Gara BESS

Gara BESS Surface Water Assessment Report

ACEnergy Pty Ltd

20 May 2025

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Project Details

Project Name	Gara BESS Surface Water Assessment Report
Client	ACEnergy Pty Ltd
Client Project Manager	HenryKing Sicad
Water Technology Project Manager	Bonnie Beare
Water Technology Project Director	Ben Hughes
Authors	Bailey Hume, Sam Schultz, Bonnie Beare
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51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800
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*

20 May 2025

HenryKing Sicad
Project Development Engineer
ACEnergy Pty Ltd
Level 3, 689 Burke Road
Camberwell, VIC 3124, AUSTRALIA

Via email: henryking.sicad@acenergy.com.au

Dear HenryKing

Gara BESS Surface Water Assessment Report

Please see attached the Surface Water Assessment report for the proposed Gara BESS. This report documents the methodology and outcomes of the assessment relating to surface water and riverine flood risk. The report also addresses the Secretary's Environmental Assessment Requirements (SEARS) for an Environmental Impact Statement (EIS).

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

Yours sincerely

Bonnie Beare
Senior Engineer
Bonnie.beare@watertech.com.au
WATER TECHNOLOGY PTY LTD

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1 INTRODUCTION

1.1 Development Overview

This report details the findings of a risk and impact assessment for the proposed Battery Energy Storage System (BESS) at 86 Woodlands Road, Armidale, NSW, along Waterfall Way (Grafton Road), approximately 5km from the Gara Dam. The proposed Gara BESS is a 400MW, 1760 MWh, 4 hours storage utility scale. The BESS will connect to the 330 kV TransGrid transmission line.

The report also addresses the Secretary's Environmental Assessment Requirements (SEARS) for an Environmental Impact Statement (EIS), as outlined by the NSW Department of Planning Housing and Infrastructure (SSD 71680710). Key items to note from the SEARS Advice, which will be assessed in this report include undertaking hydraulic and hydrologic modelling for the following events:

- 5% AEP,
- 1% AEP,
- Probable Maximum Flood (PMF), and
- 0.5% and 0.2% AEP which are advised to be used as proxies for assessing climate change.

1.2 Site Location and Layout

The Gara BESS is situated within the Macleay River catchment (Figure 1-1), amongst mostly grazing vegetation and other agricultural land. The Site is located approximately 10.4km East of the Armidale township, with Burying Ground Creek running through it, and Waterfall Way (Grafton Road) to its immediate south. Burying Ground Creek flows south towards Commissioners Waters, which joins the Gara River approximately 5 km to the east.

The proposed Gara BESS is to be located at 86 Woodlands Road, Armidale NSW 2350 (the Subject Site) and has an area of 35.24 hectares. Figure 1-2 below highlights the extent of the Subject Site, being all lots associated with the address of 86 Woodlands Road, Armidale NSW 2350.

The Gara BESS will also impact on neighbouring properties being Lots 144 and 153 DP755826 for the proposed transmission facility, and Travelling Stock Routes (TSR's) Lot 7003 DP1060212; Lot 7009 DP1060213 for the access road. While those land parcels are not shown in the figures in this assessment, the assessment fully covers all the proposed works.

The Development Footprint is proposed to enclose an area of approximately 22.43 ha within the Subject Site. The security fence will enclose lithium-ion battery containers, inverter station (or MVPS) containers, dedicated connection asset, switching station, and other supporting infrastructure. There will be screening landscape both outside the proposed security fence and within the eastern boundary of the Subject Site.

The Subject Site and surrounding lands contain several unnamed waterways, two of which are first order streams which traverse the northern portion of the site, running in an east to west direction, under the proposed overhead connection route. However, these waterways are most likely historical overland flows, lacking key habitat features for native aquatic species. There are no local wetlands located within the Subject Site.

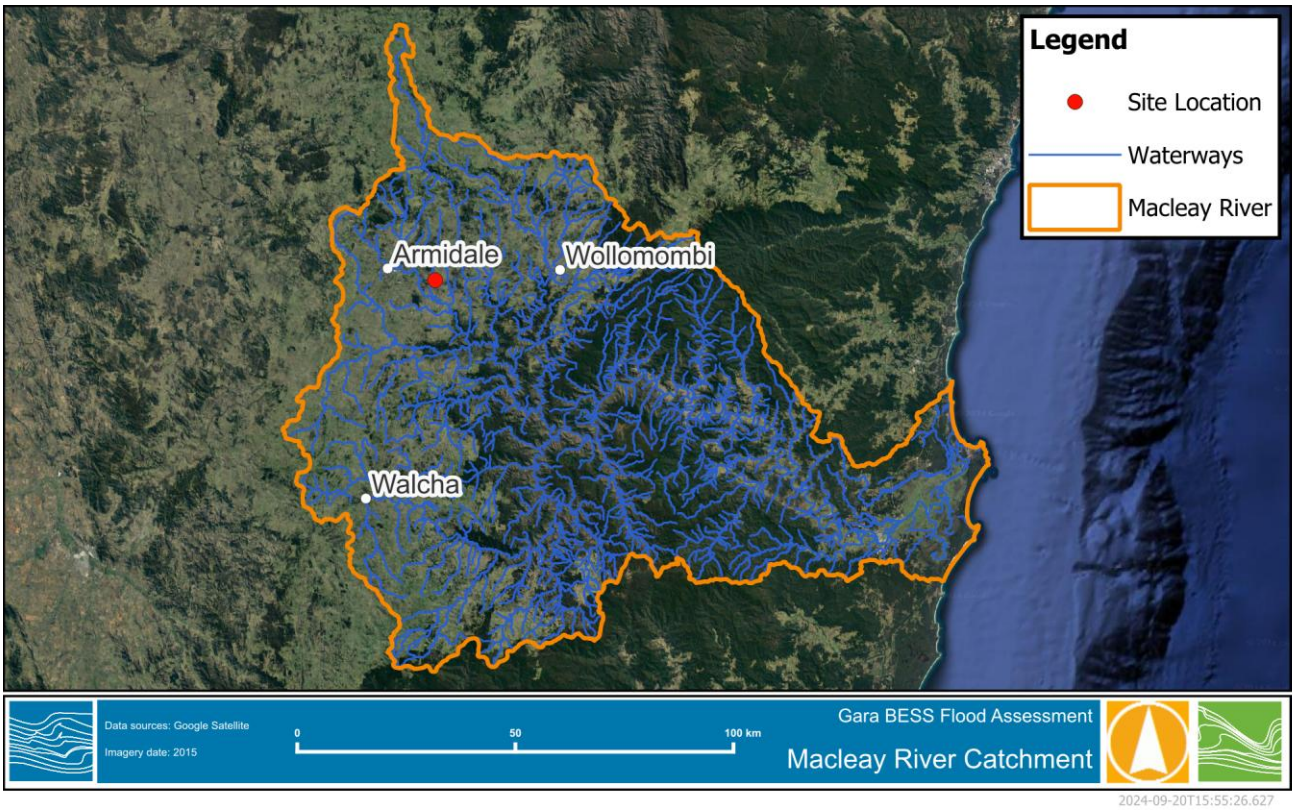

Figure 1-1 Macleay River catchment area

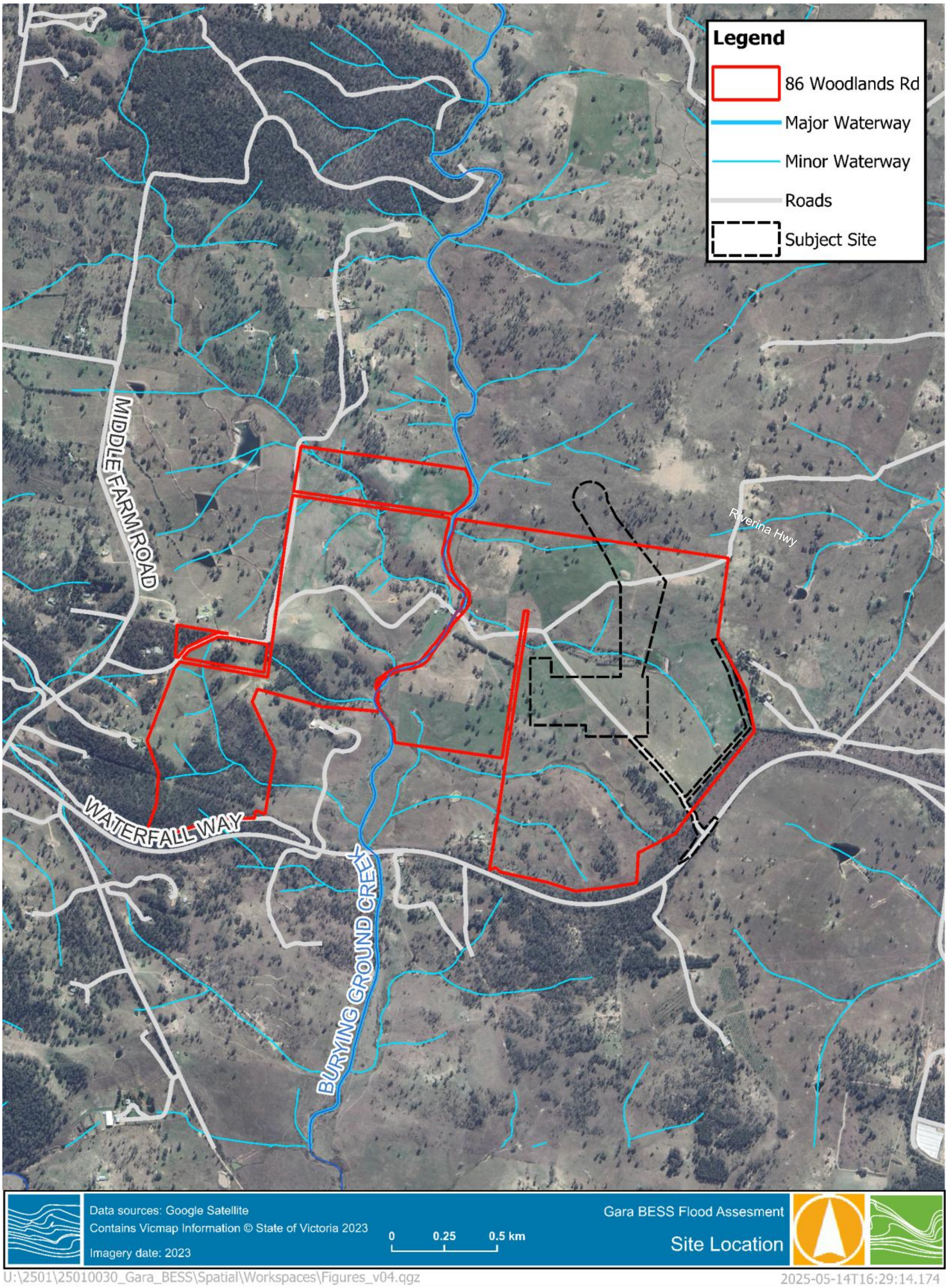

Figure 1-2 Site Location

1.3 Scope and Objective

The objective of this flood impact assessment was to assess and avoid/minimise/mitigate potential Site surface water inundation impacts. The work undertaken has involved:

- Characterisation of surface water and riverine flood risk in the project area, review of background information and topographic data.
- The development of a hydrological model to determine upstream riverine inflows of Burying Ground Creek into the hydraulic model.
- The development of a baseline hydraulic model to reflect the flooding behaviour and mechanisms (depth, water levels and velocities).
- Simulation of the 5%, 1%, 0.5% and 0.2% AEP events, as specified in the SEARs
- Determination of the Probable Maximum Flood (PMF) extent.
- Identification of potential impacts of the Subject Site on surface water; including effects on flooding (water levels, depths, velocities), and water quality.
- Provision of high-level recommendations for any mitigation or design alterations which may be required to reduce potential risks associated with flooding and drainage.

The output of the assessment is considered to provide the best currently available information on the flood risk at the Subject Site.

2 FLOODING METHODOLOGY

2.1 Overview

Hydrological modelling of the Site was undertaken in two steps:

- Step 1 - Hydrology for the Burying Ground Creek catchment was modelled using rainfall runoff software (RORB), which produced design flow hydrographs in the catchment in line with Australian Rainfall and Runoff 2019 (ARR2019) guidelines. An inflow hydrograph from the catchment upstream of the site within the RORB model was placed into a hydraulic model (TUFLOW), where the flows were routed past the topography of the Site and surrounding area to determine the maximum extent and depth of the 5, 1, 0.5, and 0.2% AEP storm events, as well as the PMF.
- Step 2: Undertake sensitivity on climate change rainfall depths to confirm SEARS advice of adopting 0.2% and 0.5% AEP events as proxies is appropriate.
- Step 3 - Hydraulics for the local catchment was modelled using the Direct Rainfall or Rain on Grid (RoG) approach, which incorporates calculated flows in the hydrological modelling, and introduces rainfall directly on the model extent for the selected AEP events. This approach included the application of available LiDAR, land use layers and structures.

