Flood Risk Report

ACEnergy BESS – Hume Highway, Holbrook, NSW 2644

ACEnergy Pty Ltd

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Project Details

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1 INTRODUCTION

1.1 Overview

ACEnergy Pty Ltd are proposing to construct a Battery Energy Storage System (BESS) at 22/-/DP809338 Hume Highway, Holbrook, NSW (the subject site). The study objective was to better understand the flooding mechanisms within the site, particularly across the location where the battery farm is proposed to be constructed. This site is referred to as 'the subject site' within this report. The report presents the flood modelling assumptions and results together with an investigation of the subject site flood risk.

1.2 Objectives

To provide ACEnergy Pty Ltd with a better understanding of the flooding and drainage behaviour within the subject site, the following tasks were completed:

- Review of existing flood information.
- Development of a 2D (Two-Dimensional) hydraulic flood model (using TUFLOW) Rain-on-Grid (RoG) methodology to assess flood risk from stormwater runoff.
- Provision of high-level recommendations for any mitigation or design alterations which may be required to reduce potential risks associated with flooding and drainage.

No previous flood studies were available for the subject site.

1.3 Site

The subject site is located approximately 5.0 km northeast of the Holbrook township in southwest NSW, located at 22/-/DP809338 Hume Highway, Holbrook, 2644 (Figure 1-1). There is an existing farm dam on the east side of the subject site, as shown in Figure 1-2.

The site facility is proposed to be installed on generally flat terrain. The topography varies from 287.9 m AHD in the west to 289.0 m AHD in the east of the subject site (Figure 1-3). The terrain slopes towards the northeast with a slope of approximately 0.7%.

