Yanco BESS

Flood Risk and Groundwater Assessment Report

ACEnergy

1 October 2024

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Client	ACEnergy
Client Project Manager	Jane Bai
Water Technology Project Manager	Ben Hughes
Water Technology Project Director	Ben Hughes
Authors	Jorja Strack (Water Technology), Daniel Wohling (IGS)
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15 Business Park Drive
Notting Hill VIC 3168

Telephone	(03) 8526 0800
Fax	(03) 9558 9365
ACN	093 377 283
ABN	60 093 377 283

ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

1 October 2024

Jane Bai
Senior Project Development Engineer
ACEnergy Pty Ltd
Level 3, 689 Burke Road
Camberwell, 3124, VIC, AUSTRALIA

Via email: Jane.bai@acenergy.com.au

Dear Jane

Flood Risk and Groundwater Assessment Report

Please see attached the Flood Risk and Groundwater Impact Assessment Report for the proposed Yanco BESS. This report documents the methodology and outcomes of the assessment relating to surface water flood risk and groundwater.

If you have any questions regarding this report, please get in touch.

Yours sincerely

Ben Hughes
Principal Engineer
Ben.Hughes@watertech.com.au
WATER TECHNOLOGY PTY LTD

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1 INTRODUCTION

1.1 Development Overview

This report details the findings of a flood and groundwater risk and impact assessment for the proposed Battery Energy Storage System (BESS) at 120 Houghton Road, Yanco, NSW (the Site/Development Site). The BESS is proposed to have a 250MW/1100MWh capacity and associated infrastructure including transmission and connection works. ACEnergy has engaged Water Technology and IGS to the assessment. The project site will be connected to the nearby Yanco Substation via a transmission line.

1.2 Site location and layout

The Yanco BESS is situated within the Murrumbidgee catchment (Figure 1-1) amongst the engineered field channels and drains within existing agricultural land. The Site is located approximately 1.5 km southwest of the Yanco township and 4.3 km to the northeast of the Murrumbidgee River. The site is situated adjacent to Houghton Road and Hume Road. The Murrumbidgee River, that passes close to the Site, is a major waterway located within Murray-Darling Basin, rising east of Tantangara and flowing generally north-west through Yanco, joining the Murray River near Narrung.

The Proposed Development Site will enclose approximately 8 ha of land by fencing around lithium-ion battery modules and other supporting infrastructure. The development footprint is approximately 10.3 ha including the proposed electricity connection and access road in addition to the works described above. Figure 1-2 below highlights the proposed site area containing the key electrical infrastructure relative to Houghton Road and the existing Yanco substation.

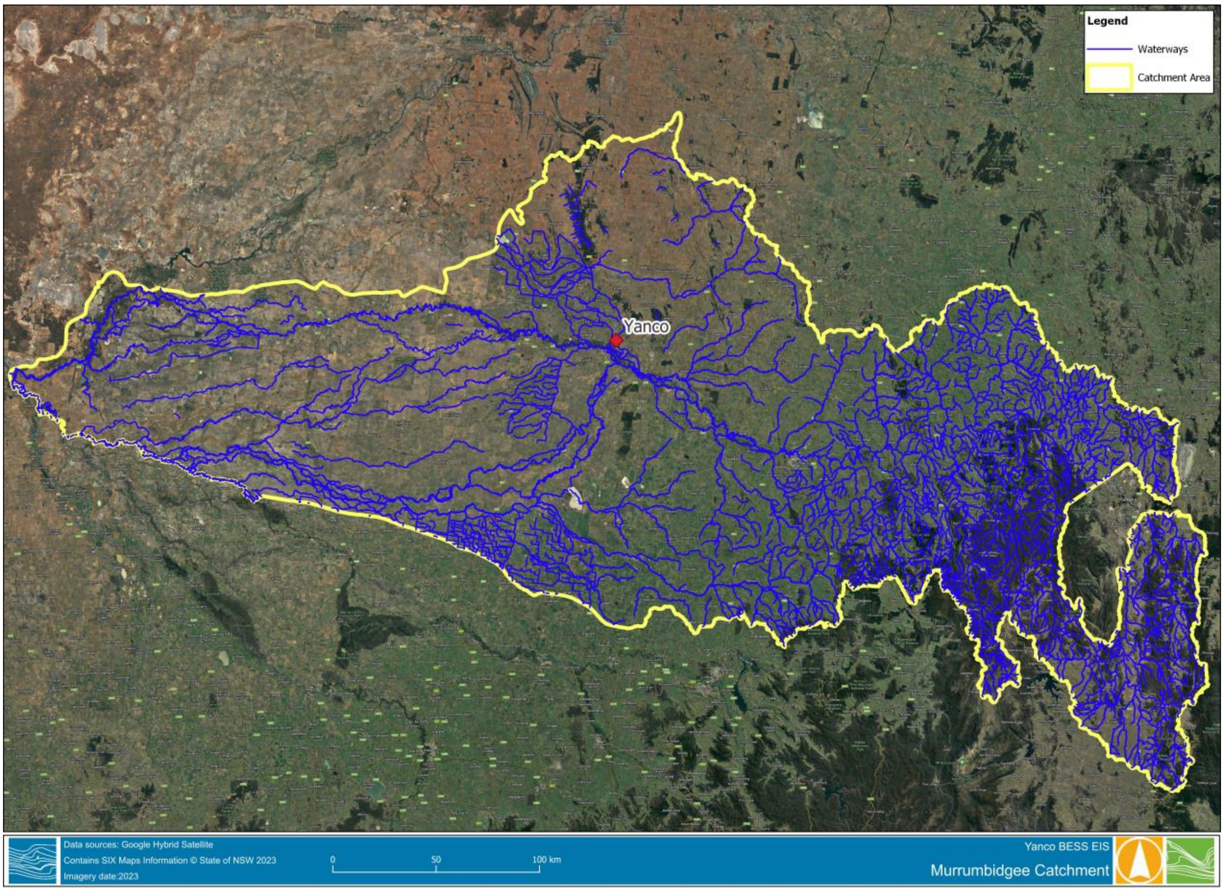

Figure 1-1 Murrumbidgee catchment area

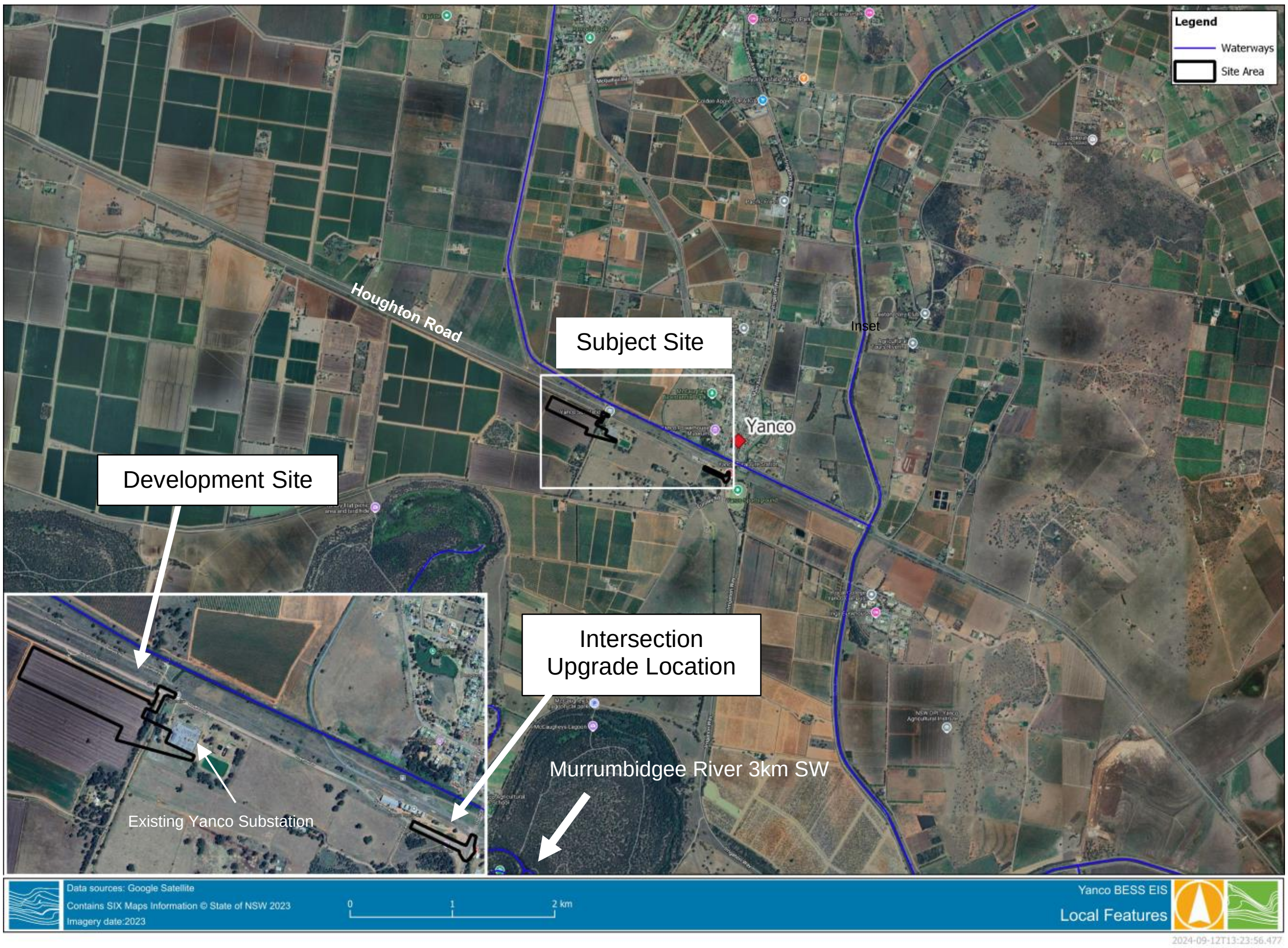

Figure 1-2 Development Site and Intersection upgrade location

1.3 Scope and Objective

The objective of this risk and impact assessment was to assess potential impacts the proposed development may have on surface water and groundwater. This included two aspects:

- The potential for the development to be impacted by surface water and groundwater (i.e. flooding of the development, inundation of construction footings etc.); and,
- The potential for the development to impact surface water and groundwater (i.e. increase flood impacts adjacent landowners, reduce groundwater availability for extraction etc.).

The assessment also outlines measures which could be used to avoid/minimise/mitigate the identified impacts. The work undertaken involved:

- Characterisation of surface water in the project area, review of background information and topographic data.
- Review of existing groundwater information as available.
- The development of a baseline hydraulic model to reflect the flooding behaviour and mechanisms (depth, water levels and velocities).
- Identification of potential impacts of the project site on surface water; including effects on flooding (water levels, depths, velocities), and water quality.

- Preliminary hydrogeological assessment to determine groundwater level and any potential groundwater and surface water interactions at the Development Site.
- Provision of high-level recommendations for any mitigation or design alterations which may be required to reduce potential risks associated with flooding, drainage and groundwater.

The output of the assessment is considered to provide the best currently available information on the flood risk and conceptualisation of groundwater at the Development Site.

2 GROUNDWATER

Local groundwater conditions have been summarised into a site-based hydrogeological conceptual model to inform an assessment of the proposed development against DCCEEWs standard Water SEARs provided for the battery electric storage project. This assessment ensures that the development proceeds in accordance with the *Water Management Act 2000* (NSW) and *Water Management (General) Regulation 2018* (NSW), notably adhering to the following:

- The NSW Aquifer Interference Policy,
- The *Water Management Act 2000* (NSW), and
- Water Sharing Plans

In addition, the Development Site is classed as a "groundwater vulnerable" area according to the NSW Department of Planning, Housing and Infrastructure (DPHIs) Groundwater Vulnerability mapping[1]. The Development Site is located within the *Leeton Local Environmental Plan 2014* (NSW) which requires groundwater vulnerability to be assessed to ensure the key groundwater systems are maintained and to protect vulnerable resources from depletion and/or contamination due to the proposed development. This hydrogeological assessment considers the key components of the groundwater system to develop a hydrogeological conceptual model that was used for the groundwater vulnerability assessment and groundwater requirements of the SEARs.

The groundwater vulnerability assessment includes an assessment of the likelihood of groundwater contamination; potential impacts on groundwater-dependent ecosystems (GDEs) and cumulative impact on the groundwater system (including impacts on nearby groundwater extraction for a potable water supply or stock water supply) considering any existing Water Access Licences (WALs) and/or groundwater abstraction the development may require. This is supported by analytical modelling to better understand the potential impacts of construction dewatering on nearby receptors.

Finally, any appropriate measures to avoid, minimise or mitigate potential impacts of the development on the groundwater are proposed.

It is understood that during construction, the site shall have excavations up to 3.5 m below ground level (BGL) for battery electric storage container footings, ~2.6 mBGL for noise wall posts and ~3.1 mBGL for transmission line footings.

2.1 Geological and Hydrogeological Conceptualisation

The Development Site is located in the Lower Murrumbidgee Alluvium (Figure 2-1). A 5 km investigation buffer was drawn around the Development Site and showed that approximately the western two thirds of the investigation buffer were within the Lower Murrumbidgee Shallow Groundwater Source, while the eastern third was within the Lachlan Fold Belt MDB Groundwater Source (Figure 2-1). Groundwater bore information was collated from the Bureau of Meteorology (BoM) Groundwater Explorer[2] within a 5 km radius of the Development Site. The geology, water levels, yields and salinity for individual bores identified with the BoM Groundwater Explorer were obtained from WaterNSW Realtime Data web portal[3].

The geology of the Lower Murrumbidgee Shallow Groundwater Source comprises Cenozoic alluvial deposits along creeks/rivers, including sediments of the Murray Basin that underly the riverine plains. The Lower Murrumbidgee Shallow Aquifer or Shepparton Formation comprises yellow/brown sands and clays. The

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[2] http://www.bom.gov.au/water/groundwater/explorer/map.shtml
[3] https://realtimedata.waternsw.com.au/water.stm

management plan (*The Basin Plan Implementation – Appendix A. Murrumbidgee Alluvium Water Resource Plan Resource Description*) defines the Shallow Aquifer as extending to a depth of 40 m below ground surface (DPIE, 2019). The Lower Murrumbidgee Deep Aquifer underlies the shallow aquifer and comprises the Calivil Formation and Renmark Group, which are composed of grey to white sands with some clay (DPIE, 2019). The management plan defines the Deep Aquifer as extending from 40 m depth to the base of the Renmark Group, which in some areas is up to 400 m below ground surface (DPIE, 2019). There is not necessarily a clear geological distinction or an aquitard between the shallow and deeper aquifers, hence the use of depth-based classifications. Regional groundwater flow directions are from east to west in both the shallow and deeper aquifers (DPIE, 2019).

The geology of the Lachlan Fold Belt MDB Groundwater Source comprises of deformed and metamorphosed marine sedimentary rocks, cherts, siltstones, mafic volcanic basalts, rhyolites, and plutonic granitic intrusions (DPIE, 2022). This geological formation extends from the Great Dividing Range to the western rangelands around the Darling River near Bourke and Louth and provides extensive stock and domestic groundwater supplies (DPIE, 2022). Groundwater in the Lachlan Fold Belt is stored and moves through fractures, joints, bedding planes, faults, and cavities within the rock mass (DPIE, 2022).

The surface geology near the Development Site was identified from the from the NSW Seamless Geology dataset (v2.1 May 2021) and comprised primarily of alluvial floodplain deposits, mixed colluvial, alluvial and aeolian deposits, alluvial channel meander plain facies and residual deposits of soil or saprolite (Figure 2-3). To the north-west of the study site was a region of claypan and lacustrine deposits. Outside of the investigation boundary to the south-east were deposits of colluvium and the Mulga Downs Group comprising of fluvial and alluvial sedimentary rocks.

The basement geology comprised of the Abercrombie Formation and primarily comprised of thin bedded mica-quartz sandstone interbedded with laminated sandstone and mudstone (Figure 2-4). Outside of the investigation area to the west lies the Leeton Igneous Complex mostly made up of weathered granite and weathered muscovite quartz.

Figure 2-1 The Murrumbidgee alluvium water resource protection area from DPIE (2019)

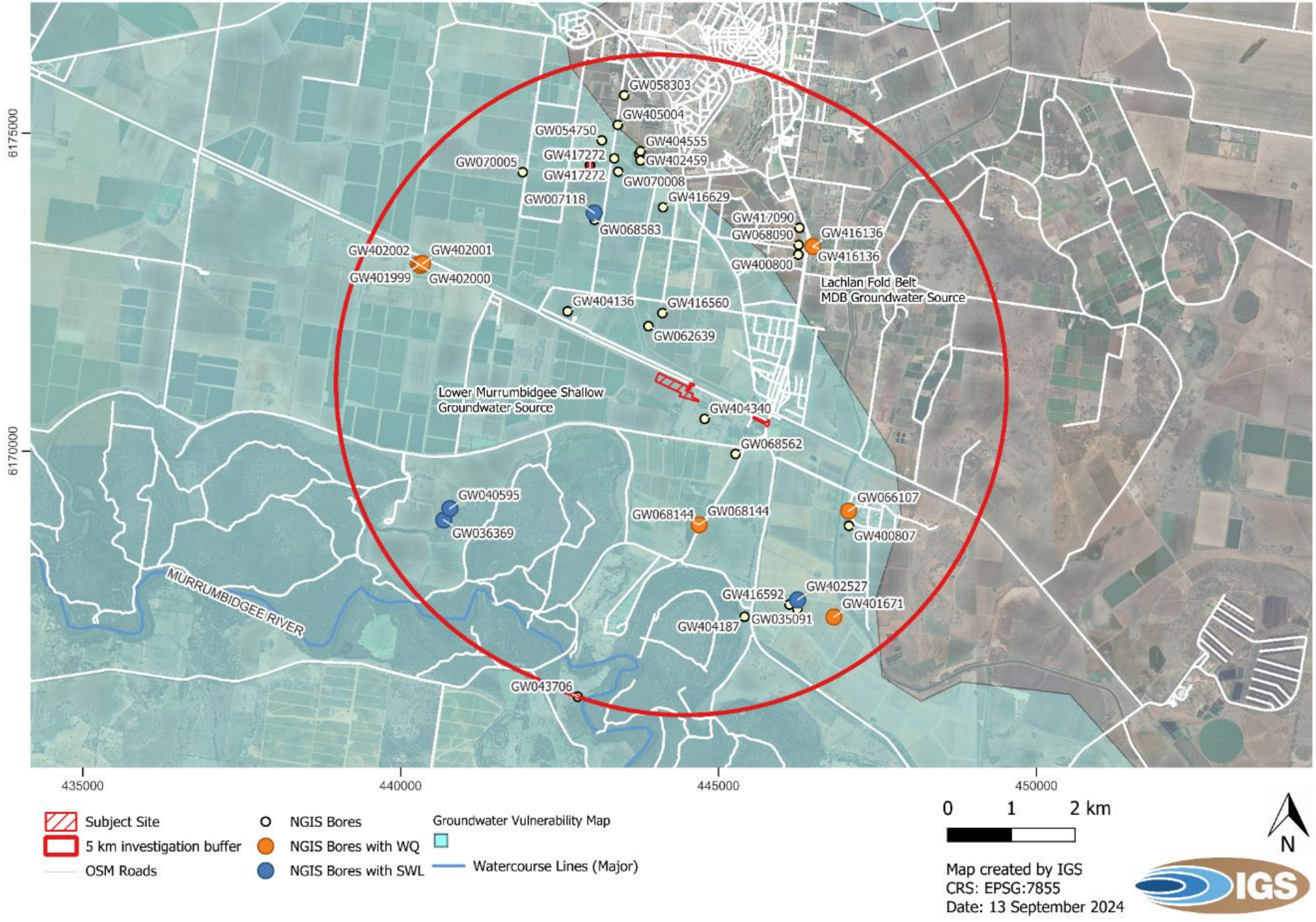

Figure 2-2 All bores in the study area with available standing water level timeseries marked in blue and salinity measurements marked in orange also shown with the groundwater vulnerability map which corresponds with the Lower Murrumbidgee Shallow Groundwater Source

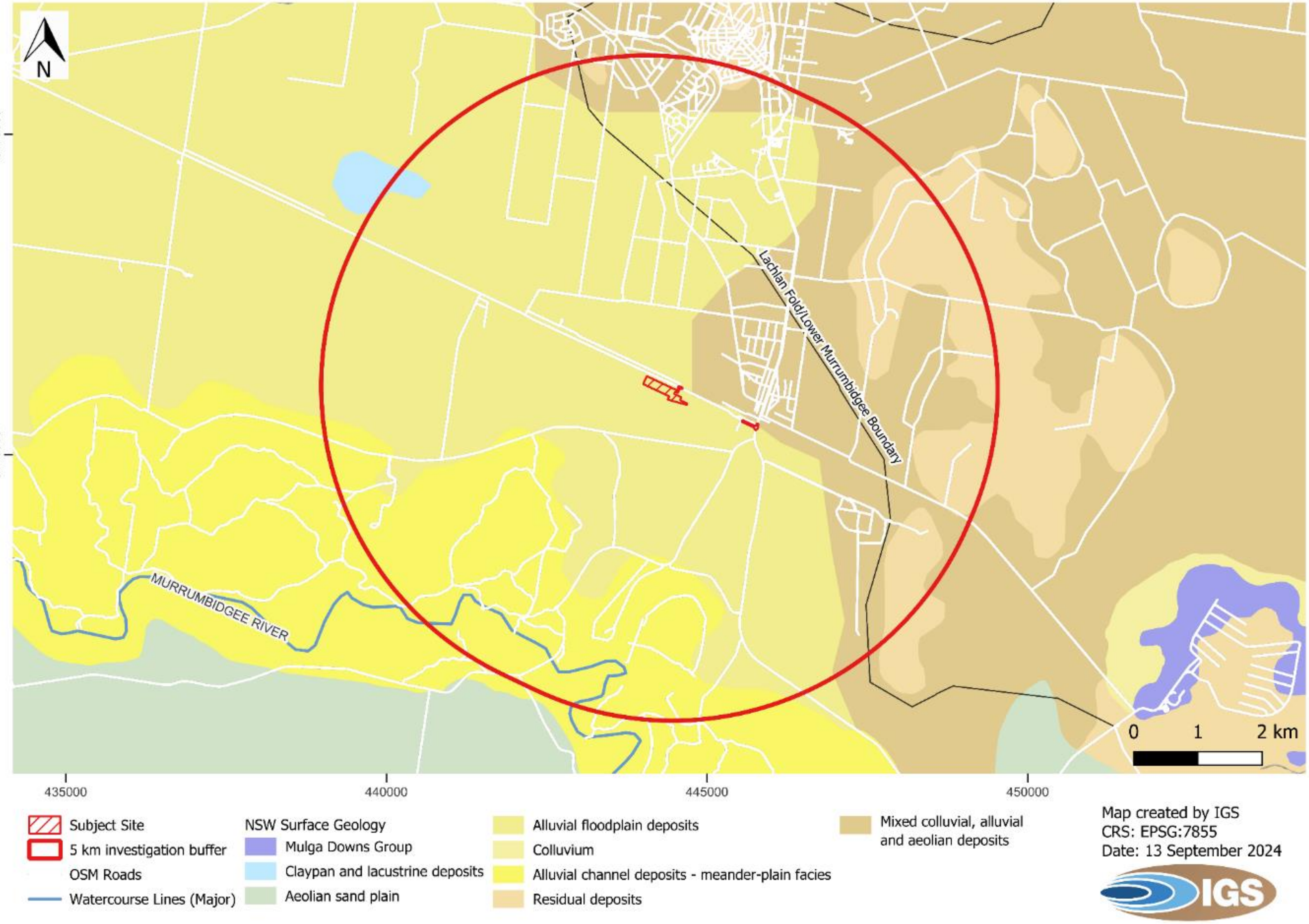

Figure 2-3 Surface geology near the Development Site from the NSW Seamless Geology dataset (v2.1 May 2021)

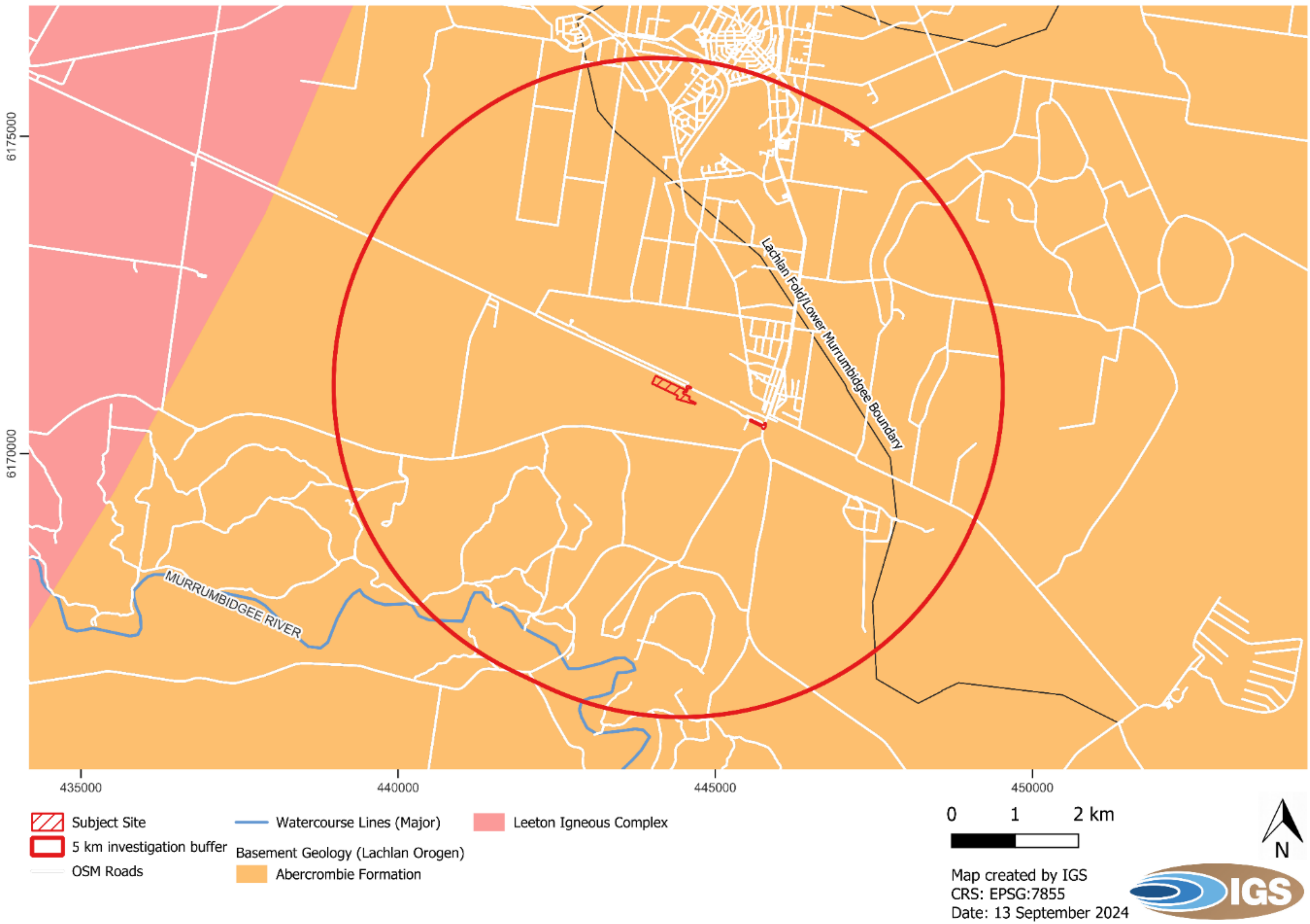

Figure 2-4 Basement geology near the Development Site from the NSW Seamless Geology dataset (v2.1 May 2021)

2.1.1 Groundwater Quality

Groundwater salinity data was available from 11 bores within a 5 km radius, of which 10 were in the shallow aquifer screened in sands and only one bore was in the deep aquifer screened in fractured rock (Table 2-1). The salinities for four of the bores in the shallow aquifer (GW401999, GW402002, GW402000 and GW402001) are questionable as the salinity, screen interval and lithology provided in the WaterNSW database are identical. Additionally, the bore report for the bore in the Lachlan Fold Belt area (GW401671) provided only a qualitative description of the salinity as "good". Based on the available data, the salinity in the shallow aquifer ranges between 100 mg/L (GW071592) and 1100 mg/L (GW400800). In comparison, the deep aquifer has only a single salinity measurement and that is higher than the shallow aquifer measurements at 7400 mg/L. Although uncertain due to only a single measurement in the deeper aquifer, these results suggest that the shallow aquifer has lower salinity than the deep aquifer in this area.

