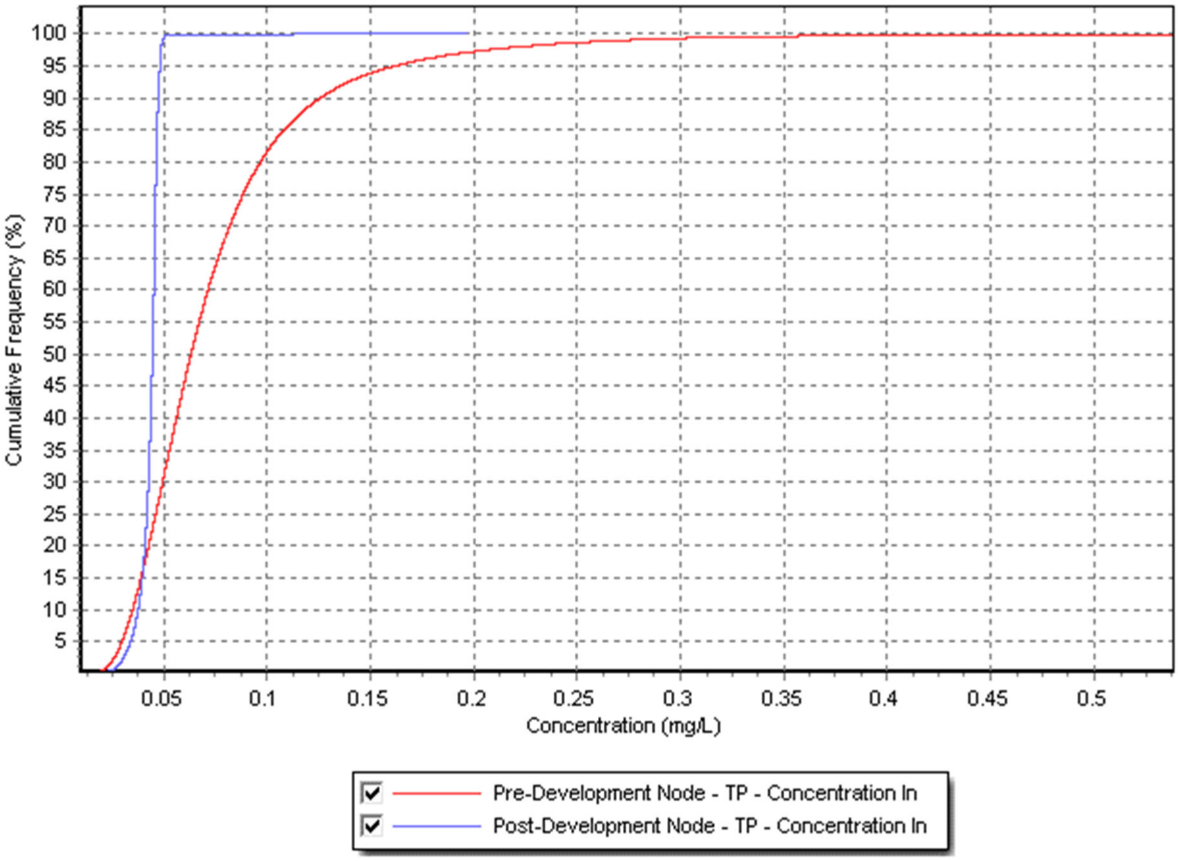

Figure 4-6 Comparative Cumulative Frequency Graph for Total Phosphorus

The graph below shows that total nitrogen concentrations in runoff (refer to **Figure 4-7**) from the post development scenario are less than the pre-development scenario at the 50th and 98th percentiles.

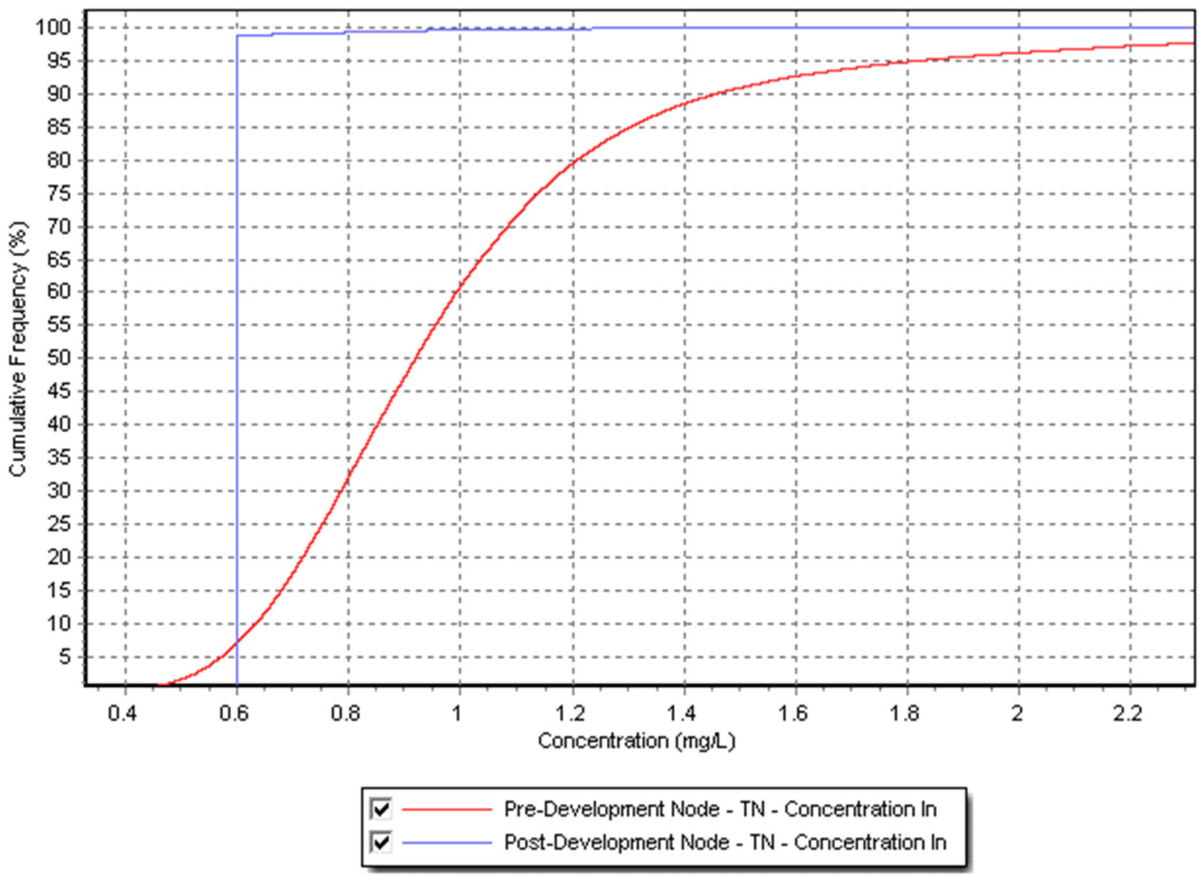

Figure 4-7 Comparative Cumulative Frequency Graph for Total Nitrogen

4.2.3.6 Additional surface water quality buffers

Although the treatment requirements for stormwater runoff were met with a bioretention system, there would be additional treatment buffers provided by the Project that are not accounted for in the modelling. These are:

- The water bodies proposed for flood attenuation onsite would provide further pollutant removal for runoff from the BESS area
- A series of vegetated swales would be used to convey surface water flows around the BESS facility and across the Site, between the dams and from the dams offsite. Some treatment would occur in the swales as water interacts with the soil and vegetation.

Further, aquatic habitats would be created by the construction of the Dams 4 and 5 and connecting swales. The creation of these habitats would contribute to the habitat values of the Pipers Flat Creek riparian corridor downstream.

4.2.4 Water use and wastewater

The Project would be connected to the existing potable water reticulated service on Brays Lane. This would service the site office and the operation of the Project. The potable water demand during the operation phase is expected to be minimal since the Site would be an unmanned facility managed remotely by Neoen. It is anticipated that the Site would be periodically visited by Neoen employees as required for maintenance activities.

The volume of wastewater produced is also expected to be limited. A wastewater holding tank would be installed to collect sewer waste at the Site during operation. The waste in the tank would be periodically collected by a truck and disposed of at an appropriately licensed waste facility offsite.

Assumptions regarding wastewater production are as follows (summarised in **Table 13**):

- Potable water and amenities for six full time equivalent employees onsite 5 days per week. Consumption of 5L/day/person = 30 L/day x (5/7) days/week = 21.4 L/day average daily demand. This is considered a conservative and 'worst-case' scenario as it likely that there would be fewer employees on site most of the time.
- One site toilet and associated wash basin requiring 0.1 kL/day. Used for 5 days per week = average daily demand would be slightly less at 0.71 kL/day (Blacktown City Council 2020)
- General washdown facilities allowing for 1 tap with daily usage 0.005 kL (BCC 2020). Used for 5 days per week = 0.004 kL per day. It is assumed that this would drain to the wastewater holding tank.

This gives an average water demand (potable) of 0.077 kL/day for when the Site is attended.

It is conservatively assumed that wastewater production would be similar and that 100% of this demand would become wastewater captured in the proposed wastewater holding tank. Therefore, it is estimated that the Site would generate approximately 0.539 kL of wastewater every week when the Site is attended.

A wastewater holding tank of 10 kL capacity is proposed. It would need to be emptied every 18 weeks (on average) by a 10,000 L vacuum tanker truck. The tank size would be optimised during detailed design.

Table 13 Site water demands and wastewater production rates

Water Use	Average Volume Wastewater Produced (kL/day)
Toilets (one toilet)	0.071
Potable water and amenities	0.002
General washdown	0.004
Total	**0.077**

With the use of the existing potable water network supply, and the wastewater holding tank, it is not expected that there would be any impacts to other users of the local potable water supply, the wastewater network or to the water quality of receiving environments.

5.0 Management and mitigation measures

5.1 Overview

This section describes the environmental management approach for surface water, flooding and water use during the construction and operation phases of the Project. Mitigation and management measures that would be implemented to minimise the effects on the receiving environment during the construction and operational phases of the Project are summarised in **Table 14**.

The construction focused mitigation and management measures described would be included in the Construction Environmental Management Plan (CEMP) for the Project.

For this Project, the disturbed area would be greater than 2,500 m^2, therefore according to the WCMS requirements and guidelines (WaterNSW 2020), a conceptual soil and water management plan (SWMP) is required. This plan must describe what would be done at the development site to control soil erosion and pollutant movement to downslope lands and receiving waters during construction and operation.

A SWMP would be produced as a subplan to the CEMP for the Project which would include measures to manage soils and surface water considerations. The SWMP would outline:

- The objectives of the SWMP
- Performance criteria and key performance indicators to measure the success of plan
- Legislative requirements including reference to relevant conditions of consent and management and mitigation measures
- A summary of the activities that are likely to cause impacts related to soil and water and the potential impacts identified in the SSD application documentation (including the EIS)
- A summary of the proposed approach to managing potential impacts
- A list of the measures that would be implemented to meet the legislative requirements and the performance criteria alongside information on who is responsible for each measure and the frequency and/or timing that applies to each measure
- An outline of the monitoring requirements that would be implemented to meet the legislative requirements and the performance criteria alongside information on who is responsible for monitoring and the frequency and/or timing that applies
- Information on reporting requirements and the approach to corrective actions.

The principal performance criteria for the Project during construction would be to ensure that surface water flows leaving the Site or worksites along the transmission line corridor have a neutral of beneficial effect on the water quality of Pipers Flat Creek and/or Coxs River.

The SWMP would include Erosion and Sediment Control Plans (ESCPs) for the construction works at the Site to show where specific controls would be employed and to help ensure that erosion is minimised and nearby the nearby watercourse of Pipers Flat Creek is protected. It is likely that up to three ESCPs may be produced to manage different stages of the construction of the Project however this would be confirmed by the construction contractor. ESCPs are likely to be required for:

1. Initial stormwater and drainage management works at the Site to alter the ephemeral drainage lines, infill or redesign dams, establish swales whilst managing associated earthworks and other early works activities (e.g. construction of site access)
2. Principal earthworks at the Site to develop the BESS facility pad, internal access roads, construction laydown areas, bioretention system etc. whilst protecting swales, dams, and the offsite receiving environment etc. from erosion and sedimentation impacts
3. Structural, electrical, and finishing works at the Site to manage the installation of battery enclosures, transformers, buildings etc. as well as landscaping, security etc. and the rehabilitation of the construction laydown area whilst protecting swales, dams, and the offsite receiving environment etc. from erosion and sedimentation impacts.

The ESCPs would provide more specific detail on the design and application of specific erosion and sediment controls and would be supported by detailed ESCP drawings showing:

- The location of relevant control measures
- How stormwater flows would be managed across the Site
- Where construction materials and spoil would be stockpiled.

Measures within the SWMP and ESCPs would be developed in line with the 'Blue Book' Managing Urban Stormwater: Soils and Construction Guidelines (Landcom, 2004). The SWMP and ESCPs would be designed to ensure that surface water flows leaving the Site would have a neutral of beneficial effect on the water quality of Pipers Flat Creek.

Various standard erosion and sediment controls would be employed to manage soils and surface water on the Site during construction of the BESS and the installation of the transmission line. The precise approach to managing soils, erosion and surface water would be confirmed by the construction contractor, however key controls and measures have been included as management and mitigation measures in **Table 14**.

5.2 Construction and Maintenance Recommendations

A bioretention basin is proposed as part of the Project to help ensure that surface water discharges from the Site meet NorBE requirements. To help ensure that the construction of bioretention basin is successful, the following measures would be undertaken:

- The design and construction of the bioretention basin would be overseen by a person with previous experience in the construction and successful operation of these systems
- Drainage systems, filtration media and vegetation would be installed in line with agreed designs to ensure proper functioning throughout the life of the treatment system
- Erosion and sediment control measures would be in place during the construction phase of the Project to ensure that the bioretention systems are protected from high sediment loads
- The bioretention system would be brought online at the end of the construction phase once major earthworks at the Site are complete to minimise the risk of clogging from sediments
- Vegetation would be selected based on local climate and rainfall regime.

To ensure the ongoing performance and visual amenity of the WSUD treatment systems, regular maintenance and monitoring is required. Both bioretention systems and swales both require minimal maintenance if sized and designed appropriately with suitable vegetation and media.

Maintenance requirements for bioretention systems include:

- Monitoring for scour and erosion
- Monitoring for and regular removal of accumulated litter, fine sediment, pests and debris
- Weed removal and plant re-establishment to maintain high nutrient removal efficiency
- Monitoring overflow pits for structural integrity and blockage
- If clogging or contamination is observed, replacement of vegetation and the filter media layer may be required.

Alternative designs to the bioretention system have been identified in Table 8 e.g. the Filterra© engineered filter media and associated proprietary products. If these are used, they must be installed and maintained in accordance with the manufacturer's recommendations.

5.3 Mitigation and management measures

The impacts identified in **Section 4.0** of this report, and the mitigation and management measures that would be implemented to minimise the effects on the receiving environment are summarised in **Table 14**.

Table 14 Mitigation and management measures

Reference	Identified impact	Mitigation and management measures	Timing
Erosion and sediment control			
SW1	Erosion and sediment control mitigation	A Construction Soil and Water Management Plan (SWMP) would be prepared for the Project in accordance with the requirements and principles of the Managing Urban Stormwater – Soils and Construction, Volume 1 (the Blue Book) (Landcom 2004), Volume 2A (DECC1 2008a) and Volume 2D (DECCW 2008b). This plan would include management and monitoring measures to be implemented to mitigate the potential surface water quality impacts which could occur during construction. This plan would outline: • The objectives of the SWMP • Performance criteria and key performance indicators to measure the success of plan • Legislative requirements including reference to relevant conditions of consent and management and mitigation measures • A summary of the activities that are likely to cause impacts related to soil and water and the potential impacts identified in the SSD application documentation (including the EIS) • A summary of the proposed approach to managing potential impacts • A list of the measures that would be implemented to meet the legislative requirements and the performance criteria alongside information on who is responsible for each measure and the frequency and/or timing that applies to each measure • An outline of the monitoring requirements that would be implemented to meet the legislative requirements and the performance criteria alongside information on who is responsible for monitoring and the frequency and/or timing that applies • Information on reporting requirements and the approach to corrective actions. The principal performance criteria for the Project during construction would be to ensure that surface water flows leaving the Site or worksites along the transmission line corridor have a neutral of beneficial effect on the water quality of Pipers Flat Creek and/or Coxs River.	Construction
SW2	Erosion and sediment control mitigation	Areas established within the Project Area for stockpiling would be planned, operated, and decommissioned in accordance with the RTA Stockpile Site Management Guideline 2011.	Construction

Reference	Identified impact	Mitigation and management measures	Timing
SW3	Erosion and sediment control mitigation	The rehabilitation of disturbed areas would be undertaken progressively as construction stages are completed, and in accordance with the Blue Book (Landcom, 2004).	Construction
SW4	Transmission line disturbing soils and local vegetation	A new underground transmission line would be constructed to connect the BESS area of the Site to the Transgrid Wallerawang 330 kV substation. Following the completion of this work, all trenched areas would be backfilled, grassed areas would be re-established, and any fencing impacted by the works would be reinstalled in accordance with the Blue Book (Landcom, 2004).	Construction
SW5	Construction laydown distributing soils and local vegetation	A construction laydown area would be constructed onsite to be used during the construction phase. Following the completion of the construction work, the construction laydown area would be re-established to the existing conditions in accordance with the Blue Book (Landcom, 2004). Any channels installed to divert flows around the laydown area during the construction phase would be removed and a vegetated swale would be established to follow the natural contours of the land between Dam 4 and Dam 5.	Constructed

SW6	Erosion and sediment control mitigation	Consistent with the SWMP, control measures would be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. Controls that would be considered, include:
		• Identification of upslope run-on waters from undisturbed areas of catchment and diversion of these around un-stabilised areas of the Site
		• Sediment management devices, such as fencing, hay bales or sandbags, coir logs and graded or lined earth or sandbag diversion bunds and banks
		• Measures to divert or capture and filter water prior to discharge, such as drainage diversion channels and sediment sumps or traps
		• Scour protection and energy dissipaters at locations of high erosion risk
		• Installation of measures at key work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays, or regular sweeping
		• Location and storage of construction materials, fuels, and chemicals, including controls where possible would be managed in accordance with Managing urban stormwater: soils and construction (the Blue Book). Controls may include:
		    o cover before significant weather events
		    o bunds
		    o diversion of offsite flows away from storage
		    o stabilised laydowns
		    o storage clear of frequently flooded low-lying areas and from residential areas
			Construction