2.2 Existing Studies

Armidale Dumaresq Council commissioned BMT WBM to complete Stage 3 of the Armidale Flood Study Review 2014[1] and Update, with previous stages conducted by Bewsher Consulting. This study formed part of the NSW floodplain management process, aimed to define the flood behaviour of Dumaresq Creek and its tributaries. Dumaresq Creek transects the township of Armidale, flowing into Commissioners Waters, approximately 12 km upstream of the confluence of Burying Ground Creek. Hydraulic events simulated in the study included 2 Year ARI, up to the Probable Maximum Flood (PMF).

Results from the Armidale Flood Study were adopted to determine the Flood Planning Level surrounding the township. A map is also published on the local council website of the Flood Planning Level, as shown below in Figure 2-1 below. It should be noted that the Subject Site at 86 Woodlands Road is outside the extent of the Flood Planning Level.

[1] BMT, July 2014, Armidale Flood Study Review and Update - Stage 3 Volume

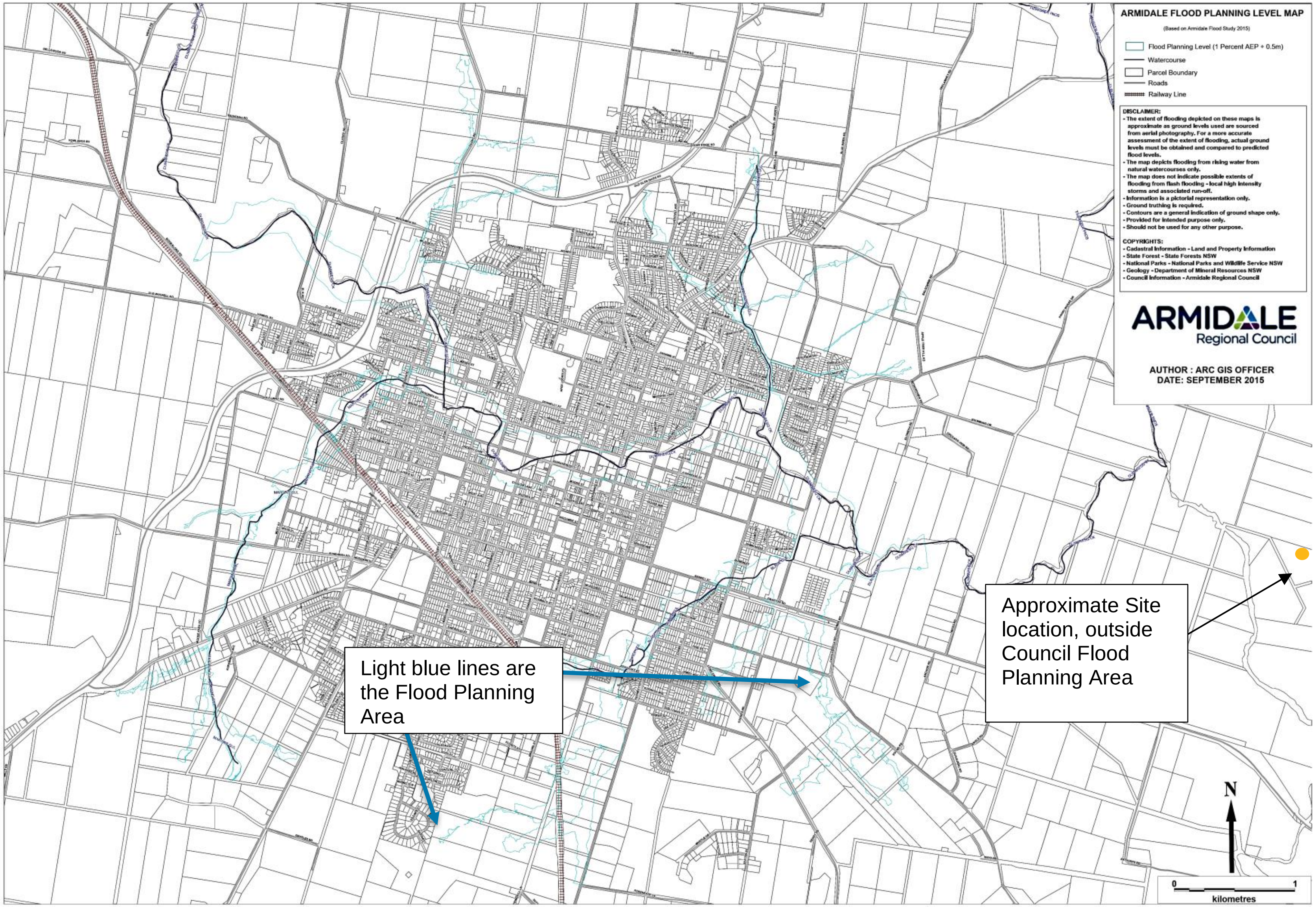

Figure 2-1 Armidale Flood Planning Level

2.3 Hydrologic Modelling

The hydrologic assessment used a runoff routing approach, modelled using RORB software. Design modelling was completed using both the Monte-Carlo and Ensemble approaches within RORB, as recommended by ARR2019.

The methodology for determining the critical AEP design flows is summarised below:

- Catchment delineation of the Burying Ground Creek catchment, upstream of the proposed Gara BESS site.
- RORB Model development.
- Determination of losses, 'kc' and 'm' model parameters.
- Determination of design inputs (e.g. rainfall, temporal patterns).
- Selection of critical storm duration and appropriate temporal pattern for design hydrographs.
- Extraction of inflow hydrographs for hydraulic modelling.

Details of these steps are provided in the following sections.

2.3.1 Catchment Delineation

The Burying Ground Creek catchment upstream of, and including, the Site was delineated into 44 subareas using a rolling-ball analysis of the regional 2m and 5m LiDAR. The resulting subareas were then processed using the GIS software QGIS in order to create a series of nodes and reaches, which represented the routing characteristic of the catchment to be used in the RORB model. Reaches were defined as natural except for the main body of the Creek, which was defined as excavated unlined to accommodate the slope of the catchment, which has an approximate gradient of 6.5%. Subarea fraction impervious was assigned based on the aerial imagery and land use characteristics of the region.

The resulting RORB model had 44 sub-catchments encompassing a total catchment area of approximately 58.5 km^2, with the proposed BESS located towards the lower end of the catchment shown in Figure 2-2.

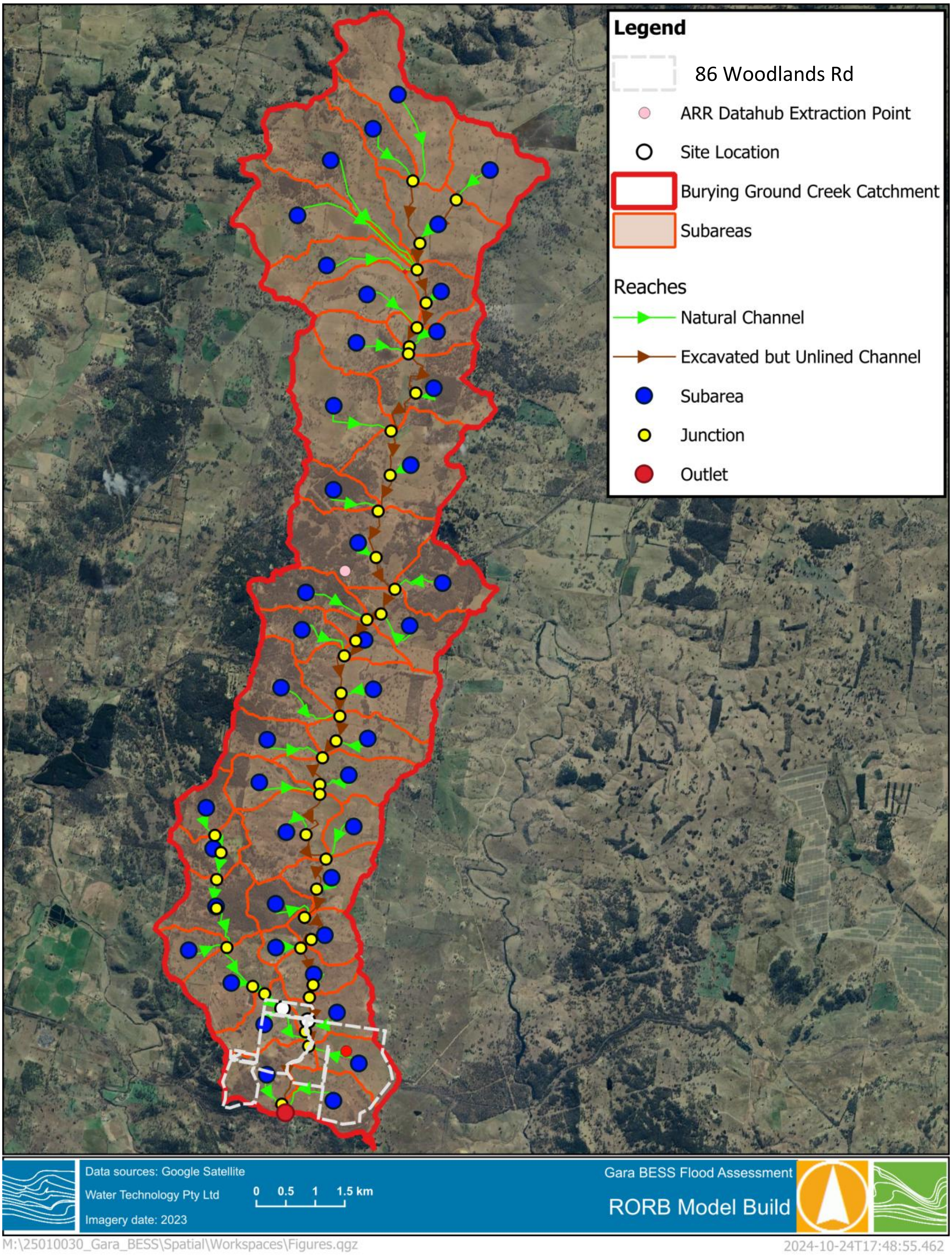

Figure 2-2 RORB model build

2.3.2 Routing Parameters – kc and m

There are no streamflow gauges within the study area catchment to calibrate the RORB model to and therefore, prediction equations for ungauged catchments were used to inform the selection of a 'reasonable' routing parameter, k_C.

McMahon and Muller (1983) showed that *kc* is directly proportional to the average flow distance (d_{av}). The recommended equation for catchments east and west of the Great Dividing Range for New South Wales is expressed as:

$k_C = 1.18A^{0.46}$

Where, *A* is the catchment area.

The RORB model *m* was set at 0.8. This is the recommended value for ungauged catchments[2].

2.3.3 Design Inputs

2.3.3.1 Event Duration

Design rainfall was derived for burst durations between 30 mins and 24 hours, based on the expectation that the critical storm duration for the study area catchment would be relatively short, given the size and steepness of the catchment area.

2.3.3.2 Intensity-Frequency-Duration (IFD)

Rainfall burst depths for the modelled AEP events were estimated for the centroid of the catchment using the 2016 ARR IFD analysis available from the Bureau of Meteorology[3]. These are displayed in Table 2-1, as well as the calculated Probable Maximum Precipitation (PMP).

- Latitude: 151.7665759
- Longitude: -30.46197

Table 2-1 Design rainfall depths (mm) for various event durations and AEP

AEP (1:Y)	30 min	1 hr	1.5 hr	2.0 hr	3.0 hr	6.0 hr	12.0 hr	24.0 hr
5	29.8	37	40.9	43.6	47.6	55.6	66.6	82
10	35.9	44.5	49.1	52.2	56.8	65.9	78.7	96.9
20	42.1	52.2	57.5	61.1	66.2	76.6	91.1	112
50	50.5	62.5	68.8	73.1	79.3	91.6	109	134
100	57.1	70.7	77.9	82.8	89.8	104	123	151
200	63.6	78.7	86.6	92	99.8	115	137	168
500	72.8	90.1	99.2	105	114	132	157	193
PMP	200	260	310	370	450	590	670	780

[2] E.M. Laurenson, R.G. Mein, and R.J. Nathan (2010), RORB User Manual
[3] http://www.bom.gov.au/water/designRainfalls/ifd/

2.3.3.3 Climate Change Sensitivity

Climate change was not assessed within this flood assessment as it was not a requirement of the SEARS. The SEARS advice specifies to use the 0.5 % and 0.2 % AEP Events as proxy climate change scenarios for the assessment. A comparison was undertaken for rainfall depths under the climate projection 4.5 and 8.5 in the year 2090. Depths show that the 1% AEP under different climate change projections for critical durations in the catchment is above the present day 0.2 % AEP. The depths are still below the Probable Maximum Flood (PMF) which is modelled in this assessment.