Table 2-1 Salinity measurements within 5 km of the study area shown with screen intervals, lithology and the interpreted aquifer. The interval of lithology intersected by the screen is bolded. Note wells marked with an * are questionable as they have identical records in the WaterNSW database

Bore	Salinity	Screen interval	Lithology	Aquifer
GW068144	230 mg/L (10/05/1989)	24 - 29 m	0 – 16.8 Clay 16.8 – 19.8 m Gravel 19.8 – 22.9 m Clay **22.9 – 24.4 m Silt** **24.4 – 29.6 m Sand** 29.6 – 29.9 m Clay	Shallow
GW401999*	360 mg/L (28/10/1998)	7 - 8 m	0 – 1 m Topsoil 1 – 4 m Clay **4 – 8.5 m Sand** 8.5 – 10 m Clay	Shallow
GW416136	600 mg/L (17/12/2012)	30.2 – 31.7 m	0 – 24 m Clay 24 – 25 m Sand 25 – 30.2 m Clay **30.2 – 31.7 m Sand** 31.7 – 33 m Silt	Shallow (Lachlan Fold Belt GW Source)
GW402002*	360 mg/L (28/10/1998)	7 – 8 m	0 – 1 m Topsoil 1 – 4 m Clay **4 – 8.5 m Sand** 8.5 – 10 m Clay	Shallow

Bore	Salinity	Screen interval	Lithology	Aquifer
GW401671	"Good" (30/12/1994)	15 – 20 m	-	Shallow
GW402000*	360 mg/L (28/10/1998)	7 – 8 m	0 – 1 m Topsoil 1 – 4 m Clay **4 – 8.5 m Sand** 8.5 – 10 m Clay	Shallow
GW402001*	360 mg/L (28/10/1998)	7 – 8 m	0 – 1 m Topsoil 1 – 4 m Clay **4 – 8.5 m Sand** 8.5 – 10 m Clay	Shallow
GW071592	100 mg/L (30/12/1993)	34.75 – 35.1 m	0 – 34.75 m Clay **34.75 – 35.1 m Sand**	Shallow
GW400800	1100 mg/L (15/05/1998)	30.5 – 33 m	0 – 4 m Clay 4 - 8 m Sand 8 – 12 m Clay 12 – 13 m Sand 13 – 28 m Clay **28 – 33 m Sand** 33 – 35 m Clay	Shallow
GW401671	1000 mg/L (30/12/1994)	15 – 20 m	NA	Shallow
GW066107	7400 mg/L (07/02/1992)	101 – 103 m	0 – 1 Topsoil 1 – 101 Sandstone **101 – 103 Fractures**	Deep

2.1.2 Groundwater levels and trends

The hydraulic head in mAHD and depth in m below the reference point or below the ground level for four bores is shown in Figure 2-5. The depth below measuring point was used for three of the bores opposed to the depth below ground level as this information was not available. Bore GW036369 had three nested piezometers at different depths (referred to as pipes), while the other bores consist of only a single pipe. The bores are generally screened in sand (Table 2-2) and the locations are show in Figure 2-2.

The highest hydraulic head measurements are in bore GW007118 in the north (>135 mAHD) with consistently lower hydraulic head measurements, mostly less than 130 mAHD, in the three bores (GW036369, GW040595 and GW402527) to the south. These hydraulic head timeseries consistently show potential for groundwater flow from the higher hydraulic head in the north to the lower hydraulic head in the south. This means flow directions in the shallow aquifer beneath the study site would be towards the river in the south.

Bore GW036369 has three piezometers at different depths with pipe 1 screened between 40.5 and 46.6 m depth, pipe 2 screened between 79.2 and 85.3 m depth, and pipe 3 screened between 134 and 140 m depth. Although slightly deeper than the 40 m cutoff depth for the shallow aquifer, pipe 1 is likely consistent with the hydraulic head in the shallow aquifer, while the subsequent pipes likely measure the hydraulic head in the deep aquifer. The screen of pipe 1 is separated from pipes 2 and 3 by 8 m of clay, which may act as an aquitard between the shallow and deep aquifer. This would explain the similarity between the hydraulic head in pipe 1 and the other bores, and the substantial difference between the hydraulic head observed in pipe 2 and pipe 3 and the other bores. The higher hydraulic head in the shallow aquifer relative to the deep aquifer indicates that an aquitard separates the shallow and deep aquifer, and the shallow aquifer has potential for downwards flow where the aquitard is leaky or absent.

The shallowest depth to water of the timeseries is an indicator of how shallow the water table is when water levels are at the highest, which can be an important metric when considering contamination risk. The shallowest depth to water in the shallow aquifer ranges from a 1.75 m in GW007118 in the north to 6.28 m in GW036369 in the south. In the deeper aquifer, GW0036369 shows a deeper depth to water than the shallow aquifer ranging from 15.73 m in pipe 2 to 15.92 m in pipe 3.

Bores show seasonal variations in hydraulic head and a long-term trend that mimics the cumulative deviation from mean monthly rainfall (CDMMR; calculated from the SILO database[4]). For GW036369, the pipes 2 and 3 (in the deeper aquifer) show greater seasonal variability than pipe 1 (likely in the shallower aquifer), possibly due to a combination of seasonal recharge/discharge processes and/or pressure loading from the overlying shallow aquifer on the confined deeper aquifer.

There are several bores with single measurements taken at the time of drilling located proximal to the Development Site. These ranged from a depth to water of 10 mBGL in GW404340 ~500 m to the south-east to 2.1 mBGL in GW402105 ~500 m to the north-west. This suggests that the depth to water at the Development Site could be anywhere between 2.1 mBGL and 10 mBGL. It is recommended that drilling is conducted to accurately characterise the depth to water beneath the Development Site.

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[4] https://www.longpaddock.qld.gov.au/silo/

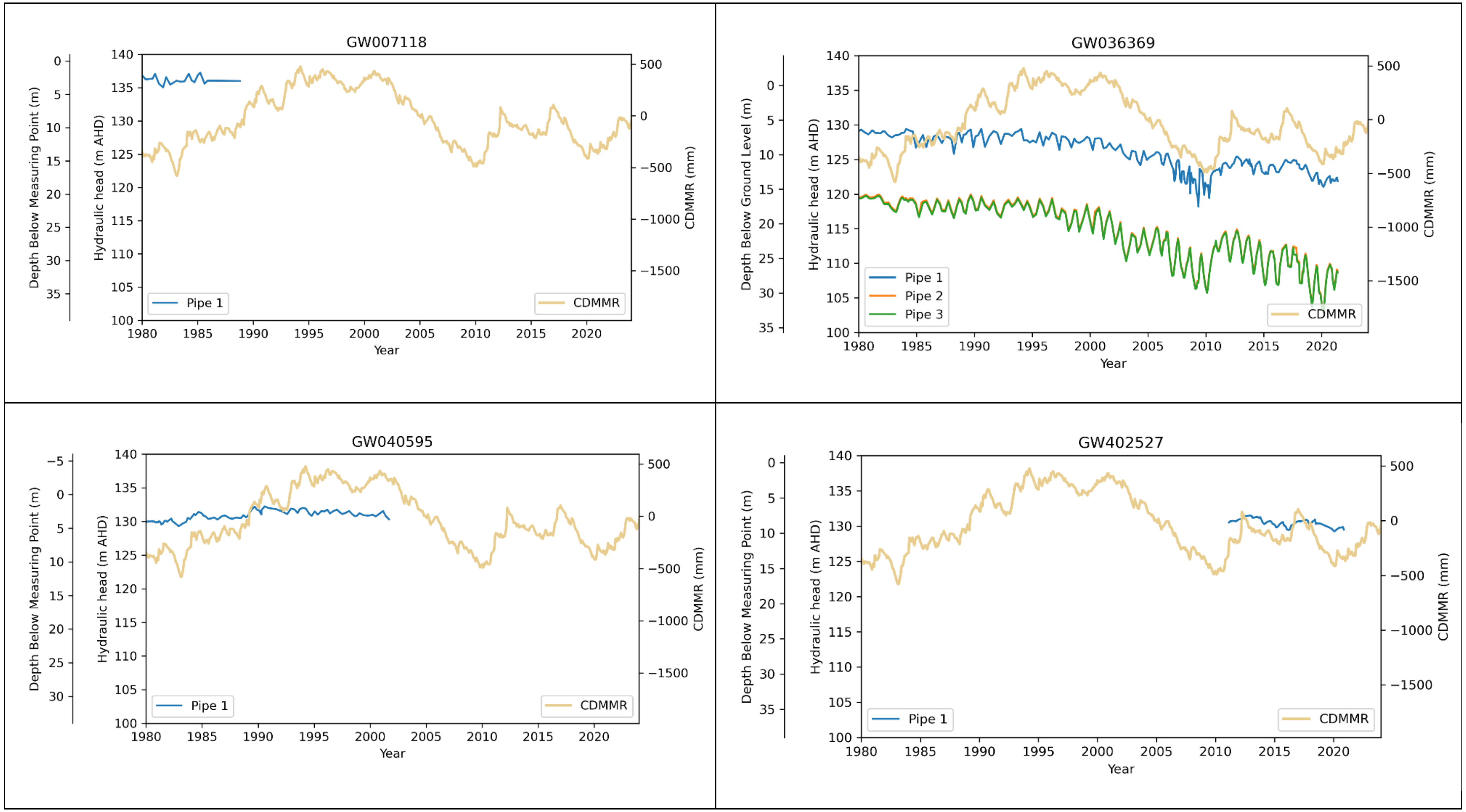

Figure 2-5 Hydraulic head measurements in mAHD and m depth below measuring point or ground level (where available) also shown with the cumulative deviation from mean monthly rainfall (CDMMR)

Table 2-2 Screen interval for each pipe in the bores shown with lithology. Bolded lithology that intersected by a screen.

Bore	Screen intervals	Lithology
GW007118	Pipe 1 16.8 – 18 m 29.6 – 35.4 m	0-16.8 m Clay **16.8-18.3 m Sand** 18.3-26.8 m Clay **26.8-35.4 m Sand** 35.4-37.2 m Clay
GW036369	Pipe 1 40.5 – 46.6 m Pipe 2 79.2 – 85.3 m Pipe 3 134 – 140 m	0-10 m Clay 10-12 m Fine coarse Sand 12-16 m Clay 16-18 m Clay-bound Sand 18-32 m Clay **32-52 Sand** 52-56 m Gravel 56-64 m Clay **64-114 m Sand** 114-116 m Gravel 116-120 m Sand **120-136 m Peat** **136-140 m Sand**
GW040595	Pipe 1 13.1 – 14 m	0-10.1 m Clay 10.1-11.3 m Loam **11.3-14.3 m Sand** 14.3-15.2 m Clay
GW402527	Pipe 1 9 – 13.3 m	0-7.2 m Clay **7.2-12.7 m Sand** **12.7-20 m Clay**

2.1.3 Aquifer properties

Limited information is available on aquifer properties (i.e., hydraulic conductivity and storativity) with no known aquifer pumping tests near the Development Site. Timms (2001) collated available information to summarise estimates of hydraulic conductivity and storativity across the Lower Murrumbidgee Shallow Alluvium (Shepparton Formation):

- Hydraulic conductivity estimates ranged between 0.1 – 60 m/d, with higher values attributed to sandier zones of the aquifer. A hydraulic conductivity of 15 m/d reported for a site at a similar distance from the Murrumbidgee River as the Development Site is considered representative of the Development Site for this assessment.
- Specific yield was estimated to range between 0.05 – 0.15 where the Shepparton Formation was unconfined. While storativity 2×10^{-4} – 8.1×10^{-3} was provided for the Shepparton Formation in floodplain areas where the aquifer is confined.

2.1.4 Groundwater-Surface Water Interactions and Groundwater Dependent Ecosystems

Groundwater-surface water interactions are likely to be important, given the shallow depth to water and the Murrumbidgee River to the south. The GDE atlas[5] was queried to locate terrestrial, aquatic and subterranean GDEs near the Development Site (Figure 2-7). There are aquatic and terrestrial GDEs located approximately 1 km south-west of the Site. The aquatic GDEs comprise wetlands and floodplain surrounding the Murrumbidgee River that are considered to have a low potential for groundwater interactions. The terrestrial GDEs comprise of *Eucalyptus camaldulensis* with a high potential for groundwater interactions. To the east of the Site (~4.6 km) is an isolated *Box/C. glaucophylla* GDE with a high potential for groundwater interactions.

[5] http://www.bom.gov.au/water/groundwater/gde/

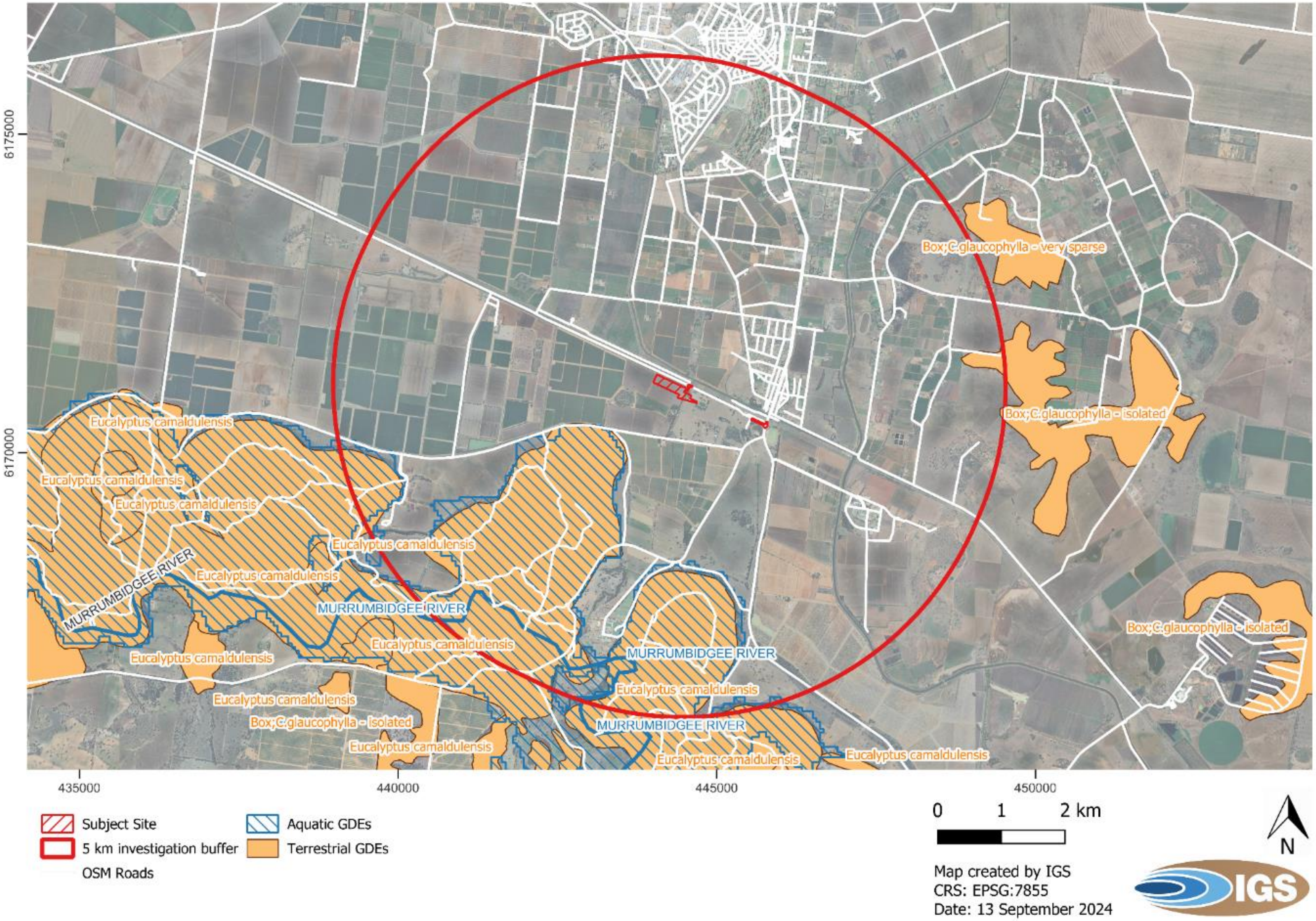

Figure 2-6 Groundwater dependent ecosystems near the Development Site from the GDE atlas

2.1.5 Groundwater Management and Use

The Lower Murrumbidgee Deep Aquifer is extensively utilised as a water source. Data for the Lower Murrumbidgee shows groundwater extraction from the shallow and deep aquifer between 2011 and 2023 (Table 2-3). Annual groundwater extraction ranges from 1,013 to 4,943.6 ML in the shallow aquifer and between 39,885.6 and 375,782.8 ML in the deep aquifer. In 2023, the water extraction from the shallow aquifer was 1016.4 ML, which is substantially lower than the extraction of 53,846.6 ML in the deep aquifer.

Nearby pumping data, including abstraction licences were not available due to privacy regulations. However, the locations of "Water Supply" and "Stock and Domestic" bores were identified by querying the BoM Groundwater Explorer for bores with a status listed as "functioning" or "unknown". This identified 26 "Water Supply" bores and two "Stock and Domestic" bores within the 5 km buffer. Of these only six "Stock and Domestic" bores were located in the Lachlan Fold Belt MDB Source area while all other bores were in the groundwater vulnerable Lower Murrumbidgee Alluvium. The locations of these bores are shown in Figure 2-7.

The groundwater productivity was examined for the study site using the mapping provided by the Department of Primary Industries (Office of Water) in 2013[6]. The mapping identifies highly productive groundwater areas categorised as highly productive where bores yielding >5 L/s with total dissolved solids <1500 mg/L (excluding small storage miscellaneous alluvial aquifers) or less productive where yields are <5 L/s and/or total dissolved solids are >1500 mg/L. The mapping (shown in Figure 2-7) suggests that the Lower Murrumbidgee Alluvium is classified as a highly productive alluvial aquifer, while the Lachlan Fold Belt MDB Source is classified as a less productive fractured rock aquifer.

Table 2-3 Annual groundwater extraction by water year for the shallow and deeper aquifer

Water year	Shallow aquifer (ML)	Deeper aquifer (ML)
2011	1,013.0	39,885.6
2012	1,178.0	107,941.5
2013	2,253.2	166,917.0
2014	3,472.2	220,898.2
2015	4,151.0	294,711.2
2016	3,212.3	266,642.5
2017	1,652.6	149,842.7
2018	4,259.6	321,016.5
2019	4,943.6	375,782.8
2020	3,671.9	324,801.6
2021	2,682.4	159,152.7
2022	1,413.5	96,059.1
2023	1,016.4*	53,848.6*

* Note data for 2023 is incomplete.

[6] https://www.planningportal.nsw.gov.au/opendata/dataset/highly-productive-groundwater-in-nsw

2.1.5.1 Environmental Planning Instrument – Groundwater Vulnerability

The NSW governments *Environmental Planning Instrument – Groundwater Vulnerability*[7] is a spatial dataset used to identify land where development implications exist due to the presence of vulnerable groundwater resources, as designated by the relevant NSW environmental planning instrument; in this case the Leeton LEP 2011 (NSW). The data shows the vulnerability (or level of risk) of aquifers to contamination relating to physical characteristics of the location, such as the depth to the water table and soil type.

The Development Site sits within the mapped area of 'groundwater vulnerability' (Figure 2-2).

[7] https://datasets.seed.nsw.gov.au/dataset/epi-groundwater-vulnerability

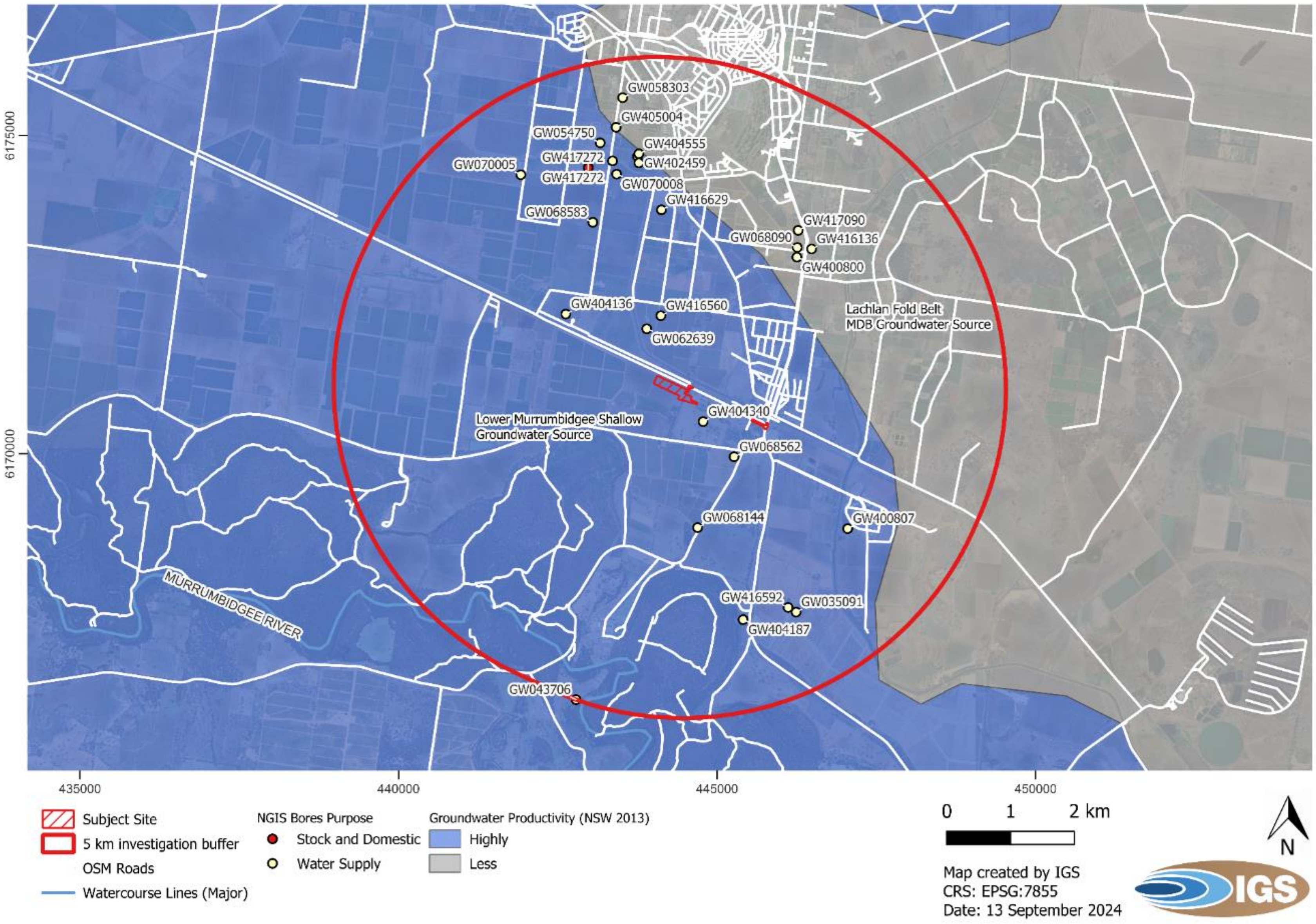

Figure 2-7 Locations of functional and unknown status bores categorised as stock and domestic or water supply shown with groundwater productivity mapping

2.2 Groundwater Vulnerability Assessment

2.2.1 Construction Dewatering

It is understood that no groundwater dewatering will be required during construction. Groundwater depth will be confirmed via on-site investigation during detailed design stage and the appropriate construction method (concrete footings or steel piling footings) will be chosen to ensure no dewatering is required.

2.2.2 Potential adverse impacts on groundwater dependent ecosystems

No mapped GDEs are within the Development Site, therefore no GDEs will be directly damaged during construction.

Potential terrestrial and aquatic GDEs are located within 5 km of the Development Site, however, construction and operations are not predicted to impact groundwater and therefore there will be no impacts to nearby potential GDEs.

2.2.3 Likelihood of contamination

It is understood that during construction, there will be no significant stored volumes of chemicals or fuels and no refuelling or washing of vehicles at the site. Therefore, the potential sources of groundwater contamination would be from minor fuel or hydraulic hose leaks, which are expected to be less than 100 L and would be managed via spill kits and removal of impacted soils via mechanical means until clean/non-odorous soils are observed. Due to the small volumes of potential sources, and management and mitigation measures, there is a low likelihood of contaminants reaching the water table. If contaminants did manage to migrate to the water table, concentrations would be extremely low resulting in a negligible risk of reducing groundwater quality for any local users or GDEs associated with the local groundwater system.

Once operational, potential contaminant sources include leakage of chemicals from batteries; however, the batteries will be lithium-ion phosphate, which does not contain heavy metals and is considered to be the safest batteries in the industry. In the unlikely event of battery failure, the battery units are self-contained, with anti-leak connections, therefore limiting any potential for contamination release. Further, as the batteries are in IP55-rated self-contained units, the opportunity for external water to interact with the internal battery and, therefore, the batteries are not considered a significant source of contamination.

Potential battery fires are expected to be contained within the individual units, as each unit has internal fire-suppression systems including flammable gas, smoke and thermal sensors, pressure release systems and aerosol fire extinguishing systems. Therefore, the risk (likelihood and consequence) from small individual fires is not considered significant. However, should a larger fire occur necessitating the use of large volumes of external water and fire-fighting chemicals, then there would be a potential for infiltration of fire-fighting liquids to the shallow aquifer. However, clean-up measures would mitigate against substantial volumes remaining in soils, and therefore, even in this scenario, the risk of contamination of groundwater is considered minimal.

There will be up 100L of fuel stored onsite, which is a potential source of contamination. However, standard management practices are in place to ensure that the fuel is stored in a bunded enclosure with a minimum 110% of the stored volume to ensure the bund can contain the entire volume of the stored fuel. Therefore, it is expected that the risk of a fuel leak will be minimal.

A 900 mm deep oil bund will be constructed to the current standards and limit the likelihood of oil leaks. With regular inspection and maintenance of the bund, oil is not considered to be a significant source of contamination.

IGS have been informed that no additional chemicals will be stored on the Development Site that would be considered to be a source of contamination. No dangerous goods will be stored onsite.

The risk of aquifer contamination associated with the proposed development during construction and operation is considered low due to there being only a few potential contaminant sources of low volume, management and mitigation measures being in place and the depth to groundwater (~7 mbgl) being sufficient to restrict a direct and rapid pathway. The water table is unlikely to be encountered during construction, eliminating the potential for the creation of a pathway for contamination through the thick, unsaturated soils.

2.2.4 Mitigation measures

Mitigation measures are focussed primarily on preventing chemical spills from reaching the groundwater system in the unlikely event of leakage. Mitigation measures include:

- Self-bunded battery storage units.
- Self-bunded fuel storage areas.
- Regular maintenance and inspection of fuel bund, oil bund and battery storage units.
- Development of site management plans that detail responses to leaks such as spill kits, removal and appropriate testing and disposal of impacted soils and options for installing groundwater monitoring bores in the case of a significant fire or unexpected leak.

Groundwater monitoring is not required during the construction and operation of the facility; however, should groundwater monitoring bores be required in the future due to a significant release or major fire, then bores should be installed downgradient of the fuel storage, oil bund and the downgradient (western) site boundary as well as one ‘clean’ bore upgradient on the eastern boundary.

It is recommended, that several shallow bores and/or geotechnical drillholes be drilled in the Development Site to verify lithology, depth to water and attain baseline water quality (if groundwater level is shallow, < 3.2 mBGL).

2.2.5 Cumulative impact of the development on groundwater

There is a negligible to low risk to groundwater from the proposed project and therefore no additional impacts are predicted to those that may already be present in the area.

3 FLOODING METHODOLOGY

3.1 Overview

Assessment of the flood risk to the Site was separated into mechanisms; riverine flooding and direct catchment inundation. The following sections describe the methodology for each component of the assessment.

3.2 Riverine Flooding

A desktop review was undertaken to determine existing flood risk from riverine sources to the Site. The Murrumbidgee River is located approximately 4.30 km to the south of the site. An existing Murrumbidgee River flood study was commissioned by Narrandera Shire Council in 2019[8], highlighting the proposed BESS location remains flood free up to the PMF design event as part of the hydraulic assessment. The Site relative to the riverine flooding from the Murrumbidgee River during the PMF flood event is shown in Figure 3-1.

Whilst the Site is located outside of the model extent (shown by the black dashed line), Figure 3-1 shows the land to the south of the Site with an elevation of approximately 138.00 mAHD has an indicative inundation depth of between 0.1 to 0.3 m. The Site is located at an elevation of between 138.50 to 139.20 m AHD which is higher than the estimated PMF level of 138.30 m AHD around the Site. It should be noted that this is considered a conservative PMF extent due to the confined nature of the model rather than modelling the full flood extent.