Reference	Identified impact	Mitigation and management measures	Timing
		• Stabilisation of the surface of batters and drains, including temporary works and diversions.	
Surface water quality			
SW7	Surface water contamination	A Spill Management Procedure would be prepared and implemented as part of the CEMP to minimise the risk to surface water quality of pollution arising from spillage or contamination on the Site and adjoining areas during the construction phase. The Spill Management Procedure would address, but not necessarily be limited to: • Management of chemicals and potentially polluting materials • Any specialist containment, security and bunding requirements • Maintenance of plant and equipment • Emergency management, including notification, response, and clean-up procedures	Construction
SW8	Surface water contamination	Discharge of potentially contaminated runoff, originating from the construction site, would not occur without prior treatment or testing, and/or prior approvals. Surface water would be managed in accordance with Managing urban stormwater: soils and construction (the Blue Book). If dirty water runoff or potentially contaminated water cannot be treated onsite, then it would need to be disposed of at an appropriately licensed facility.	Construction
SW9	Stormwater runoff water quality	Stormwater treatment measures would be incorporated into the drainage design to provide treatment of surface water runoff before discharging from the Site. Stormwater treatment devices would be used to ensure a Neutral or Beneficial Effect (NorBE) on runoff water quality. A bioretention system is proposed, but other options may be considered provided that an equivalent or better performance outcome can be achieved.	Operation
SW10	Accidental spills and leaks from batteries and transformers	The battery design would incorporate spill containment measures and/or spill response procedures and facilities to prevent spillage from impacting surface water quality and runoff. The transformers at the Site would be designed in line with the relevant Australian Standards for power transformers. The transformers at the Site would be designed in line with the appropriate Australian Standards and located within impermeable bunds which are designed to contain 110% of the volume of the oil in the transformer.	Operation

Reference	Identified impact	Mitigation and management measures	Timing
Flooding and drainage			
SW11	Dam safety	If required by Dam Safety NSW, the dam modifications proposed would be designed in accordance with the relevant guidelines and standards (Including the; Dam Safety NSW guidelines (Dam Safety NSW 2021), *Dam Safety Act 2015* (NSW Government 2019) and *Dams Safety Regulation 2019 (NSW Government 2020)*) (e.g. ensuring the embankments are stable and of suitable material to prevent piping failure or stability failure, making sure each dam has a designated spillway, assessing potential downstream impacts if the dam were to fail and implement maintenance plan and safety procedures to prevent failure, etc.)	Pre-construction (design) and operation
SW12	Flood mitigation	Where existing drainage lines are to be impacted during construction, then an alternate (diversion) path, of equal capacity, would be established prior to commencing construction works. This would be included in the construction methodology to be developed in advance of construction works commencing. The construction methodology would include temporary stabilisation of disturbed outlets and banks of drainage lines.	Pre-construction and Construction
SW13	Floodwaters	Regular monitoring of weather and rainfall conditions would be conducted to identify severe weather warnings and potential flood conditions for the Project Area. Procedures would be included in the CEMP to cease work and secure equipment to ensure safety of workers prior to and during potential flood conditions.	Construction
SW14	Site drainage	The site drainage would be designed to drain the BESS area to the proposed Dam 5. Dam 5 would provide attenuation for increases in peak flows that result from the Project.	Operation
SW15	Floodwaters	The ground surface of the BESS area would be set at a level above the 1 % AEP flood event so that the infrastructure would not be impacted by regional flooding. The office buildings, inverters, transformers and batteries would be elevated above surface level on concrete pads to protect them from potential local flooding impacts.	Operation
Water use and wastewater			
SW16	Wastewater disposal	Wastewater collected on site would be periodically removed by a licensed waste contractor.	Construction and operation

6.0 Cumulative Impact Assessment

Other developments in the area include:

- The Wallerawang ash fly dam remediation
- Wallerawang Power Station decommissioning
- Another large battery project to be developed at the former Wallerawang Power Station

These projects have the potential to impact water quality during their respective construction phases, and it is expected that appropriate mitigation measures would be implemented to mitigate potential impacts. Further for the operational phases of these projects, it is expected that runoff and wastewater would be managed in accordance with the NorBE requirements such that there is no impact to downstream water quality. These other nearby developments are not expected to have an impact on this project, or the ability of this project to provide mitigation during the construction or operation phases.

Further, no cumulative impacts are expected to arise as a result of the Project. The requirement for the Project to have a Neutral or Beneficial Effect on water quality has guided design such that the Project would have a net improvement in the quality of runoff from the Site. Additionally, the rehabilitation of the Site after the construction phase would introduce aquatic habitat values in the ponds and swales associated with site drainage, which would provide additional buffering capacity for the water quality of site runoff.

Flooding would be attenuated by the dams proposed for the Site so that there would be no residual impacts to flooding downstream.

7.0 Summary

This report involved an impact assessment for surface water, flooding and water use related to the construction and operation of the Great Western Battery Project.

This assessment involved a desktop review of the existing environment to identify surface water receptors and the existing flood and drainage behaviour of the Site. Identification of construction and operational impacts of the Project and establishing the appropriate mitigation and management measures to eliminate or minimise adverse impacts.

Under existing conditions, the Project Area was almost entirely pervious and undeveloped. The Project Area contains numerous well-defined flow paths and farm dams that were likely constructed for water harvesting purposes. The existing farm dams play an important role in slowing down surface water flows as they move through the Site and help to contain more surface water onsite, thereby reducing the amount of water discharged offsite and entering Pipers Flat Creek. The Project is likely to change the existing dams and flow paths due to the site layout considerations and increases in the imperviousness of the Site.

The key potential changes and impacts resulting from the Project include:

- Construction works of the Project that could disrupt the existing flow patterns to receiving waterways, such as Pipers Flat Creek
- Concentrated flows moving through and discharging from the Site that could scour the earth
- Disturbed surfaces and stockpiles during construction that could increase the risk of sediment mobilisation and transportation via surface flows
- Construction of the new underground transmission line, connecting the BESS area of the Site to the Transgrid Wallerawang 330 kV substation, that could disturb soils and vegetation during the construction phase
- New pollutants introduced during both construction and operational phases of the Project, due to the soils mobilised during construction, new materials and machinery being used onsite, changes to the land use and ongoing operations at the Site
- The potential for spills and leaks from the batteries and transformers, which could introduce hazardous substances that could enter water discharging to Pipers Flat Creek and neighbouring properties
- An increase in impervious area that could increase surface water pollutants generated by the Site
- Flooding on the Site which could coincide with construction works presenting a safety risk to workers and the potential of floodwaters to carry construction equipment and/or material downstream presenting both safety and environmental concerns
- Flooding on Site which could damage buildings, inverters, transformers and batteries
- An increase in water and wastewater demands, and alterations to the water supply arrangements, as a result of increased personnel during both construction and operational phases of the Project.

Mitigation and management measures were identified as part of this assessment to address the above impacts. These include:

- A Construction Soil and Water Management Plan (SWMP) would be developed, in accordance with the Blue Book (Landcom, 2004), to minimise the erosion potential and sediment production across the Project Area
- The rehabilitation of disturbed areas would be undertaken progressively as construction stages are completed, and in accordance with the Blue Book (Landcom, 2004), such as the transmission line
- A Spill Management Procedure would be prepared and implemented as part of the CEMP to minimise the risk to surface water quality of pollution arising from spillage or contamination on the Site and adjoining areas during the construction phase

- The battery design would incorporate spill containment measures and/or spill response procedures and facilities to prevent battery spillage from entering the Site drainage system or downstream waterways.
- Water sensitive urban design (WSUD) measures, such as bioretention systems, would be incorporated into the drainage design in order to treat surface water before discharging to the receiving environment
- Management measures would be in place to cease works when a severe weather warning is issued for the immediate area, and equipment would be secured accordingly, to mitigate the risks of flooding along the ephemeral drainage line during construction works
- The office buildings, inverters, transformers and batteries would be elevated above surface level on concrete pads to protect them from potential floodwater impacts during the operational phase.

The assessment indicates through adequate adaptation of recommended mitigation and management measures that the construction and operation of the Project is unlikely to result in serious adverse impacts to local surface water quality and quantity, including receiving environments, such as Pipers Flat Creek and neighbouring properties.

7.1 NorBE

The Project adheres to the Neutral or Beneficial Effect (NorBE) guidelines of WaterNSW as required by the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011.

For the construction phase, the protection of water quality is addressed with the requirements for Soil and Water Management Plans, and Erosion and Sediment Control Management Plans that are described in the mitigation measures applicable to the construction phase.

For stormwater runoff during the operation phase, the MUSIC model results conceptually show that NorBE criteria would be achieved for the Site. For the modelled proposed scenario, total suspended solids, total phosphorus, total nitrogen and gross pollutant loads are all 10% less than existing scenario conditions. The 50th to 98th percentiles of total suspended solids, total phosphorus and total nitrogen concentrations for the proposed scenario are lower than the existing scenario conditions. Achievement of an overall sustainable neutral or beneficial effect on water quality for the development can be achieved with an appropriately sized bioretention system.

Wastewater management will not impact water quality as all wastewater will be captured onsite and trucked to a wastewater treatment facility.

Therefore, it is expected that the development will have a neutral or beneficial effect on water quality, consistent with the ‘Neutral or Beneficial Effect on Water Quality Assessment Guideline 2015’ (WaterNSW, 2015).

8.0 References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Biosis (2021). *Great Western Battery, Wallerawang: Biodiversity Development Assessment Report.* Report for AECOM. Authors: Price. P, Cerato. Stephanie. Biosis Pty Ltd: Western Sydney, NSW. Project no. 34343

Blacktown City Council (2020). Water sensitive urban design (WSUD) developer handbook – MUSIC modelling and design guide.

BoM (2006). *Evaporation: Average Monthly & Annual Evaporation.* Available at: http://www.bom.gov.au/watl/evaporation/

BoM (2017). *National Water Account 2017 – Sydney: Geographic Information – Bureau of Meteorology*. Australian Government. Available at: http://www.bom.gov.au/water/nwa/2017/sydney/regiondescription/geographicinformation.shtml

BoM (2021). Weather Station Directory. Available at: http://www.bom.gov.au/climate/data/stations/

Commonwealth of Australia (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Editors: Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallic M and Testoni I.

Dams Safety NSW (2021), *Dams Safety NSW - Resources*, Available At: https://www.damsafety.nsw.gov.au/publications#

Department of Environment and Climate Change and Water (DECC) (2008a). *Managing Urban Stormwater: Soils and Construction Volume 2A Installation of Services (known as the Blue Book Volume 2).* Available at: https://www.environment.nsw.gov.au/research-and-publications/publications-search/managing-urban-stormwater-soils-and-construction-volume-2a-installation-of-services

Department of Environment and Climate Change and Water (DECC) (2008b). Managing Urban Stormwater: Soils and Construction Volume 2D Main Road Construction (known as the Blue Book Volume 2). Available at: https://www.environment.nsw.gov.au/research-and-publications/publications-search/managing-urban-stormwater-soils-and-construction-volume-2d-main-road-construction

Department of Planning, Industry and Environment (DPIE) (1995).Environmental Planning Instrument – Acid Sulfate Soils. State Government of NSW and Department of Planning, Industry and Environment 1995. Available at: https://www.planningportal.nsw.gov.au/opendata/dataset/epi-acid-sulfate-soils

Department of Planning, Industry and Environment (DPIE) (2016). Hydrogeological Landscapes of New South Wales and the Australian Capital Territory. State Government of NSW and Department of Planning, Industry and Environment 2016. Available at: https://datasets.seed.nsw.gov.au/dataset/hydrogeological-landscapes-nsw-act

Department of Planning, Industry and Environment (DPIE) (2011). State Environmental Planning Policy (Sydney Drinking Water Catchment. Available at: https://pp.planningportal.nsw.gov.au/publications/environmental-planning-instruments/state-environmental-planning-policy-sydney-drinking-water-catchment-2011

Engineers Australia (1987). Australian Rainfall and Runoff.

Healthy Rivers Commission (HRC) (1998) Independent Inquiry into the Hawkesbury Nepean River System. Final Report. HRC, Sydney

King, D. P (1990). Soil Landscapes of the Wallarewang 1:1000 000 Sheet. Department of Conservation and Land Management.

Landcom (2004). Managing Urban Stormwater- Soils and Construction, Volume 1, 4th Edition (known as the Blue Book Volume 1). Available at: https://www.environment.nsw.gov.au/research-and-publications/publications-search/managing-urban-stormwater-soils-and-construction-volume-1-4th-editon

Lithgow City Council (2004). City of Lithgow LGA. Department of Lands. Available at: http://council.lithgow.com/pdfs/lithgowlga.pdf

New South Wales Government (2001) Statement of Joint Intent for the Hawkesbury-Nepean River System. Healthy Rivers Commission, Sydney

NSW Government (2019). Dams Safety Act 2015 No 26. Available at: https://legislation.nsw.gov.au/view/html/inforce/current/act-2015-026

NSW Government (2020). Dams Safety Regulation 2019. Available at: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2019-0506#pt.1

NSW Government (2021). *NSW Planning Portal*. Available at: https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address

WaterNSW (2015). *Sydney's drinking water catchments*. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0004/55975/Fact-sheet-and-map-Sydney-drinking-water-catchments.pdf

WaterNSW (2019). *Using MUSIC in Sydney Drinking Water Catchment, Second Edition*. Water NSW Standard. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0020/58250/Using-MUSIC-in-the-Sydney-Drinking-Water-Catchment.PDF

WaterNSW (2020). *Developments in the Sydney Drinking Water Catchment - Water Quality Information Requirements.*

WaterNSW (2021) *Neutral or Beneficial Effect on Water Quality Assessment Guideline 2021. Accessed 19 November 2021 at: https://www.waternsw.com.au/__data/assets/pdf_file/0004/165775/NorBE-Assessment-Guideline-2021.pdf*

Yoo E.K. (1992) Western Coalfield Regional Geology (southern part) 1:100 000, 1st edition. Geological Survey of New South Wales, Sydney

Appendix A

Great Western Battery Flood Assessment

Prepared for
Neoen Australia Pty Ltd
Co No.: 160 905 706

AECOM

Great Western Battery

Flood Assessment

08-Dec-2021

aecom.com

Delivering a better world

Great Western Battery

Flood Assessment

Client: Neoen Australia Pty Ltd

Co No.: 160 905 706

Prepared by

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AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Table of Contents

1.0 Introduction

1.1 Background

Neoen Australia Pty Ltd (Neoen) is seeking development consent to construct, operate and maintain a new battery energy storage system (BESS) located at 173 Brays Lane, Wallerawang (the Site). The Site is located approximately 110 kilometres west of Sydney's CBD and is therefore located within the Local Government Area (LGA) of the City of Lithgow City Council (Council). The location of the Site is shown in **Figure 1-1**.

The Project encompasses the construction, operation and maintenance of the new BESS as well as a new transmission line connection to Transgrid's existing 330 kilovolt (kV) substation at Wallerawang. The proposed BESS would have a combined energy and power capacity of approximately 500 megawatts (MW) and approximately 1000 megawatt-hour (MWh), respectively.

The existing Site contains a number of flow paths and farm dams. These existing farm dams were likely constructed for water harvesting purposes but would also offer flood storage and attenuation during rainfall events.

Development of a feasible site layout plan has therefore relied on the management of surface water and flooding to ensure that the Project does reduce the quality or increase the quantity of water leaving the Site as this could potentially impact downstream properties or other sensitive receptors. The management of stormwater across the Site also aims to meet the relevant legislation, requirements and guidelines.

Neoen has prepared a site layout plan that will alter existing dams and flow paths. AECOM Australia Pty Ltd (AECOM) has been engaged by Neoen to assess the flooding impacts resulting from the Project and propose necessary measures to eliminate or mitigate potentially significant adverse impacts. The flooding impacts have been assessed through the use of flood modelling.

1.2 Site description

The Site is located within Lot 4 DP751651. The southern and eastern boundaries of the Lot within which Site is located is bounded by Brays Lane. The Lot consists of the Site, where the BESS facility would be constructed, and an existing private residential property and immediate surrounds located at the south-east corner of the Lot. The Lot extends approximately 400 metres west and north of Brays Lane, forming an almost square-shaped property.

The location and extent of the Site, as well as the existing flow paths and various dams scattered across the Site, are displayed in **Figure 1-2.**

There are four (4) main dams on the Site (dams 1, 2, 3 and 4) in addition to three (3) smaller dams located within the south-eastern residential property (dams A, B and C). There are also two main flow paths moving through the Site:

- Northern flow path – collecting runoff from the northern portion of the Site and running through dams 1, 3 and 4, before directing flow over Brays Lane and then discharging to Pipers Flat Creek.
- Southern flow path – collecting runoff from the southern portion of the Site and directing it through Dam 2, before merging with the northern flow path at Dam 3.

These main flow paths, as well as all other flow paths across the Site, are ephemeral and only convey surface water following rainfall events.

A small (approximately 1.6 ha) portion of the Site also directs runoff into the south-east residential property, feeding into existing dams across that property (dams A, B and C).

This assessment primarily focuses on the four dams located within the Site (dams 1, 2, 3 and 4) as these dams would be directly impacted by the Project works. Existing dams located within the south-eastern residential property are not part of the Project; however, the Project may indirectly affect inflows into dams A, B and C. For this reason, potential impacts to dams A, B and C have been briefly addressed as part of this assessment.

The existing dam storage volumes and depths were estimated using the available Digital Elevation Models (DEMs) obtained from the NSW Government – Spatial Services. The DEMs were developed using LiDAR survey data, which was not capable of accurately capturing the invert of the dams. Instead, the water surface elevation is captured within these dams at the time of survey. On this basis, the invert and surface area at the invert of these dams has been estimated using likely dam depths and existing embankment slopes. The estimated dam storage volumes are summarised in **Table 1-1**.

Table 1-1 Dam storage volumes

Dam	Spill level (mAHD)	Depth (m)	Invert level[1] (mAHD)	Plan area[2] (m^2)	Storage volume (m^3)
1	892.85	1.95	890.90	1,440	1,720
2	892.15	1.70	890.45	2,475	3,315
3	890.80	4.30	886.50	14,200	26,725
4	883.35	1.60	881.75	2,260	1,080
A	889.15	1.05	888.10	365	230
B	885.20	0.40	884.80	145	30
C	884.65	0.65	884.00	80	15

Notes:

1 – calculated based on assumed dam depths and existing embankment slopes.

2 – recorded at the top of the dam (i.e. the maximum plan area).