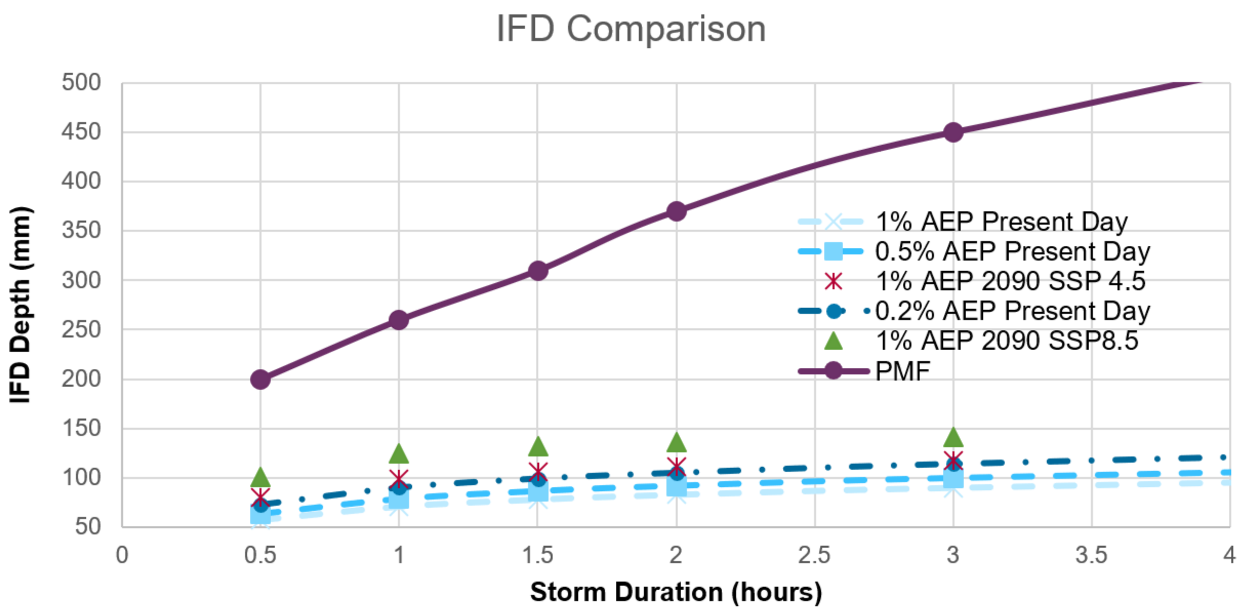

Figure 2-3 IFD Comparison to Climate Change

2.3.3.4 Areal Reduction Factors

The point rainfall estimates were converted to catchment average values using the areal reduction factors developed for Australia during the recent revision of ARR2016[4], Book 2 Chapter 4. Conceptually, this factor accounts for the fact that larger catchments are less likely to experience high intensity rainfall over the whole of the catchment.

2.3.3.5 Temporal Patterns

Design storm temporal patterns were downloaded from the ARR Data Hub[5] and were used to simulate the distribution of burst rainfall depth during each storm event modelled. Point based temporal patterns were used given the catchment size of <75 km^2.

2.3.3.6 Spatial Patterns

A uniform spatial pattern was adopted.

[4] http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/
[5] https://data.arr-software.org/

2.3.3.7 Design Losses

An initial/continuing loss model was applied for the RORB modelling. A variety of sources were assessed to determine appropriate design losses for the model. An initial loss of 15 mm and continuing loss value of 1.5 mm/hr were calibrated in the 1992 Floodplain Management Flood Study, referenced in the 2004 Armidale Flood Study[6] and used in subsequent flood studies in the area; these have been adopted for this study.

These *k* and loss values (Table 2-2) were adopted in the RORB design modelling for the purpose of flood impact assessment.

Table 2-2 Adopted RORB parameter values

Parameters	Adopted Values
m	0.8
k_C	7.67
Initial Loss (mm)	15.0
Continuing Loss (mm/hr)	1.5

2.3.4 Model Verification

Sensitivity of k_C and rainfall losses were estimated by comparing modelled peak flows with peak flows produced by the ARR Regional Flood Frequency Estimation (RFEE) method[7]. The RFFE method is a replacement for the Probabilistic Rational Method described in the previous version of ARRs. It is a software implementation of the ARR Revision Project 5. A full description of the method is provided in ARR project (http://arr.ga.gov.au/).

The RORB model was run in a Monte Carlo framework, and the results compared to those produced by RFFE. It should be noted that RFFE has certain limitations. In this instance, the catchment is particularly long, narrow, and steeper than the RFFE process is designed to assess. Given these characteristics, the catchment can be expected to produce faster flows and less attenuation, so it is reasonable to assume that RFFE will tend to underestimate peak flows.

With the RORB parameters shown in Table 2-2, the RORB model produced a peak flow of 444.1 m³/s compared to 167.4 m³/s produced by the RFFE model at the outlet position for 1% AEP. The RORB peak flow is still within the 95% confidence limit, with the expected underestimate as previously noted.

2.3.5 RORB Outputs

The results of the RORB Monte Carlo analysis at the catchment outlet are shown in Table 2-3.

Table 2-3 RORB Monte Carlo results – Catchment outlet

AEP (%)	RORB Peak Flow (m³/s)	Critical Duration (h)
50	87.0	4.5
20	175.6	1.5
10	237.7	2

[6] https://flooddata.ses.nsw.gov.au/flood-projects/armidale-flood-study
[7] https://rffe-2021.wmawater.com.au/

AEP (%)	RORB Peak Flow (m³/s)	Critical Duration (h)
5	292.5	2
2	374.5	1.5
1	444.1	1.5
0.5	515.4	1.5
0.2	595.7	1.5

For use in the hydraulic model, peak flows were extracted from the print points shown in Figure 2-2 for the proposed design AEP events. These hydraulic model inflows are shown in Table 2-4 below.

Table 2-4 RORB Monte Carlo results – Hydraulic model inflows

AEP (%)	Western Print Point Peak Flow (m³/s)	Eastern Print Point Peak Flow (m³/s)
5	37.3	257.1
1	53.6	392.5
0.5	61.4	451.9
0.2	72.3	521.4

2.3.5.1 Probable Maximum Flood (PMF)

For the PMF, an ensemble run generated results for durations between 30 minutes and 96 hours, all temporal patterns. The inflows to be used in the hydraulic model were the peak flow calculated by an individual storm, see Table 2-5.

Table 2-5 PMF Ensemble peak flow results

Event	Western Print Point	Eastern Print Point
Duration (h)	1	2
Temporal pattern	03	10
Peak Flow (m³/s)	286.6	2301

2.4 Hydraulic Model Development

To understand how direct catchment runoff impacts the Site, a hydraulic modelling assessment 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 complete local catchment area draining to the Site, downstream of the RORB inflows.

2.4.1 Hydraulic Model

TUFLOW HPC was selected as the numerical solver for the development of the surface water and riverine 2D hydraulic model. The High-Performance 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 build of TUFLOW.

2.4.2 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 6.1 km² which included the full contributing catchment from localised runoff. It utilised of a uniform grid of 2 m resolution square cells to take advantage of the best-available LiDAR.

The topography of the site in the hydraulic model was represented by 2m resolution LiDAR captured in 2015 (Armidale201505-LID2-AHD_2m). This LiDAR adequately represented the floodplain topography, allowing for accurate flood routing for out of bank and surface water 2D flow (Figure 2-4).

The following modification was also added to the LiDAR to provide additional detail to the 2D domain of the hydraulic model:

- Survey of Waterfall Way (Grafton Road) and the adjoining access track in the south-east section of the model. These survey points were generated into a TIN and stamped onto the base 2m LiDAR.

2.4.3 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[8]. Amendments to the spatial distribution of roughness was made using aerial imagery and engineering judgement. Figure 2-5 highlights the distribution of material types across the modelled domain. Each land use type was assigned a corresponding Manning's 'n' value in the TUFLOW Materials File, as shown in Table 2-6, with a set default Manning's 'n' value of 0.04 (material ID: 9).