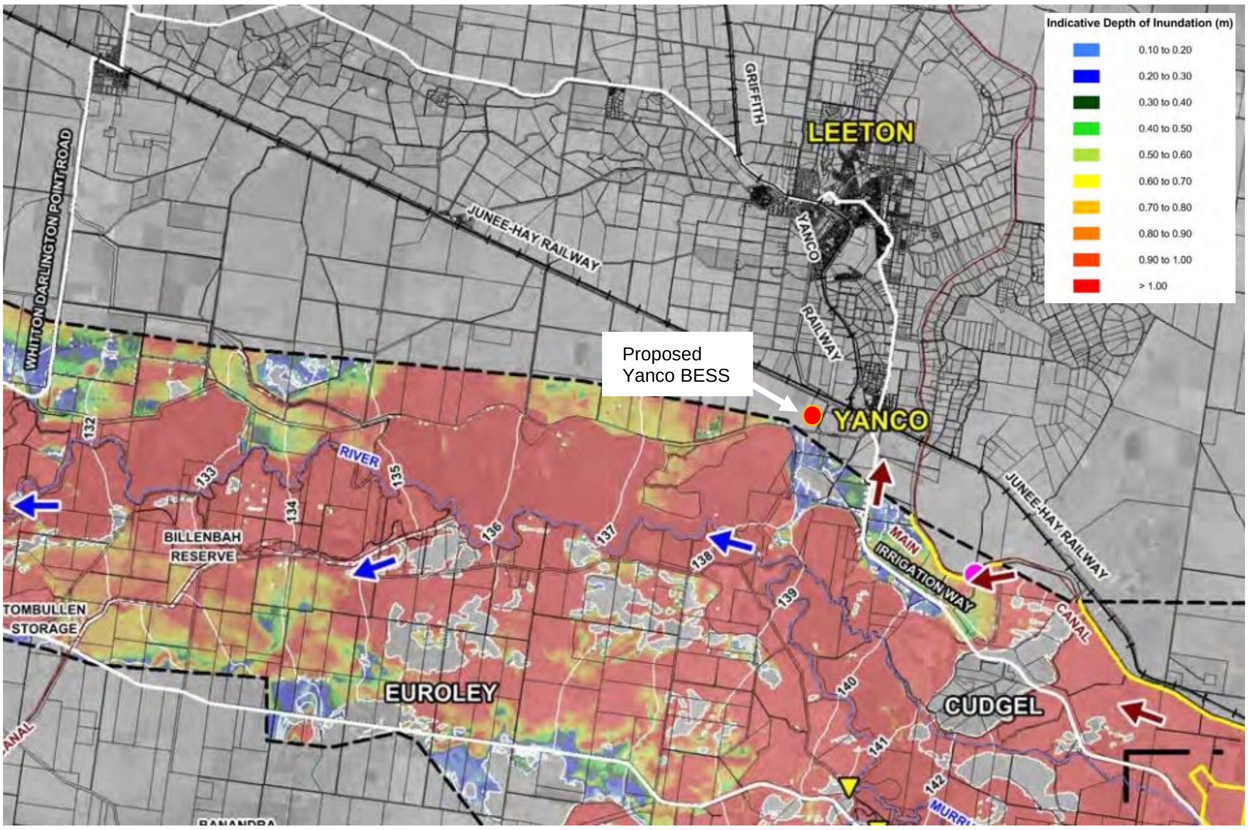

Figure 3-1 PMF Riverine Flood Risk from the Murrumbidgee River (Lyall & Associates 2019)

[8] https://flooddata.ses.nsw.gov.au/flood-projects/leeton-shire-flood-study

3.3 Direct catchment runoff

3.3.1 Overview

To understand how direct catchment runoff impacts the Site, hydraulic modelling was completed using a two-dimensional (2D) TUFLOW flood model. TUFLOW software is one of the most widely used hydraulic modelling software packages in Australia. The software is considered an appropriate modelling tool for modelling riverine and local overland flooding. TUFLOW allows the simulation of runoff generated from local rainfall on a grid that is representative of the site topography, known as "Rain on Grid" (RoG) modelling.

The domain of the 2D TUFLOW model extended beyond the Site boundary to cover the local catchment area draining to the site.

Climate change modelling used forecasting data for changes to rainfall intensity predicted for the year 2090 and the Representative Concentration Pathway (RCP) 8.5 scenario. The RCPs are used for making projections based on four different 21st century pathways of anthropogenic Greenhouse Gas (GHG) emissions and atmospheric concentrations, air pollutant emissions and land use[9]. The RCPs include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high GHG emissions (RCP8.5). RCPs consider the impact of atmospheric concentrations of greenhouse gases and aerosols, along with the uncertainty in possible future emissions. The use of RCP 8.5 would allow for the worst-case scenario.

3.3.2 Hydraulic Model Development

3.3.2.1 Hydraulic Model

TUFLOW HPC was selected as the numerical solver for the development of the fluvial 2D hydraulic model. The Heavily Parallelised Compute (HPC) version solves the full 2D shallow water equations including inertia and turbulence. The HPC solver also enables adaptive time-stepping in conjunction with smaller grid resolutions for greater granularity of results and topographic features. The modelling undertaken as part of this assessment has utilised the 2023-03-AE-iSP-w64 software build of TUFLOW.

3.3.2.2 Topographic Data

The estimation of flood effects in engineered environments with complex flow paths can be sensitive to model grid resolution. The model domain covered an area of approximately 28.0 km² and comprised of a uniform fixed grid of 3 m resolution. Sub-Grid Sampling (SGS) was also utilised to take advantage of the 1 m high resolution LiDAR to derive a non-linear storage relationship. The benefit of sub-grid sampling is defining the finer scale urban features whilst also representing reasonable simulation times with a larger cell size. The effect of cell size was examined in the sensitivity analysis in Section 4.2.3.

The topography of the site in the hydraulic model was represented by 1 m resolution LiDAR captured in 2014 (Yanco201402-LID1-AHD_55_0002_0002_1m) sourced from the NSW state government via the ELVIS website[10]. This LiDAR adequately represented the floodplain topography, allowing for accurate routing for out of banks and surface water 2D flow (Figure 3-2).

The following components were also added to the baseline LiDAR DTM to add more detail to the 2D domain of the flood model:

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[9] https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf
[10] https://elevation.fsdf.org.au/

- Embankment levels along several of the open channels were enforced to ensure the spill levels and conveyance along the channels were adequately captured.

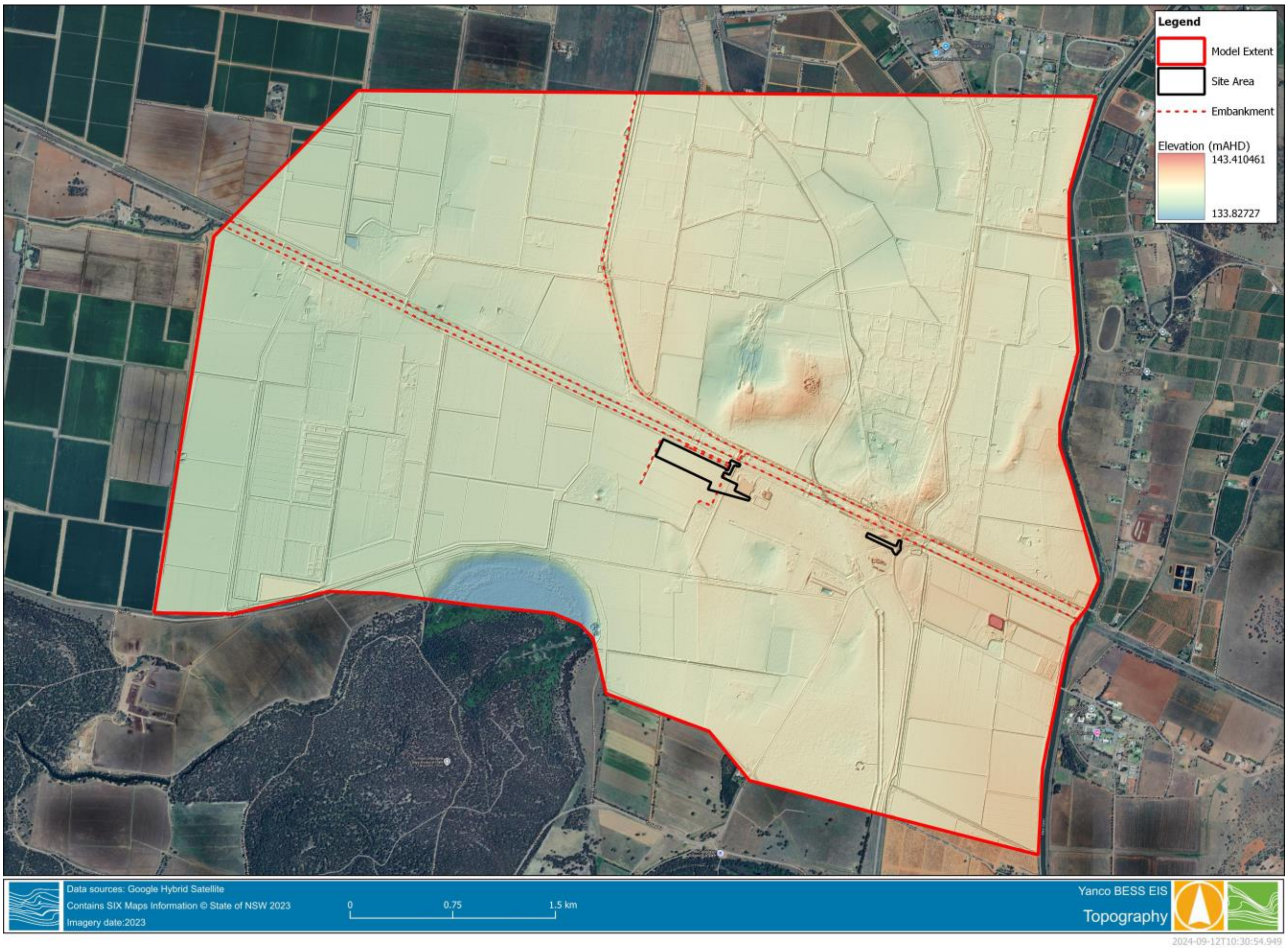

Figure 3-2 Model Extent & Topography

3.3.2.3 Hydraulic (Manning's) Roughness

The hydraulic model used Manning's 'n' to represent the hydraulic roughness to determine the restriction caused by the range of land uses within the model area. Local council planning layers were used to assign a specific Manning's 'n' roughness coefficient based on values taken from those in published texts such as Chow[11]. Each land use type was assigned a corresponding Manning's 'n' value in the TUFLOW Materials File as shown below with a set default Manning's 'n' value of 0.04 (material ID: 108).

[11] Chow, V.T., 1959. Open-channel hydraulics, McGraw-Hill, New York

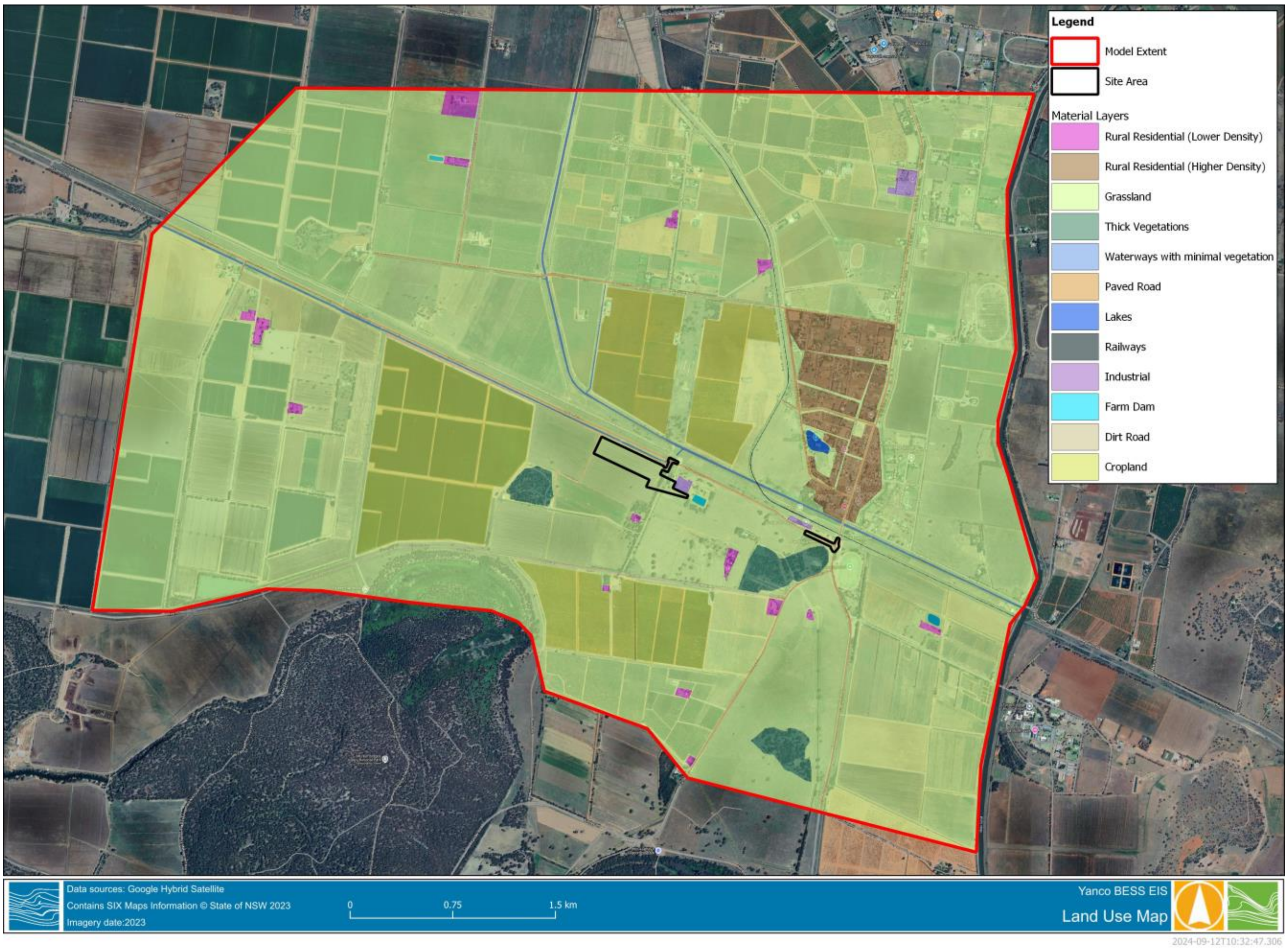

Figure 3-3 Land use

Table 3-1 Manning's 'n' Roughness Coefficients

Land Use	Manning's 'n' Roughness Coefficient
Buildings	0.5
Residential area	0.15
Cropland	0.05
Grassland	0.04
Bush/shrubs	0.06
Forestry (dense vegetation)	0.095
Waterways	0.03
Farm Dam	0.08
Sealed Roads	0.025
Dirt Roads	0.03

3.3.2.4 Hydraulic structures

Several hydraulic structures connecting the channels and drains around the Site were observed in satellite imagery. The landholder was able to provide information on the culvert shapes and sizes for numerous structures around the Site. The remaining structures around the Site were estimated based on nearby structure sizes and reasonable estimates.

3.3.3 Hydrologic Input

3.3.3.1 Rainfall

RoG modelling requires hydrologic inputs of rainfall and losses to be applied to the hydraulic model. The TUFLOW QGIS plugin was used to extract design rainfalls and associated temporal pattern data from the ARR 2019 and Bureau of Meteorology (BoM) databases for the catchment (coordinates: 146.3914, -34.6004).

With the model extent being larger than the discrete catchment that the site is located within, a conservative approach was taken with no areal reduction factors being applied to the design rainfall.

Temporal patterns were selected from the Murray Basin zone. Three temporal patterns were modelled for each storm duration, consisting of front loaded, mid-loaded and rear loaded storms. Figure 3-4 showcases the temporal pattern comparison in the rainfall hyetograph for the 1% AEP 60-minute event.

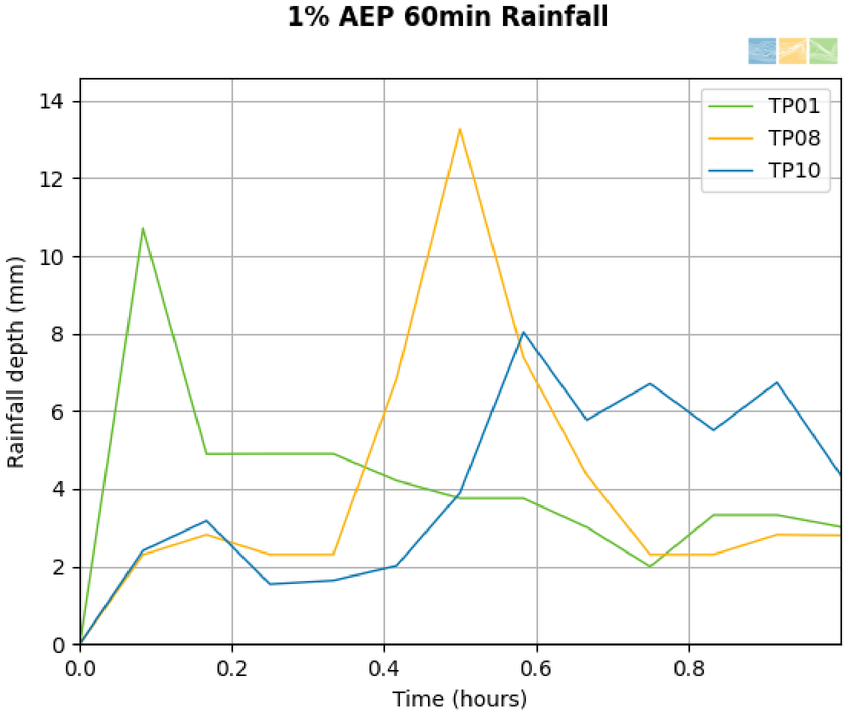

Figure 3-4 Temporal pattern comparison

The PMF rainfall depth was estimated from the Probable Maximum Precipitation (PMP) rainfall depth using a Generalise Short-Duration Method. A scale factor between the 1 in 2000-year rainfall depth and PMP was used to determine the PMF rainfall depth for each of the investigated storm durations.

3.3.3.2 Losses

Rainfall losses were accounted for using the initial loss / continuing loss method and were assigned to each land use type based on expected fraction imperviousness. Land use types were based on those identified as part of applying the Manning's roughness coefficients.

Losses were applied to the model in the hydraulic roughness database, alongside the roughness values. These losses represent the fact that not all rainfall is converted into runoff.

Starting values of 26.0 mm for initial loss (IL) and 0.1 mm/h for continuing loss (CL) were taken from the ARR datahub based on the spot location within the Murray-Darling Basin at Yanco. As is recommended, these starting values were reduced based on engineering judgement and adopted values are tabulated in Table 3-2.

Further sensitivity analysis in comparison to soil infiltration is given in Section 4.2.2.

Table 3-2 Rainfall loss values

Land Use	Initial Loss	Continuing Loss
Buildings	2.5	0.1
Residential area	12.5	0.1
Cropland	12.5	0.1
Grassland	12.5	0.1
Bush/shrubs	12.5	0.1
Forestry (dense vegetation)	12.5	0.1
Waterways	0.0	0.0
Farm Dam	0.0	0.0
Sealed Roads	1.0	0.5
Dirt Roads	1.0	0.5

3.3.3.3 Boundary Conditions

The RoG method was used, which applies the rainfall directly onto the catchment land surface. This approach is particularly beneficial for catchment-based studies and the impact of dry and saturated ground conditions can be assessed, as well as the influence of groundwater levels. The direct rainfall is assumed to be spatially uniform across the entirety of the model extent at Yanco. TUFLOW converts the original rainfall hyetograph to a hydrograph to smooth the transition from one rainfall period to another.

A series of stage-discharge (HQ) curves have been applied around the perimeter of the model domain to remove surface water runoff water that flows away from the Site into neighbouring catchments. Each of these curves were automatically generated by TUFLOW and were based on a slope derived from local ground topography.

All external boundary conditions have been located sufficiently far enough away from the area of interest to remove the influence of boundary effects on predicted peak water levels. Figure 3-5 showcases the boundaries relative to the Site.

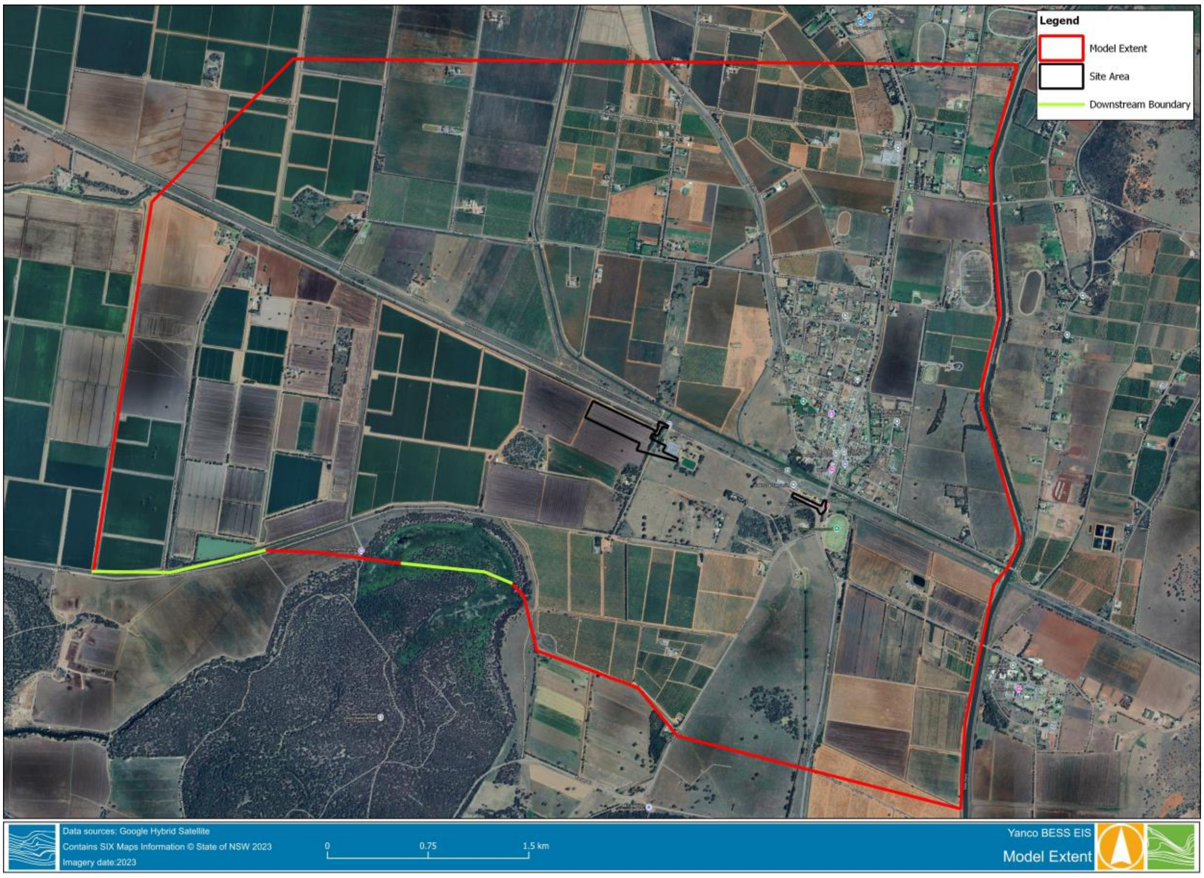

Figure 3-5 Model Extent and Boundary conditions

3.3.4 BESS Design Updates

To account for the changes in site topography due to the BESS, the baseline RoG model included topographic and land use changes to the hydraulic model as a 'developed' scenario. As is seen in Figure 3-6below, the proposed design incorporates crushed rock and concrete pads/footings for the batteries and other infrastructure. No major earthworks are expected that would alter the flooding mechanism in or around the site. A summary of the changes made to the TUFLOW hydraulic model are noted below and in Figure 3-6:

- The surface of the proposed Site will change from open grassed area to crushed rock. The upgraded access road between Houghton Road and Hume Road is assumed to be sealed, however may remain a gravel road. These changes are represented by industry standard Manning's values;
- Three soundwalls have been represented as layered flow constriction layers in TUFLOW. These soundwalls are impermeable walls with 0.15 m gaps between the wall and natural ground surface to allow shallow water to flow into/out of the site. It has been assumed the height of the soundwall is above the PMF maximum flood height.
- A sample high level layout of the BESS units was provided by Acenergy to represent the proposed design. The modelling of the BESS units accounts for the minor blockage associated with the piers on which the BESS units are positioned. Given there is no significant overland flow paths entering the site, the placement of these BESS units within the broad area defined in the model is not likely to impact stormwater runoff behaviour. Each BESS unit has been represented by a small uplift in the underlying DTM by 0.3m (assuming entire blockage of shallow overland flow); and
- The material land use has been adjusted to account for any crushed rock and BESS unit based on industry standard Manning's values.

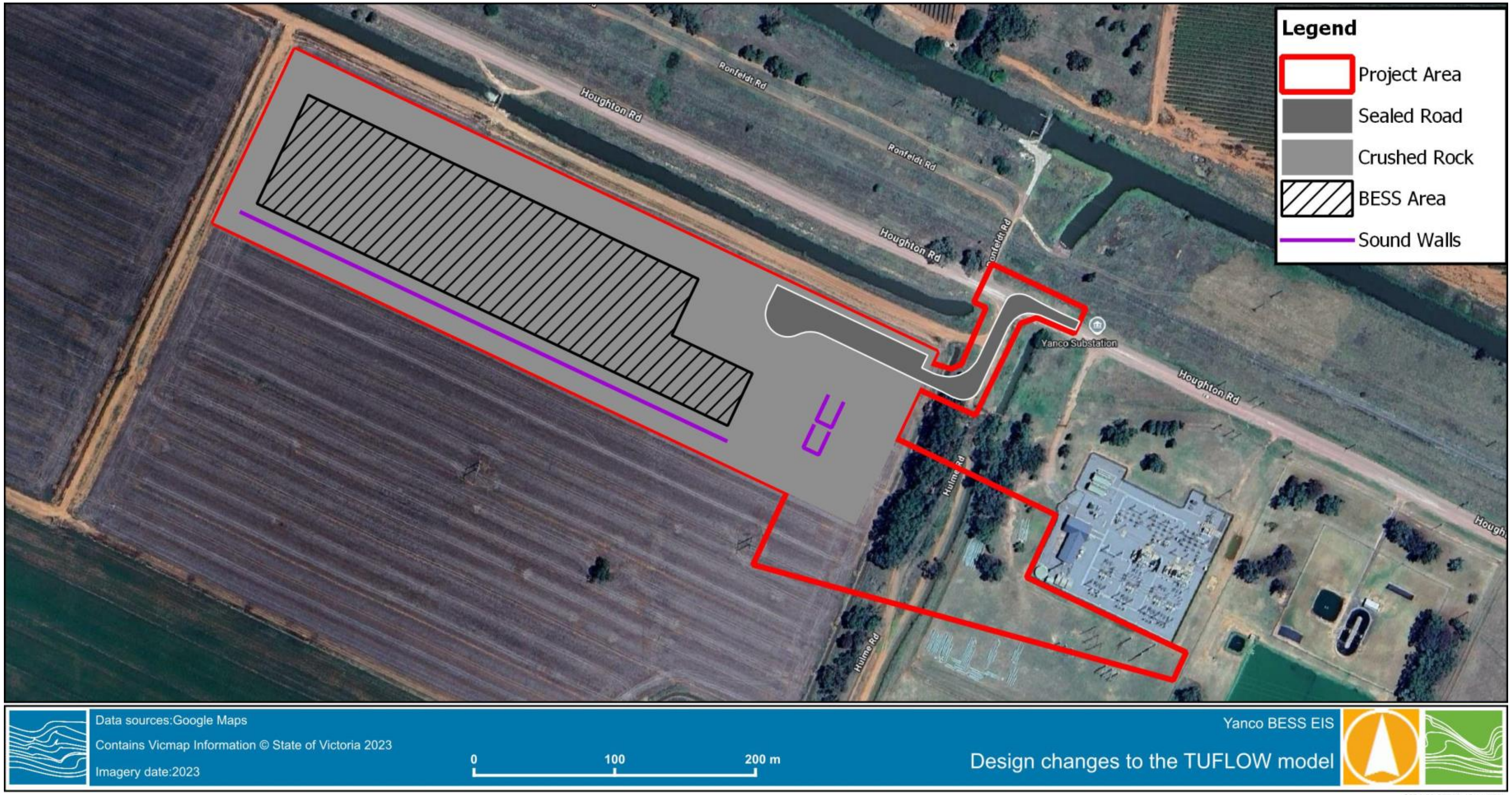

Figure 3-6 Hydraulic model changes for the design scenario

4 DIRECT CATCHMENT RUNOFF MODELLING

4.1 Model verification

There are several peak flow estimation methods that can be used for broad comparison to modelled peak flows, all dependent on having a catchment which discharges to a confined flow path. Due to the lack of defined overland flow paths within the model extent, no method was found suitable for verification of the current model results.