FIGURE 1-1 SUBJECT SITE LOCATION

FIGURE 1-2 SUBJECT SITE

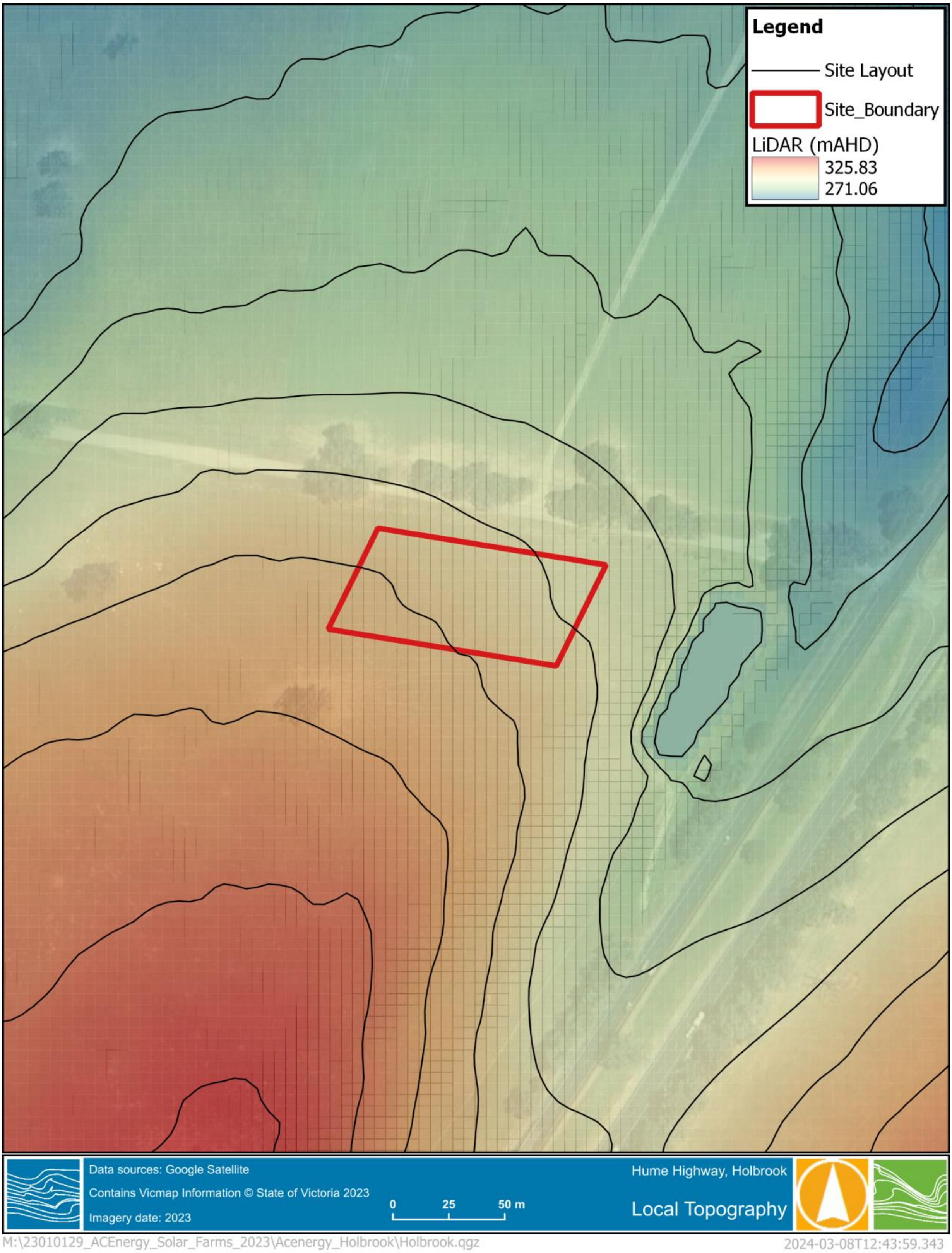

FIGURE 1-3 SUBJECT SITE TOPOGRAPHY

2 FLOODING

2.1 Methodology

A two-dimensional Rain on Grid (RoG) hydraulic modelling approach was employed for this investigation using Australian Rainfall and Runoff (ARR) 2019 guidelines[1] and TUFLOW hydraulic flood modelling software. Simulations were completed using TUFLOW Build 2023-03-AB Single Precision with HPC (Highly Parallelised Computations) solution scheme on a GPU solver.

The RoG methodology is extensively used for flood mapping of urban and rural areas. It allows for a comprehensive flood risk assessment by identifying overland flow paths based on the topography dataset as illustrated in the flow chart in Figure 2-1.

- The rainfall layer, which consists of one single rainfall polygon over the model extent was produced in a GIS package.
- Hyetographs (rainfall depth timeseries) were created for a range of design rainfall AEP (Annual Exceedance Probability) events and durations using QGIS TUFLOW plugin and the 2016 Bureau of Meteorology Intensity Frequency Duration (IFD) at the centroid of the catchment. These were applied to the TUFLOW model to represent catchment rainfall under various durations for the 1% AEP design storm.