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

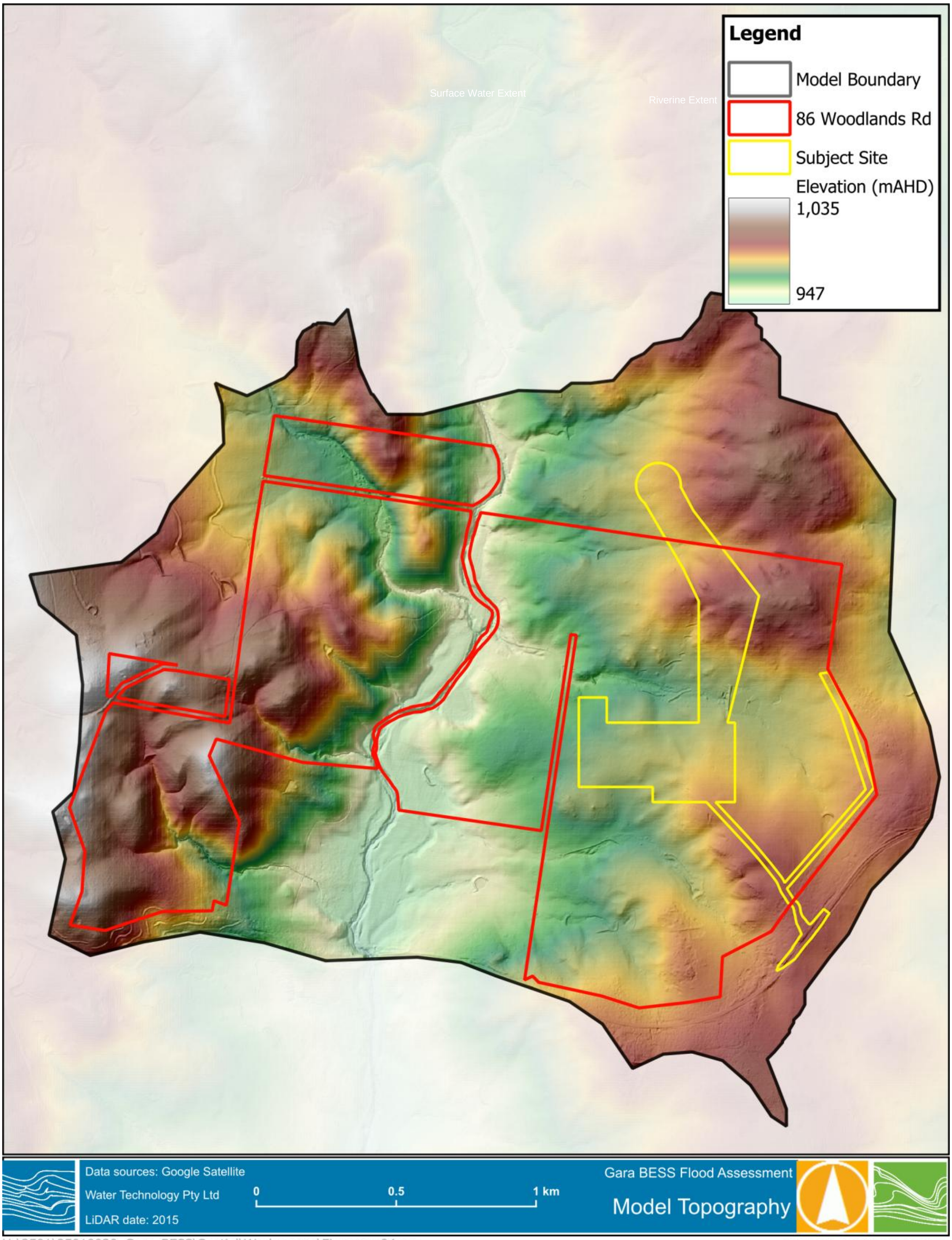

Figure 2-4 Model Extent & Topography

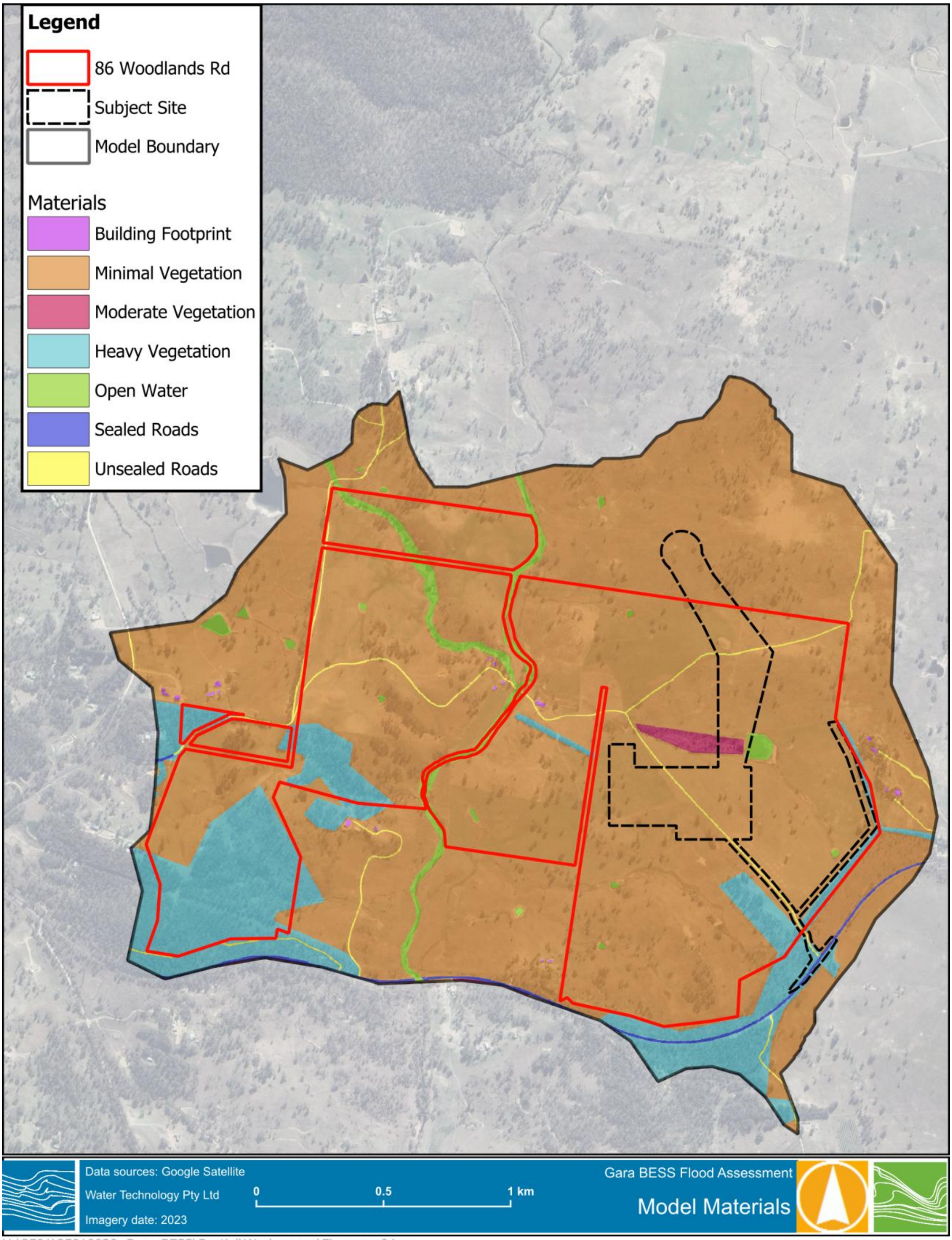

Figure 2-5 Existing Scenario Land use

Table 2-6 Manning's 'n' Roughness Coefficients

Land Use	Manning's 'n' Roughness Coefficient
Building footprints	0.500
Minimal vegetation	0.040
Medium vegetation	0.060
Heavy vegetation	0.090
Open water	0.020
Sealed roads	0.020
Unsealed roads	0.030
Concrete pads	0.025
Crushed rock sub-base	0.070

2.4.4 Hydraulic Structures

Several hydraulic structures were identified in the supplied data from ACEnergy, including two culverts crossing the access track north of the proposed development (0.45 m Ø), two culverts crossing the south-eastern access track (0.45 and 0.3 m Ø), and one culvert crossing Waterfall Way (Grafton Road) (1.0 m Ø). These identified circular culverts were applied to the TUFLOW model as explicit 1D elements using supplied invert details. Default entry and exit coefficients were applied to the circular culvert.

The 1D circular culverts were coupled to the 2D domain using a sink/source (SX) type connection. SX connections do not preserve the momentum of the flow rate, rather the water level and volume are applied to the connected cells and then dispersed within the 2D domain. This method is recommended by TUFLOW for explicit structures such as culverts where the diameter is less than the cell size. The number of 1D/2D connections created in the existing and developed scenario is commensurate with the diameter of the structure.

2.4.5 Hydrologic Input

2.4.5.1 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 data from the ARR 2019 and Bureau of Meteorology (BoM) databases for the surface water catchment (coordinates: 151.76065, -30.53640).

To determine the peak surface water flood levels within the area of interest, an ensemble approach based on rainfall from the Central Slopes zone was used in this assessment. To determine a critical duration, a representative, centrally loaded temporal pattern was run for several durations for each AEP event. It was noted that there were two critical durations of interest; one was the surface water flow across the site, the other was for the waterway directly to the north of the site. Appendix A shows the duration that created the largest peak depth at any point in the model. With two critical durations identified for each AEP event, the ensemble approach modelled 10 available temporal patterns for each of the critical durations. The median depths from these ensemble runs were extracted, and for each AEP event, the maximum of the two critical duration median depths was calculated to create a composite peak result. Further discussion surrounding the post-processing method for the surface water results are found within Section 3.2.

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.

2.4.5.2 Riverine Inflow

The model uses the RORB derived inflows that have been output at the upstream print locations in Figure 2-2. A conservative approach was selected to model these riverine inflows, so for each AEP event, the peak flow calculated in the Monte-Carlo analysis was applied as a constant inflow. This eliminated potential issues with different timings of rainfall on the hydraulic model and riverine flows from the hydrologic model, and serves as a worst-case scenario for downstream conditions of the site during surface water assessments.

2.4.6 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 15 mm for initial loss (IL) and 1.5 mm/h for continuing loss (CL) were taken from the calibrated values in the 1992 Floodplain Management Flood Study, see the 2004 Armidale Flood Study[9]. As is recommended, these starting values were reduced based on engineering judgement and tabulated in Table 2-7.

Table 2-7 Rainfall loss values

Land Use	Initial Loss (mm)	Continuing Loss (mm/h)
Building footprints	2	1
Minimal vegetation	7.5	1.5
Medium vegetation	7.5	1.5
Heavy vegetation	7.5	1.5
Open water	0.5	0.5
Sealed roads	1	0
Unsealed roads	1	0
Concrete pads	1	0
Crushed rock sub-base	2	0.5

2.4.7 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 design/mitigation measures can be assessed. The direct rainfall is assumed to be spatially uniform across the entirety of the surface water catchment at the proposed BESS site. TUFLOW converts the original rainfall hyetograph to a hydrograph to smooth the transition from one rainfall period to another.

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[9] https://flooddata.ses.nsw.gov.au/flood-projects/armidale-flood-study

A series of stage-discharge (HQ) curves were applied to sections of the model domain perimeter to remove surface water runoff and creek flow that is discharging away from the Site into neighbouring catchments or further downstream. Each of these discharge curves were automatically generated by TUFLOW and were based on a slope derived from local ground topography. The riverine inflow boundaries use a flow-time (QT) boundary that reference a database of peak flows generated from RORB.

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 2-7 highlights the internal and external boundaries relative to the Site.

2.4.8 Initial Water Level

A small dam is located to the north of the proposed BESS area which captures runoff from the small upstream tributary. The location of the dam is shown in Figure 2-8 and the initial water level in the hydraulic model has been assumed to be full as a conservative approach.

2.4.9 Gara BESS Design Updates

To account for the changes in landscape because of the BESS, the developed scenario for the RoG model included topographic and land use changes. Details for each of the main model updates are described below for the proposed elements, with specific materials roughness and losses available in Tables Table 2-7:

- BESS and transformers – The proposed batteries and MVPS have been included as a 0.3 m uplift on the underlying topography, and the land use material changed to concrete footings. Representing the concrete footings presents a conservative case in undertaking the flood assessment.
- Site topography – The existing terrain was updated to include a representation of the proposed design surface as a 0.1 m resolution TIN of the ACEnergy supplied elevation points as shown in Figure 2-6. Most notably this includes a basin in the north-west section of the Site. Additionally, the land use material across the proposed BESS area was changed to crushed rock.
- Access road – The access road into the Site from Waterfall Way (Grafton Road) was raised by 0.05 m on existing levels for the likely re-sheeting of the road surface. The land use material was likewise updated to a sealed road to account for the proposed road upgrade to handle heavy vehicles.
- Waterfall Way intersection - the topography around the Waterfall Way intersection to the access road was updated based on the elevation data supplied by ACEnergy. The existing culvert that crosses the access track at Waterfall Way (Grafton Road) was also lengthened to factor the new proposed road extent.