4.2 Sensitivity Assessment

Key parameters in any hydraulic model should be varied to ensure the model is stable and to determine the sensitivity of the modelled outputs to the choice of model parameters.

Sensitivity analysis is the study of how the variation in the output of a model (depth) can be apportioned, qualitatively or quantitatively, to different changes in the model inputs (model variables, boundary conditions and parameters). Sensitivity analysis is used to identify:

- The factors that potentially have the most influence on model outputs;
- The factors that need further investigation to improve confidence in the model; and
- Regions in space of inputs where the variation in the model output is maximum.

A summary of the key parameters tested is provided in Table 4-1.

Table 4-1 Key parameters for Sensitivity testing

Parameter	Scenario	AEP
Terrain roughness	Global ±20% change in the material roughness values	1%
Loss method	Global -50% change in loss values	1%
Cell size	A range of cell sizes were tested with and without sub-grid sampling (SGS)	1%

4.2.1 Terrain roughness

A separate universal uplift and reduction of 20% to the Manning's 'n' roughness coefficient values was applied across the entirety of the model domain. This resulted in a minor to negligible change in predicted peak flood levels at and around the Site area. The differences were generally less than 10mm from the decrease and uplift of 20% in Manning's roughness values. The results of this analysis of not surprising considering the lack of upstream area. As such, this would be indicative of the model area being driven by volume rather than influences on conveyance and timing.

4.2.2 Loss method

To determine the influence of loss methods on the precited peak flood levels, an assessment was made to understand the sensitivity of the initial/continuing loss (IL/CL) values adopted. Initial/continuing losses were extracted from the ARR online datahub[12] as a starting point and then modified based on modelling experience and any nearby flood study information. These values have been tabulated in Section 3.3.3.2. The losses adopted in the model have been halved to understand the impact losses have on the maximum water levels

[12] https://data.arr-software.org/

and flood depths on the Site. The reduced losses generally showed slightly higher water levels. The differences in peak water levels were often <0.01m around the Site. This demonstrates losses don't have a significant impact on the modelling. The change is also relatively minor likely due a low CL value of 0.1 being adopted for the modelling.

4.2.3 Cell size convergence

Various grid sizes were tested to determine how the cell size impacts the model results at the Site. Two grid sizes were tested with sub-grid sampling of 1m (SGS 3m, 5m) and three grid sizes were tested without the application of sub-grid sampling (EXG 1m, 3m, 5m).

An idealised 1m grid size, that would utilise all the available underlying topography resolution, was simulated as part of the testing to compare to the other grid sizes. In general, it was found that grid sizes without sub-grid-sampling appear to both under and overestimate peak water levels and the receding limb over time. There are however, areas of the model domain where there is little difference, and this is likely a function of the small catchment with few complex flow paths. Figure 4-1 compares a timeseries of water levels near the Site across the modelled cell sizes. The 1m non-SGS model compares well with the SGS models, however the runtime was 15x as long. Overall, the use of SGS indicates a good correlation of the modelled result, and the 3m cell size with sub-grid sampling was selected to maintain a higher degree of precision but with more reasonable run times.

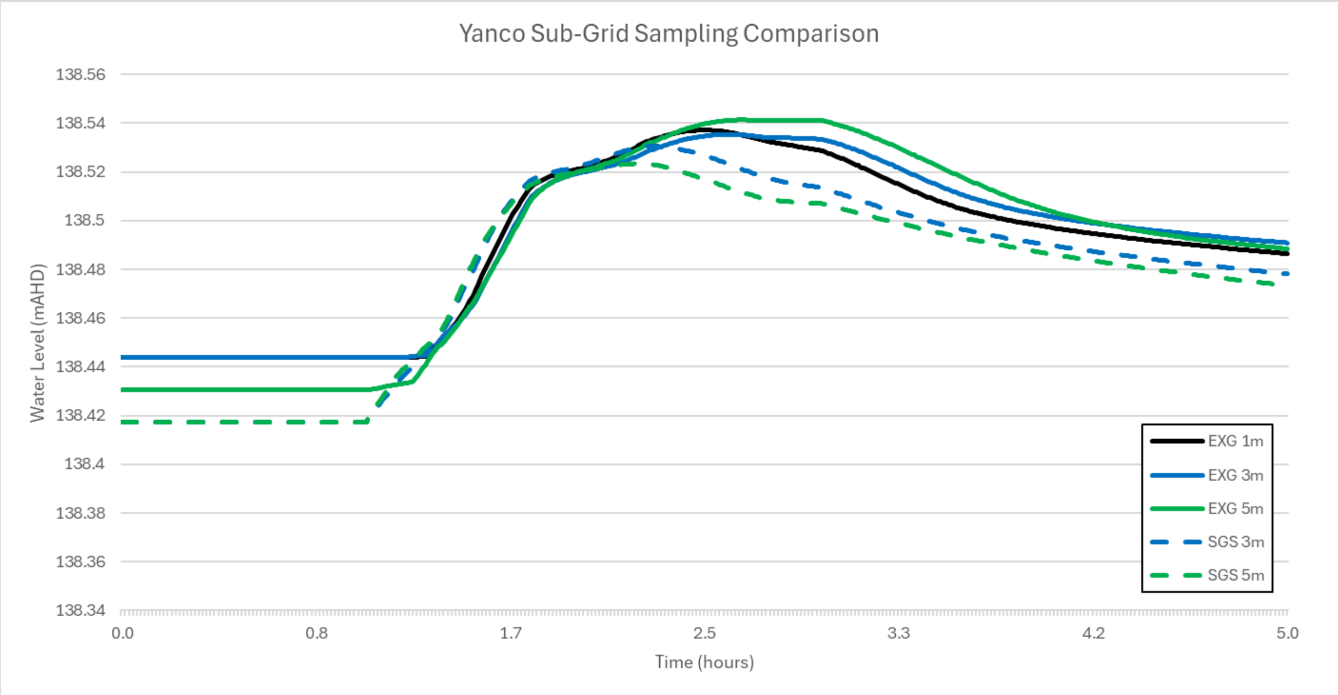

Figure 4-1 Sub-Grid Sampling Comparison

4.3 Critical Duration Selection

The critical storm duration is typically defined as the duration of rainfall which produces the greatest flood extent and flood depth at the site. Even within a small area (such as the site), the critical duration can vary due to several factors, including topography, land use, size of the upstream catchment and nature of the drainage system. As recommended in ARR (2019) the temporal pattern that produced the median was taken forward for further analysis.

All simulated AEP events were modelled with an identified back-loaded, mid-loaded and front-loaded temporal patterns for a range of events to capture the influence of short to longer duration storm events. The results across several durations for the 1% and 10% events are shown in Figure 4-2 and Figure 4-3. The results indicate that 3-hour duration is the critical storm at the Site over the BESS layout for the events shown, with areas surrounding the site dominated by longer durations.

The remaining median temporal pattern AEP results are displayed in Appendix A.

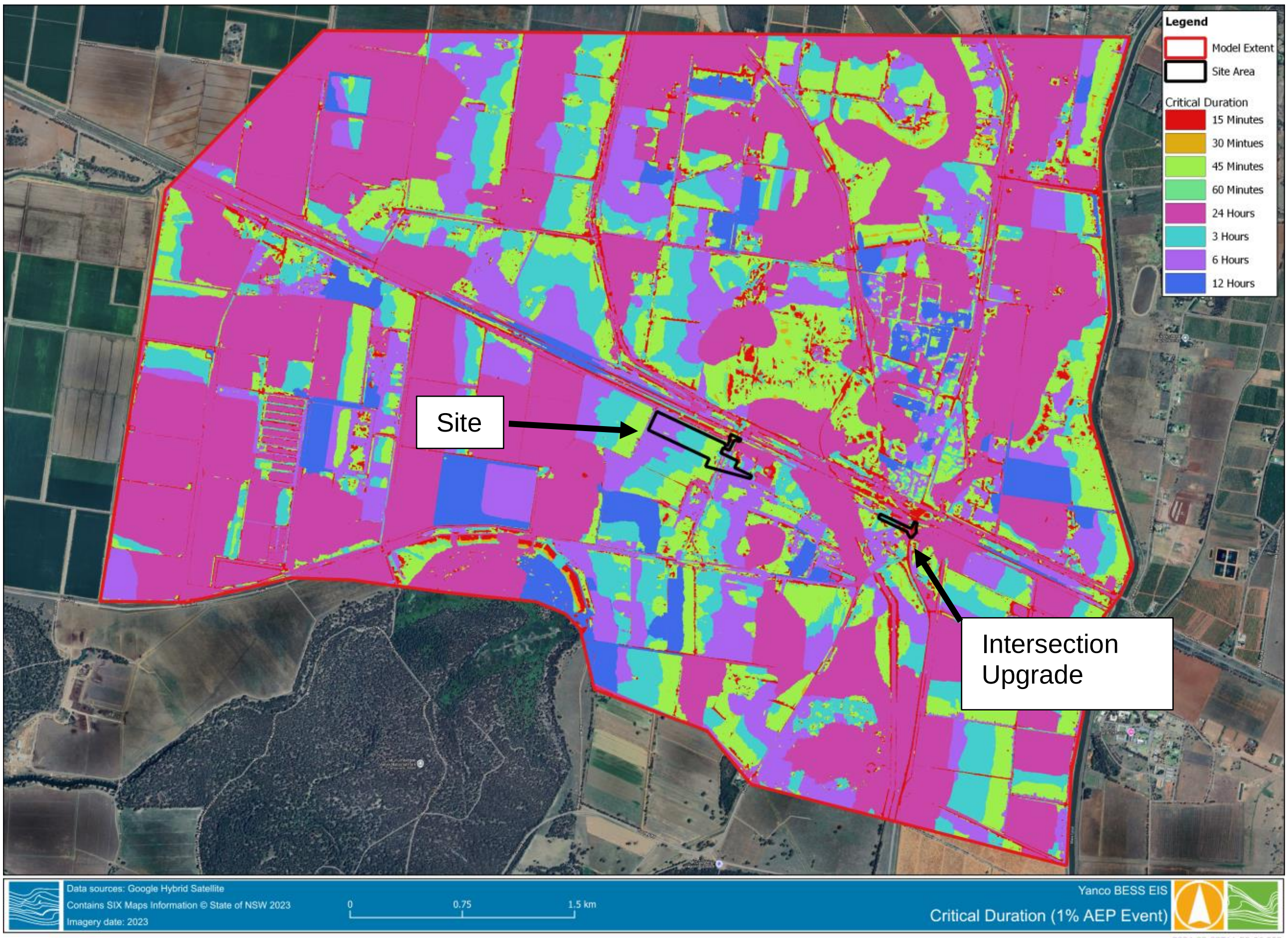

Figure 4-2 Critical Durations - Existing Conditions (1% AEP event)

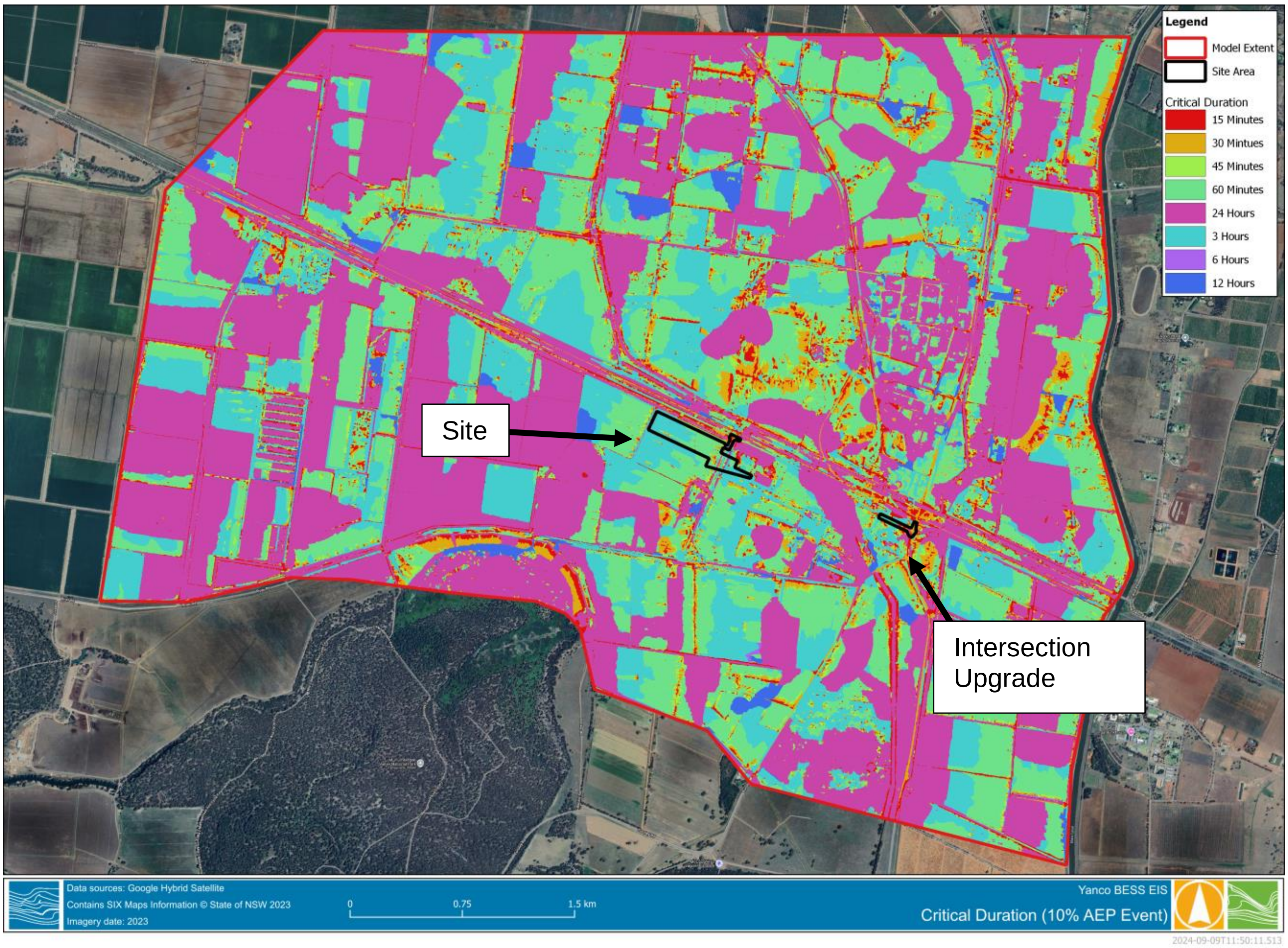

Figure 4-3 Critical Durations - Existing Conditions (10% AEP event)

4.4 Modelling Parameters

In general, standard default TUFLOW parameters were used in the modelling of the rainfall across the Yanco BESS model domain. Key parameters are noted below:

Table 4-2 Key model parameters

Parameter	Value
Cell wet/dry depth	0.0002
SGS sample frequency	5
SGS Approach	Method B
SGS Depth Output	Cell Average

The computation timestep is adaptive over the course of the simulation with 2D time-varying outputs generated every 10 minutes, and every 5 minutes within the plot output (PO) points/lines.

4.5 Quality Assurance

This section outlines the Quality Assurance (QA) measures undertaken in developing the Yanco BESS hydraulic model.

Part of the general model QA involves reviewing the TUFLOW messages generated during the model compilation stage and resolving any issues. Warnings produced by TUFLOW during the run were also investigated. Locations causing recurring warnings were identified and a solution implemented to reduce or remove the source of the issue. Model logs have also been utilised to record the key decisions made when developing the model, allowing for traceability and aid in the transfer of the models between different users. The main components of the Yanco BESS model build, configuration and application were recorded and have been reviewed internally and signed-off by a senior hydraulic modeller.

Further QA over the course of the model build was undertaken, those checks include:

- Material roughness was checked by importing and thematically mapping the uvpt_check file and DEM_M to ensure surface resistance was applied correctly with respect to aerial images;
- The extent of the 2D domain was reviewed to unsure it was not limiting flood extents in the larger flood events within the area of interest;
- Key topographic features were also reviewed to ensure that blockages and attenuation were captured within the grid sampling to prevent ‘leaky’ embankments; and
- Minimum dT values across the 2D domain were reviewed to highlight any troublesome areas that were slowing down overall run time.

4.6 Model Limitations

This model has been developed to take advantage of the most accurate available data to help inform flood risk at the Site. There are however several limitations to the hydraulic model worth noting:

- No model verification was undertaken with rated upstream gauge flows or event observations.
- Not all hydraulic control structures have been explicitly modelled as part of this assessment. As such the connectivity between the Main Channel and the feeder field drains via these structures is unknown and the influence these may have on localised flood risk.

5 FLOODING RESULTS

5.1 Overview

The results of the flood modelling are presented in this section. The maximum flood depth, velocity and hazard for each modelled AEP was determined across the modelled event durations. Note that flood depths less than 20 mm and puddle sizes less than 0.01 ha have been filtered from all results.

In this report only the 10%, 5% and 1% AEP and PMF events are discussed under existing site conditions, with the remainder of the results provided in mapping. Results for the 1% AEP were used for the discussion of flood levels under the climate change condition.

Floods can be hazardous, producing harm to people, damage to infrastructure and potentially loss of life. In examining the potential hazard of flooding at the site, there are several factors to be considered, as outlined in ARR 2019 (Book 6 Chapter 7)[13]. An assessment of flood hazard should consider:

- Velocity of floodwaters;
- depth of floodwaters;
- Combination of velocity and depth of floodwaters;
- Isolation during a flood;
- Effective warning time; and
- Rate of rise of floodwater.

The flood hazard of the site was assessed in accordance with ARR2019, which defines six hazard categories. The combined flood hazard curves are presented in Figure 5-1 and vulnerability thresholds classifications are tabulated in Table 5-1.

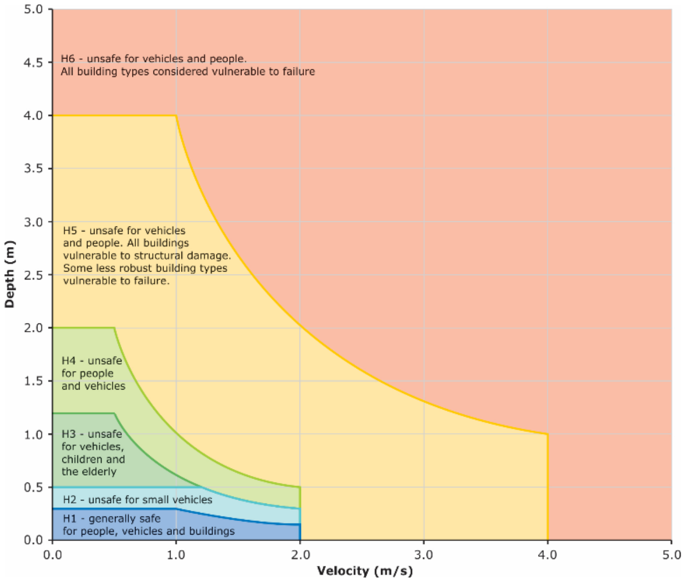

Figure 5-1 Combined flood hazard curves

Table 5-1 Hazard classification (ARR, 2016)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)	Description
H1	D*V ≤ 0.3	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	D*V ≤ 0.6	0.5	2.0	Unsafe for small vehicles.
H3	D*V ≤ 0.6	1.2	2.0	Unsafe for vehicles. children and the elderly.
H4	D*V ≤ 1.0	2.0	2.0	Unsafe for vehicles and people.
H5	D*V ≤ 4.0	4.0	4.0	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	D*V > 4.0	-	-	Unsafe for vehicles and people. All building types considered vulnerable to failure.

[13] http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/

5.2 Existing Conditions

The 1% AEP hydraulic model results outlined in Figure 5-3 to Figure 5-8 indicate that the 1% AEP event does not produce any major external catchment flow paths through the Site. The general fall across the topography is from the south-east to the north-west. A long-section through the Site area (Figure 5-2; point A to point B within Figure 5-3) shows the predicted peak water levels for the 1% AEP event overlayed onto the underlying elevation data. The results highlight the shallow depths of flooding produced across the Site, sheet off to the north-west and pond against the channel embankments. A similar flooding mechanism is seen in all events up to the 1% AEP + climate change event.

The velocities and flood hazard classifications follow a similar pattern, with peak velocities across the Site ranging from 0.03 – 0.15 m/s. These velocities are considered low and are reflective of the H1 Flood Hazard classification.

Consideration of climate change was applied to the 1% AEP event. The flooding mechanism and behaviour was similar and resulted in a shallow level of flooding across the Site. The 1% AEP + climate change event resulted in a peak depth of 0.35 m in in the north-west corner of the Site.

All remaining results across the modelled events can be found in Appendix B.

Note: The results presented do not account for joint inundation with riverine flooding from the Murrumbidgee River in the extreme events.

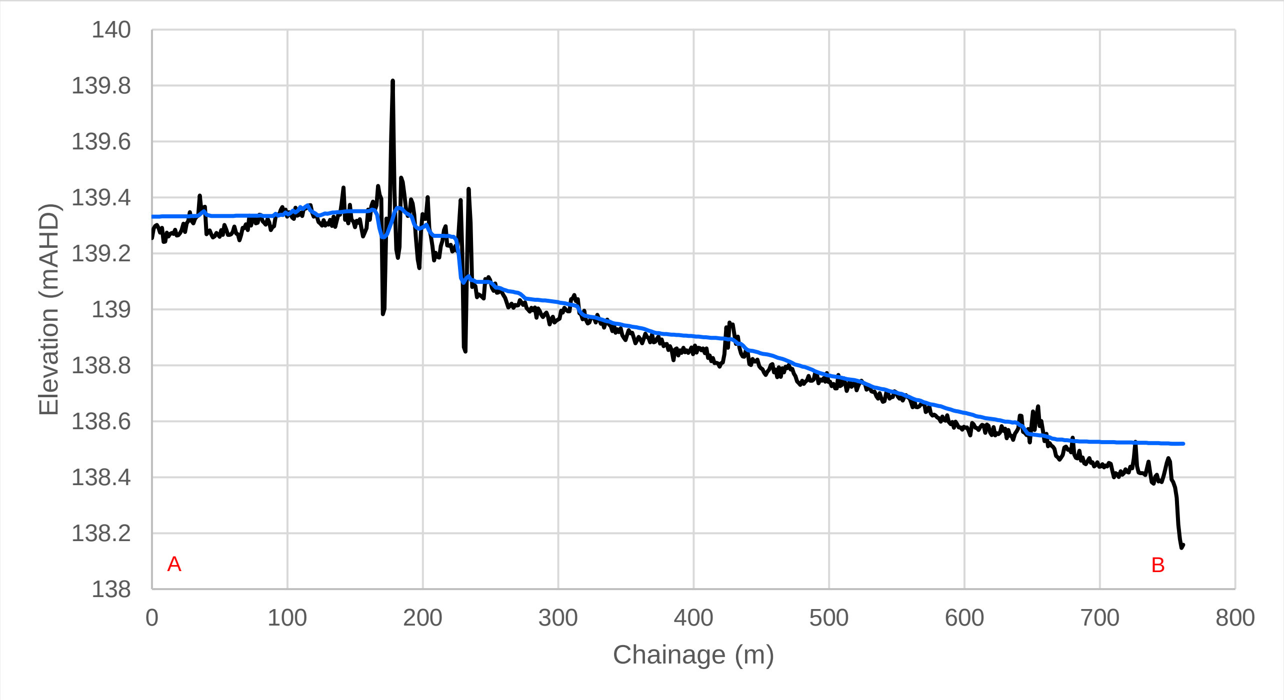

Figure 5-2 Existing Conditions – 1% AEP water level (long-section through Site)

Figure 5-3 Existing Conditions – 1% AEP flood depth

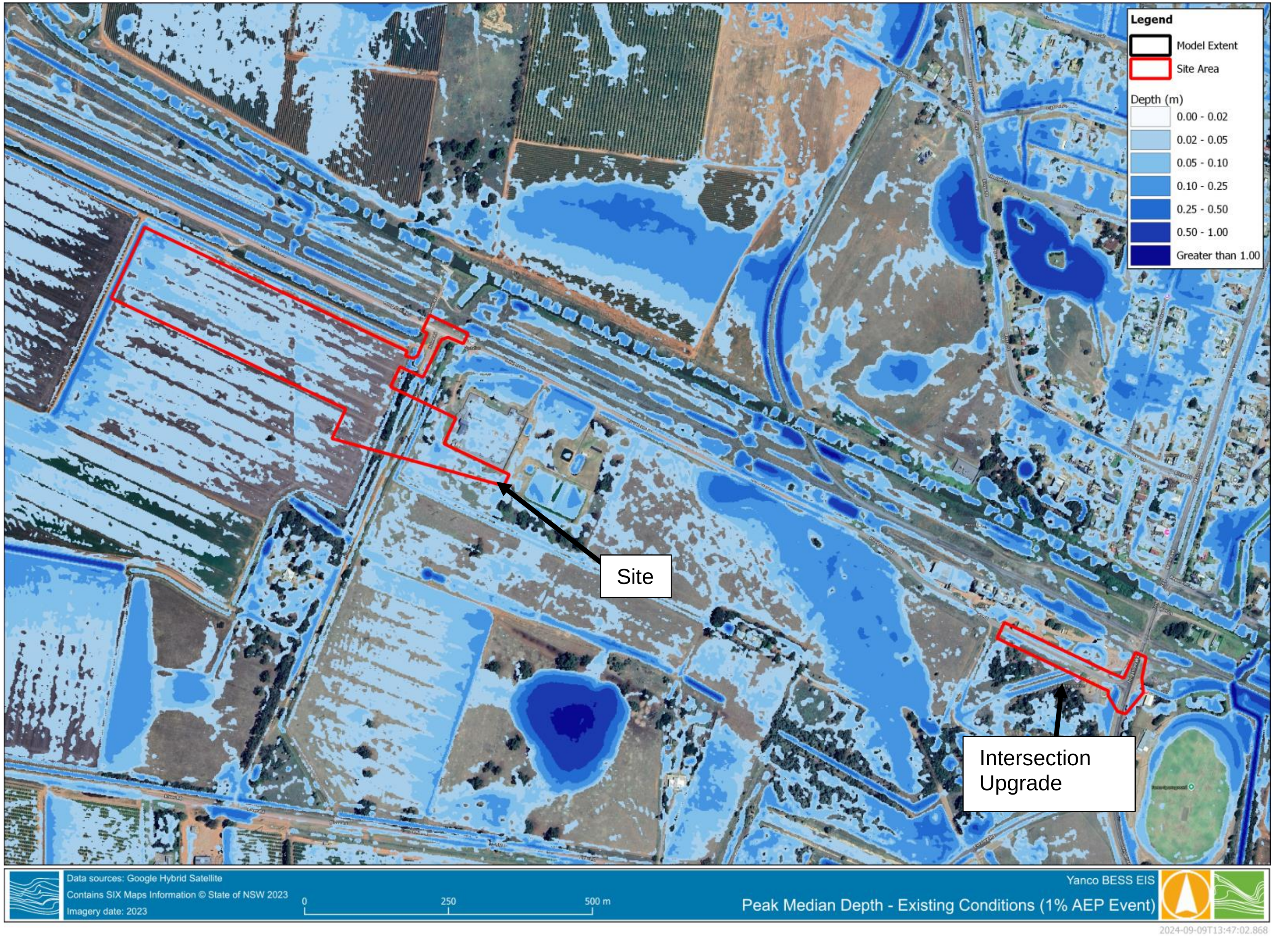

Figure 5-4 Existing Conditions – 1% AEP flood depth (Zoomed In)