The precise dam depths and storage volumes would be confirmed during detailed design to establish the actual height-storage relationship as this may impact the flooding assessment, any onsite water management measures, and any safety measures required as part of the relevant dam regulations.

1.3 The Project

The key Project components on the Site would consist of the following:

- battery storage (BESS) area
- internal access road
- 330 kV substation
- office buildings, amenities and carpark
- control room and switch rooms
- temporary hardstand for storage during construction works. After the completion of construction works, this area will be returned to natural (vegetated) conditions.

The indicative site layout that has been adopted for this impact assessment is shown in **Figure 1-3**.

1.4 This report

As the Project would alter a number of existing dams and flow paths across the Site, it is likely that the existing surface water and flood behaviour would also alter across the Site and at downstream locations. The purpose of this report is to assess and quantify the potential flooding impacts.

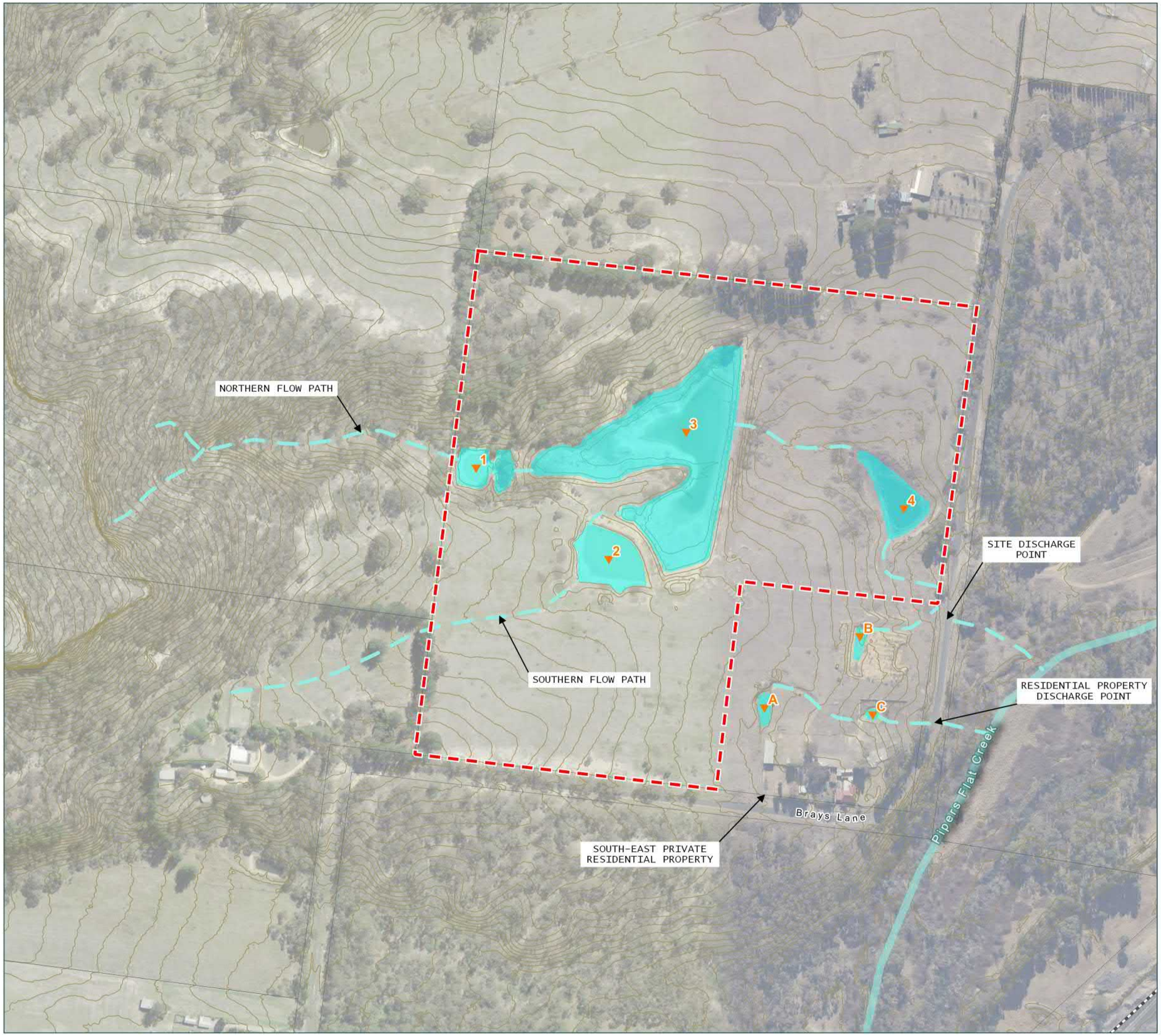
This report outlines the relevant legislation, standards and guidelines, highlights the key objectives for the flooding assessment, details the adopted methodology, models the proposed development, and summarises the findings of the assessment.

Figure 1-1

Regional context of the Project Location

Legend

- Site boundary
- Transgrid Wallerawang 330 kV Substation
- The Project Area
- State Forest
- NPWS Reserve
- Watercourse
- Primary road



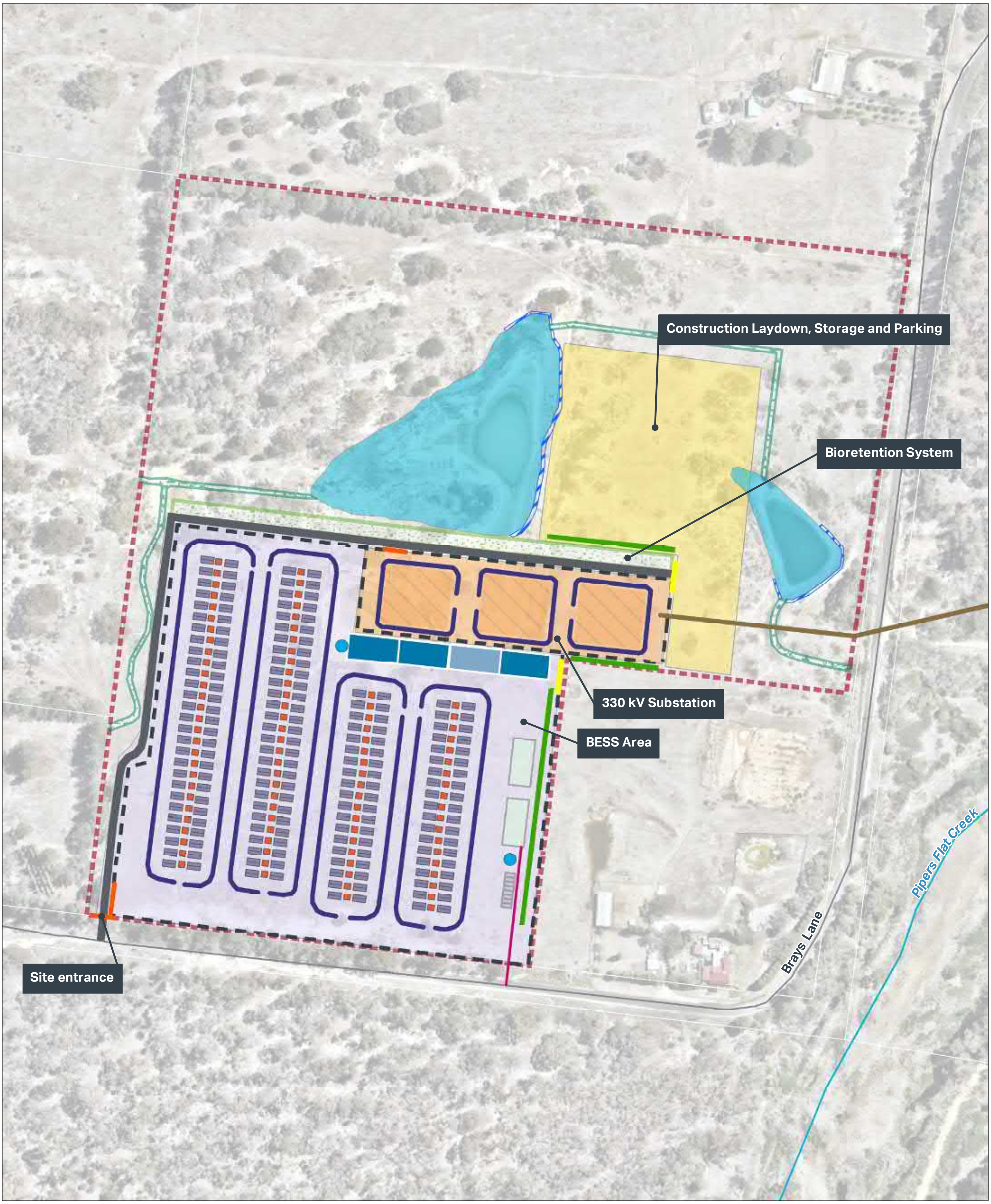
0 50 100 150

Legend

- Dam number
- Site area
- Flow path
- Watercourse
- Dam
- 1 m contours
- Cadastre

FIGURE 1.2

GREAT WESTERN BATTERY LOCALITY PLAN



Indicative layout of the Site

The Site
Substation
Internal access road
Noise wall
Access Gate
Security Fencing
Water Connection Point
Transmission Line Alignment
Emergency Exit
Watercourse
Local road
Water Tank
Large Transformers
Battery and Inverter
Transformers
Bioretention System
Dam Walls
Swales
330 kV Substation
Control Room
Switch Rooms
Landscape Planting
O&M Building
Carpark
Approx Extent Of Dam Modification
Construction Laydown, Storage And Parking
BESS Area

N
0 30 60 m

AECOM

Source: Imagery © Nearmap, 2020.

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2.0 Methodology

This section summarises the relevant legislation, standards and guidelines for flooding across the Project Area. It also details the adopted methodology used to assess the flooding impacts as they relate to the relevant legislation, standards and guidelines.

2.1 Relevant legislation, standards and guidelines

2.1.1 Secretary's Environmental Assessment Requirements

Table 2-1 outlines the flood-related Secretary's Environment Assessment Requirements (SEARs) and identifies where the requirements have been addressed in this report.

Table 2-1 SEARs for flooding

SEARs requirement	Addressed
An assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including watercourses traversing the site and surrounding watercourses, 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.	**Section 5.0** addresses the flooding impacts. The groundwater impacts have been addressed in Chapter 12 of the EIS and the surface water impacts have been addressed in the Water Cycle Management Study (WCMS) Report to which this report is attached.

2.1.2 Sydney Drinking Water Catchment

The Project is part of the Warragamba Catchment which is located within Sydney's Drinking Water Catchment and is therefore subject to the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (SEPP). This policy requires that the Project has either a Neutral or Beneficial Effect (NorBE) on the quality of water across the catchment.

2.1.3 Water Cycle Management Study

All development applications in Sydney's Drinking Water Catchment should include a water cycle management study (WCMS) to assist with the consent authority's and WaterNSW's assessment of the Project, to determine whether the development would be capable of meeting requirements of the NorBE policy. The WCMS must include information, reports and modelling appropriate for the water quality risks introduced by the development. Developments introducing more water quality risks would require a more in-depth study (WaterNSW 2020).

A separate report will be prepared for the WCMS. However, there are some flood-specific requirements that must be addressed as part of the WCMS. These include:

- an accurate description of the current stormwater management must be provided and must show existing drainage in relation to contours and/or topography
- a flood assessment must be undertaken, and associated flood planning levels must be defined for the development site, if relevant.

2.1.4 Council requirements

There is currently no Development Control Plan (DCP) applicable to the City of Lithgow Council (Council) LGA following the repeal of all DCPs on 20 January 2017. It is however common for Council's to require that new developments achieve the following in relation to flood management:

- Flood protection to buildings and other important site infrastructure in all events up to and including a 1% AEP event.
- No adverse impacts to flooding at downstream properties or watercourses.

2.1.5 Australian Rainfall and Runoff

Australian Rainfall and Runoff (ARR) documents the best practice guidelines for estimating design flood characteristics in Australia (Ball et al., 2019). The modelling undertaken as part of this assessment has been carried out in accordance with the latest (2019) ARR guidelines.

2.1.6 Dam Safety NSW

Dams Safety NSW is an independent state regulator established under the *Dams Safety Act 2015*. It is responsible for developing and implementing regulation for effective dam safety management to protect life, property and the environment from dam failures. To meet this objective, Dams Safety NSW have the authority to 'declare' whether dams are deemed a potential threat to downstream life or possible of causing major property, environmental, or public welfare damage.

It is anticipated that a consequence assessment (considering life safety and non-life safety consequences), and a dam break study may be required to determine if any dam on Site should be 'declared' by Dam Safety NSW. Any declared dams would be required to meet the objectives set forth in the Dam Safety NSW guidelines (Dam Safety NSW 2021), which would help the dam owner comply with the requirements of the *Dams Safety Act 2015* (NSW Government 2019) and the *Dams Safety Regulation 2019* (NSW Government 2020).

The proposed alterations to existing dams across the Site have not been assessed by Dams Safety NSW as part of this report. However, they will need to be assessed and dam regulations will need to be considered during the detailed design process.

2.2 Objectives

The overarching objective of this assessment is to determine the potential impacts of the Project, with regards to stormwater management and flooding. This assessment has considered impacts to surrounding properties and the downstream environment.

The assessment has been based on information and data that was available at the time of completion.

2.3 Adopted approach

The adopted approach for assessing flooding impacts resulting from the Project broadly follows:

- The development of a flood model to represent the existing flood behaviour across the Site (the baseline conditions).
- Modelling the flood behaviour for the proposed scenario to assess changes to the existing flood behaviour as a result of development.
- Comparing flood behaviour across the Site to determine whether the proposed Project layout and stormwater management plan can maintain existing discharge conditions and/or identifying any significant impacts resulting from the changes to existing dams. The comparison involved:
    - Analysing the peak discharge hydrographs leaving the Site and draining to Pipers Flat Creek in order to identify the likely impacts of the stormwater management options.
    - Identifying impacts to the south-eastern property by looking at the peak discharge rates and volumes entering the property.

3.0 Proposed development

3.1 General

The existing dams have a significant influence on surface water flows and flooding across the Site. They play an important role in slowing down surface water flows as they move through the Site and help to contain more surface water onsite, thereby reducing the amount of water discharging offsite and entering Pipers Flat Creek.

As the Project would need to encroach on, and fill, some of the existing dams, the existing flood behaviour would likely change and peak discharge leaving the Site would increase due to a reduction in flood storage and attenuation of flows.

In accordance with the requirements outlined in **Section 2.0**, discharge from the Site should be improved or maintained so as to ensure that the Project does not adversely impact flooding across the receiving environment and downstream catchment. In order to ensure that the Project is capable of adhering to these requirements, the size of Dam 3 would be significantly increased to create a single large dam at the centre of the Site to account for the lost retention storage at dams 1, 2 and 3. These proposed changes aim to replicate the existing dam configuration/layout as much as possible in order to reduce impacts.

Dam 4 would also need to be upgraded for the Project, as the construction laydown area would impede on the existing footprint of the dam. Upgrading the dam would also account for the additional runoff generated by the construction laydown area as it is likely that this area could in part or in full be impermeable during construction.

The proposed stormwater management plan and altered dam footprints are shown indicatively on **Figure 3-1**.

The main objectives of the stormwater management plan are to:

- Match the existing peak discharge rate, volume and shape of the hydrograph (i.e. the rate of discharge in relation to time) so as not to adversely impact downstream flooding.
- Maintain as much of the existing storage as possible and supplement for lost storage where possible. This would help to achieve the same attenuation of flows which would result in similar discharge rates.
- Maximise the plan area of the dams to spread additional runoff generated by the newly impervious surfaces introduced as part of the development.
- Minimise alterations to existing flow paths to help maintain the existing distribution of surface water across the Site. This aims to keep the same areas draining to the same dams.
- Direct the majority of the development zone (i.e. paved/impervious areas across the battery storage area) into the upstream Dam 3, as the downstream Dam 4 does not have as much storage capacity.

3.2 Dam and flow path alterations

The existing combined storage across dams 1, 2 and 3 and the storage that was targeted for the new large dam is in the order of 32,000 m^3. In order to achieve this storage volume, the footprint of the existing Dam 3 has been extended further west, the batter slopes have been steepened, and the base of the dam has been flattened to achieve more depth/storage within a smaller space. This new, larger dam is denoted as Dam 5 on **Figure 3-1**.

Dam 4 would also increase in volume in order to manage flows from the temporary hardstand zone. The existing storage at Dam 4 and the minimum storage targeted with the proposed upgrades is in the order of 1,100 m^3. It is likely that some additional storage would also be required to account for the additional runoff generated by the construction laydown area. The dam alterations include flattening the base of the dam and steepening the batter slopes to achieve more storage at the base of the dam, without having to raise the dam embankment.

Both of the above dam alterations would include reinstating the dam crest and providing a formal spillway point. This helps to control the rate of discharge from the dams and minimises the risk of dam failure through the collapse of the embankment.

The retention storage, depths and plan areas achieved with the proposed dam alterations for the Project are summarised in **Table 3-1**. These dam properties would need to be confirmed and/or adjusted accordingly during the detailed design phase.

Table 3-1 Dam storage volumes achieved for Proposed Scenario

Dam	Altered dam properties					Target volume (m^3)
	Spill level (mAHD)	Depth (m)	Invert level (mAHD)	Plan area (m^2)	Achieved volume (m^3)	
5	891.00	4.50	886.50	12,900	32,300	32,000
4	883.50	1.75	881.75	2,800	2,800	1,100[1]

Notes:

1 – excludes the additional storage required to account for more runoff generated by the temporary hardstand construction laydown area.

