APPENDIX M

Hydrology and flood risk assessment

Birriwa Solar and Battery Project Hydrology and Flood Risk Assessment

FINAL REPORT

20 June 2022

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Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for UPC\AC Renewables Australia.

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Cover image: abstract river image, Shutterstock

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Definitions and Abbreviations

Item	Definition
ABS	Australian Bureau of Statistics
AC	Alternating current
Access route	The route that will be used to access the project between the Castlereagh Highway and the access point to the site. The access route uses a section of Barneys Reef Road and a section of Birriwa Bus Route.
AEP	Annual Exceedance Probability
Alluvium	Alluvium Consulting Australia Pty Ltd
ARR2019	Australian Rainfall and Runoff 2019 Guidelines
Associated residence	A residence that is associated with the project – i.e. they have a landholder agreement with ACEN Australia for the project. Residences identified with an 'A' are associated.
BESS	Battery energy storage system
CWO	Central-West Orana
DC	Direct current
DEM	Digital Elevation Model
Development footprint	The area to be developed within land where ACEN Australia hold landholder agreements. All operational components of the project will be within the development footprint. The development footprint is the outcome of the iterative process outlined in the EIS which led to excluding certain areas of environmental or social constraint.
DPE	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
EnergyCo	Energy Corporation of NSW
EPA	NSW Environment Protection Authority (EPA)
EP&A Act	NSW Environmental Planning and Assessment Act 1979

Item	Definition
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
ha	hectares
km	kilometres
kV	Kilovolt
LEP	Local Environmental Plan
LGA	Local government area
LiDAR	Light Detection and Ranging
MW	Megawatts
Non-associated residence	A residence that is not associated with the project, with no landholder agreement with ACEN Australia. Residences identified with an 'R' are non-associated.
NSW	New South Wales
Operational infrastructure area	The proposed location of key operational infrastructure, including the BESS, substation, T-Link connection point, offices, car park, amenities and storage. Two locations are considered for the operational infrastructure area, but only one of the two location options will be implemented.
Planning Systems SEPP	State Environmental Planning Policy (Planning Systems) 2021
PV	Photovoltaic
Restricted development area	Land within the development footprint where disturbance will be avoided wherever possible, with the exception of that required for the provision of access and electrical reticulation (i.e. private internal access roads and electrical cables).
REZ	Renewable Energy Zone
Road upgrade corridor	The area of direct impact for public road upgrade works along the access route, which comprises part of Barneys Reef Road and Birriwa Bus Route South (connecting the access point to the site with the Castlereagh Highway).
SEARs	Secretary's Environmental Assessment Requirements
SIA	Social impact assessment
SSD	State significant development
Study area	The area of assessment for baseline surveys and studies conducted for the EIS. The study area comprises the maximum area considered for the project based on the extent of land where ACEN Australia hold landholder agreements and the area of potential impact for road upgrades
T-Link	Transmission link - NSW Energy Corporation's planned new 500/330 kV transmission line, substation(s) and related infrastructure within the CWO REZ.
TEC	Threatened ecological communities
The project	Birriwa Solar and Battery Project; a large scale solar photovoltaic generation facility along with battery storage and associated infrastructure. 'The project' refers to the project in its entirety; encompassing arrays of PV modules, power conversion units, BESS, connection infrastructure, road upgrades and ancillary infrastructure.
ACEN	ACEN Australia

1 Introduction

1.1 Overview

ACEN Australia Pty Ltd (ACEN Australia), formerly operating as UPC/AC propose to develop the Birriwa Solar and Battery Project; a large scale solar photovoltaic (PV) generation facility along with battery storage and associated infrastructure (the project). The solar component of the project will have an indicative capacity of around 600 megawatts (MW) and include a centralised battery energy storage system (BESS) of up to 6000 MW for a 2 hour duration. The BESS will enable energy from solar to be stored and then released during times of demand.

The project is in the localities of Birriwa and Merotherie, approximately 15 kilometres (km) south-west of the township of Dunedoo, in the Central West of New South Wales (NSW) as shown in Figure 1. The project is within the Mid-Western Regional Council local government area (LGA) and is within the Central-West Orana (CWO) Renewable Energy Zone (REZ).

The project is State significant development (SSD) pursuant to Schedule 1 of the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP). Therefore, a development application for the project is required to be submitted under Part 4, Division 4.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). This Flood Impact assessment report forms part of the Environmental Impact Statement (EIS).

1.2 Assessment approach and requirements

This flood modelling impact assessment report has been conducted in accordance with the Australian Rainfall and Runoff 2019 (ARR2019) guidelines. This study has assessed the flood risk in baseline and post-development conditions at the site for the 5%, 1%, 1 in 200, 1 in 500 and 1 in 2000 Annual Exceedance Probability (AEP) storm events. This report comprises of the following sections:

- a description of the project, local setting and surrounds;
- a summary of the assessment methodology;
- a description of the existing conditions; and
- predicted impacts of the project during operation; and

This assessment has been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE) which were set out in the Planning Secretary’s Environmental Assessment Requirements (SEARs) for the project, issued on 5 November 2021. The SEARs identify matters which must be addressed in the EIS and essentially form its terms of reference.

Table 1 lists individual requirements relevant to this Flood Impact assessment and where they are addressed in this report.

Table 1. Flooding related SEARs and government agency assessment recommendations

Requirement	Section addressed
DPE - SEARs	
An assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources 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;	Flooding impacts are addressed in this report. Groundwater resources, groundwater dependant ecosystems and acid sulfate soils are addressed in the biodiversity and soils assessments, respectively, prepared for the EIS.
10. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a) Flood prone land. b) Flood planning area, the area below the flood planning level. c) Hydraulic categorisation (floodways and flood storage areas). d) Flood hazard	Flood prone land and flood hazard is mapped for all design events in Attachment 1. The decision on an appropriate flood planning level for commercial and industrial developments relates more to economic benefits versus costs. Section 4.2 discusses flooding constraints for the site. All required design flood events are mapped in Attachment 1.
11. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.	Section 3 of the report discusses the development of hydrology and hydraulic modelling for the required events.
12. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a) Current flood behaviour for a range of design events as identified in 14 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Section 4.2 discusses the developed scenario and all design events in 11 and 12 are presented in Attachment 1.
13. Modelling in the EIS must consider and document: a) Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. b) The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood, or an equivalent extreme flood. c) Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories. d) Relevant provisions of the NSW Floodplain Development Manual 2005.	There are no known detailed flood studies of Huxleys Creek and White Creek in Birriwa. Flood impacts are discussed in Section 4.2 for the required design events. No increase in runoff outside the development footprint and floodplain storage preserved.

Requirement	Section addressed
14. The EIS must assess the impacts on the proposed development on flood behaviour, including: a) Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b) Consistency with Council floodplain risk management plans. c) Consistency with any Rural Floodplain Management Plans. d) Compatibility with the flood hazard of the land. e) Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. f) Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. g) Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. h) Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council. i) Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council. j) Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES. k) Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	[Item 14 a] Flood impacts are discussed in Section 4.2 for the required design events . [Item 14 b-d] No flood studies or management plans were identified for the Project Area. The available Rural Residential, Industrial and Residential Strategy (RRIR Strategy) was prepared for the Mudgee Shire Council and therefore does not address the full Mid-Western Region. Flood hazard is very low thus compatible with most developments. [Item 17 e-f] The project does not store or divert flow and does not alter the hydraulic function in floodways and is an appropriate development for the nature of flooding experienced which is predominantly overland sheet flow (see Section 4.2). [Item 14 g] Not due to the solar farm itself, however this issue will also to be addressed in construction planning. Riparian vegetation or river banks or water courses are not present in the Development footprint (see Section 4.2). [Item 14 h] No direct flood emergency management issues. Refer to Section 4.3 on emergency management. SES and Council will be provided with a copy of this report. [Item 14 i-j] The Risk to life from flooding is low, however some emergency management recommendations are made to assist transport away from the Project Area. The 0.05% AEP (2000yr ARI) event was simulated as a proxy to the PMF. Refer to Section 4.3 on emergency management. [Item 14 k] No impacts are expected.

A number of technical terms have been utilised throughout this report for the discussion of hydrology and flooding. These are explained in the Definitions and Abbreviations .

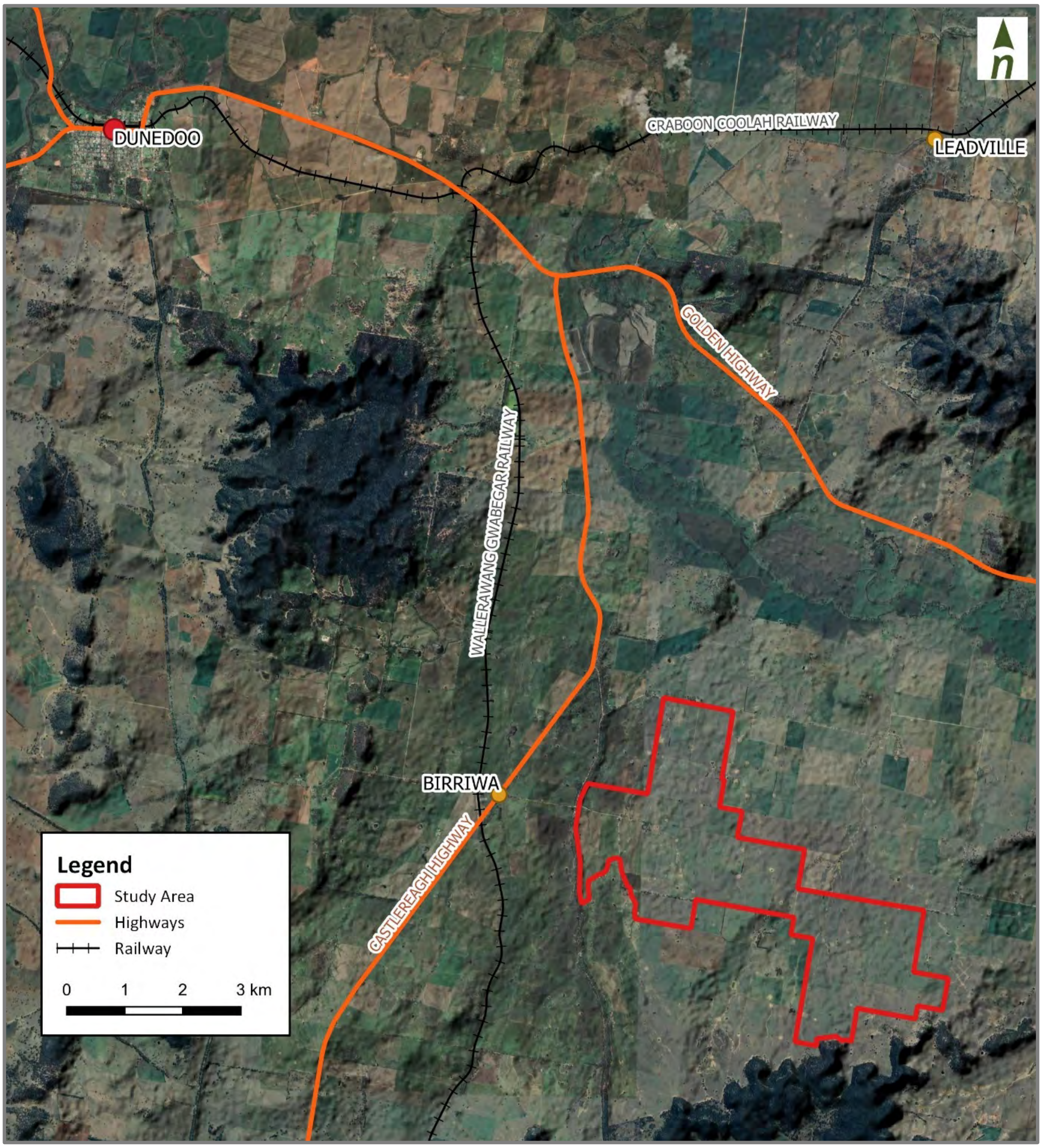


Figure 1. *Locality Plan*

2 Project description and setting

2.1 Project overview

A full project description is provided in Chapter 3 of the EIS. The project will comprise the following key components:

- a network of approximately 1 million solar panels and associated mounting infrastructure;
- a 1,000 MW capacity BESS, with a storage duration of 1,000 MWh;
- an onsite substation with a capacity of up to 500/330 kilovolt (kV);
- electrical collection and conversion systems, including inverter and transformer units, switchyard and control room;
- underground and aboveground cables;
- a management hub, including demountable offices, amenities and equipment sheds;
- parking and internal access roads;
- security fencing;
- temporary construction compound (during construction and decommissioning only); and
- upgrade of the site access route (Barneys Reef Road and part of Birriwa Bus Route).

The impact footprint (comprising the development footprint, road upgrade corridor, and construction footprint of public road crossings) are shown on Figure 2.

The project will connect to the proposed CWO REZ transmission link (T-Link) via a substation to be located within the development footprint. The proposed T-Link and how it relates to the project is described further in Chapter 1 of the EIS.

2.2 The study area

The project will be developed within a study area of approximately 1,300 hectares (ha) and is comprised of 18 freehold land parcels. The study area is the area of assessment for baseline surveys and studies conducted for the EIS. The study area comprises the maximum area considered for the project based on the extent of land where ACEN Australia hold landholder agreements and the area of potential impact for road upgrades.

The properties within the study area are currently primarily used for sheep and cattle grazing as well as low intensity dry land cropping. There are scattered rural residential properties within and surrounding the project area, including four associated residences within or in close proximity to the study area. There are 20 non-associated residences within 2 km of the study area and an additional 20 within 5 km.

The development footprint is the land within the study area that will be used for the operation of the project, which excludes certain areas of environmental or social constraint. The development footprint has been refined through an iterative design process throughout the preparation of the EIS and has been informed by the outcomes of community and stakeholder engagement and environmental, social and economic assessments.

The road upgrade corridor is the area of direct impact for public road upgrade works along the access route, which comprises part of Barneys Reef Road and Birriwa Bus Route South (connecting the access point to site with the Castlereagh Highway) (Figure 2).

The study area will be accessed via the Castlereagh Highway, Barneys Reef Road and Birriwa Bus Route. From the site access point, private internal roads will be used to traverse the development footprint. A section of Barneys Reef Road and Birriwa Bus Route will require upgrades as part of the project (Figure 2).

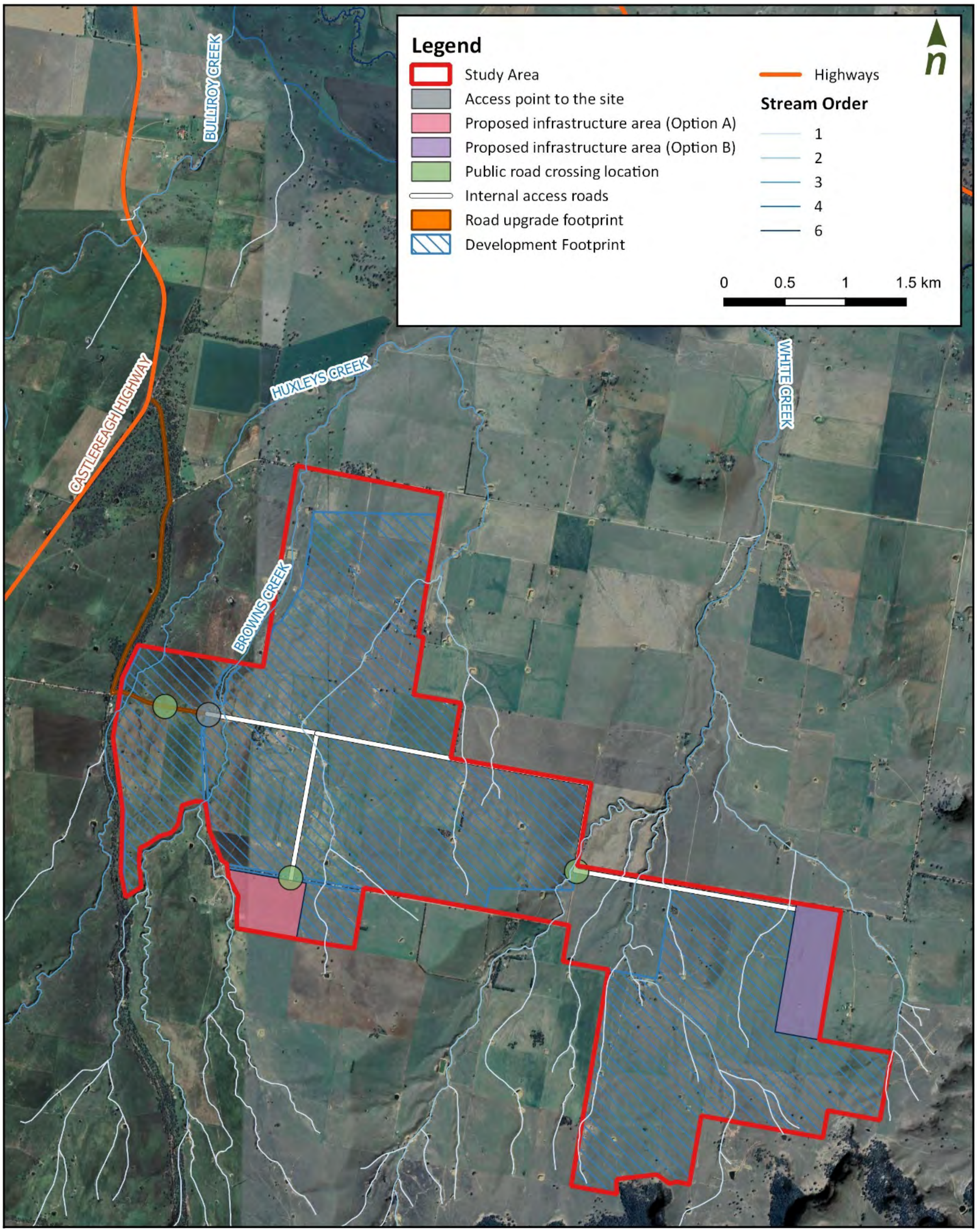


Figure 2. *Study Area overview*

3 Hydraulic Modelling

3.1 Overview

The proposed development is configured to sit atop land historically used for farming and agricultural uses. The site is situated adjacent to the Castlereagh Highway and south of the Talbragar River. The study area is approximately 13 km^2 and the PV array area (i.e. development footprint) will be up to 12 km^2. The development also includes about 3.3 km of upgrades to local roads for access to the site. There are two locations proposed as operational infrastructure areas that include a substation, operational facility and BESS (Options A and B). The proposed project site overview is shown in Figure 2.