Figure 5-5 Existing Conditions – 1% AEP flood velocity

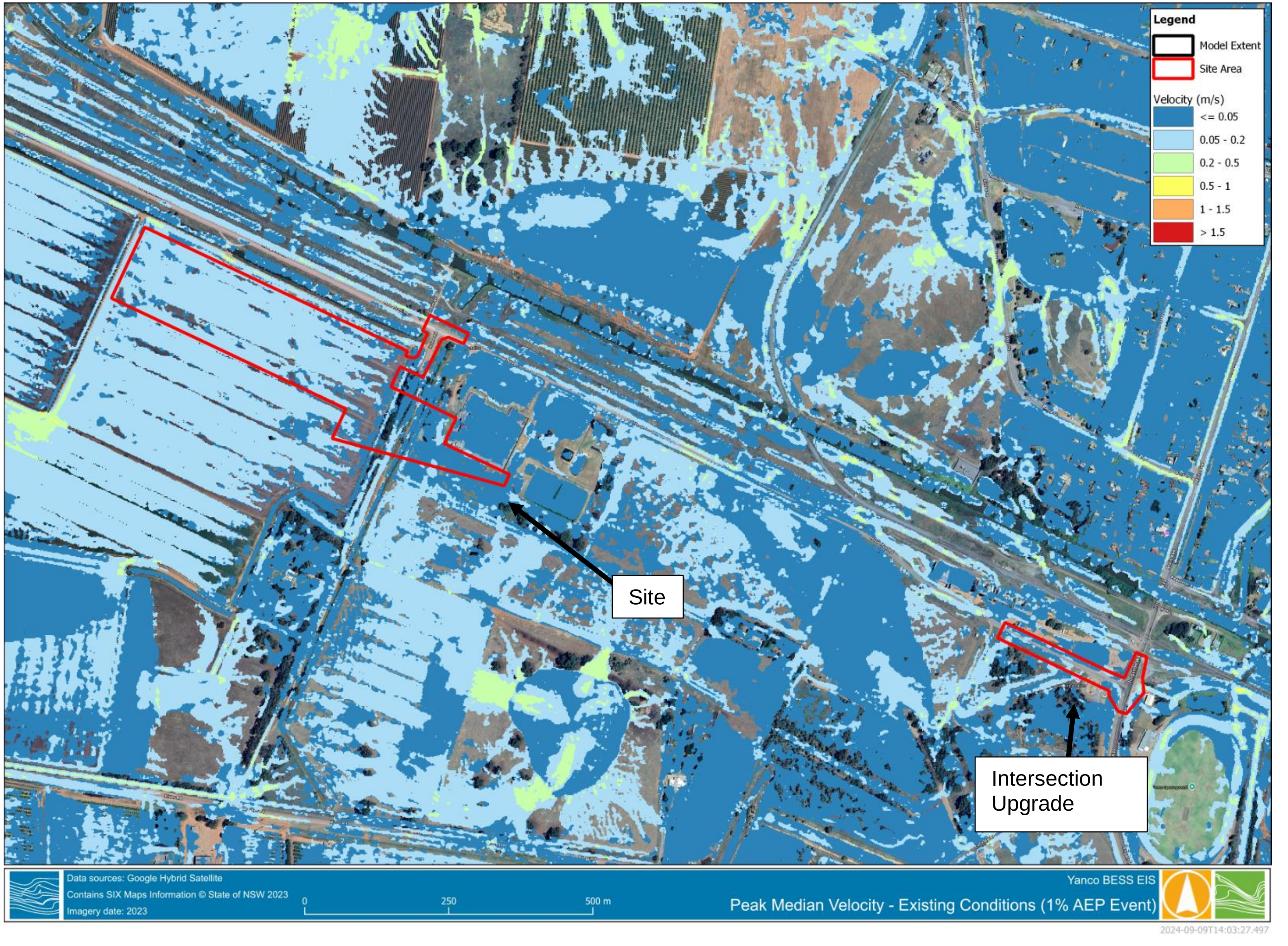

Figure 5-6 Existing Conditions – 1% AEP flood velocity (Zoomed In)

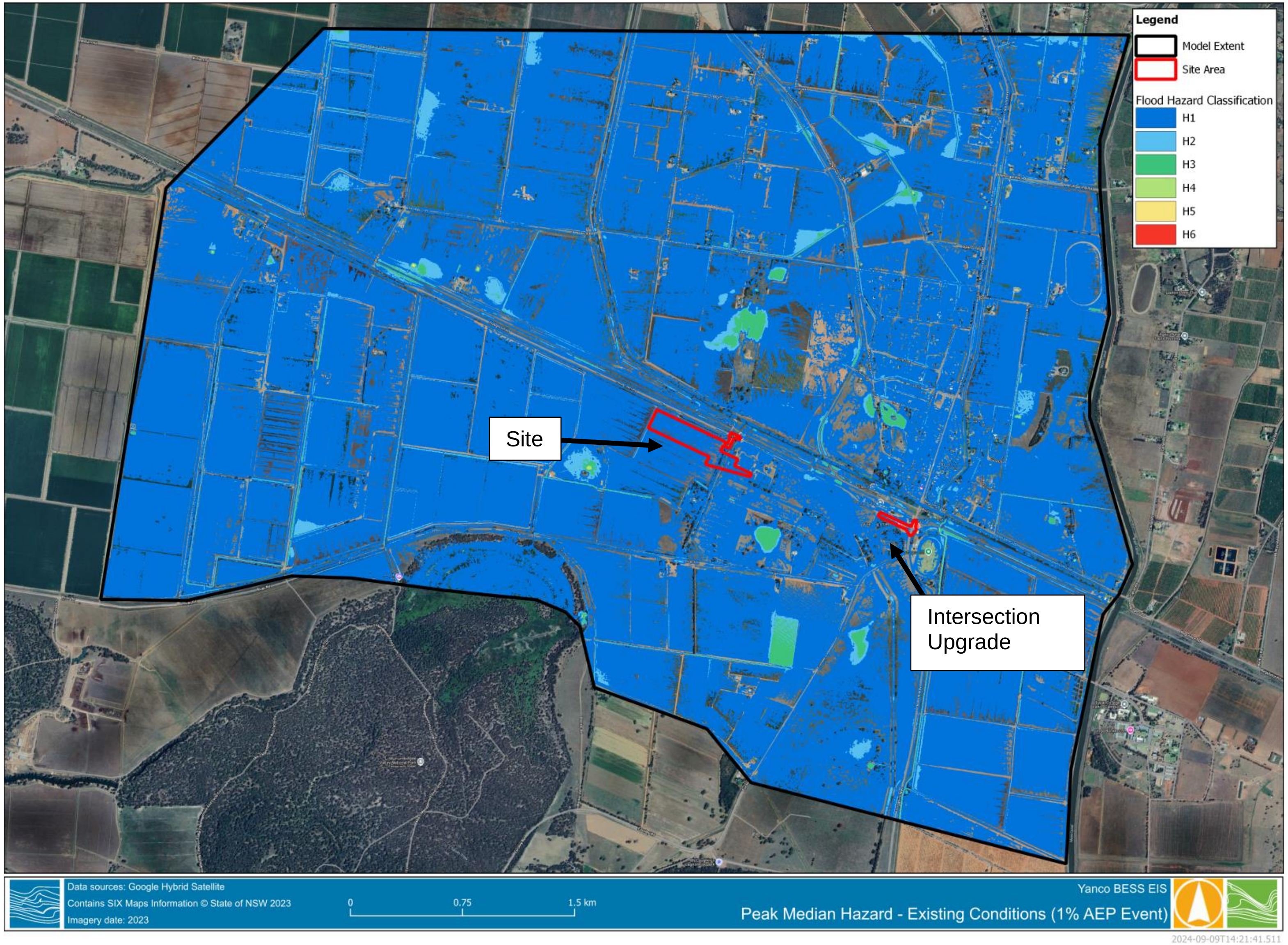

Figure 5-7 Existing Conditions – 1% AEP flood hazard

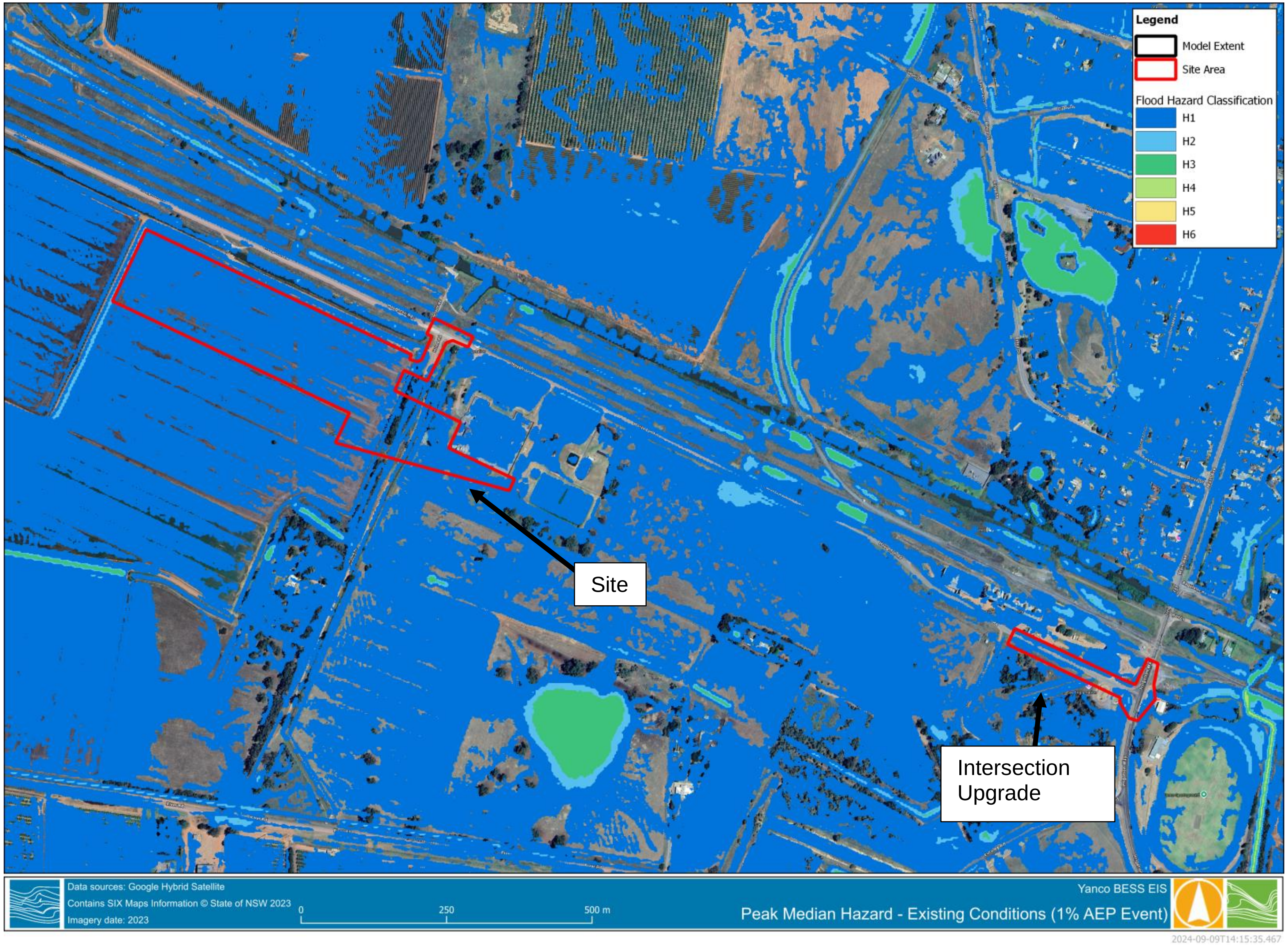

Figure 5-8 Existing Conditions – 1% AEP flood hazard (Zoomed In)

5.3 Developed Conditions

The impact of the proposed development on the flood behaviour is likely to be very low as no major changes to the land topography (cut/fill) are expected or have been assumed within the hydraulic modelling. The existing conditions RoG model was modified to include raised areas for the BESS and project infrastructure locations. Only those changes detailed in Section 3.3.4. to account for the installation of key assets have been modelled.

Developed conditions mapping outputs from the hydraulic model were compared to existing conditions identify changes in water levels and inundation extents caused by the development for a 1% AEP event. The flooding mechanisms across the AEP events display a similar behaviour and preferential flow path north-west towards the low-lying areas. The maximum depth in the 1% AEP developed condition scenario within the Development Site is 210 mm. The inclusion of the Yanco BESS and adjustments to the local topography resulted in small, localised areas of increased attenuation around the BESS area (Figure 5-11; blue and red shaded areas). Off-site, small pockets of increased flood levels can be observed adjacent to irrigation channels where peak water level differences range from 0.02 – 0.05 m. The 1% + Climate Change event displays negligible difference in the peak water levels across the Site and wider model domain, other than an increase in water levels around the BESS infrastructure.

The proposed development is not predicted to result in indirect or direct damage to the local community in the event of significant flooding. Furthermore, the implications of the BESS becoming non-operational (offline), on the power supply to the local community are not considered within the scope of this assessment. No other detriment is observed that would impact other nearby receptors or emergency management within the local region.

Access and egress from the Site are not expected to be impacted by surface water flood risk up to the PMF event. Looking at wider access implications, access may be impacted along Houghton Road from the Yanco township based on the results of the Murrumbidgee River Flood Study should wider riverine flooding also occur. This occurs under current and conditions and the proposed development is not likely to impact this.

All developed conditions results across the modelled events can be found in Appendix C.

Figure 5-9 Developed Conditions – 1% AEP flood depth

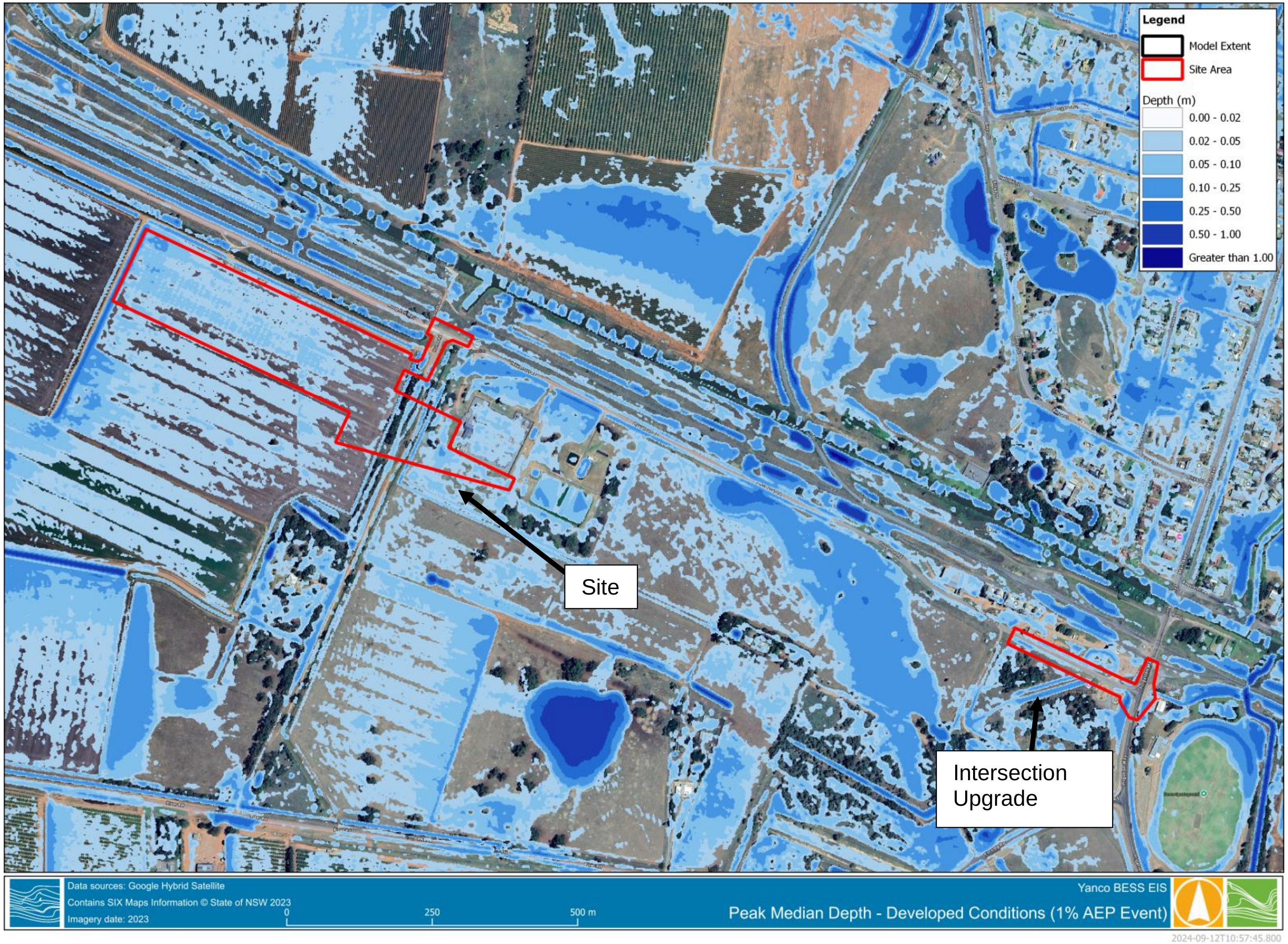

Figure 5-10 Developed Conditions – 1% AEP flood depth (Zoomed In)

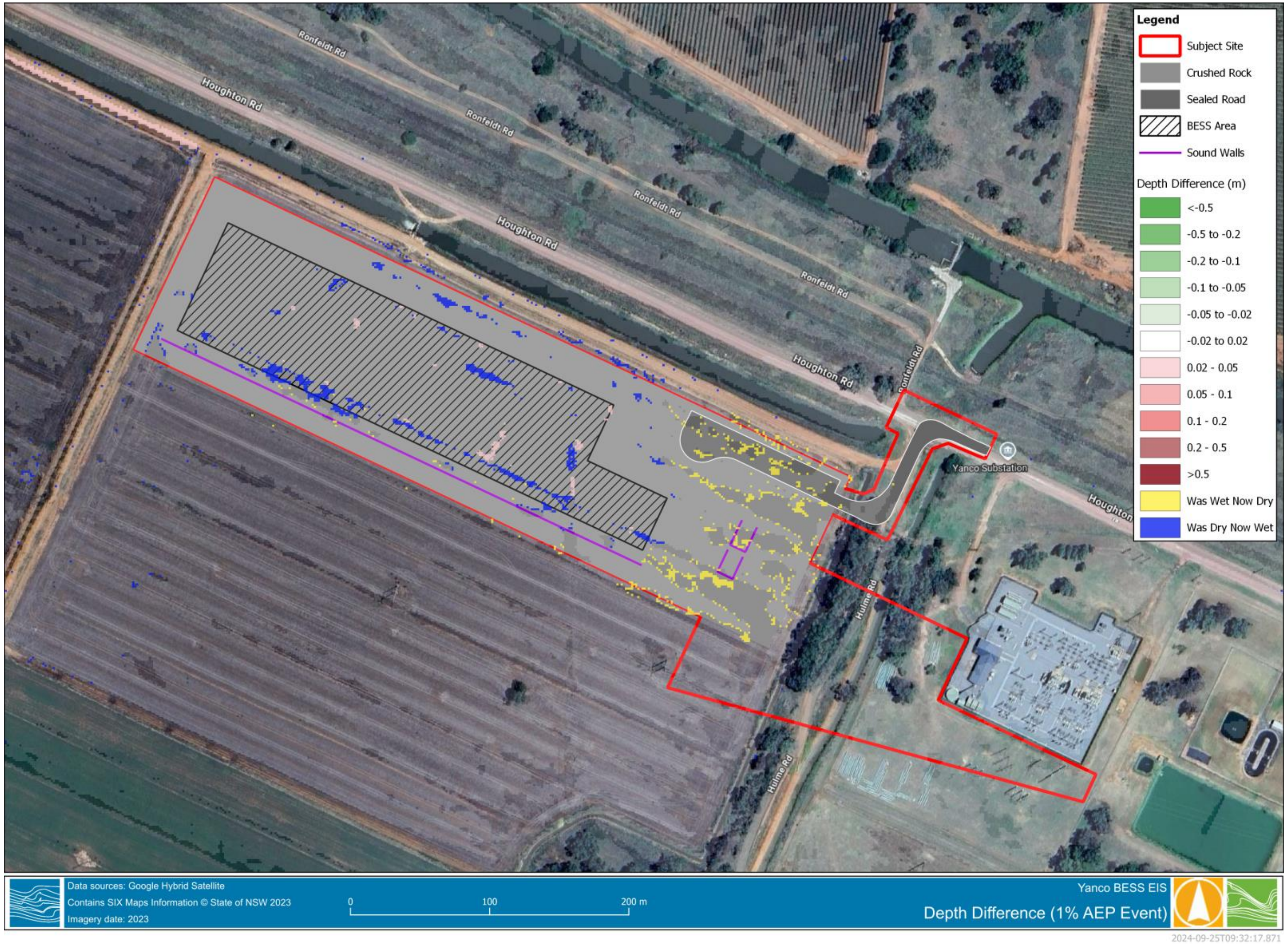

Figure 5-11 Change in 1% AEP peak depth

6 FLOOD RISK RECOMMENDATIONS

Based on the flood depth, velocity and hazard levels estimated in the flood modelling of the site, the site is generally categorised as low risk to surface water flooding. The following recommendations are proposed to be adopted at the site:

- Any sensitive infrastructure such as inverters and battery storage etc, should be located 450mm above finished ground level. This would ensure infrastructure is located above the 1% AEP flood level with a minimum of 230 mm freeboard. It is common for this type of infrastructure to be housed within shipping containers or small sheds with relatively small footprints. Given the shallow depths across the site, raising this infrastructure is unlikely to result in any adverse flooding or drainage impacts offsite.
- The footings should be designed to withstand the flood velocities described in this report, which are mostly low within the Site.
- It is recommended that the best practice principles to stormwater and sediment control be incorporated into the design, construction and operation phases of the BESS site.
- It is anticipated that vehicles can safely access and egress from the Site, however consideration should be given to not restrict the movement of emergency vehicles on Houghton Road with any scheduled roadworks associated with construction.

It is recommended that ACEnergy review this report and consider its findings in conjunction with the findings of other reports related to the environment and potential constraints of the proposed site. Further progression of the site design should consider the findings of all relevant investigations.

7 STANDARD ENVIRONMENTAL ASSESSMENT REQUIREMENTS

As the proposed BESS is a state significant development, the Planning Secretary's Environmental Assessment Requirements (SEARs) apply. The items of concern identified in the SEAR that have been addressed in the report. The responses for each item are found in the table below.

Table 7-1 SEARS items and responses

SEAR Items	Responses
Water	
An assessment of the likely impacts of the development (including flooding) on surrounding watercourses (including their Strahler Stream Order) and groundwater resources and measures proposed to monitor, reduce and mitigate these impacts including water management issues.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. Groundwater management and mitigation measures are discussed in Section 2. **Complies**.
A site water balance for the development.	No water balance is required as there is no expected capture or use of surface water on site. **Complies**.
Details of water requirements and supply arrangements for construction and operation.	At this stage, no water requirements or supply arrangements are required for construction and operation. If this changes, details of these requirements will be addressed. **Complies**.
Assessment of the impacts of the development, including any changes to flood risk and overland flows on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies**.
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).	The Site is relatively flat with a slight gradient towards the northwest. There is no foreseeable need for continued erosion and sediment control besides those outlined in the construction management plan in accordance with industry standards. **Complies**.
Assessing the impacts of the development, including any changes to flood risk and overland flows on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies**.
Where the project involves works within 40 metres of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI Guidelines for Controlled Activities on Waterfront Land (2018) and (if necessary) Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI 2003), and Policy & Guidelines for Fish Habitat Conservation & Management (DPE, 2013).	Not Applicable as the site is located over 1 km from the nearest river, lake or wetland. **Complies**.

SEAR Items	Responses
Flood Risk Management	
The EIS must map the following features relevant to flooding as described in the Flood Risk Management Manual: the policy and manual for flood liable land (NSW Government 2023) 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.	The proposed development is not within an area of riverine flooding, as discussed in Section 3.2. The proposed development is shown in Figure 8-1 in relation to the Flood Planning Area (Leeton Local Environmental Plan 2014). The report has investigated the direct catchment runoff impacts of the Site using TUFLOW. **Complies**.
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.	The design flood levels have been investigated for the 10%, 5%, 1% 1% + CC, 0.5%, 0.2% and PMF events as described in Section 3. **Complies**.
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 7 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.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies**.
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. 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, hazards and hydraulic categories. d. Relevant provisions of the Flood Risk Management Manual: the policy and manual for flood liable land (2023).	An existing flood study for the Murrumbidgee River (2019) has been examined in Section 3.2. The existing conditions have been investigated in Section 5.2 with relevant maps located in Appendix B. The developed conditions have been investigated in Section 5.3 with relevant maps located in Appendix C. **Complies**.

SEAR Items	Responses
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. &. Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks 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 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 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 SES. k. Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	The impacts of the proposed development are summarised in Section 5. The inclusion of the Yanco BESS and adjustments to the local topography resulted in small, localised areas of increased attenuation around the BESS area and small pockets of increased water depths adjacent to irrigation channels (less than 5 cm). Section 3.2 discusses the available flood studies, and the existing conditions (including existing flood behaviour) is outlined in Section 5. The proposed BESS is not predicted to influence localised erosion or siltation or cause destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses. The proposed site is located outside of the Murrumbidgee riverine flooding extent (up to PMF) and is not anticipated to impact emergency management procedures, risk to life from flood or social and economic costs to the community as consequence of flooding. **Complies.**

8 LEETON LOCAL ENVIRONMENT PLAN 2014

The proposed Site is within Leeton Shire LGA and therefore it is within the area to which the Leeton Local Environmental Plan (LEP) 2014 applies. However, Clause 1.9(1) of the LEP states that:

> *This Plan is subject to the provisions of any State environmental planning policy that prevails over this Plan as provided by section 3.28 of the Act.*

Therefore, other State Environmental Planning Policies prevail over the LEP 2014. As good practice, consideration has been given to the LEP provisions for guidance.

The Site sits within the rural primary production (RU1) zoning and falls outside of the Flood Planning Map for the Leeton LGA. As a consideration, Section 5.21 of the LEP 2014 outlines the flood planning controls that apply to developments within the LGA.

Table 8-1 Table identifying floodplain related controls in the Leeton LEP 2014

Flood planning controls		Response
5.21(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development	(a) is compatible with the flood function and behaviour on the land, and	The proposed development complies with the local development controls and has been recommended to include a freeboard above the 1% AEP surface water level. The Site is situated outside of the flood planning level (Figure 8-1). **Complies.**
	(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	The qualitative assessment undertaken as part of this flood risk report have detailed the flooding mechanisms within the proposed Site. The assessment demonstrates that the Site is mapped outside of the flood planning level. Surface water flood risk has likewise indicated shallow sheet flow. Therefore, the proposed BESS will not adversely impact riverine or surface water flood behaviour on neighbouring properties. **Complies.**
	(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	The proposed development is not within an area of riverine flooding and a Flood Response Plan is not considered a requirement. **Complies.**
	(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	The proposed development is predicted to cause minor increases in water levels around the elevated BESS and access roads. Recommendations have been given to include hydraulic structures under each access road, and to elevate the BESS compound above the 1% AEP event. The predicted peak flood depths and hazards within the lease area are not anticipated to pose a risk to life in the event of a flood. **Complies.**

Flood planning controls		Response
	(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	The proposed BESS is not predicted to influence localised erosion or siltation as the Site sits on an existing managed field. The proposed access roads are expected to be constructed to industry standards to ensure trafficable areas do not compromise both the structural integrity and vegetation along the channel embankments. **Complies.**
5.21.3. In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters	(a) the impact of the development on projected changes to flood behaviour as a result of climate change,	This surface water flood risk report has qualitatively assessed the impacts of increased rainfall as a result of climate change. The shallow depth and low hazard classification will define the Site area as having no impact on broad flood behaviour on neighbouring properties in events up to and including the PMF. **Complies.**
	(b) the intended design and scale of buildings resulting from the development,	The proposed BESS site includes containerised lithium-ion battery modules and associated electrical infrastructure. The site is not expected to be in use at all times and will be situated above the 1% AEP flood level from surface water flooding. **Complies.**
	(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	Due to the shallow stormwater flooding, low hazard at the Site and lack of riverine flooding, inundation driven risk to life is not predicted a Flood Response Plan is not considered necessary. **Complies.**
	(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion	It will not be possible to modify, relocate or remove the proposed building as a response measure to flooding. The proposed Site is located on the upslope within the existing field and is close to the Houghton Road to facilitate access/egress. The site is not subject to coastal erosion. **Complies.**

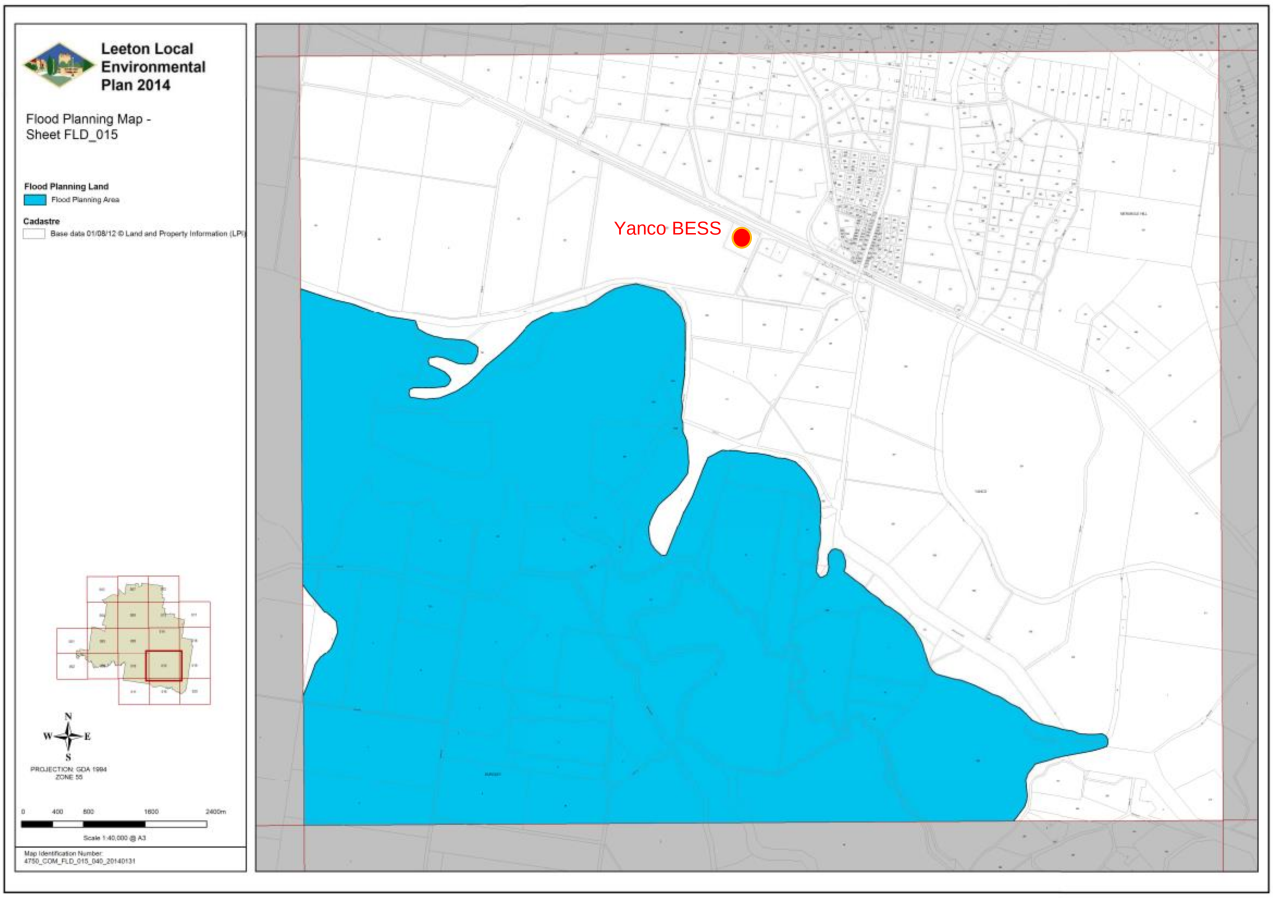

Figure 8-1 Flood Planning Area (Leeton Local Environmental Plan 2014)

9 LEETON DEVELOPMENT CONTROL PLAN 2022

The Leeton Development Control Plan (DCP) 2022 addresses flooding in Section K of the report.