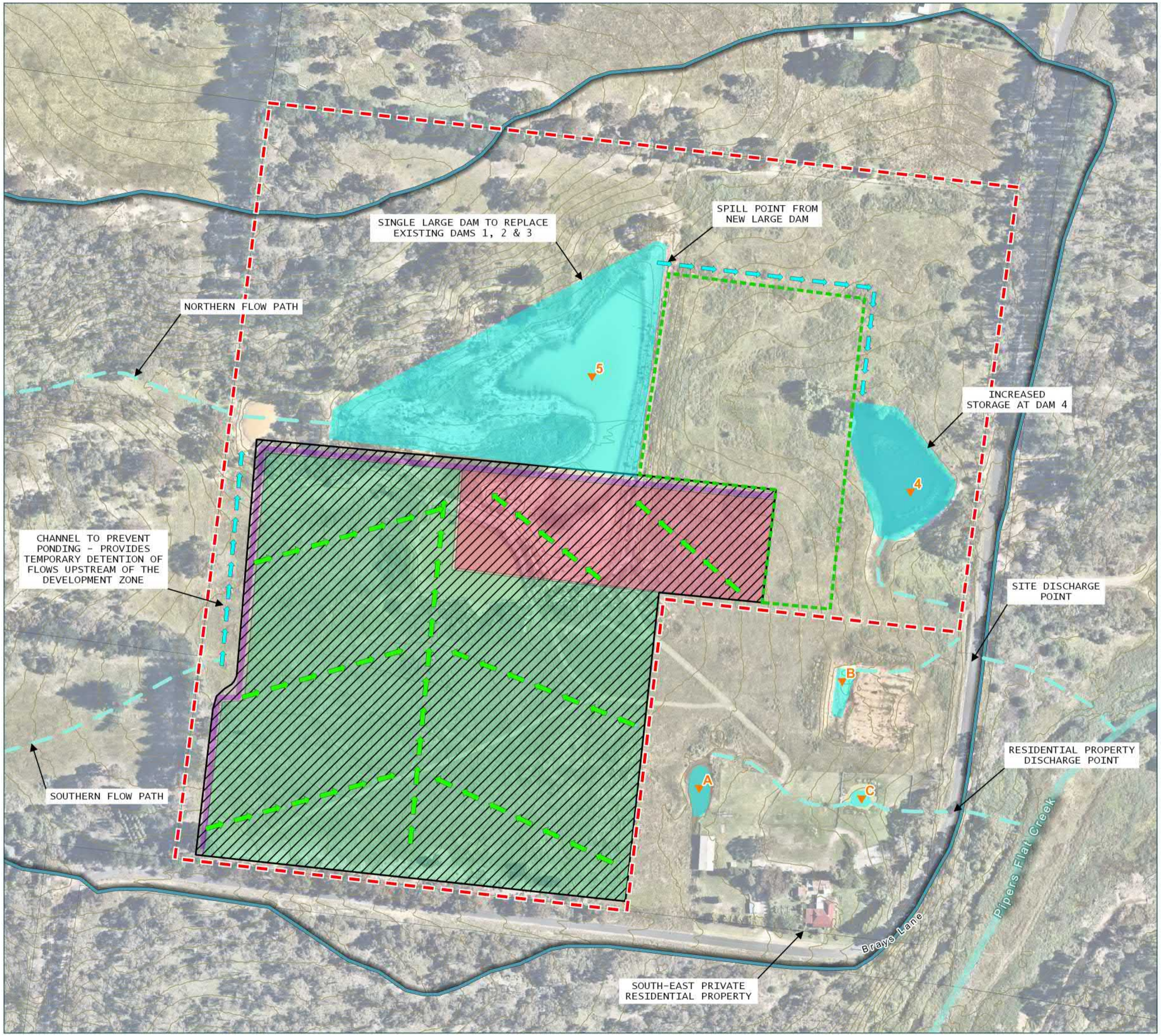
Runoff from the main portion of the development zone (i.e. the battery storage area, access roads, offices and amenities) has been directed towards Dam 5 via a wide ‘v-shaped’ channel that runs in a northerly direction through the development zone. This allows the larger Dam 5 to retain the majority of runoff from the development zone.

In doing so, the area that currently directs runoff into the south-eastern property would now drain towards Dam 5. Therefore, flow entering the south-east property would be significantly reduced and inflows into their dams would only consist of runoff generated by their property itself.

The development zone would also obstruct the southern flow path. This would cause floodwaters to pond on the upstream (western) side of the development zone. For the purposes of this assessment, it has been assumed that an open channel, capable of conveying the 1% AEP flows, would be constructed along the western boundary of the Site. The channel would allow ponded waters to freely drain towards Dam 5.

Runoff from the temporary hardstand construction laydown area is directed to Dam 4. Existing surface levels across this zone are up to 4 m lower in elevation compared to elevations along the top of embankment for Dam 5. The adopted surface grades across the temporary hardstand follow the natural topography, which fall towards a low point that directs flow in an easterly direction towards Dam 4.

A number of open channels or swales have been included around the development zone to prevent surface flows from entering and potentially damaging construction equipment or material. These proposed channels/swales are shown in **Figure 3-1**.



0 25 50 75 100

Legend

- Dam number
- Site area
- Watercourse
- 1 m contours
- Cadastre
- Surface Grade
- Open Channels / Swales
- Construction Laydown Area
- Development Zone

Indicative Site Layout

- 330 kV Substation
- BESS area
- Internal access road

GREAT WESTERN BATTERY PROPOSED PLAN

4.0 Model development

4.1 General

A flood model (Tuflow) was developed to assess the performance of the stormwater management and dam alteration plan in comparison to the existing flood behaviour and existing discharge conditions. The following sections detail the process for developing the model and highlight the key assumptions that were adopted.

4.2 Available information

The model was developed using a number of inputs and information supplied by Neoen or obtained from available sources. Data used to guide the model development is listed in **Table 4-1**.

Table 4-1 Model inputs and available information

Description	Reference / Source	Date obtained / received	Comments
Topographical data	NSW Government – Spatial Services	March 2021	1-metre resolution digital elevation model (DEM) developed using LiDAR data. The DEM was obtained from ELVIS (Elevation Information System).
Rainfall depths	Bureau of Meteorology (BoM)	March 2021	Rainfall depths for a suite of storm durations and AEPs.
Temporal patterns	ARR Data Hub	March 2021	An ensemble of ten (10) temporal patterns for each storm duration and AEP.
Conceptual Site layout plan	Neoen	October 2021	
Aerial imagery	NSW SIX Maps/NearMap	July/October 2021	Aerial imagery used to define the existing surface materials.
Flood information along Pipers Flat Creek	Aurecon (2014)	-	Flood study along Pipers Flat Creek – used to confirm the downstream boundary assumptions.

4.3 Model setup

The adopted modelling approach and any key inputs into the model are summarised in **Table 4-2**.

Table 4-2 Adopted modelling approach

Component	Adopted value / approach
Model version	TUFLOW Version 2020-10-AA with HPC solution scheme using GPU hardware
Hydrological approach	Direct Rainfall with an adopted soil infiltration model for pervious surfaces
Grid cell size	2.0 m
Topography	The existing topography was represented using the DEM obtained from the NSW Government – Spatial Services.

Component	Adopted value / approach
Rainfall	Rainfall depths and temporal patterns were obtained from the BoM and ARR Data Hub, respectively, for the Site location (Latitude: -33.396, Longitude: 150.068). An ensemble of ten (10) rainfall hyetographs was generated for each storm duration, in accordance with the latest (2019) ARR guidelines. These hyetographs were then applied to the 2D domain.
Infiltration	Runoff from the 2D domain was simulated using an Initial loss–continuing loss infiltration model with the following losses, obtained from the ARR Data Hub for the Site location (Latitude: -33.396, Longitude: 150.068): • Impervious surfaces: - Initial loss: 1.0 mm - Continuing loss: 0.0 mm/hr • Pervious surfaces: - Initial loss: 39.0 mm - Continuing loss: 2.4 mm/hr The initial loss value for pervious surfaces (39.0 mm) was reduced by differing amounts for each storm duration and AEP to account for storm pre-burst. This is known as the probability neutral burst initial losses. Note that the adopted losses are based on relevant guidelines and are similar to those adopted for the nearby *Lidsdale Siding Flooding Assessment* undertaken by Aurecon (2014) (i.e. 33.0 mm initial loss and 2.5 mm/hr continuing loss).
Surface roughness / bed resistance	The following Manning's roughness (n) values were adopted for the various surface treatments: • Asphalt roads and hardstand surfaces – 0.020 • Concrete surfaces – 0.015 • Smooth area with minimal vegetation – 0.025 • Short grass and grassed channels – 0.035 • High grass – 0.050 • Light brush and trees – 0.080 • Dense brush and trees – 0.160 • Private property land – 0.100 • Buildings – 10.000
Downstream boundary conditions	The downstream model boundary (i.e. where water can leave the model) was set along Brays Lane, as it is assumed that flow spilling over Brays Lane can freely discharge to Pipers Flat Creek. This is based on flood modelling results completed as part of the *Lidsdale Siding Flooding Assessment* (Aurecon, 2014). The modelling results showed that levels within Pipers Flat Creek range from 878.5 to 879.5 mAHD in a 1% AEP storm event, while levels along Brays Lane range from 881.0 to 885.0 mAHD.

4.4 Assumptions

A number of key assumptions were made during the development of the model. These include:

- All dams will be full prior to the commencement of a storm event. This assumes there have been other rainfall events that occurred and filled up the dams prior to the commencement of the design event (i.e. worst-case conditions). This is considered a reasonable assumption as the dams do not have a low-level outlet to drain the dam after a storm event occurs. Without spilling, the dams can only drain via infiltration and evaporation which would take a significant amount of time given the large storage volumes across these dams.

- Adopted surface grades across the development zone aimed to balance cut/fill as much as possible, while also keeping the development above peak 1% AEP flood levels. Surface grades across the main development zone have been kept as flat as possible, while surface grades across the temporary hardstand zone match the existing terrain as much as possible. It should be noted that a detailed cut/fill analysis for the proposed Site layout has not been undertaken as part of this assessment and will need to be undertaken during the detailed design process.
- Existing dam embankment levels were maintained where possible, as it is assumed that dam embankments would not be raised significantly as part of the Project. No dam inspections have been undertaken to confirm whether any existing dam embankment is suitable, this would be completed at detailed design. It was also assumed that formal spillways would be designed and constructed into the dam embankments to control spilled flows and reduce the risk of dam failure.
- It has been conservatively assumed that all areas within the development zone would be completely impervious (e.g. concrete, asphalt, hardstand surfaces, etc.).
- The temporary hardstand construction laydown area would return to natural (vegetated) conditions after construction works have been completed. However, it has been conservatively assumed that the design storm events modelled would occur while the construction laydown area is in place. The flood modelling has therefore captured both construction and operational phases of the Project in one complete model.

4.5 Calibration and validation

Given the Site is within private property and is located upstream of any major watercourses, there is no available/reliable flood records or information to help calibrate and validate the model. In the absence of existing flood records, the model was developed in accordance with relevant guidelines, such as the latest ARR guidelines (Ball et al., 2019).

The adopted model parameters were also compared with adopted model parameters for other flood studies that were completed for nearby sites, such as the *Lidsdale Siding Upgrade Flooding Assessment* (Aurecon, 2014).

4.6 Modelled events

The design flood events and storm durations modelled are listed in **Table 4-3**.

Table 4-3 Modelled flood events and durations

Modelled AEPs:	1%, 2%, 5%, 10%, 20% and 50%
Modelled storm durations (minutes):	15, 30, 45, 60, 90, 120 and 180

Consistent with the latest (2019) ARR guidelines (Ball et al., 2019), an ensemble of ten (10) temporal patterns was modelled for each storm duration to identify the median results across the entire floodplain. The representative flood envelope was then produced for each AEP, using the critical (maximum) results from all modelled storm durations.

5.0 Modelled results

Impacts resulting from the Project were measured by comparing the existing and proposed hydrographs discharging from the Site. The peak discharge hydrographs for the various AEPs are provided in **Appendix A Flood Modelling Results**.

The existing and proposed flood maps, including flood depths and flood level contours, are presented in maps B1 to B12 of **Appendix B Flood Maps**. The flood maps do not show any nuisance flooding as the flood depth maps do not show any areas with flooding greater than 30 mm depth for the 1% AEP.

The results are discussed in the following sections.

5.1 Existing conditions

As can be seen from the results (refer to **Appendix B**, Maps B1 to B6), the general flood behaviour across the existing Site consists of:

- Floodwaters along the northern flow path move in an easterly direction and enter Dam 1 before eventually spilling into Dam 3.
- Floodwaters along the southern flow path move in a north-easterly direction and enter Dam 2 before eventually spilling into Dam 3.
- Flows overtopping from Dam 3 then head in an easterly direction towards Dam 4.
- Flows spilling out of Dam 4 are then directed towards Brays Lane, where flows overtop the road and head towards Pipers Flat Creek.
- A small portion (2.0 ha) of the Site directs runoff into the adjacent south-east property and feeds into their existing dams A and C. Rain falling directly on the property also helps fill these two dams, along with Dam B.
- Flow spilling out of Dam B heads towards Brays Lane and merges with flows discharging from the Site before overtopping the road and heading towards Pipers Flat Creek.
- Flow spilling out of dams A and C head towards Brays Lane, where they overtop the road and head towards Pipers Flat Creek. The point where these private property flows overtop Brays Lane is approximately 75 m south of the discharge point for the Site.

5.1.1 Site discharge

The existing dams across the Site (dams 1, 2, 3 and 4) slow down and attenuate floodwaters as they move through the Site. This helps to contain more surface water onsite and reduce peak discharge rates and volumes.

The modelled results indicate that the peak discharge rate leaving the Site, under existing conditions, would be in the order of 2.9 m^3/s in a 1% AEP event and 1.1 m^3/s in a 10% AEP event. The peak discharge volumes are estimated to be in the order of 9,960 m^3 in a 1% AEP event and 4,065 m^3 in a 10% AEP event. This peak discharge occurs in the 120-minute duration for both events.

5.1.2 South-eastern property

The modelled results show that peak flow rates entering the south-east property at its western boundary are estimated to be in the order of 0.4 m^3/s in a 1% AEP event and 0.2 m^3/s in a 10% AEP event. The peak volume entering the property is estimated to be in the order of 661 m^3 in a 1% AEP event and 310 m^3 in a 10% AEP event.

5.2 Developed conditions

As can be seen from the modelled results (refer to maps B7 to B12 of **Appendix B**), the main flood impacts resulting from the Project include:

- The diversion flow path (location of this diversion flow path is represented by the swale depicted on

Figure 1-3) along the western boundary of the Site helps to prevent the development from obstructing the southern flow path. The diversion flow path directs flows from the southern flow path into the northern flow path and then into Dam 5.

- The Project alters flow paths across the development zone, directing runoff from most of the area towards Dam 5 at the centre of the Site. The temporary construction laydown area is the only area that directs runoff towards Dam 4.
- Surface flows have been directed around the development zone via a network of diversion flow paths and swales.
- Storage that was lost at dams 1, 2 and 3, by partially or completely filling them to make room for the development zone, has been moved to other areas of the Site. This alters the location and extents of flood storage across the Site.
- Flood extents and depths at Dam 4 have increased due to the proposed upgrades.
- Flows that were previously entering the south-eastern property have effectively been reduced to zero, as the development extends all the way up to the south-eastern property. The area that currently drains towards the south-eastern property is now directed back towards Dam 5. This reduces the amount of flow filling up their dams and leaving their property.

5.2.1 Site discharge

The existing and proposed discharge hydrographs were compared for the same critical duration and median temporal pattern. The peak discharge hydrographs taken at the discharge point at Brays Lane for the 1% and 10% AEP events are shown in **Figure 5-1** and **Figure 5-2**.

The peak hydrographs for all of the modelled design storm events are provided in **Appendix A**.

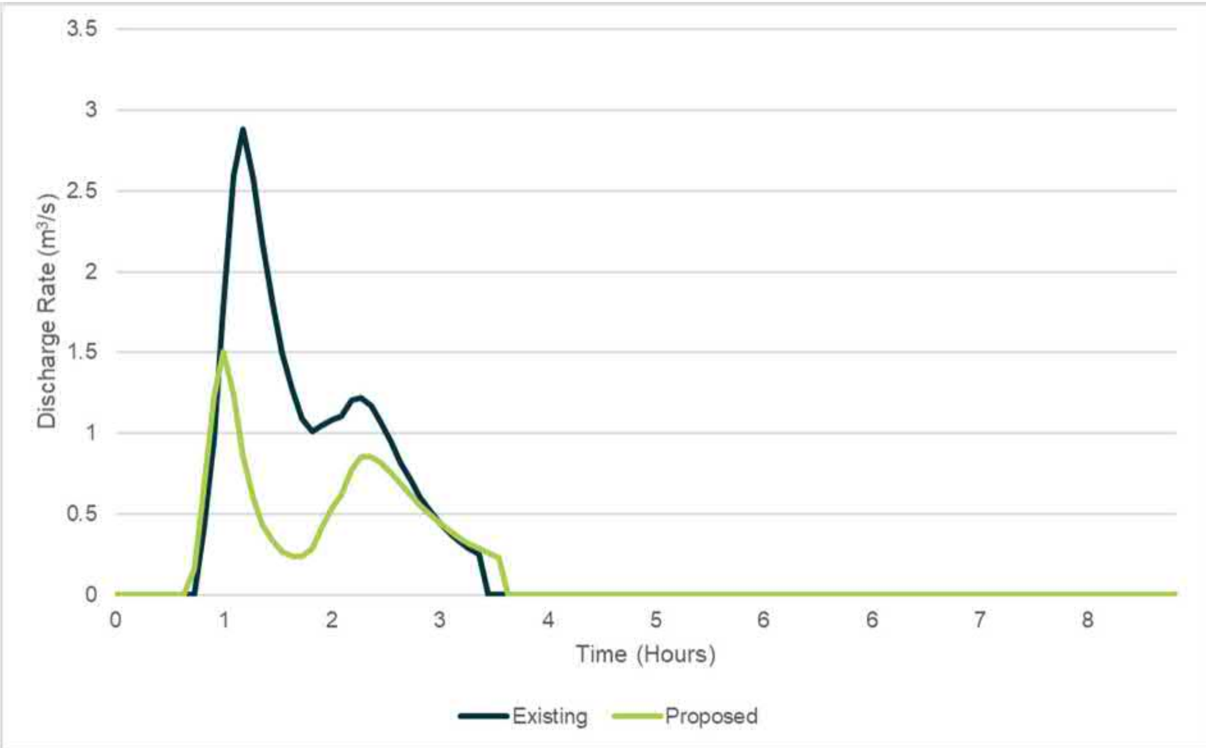


Figure 5-1 Peak discharge hydrograph - 1% AEP event

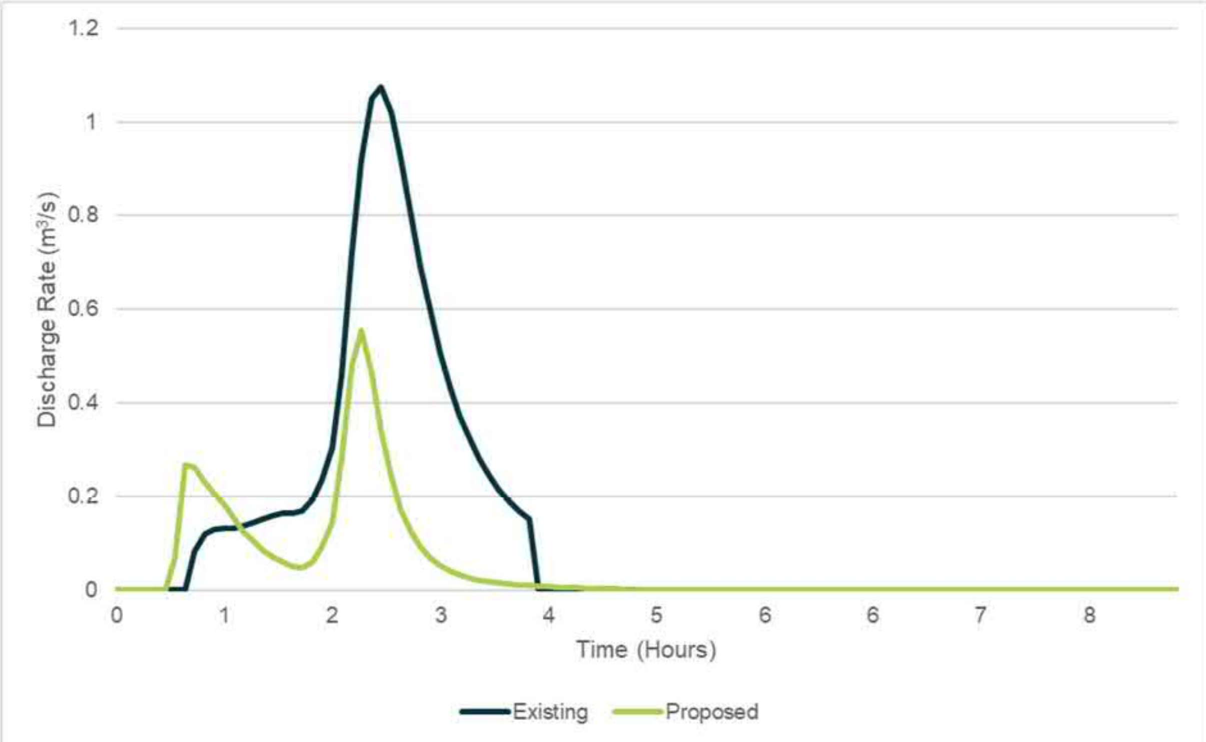


Figure 5-2 Peak discharge hydrograph - 10% AEP event

The peak discharge rates, time to peak, and peak discharge volumes are summarised in **Table 5-1**.