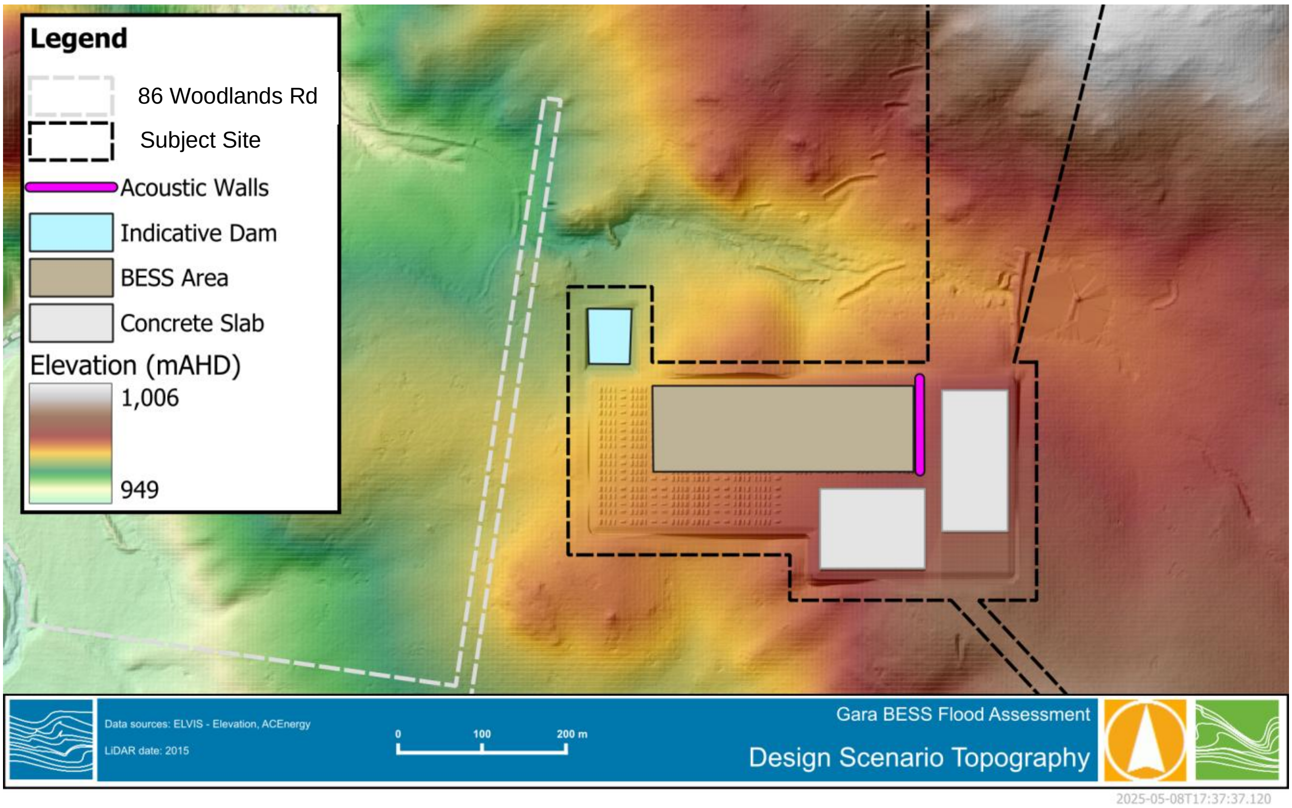

Figure 2-6 Design Scenario Topography

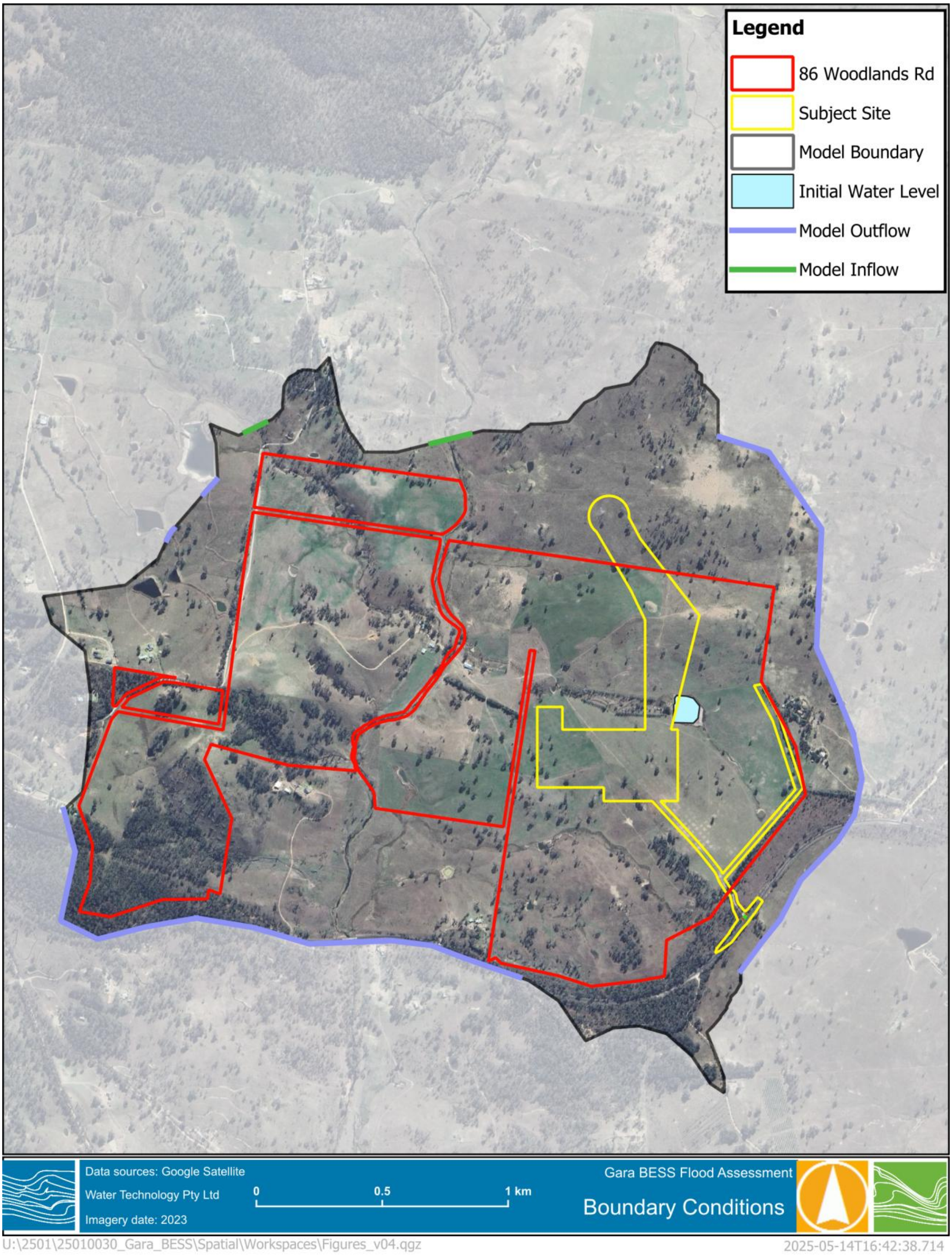

Figure 2-7 Boundary conditions

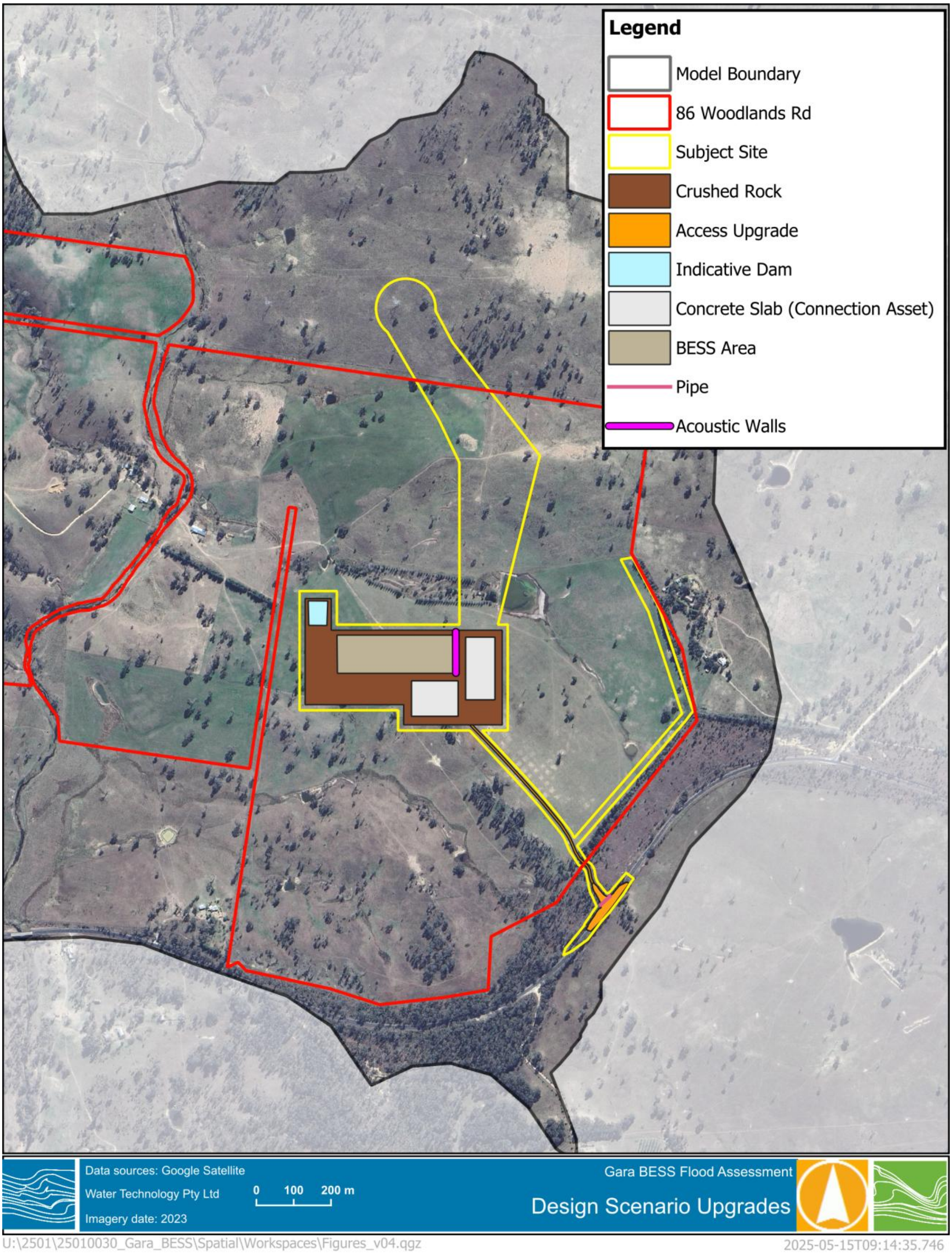

Figure 2-8 Hydraulic model changes for the design scenario

3 FLOODING RESULTS

3.1 Overview

The results of the flood modelling are presented in this section. The maximum flood level, 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 0.02 ha have been filtered from all results.

In this report only the 5%, 1% AEP and PMF events are discussed under existing and developed site conditions, with the remainder of the results provided in mapping and provided as GIS layers. Results for the 0.5% and 0.2% AEP were used for the discussion of flood levels as a proxy for increased rainfall intensity under climate change conditions.

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)[10]. 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 3-1 and vulnerability thresholds classifications are tabulated in Table 3-1.

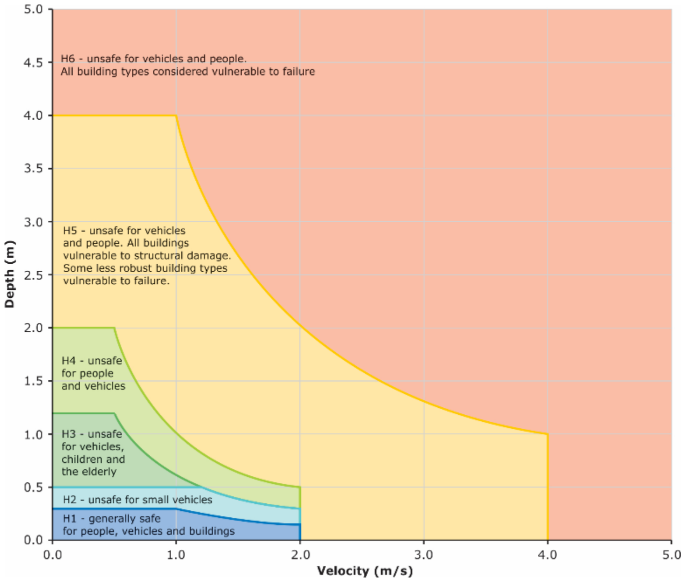

Figure 3-1 Combined flood hazard curves

Table 3-1 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.

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

3.2 Grid Processing Methodology

All simulated AEP events for the surface water assessment were modelled with a range of durations from 30 minutes to 24 hours. The median result for the two key critical durations for each event were then merged together to create a composite maximum envelope. Figure 3-2 visualises this process.

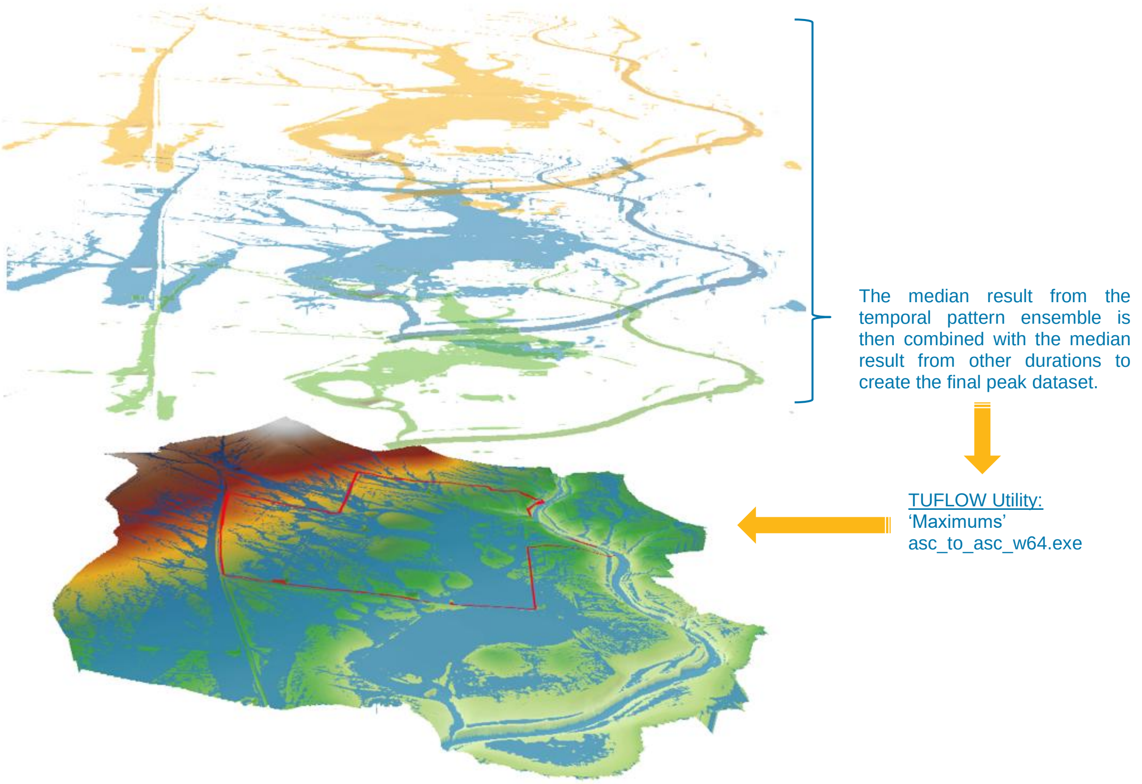

Figure 3-2 Processing the temporal pattern and duration overlap

3.3 Existing Conditions

The 1% AEP hydraulic model results outlined in Figure 3-4 to Figure 3-6 indicate that the 1% AEP event does not produce any major external catchment flow paths through the Site. The general fall across the proposed Site is from the south-east to north-west, split across three minor tributaries. Predicted 1% AEP peak depths within the Site ranges between 0.03 to 0.09 metres within the three tributaries. There is a minor branch of Burying Ground Creek that traverses from east to west just north of the BESS area. A small farm dam is also located just to the south of the BESS area which was assumed full in the hydraulic modelling.

Peak water level within Burying Ground Creek closest to the Site is approximately 955.5 mAHD, at least 17 metres below the lowest elevation within the proposed BESS area. A long-section through the lease area (Figure 3-3; south-east to north-west) further confirms this, with the predicted peak water levels for the PMF AEP event overlayed onto the underlying DTM. The results highlight the shallow depths of flooding produced across the Site flow off in three directions but generally in a south-east to north-west direction. A similar flooding mechanism is seen in the 5% AEP and 1% AEP events.

The velocities and hazard classification follow a similar pattern, with peak velocities within the Site ranging from 0.3 to 0.1 m/s. This is quite slow and is reflective of the H1 hazard classification. Risk to people and vehicles within the Site area in existing conditions is therefore not considered a concern.