The Site is not located within the floodway and falls outside of the designated flood planning area from riverine flooding as indicated by Figure 8-1. The Site is not susceptible to riverine flooding, even in extreme events up to the PMF. The DCP 2022 provisions therefore do not apply, however consideration is given below for stormwater inundation.

With regards to stormwater inundation, the proposed Site experiences shallow sheet flow across the Site in events modelled upto the 0.2% AEP event. From Table 9-1 of the DCP 2022, the development controls for areas located within the floodplain have been assessed against the Site, for requirements relating to stormwater

Table 9-1 Table identifying floodplain related controls in the Leeton DCP 2022

Floodplain	
Development controls for residential and rural zones	***Response***
K1.7 (a) Development is to ensure free draining of stormwater runoff and ensure drainage connectivity to a downstream drainage channel.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies.**
K1.7 (e) Development does not impede the flow of floodwaters/stormwater runoff causing worsening of flood depths or levels on neighbouring properties. This includes any significant flow obstructions within the development.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies.**
K1.7 (f) Development does not increase the flood level or flow of stormwater runoff to surrounding properties.	Flood risk and impacts are discussed in Section 5 and the maps in Appendix C. **Complies.**
K1.7 (p) Openings in structures such as fences or the like should be provided below the Flood Planning Level to allow free flow of stormwater.	Whilst the site is outside of the flood planning area, consideration has been given to allow a 150 mm gap under the sound walls to allow stormwater runoff to freely flow. **Complies.**

10 SUMMARY

10.1 Assessment Method

Technical assessments of potential surface water impacts of the development of a BESS were undertaken to address the requirements of the SEARs.

A review of existing groundwater risk, riverine flood modelling projects and specific site based hydraulic flood modelling was conducted. Surface water modelling of the Development Site investigated the potential for the site to be inundated from direct (local catchment) inundation and riverine flooding and the potential for the development to alter the hydrological regime on neighbouring properties.

10.2 Key Findings

10.2.1 Surface Water

10.2.1.1 Riverine flooding

The Murrumbidgee River is located approximately 4.30 km to the south of the site. An existing Murrumbidgee River flood study was commissioned by Narrandera Shire Council in 2019[14], highlighting the proposed BESS location remains flood free up to the PMF design event as part of the hydraulic assessment. The Site is located at an elevation of between 138.50 to 139.20 m AHD which is higher than the estimated PMF level of 138.30 m AHD around the Site.

10.2.1.2 Direct catchment runoff

The hydraulic flood modelling assessment indicated that neither the project area, nor the BESS layout would be impacted by significant local inundation, other than shallow sheet flow through the Site.

A developed conditions modelling scenario was undertaken for the proposed layout. This scenario showed limited potential for the development to influence regional surface water levels, with no significant local changes to flood levels observed outside of the project area.

10.2.2 Groundwater

Based on the understanding of the local hydrogeological regime and site operations during construction and operation, it is considered that there is limited risk to groundwater or GDEs. This conclusion is derived from:

- No significant volumes of potential contaminants will be stored on the Development Site during construction and operation phases and the small volumes that are shall be appropriately bunded and infrastructure maintained.
- The battery units are self-contained and will control any potential leaks. There is limited opportunity for the leaching of metals due to the containment and lack of water in the battery units.
- Site management plans will provide details on the clean-up of small spills via spill kits and soil removal.
- Groundwater levels are potentially as shallow as 2.1 mBGL but will be confirmed prior to construction to inform the most appropriate approach.

[14] https://flooddata.ses.nsw.gov.au/flood-projects/leeton-shire-flood-study

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APPENDIX A – CRITICAL DURATION AND TEMPORAL PATTERN SELECTION

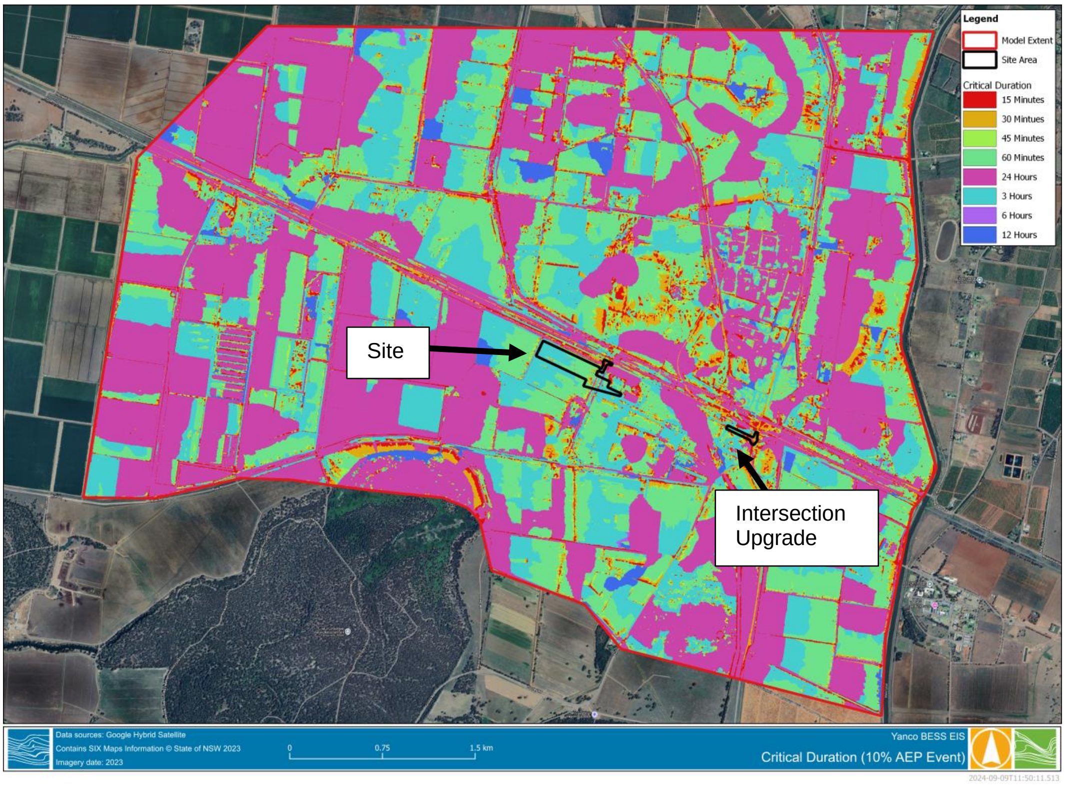

Figure A 1 Critical Duration (10% AEP)

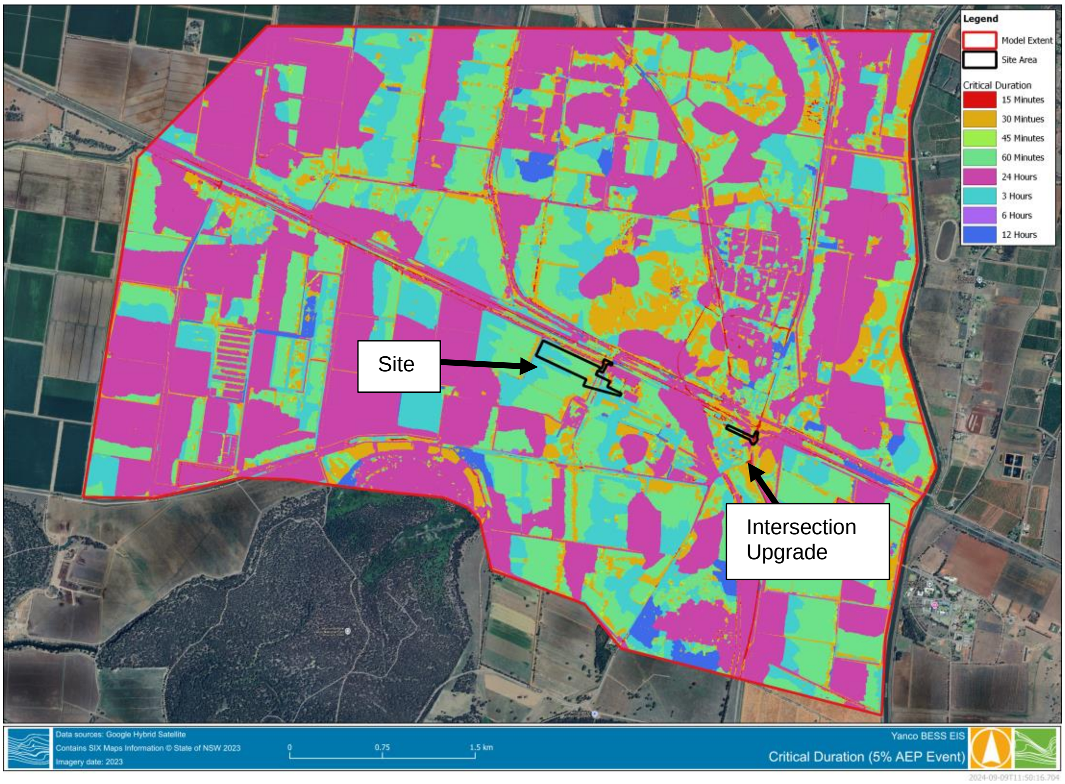

Figure A 2 Critical Duration (5% AEP)

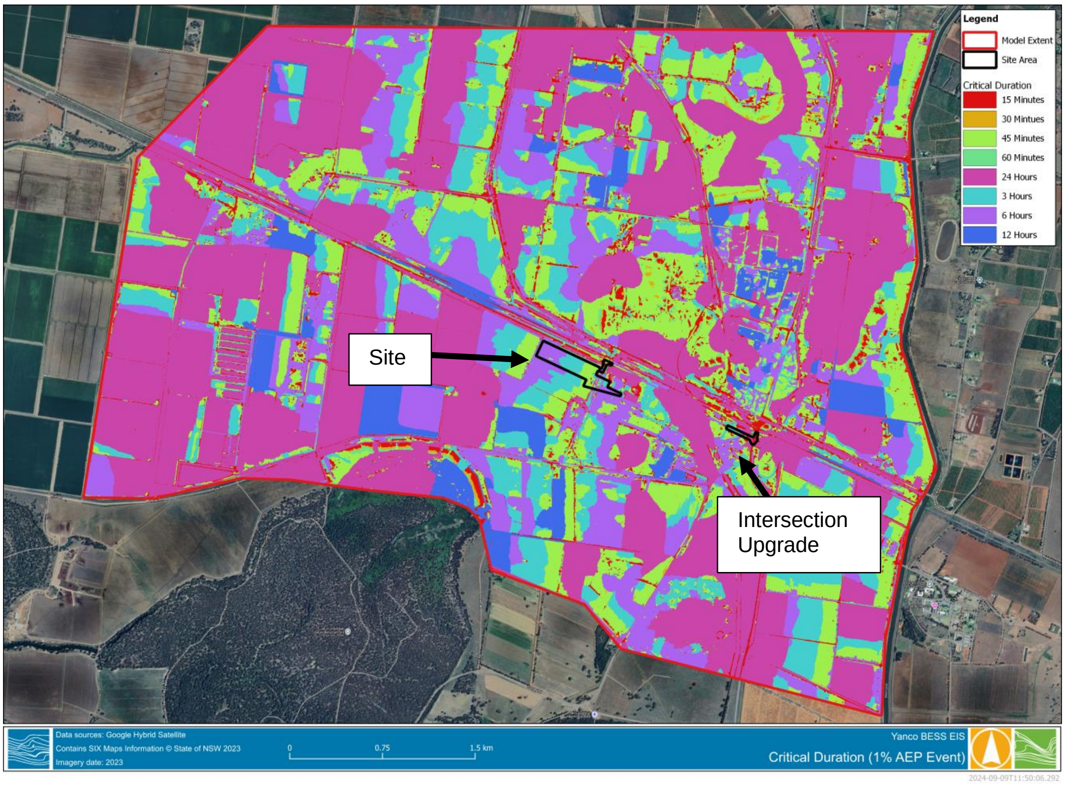

Figure A 3 Critical Duration (1% AEP)

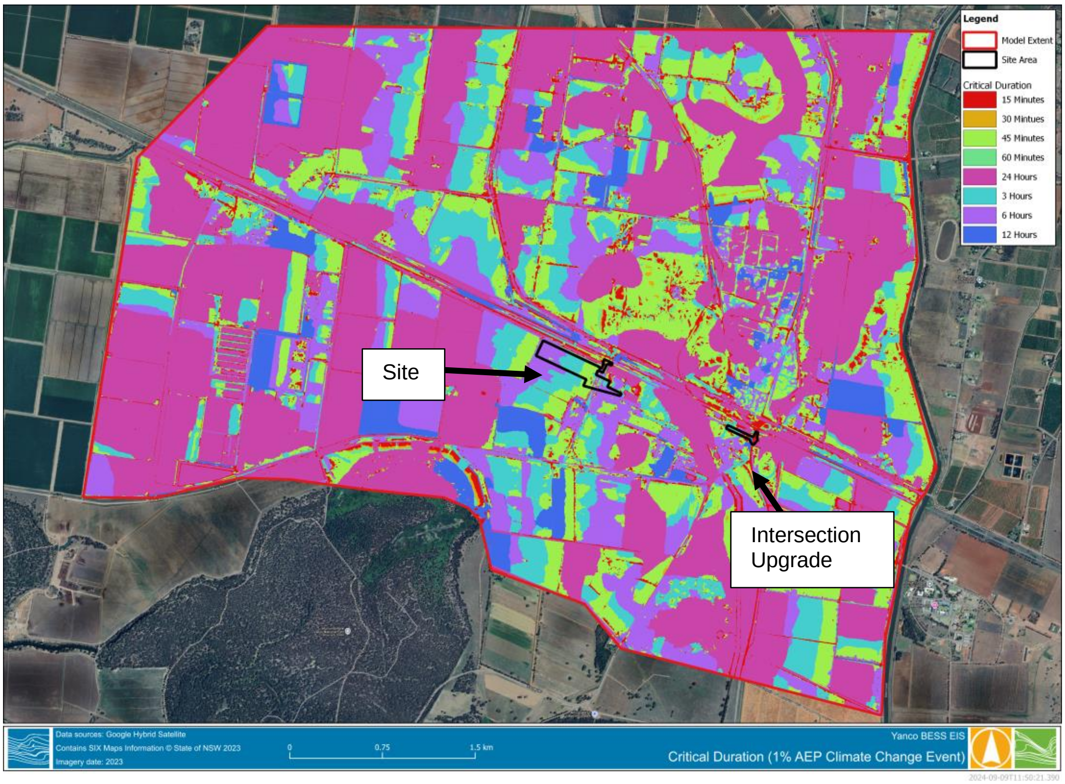

Figure A 4 Critical Duration (1% AEP + CC)

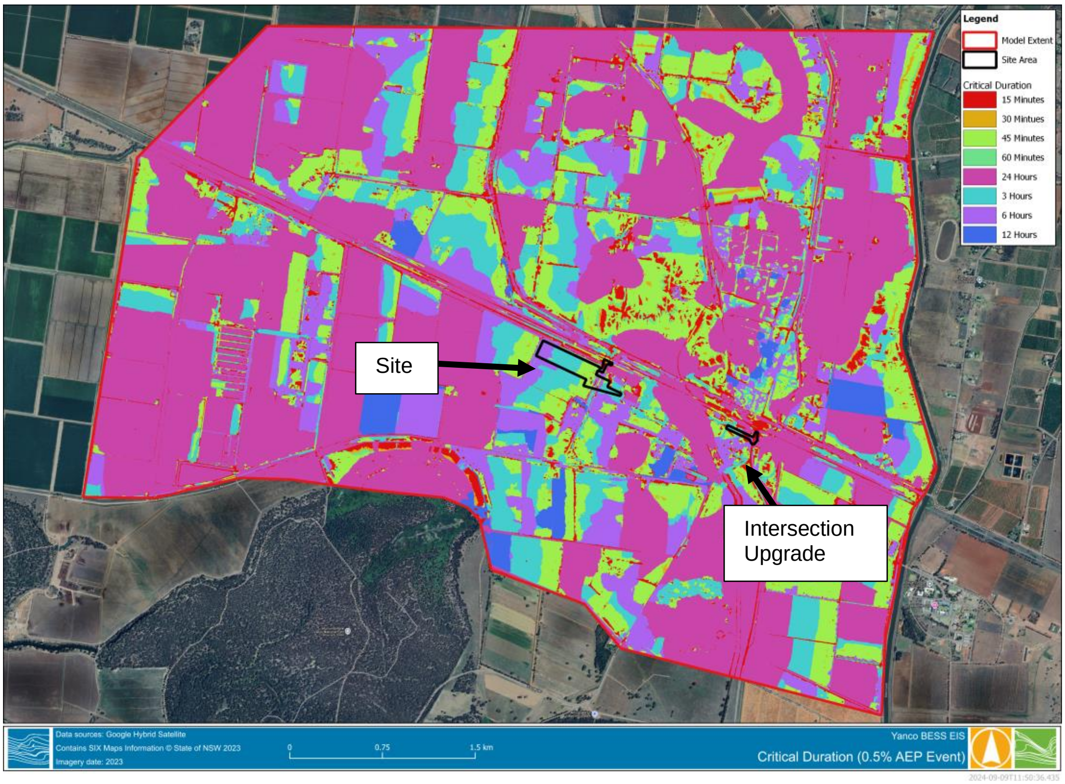

Figure A 5 Critical Duration (0.5% AEP)

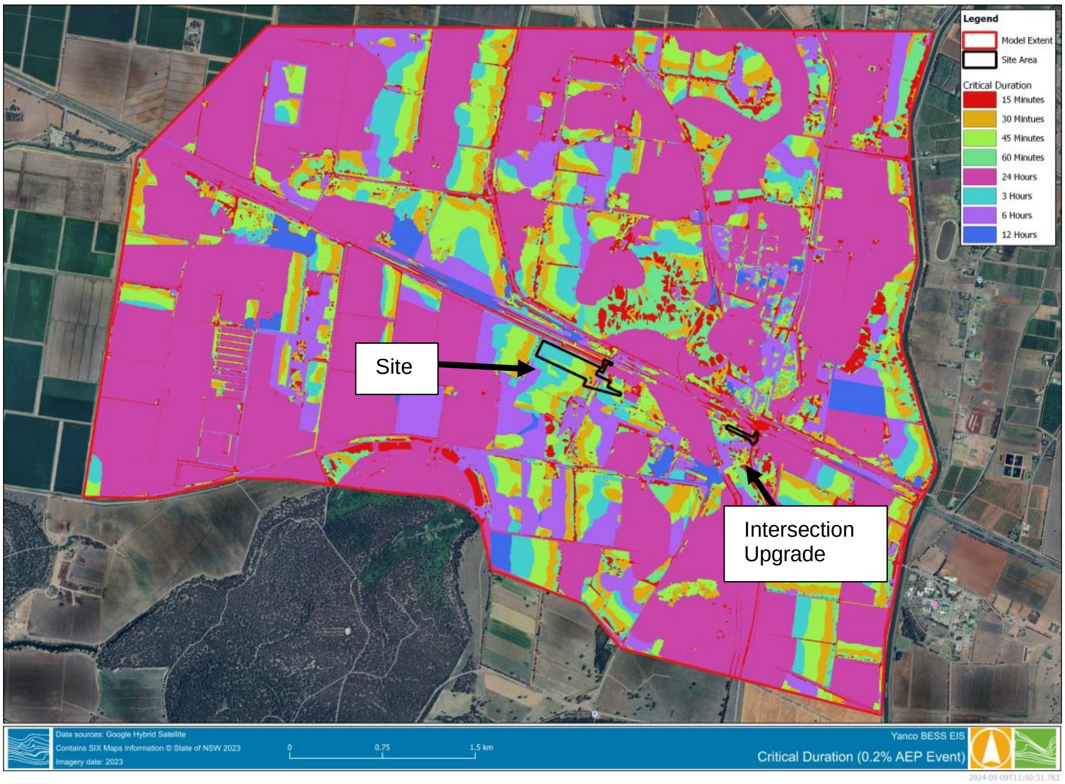

Figure A 6 Critical Duration (0.2% AEP)

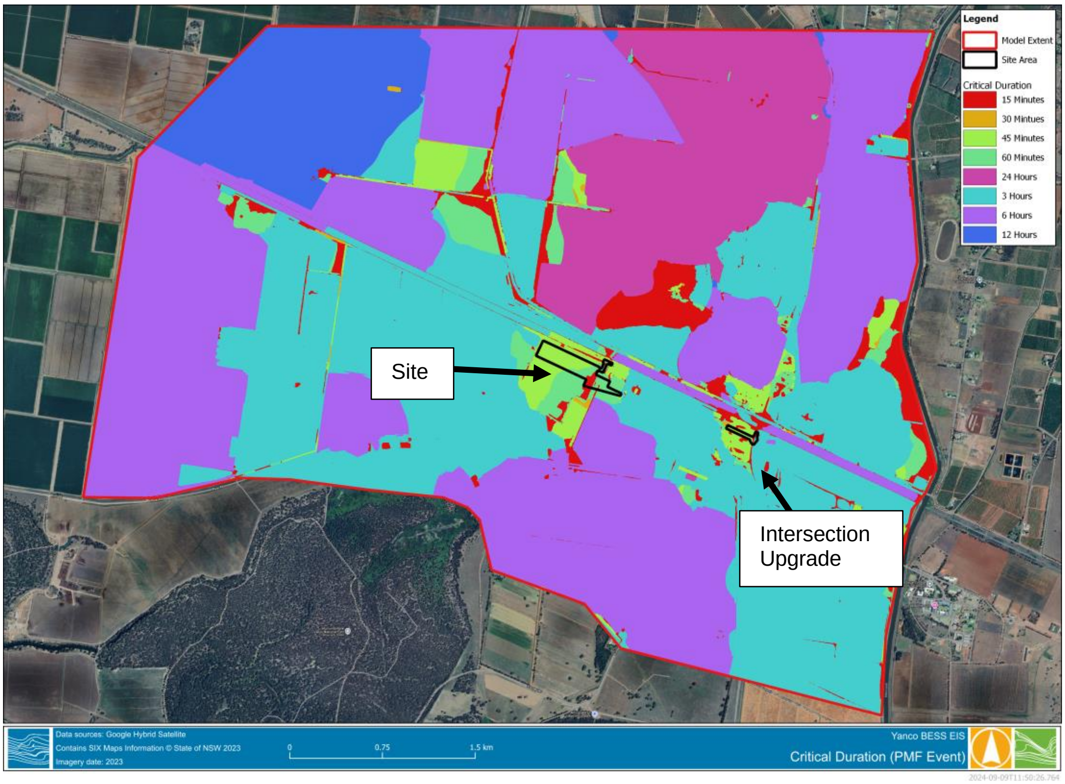

Figure A 7 Critical Duration (PMF)