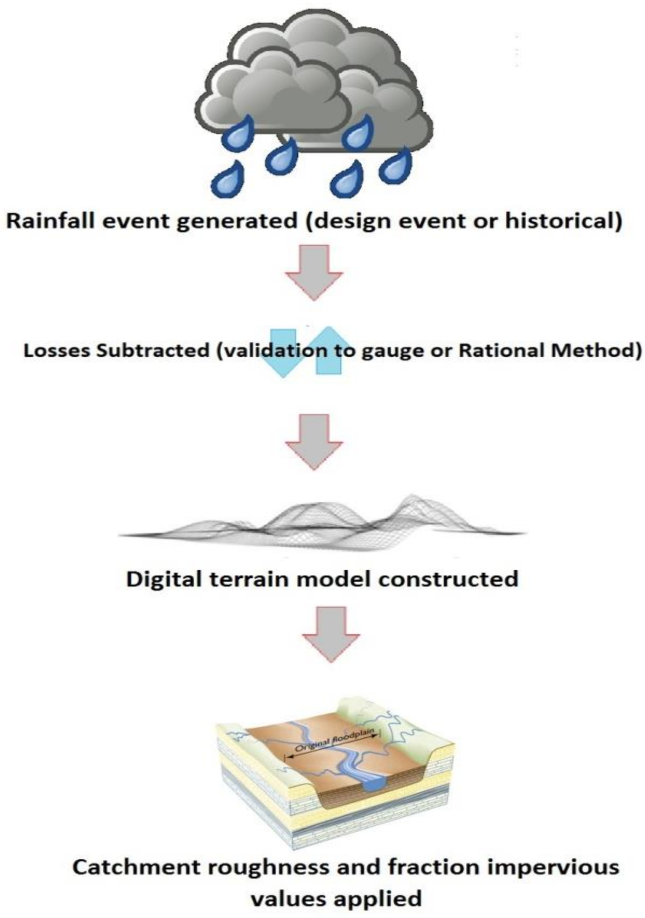

FIGURE 2-1 RAINFALL ON GRID MODELLING APPROACH

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

A new hydraulic model was constructed using land use, cadastral, topography and aerial photography datasets to identify different land uses which are represented from a hydrologic and hydraulic perspective as surface roughness and initial and continuing loss values.

The upstream catchment and wider area were modelled. The TUFLOW model set-up is presented in Figure 2-2, highlighting the model extent.

FIGURE 2-2 TUFLOW MODEL SETUP

2.1.1 Digital Elevation Model, Losses and Hydraulic Roughness

A Digital Elevation Model (DEM) was generated from 5 m resolution LiDAR, supplied by NSW Spatial Services via Geoscience Australia's Elevation Information System (ELVIS)[2]. It should be noted that 5 m resolution only provides a basic understanding of the flooding mechanisms within the site and future model updates should be undertaken when better topography data around the subject site becomes available. It is also expected the vertical accuracy of the data would not be as good as detailed LiDAR or ground survey was available, which would improve the model outputs.

Table 2-1 summarises the rainfall losses and hydraulic roughness used for the hydraulic modelling as per the land use types within the model. These values were adopted based on Water Technology's experience with RoG models in the surrounding area.

A check was also undertaken to test the sensitivity of infiltration losses. It was found that reducing the losses by 50% for the critical duration (1% AEP, 180 minutes, TP02) had negligible impacts on the flood extent and maximum flood depths (<2cm) around the subject site.

[2] https://elevation.fsdf.org.au/

TABLE 2-1 MODEL PARAMETERS

Land use types	Manning's 'n' (roughness)	Initial loss (mm)	Continuing loss (mm/hr)
Open pervious area	0.040	14	2
Residential - rural	0.150	14	2
Roads/carpark/paved area	0.025	1	0.5
Open water	0.020	0	0

2.1.2 Boundaries

A tailwater (2D TUFLOW 'HQ') boundary was set and extended around the downstream model boundary to allow overland flow to freely drain out of the model, with a constant slope of 0.5%. This was located downstream of the site and is not likely to impact on flood behaviour at the site as runoff from within the site is contained due to irrigation channels.

2.1.3 Rainfall

The mean monthly rainfall observed at Holbrook (Croft Street) Gauge 72142 from 2000 – 2024 is presented in Figure 2-3, indicating a fairly even monthly distribution.