The development footprint sits within a catchment with two main creeks, Huxleys Creek and White Creek. These two watercourses present the greatest risk of flooding. Watercourses in Figure 2 are displayed using the Strahler Stream Order where all links without any tributaries are assigned an order of 1 and are referred to as first order. The stream order increases when streams of the same order intersect. Therefore, the intersection of two first-order links will create a second-order link, the intersection of two second-order links will create a third-order link, and so on.

The development footprint also comprises several ephemeral overland flow paths running along and through the site extents that will influence flooding characteristics at the site. This study aims to assess the use the hydraulic model to determine the risk of flooding on site under existing conditions and assess the impacts of proposed development.

3.2 Background Information

Modelling Rationale

A short literature review was conducted to assess industry trends in terms of modelling the surface water impact of PV arrays. A summary of relevant literature is given below:

Cook and McCuen, 2013. Journal of Hydrologic Engineering, ASCE. Hydrologic Response of Solar Farms.

- The solar panels themselves do not have a significant effect on catchment runoff.
- If the runoff characteristics of the final ground cover under the panels is increased (increased impervious hard-stand area, or decreased roughness) then runoff may increase.

Water Solutions, 2017. Lower Wonga Solar Q1 Renewable Energy Generation Facility Flood study.

- There are no expected changes to the runoff volumes, peaks, or times to peak for flood events in the catchment due to all the additional surface area of solar panels provided the surface coverage is maintained.
- Considered that a healthy cover of vegetation will ensure similar levels of infiltration as currently experienced at the study area.

It may be concluded that so long as the study area vegetation conditions are reinstated similar to pre-developed conditions following construction, additional runoff from the study area is unlikely to occur. Small increases in imperviousness are unlikely to increase peaks due to hydrograph timing effects. Therefore, the modelled existing conditions are likely to reflect the impact of the solar panels on the downstream runoff. As such no change in the modelled imperviousness within the extent of the PV arrays was made in the developed model scenario.

Modelling Approach

An uncalibrated, 2-Dimensional (2D) hydraulic model was built using the TUFLOW software package. A Direct Rainfall approach was employed for this study whereby a rainfall hyetograph is applied directly to the model grid within the contributing catchment. A 5 m cell resolution was adopted and is considered appropriate for the purposes this study. No calibration has been undertaken due to a lack of historical flow and level data which would be required to undertake a model calibration or validation.

A baseline model scenario was developed which adopts current catchment land use and topographic conditions.

A developed scenario model was then configured, adopting the proposed development envelopes provided by ACEN Australia, which outlines the extent of PV arrays, access tracks and site infrastructure to enable a comparison with the existing results. In addition, the proposed alignment of internal access roads was conservatively buffered to a width of 10 m (5 m each side of the provided centreline) and incorporated into the model through changes to Manning's 'n' and imperviousness.

3.3 Data analysis & limitations

Topographic Data

Coverage of the ground surface in and around both the sites was sourced from the publicly available LiDAR data acquired from ELVIS (Elevation - Foundation Spatial Data https://elevation.fsdf.org.au/). The resolution of the Digital Elevation Model (DEM) was 1 m x 1 m, which formed the basis of the localised overland flood modelling.

As it was unclear whether the retaining basins were engaged with ponding water or filled over, no terrain adjustments were made in the DEM to compensate for the volume of water in each basin, or the lack thereof. However, these stock dams are small and will typically fill early in a storm event to not impact the peak should the basins be filled as part of the project.

3.4 Hydraulic Roughness

In the study catchment the land uses were delineated based on the aerial imagery as shown in Figure 3. Depth varying Manning's 'n' coefficients (i.e. Manning's coefficients reducing with increased flood depth) were then applied to the land uses based on typically adopted values as shown in Table 2.

To represent fully developed conditions, the extent of development shown in Figure 2 was used to categorise the future land use and apply the manning's 'n' coefficients from Table 2. The developed case land use map is presented in Figure 4.

Table 2. Manning's 'n' coefficients for 2D model domain

Land use	Coefficient below 30mm depth	Coefficient above 100mm depth	Note
Grazing native vegetation (Default)	0.1	0.06	Linear interpolation between 30-100mm depth
Water Bodies	0.03	0.03	Single value used
Sealed Roads	0.1	0.025	Linear interpolation between 30-100mm depth
Unsealed Roads Waterway no vegetation	0.1	0.035	Linear interpolation between 30-100mm depth
Railway Water light vegetation	0.1	0.05	Linear interpolation between 30-100mm depth
Moderately dense vegetation	0.1	0.07	Linear interpolation between 30-100mm depth
Dense vegetation	0.1	0.08	Linear interpolation between 30-100mm depth
Waterway dense vegetation	0.1	0.1	Linear interpolation between 30-100mm depth
Buildings	0.1	0.5	Linear interpolation between 30-100mm depth
Development - PV arrays	0.1	0.06	Linear interpolation between 30-100mm depth
Development - BESS and Operational Areas	0.1	0.04	Linear interpolation between 30-100mm depth

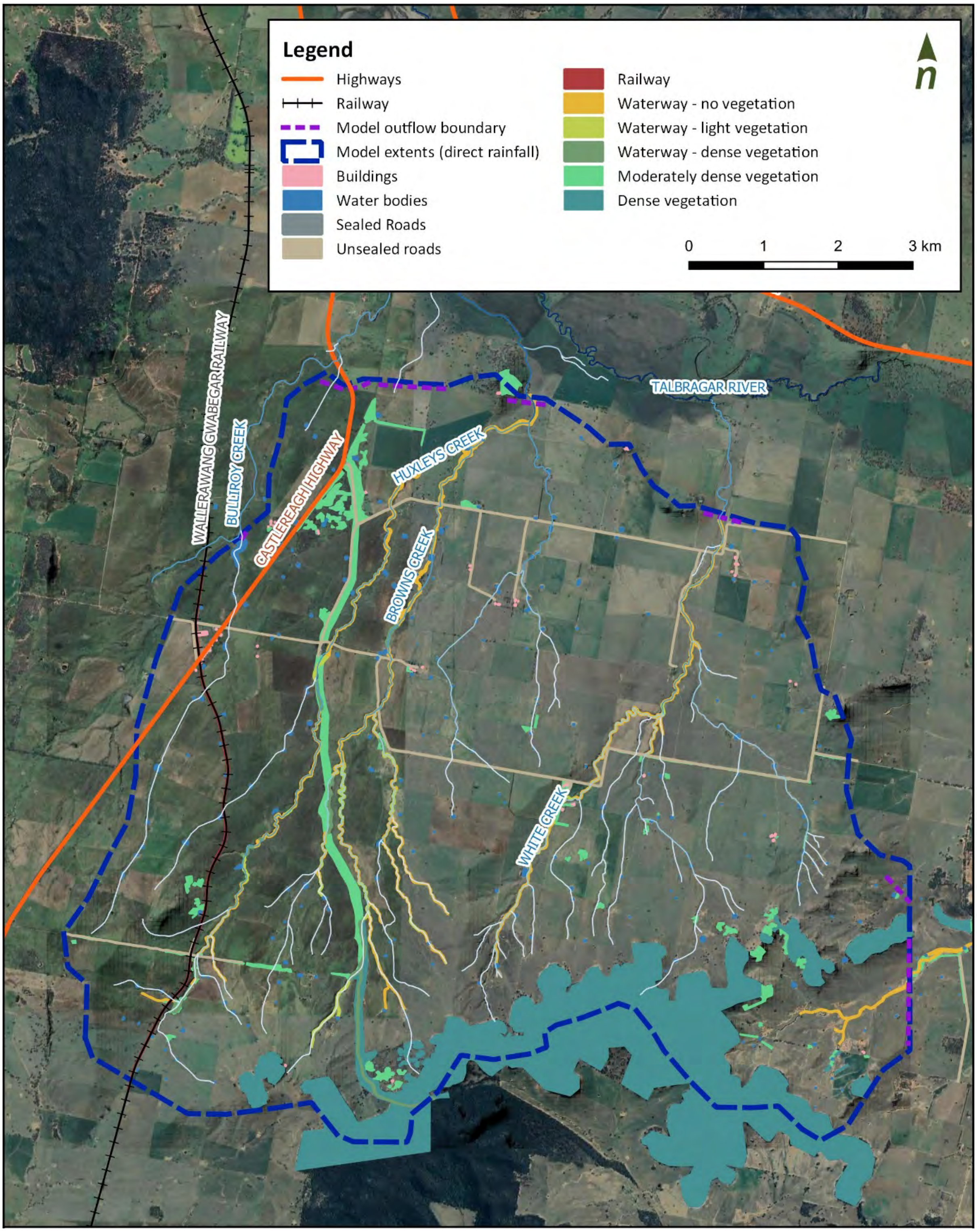


Figure 3. *Extent of the Existing Case TUFLOW model with flow paths and land use*

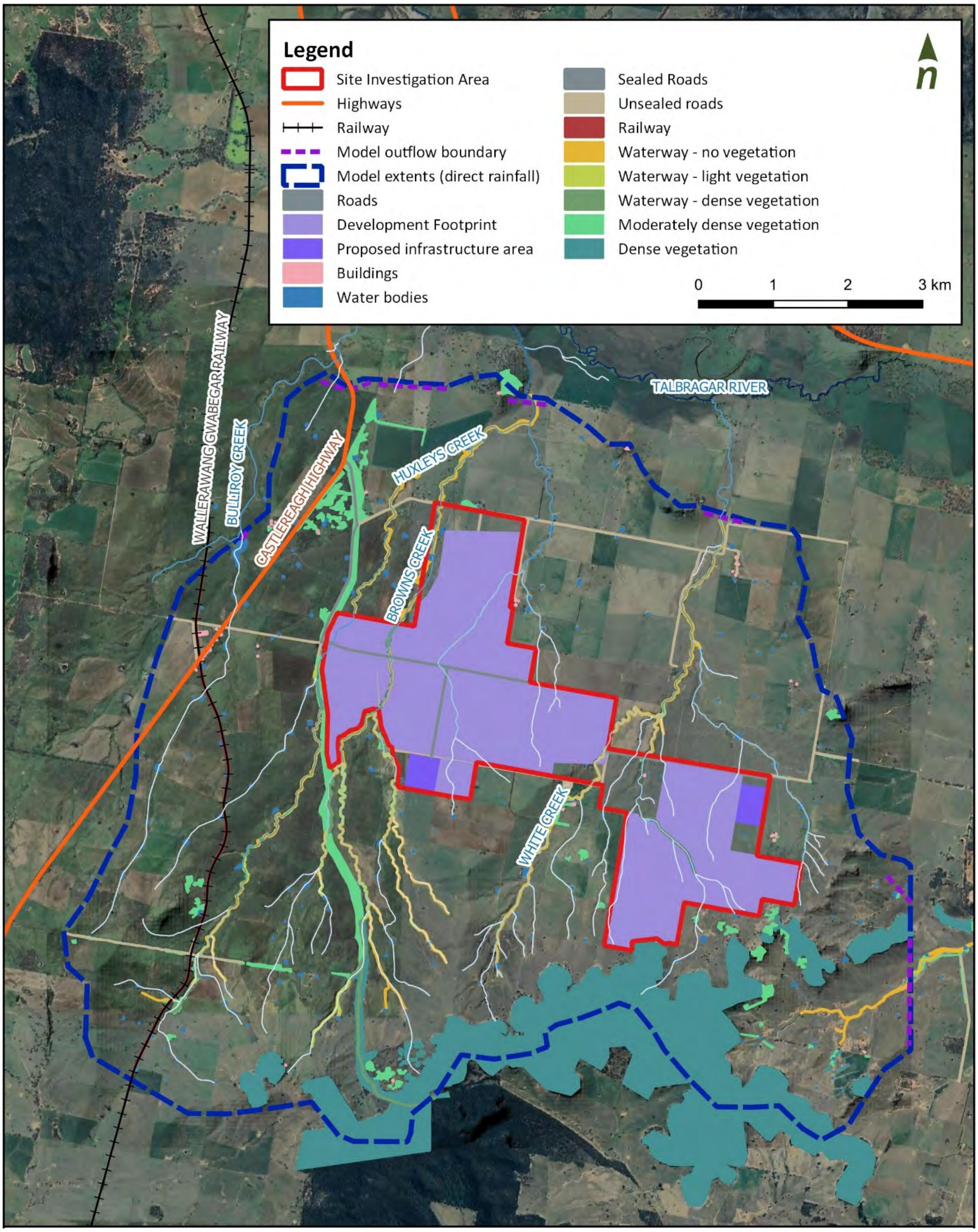


Figure 4. *Extent of the Developed Case TUFLOW model with updated land use*

3.5 Hydrology

For this study a direct-rainfall (or rain-on-grid) approach has been adopted to apply inflows to the hydraulic model. With this approach rainfall is applied to directly to the Digital Elevation Model (DEM) of the entire catchment area. Hydrologic analysis is limited to the development of the rainfall hyetographs which are used as boundary conditions in the hydraulic model. The following events were simulated for the assessment:

- **5% AEP:** To assess the distribution of flow paths throughout the site and establish where dominant flow paths in the smaller, more frequent events are likely to be.
- **1% AEP:** to determine areas of low flood risk and levels for key site infrastructure (e.g. substations, access).
- **0.2% and 0.5% AEP:** to assess the flood behaviour in very rare flood events.
- **0.05% AEP:** to assess the flood behaviour in an extreme event and note the impacts on all infrastructure.

To determine the storm durations which were critical to the site, a wide range of durations were simulated. For small to medium-sized catchments a typical critical duration can range between 20 minutes to 12 hours. As such, the range of storm durations selected to run included 12 storms ranging from 20 minute up to the 720 minute storm. The longer storm durations were included to ensure the critical storm is correctly identified, including for areas downstream of the project site.

The ARR2019 guidelines (Geosciences Australia, 2021) contain the currently adopted methods for hydrologic flow estimation including updates to rainfall intensities, rainfall losses and temporal patterns. Part of this approach is to use an ensemble of temporal patterns (ten patterns for each storm duration) to allow for the conveyance and storage characteristics of the catchment to be represented.

Critical Storm Durations

The critical duration of each design event is defined as the duration that results in the highest median peak flow rate of the associated temporal pattern ensembles. Overall, 480 different TUFLOW simulations were run in the baseline conditions to determine the critical storm durations and temporal patterns. The same critical durations and temporal patterns were run for developed conditions to enable a direct comparison in flood levels and determine the flood level impacts. A number of storm durations were adopted for each return period to account for the spatial variation in critical durations within the site boundary.

Losses

Losses from the ARR2019 Data Hub have been adopted for this assessment. The full losses were an initial loss of 20 mm and a continuing loss of 1.6mm/hr. The losses applied in each AEP and duration combination also consider the storm duration (initial losses interpolate to 0 for durations under 1 hour) and the preburst rainfall depth considered. This assessment has adopted the 50th percentile preburst as per the ARR2019 Data Hub guidance.

Impervious zones

The two locations proposed as operational infrastructure areas will be approximately 25 ha in size and both have been simultaneously assessed in the flood model as they drain to different creeks. An allowance for the increase in runoff volume in the Developed case was included making the operation areas 75% impervious and any proposed access roads as 100% impervious. This is considered to be a conservative assumption but is intended to demonstrate the potential for impacts the newly impervious areas may have in the overall catchment.

4 Flood Impact Assessment

Generally, there are two potential mechanisms by which development within the study area could have an impact on flood risk.

- Impacts on flood levels due to the proposed development obstructing flows, OR
- Impacts on flood levels due to the study area yielding additional runoff due to development.

As discussed in Section 3.2 the PV panels on the site are not anticipated to increase catchment imperviousness. Therefore, the only increases in impermeable area due to the development are from the construction of access tracks, site buildings and site infrastructure on pads (substations, BESS etc).

As such, a developed case scenario was configured in the 2D model with adjusted rainfall losses within the project footprint (the area that will be disturbed) for the proposed operational infrastructure area including substation, operational facility and BESS as outlined in the Project data provided by ACEN Australia to model the impact from the development in the downstream areas. As described in Section 3.5, the new roads, site buildings and site infrastructure have had their land use updated to reflect their fully impervious land use.

4.1 Existing Conditions (Baseline)

The moderately sloping nature of the catchment has resulted in relatively shallow flood depths across the site with deeper, faster moving flows in the creeks and narrow floodplain. In the majority of modelled events the flood depth in the major flow paths is generally over 1.0m deep, with overland flow paths typically less than 0.25m. There are pockets of trapped ponding distributed across the site, but these are associated with the existing farm dams as shown in Figure 5 (1% AEP event).

Flow velocities along the main channels and branches of Huxleys Creek, Browns Creek and White Creek are highest with values of between 1.0-2.0 m/s in the 1% AEP event. In the adjacent floodplain areas the flow velocities are typically in the range of 0.5-0.8 m/s whereas velocities in most of the overland flow paths are generally under 0.5 m/s and pose a low risk.

For the baseline case, the peak depths and velocities in the 1% AEP event are shown in Figure 5 and Figure 6. Complete flood mapping is presented in Attachment A.