The 0.5% and 0.2% AEP events were also simulated as proxies for assessing sensitivity to climate change (as specified in the SEARS). Results indicate similar flood behaviour to the 1% AEP, with approximately 0.1m increase in flood depth in the 0.5% and 0.2% respectively.

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

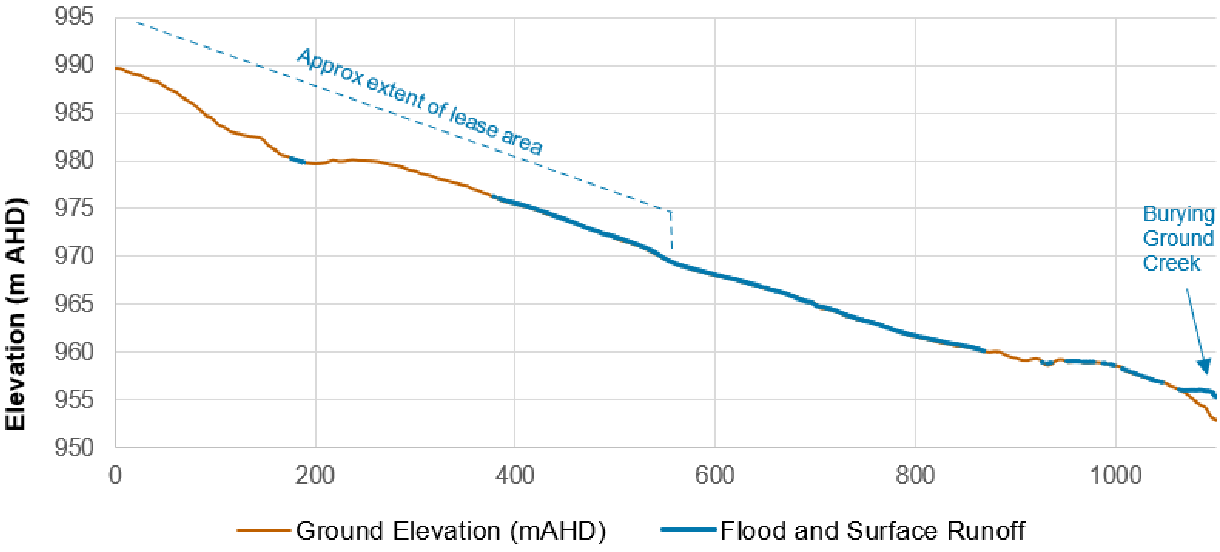

Figure 3-3 Existing Conditions – 1% AEP water level (long-section through Site)

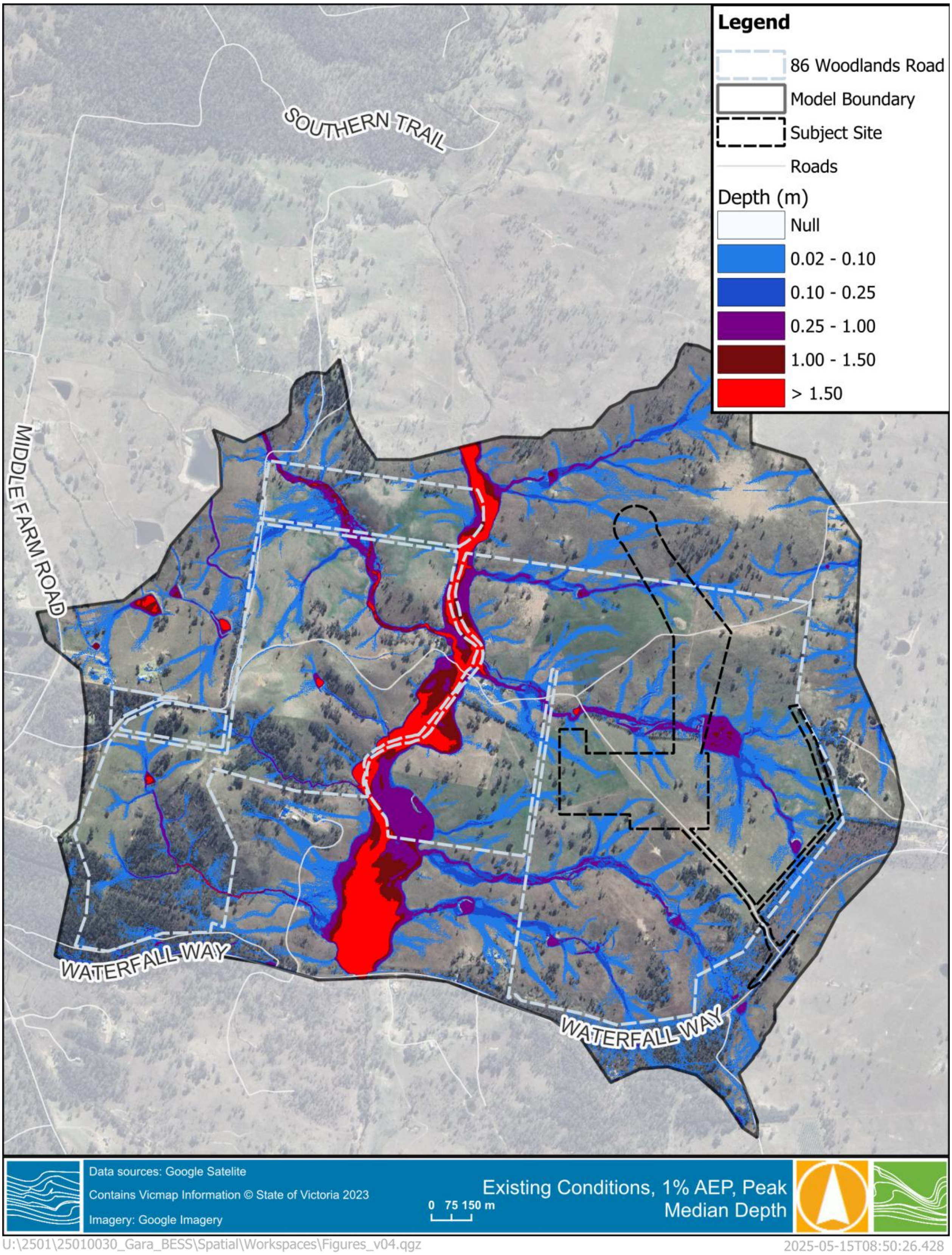

Figure 3-4 Existing Conditions – 1% AEP flood depth

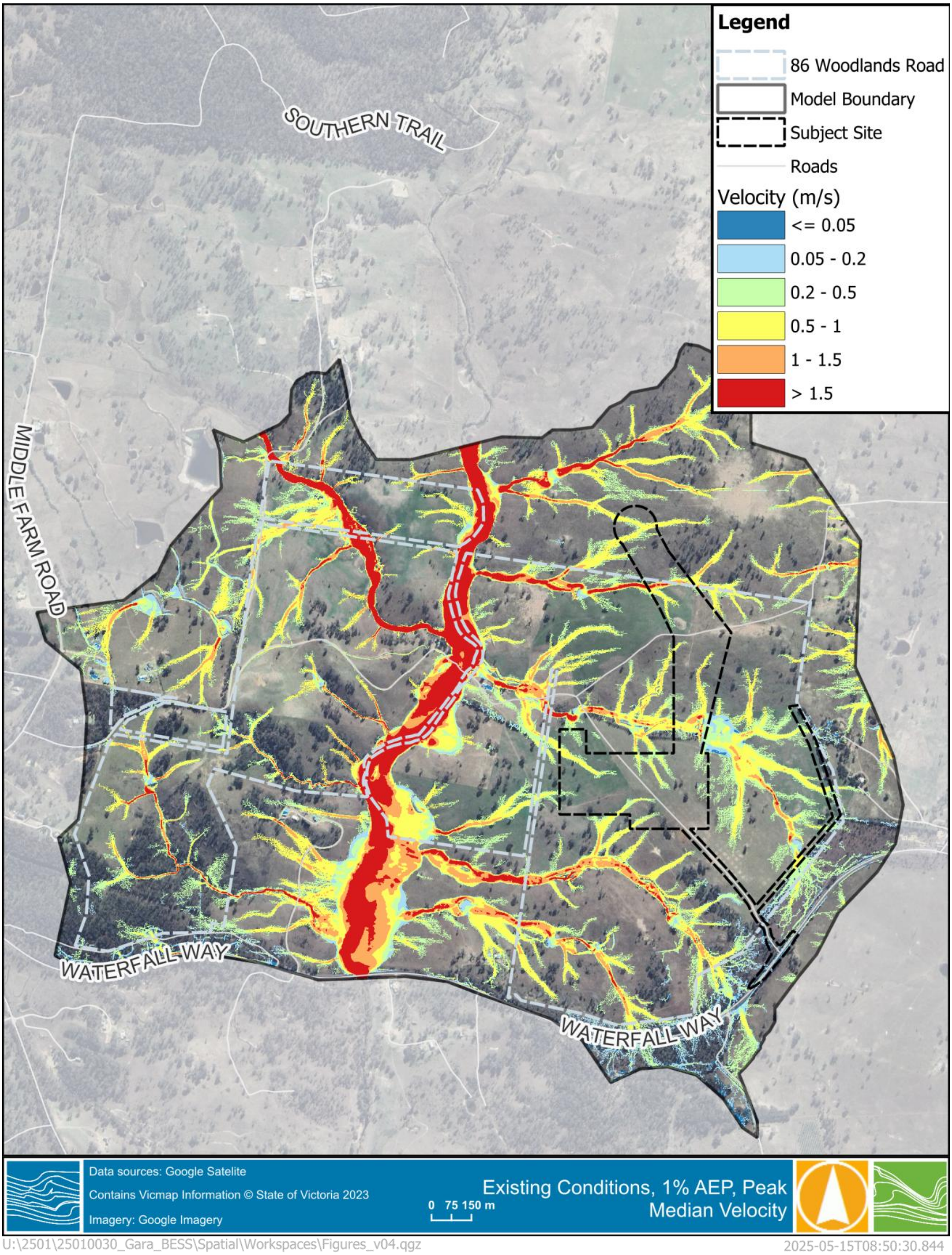

Figure 3-5 Existing Conditions – 1% AEP flood velocity

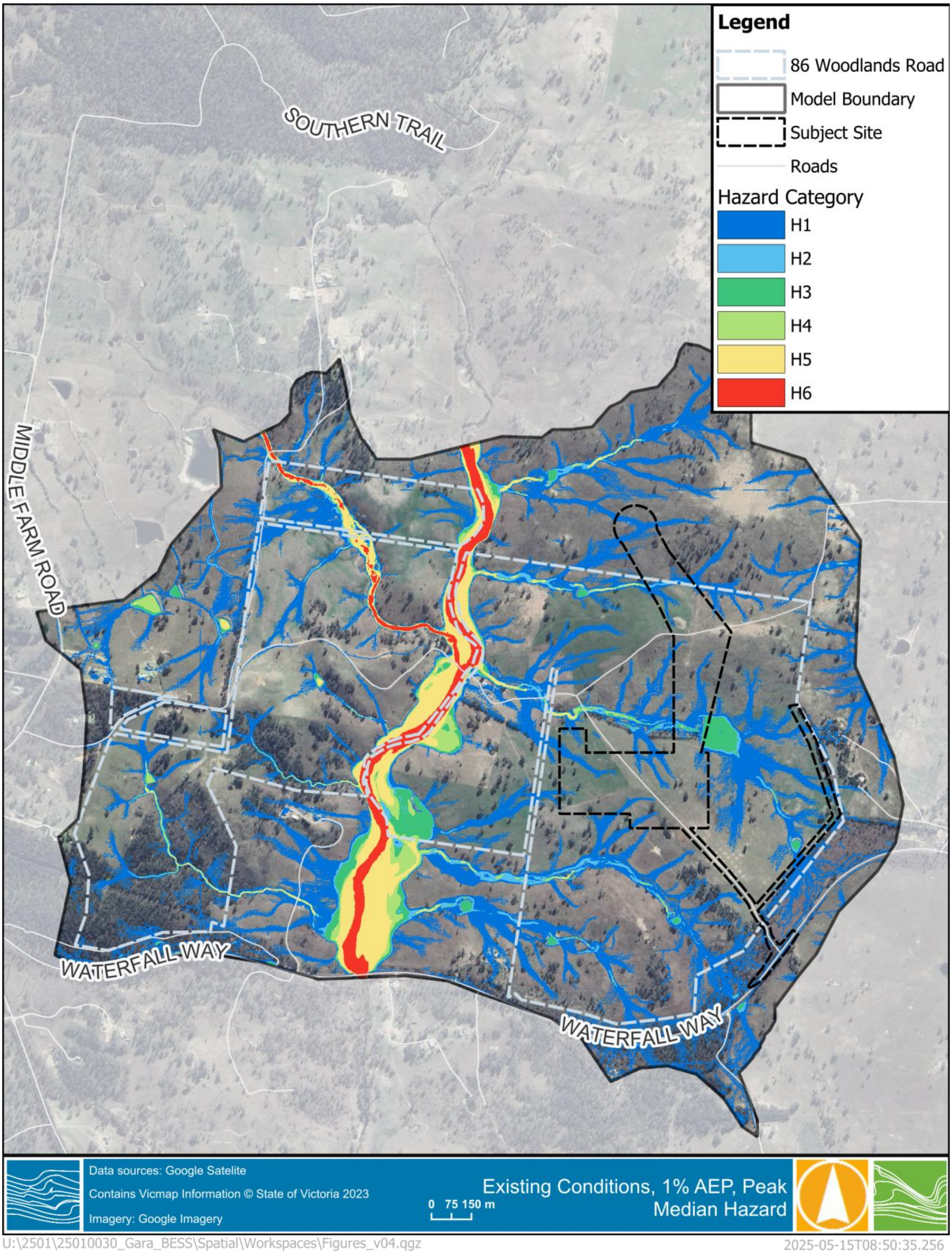

Figure 3-6 Existing Conditions – 1% AEP flood hazard

3.4 Developed Conditions

The impact of the proposed development on the flood behaviour is negligible to very low. The changes to land topography (cut/fill) proposed for the BESS facility are detailed in Section 2.4.9. To account for the installation of key assets, the baseline RoG model was also modified to include raised access track and project infrastructure locations.