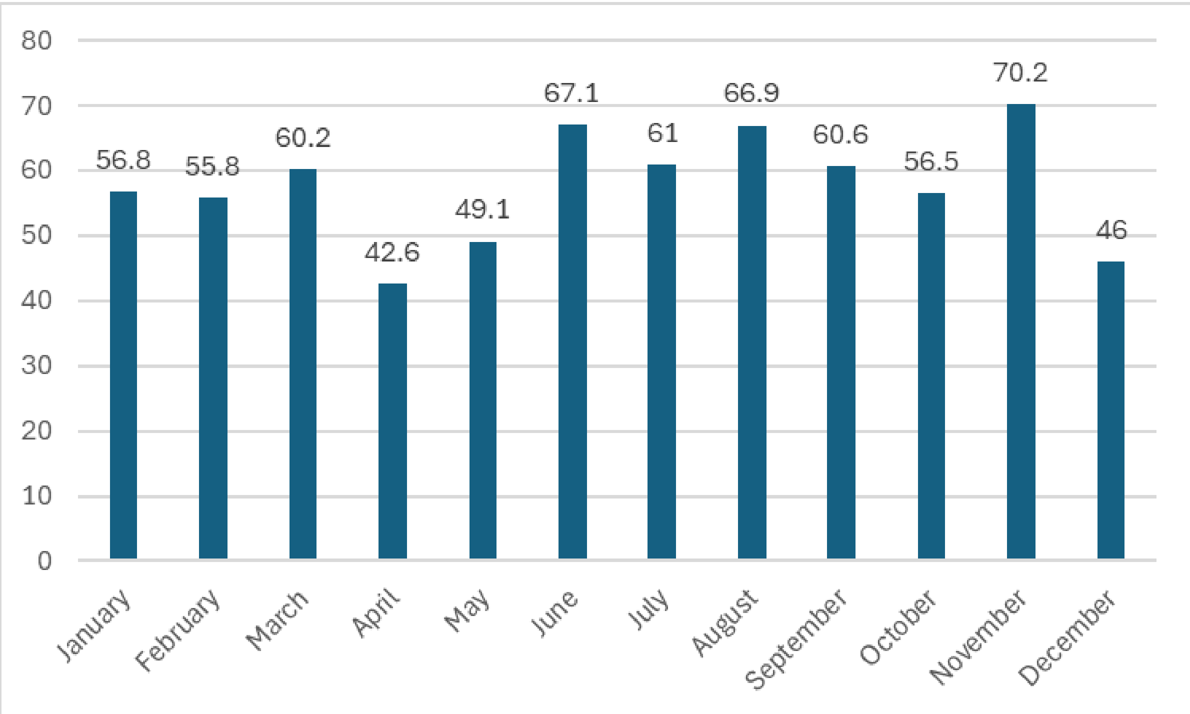

FIGURE 2-3 AVERAGE MONTHLY RAINFALL IN HOLBROOK (2000 – 2024)

2.1.4 TUFLOW Model Checks

- The following checks were undertaken on the TUFLOW model parameters and outputs:
  - 2D timestep: The adaptive 2D timestep drops to a minimum of 0.5 seconds. A 'Classic' TUFLOW model would be expected to have a timestep no less than ¼ of the grid size (5 m), i.e. 1.25 seconds,

with a healthy HPC model no lower than a tenth of this figure. Hence, the adopted timestep is within the recommended range.

- Model mass errors: The mass errors for all models was less than 1% and within the recommended range.
- Errors and warning messages: No errors were found within the model and all warnings were reviewed and either acceptable or fixed, if required.

2.1.5 Critical Duration and Temporal Pattern Assessment

The model was run for the following 1% AEP design storm durations; 3, 6, 12, & 24 hours, using three ARR 2019 temporal patterns representative of front, mid and back loaded storm events.

Results were processed to select the combination of durations and temporal patterns resulting in the maximum flood depths throughout the catchment and covering the site. This is a conservative method of identifying areas prone to flooding in a 1% AEP event.

The modelled durations and temporal patterns are shown in Table 2-2.

TABLE 2-2 MODELLED DURATION AND TEMPORAL PATTERN

AEP Event	1%
Durations	3, 6, 12, & 24 hours
Temporal Pattern	TP01, TP02, TP05

2.2 Flood Hazard Classification

Floods can be hazardous, producing harm to people, damage to infrastructure and potentially loss of life. In examining potential flood hazard there are several factors to be considered, as outlined in ARR 2019 (Book 6 Chapter 7)[3]. An assessment of flood hazard should consider:

- Velocity of floodwater.
- Depth of floodwater.
- Combination of velocity and depth of floodwater.
- Isolation during a flood.
- Effective warning time.
- 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 2-4 and vulnerability thresholds classifications are tabulated in Table 2-3.