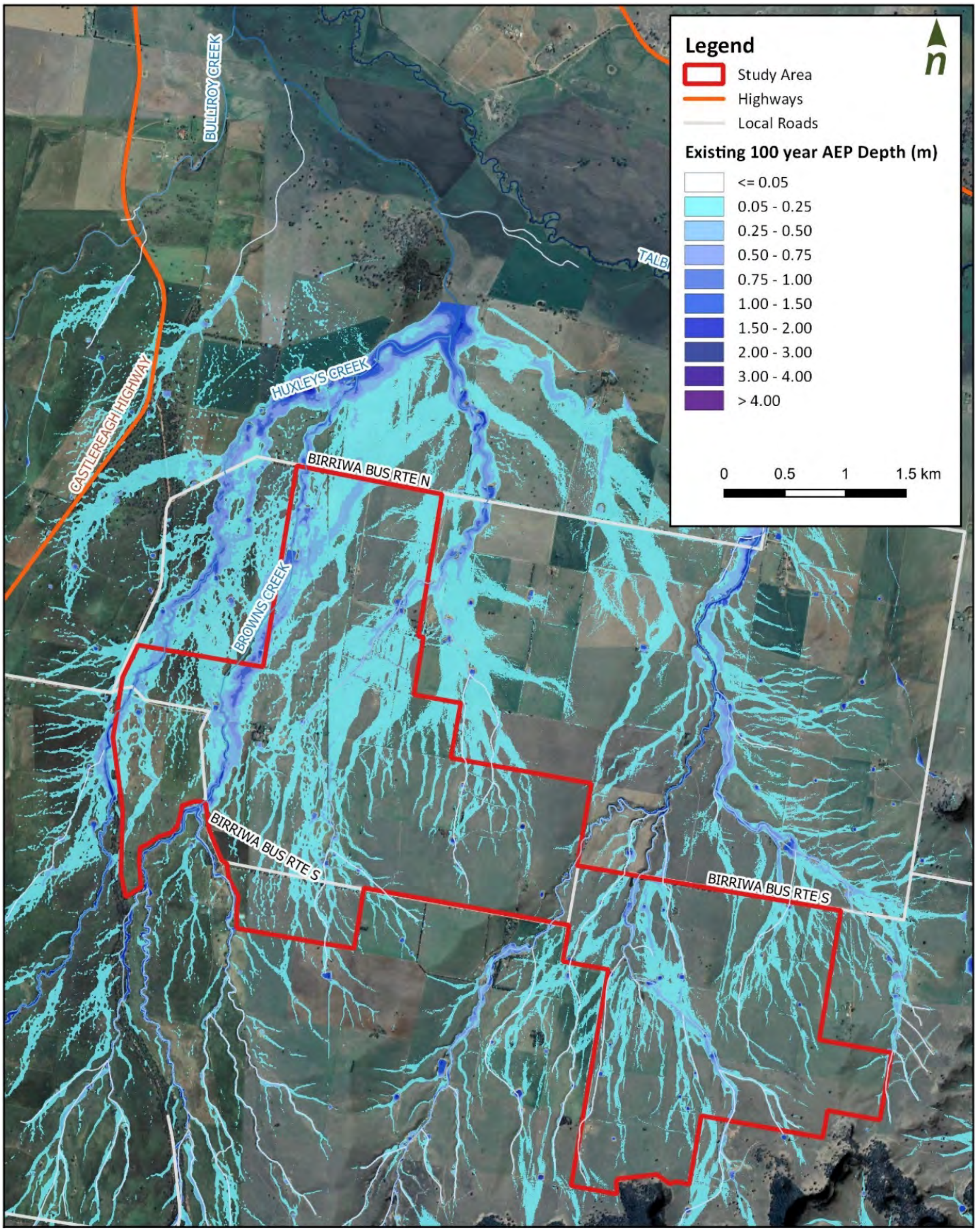


Figure 5. *Flood Depth 1% AEP Baseline*

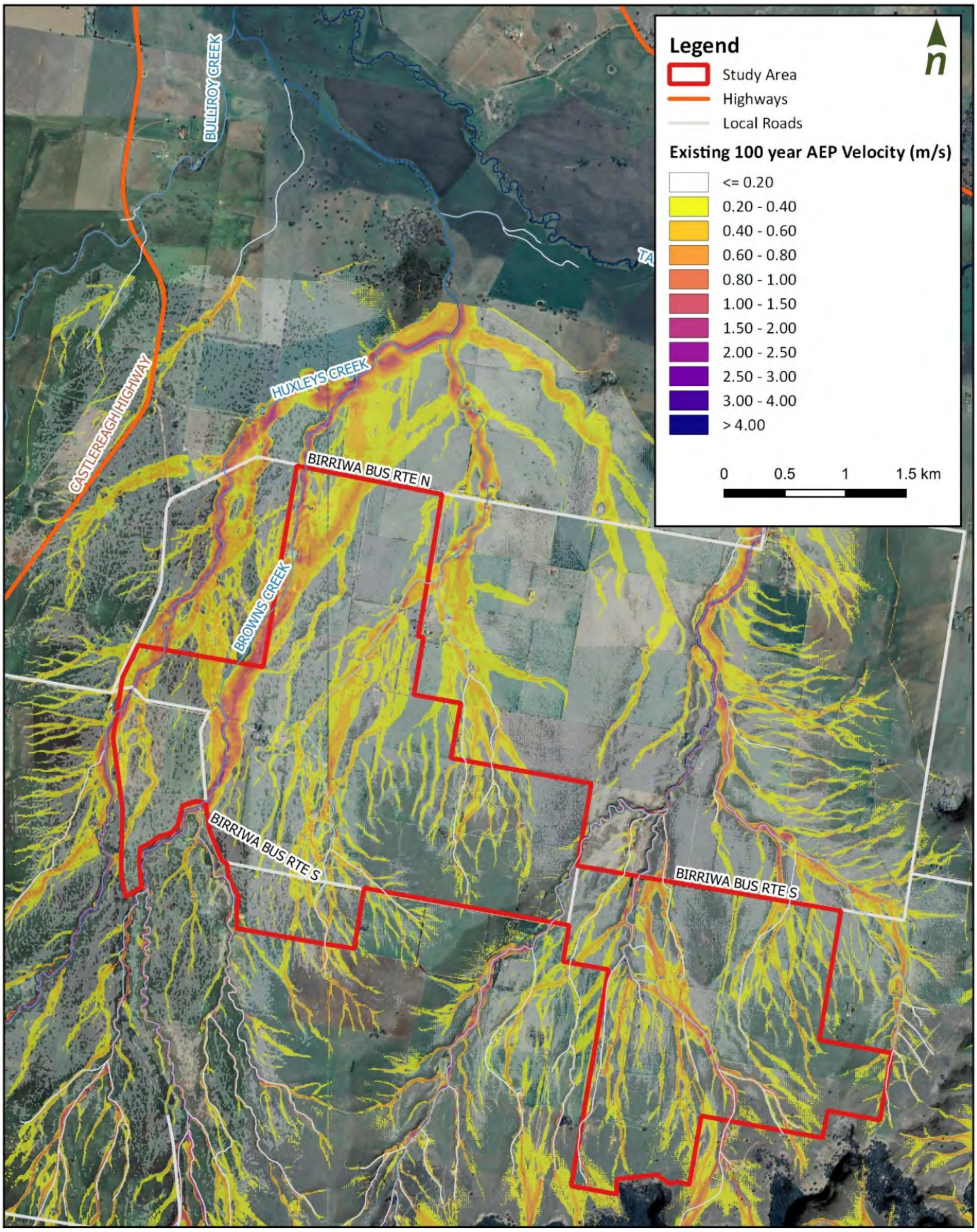


Figure 6. *Flood Velocity 1% AEP Baseline*

4.2 Developed Scenarios

Due to the small extent of development (at the ground level) the impacts of development to flood depth, velocities and levels is small. For proposed site infrastructure outside the primary flow paths, flood impacts are considered to be minor in all modelled events.

The peak depths and velocities for the 1% AEP event are shown in Figure 7 and Figure 8 while Figure 9 shows the changes in peak flood levels due to development in this same area. Complete flood mapping is presented in Attachment A.

It is proposed that significant earthworks are generally not required for the development footprint or solar panel installations. Access roads planned within the development footprint are to be designed to ensure overland flow is not re-directed. Building and infrastructure pads will not be positioned within concentrated overland flow.

Some minor flood impacts extend outside the study area on the northern edge of the development footprint extending downstream along Huxleys Creek, adjacent to Barneys Reef Road. In the 1% AEP event the magnitude of this increase is between 1-2 cm and extends less than 250m into the neighbouring property. This is caused by the PV solar arrays extending across Huxleys Creek inside the development footprint. The higher hydraulic roughness of the developed scenario slightly reduces the flow velocity which creates a small increase in peak water level. In all other modelled events, the location, extent and magnitude of the impacts are very similar. There are no other locations where the development adversely increases or re-directs flooding at neighbouring properties.

Huxleys Creek is an area of higher flood hazard and the installation of PV arrays in this area will be avoided in Detailed Design unless the hazard can be mitigated. As such, mitigating the minor flood impacts shown in Figure 9 is recommended by maintaining a riparian buffer where the baseline hydraulic roughness will remain unchanged. Although the reach of Huxleys Creek within the development footprint does not have riparian vegetation, avoiding installation of PV arrays in the watercourse corridor will reduce, and likely eliminate, the offsite impacts.

There will also be security fencing situated around the perimeter of the site with setbacks from the creeks based on the required vegetation buffer. Due to the presence of multiple flow paths across the site, the fencing is likely to become a trap for lose vegetation in high flow events and may put and additional structural loading on the fence which may cause damage.

While there have been increases in impermeable area, in context the impervious proportion in the catchment is still insignificant and the model results show negligible changes in flood level overall from the two proposed operational infrastructure areas. It is recommended that the BESS modules are aligned with local overland flow paths to prevent flows being redirected which could lead to localised increased in flood level and higher risk of scour and erosion.

The Project Area is not expected to increase runoff, provided developed case vegetation and land cover provides similar levels of infiltration and retardance. The increase in imperviousness within the proposed infrastructure area options do not create offsite impacts. The project earthworks do not include any infilling or depletion of floodplain storage. The filling and levelling of small farm dams within the development footprint is not anticipated to impact peak flows as they fill early in a storm event and are located outside the floodplain in overland flowpaths.

The Project will not directly or indirectly increase erosion or siltation, and the creeks and watercourses passing through the development footprint have almost no existing riparian vegetation. The volume of runoff and velocity of flow will not change with any significance as the developed case vegetation is expected to provide similar hydraulic roughness.