Table 5-1 Peak discharge, time to peak and volumes

Event	Peak discharge (m^3/s)		Time to peak[1] (minutes)		Discharge volume (m^3)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
1% AEP	2.88	1.51	65 (1.1)	55 (0.9)	9,960	5,488
2% AEP	2.07	0.67	120 (2.0)	120 (2.0)	8,062	3,567
5% AEP	1.55	0.75	90 (1.5)	70 (1.2)	4,970	1,913
10% AEP	1.08	0.55	135 (2.3)	125 (2.1)	4,065	1,590
20% AEP	0.71	0.33	170 (2.8)	150 (2.5)	3,374	1,466
50% AEP	0.00	0.05	-	325 (5.4)	0	257

Notes:

1 – values in parentheses represent the time to peak in hours.

The results show that Project is capable of maintaining (or reducing) the peak discharge rates and volume for all design storm events, except the 50% AEP event. The shape of the hydrographs (i.e. the change in the rate of discharge over time) is also relatively similar to existing conditions. This is due to the proposed dam configuration/layout being very similar to existing conditions.

There is zero discharge from the existing Site in the 50% AEP event due to the largely pervious nature of the existing Site, in addition to the low rainfall depths that occur in such a frequent storm event. As the Project introduces a large area of newly impervious surface, the total runoff generated by the Site is also increased. The dams are effective at attenuating these flows and reducing peak discharge rates. However, they are not capable of reducing discharge rates down to zero since it has been assumed that all dams are completely full at the beginning of a storm event (which in certain circumstances is unlikely to be the case).

The peak discharge rate is only increased by 50 L/s in the 50% AEP event. This small increase in flow would have negligible impact on the downstream environment.

On this basis, the Project is considered to have a beneficial impact on the downstream environment as peak flows and volumes are significantly reduced in every other storm event.

The proposed dam alterations would be capable of adhering to the requirements outlined in **Section 2.0**, as the Project is not expected to result in an increase to the peak discharge rate or volumes during the major storm events, and would therefore be unlikely to result in an adverse flood impact on the receiving environment.

5.2.2 South-eastern property

The proposed development results in a reduction to flows entering the south-east property. Under existing conditions, the property was receiving peak discharge rates of approximately 0.4 m^3/s in a 1% AEP event and 0.2 m^3/s in a 10% AEP event from the south-east portion of the Site. The peak volumes received were also estimated to be in the order of 661 m^3 (1% AEP) and 310 m^3 (10% AEP).

As a result of the Project, the modelled results indicate that flow entering the property via its western boundary would be effectively reduced to zero. This is due to the development zone extending all the way up to the eastern Site boundary. Runoff generated in this area is now being directed to Dam 5 as opposed to the south-eastern property.

There are a number of options to service these existing dams within this property, and these include, but are not limited to:

- Allowing a portion of the development to drain into their dams
- Providing the property owner with access to stored water with dams across the Site (e.g. Dam 4).

The proposed subdivision of the Lot following construction of the BESS facility would provide the owner of the south-east property access to Dam 4 and Dam 5 and would therefore mitigate the reduce of inflows to dams A, B and C.

6.0 Summary

A number of existing dams across the Site would need to be altered to allow for the construction of the proposed BESS. These dam alterations would have an impact on the existing flood behaviour across the Site as well as discharge to Pipers Flat Creek. To understand and mitigate these potential impacts and adhere to the relevant requirements of local policies and guidelines, a stormwater management plan has been prepared and assessed with the assistance of flood modelling.

This proposed stormwater management plan aims to provide one large dam (Dam 5) at the centre of the Site to replace lost flood storage across existing dams that would be impeded by the proposed development at the Site. This involved increasing the storage and footprint of the existing Dam 3 and aims to replicate existing conditions as much as practicable.

The flood modelling results showed that proposed stormwater management plan is capable of maintaining (or even reducing) the peak discharge rates and volumes in all of the major storm events. Therefore, this would be a viable solution to minimising the flooding impact of the Project on the receiving environment.

Under existing conditions, the Site is estimated to discharge to Pipers Flat Creek at a peak discharge rate of 2.9 m^3/s in a 1% AEP event and 1.1 m^3/s in a 10% AEP event. The modelled results indicated that the proposed changes were capable of reducing the peak discharge rate to 1.5 m^3/s in a 1% AEP event and 0.6 m^3/s in a 10% AEP event.

The Project would require a large amount of earthworks to achieve the levels, grades and storages required to maintain or reduce peak discharge rates in comparison to existing conditions. A civil earthworks design would be required to determine the overall feasibility of the proposed plan including the cut/fill balance and the amount (if any) imported material would be required.

Under the conditions modelled, the Project is able to maintain (and reduce) site discharge to existing conditions. This is likely to result in a negligible impact to flooding across the downstream environment.

The Project would also aim to minimise disturbances to the existing natural topography across the Site, therefore, meeting the requirements outlined in the WCMS Guidelines (WaterNSW 2020) and State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (SEPP).

The residential property at the south-eastern corner of the Site has a number of existing dams that are currently, under existing conditions, fed by runoff from the south-east portion of the Site. The peak flow rates entering the south-east property at its western boundary (under existing conditions) are estimated to be in the order of 0.4 m^3/s in a 1% AEP event and 0.2 m^3/s in a 10% AEP event.

The south-east portion of the Site that previously drained into the south-east property would be directed back towards the new larger dam at the centre of the Site, under proposed conditions. This effectively reduces the amount of water entering the private property down to zero in all events. This would in turn reduce the volume of water entering their dams. The proposed subdivision of the Lot following construction of the BESS facility would provide the owner of the south-east property access to Dam 4 and Dam 5 and would therefore mitigate the reduce of inflows to dams A, B and C.

7.0 References

Aurecon (2014). *Lidsdale Siding Upgrade – Lidsdale Siding Flooding Assessment Report.* Prepared for Centennial Coal. Reference: 233327. Revision: 2.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation*. Commonwealth of Australia.

Dam Safety NSW (2021), *Dams Safety NSW - Resources*, Available At: https://www.damsafety.nsw.gov.au/publications#

Department of Planning, Industry and Environment (DPIE) (2011). *State Environmental Planning Policy (Sydney Drinking Water Catchment*. Available at: https://pp.planningportal.nsw.gov.au/publications/environmental-planning-instruments/state-environmental-planning-policy-sydney-drinking-water-catchment-2011

NSW Government (2019). Dams Safety Act 2015 No 26. Available at: https://legislation.nsw.gov.au/view/html/inforce/current/act-2015-026

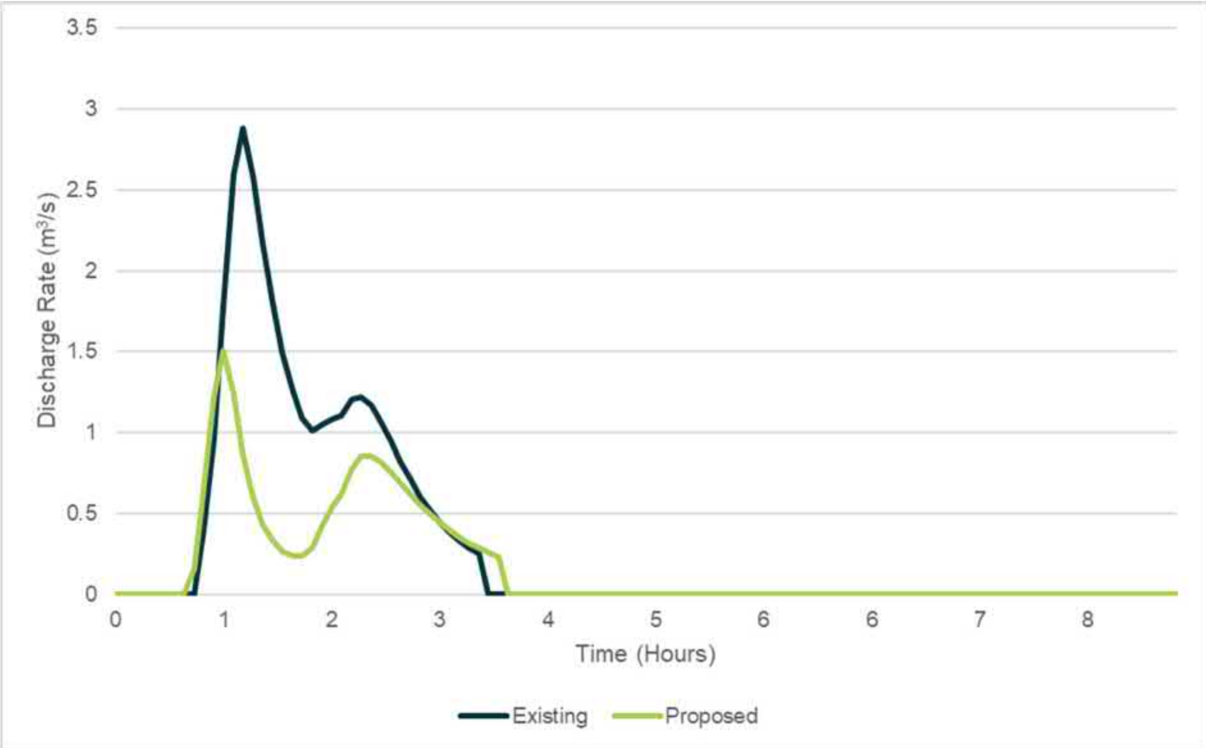
NSW Government (2020). *Dams Safety Regulation 2019*. Available at: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2019-0506#pt.1

WaterNSW (2020). *Developments in the Sydney Drinking Water Catchment - Water Quality Information Requirements.*