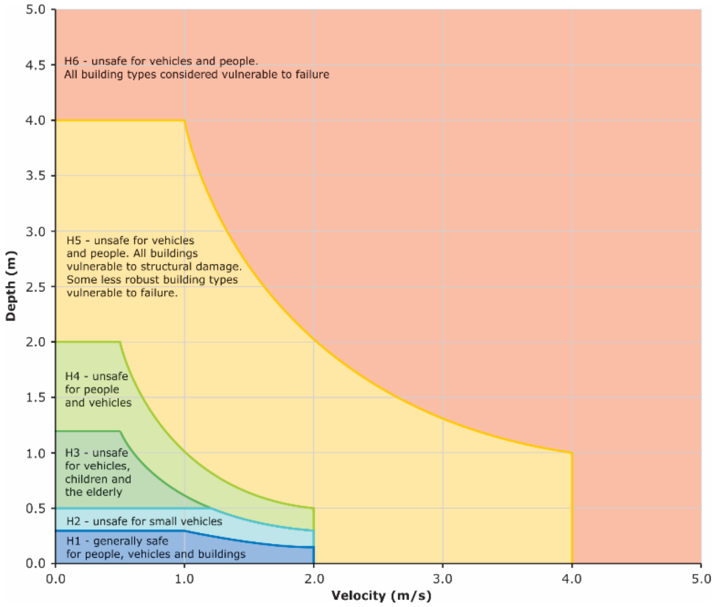

FIGURE 2-4 COMBINED FLOOD HAZARD CURVES

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

TABLE 2-3 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.

2.3 Results

The existing conditions 1% AEP depth, velocity and flood hazard results are shown from Figure 2-5 to Figure 2-7. The flood depth map was filtered for small depths (below 0.02 m) and puddles less than 100m^2 were removed.

It should be noted that no drainage structures were included in the hydraulic model and limited topographic data was available.

The following observations can be made for the 1% AEP flood event:

- The maximum flood depth within the site was less than 100 mm.
- The maximum peak velocities within the site were less than 0.05 m/s.
- A flood hazard map was created from the product of both flood depth and velocity as described in the previous section. The subject site and facilities are classified as H1 'Generally safe for vehicles, people, and buildings'. This is due to the very slow moving shallow water.