Developed conditions output from the hydraulic model were compared to that of existing conditions to show the change in depths and inundation extents caused by the development for a 5% AEP up to the PMF event. The predicted changes in peak flood levels are a result of the proposed development cut and fill, and concrete footing elevations. The design updates produce a slight attenuation in overland flow behind the access road and elevated platform (Figure 3-7). It should be noted that the topography changes occur at the top of the catchment and do not significantly alter flood behaviour through Burying Ground Creek.

The inclusion of the Gara BESS and adjustments to the local topography indicate areas of decreased runoff around the vicinity of the proposed Site. The difference in the predicted peak flood depth results, shown in Figure 3-7 and Appendix C, highlight areas of new inundation (blue) across the BESS facility. This can be attributed to the raised the pad levels within the development fill that act as obstacles to the shallow sheet flow, which slopes towards the north-west corner. The predicted maximum depth of flooding within the proposed BESS area does not exceed 0.1m in the 1% AEP event, which is considered low and does not encroach above the concrete footings. Peak depth in the PMF does not exceed 0.15 m within the BESS facility. Within the development extent, there are areas of depth up to 1 m, these areas are located within the tributaries that drain from east to west. The placement of the proposed electricity poles/towers within the development extent should be located outside any mapped flood extent in all events, if practical.

The extent of reduced flood depths (Figure 3-7; yellow and green areas) are a result of the re-sloped land for the proposed development fill. Existing runoff within the BESS area was generally conveyed in three separate directions towards Burying Ground Creek. In the developed scenario however, the design topography disperses the shallow sheet flow and collects runoff at the basin in the north-west corner. Localised reductions in peak flood depths can be seen along the north-west tributary that drains the BESS area of between 0.02 m and 0.5 m for the 5% AEP and PMF Events respectively. The reductions are likely a result of the small attenuation and timing difference caused by the raised pad areas within the BESS. The basin in the north-west corner of the BESS is also predicted to capture this runoff prior to water quality treatment.

There are also some small changes in flood extent surrounding the proposed intersection upgrade at Waterfall Way (Grafton Road). In the existing scenario, there is a 300 mm diameter pipe that transects the access road at the Waterfall Way (Grafton Road) intersection that provides conveyance in a north to south direction. In the developed scenario, this pipe has been extended to allow for the widening of the road for the intersection upgrade. This was not formally incorporated in preliminary design drawings provided by ACEnergy but is recommended in future design stages.

The changes in peak flood depth due to the proposed development are localised and do not adversely affect neighbouring properties or the wider model domain. The location of the proposed BESS, situated on a ridge of the of the Burying Ground Creek catchment is considered suitable from a flood risk perspective and outside the riverine PMF extent. The proposed development is not predicted to result in indirect or direct damage to the local community in the event of significant flooding. 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 1% AEP event. Looking at wider access implications Waterfall Way (Grafton Road) is likely to remain open up to the 1% AEP Regarding access implications, the construction phase and resurfacing of access roads may create a bottleneck to any evacuation and emergency services. Therefore, it is recommended to not impede the movement of vehicles on the Waterfall Way (Grafton Road) more than necessary during the construction and operation of the proposed BESS.