APPENDIX B – EXISTING MODELLING RESULTS

Figure B 1 Existing Conditions – 10% AEP flood depth

Figure B 2 Existing Conditions – 10% AEP flood velocity

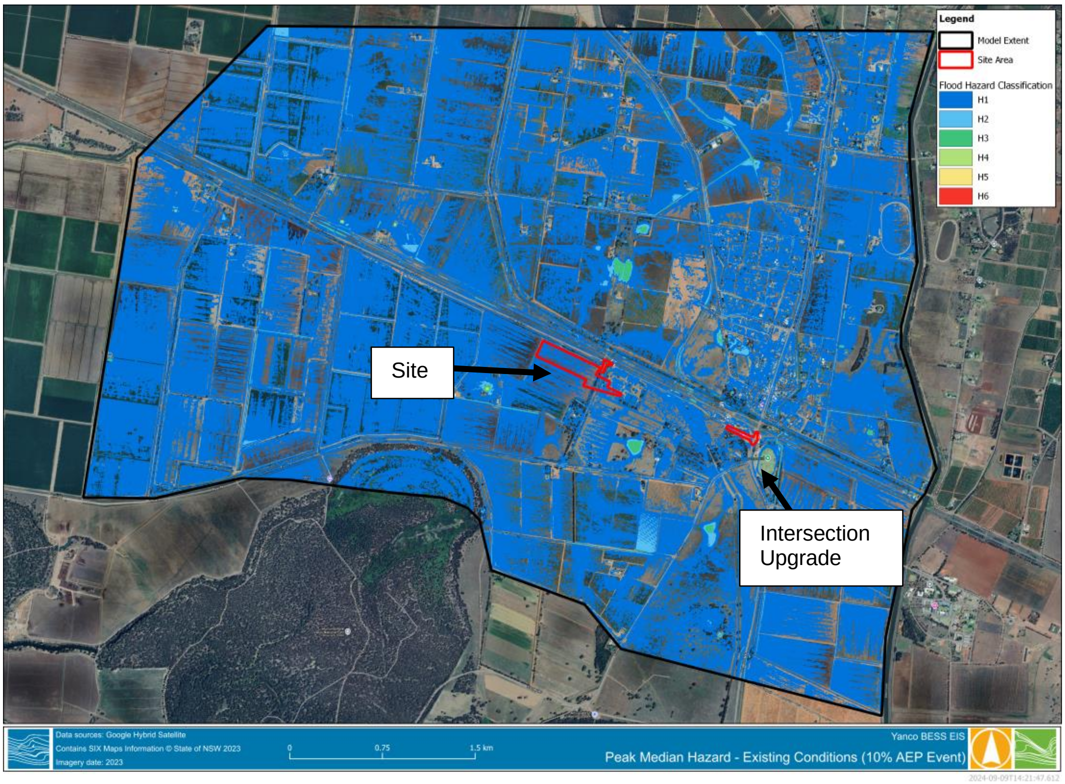

Figure B 3 Existing Conditions – 10% AEP flood hazard

Figure B 4 Existing Conditions – 5% AEP flood depth

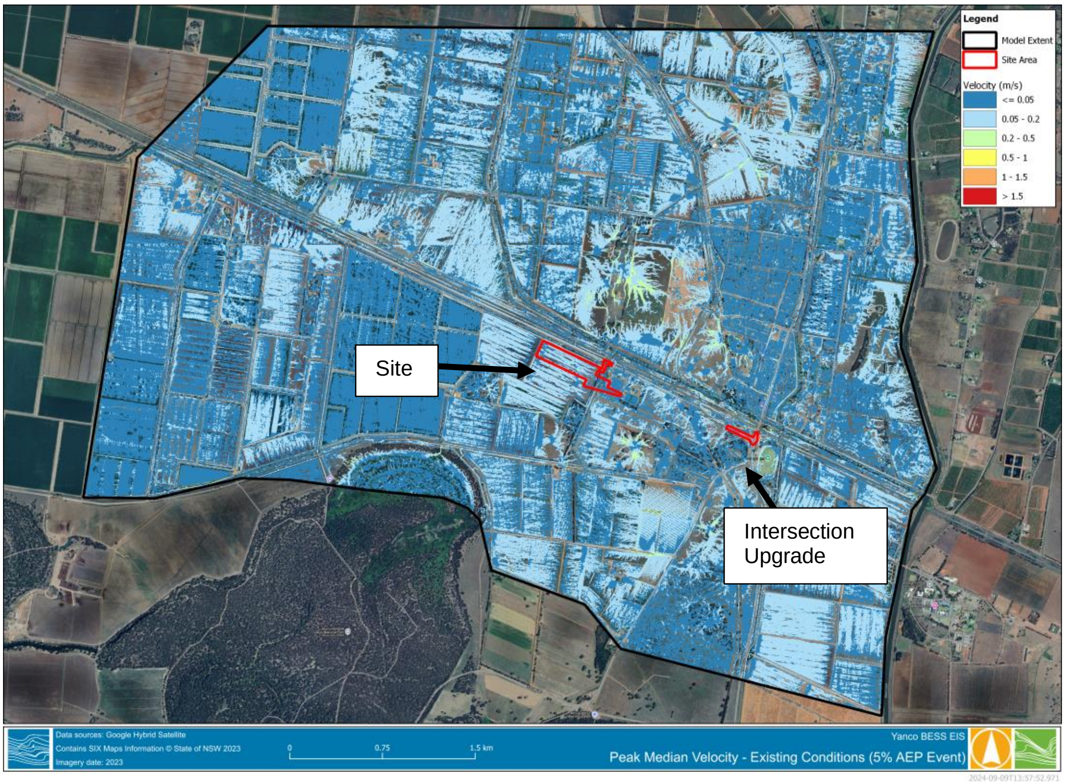

Figure B 5 Existing Conditions – 5% AEP flood velocity

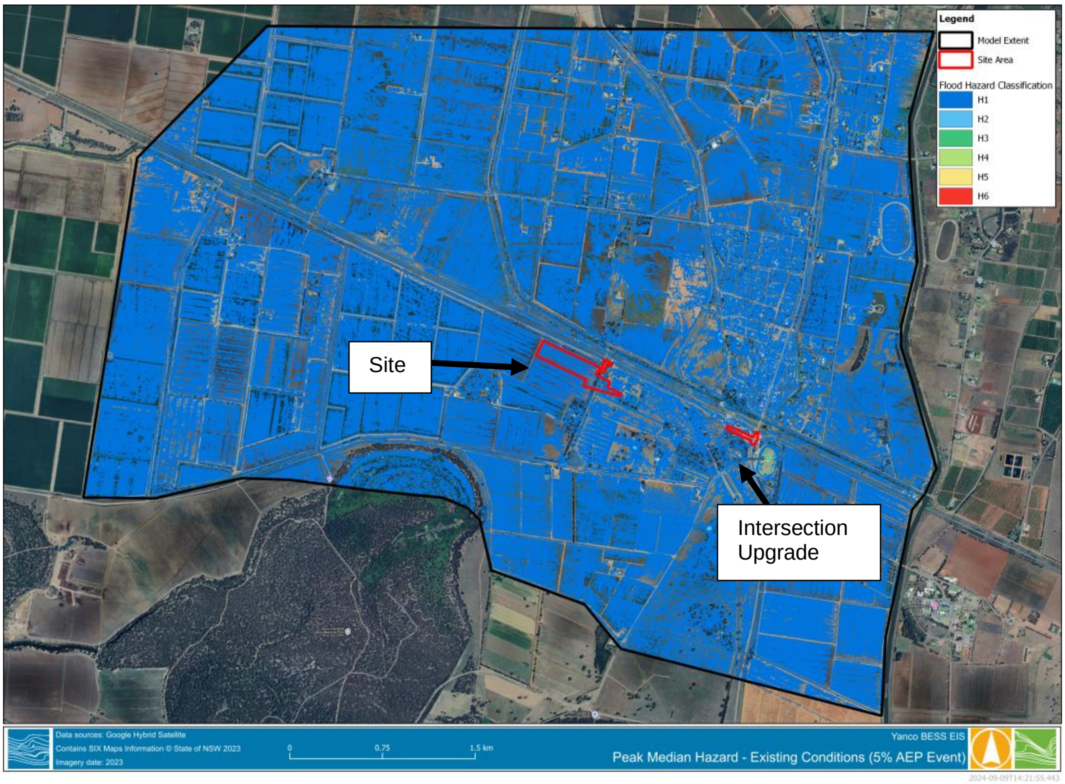

Figure B 6 Existing Conditions – 5% AEP flood hazard

Figure B 7 Existing Conditions – 1% + climate change AEP flood depth

Figure B 8 Existing Conditions – 1% + climate change flood velocity

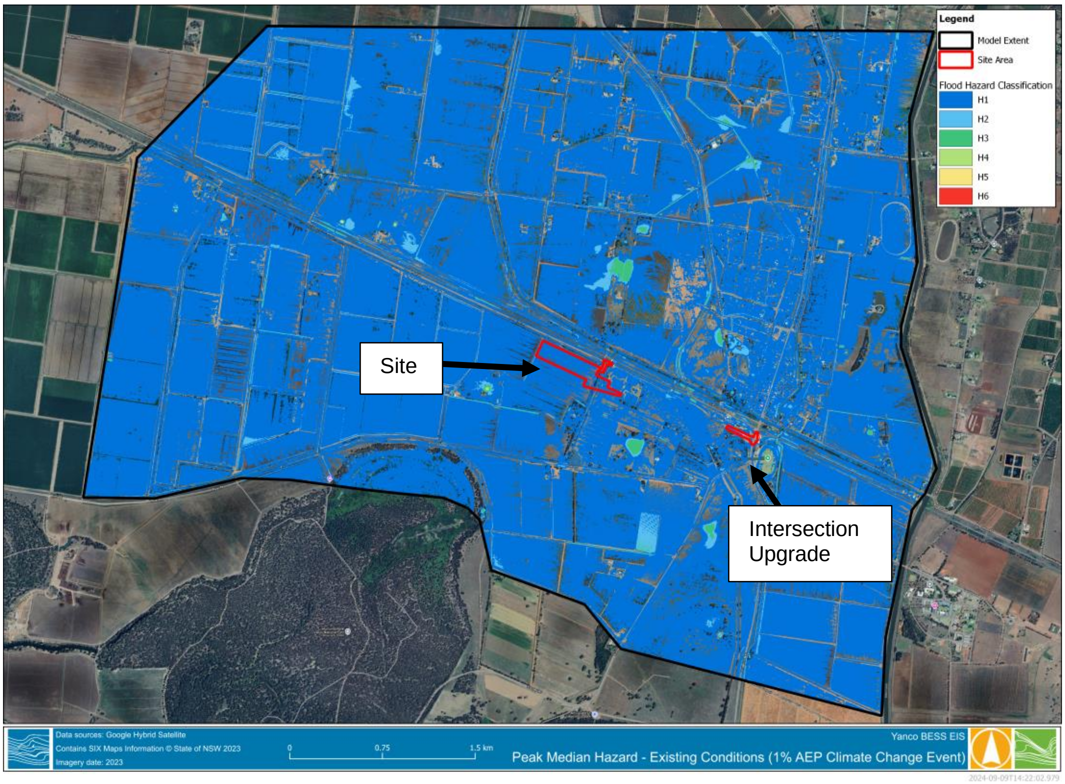

Figure B 9   Existing Conditions – 1% + climate change flood hazard

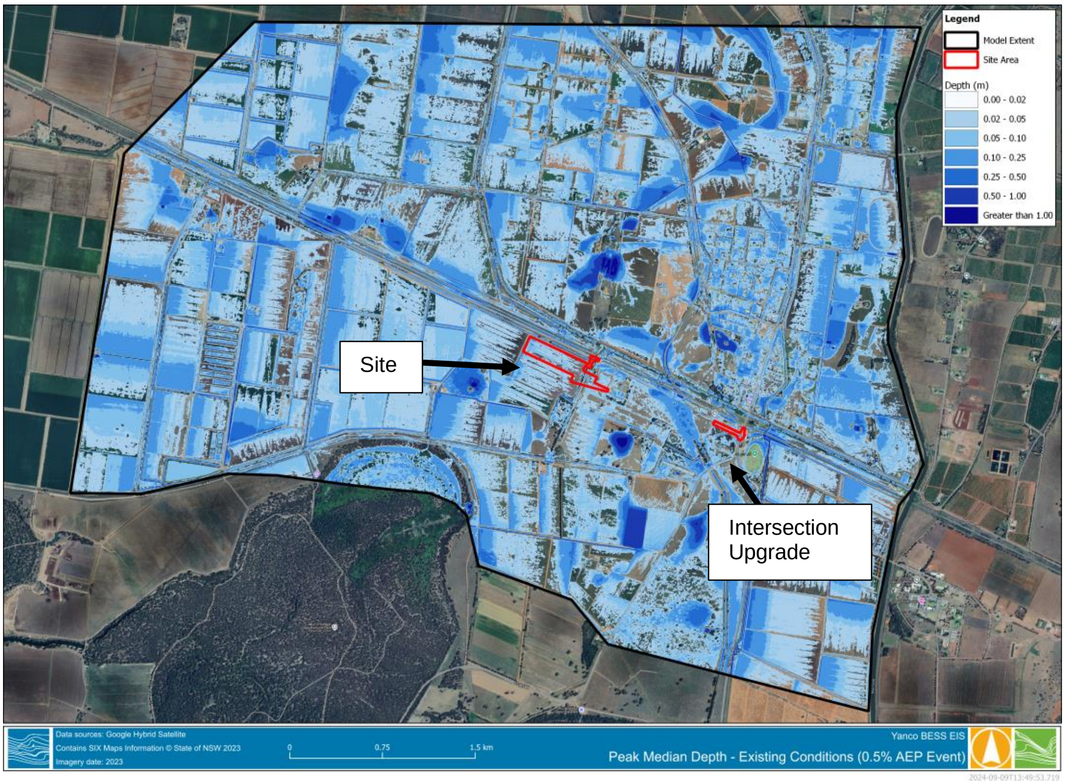

Figure B 10 Existing Conditions – 0.5% flood depth

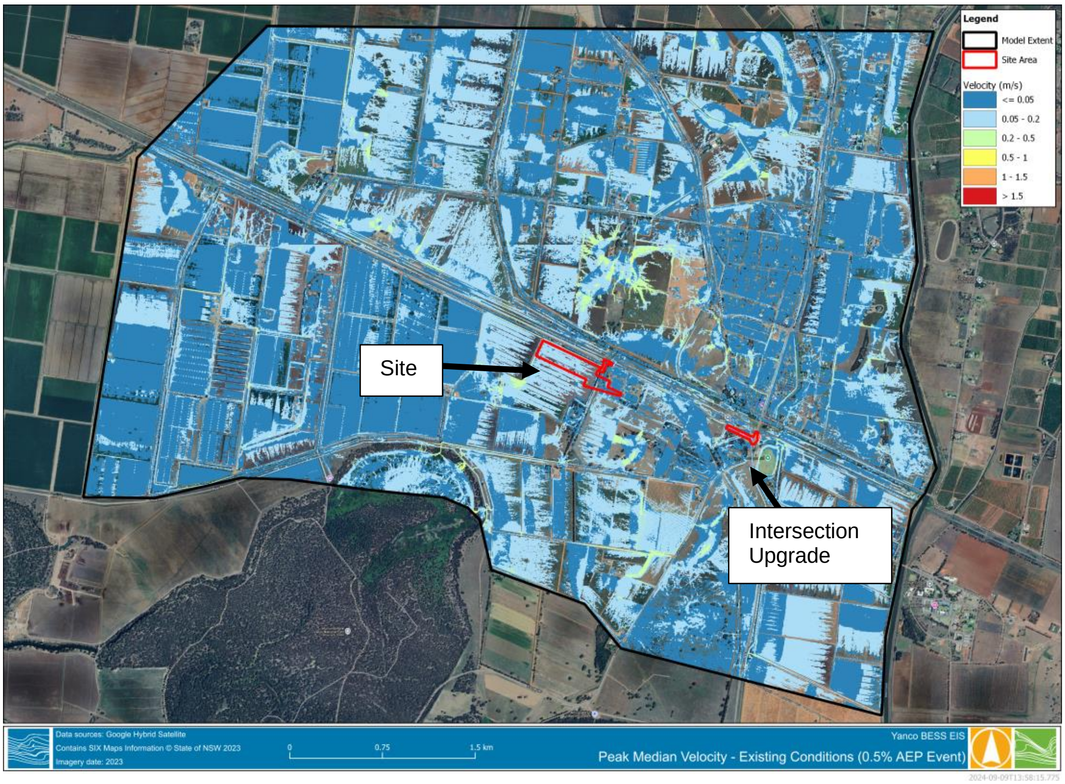

Figure B 11 Existing Conditions – 0.5% flood velocity

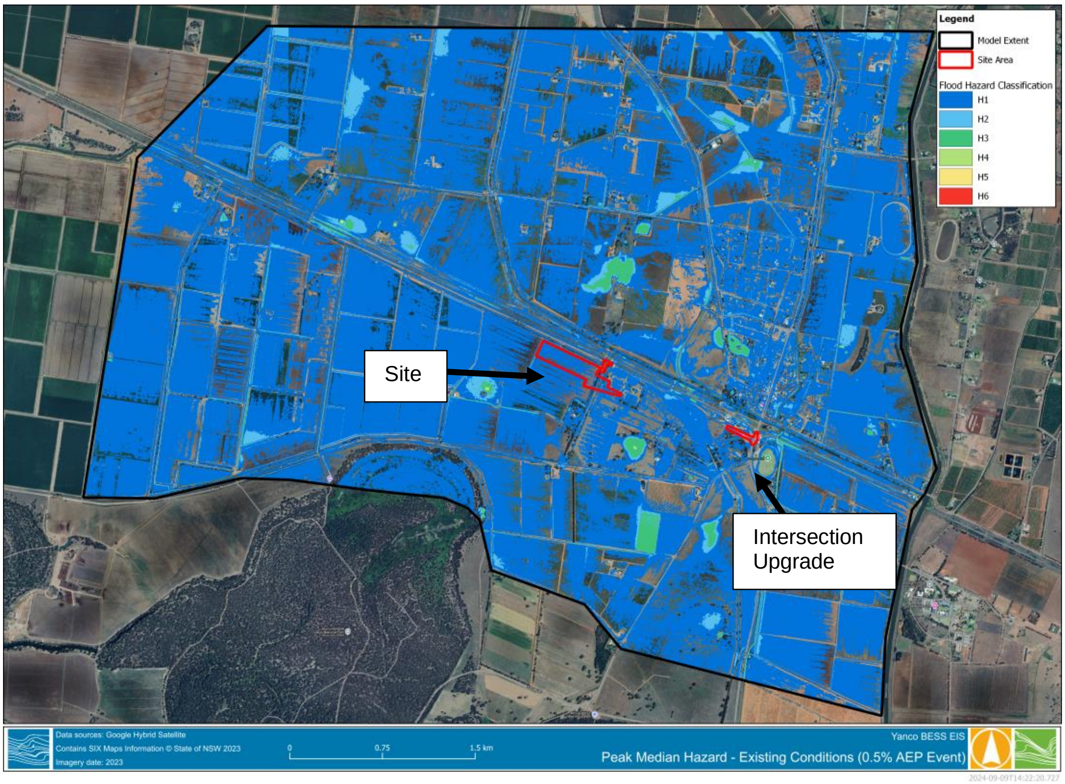

Figure B 12 Existing Conditions – 0.5% flood hazard

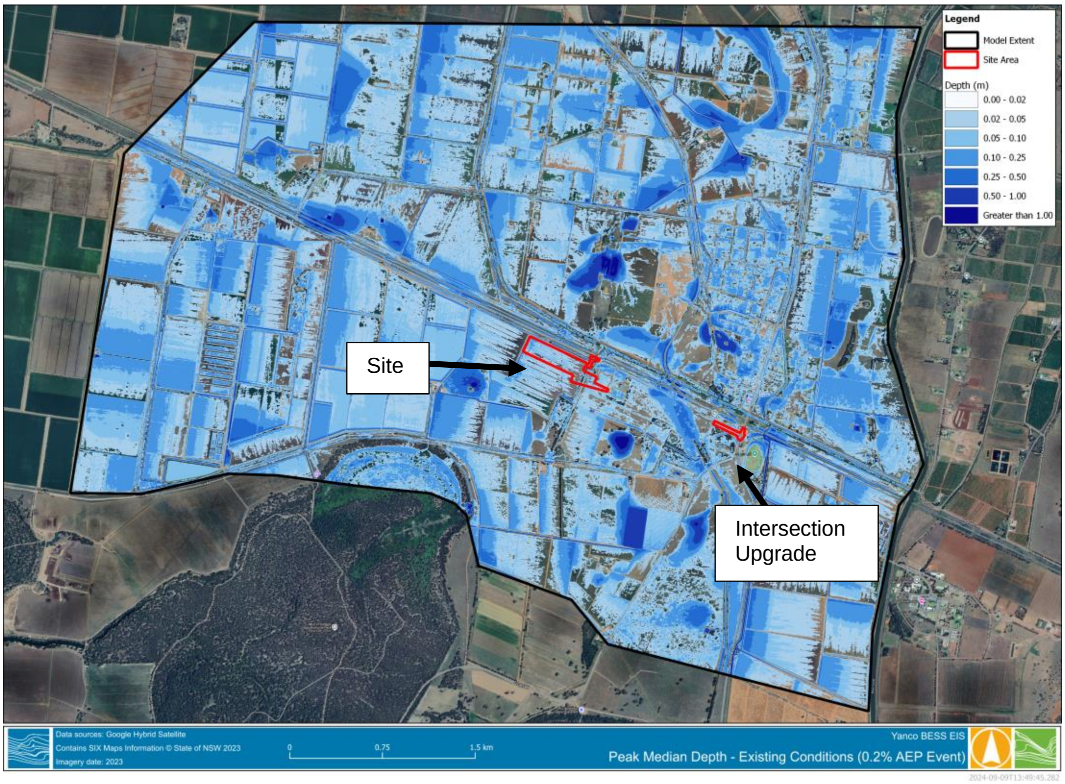

Figure B 13 Existing Conditions – 0.2% flood depth

Figure B 14 Existing Conditions – 0.2% flood velocity

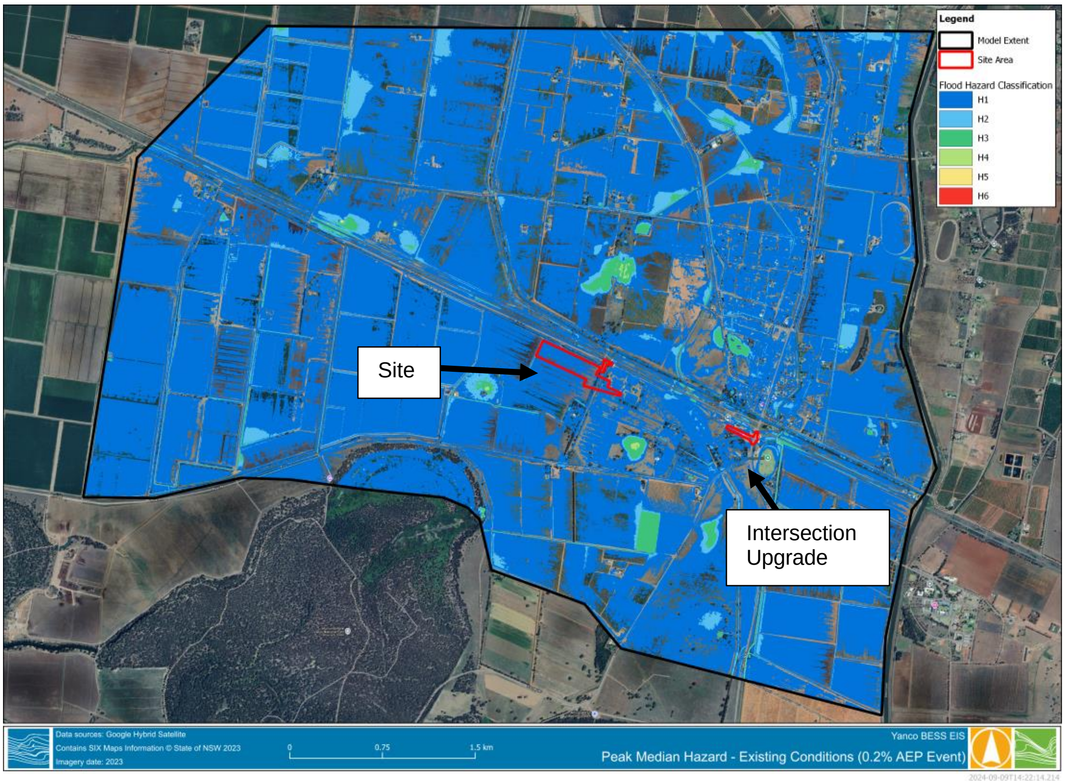

Figure B 15 Existing Conditions – 0.2% flood hazard

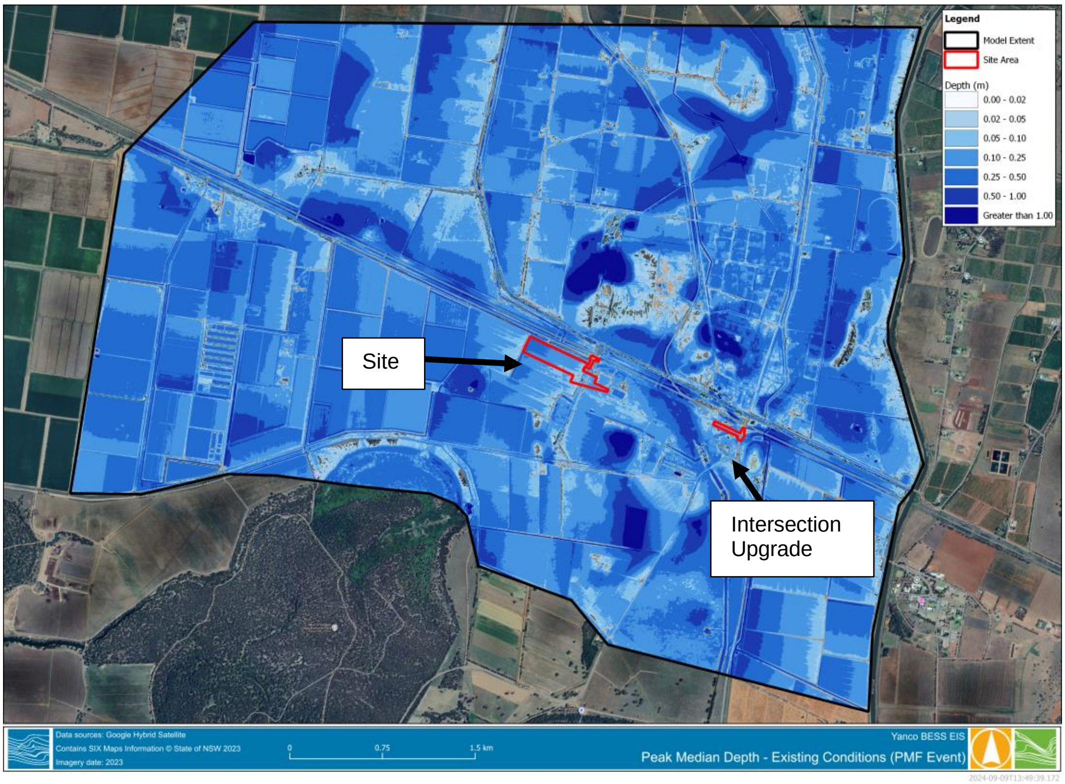

Figure B 16 Existing Conditions – PMF flood depth

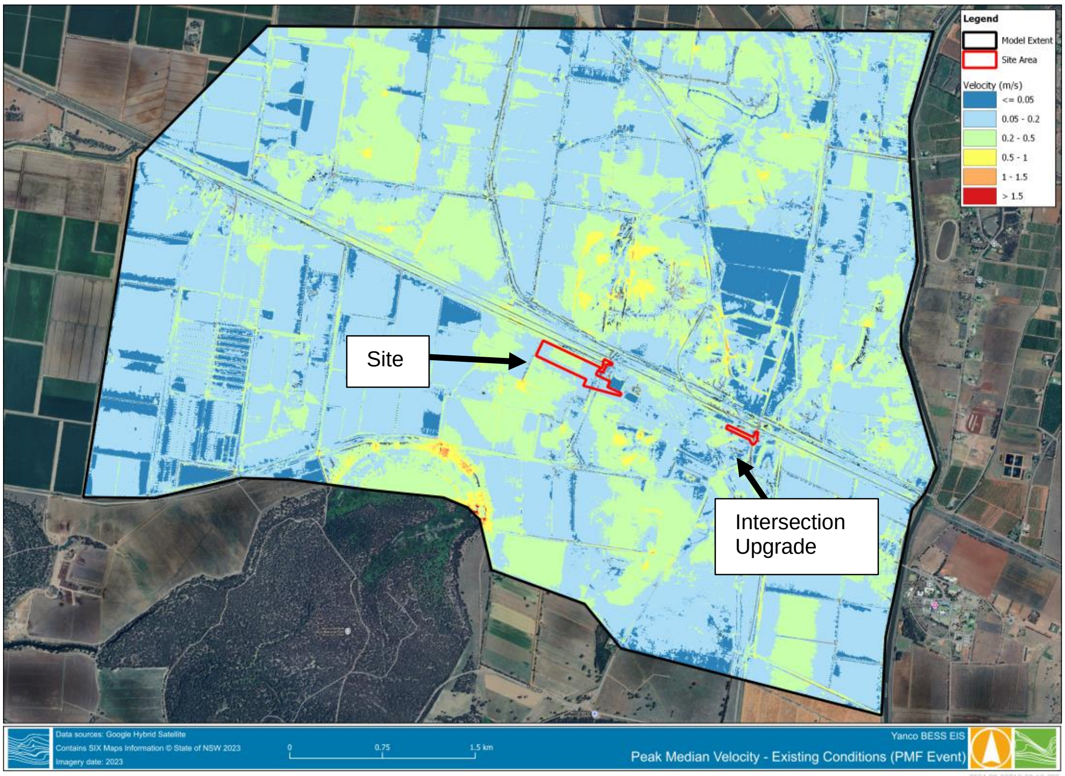

Figure B 17 Existing Conditions – PMF flood velocity

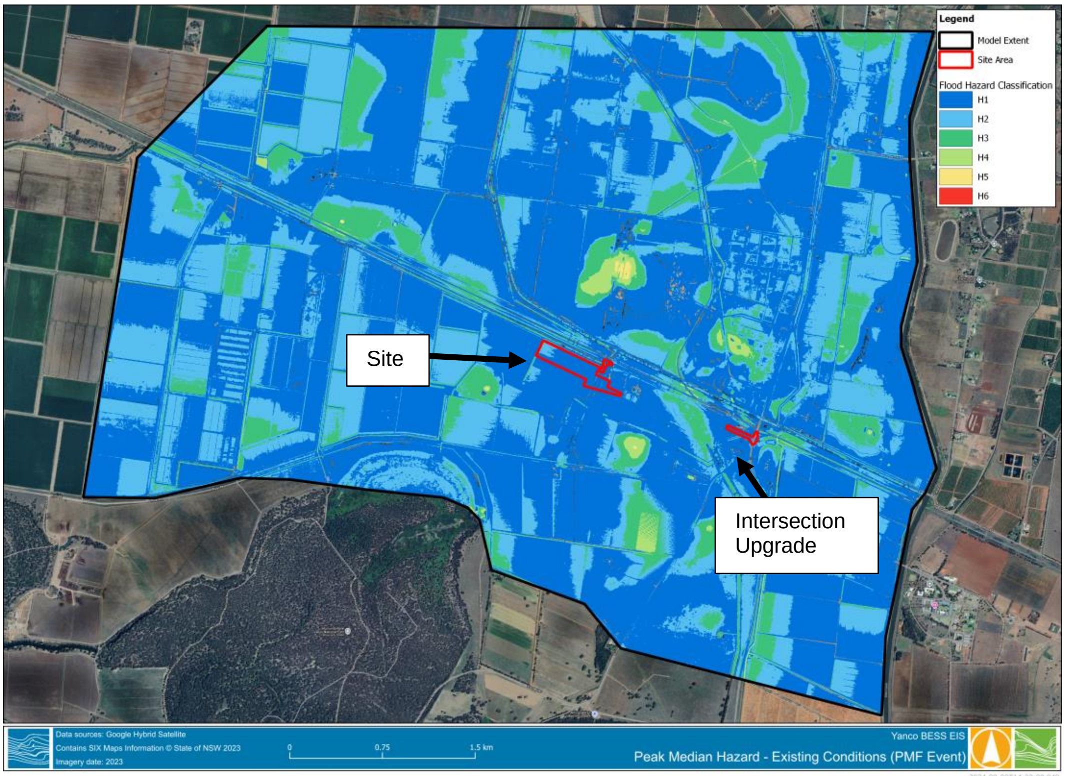

Figure B 18 Existing Conditions – PMF flood hazard

APPENDIX C – DESIGN MODELLING RESULTS

Note:
The baseline peak water level is compared against the design scenario (BESS installation) peak water level.