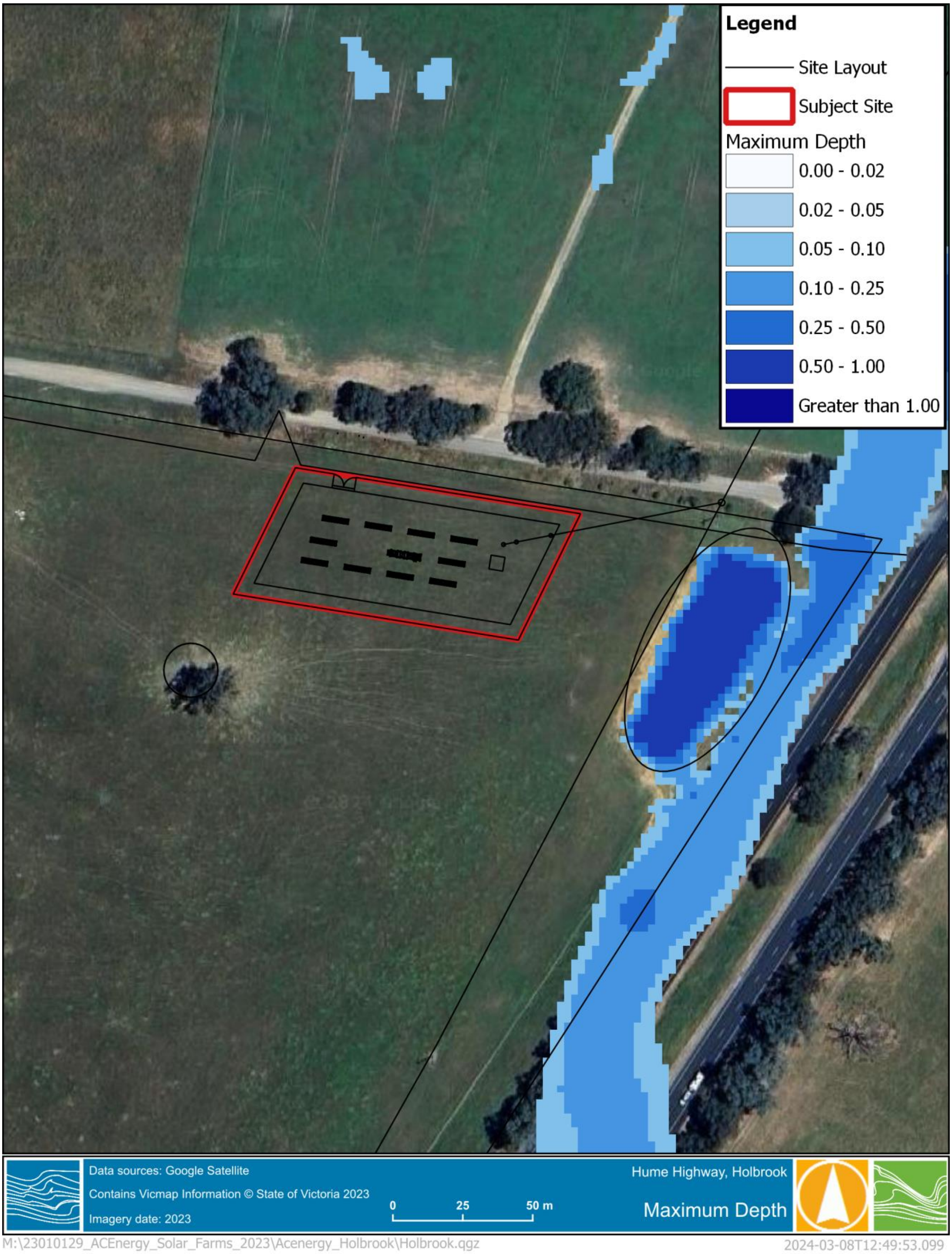

FIGURE 2-5 1% AEP MAXIMUM FLOOD DEPTH (DEPTHS BELOW 0.02M NOT SHOWN)