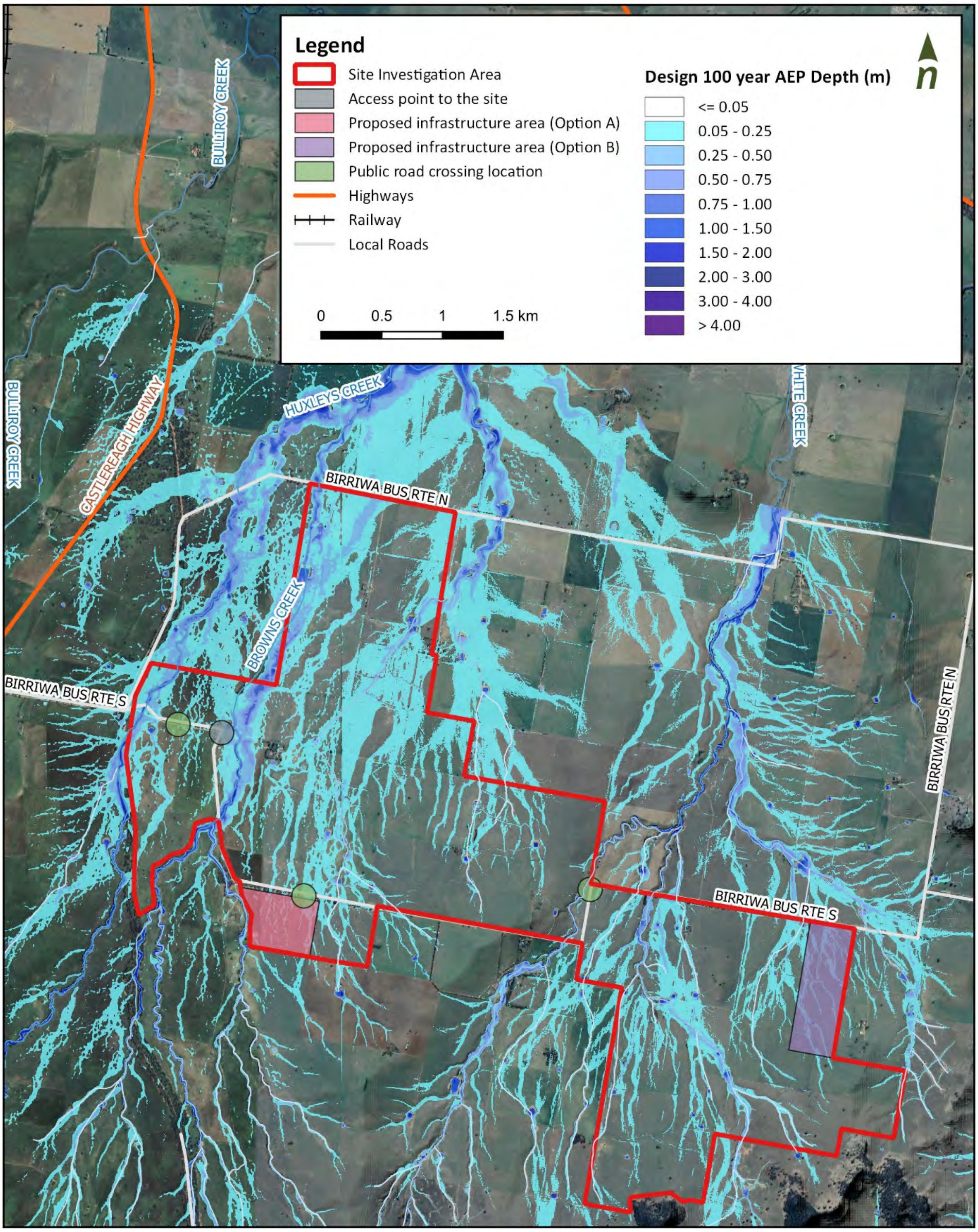


Figure 7. *Flood Depth 1% AEP Developed Case*

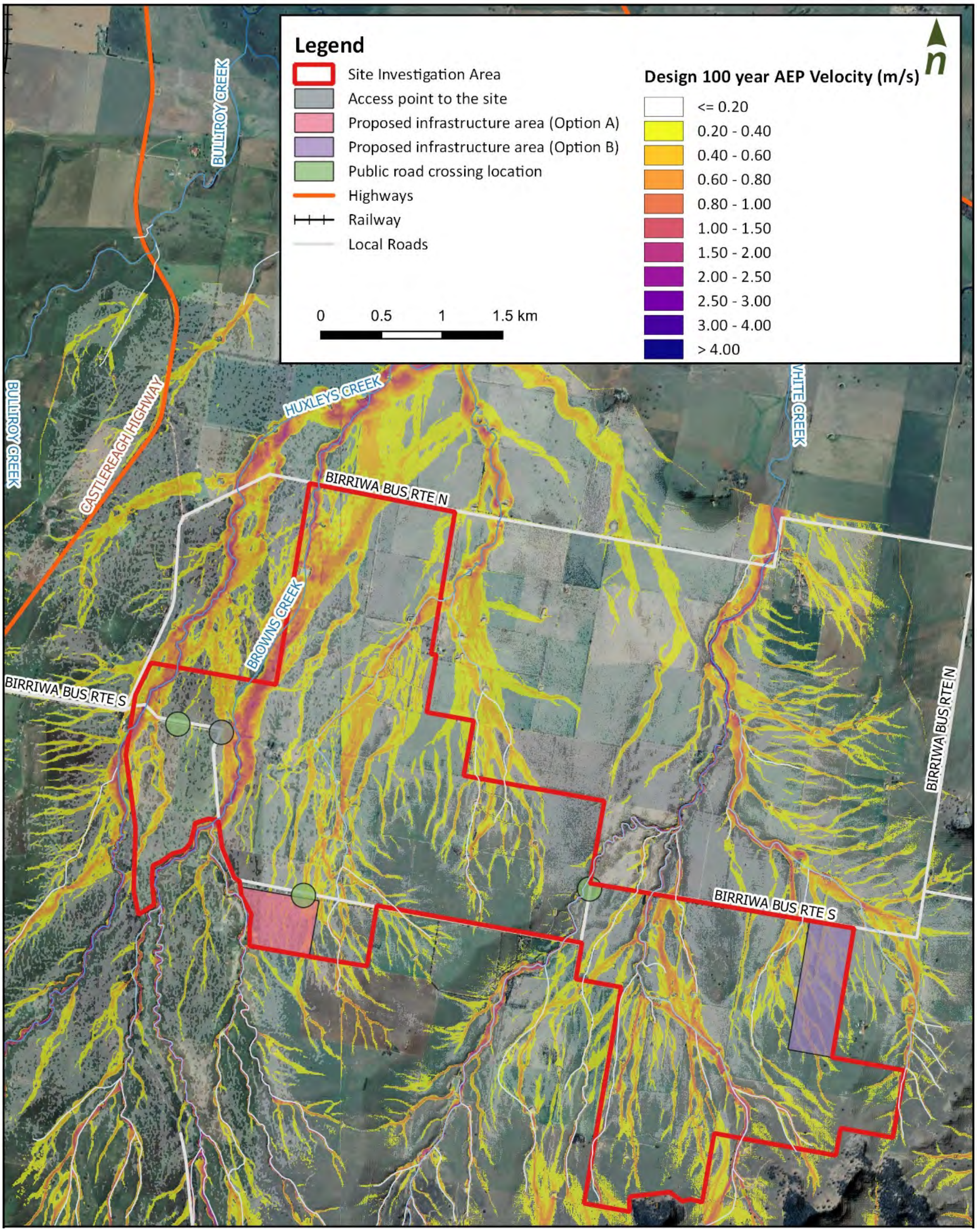


Figure 8. *Flood Velocity 1% AEP Developed Case*

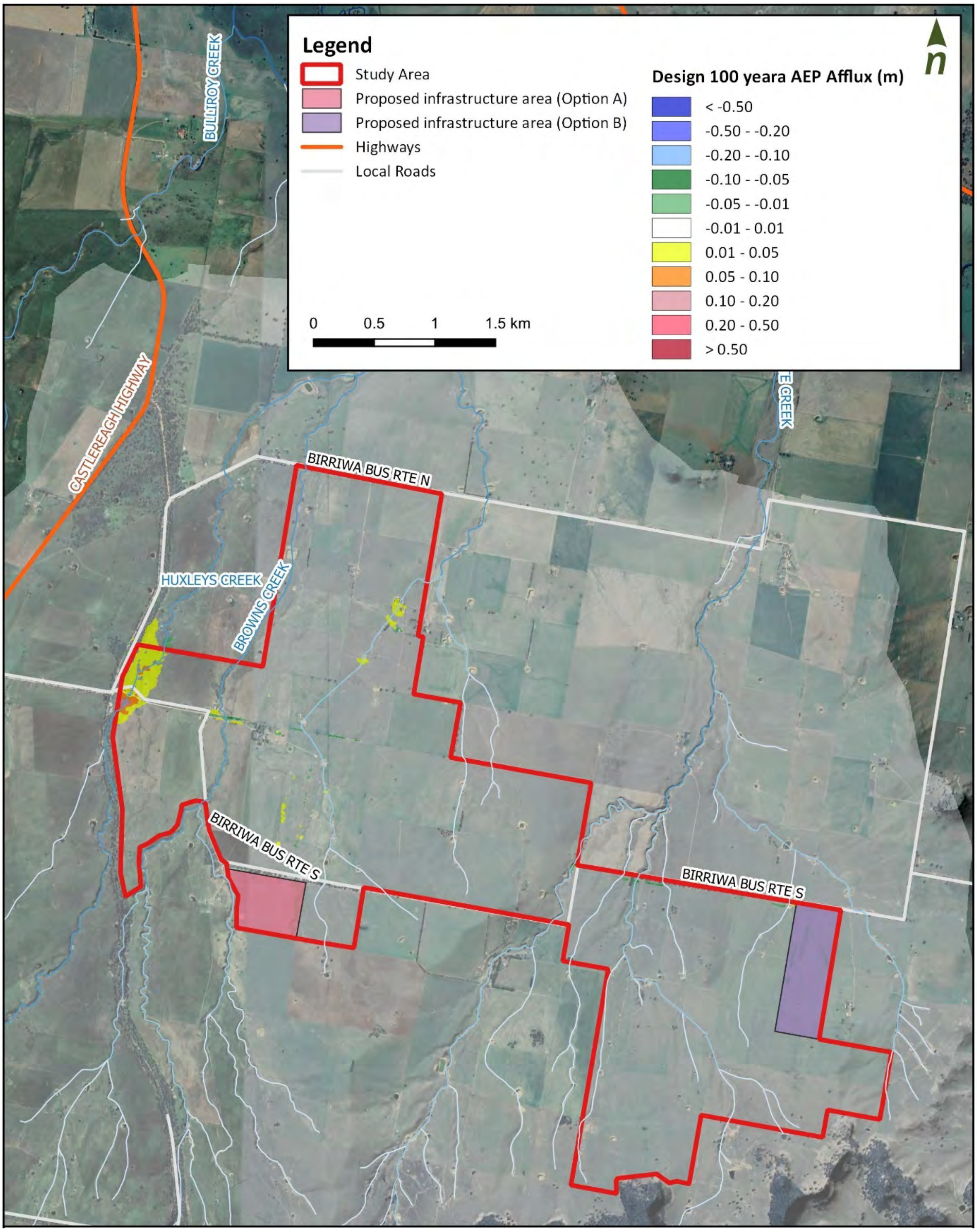


Figure 9. *Flood Level Difference 1% AEP Case*

Constraints for site infrastructure

Panel footings located in high velocity areas create the potential for localised scouring around the solar panel poles which can lead to deflection of the array and cracking of solar panels. To reduce the likelihood for erosion and damage to the solar panels the foundations for the photovoltaic arrays and transmission lines should be located away from areas that exceed flood depths of 0.3 m and flow velocities greater than 1.5 m/s. However, in areas where higher flood depths are predicted these locations could include solar panels, but they would require raising of the solar panel poles which can be confirmed as part of the detailed design.

The solar panels should be designed to provide a minimum of 300 mm freeboard for the lowest edge above the maximum 1% AEP flood level. The panel post and footings should be designed to withstand the flood velocities described in this report, which are mostly low in the areas proposed for solar panels.

To provide guidance on the areas that are most appropriate for PV arrays and other site infrastructure (e.g., substation, the operational facility and BESS) the waterways and constraint areas in Figure 10 have been defined using the flood depths and velocities from the 1% AEP event as described below:

- **Area of higher flood hazard**: consider flood constraints in the project's detailed design and avoid installation of PV arrays or BESS infrastructure in this area unless the hazard can be mitigated. This area includes depths above 0.3m and velocities above 1.5 m/s.
- **Area of low flood hazard**: the project's detailed design should consider any infrastructure with a 300mm freeboard. This area includes depth above 0.1m and velocities above 1.0 m/s.
- **Unconstrained**: All other areas.

Note that existing farm dams have been included in Figure 10 as these may be filled and levelled meaning that depths will generally be shallow, and most will not form part of the area of higher flood hazard.

Access roads

The project requires part of Barneys Reef Road and the Birriwa Bus Route to be upgraded and a network of internal unsealed roads will provide access to the solar arrays for construction and ongoing operational maintenance. The location of the roads will be finalised during detailed design for the project, but the current design for illustration purposes is presented in Figure 11.

The current configuration of access roads will require waterway crossings listed in Table 3 which also details the peak depth and flow velocities for the 1% AEP event. The NSW Office of Water *Guidelines for watercourse crossings on waterfront land* (July 2012) outlines what should be considered in the design and construction of watercourse crossings to maintain natural hydrological regimes:

- Accommodate site hydrological conditions.
- Do not alter natural bank full or floodplain flows or increase water levels upstream.
- Do not change the gradient of the bed except where necessary to address existing bed and bank degradation.
- Do not increase velocities by constricting flows, for example filled embankments on approaches.
- There is no formal guidance on the level of immunity for waterway crossings.

The waterway crossings listed above will be important for the development to occur safely while minimising waterway impact. Site specific designs for this structure are recommended and this will be finalised at detailed design and constructed generally in compliance with the guidelines listed above, and in accordance with the development consent conditions.

Peak flood velocities crossing the access tracks will need to be managed during construction to ensure sediment is not mobilised in a significant rain event. Inspection after storm events will be required to ensure erosion does not impact the access roads though the life of the solar. Erosion and sediment controls can be implemented during construction in accordance with the Landcom guidelines for *Managing Urban Stormwater: Soils and construction* (Landcom, 2004) that provide for industry to reduce the impacts of land disturbance activities on waterways.

Table 3. Access road waterway crossings

Road	Waterway Crossing	Peak 1% AEP Depth	Peak 1% AEP Velocity
Proposed road upgrade	Huxleys Creek	1.4 m	2.0 m/s
Internal access road	Browns Creek	0.8 m	1.8 m/s
Internal access road	White Creek	1.6 m	2.2 m/s
Internal access road	White Creek branch	0.7 m	1.2 m/s

4.3 Flood Emergency Management

Severe Weather Warnings

The Bureau of Meteorology has a range of severe weather warning systems appropriate for use in the operation of the solar farm. It is recommended that operations staff have access to the following facilities for early severe weather warnings:

- The "BOM Weather" application provides severe weather warnings, summaries listed by State, and live updates. Other information provided by the application such as radar and forecasts are also useful.
- The BOM "RSS feeds" (Really Simple Syndication) is an information system which provides the latest weather information and may be issued any time. RSS feeds has a Land Warning feed for NSW, which can provide up-to-date information as soon as it becomes available to desktop and mobile devices. See: http://www.bom.gov.au/rss/

During heavy weather warnings, ABC Radio announce information on flood affected areas and road closures. Radio and BOM information should be reviewed frequently for potential major flooding and road closures.

Notification of Staff at Risk from flooding

Facility members and visitors can be notified of potential flooding, road and facility closure via several mechanisms:

1. Staff severe weather applications (above)
2. "Group Text" (message) notification via mobile phone, sent to all members;
3. Group email;
4. Individual telephone notifications.

Evacuation Route

ACEN Australia is to plan the evacuation routes, taking into account zones of high flood hazard shown in Attachment A.

Consultation

The Study Area is free from regional riverine flooding from the Talbragar River, and flood risks are from flash flooding of the local creeks. Consultation has presently not been undertaken directly with Council officers or the State Emergency Service (SES). Staff are not required to be present at the Project Area O&M facility during large flood events. The assessment confirms that flood evacuation routes are realistically achievable for the Project Area, without placing additional burden on SES staff.

Flood Emergency Management Plan

At this point in time, it is not considered warranted to produce detailed emergency management procedures for flooding. However, it is proposed that a detailed Flood Emergency Management Plan (FEMP) be developed in due course, covering but not limited to the following.

Roles and Responsibilities

It is noted that further details and specific procedures need to be developed for the Study Area, and this report clearly lays the foundation for these procedures and demonstrates that flood warning and evacuation of the Study Area is realistically achievable. The initial requirement for the procedures will need to identify roles and responsibilities:

- Who has legal responsibility for the maintenance and implementation of the FEMP;
- The specific roles and responsibilities of the business owner or facility manager;
- Whether there are Flood Duty Officers on-site and their roles and responsibilities;
- Roles and responsibilities of all facility users including public and members.

Procedures for Before, During and After a Flood

Flood emergency management procedures and training will be crucial for staff and management working at the facility, but also a formalised induction will be required for new members. The development of future WHS Procedures (recommended to be undertaken by a WHS specialist), Staff Training and Inductions should include at a minimum but not be limited to:

1. At all times
    - Annual testing (e.g., drills) of FEMP procedures, including annual review and update;
    - Adequate resourcing of the FEMP, including designated trained flood duty officers;
    - Staff and club member induction accreditation;
    - Monitoring of weather conditions and warnings, weather forecasts;
    - Create and annually update the emergency contact list;
    - Ensure all equipment and resources to implement the FEMP are available and in working order.
2. When a flood is likely
    - The FEMP manager monitors the official warnings, selected response triggers and warning system;
    - Facility occupants are notified of the possibility of flooding and reminded of actions and procedures should an emergency response be required;
    - If early evacuation is the selected response action, the selected means of transport is provided, and evacuation occurs before cut off time;
    - If sheltering in place is the selected response action stocking or food and medications is undertaken by occupants according to the maximum possible duration of isolation;
    - Other resources are brought in as required by the FEMP;
    - Movable objects are secured, and chemicals lifted above PMF level;
    - Outdoor activities are suspended;
    - Safety equipment is checked.
3. During a Flood
    - The FEMP manager monitors the official warnings, response triggers and warning system;
    - Evacuations cease, and no one leaves the premises until all clear is given by emergency services;
    - Members who are not on the premises at the time are notified not to try and reach the premise;
    - FEMP manager provides regular updates on the situation to members.
4. After a Flood
    - Check the building structural integrity before evacuees can return to the premises (a qualified structural engineer may be required);
    - Check the safety and function of services before evacuees can return to the premises;
    - Organise a safe clean-up;
    - Review the FEMP to account for lessons learnt.

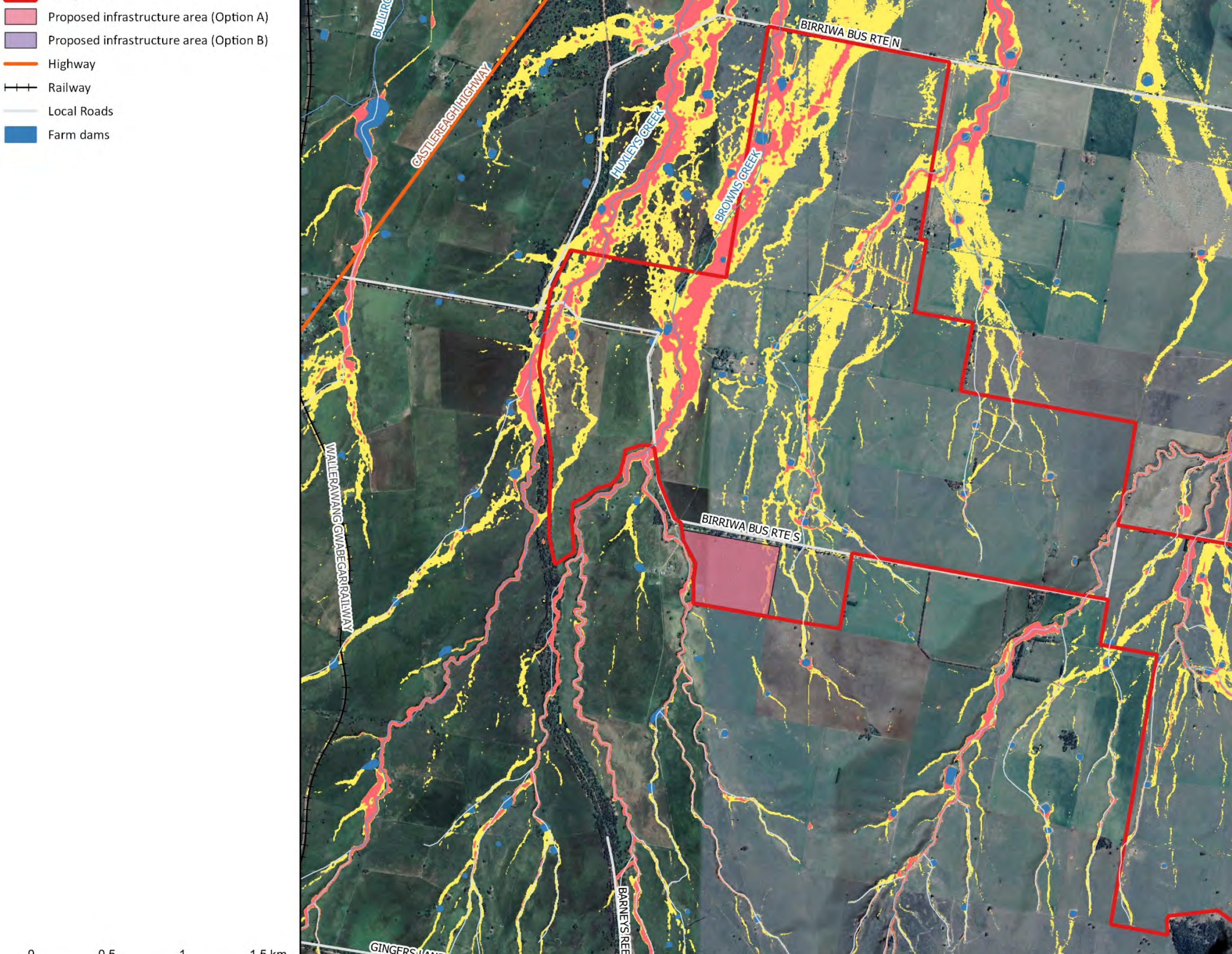
4.4 Mitigation measures

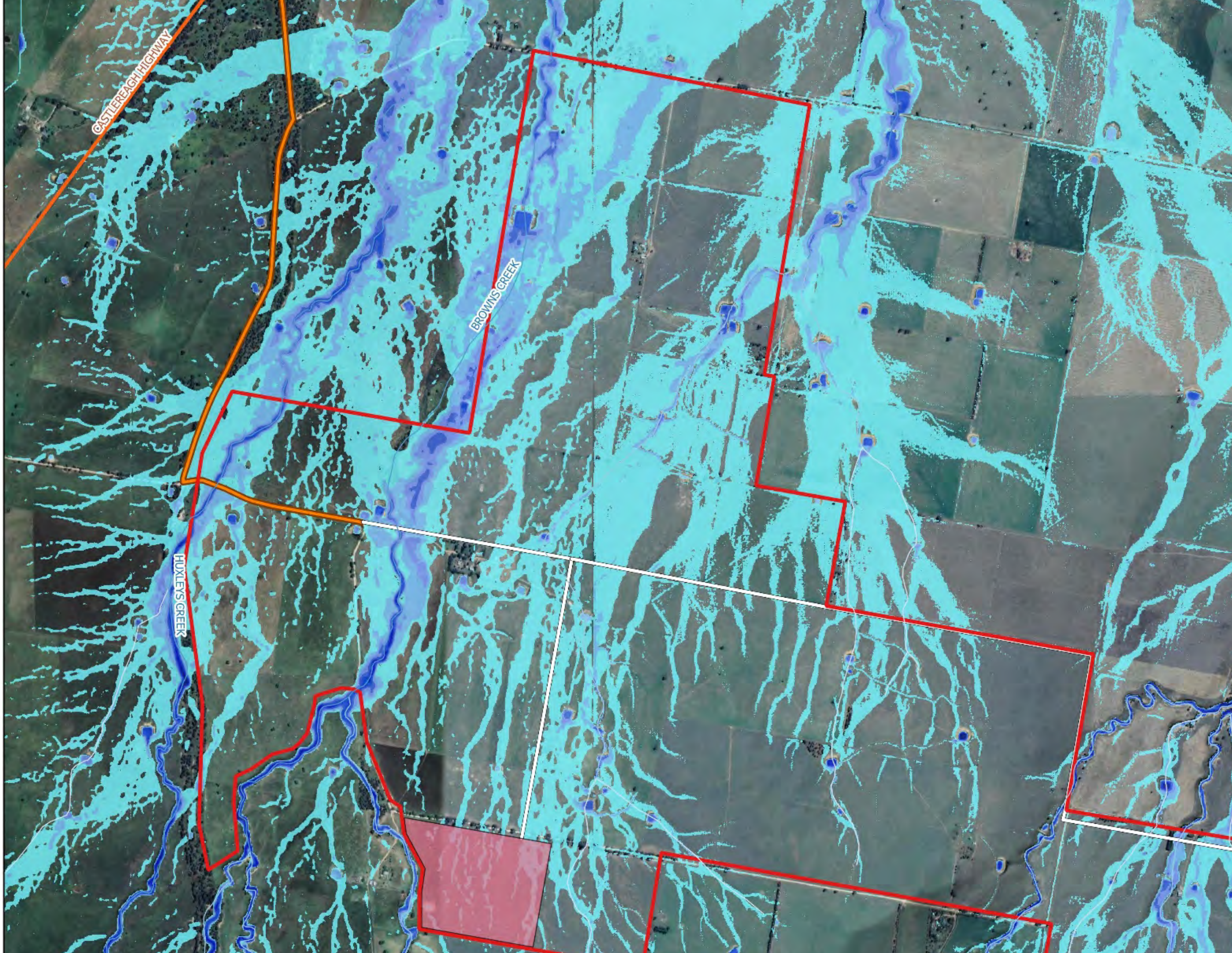
In particular, to withstand potential events up to 1% AEP, the following is recommended:

- Maintaining the natural state of the draining flow paths whenever possible. Internal access roads, where crossing watercourses, should be designed for 10% AEP design flow and could include compacted rock causeways to provide low maintenance access with limited impact on the waterway or culvert structures.
- Foundations for the photovoltaic arrays and transmission lines should be located away from areas that exceed both flood depths of 0.3m and flow velocities greater than 1.5 m/s. Detailed design of the project should consider the results of the flood models, in particular the 1% AEP scenario. For instance, solar panels should be designed to provide a minimum of 300 mm freeboard for the lowest edge above the maximum 1% AEP flood level. and the panel post and footings should be designed to withstand the flood velocities described in this report (scour protection if required).
- Infrastructure with the potential to cause pollution to waterways in the event of flooding, such as inverters and battery storage should be located with a minimum 300 mm freeboard above the maximum 1% AEP flood level. Given the shallow depths across the site, raising these small fill pads is highly unlikely to result in any adverse impacts offsite.
- BESS components are located on pad areas and are aligned with local overland flow paths to prevent flows being redirected which could lead to localised increased in flood level and higher risk of scour and erosion.
- The design and construction of waterway tracks and cable crossings and all internal tracks crossing watercourses within the proposed development footprint should be generally in accordance with the *Guidelines for controlled activities on waterfront land – riparian corridors*[1] (Natural Resources Access Regulator 2018*), Guidelines for watercourse crossings on waterfront land* [2](Department of Primary Industries, Office of Water) and *Guidelines for laying pipes and cables in watercourses on waterfront land* (NSW Office of Water 2012).
- The best practice principles for stormwater and sediment control outlined in the *Managing Urban Stormwater: Soils and construction* (Landcom, 2004) guidelines will be incorporated into the design, construction and operation phases of the solar farm site as part of a Stormwater Management Plan and Sediment Control Plan.
- Fencing is to be designed to consider flood levels across the site through construction of floodways or relocating the fencing to reduce the likelihood of fence blockage due to loss of vegetation in storm events. Relocating fencing may reduce the quantum of ongoing maintenance required.

[1] https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0003/367392/NRAR-Guidelines-for-controlled-activities-on-waterfront-land-Riparian-corridors.pdf

[2] https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0010/386209/licensing_approvals_controlled_activities_watercourse_crossings.pdf


Proposed infrastructure area (Option A)
Proposed infrastructure area (Option B)
Highway
Railway
Local Roads
Farm dams
CASTLEREAGH HIGHWAY
HUXLEYS CREEK
BROWNS CREEK
BIRRIWA BUS RTE N
BIRRIWA BUS RTE S
WALLERAWANG GWABEGAR RAILWAY



CASTLEREAGH HIGHWAY
BROWNS CREEK
HUXLEYS CREEK

5 Conclusions & Recommendations

This investigation has been undertaken to provide a flood impact assessment in support of the design of infrastructure for the Birriwa Solar and Battery project. Existing conditions flood modelling was undertaken for a range of AEP events including 5%, 1%, 0.5%, 0.2% and 0.05% for the entire study area to provide guidance on the planning of internal infrastructure and to assess any external impacts which may occur dur to the site development.

Flood prone areas have been mapped and areas of higher flood risk identified. Medium to high risk infrastructure in the Project Area should have a high level of flood immunity and be elevated above appropriate designated flood levels (including a freeboard allowance). Flood emergency management was investigated including such elements as severe weather warnings and river flood levels (early warning), notification of staff, communication protocols and sources of up to date information, evacuation, and emergency management procedures.

The slope and aspect of the land directs runoff into the primary waterways across the site. In the 1% AEP design event the flow in the flow paths is shallow and generally less than 0.25m except in the waterways and narrow floodplain areas. During preparation of the EIS and this flood impact assessment, ACEN Australia proposed to avoid locating critical infrastructure away from major flow paths in order not to create significant flood impacts., Despite this, there is one area to the north of the site boundary along Huxleys Creek where peak water surface elevations increase by 1-2 cm. The proposed substation and BESS areas (option A or option B) or any other related infrastructure do not cause increases in flood level outside of the site boundary.

The project should be designed with consideration of the flood modelling results to ensure assets are set a minimum of 300mm from the 1% AEP flood level. Infrastructure placed in the mapped flow paths should consider the potential for localised increases in water level which may occur as a result of the redirection of flows which cannot be captured at this stage in the hydraulic modelling. More detailed hydraulic investigations of the finalised infrastructure layout that would identify localised increases should be undertaken at detailed design. Where possible site infrastructure should be located in areas showing slow and shallow moving waters. Consideration should also be given to the ongoing maintenance implications of situating access roads parallel to flow paths due to the increased risk of erosion which may impact site access.

The recommended mitigation measures are provided in Section 4.4. The project will not significantly impact the existing flood regime and hydraulic characteristics if the development is constructed and operated in accordance with the listed recommendations.

5.1 Evaluation of the project

The Birriwa Solar Farm and Battery Project will comprise a large scale solar photovoltaic (PV) generation facility along with battery storage and associated infrastructure. There are two locations proposed as operational infrastructure areas that include a substation, substation and BESS areas (Options A and B). The flood modelling has included both options as they are located on separate creeks.

A short literature review was conducted to assess industry trends in terms of modelling the surface water impact of PV arrays which determined that so long as the study area vegetation conditions are reinstated similar to pre-developed conditions following construction, additional runoff from the study area is unlikely to occur. Small increases in imperviousness are unlikely to increase peaks due to hydrograph timing effects. Therefore, the modelled existing conditions are likely to reflect the impact of the project infrastructure on the downstream runoff. As such no change in the modelled imperviousness within the extent of the project infrastructure was made in the developed model scenario.

The flood impact assessment has been conducted in accordance with the Australian Rainfall and Runoff 2019 guidelines. Comparison of the existing and developed scenarios shows a minor flood impact extends outside the northern boundary of the study area along Huxleys Creek. In the 1% AEP event the magnitude of this increase is between 1-2 cm. This is caused by a slight increase in hydraulic roughness along Huxleys Creek within the development footprint (compared to existing) due to installation of project infrastructure (worst case scenario).

Huxleys Creek is an area of higher flood hazard and the installation of PV arrays in this area will likely be avoided in detailed design which will reduce, and likely eliminate, the offsite impacts.

6 References

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

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Landcom, 2004. Managing Urban Stormwater: Soils and Construction, 4th edition. New South Wales Government, March 2004.

NSW, 2005, "New South Wales Floodplain Development Manual. Department of Infrastructure", Planning and Natural Resources. New South Wales Government, April 2005.

Water Solutions, 2017, "Lower Wonga Solar Q1 Renewable Energy Generation Facility Flood Study", source: https://www.gympie.qld.gov.au/documents/40033667/0/Flood%20Study.pdf

Attachment A. Flood Mapping

Attachment A – Flood Mapping

Figure A1 - Baseline 20 year AEP Flood Depth
Figure A2 - Baseline 100 year AEP Flood Depth
Figure A3 - Baseline 200 year AEP Flood Depth
Figure A4 - Baseline 500 year AEP Flood Depth
Figure A5 - Baseline 2000 year AEP Flood Depth

Figure A6 - Baseline 20 year AEP Flood Depth
Figure A7 - Baseline 100 year AEP Flood Depth
Figure A8 - Baseline 200 year AEP Flood Depth
Figure A9 - Baseline 500 year AEP Flood Depth
Figure A10 - Baseline 2000 year AEP Flood Depth

Figure A11 - Baseline 20 year AEP Flood Hazard
Figure A12 - Baseline 100 year AEP Flood Hazard
Figure A13 - Baseline 200 year AEP Flood Hazard
Figure A14 - Baseline 500 year AEP Flood Hazard
Figure A15 - Baseline 2000 year AEP Flood Hazard

Figure A16 - Flood Level Difference 20 year
Figure A17 - Flood Level Difference 100 year
Figure A18 - Flood Level Difference 200 year
Figure A19 - Flood Level Difference 500 year
Figure A20 - Flood Level Difference 2000 year

Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

20 year AEP Depth (m)

<= 0.05

0.05 - 0.25

0.25 - 0.50

0.50 - 0.75

0.75 - 1.00

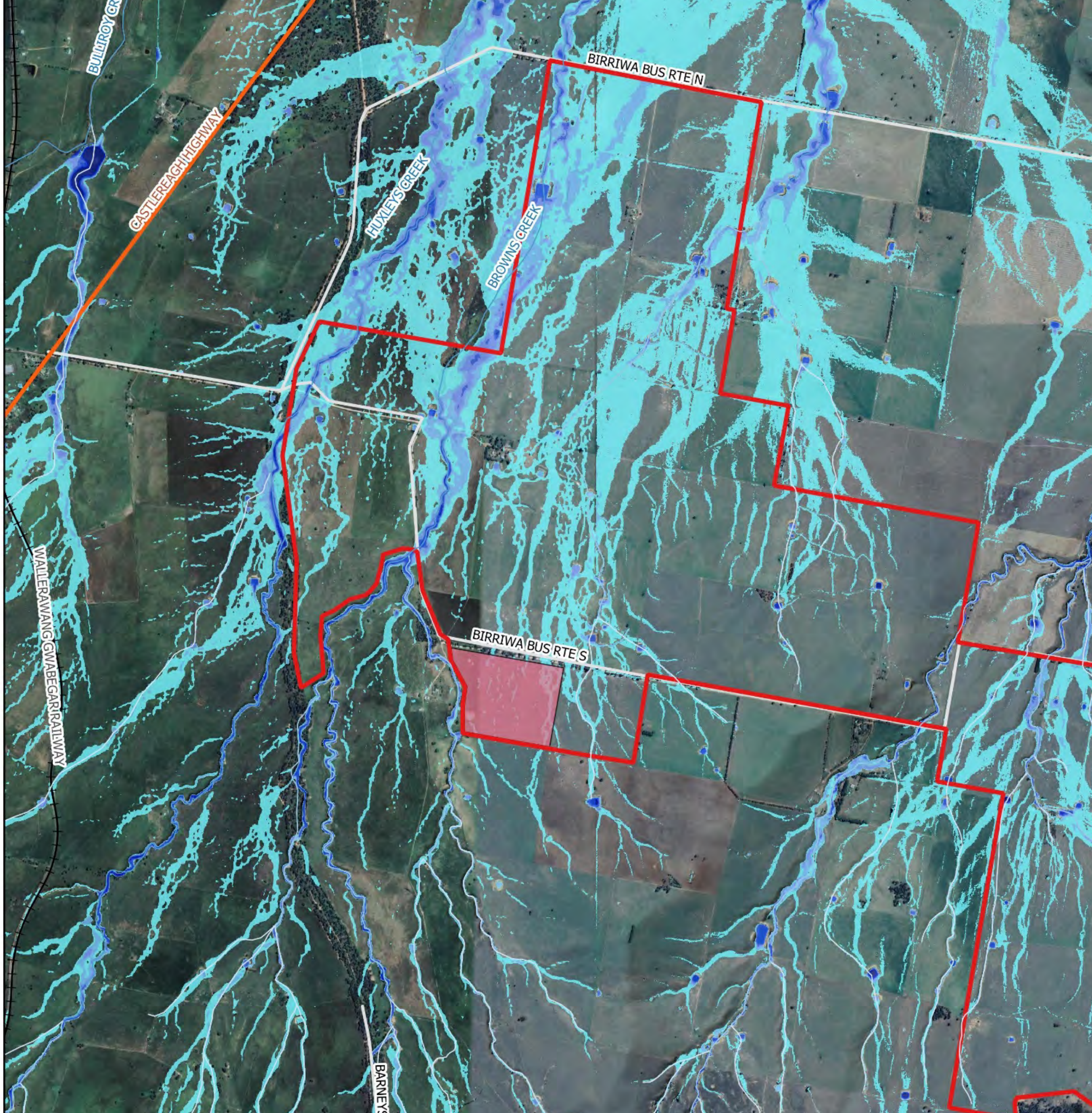
1.00 - 1.50

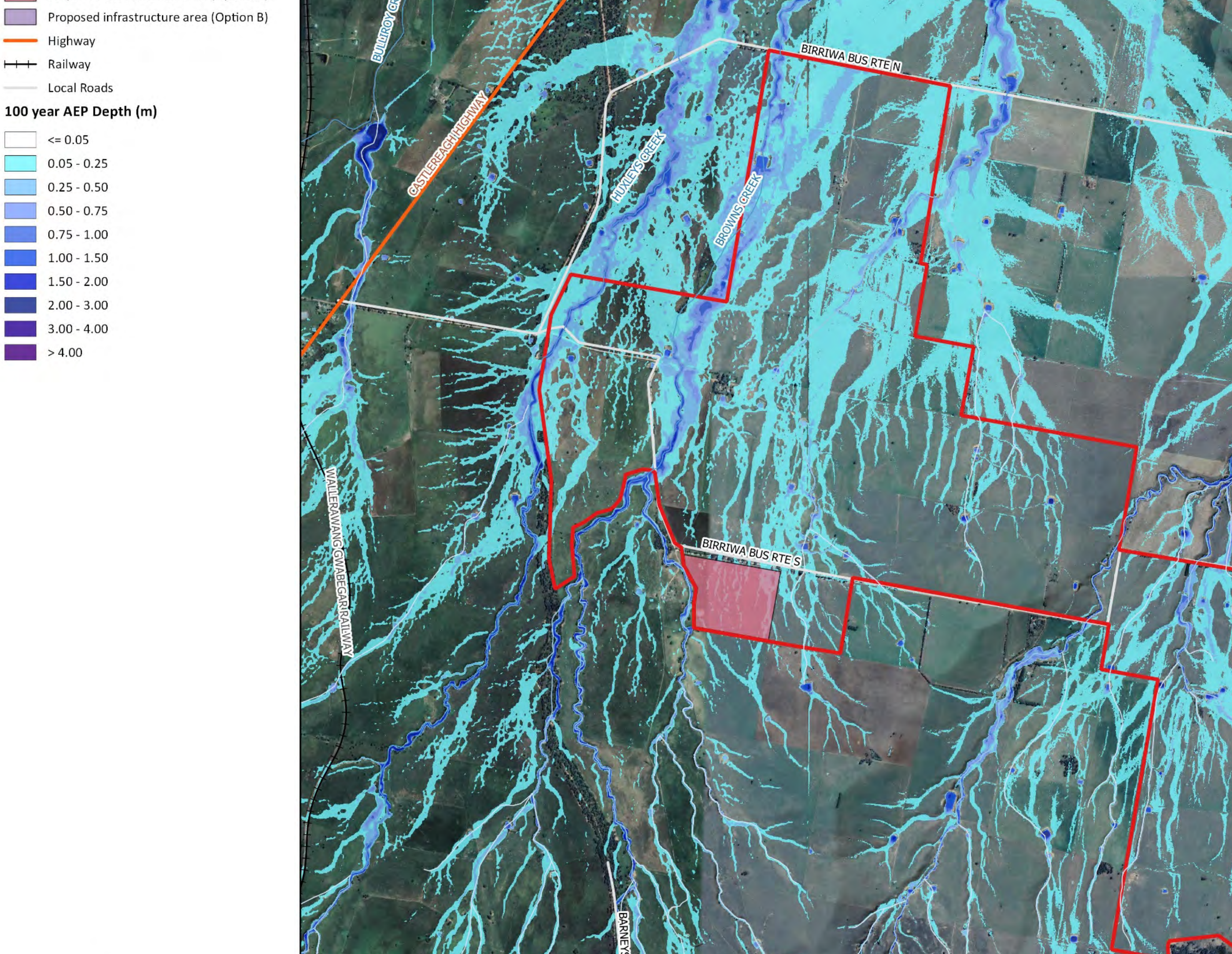
1.50 - 2.00

2.00 - 3.00

3.00 - 4.00

> 4.00





Proposed infrastructure area (Option B)
Highway
Railway
Local Roads
100 year AEP Depth (m)
<= 0.05
0.05 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.50
1.50 - 2.00
2.00 - 3.00
3.00 - 4.00
> 4.00
CASTLEREAGH HIGHWAY
HUXLEYS CREEK
BROWNS CREEK
BIRRIWA BUS RTE N
BIRRIWA BUS RTE S
WALLERAWANG GWABEGAR RAILWAY

Proposed infrastructure area (Option B)