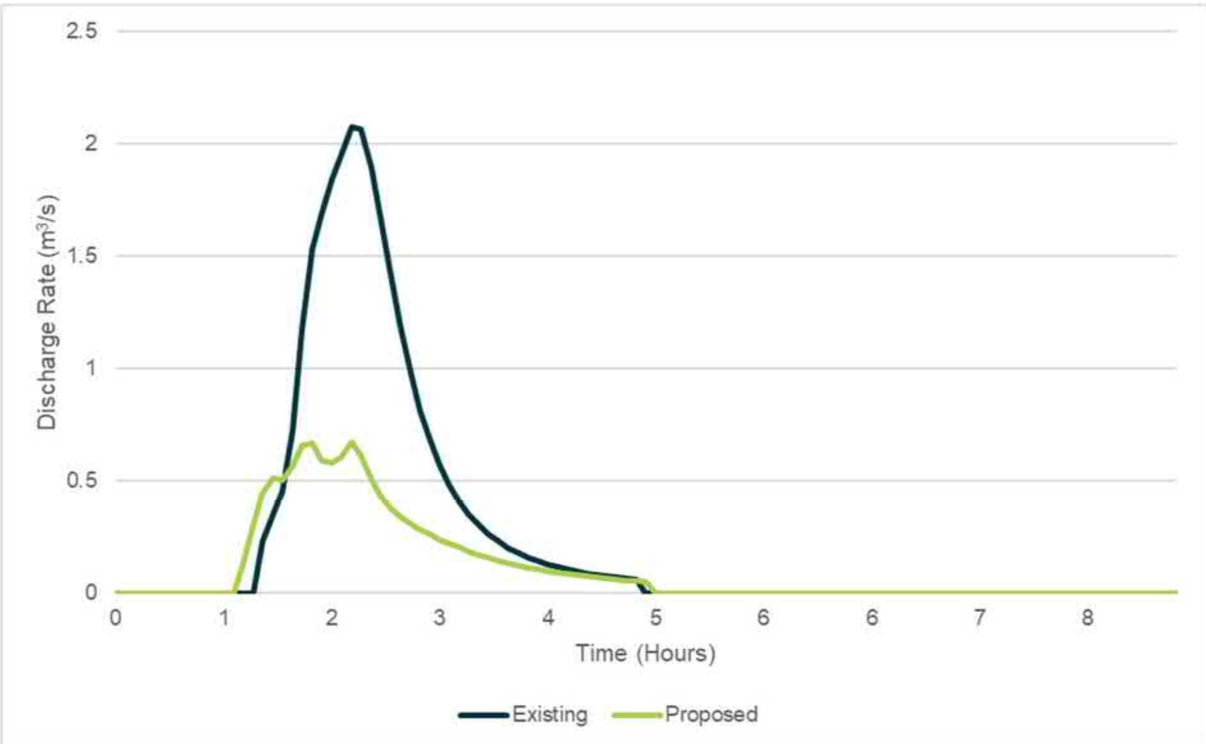
Appendix A

Flood Modelling Results

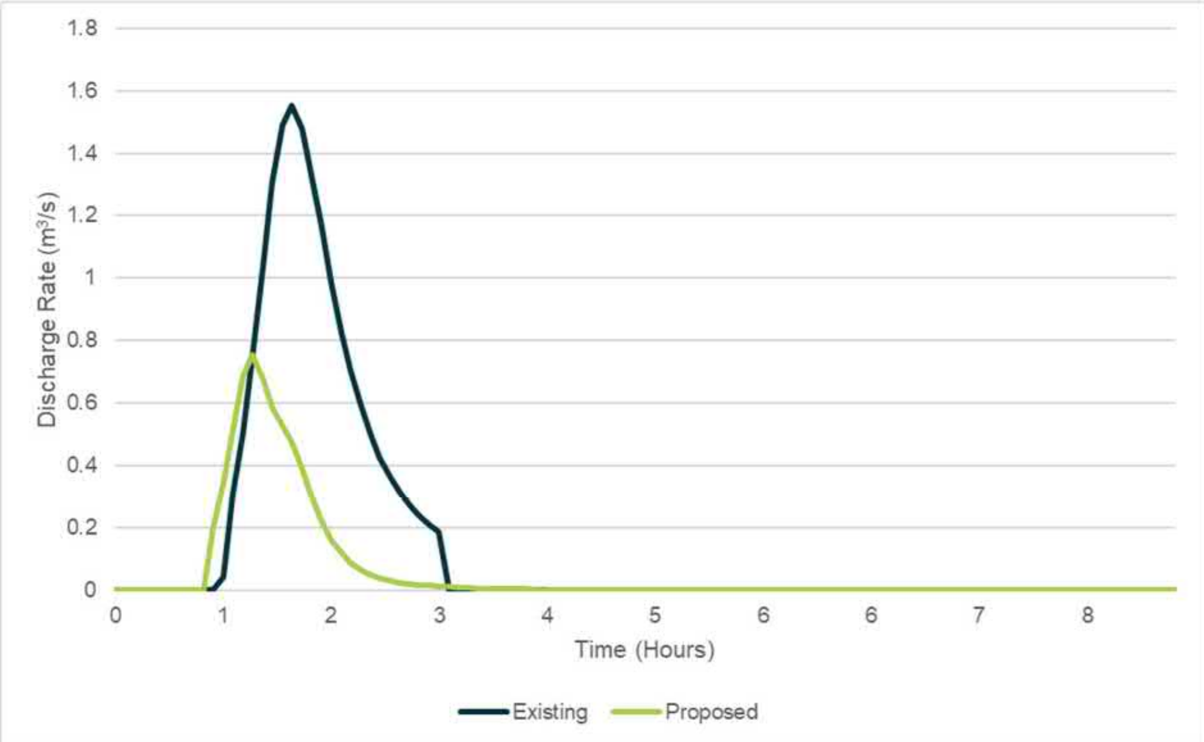
Appendix A Flood Modelling Results



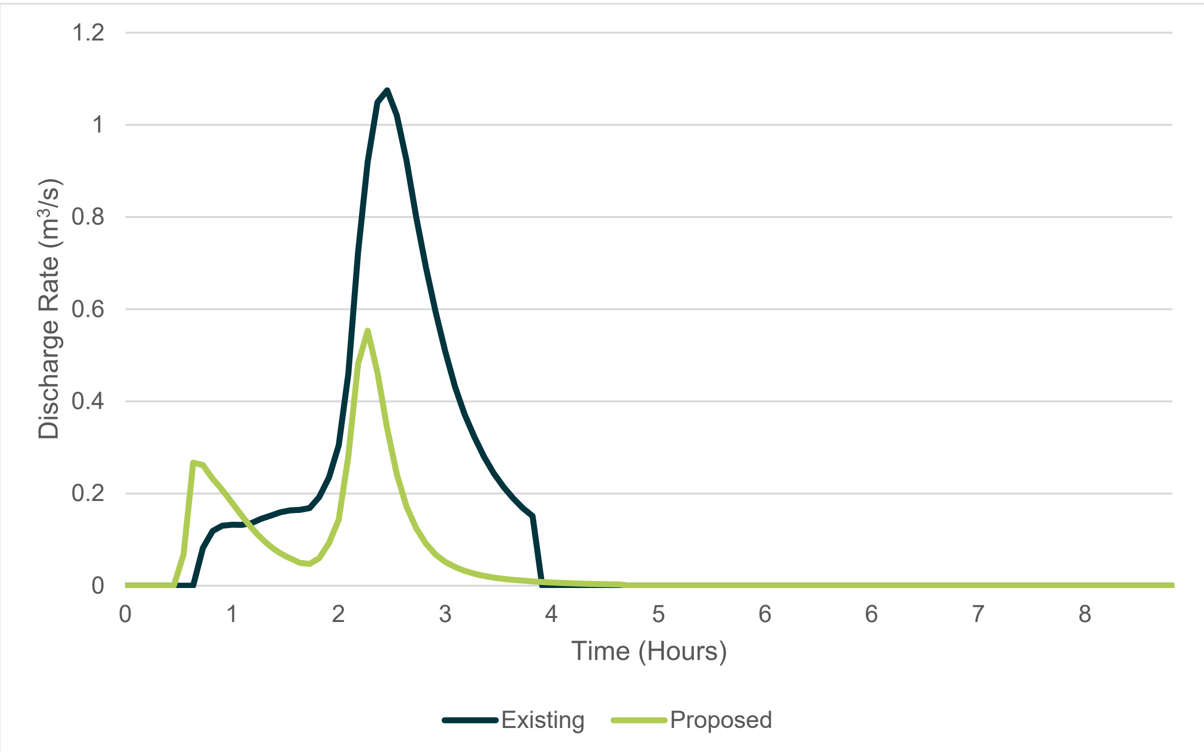
A 1 Peak Discharge Hydrograph - 1% AEP



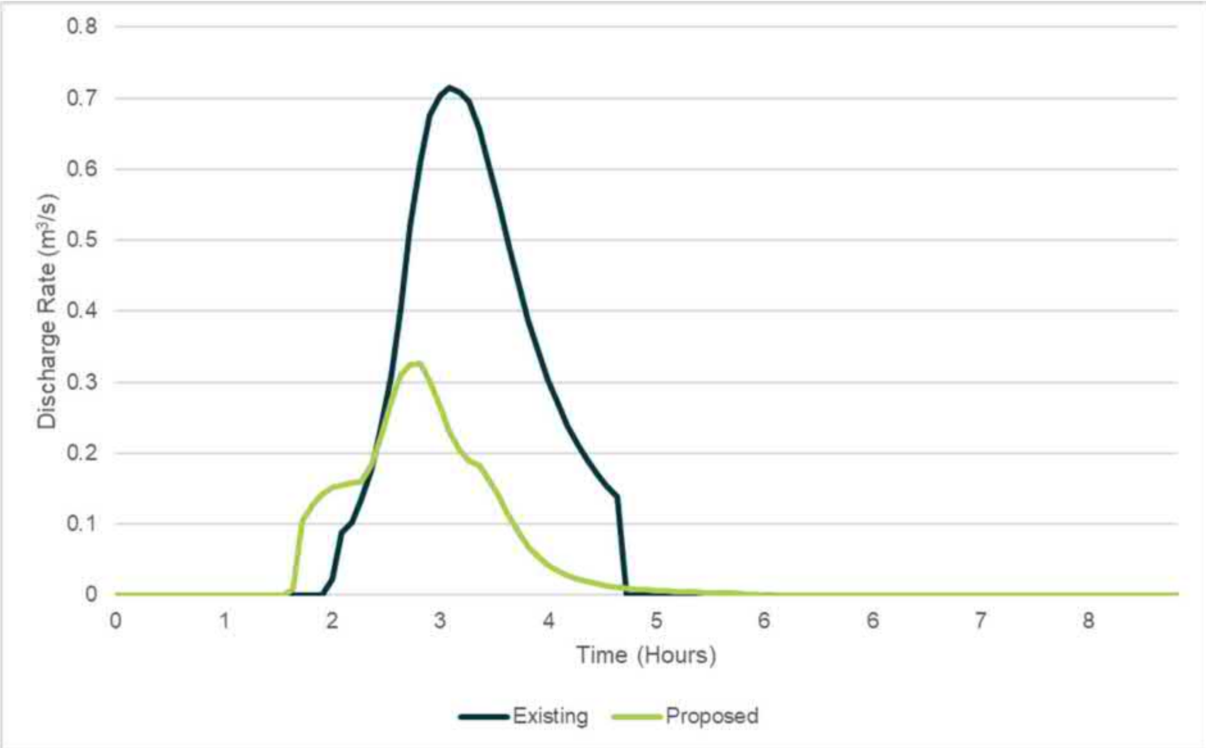
A 2 Peak Discharge Hydrograph - 2% AEP



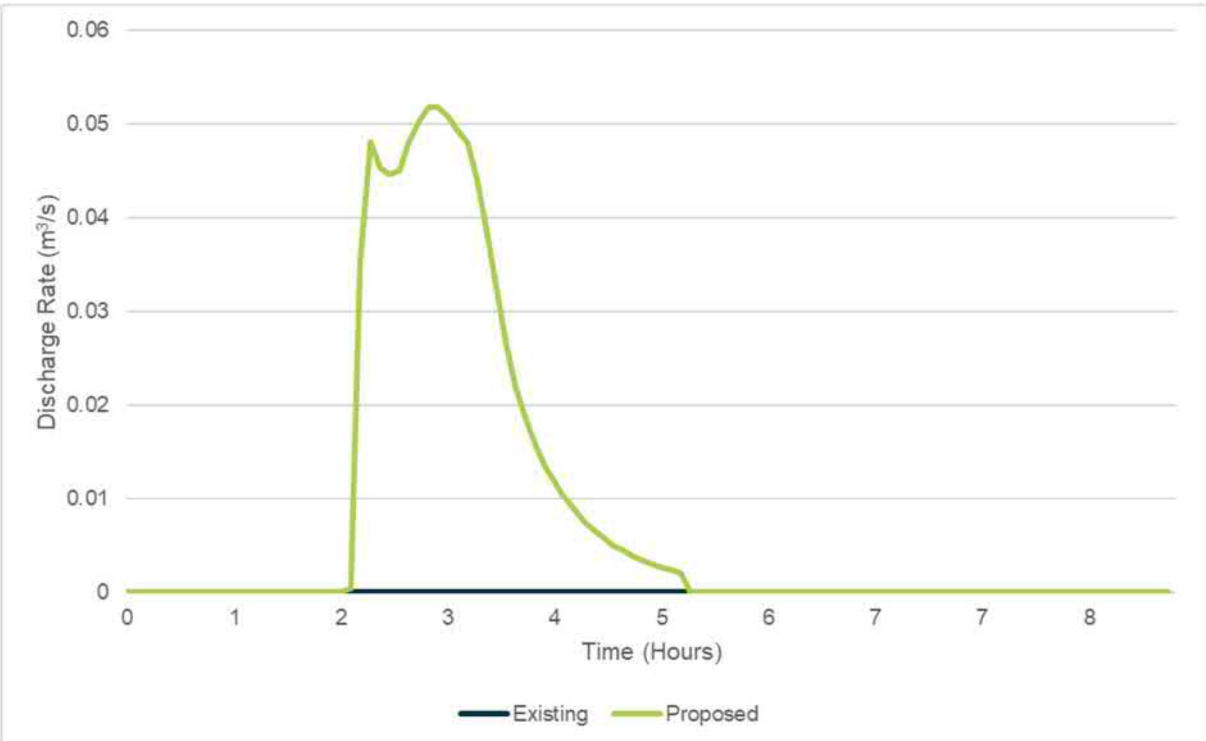
A 3 **Peak Discharge Hydrograph - 5% AEP**



A 4 **Peak Discharge Hydrograph - 10% AEP**



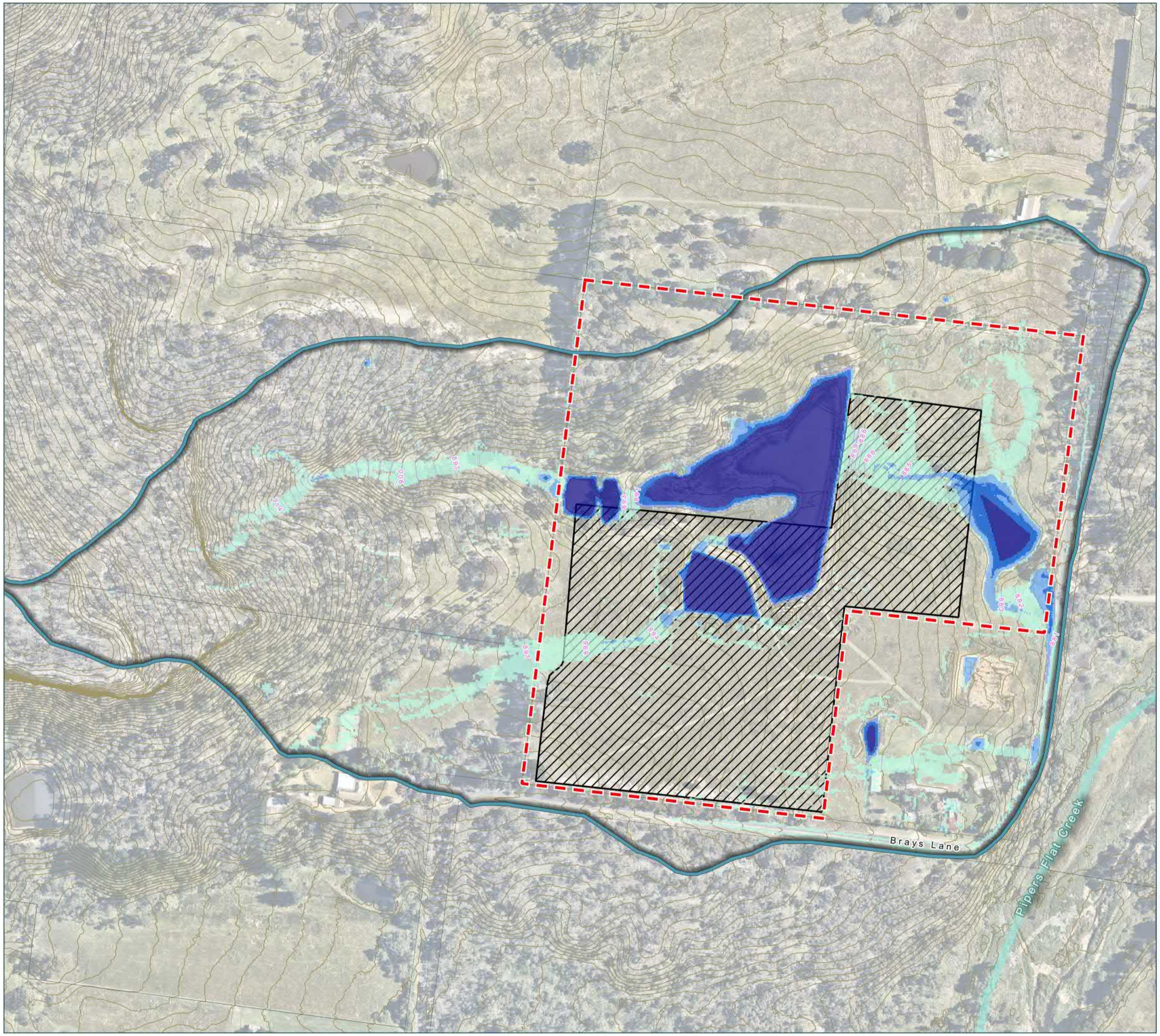
A 5 **Peak Discharge Hydrograph - 20% AEP**



A 6 **Peak Discharge Hydrograph - 50% AEP**

Appendix B

Flood Maps



AECOM

0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

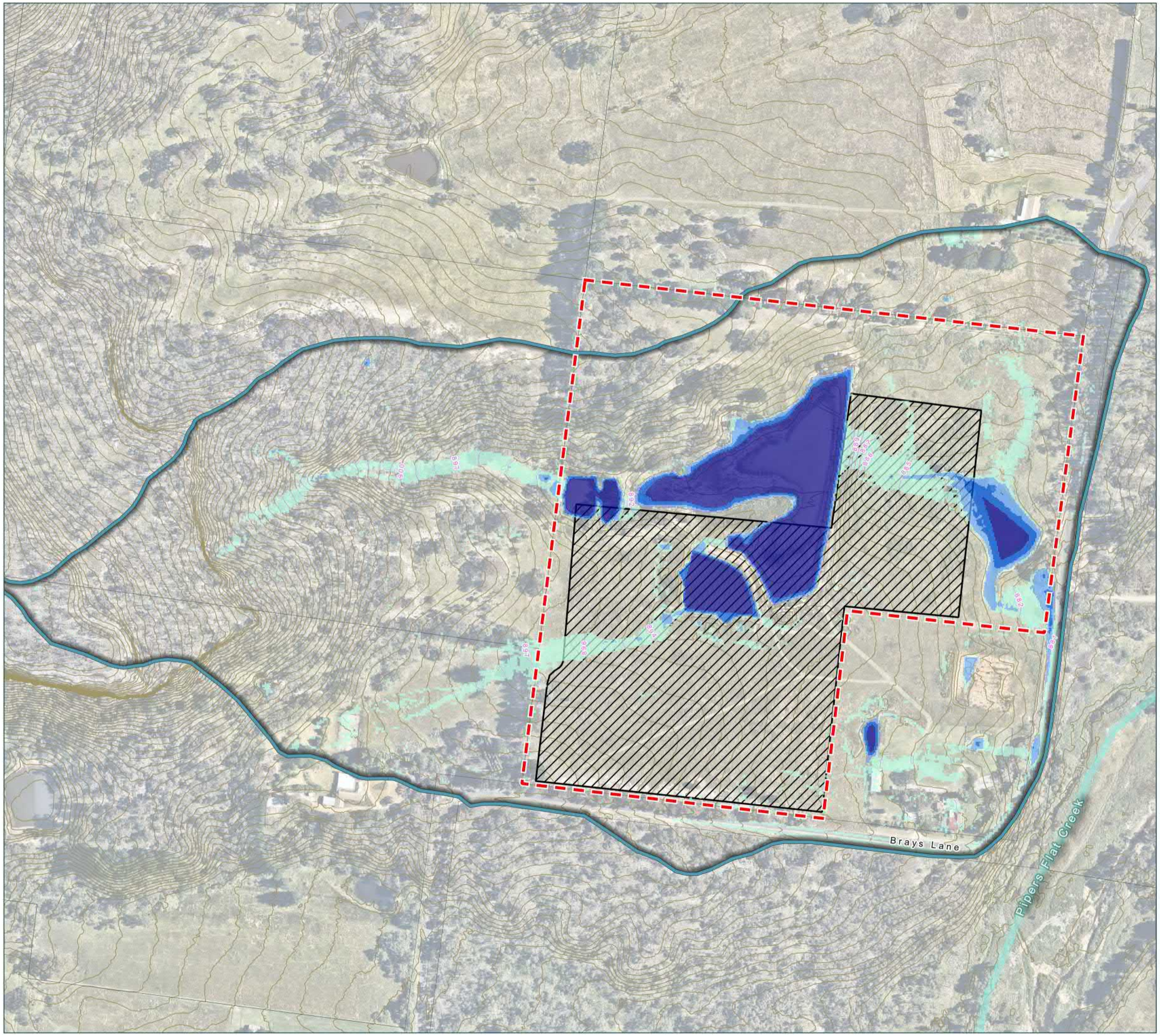
Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B1

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 1% AEP

Source: Imagery © Nearmap, 2020



0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

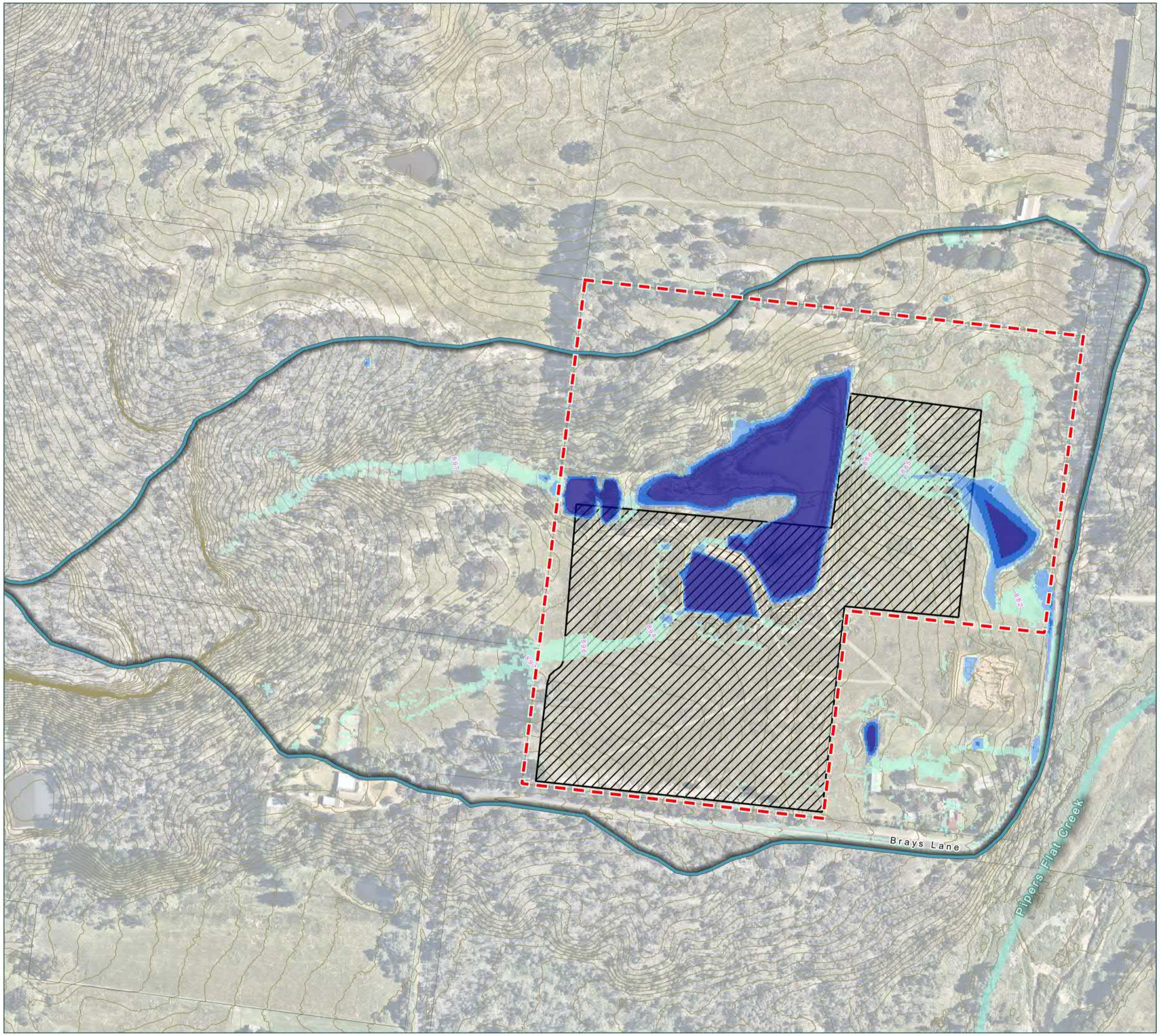
Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B2