FIGURE 2-6 1% AEP MAXIMUM FLOOD VELOCITY

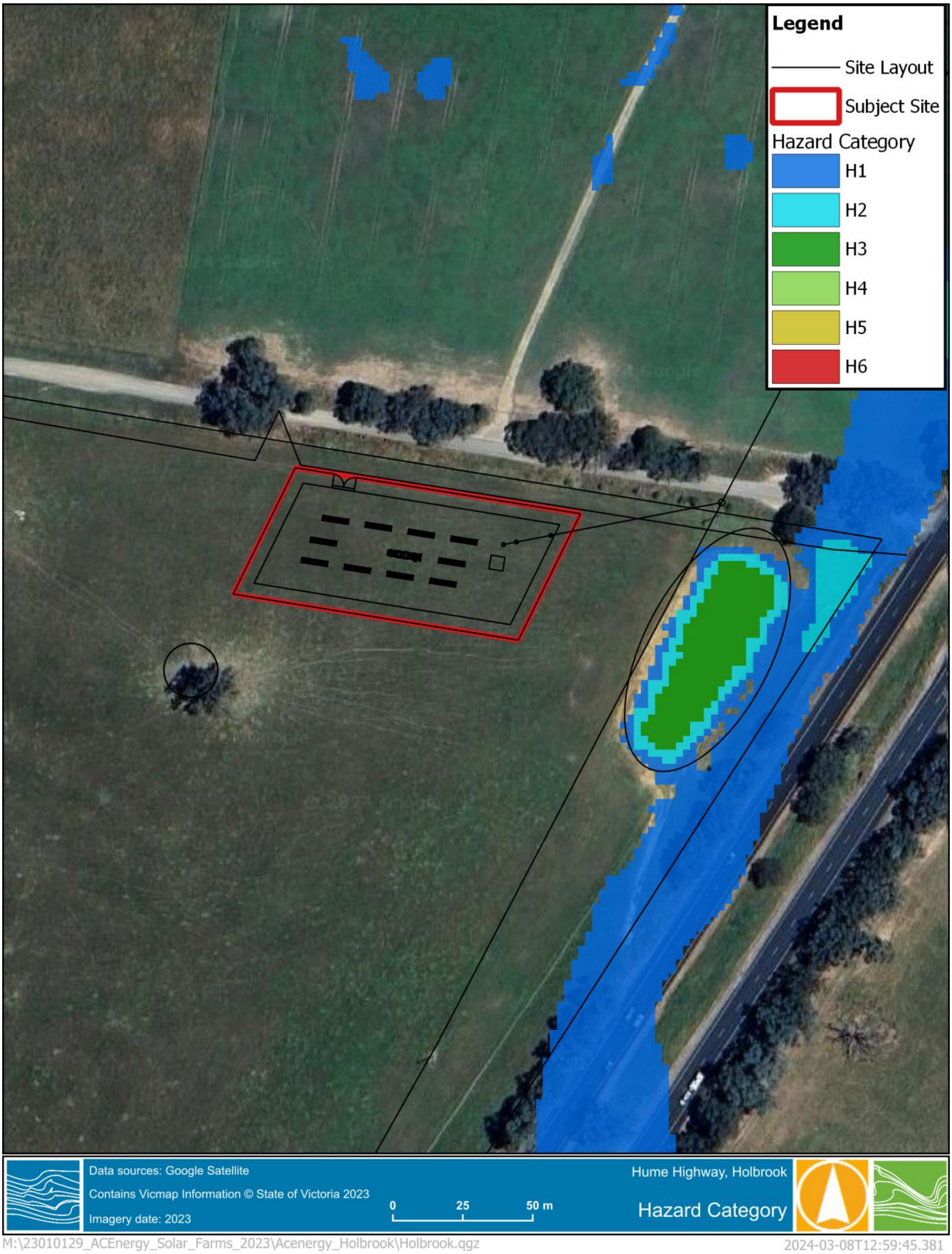

FIGURE 2-7 1% AEP MAXIMUM FLOOD HAZARD

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Surface Water

The flood investigation provided within this report provides flood mapping for the proposed BESS at Hume Highway, Holbrook, NSW (22/-/DP809338). A 2D hydraulic flood model was developed and modelling undertaken in line with the latest flood modelling software; industry standards (i.e. BoM IFD and ARR 2019 guidelines) and the latest available 5 metre LiDAR dataset (NSW Spatial Services) for the 1% AEP design storm event.

It should be noted that 5 meter resolution topographic data only provide a basic understanding of the flooding mechanisms within the site and future model updates should be undertaken when better topography data around the subject site becomes available.

The flood modelling and mapping combined with some external information confirmed that there are no significant overland flow paths across the site (facility location). In the main flow paths, depths were less than 100 mm and maximum velocities less than 0.05 m/s, resulting in the site being classified as flood hazard H1 (generally safe for people, vehicles, and buildings).

Based on the findings of the flood modelling, it is recommended to set any batteries and critical electrical infrastructure at least 200 mm above the ground level, and if available detailed topographic data should be used as the basis for additional modelling.

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