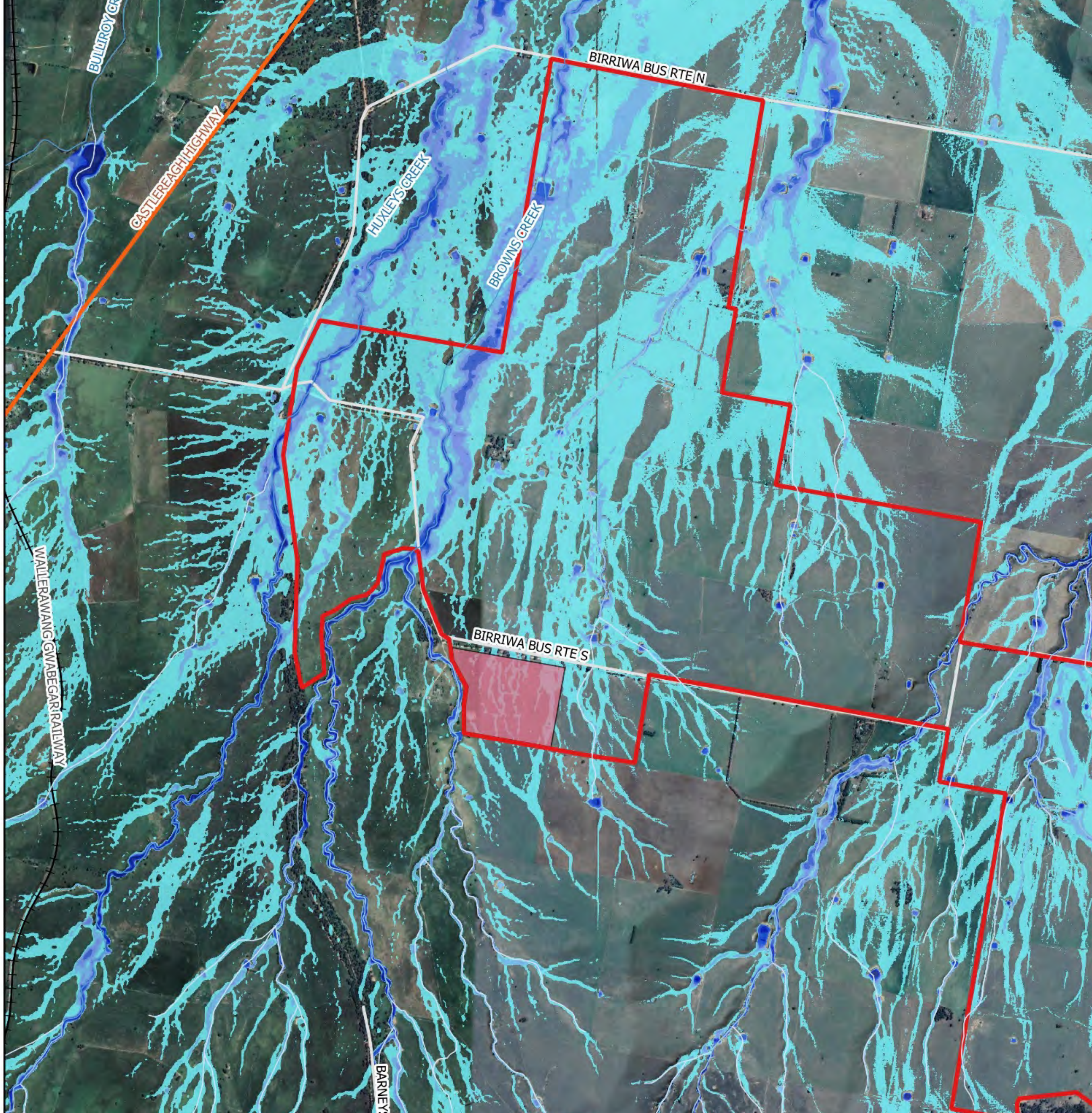
Highway

Railway

Local Roads

200 year AEP Depth (m)

- <= 0.05
- 0.05 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- > 4.00



Proposed infrastructure area (Option B)

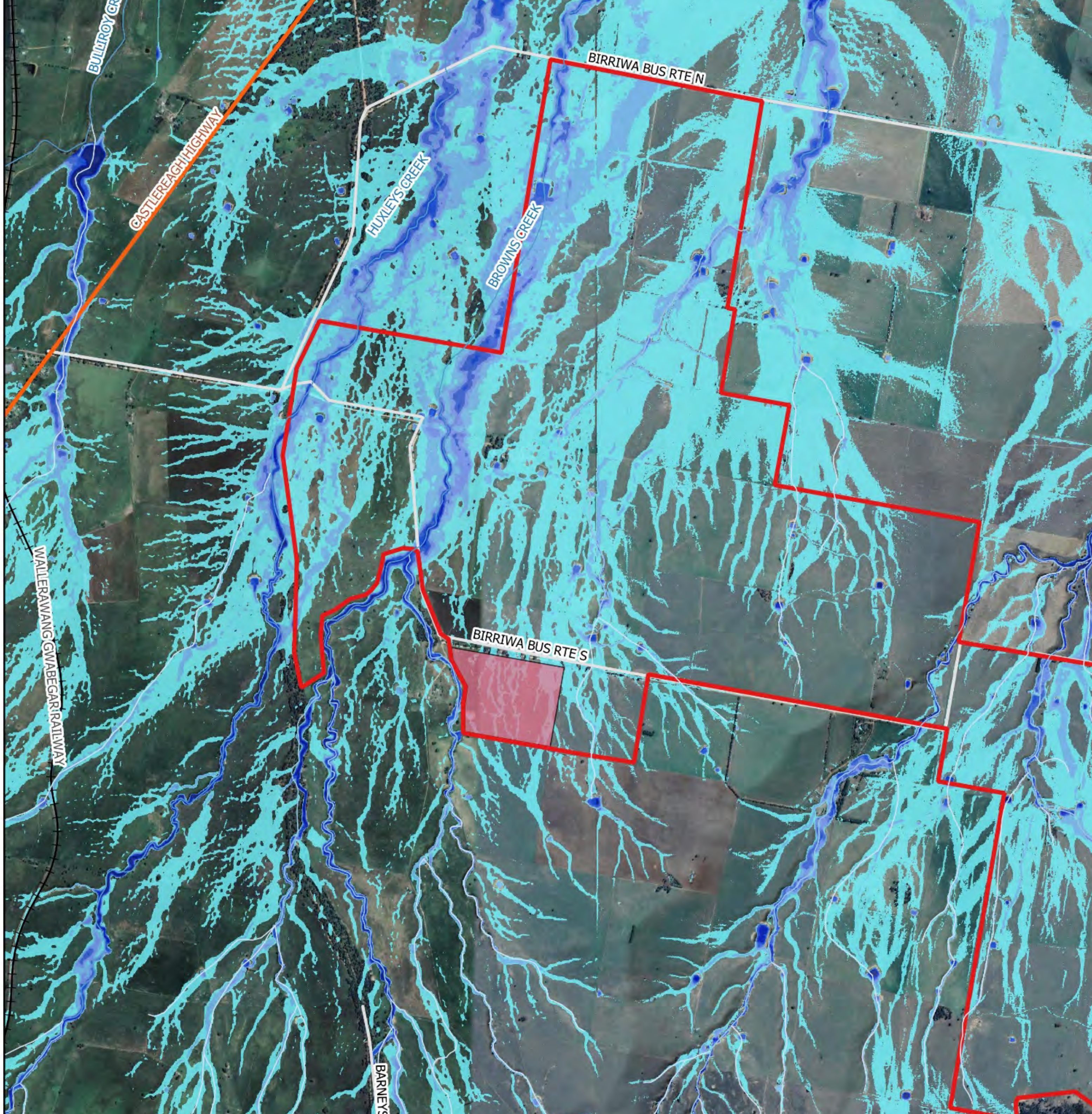
Highway

Railway

Local Roads

500 year AEP Depth (m)

- <= 0.05
- 0.05 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- > 4.00



Proposed infrastructure area (Option B)

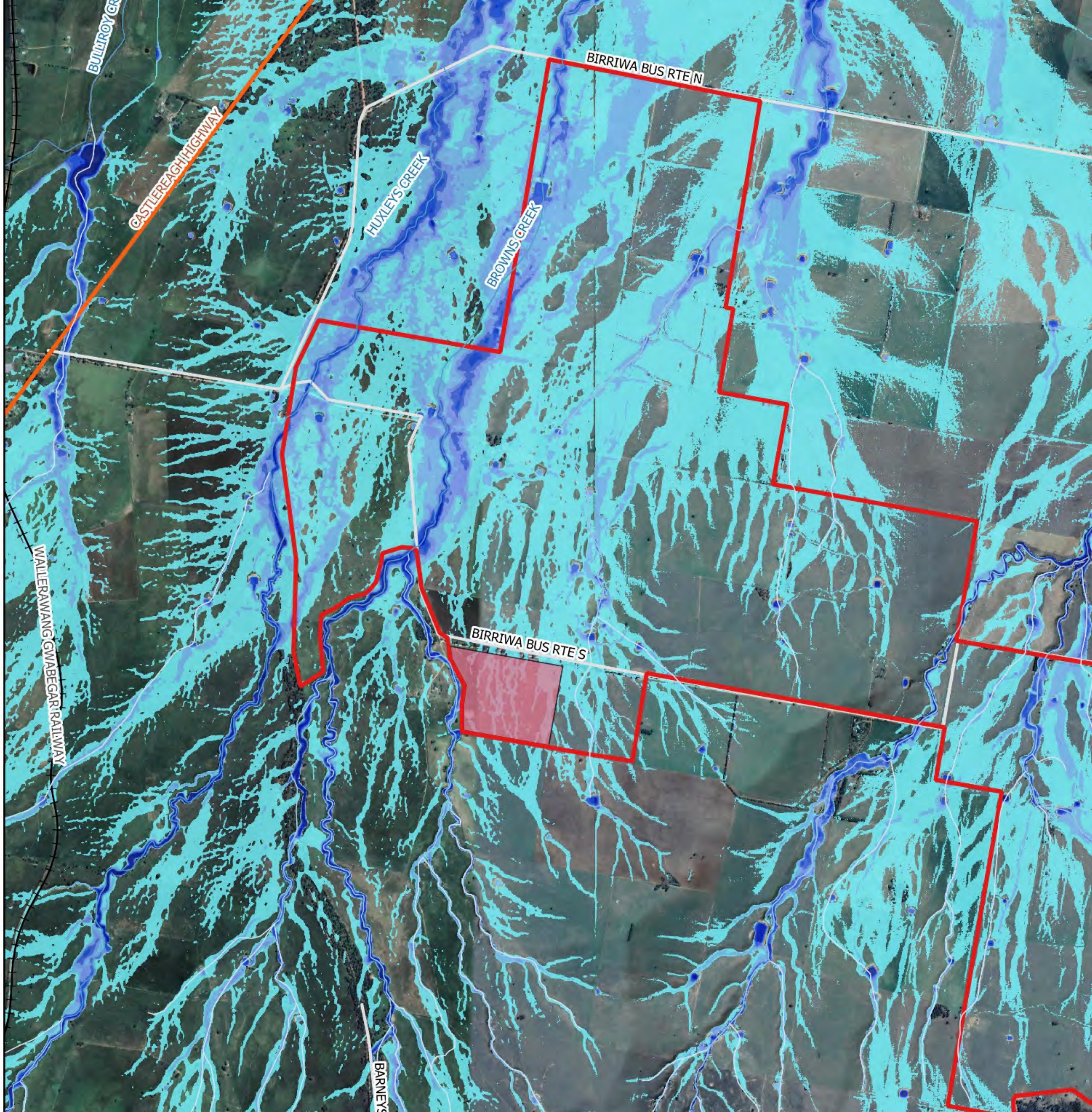
Highway

Railway

Local Roads

2000 year AEP Depth (m)

- <= 0.05
- 0.05 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- > 4.00



Proposed infrastructure area (Option B)

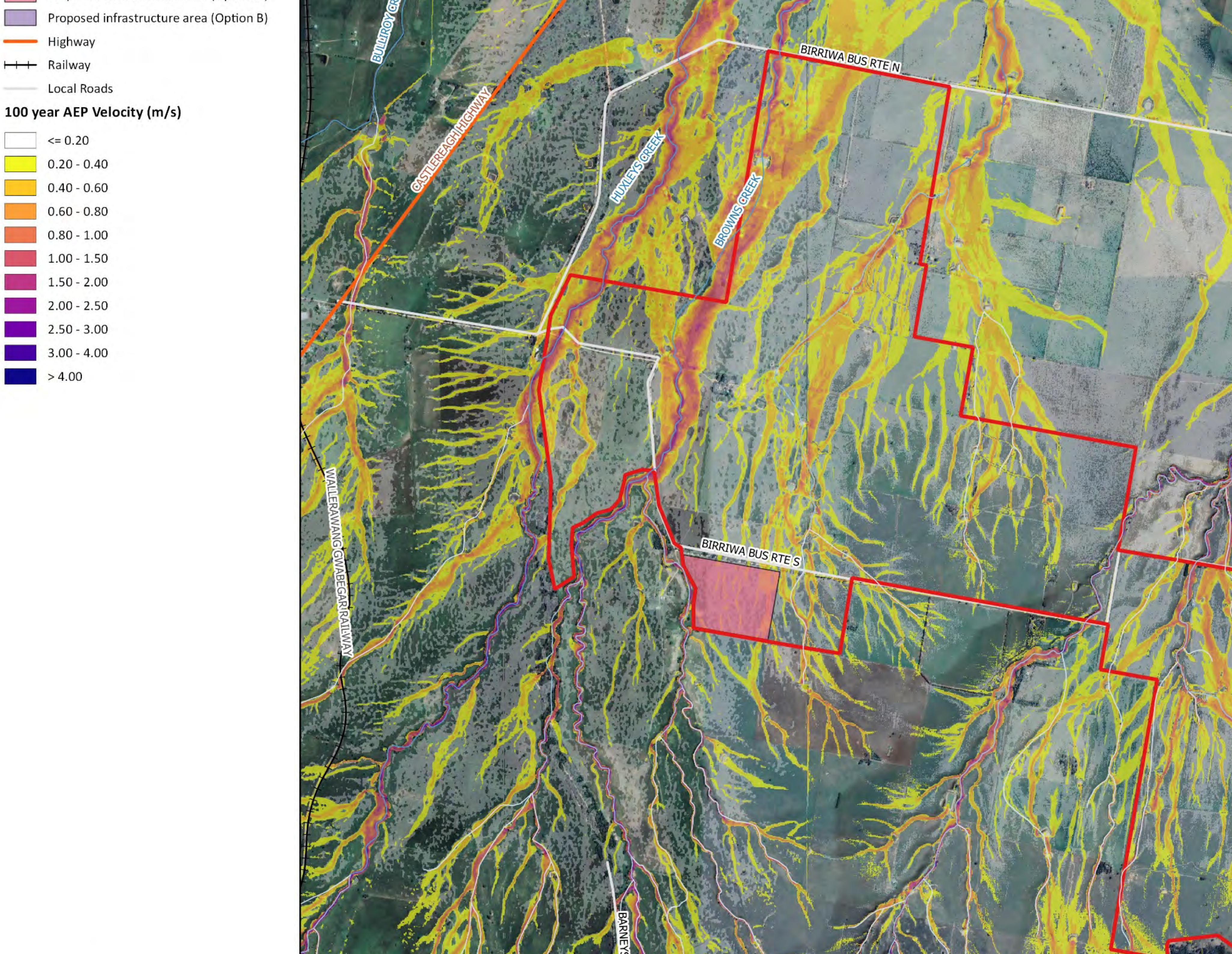
Highway

Railway

Local Roads

20 year AEP Velocity (m/s)

- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- > 4.00



Proposed infrastructure area (Option B)
Highway
Railway
Local Roads
100 year AEP Velocity (m/s)
<= 0.20
0.20 - 0.40
0.40 - 0.60
0.60 - 0.80
0.80 - 1.00
1.00 - 1.50
1.50 - 2.00
2.00 - 2.50
2.50 - 3.00
3.00 - 4.00
> 4.00
CASTLEREAGH HIGHWAY
HUXLEYS CREEK
BROWNS CREEK
BIRRIWA BUS RTE N
BIRRIWA BUS RTE S
WALLERAWANG GWABEGAR RAILWAY

Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

200 year AEP Velocity (m/s)

- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- > 4.00

Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

500 year AEP Velocity (m/s)

- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- > 4.00

Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

2000 year AEP Velocity (m/s)

- <= 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- > 4.00

Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

20 year AEP Flood Hazard

H1 - Relatively benign flow conditions. No vulnerability constraints. Omitted for clarity

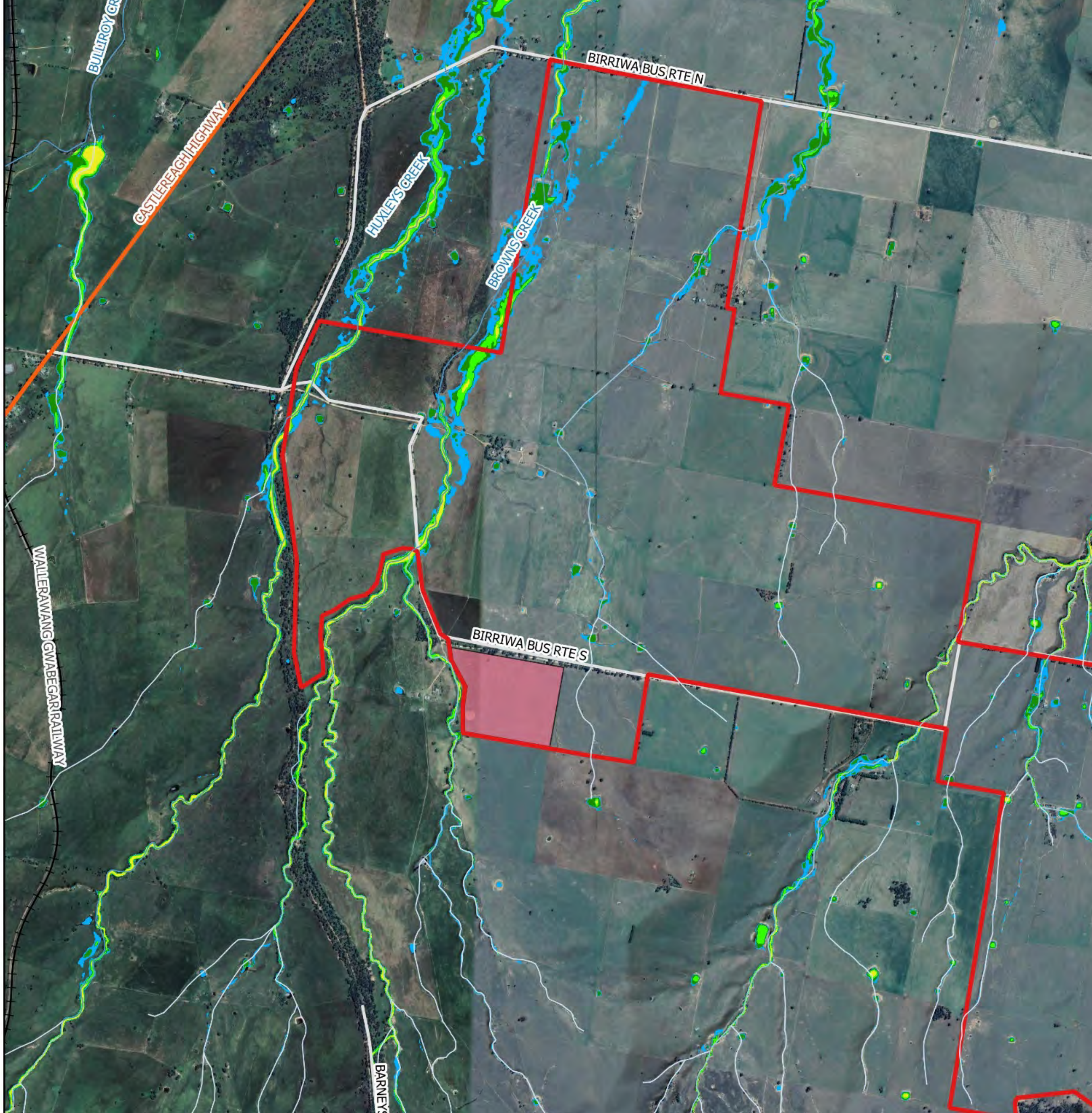
H2 - Unsafe for small vehicles.