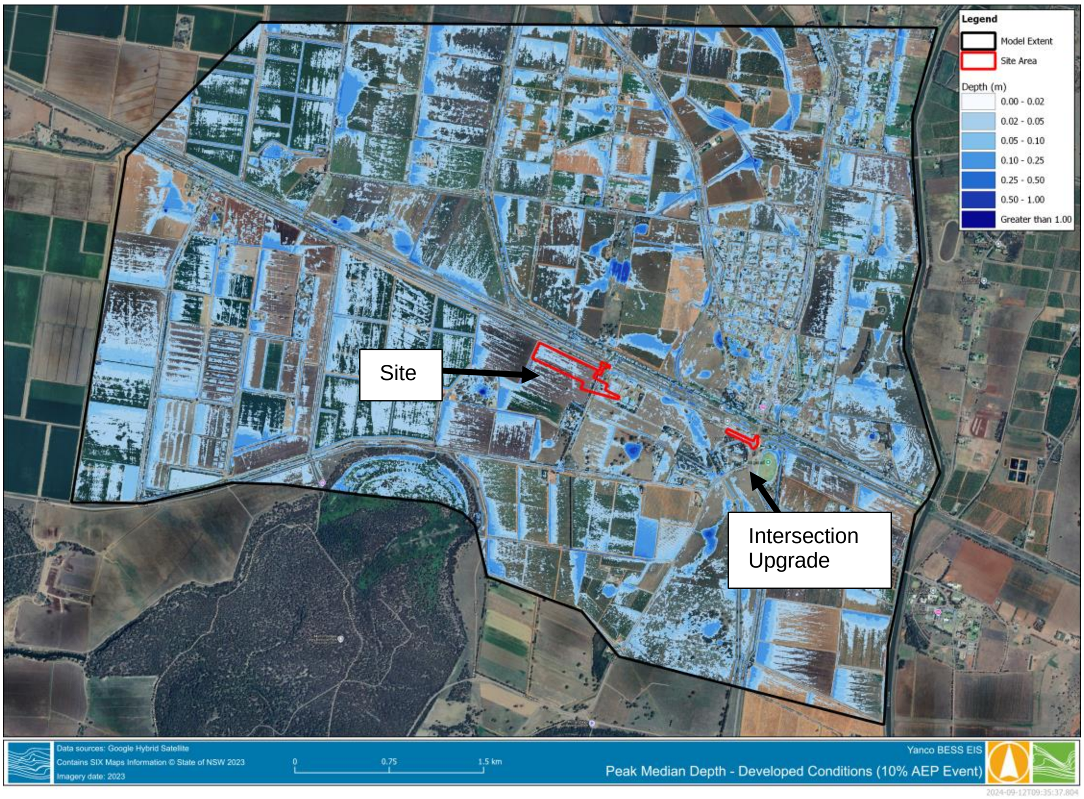

Figure C 1 Design Conditions – 10% AEP flood depth

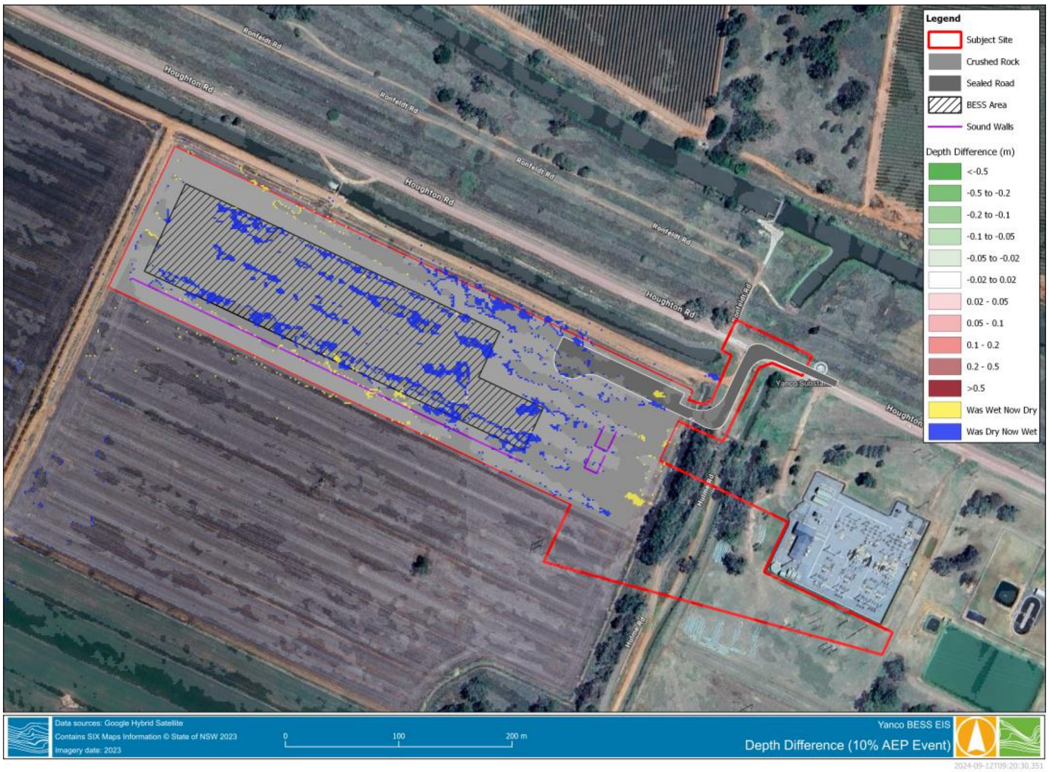

Figure C 2 Design Conditions – 10% AEP depth difference

Figure C 3   Design Conditions – 5% AEP flood depth

Figure C 4   Design Conditions – 5% AEP depth-difference

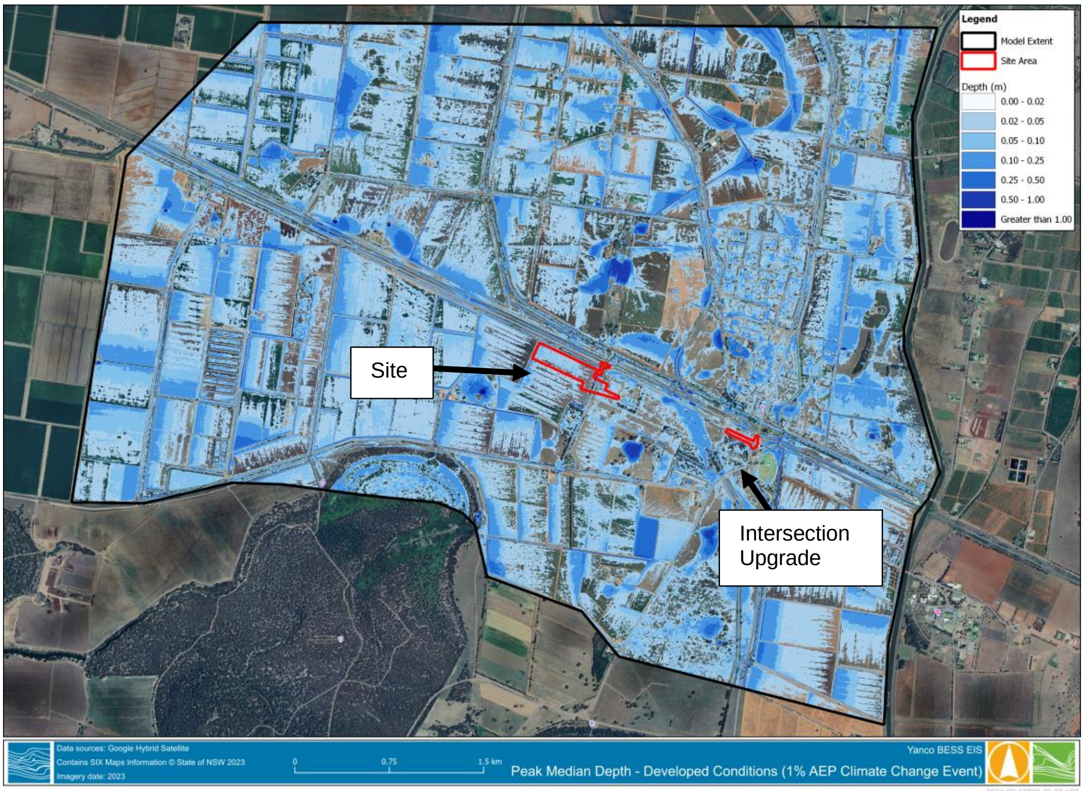

Figure C 5 Design Conditions – 1% AEP + Climate Change flood depth

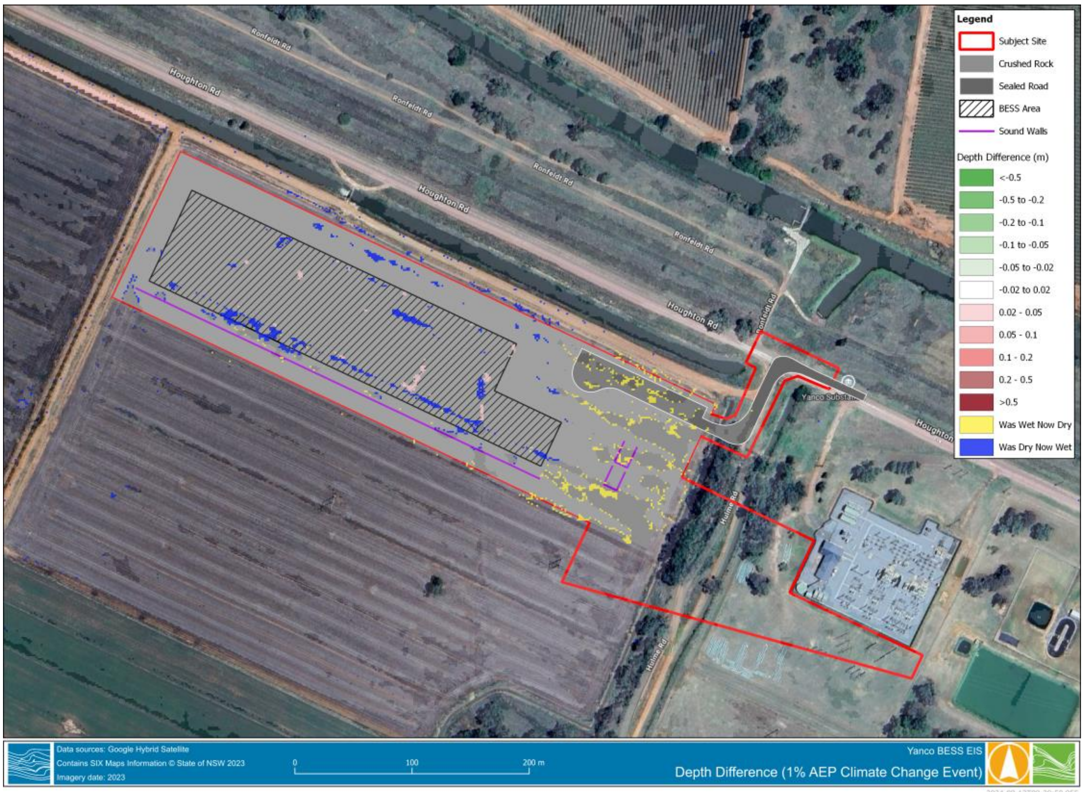

Figure C 6 Design Conditions – 1% AEP + Climate Change depth-difference

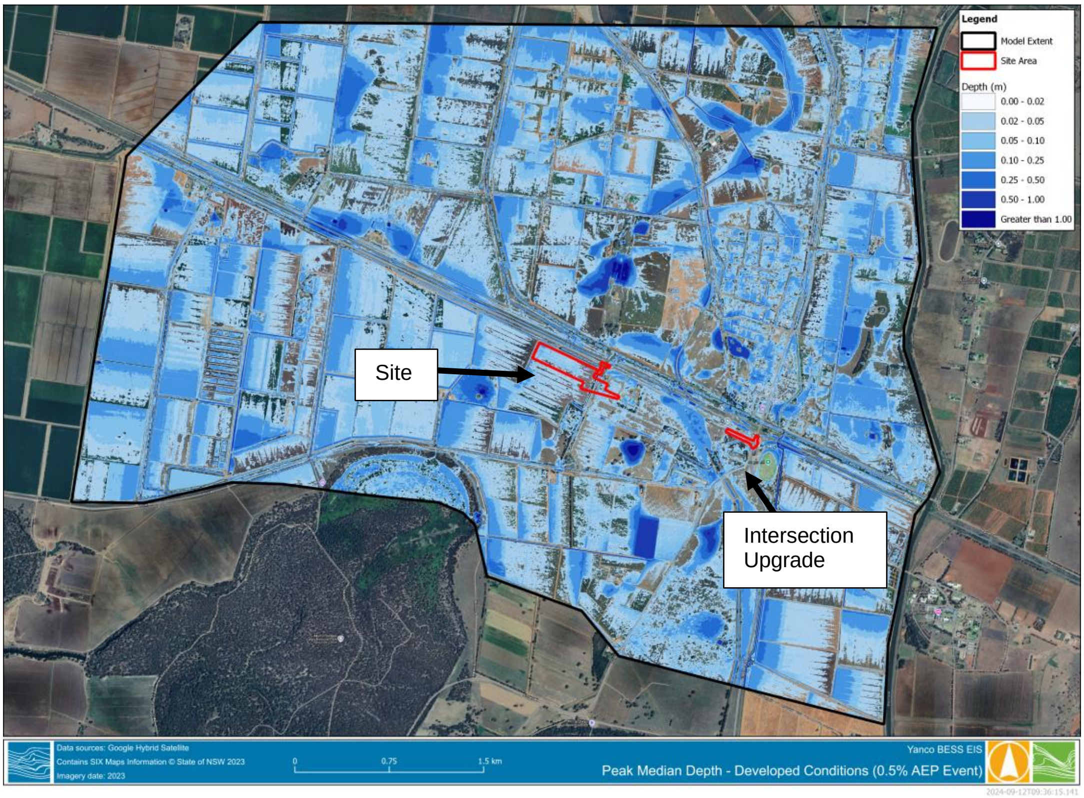

Figure C 7 Design Conditions – 0.5% AEP flood depth

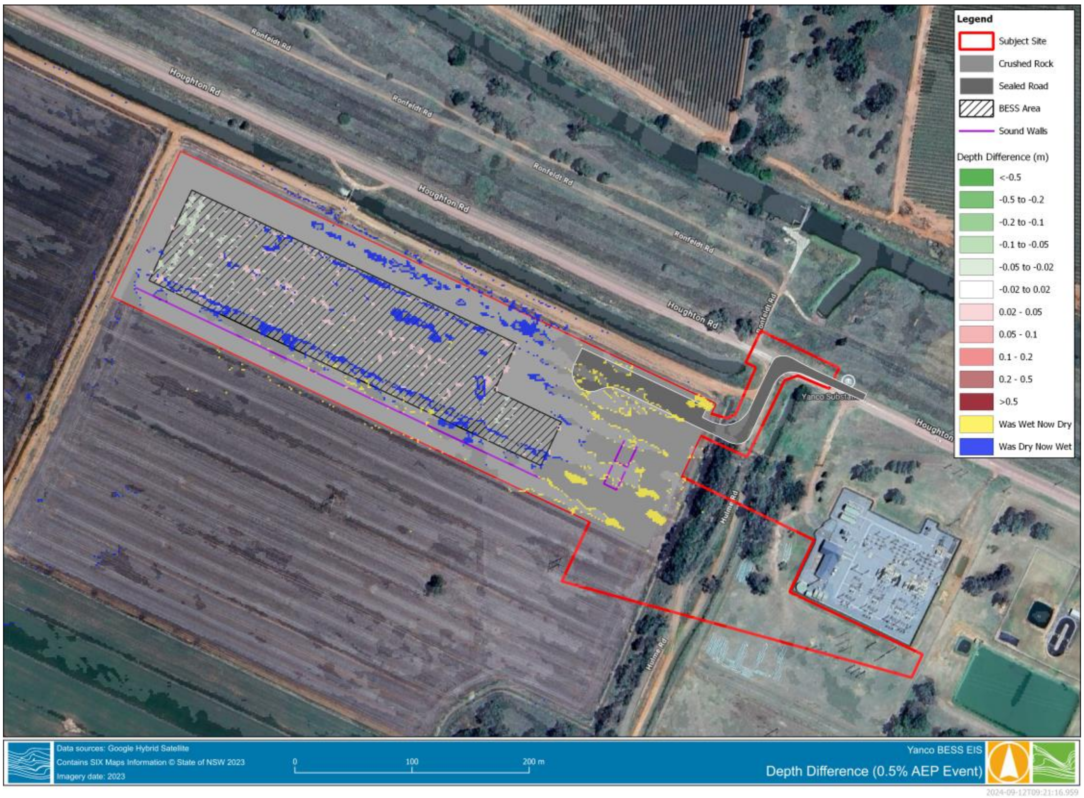

Figure C 8 Design Conditions – 0.5% AEP depth difference

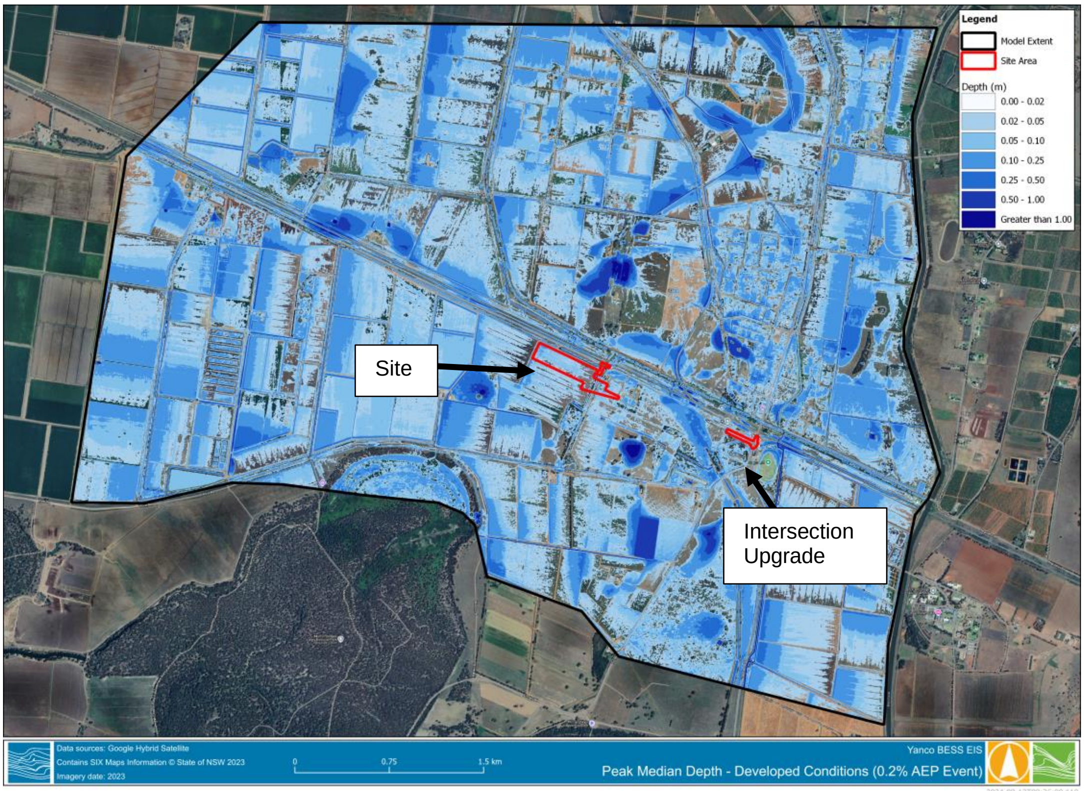

Figure C 9 Design Conditions – 0.2% AEP flood depth

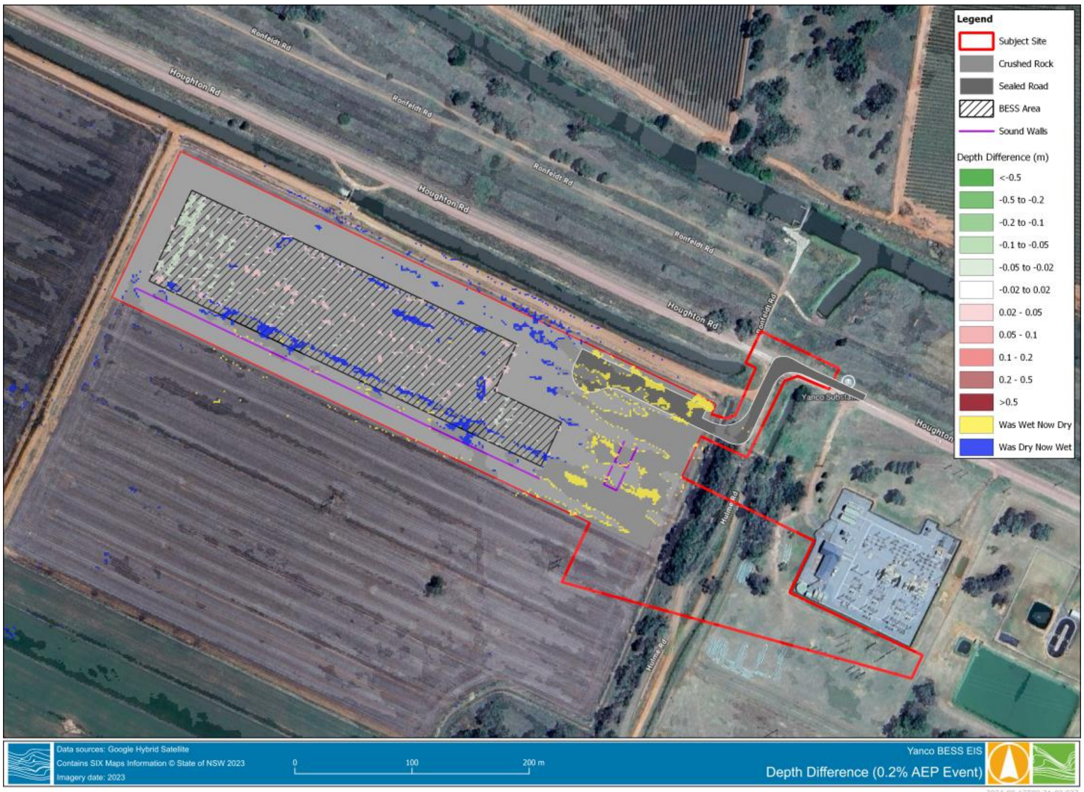

Figure C 10 Design Conditions – 0.2% AEP depth difference

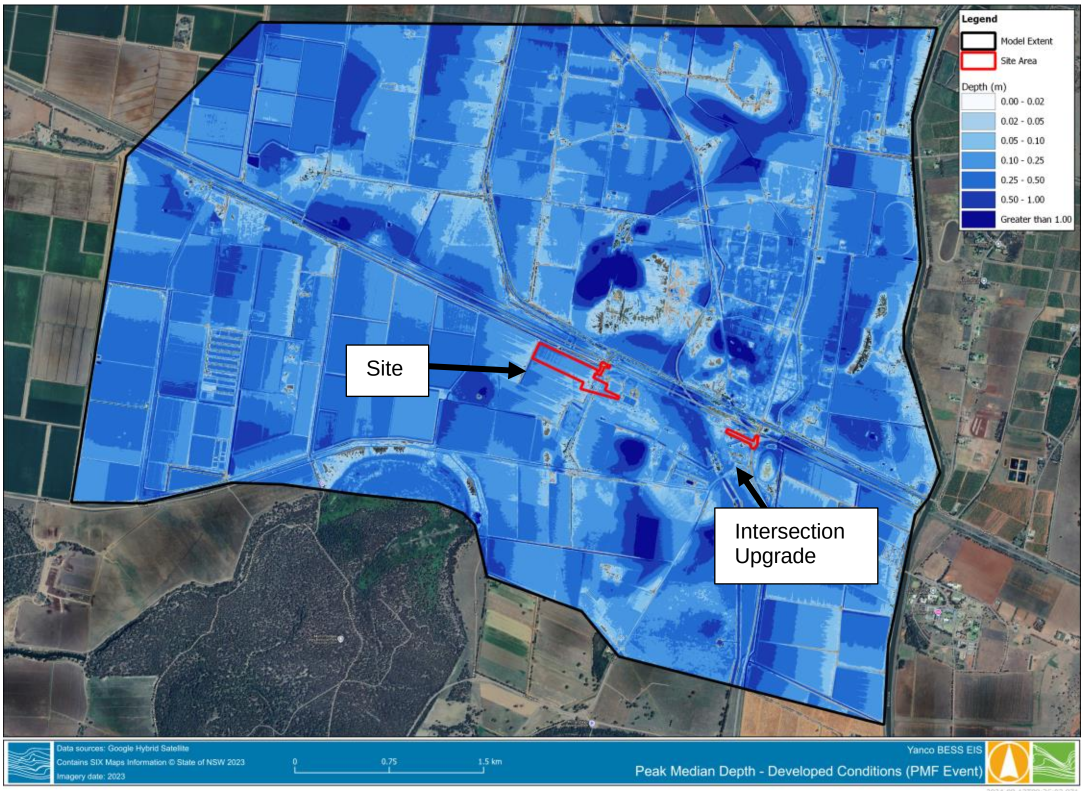

Figure C 11 Design Conditions – PMF flood depth

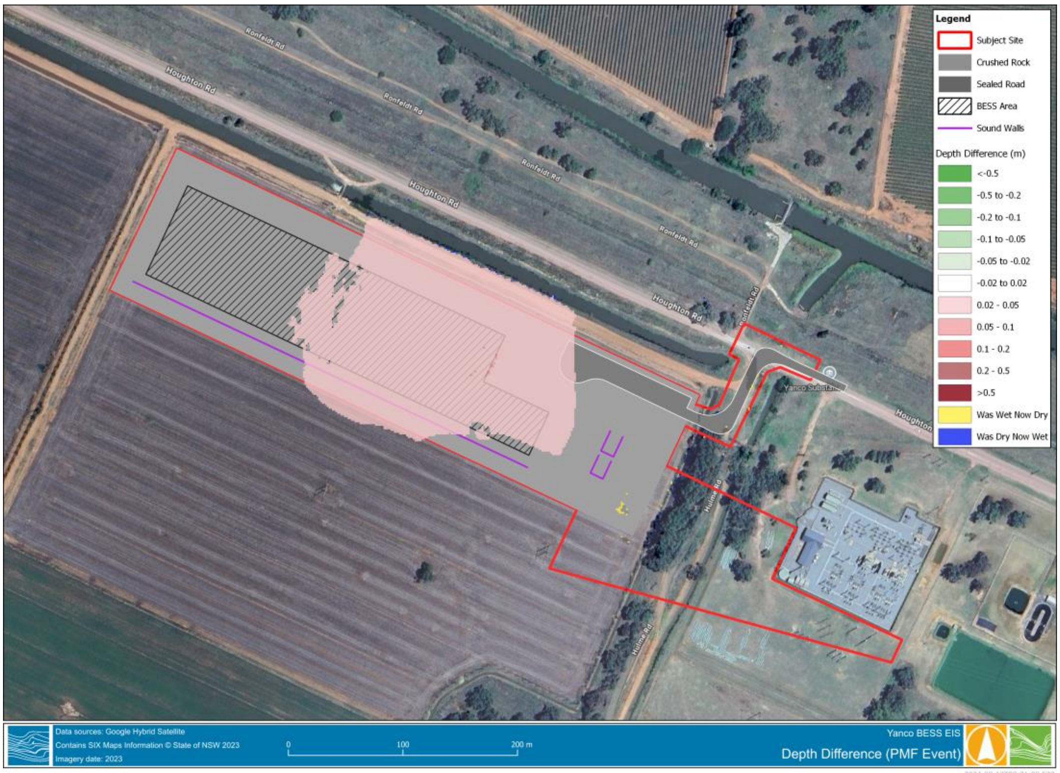

Figure C 12 Design Conditions – PMF depth difference

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Level 1, 21 Adelaide Street
Fremantle WA 6160
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong

51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800

Wimmera

597 Joel South Road
Stawell VIC 3380
Telephone 0438 510 240

Gold Coast

Suite 37, Level 4, 194 Varsity Parade
Varsity Lakes QLD 4227
Telephone (07) 5676 7602

watertech.com.au