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 2% AEP

Source: Imagery © Nearmap, 2020



0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

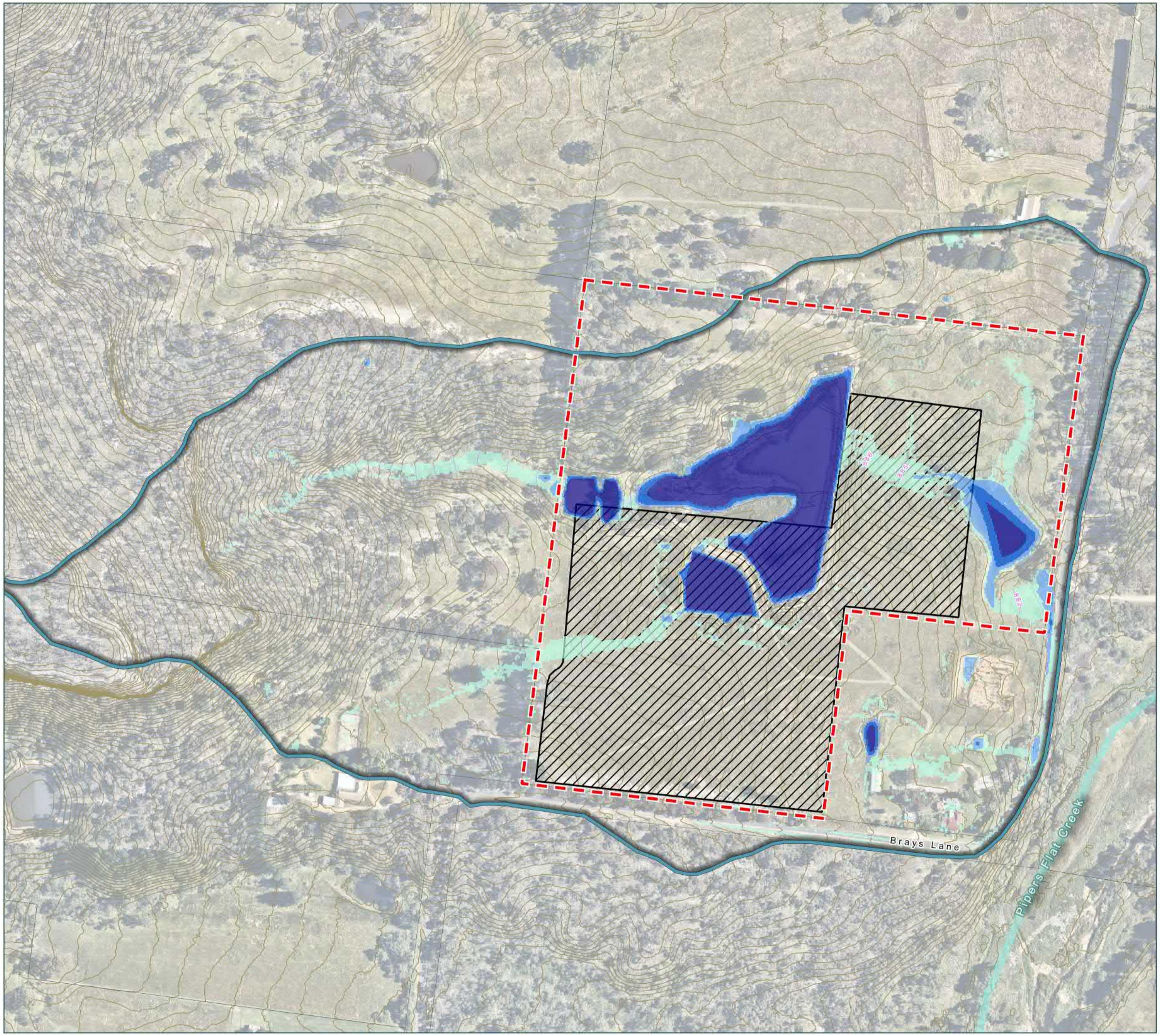
- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B3

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 5% AEP

Source: Imagery © Nearmap, 2020

AECOM



0 50 100 150

Legend

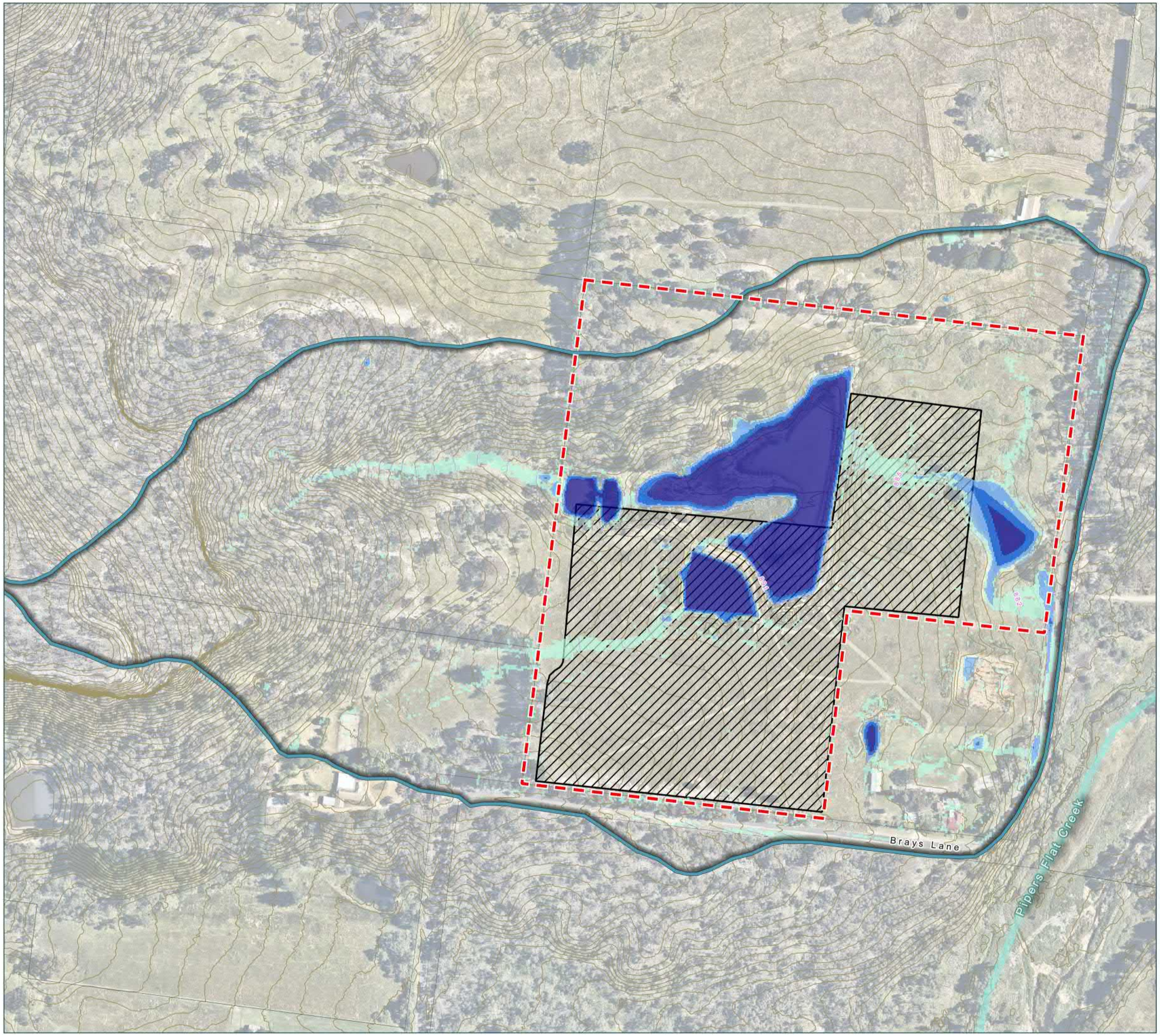
- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B4

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 10% AEP



AECOM

0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

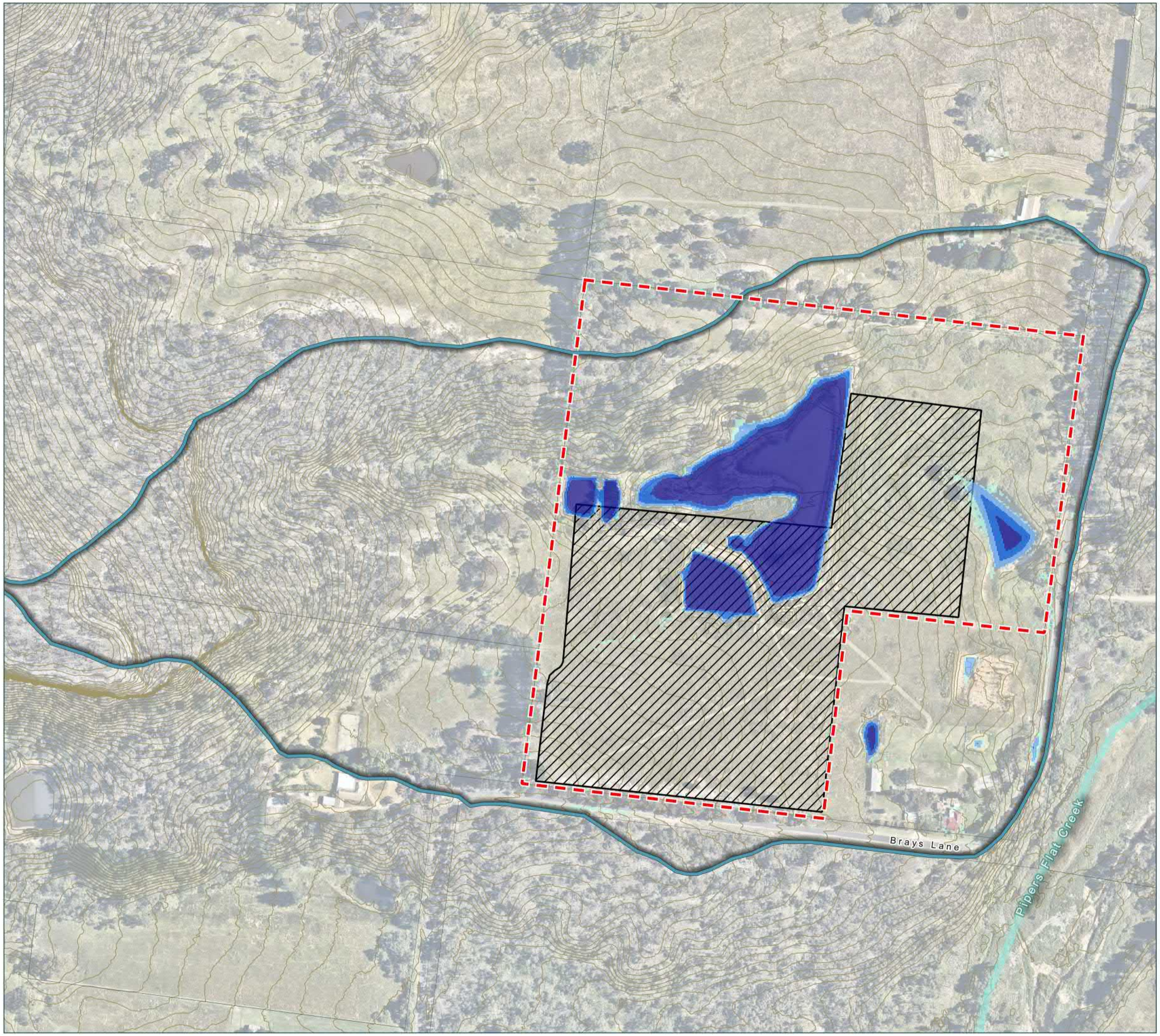
Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B5

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 20% AEP

Source: Imagery © Nearmap, 2020



AECOM

0 50 100 150

Legend

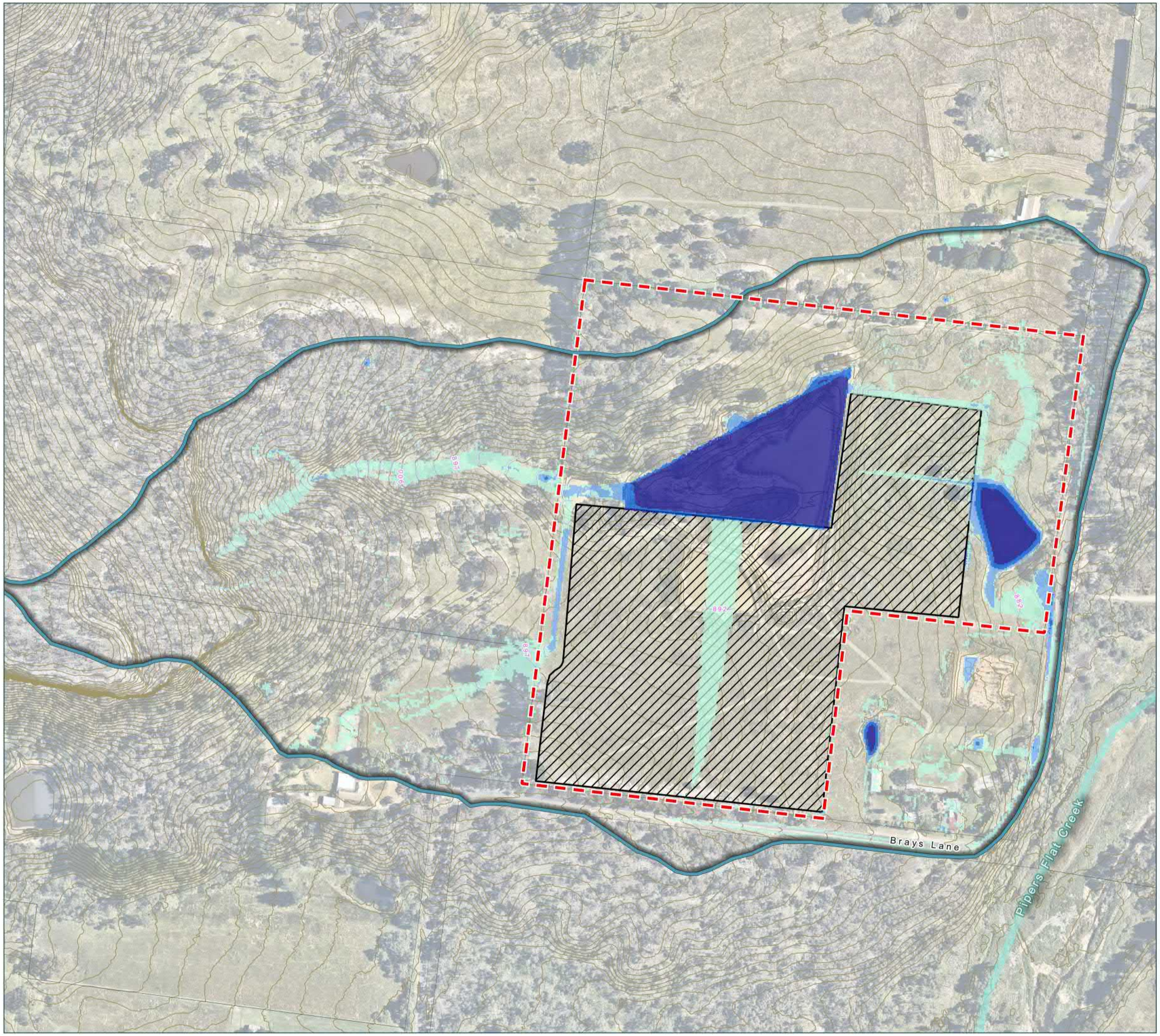
- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B6

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS EXISTING SCENARIO - 50% AEP



0 50 100 150

Legend

Site area

Watercourse

Flood level contours (1 m interval)

1 m contours

Model boundary

Development zone

Cadastre

Flood depth (m)

< 0.03 (not shown)