H3 - Unsafe for all vehicles, children and the elderly.

H4 - Unsafe for all people and all vehicles.

H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.

H6 - Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.



Proposed infrastructure area (Option B)

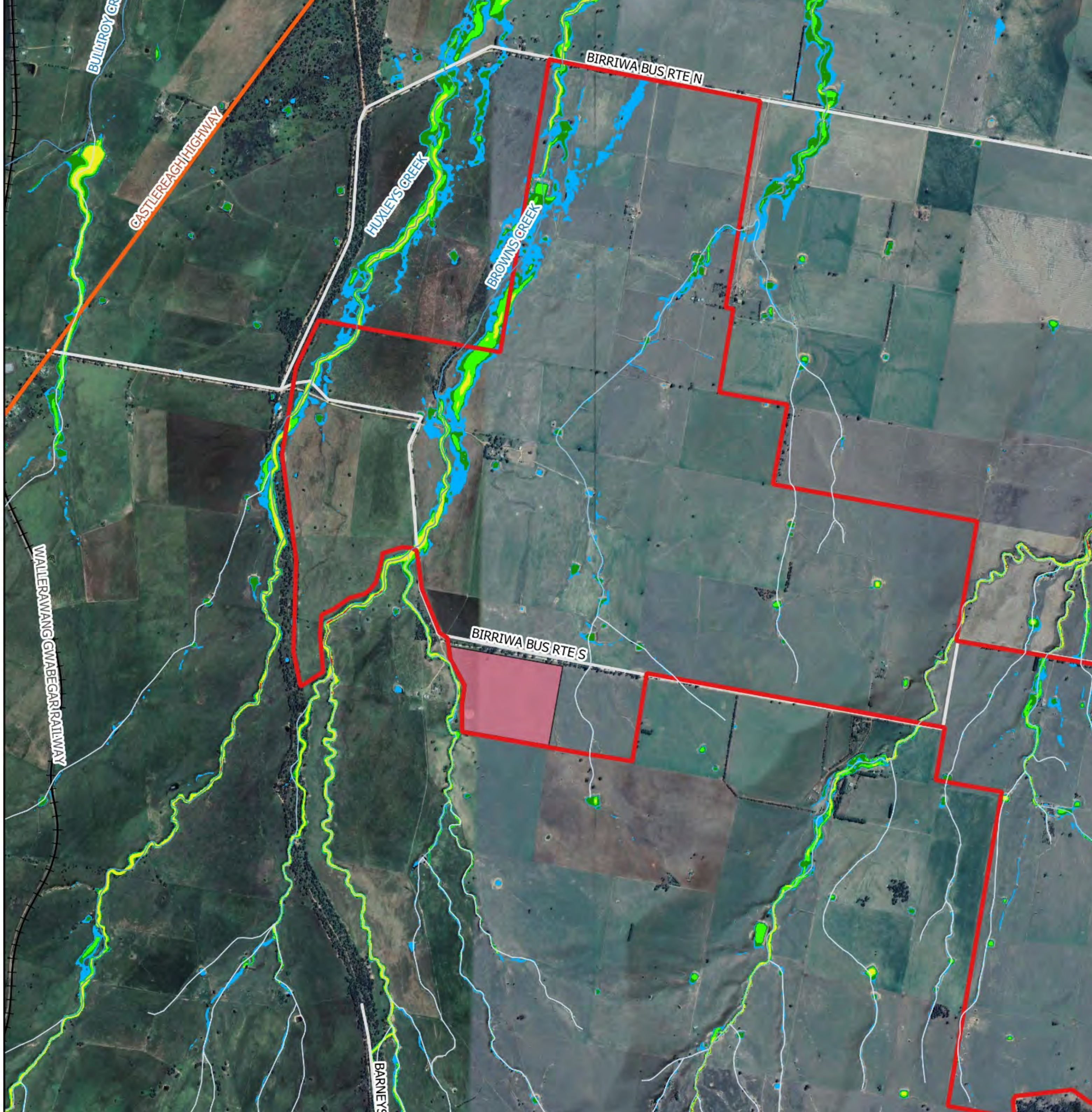
Highway

Railway

Local Roads

100 year AEP Flood Hazard

- H1 - Relatively benign flow conditions. No vulnerability constraints. Omitted for clarity
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for all vehicles, children and the elderly.
- H4 - Unsafe for all people and all vehicles.
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
- H6 - Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.



Proposed infrastructure area (Option B)

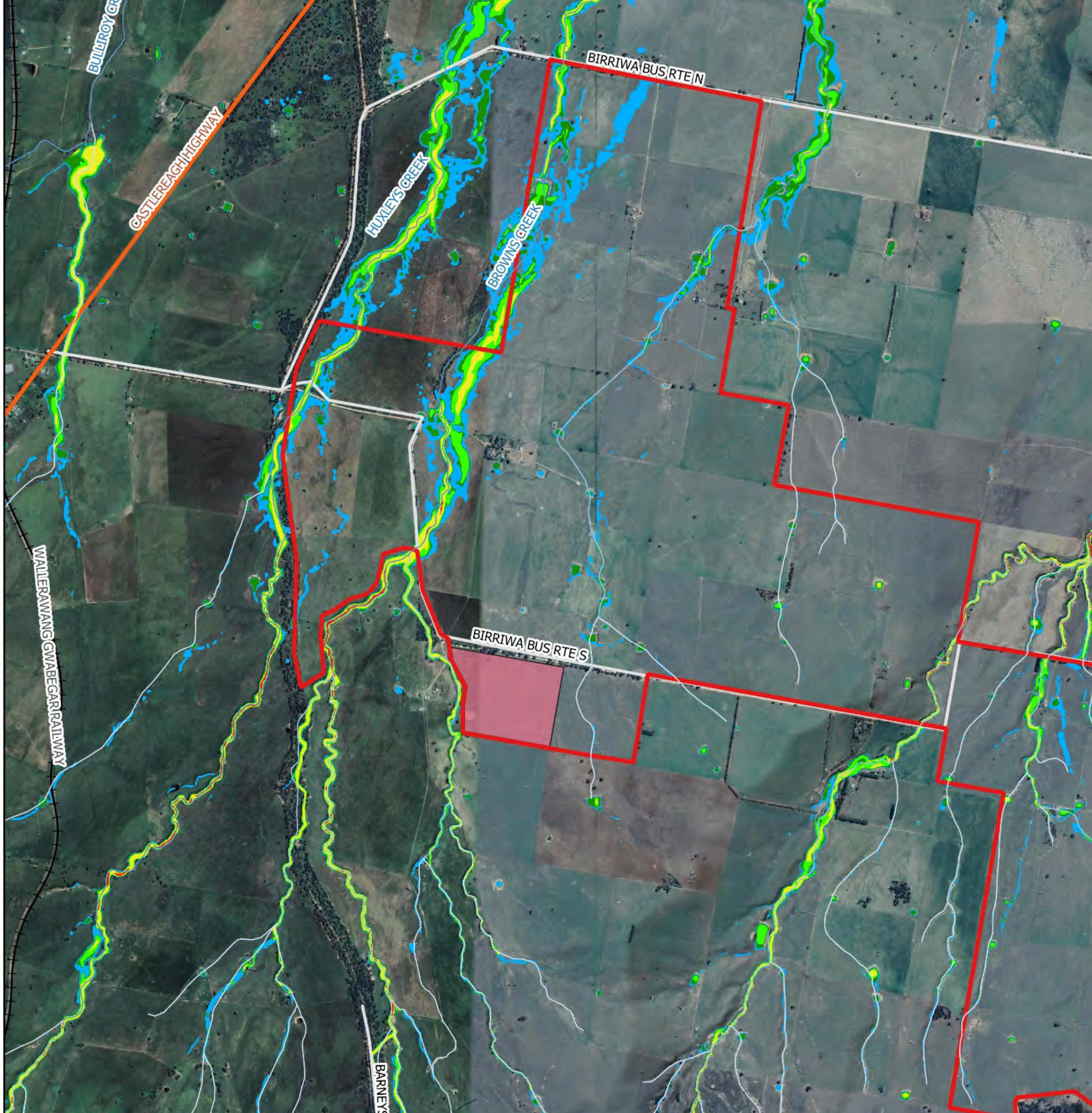
Highway

Railway

Local Roads

200 year AEP Flood Hazard

- H1 - Relatively benign flow conditions. No vulnerability constraints. Omitted for clarity
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for all vehicles, children and the elderly.
- H4 - Unsafe for all people and all vehicles.
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
- H6 - Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.



Proposed infrastructure area (Option B)

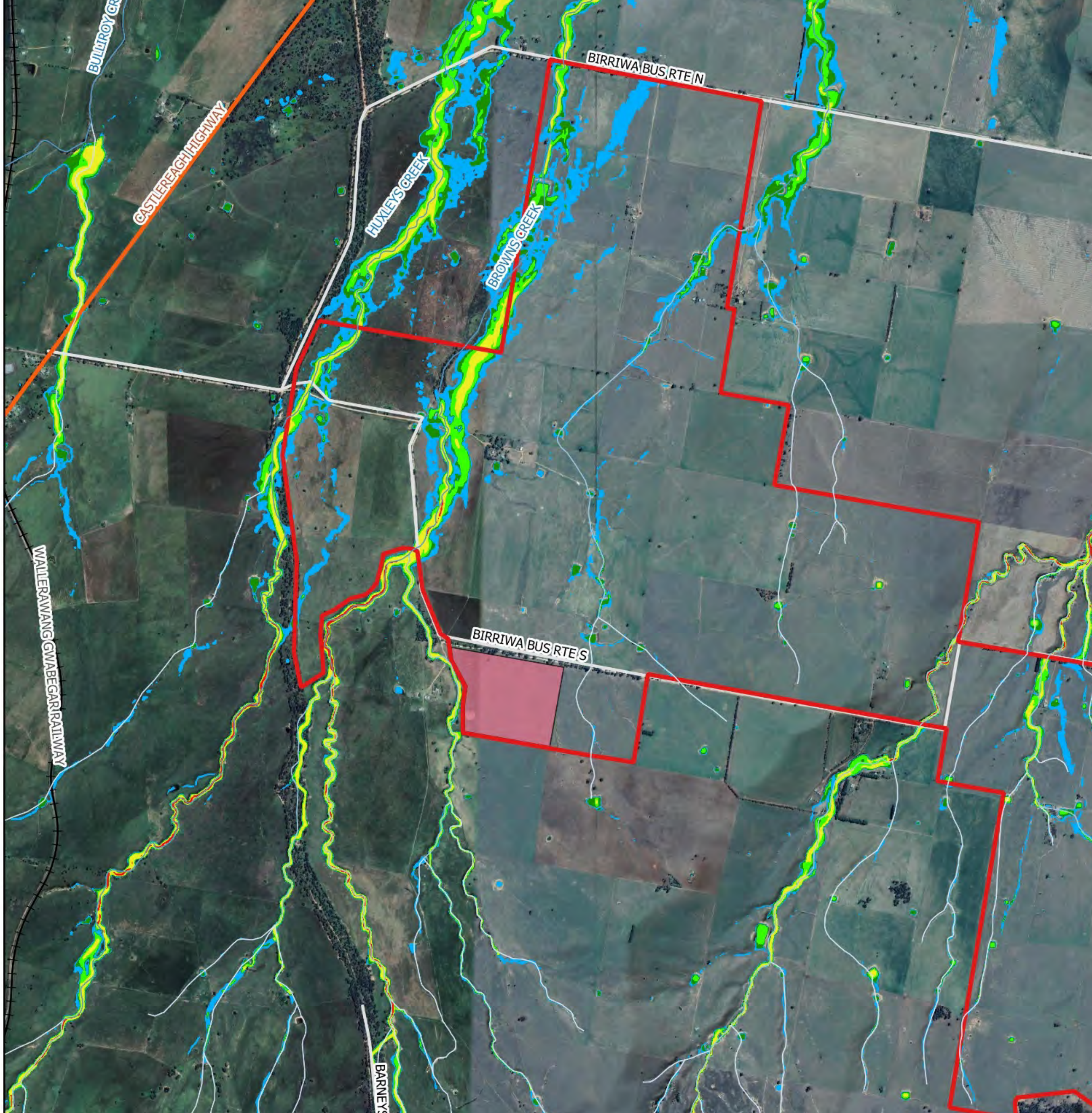
Highway

Railway

Local Roads

500 year AEP Flood Hazard

- H1 - Relatively benign flow conditions. No vulnerability constraints. Omitted for clarity
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for all vehicles, children and the elderly.
- H4 - Unsafe for all people and all vehicles.
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
- H6 - Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.



Proposed infrastructure area (Option B)

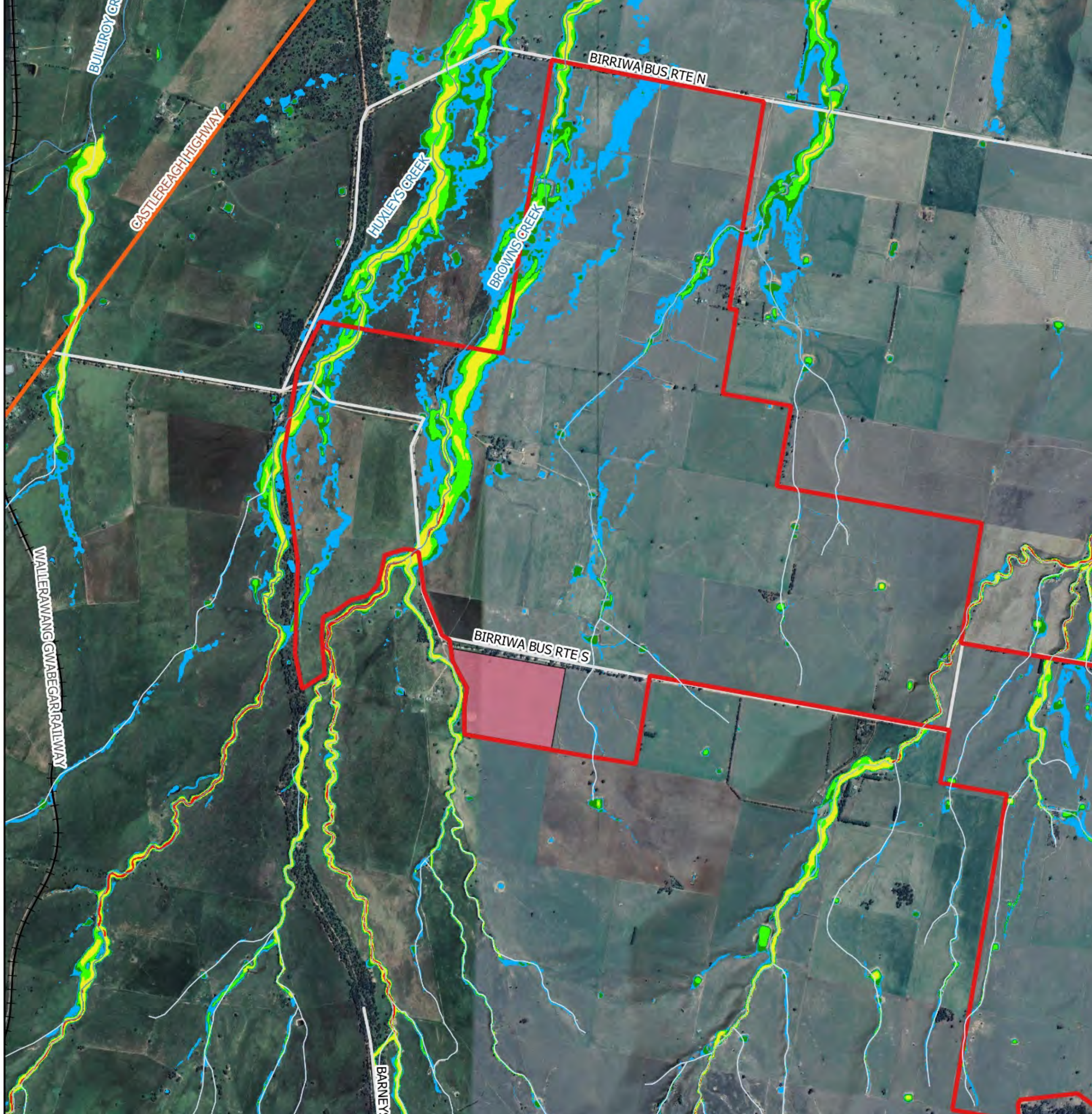
Highway

Railway

Local Roads

2000 year AEP Flood Hazard

- H1 - Relatively benign flow conditions. No vulnerability constraints. Omitted for clarity
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for all vehicles, children and the elderly.
- H4 - Unsafe for all people and all vehicles.
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
- H6 - Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.



Proposed infrastructure area (Option B)

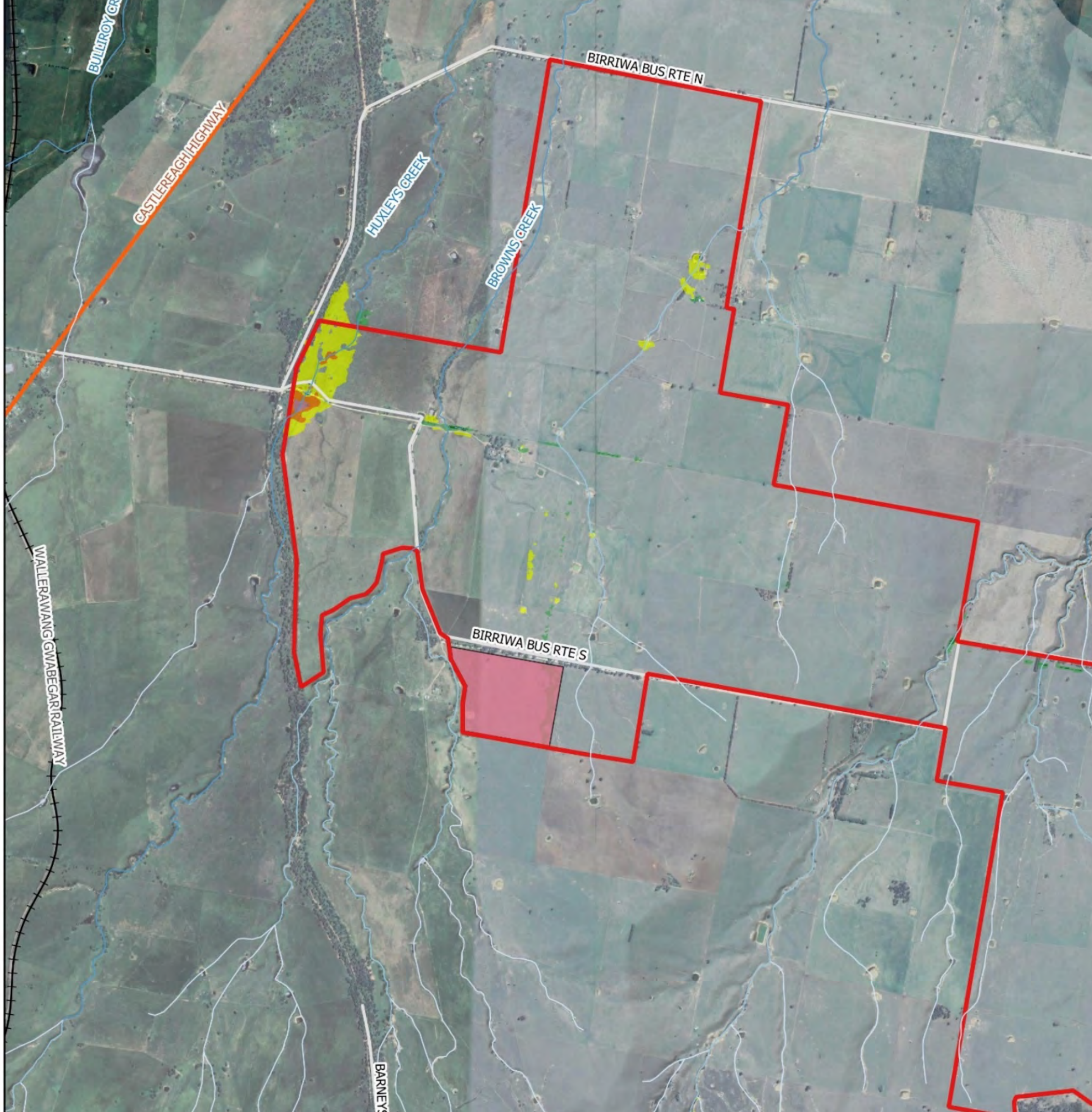
Highway

Railway

Local Roads

100 year AEP Flood Impacts (m)

- < -0.50
- -0.50 - -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - -0.01
- -0.01 - 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.50
- > 0.50



Proposed infrastructure area (Option B)

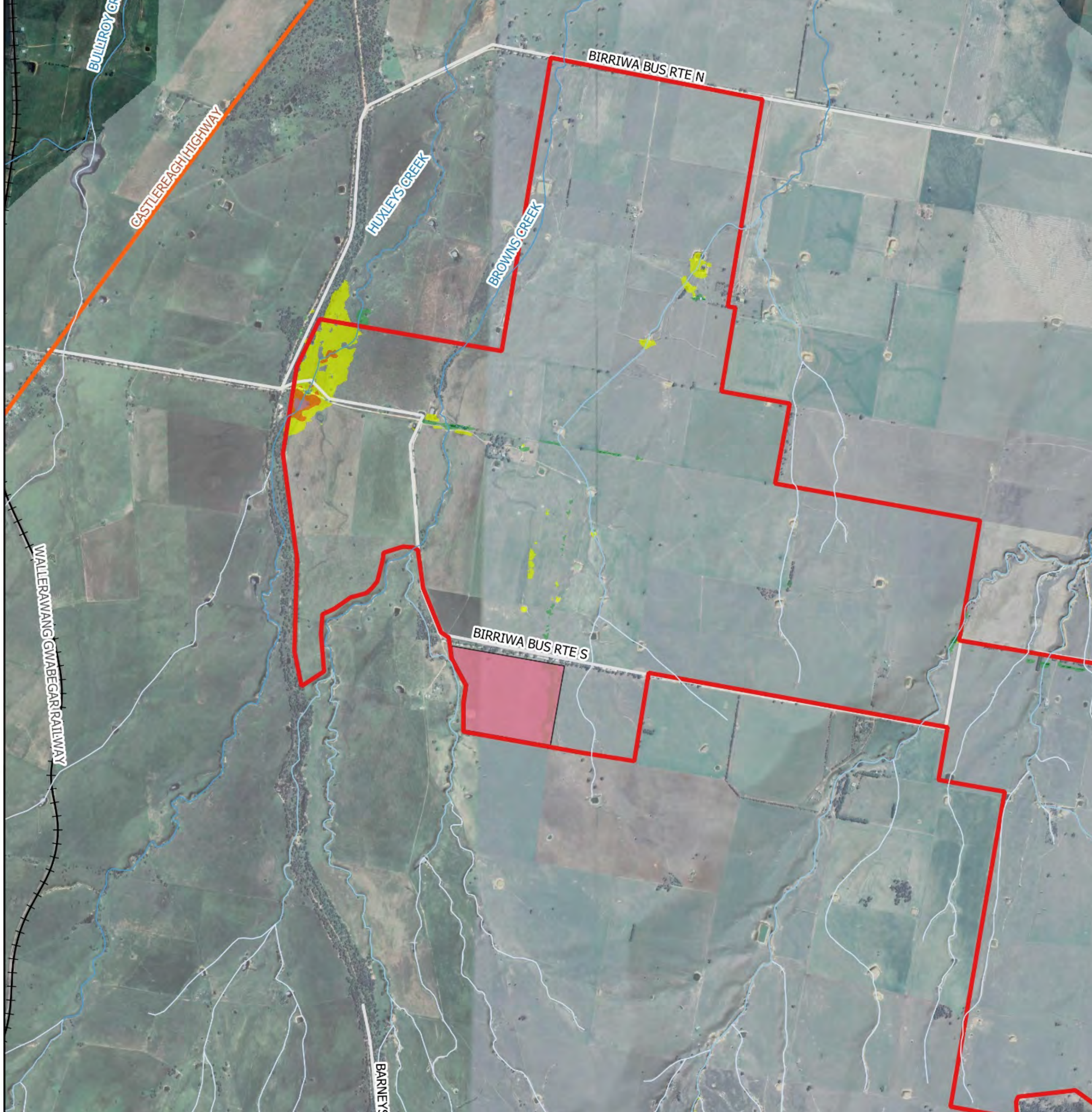
Highway

Railway

Local Roads

100 year AEP Flood Impacts (m)

- < -0.50
- -0.50 - -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - -0.01
- -0.01 - 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.50
- > 0.50



Proposed infrastructure area (Option B)

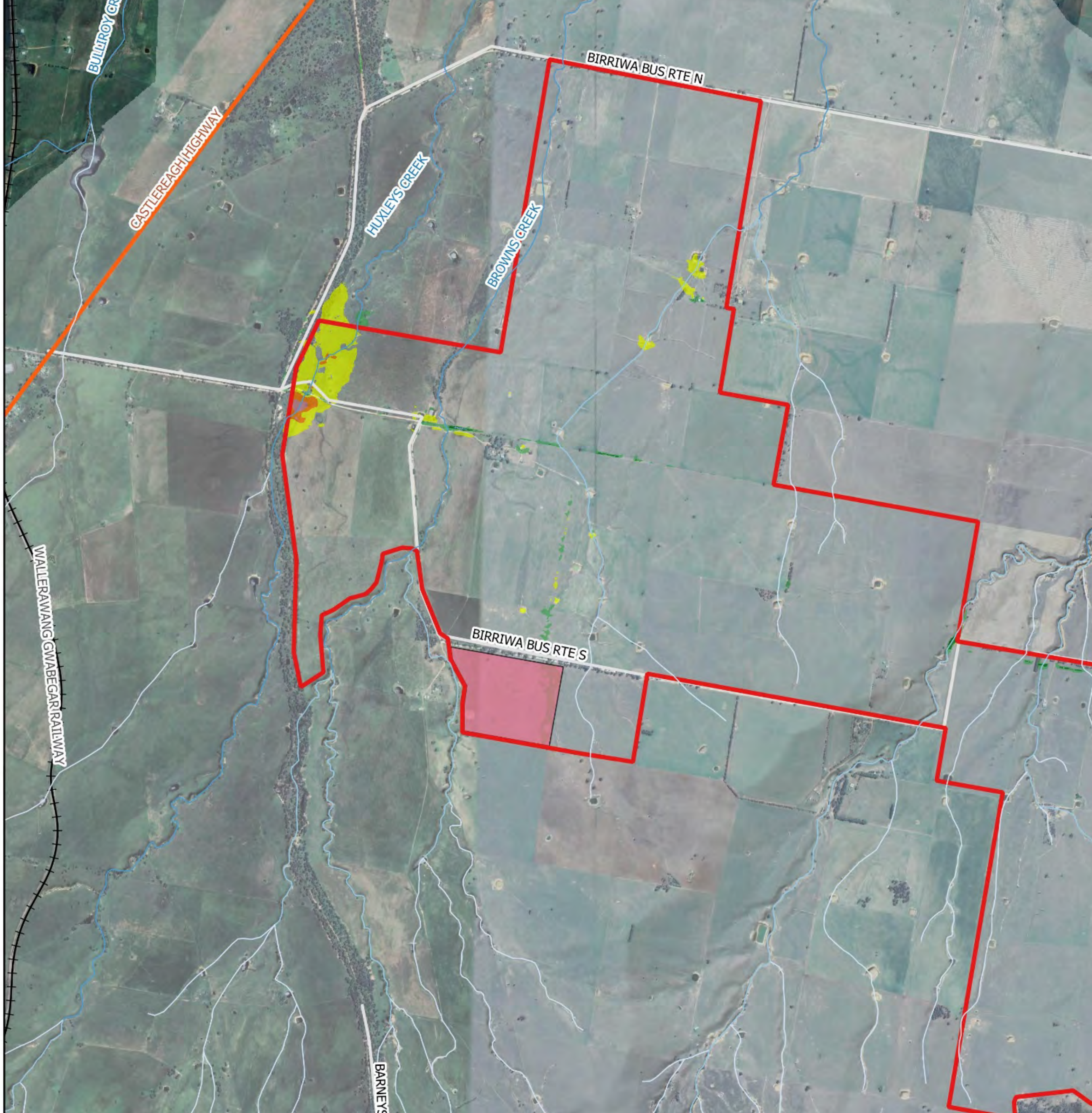
Highway

Railway

Local Roads

200 year AEP Flood Impacts (m)

- < -0.50
- -0.50 - -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - -0.01
- -0.01 - 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.50
- > 0.50



Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

500 year AEP Flood Impacts (m)

< -0.50

-0.50 - -0.20

-0.20 - -0.10

-0.10 - -0.05

-0.05 - -0.01

-0.01 - 0.01

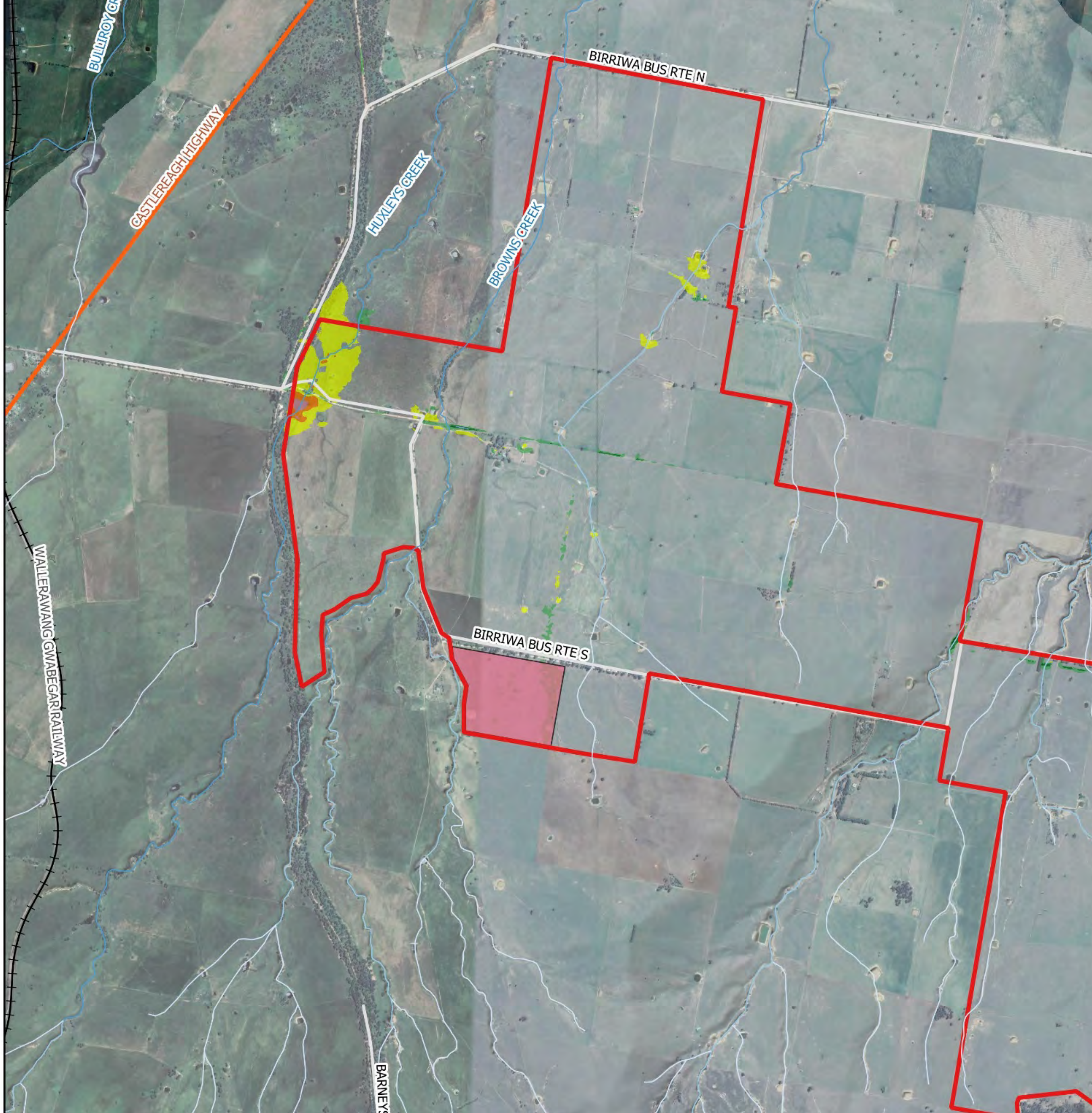
0.01 - 0.05

0.05 - 0.10

0.10 - 0.20

0.20 - 0.50

> 0.50



Proposed infrastructure area (Option B)

Highway

Railway

Local Roads

2000 year AEP Flood Impacts (m)

< -0.50

-0.50 - -0.20

-0.20 - -0.10

-0.10 - -0.05

-0.05 - -0.01

-0.01 - 0.01

0.01 - 0.05

0.05 - 0.10

0.10 - 0.20

0.20 - 0.50

> 0.50