0.03 to 0.15

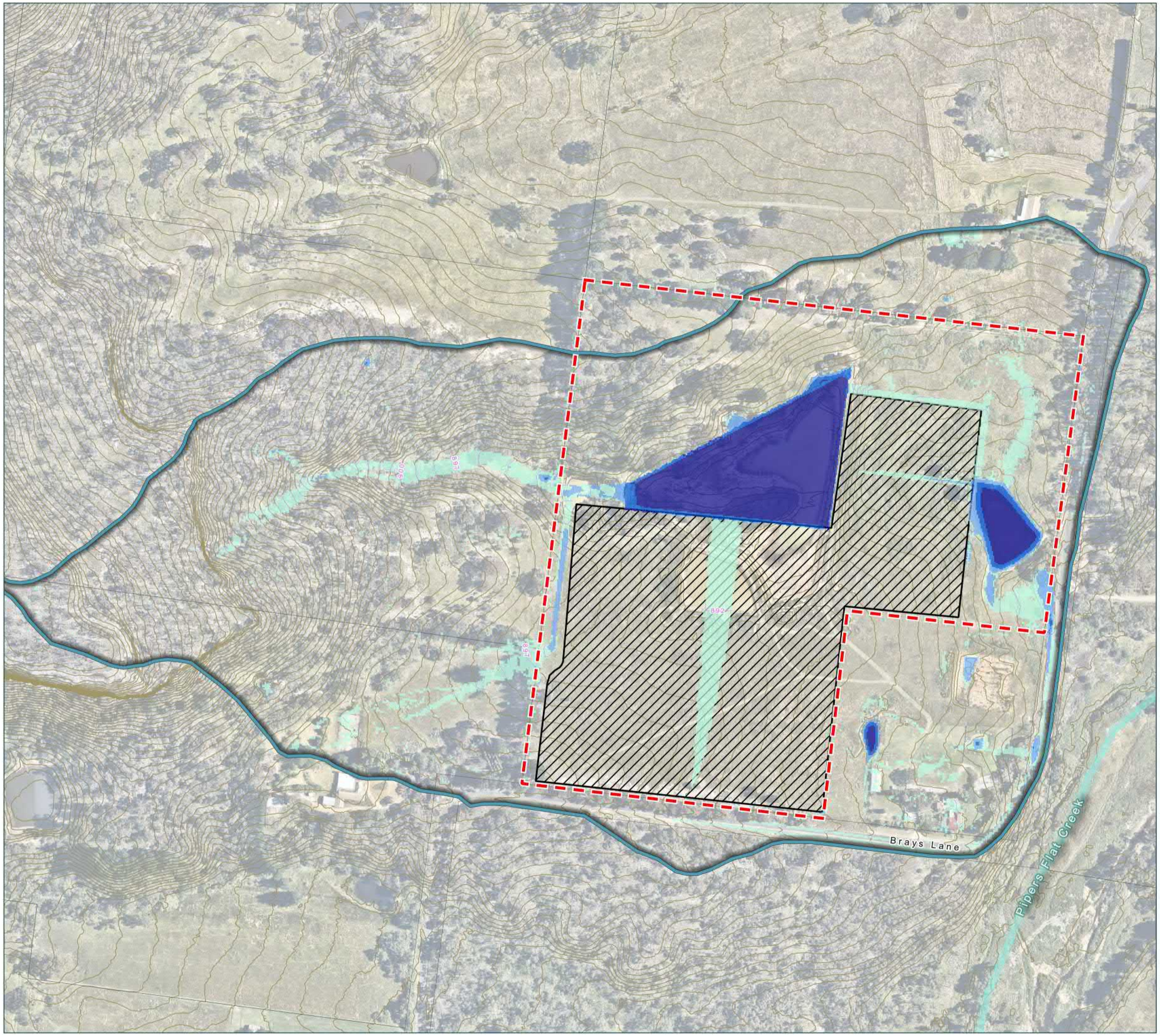
0.15 to 0.5

0.5 to 1.0

> 1.0

MAP B7

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 1% AEP



AECOM

0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

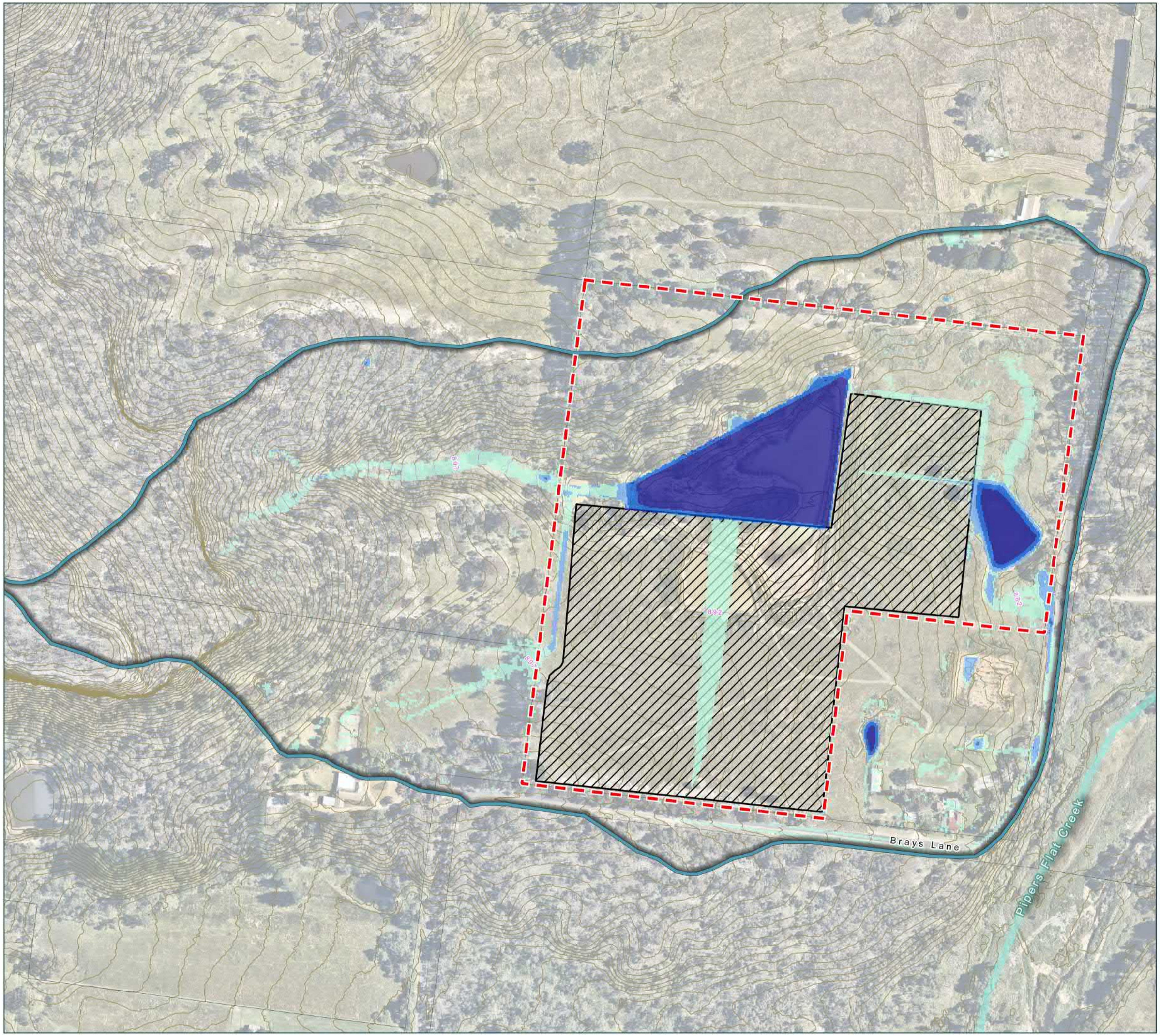
Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B8

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 2% AEP

Source: Imagery © Nearmap, 2020



AECOM

0 50 100 150

Legend

Site area

Watercourse

Flood level contours (1 m interval)

1 m contours

Model boundary

Development zone

Cadastre

Flood depth (m)

< 0.03 (not shown)

0.03 to 0.15

0.15 to 0.5

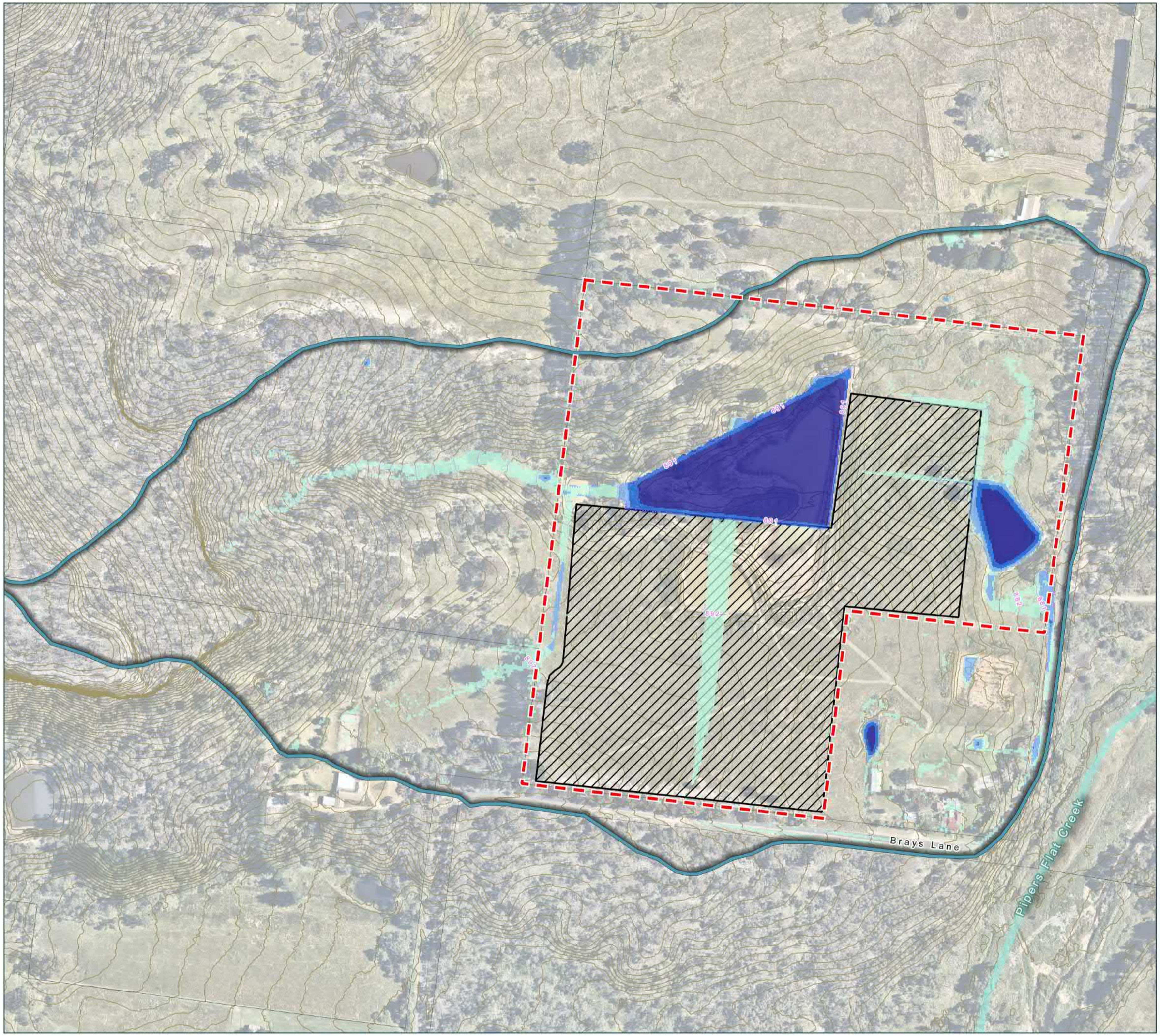
0.5 to 1.0

> 1.0

MAP B9

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 5% AEP

Source: Imagery © Nearmap, 2020



AECOM

0 50 100 150

Legend

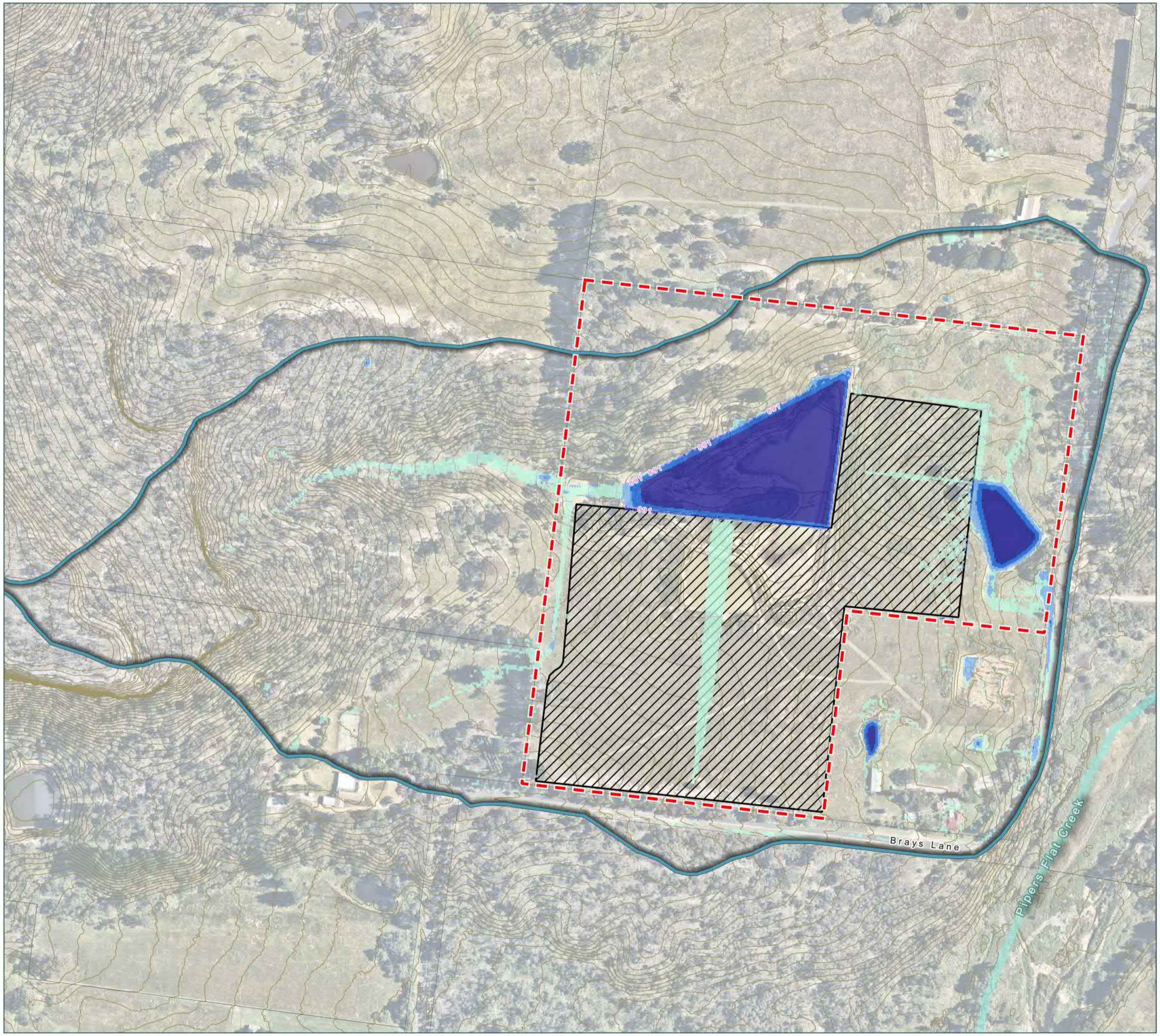
- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B10

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 10% AEP



AECOM

0 50 100 150

Legend

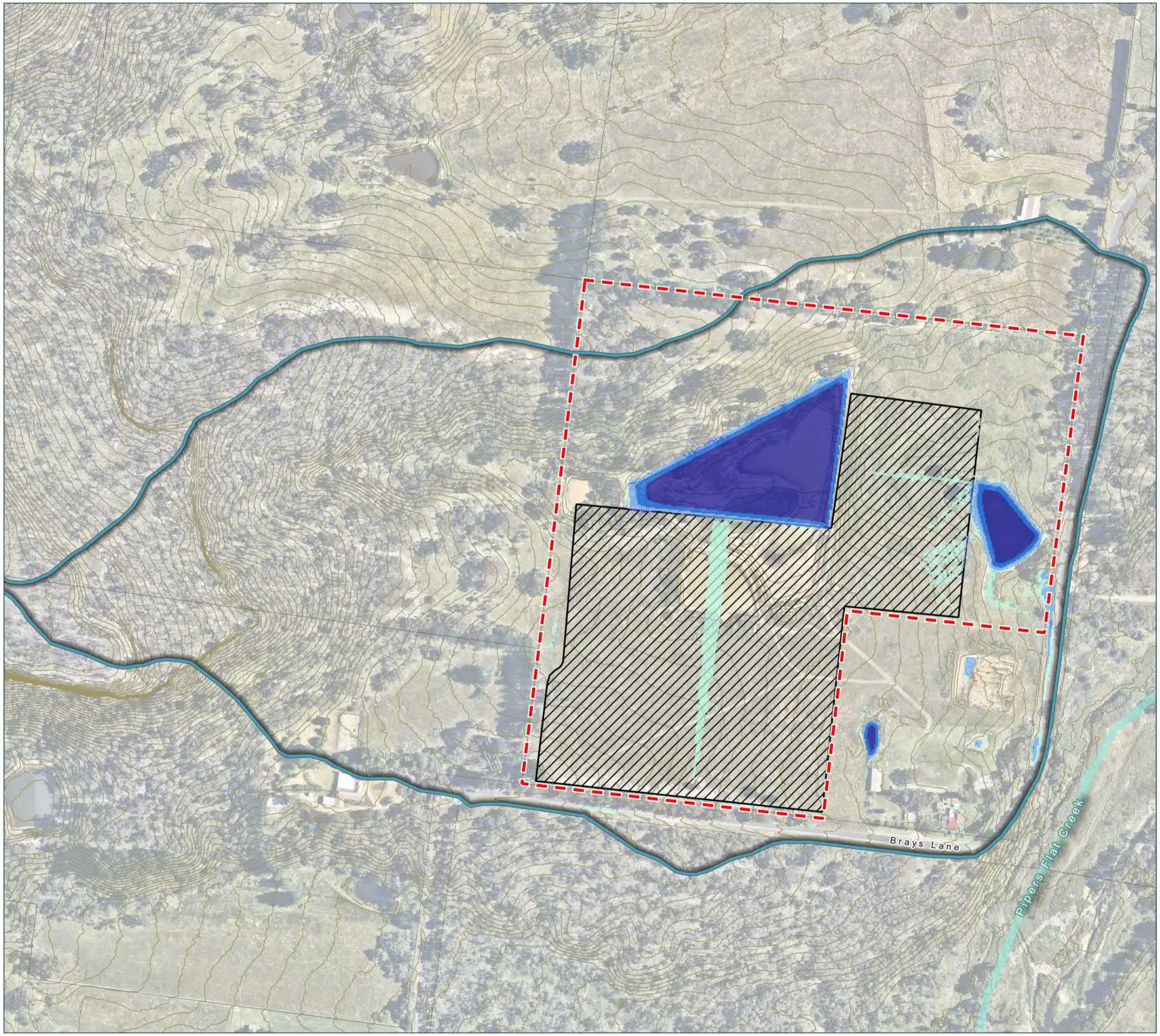
- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B11

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 20% AEP



AECOM

0 50 100 150

Legend

- Site area
- Watercourse
- Flood level contours (1 m interval)
- 1 m contours
- Model boundary
- Development zone
- Cadastre

Flood depth (m)

- < 0.03 (not shown)
- 0.03 to 0.15
- 0.15 to 0.5
- 0.5 to 1.0
- > 1.0

MAP B12

GREAT WESTERN BATTERY FLOOD DEPTHS & LEVELS PROPOSED SCENARIO - 50% AEP

Source: Imagery © Nearmap, 2020