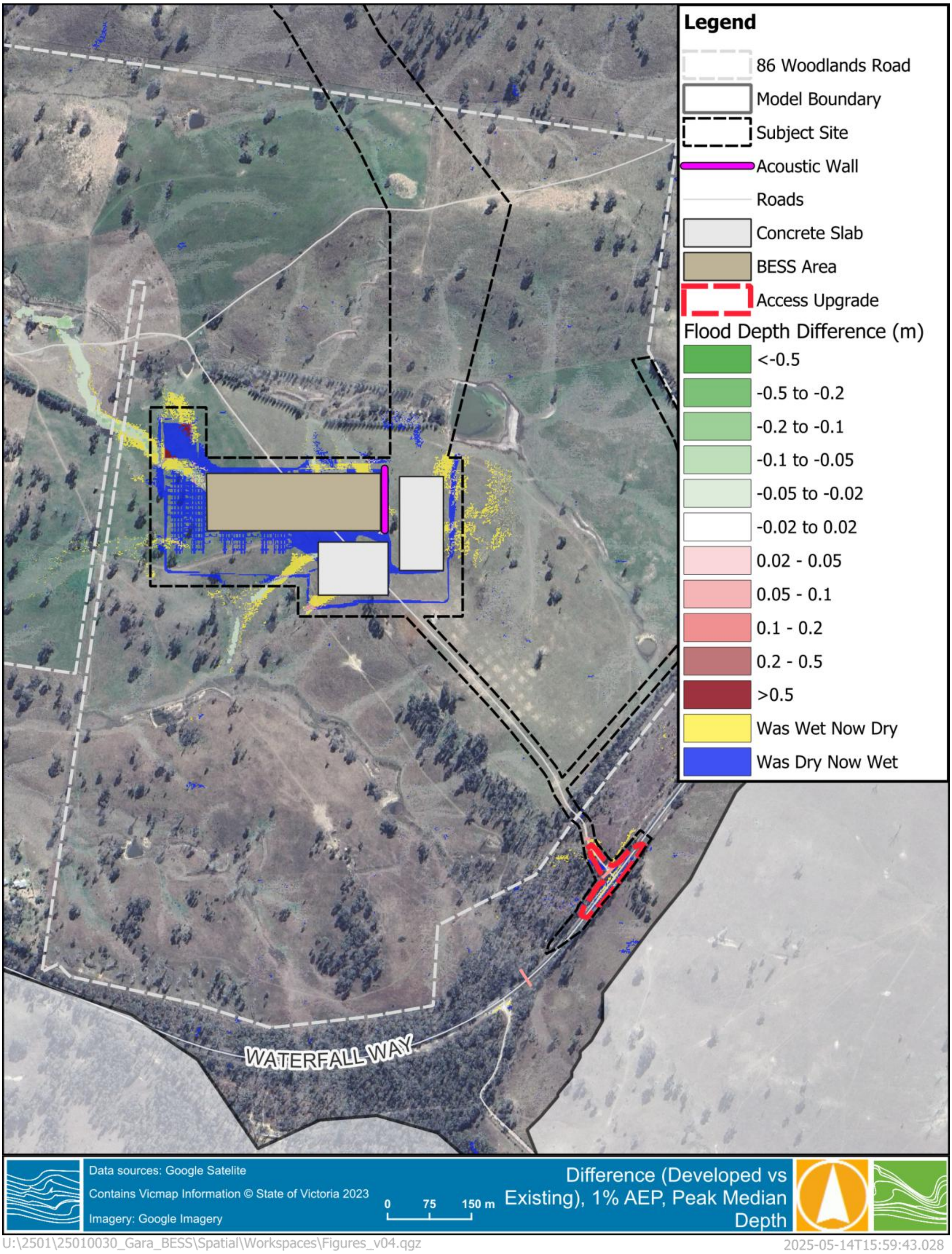

Figure 3-7 Change in 1% AEP peak depth

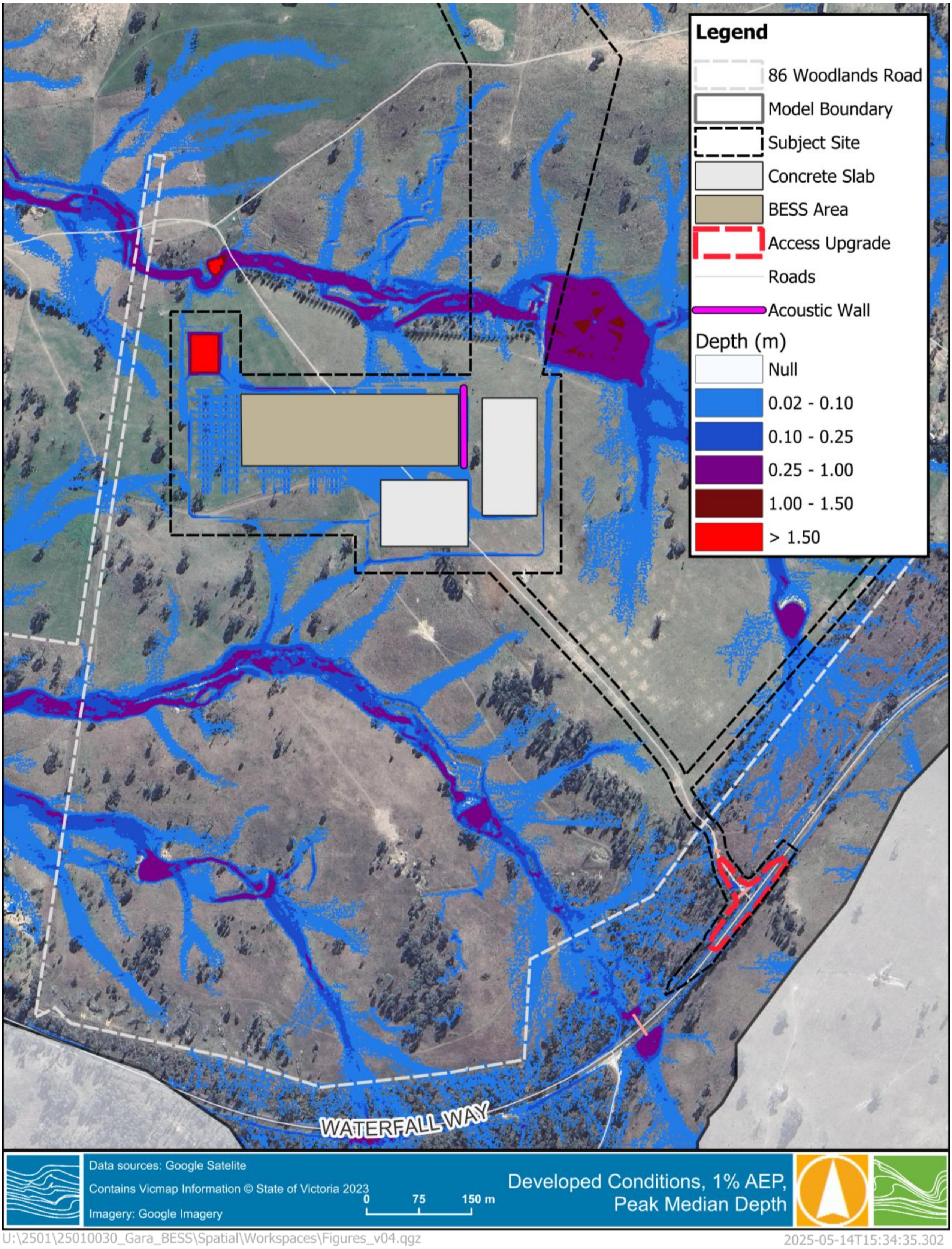

Figure 3-8 Developed Conditions 1% AEP Peak Depth

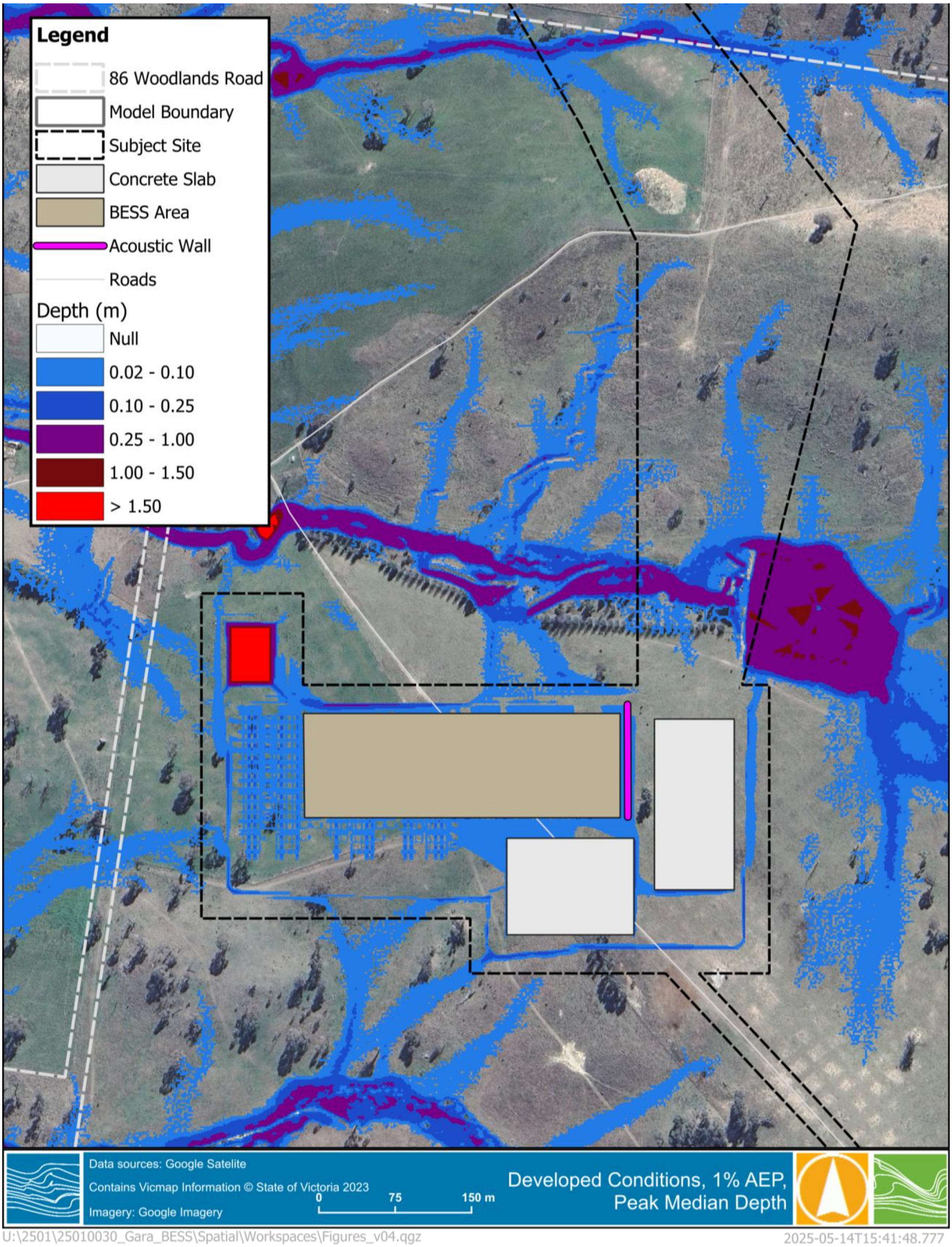

Figure 3-9 Developed Conditions 1% AEP Peak Depth at the BESS Facility

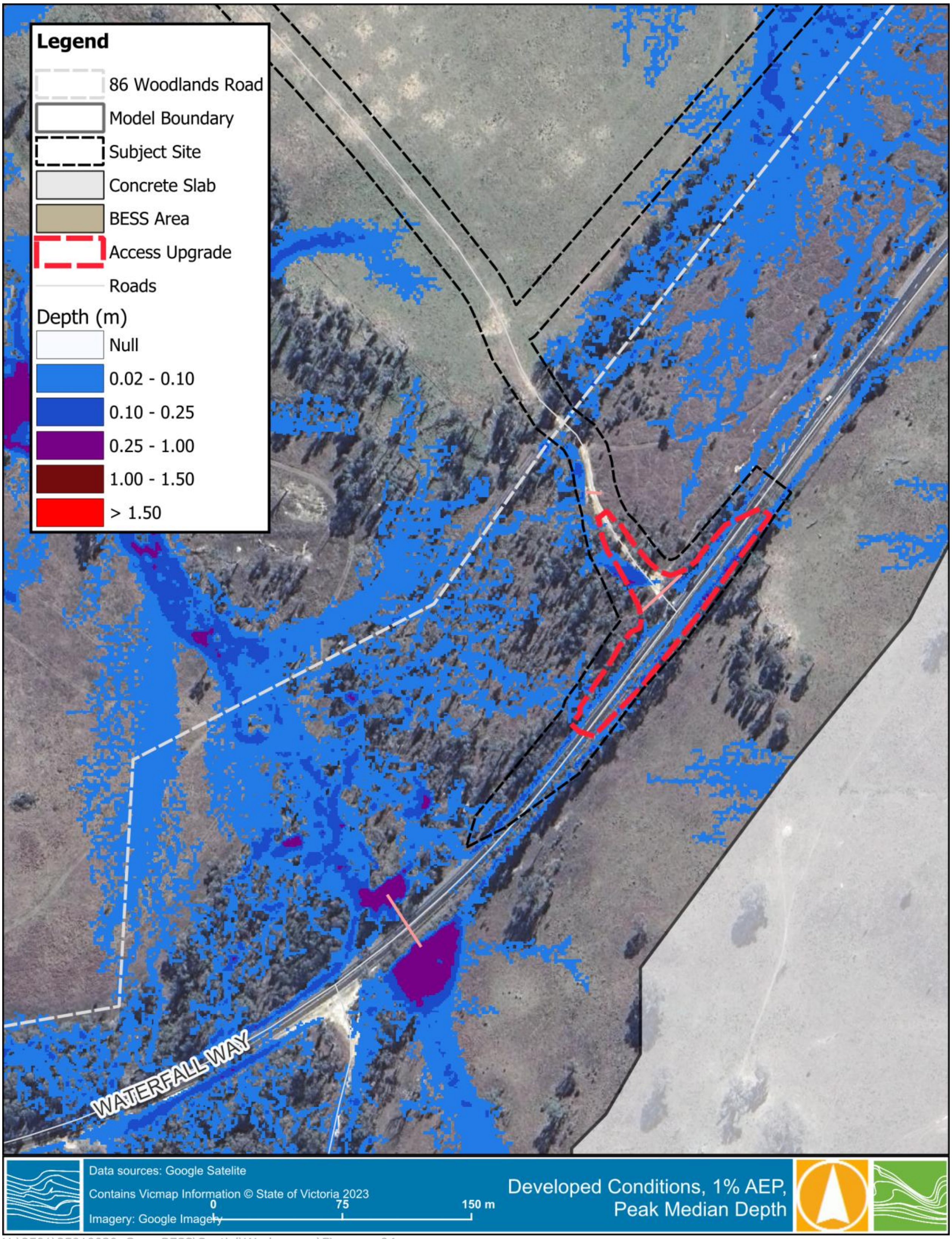

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Figure 3-10 Developed Conditions 1% AEP Peak Depth at the Access Upgrade

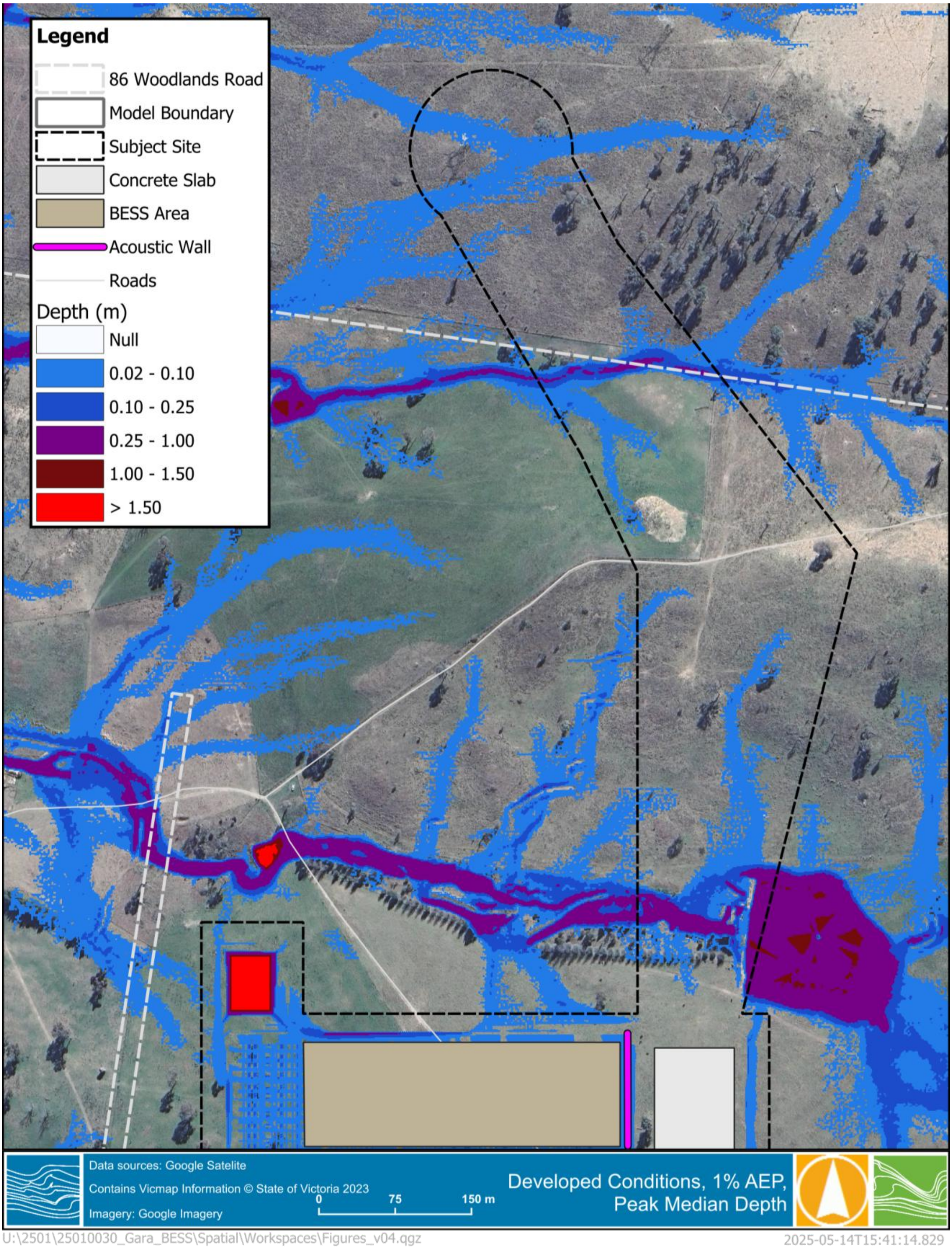

Figure 3-11 Developed Conditions 1% AEP Peak Depth within the Electricity Extent

4 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 on raised concrete footings to 300mm elevation above finished ground level at the site. 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 these small concrete footings is highly unlikely to result in any adverse impacts offsite.
- The footings should be designed to withstand the flood velocities described in this report, which are mostly low in the Development Footprint.
- Extension of existing 300 mm diameter pipe under the existing access tract at the intersection with Waterfall Way (Grafton Road).
- Incorporate drainage channels in a north to south direction within the BESS area to control surface runoff within the proposed facility.
- The location of the proposed electricity poles/towers within the development extent should be outside any mapped flood depth in all modelled events, if practical.
- 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 via Waterfall Way (Grafton Road).

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.

5 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 SEARs item are found in the Table 5-1 below.

Table 5-1 SEARs items and responses

SEAR Items		Responses
Key Issue		
Water Take and Licensing		
1	A detailed and consolidated site water balance	No water planned to be extracted No water balance is required as there is no expected extraction or re-use of water from Site.
2	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent.	The Groundwater assessment is not covered within this report. The proposed development fill alters surface runoff behaviour slightly but does not result in detrimental flood levels external to the Site. See Section 3.4 for discussion.
3	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained.	Groundwater not covered within this report. No water is expected to be extracted from Site.
4	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the *Water Management Act 2000* should be detailed by the proponent.	No WAL required. for the proposed Site.
Water Impacts		
5	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions	Not covered in this report.

SEAR Items		Responses
6	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels: including measures proposed to reduce and mitigate these impacts.	Addressed in Section 3.4 and detailed mapping in Appendix A. There is negligible impact to water quantity, any small areas of increased water level do not occur outside the property boundary. Any runoff from within the Site is likely to be captured within the proposed basin at the north-west corner of the BESS area.
7	Proposed surface and groundwater monitoring activities and methodologies.	Not covered in this report.
Assessment against Policy Guidelines		
8	Identification and impact assessment of all works/activities located on waterfront land including an assessment against Guidelines for Controlled Activities on Waterfront Land (NRAR 2018)	Impact assessment of the proposed BESS on existing flood conditions is addressed in 3.4.
9	Assessment of project against relevant policies and guidelines	Addressed below in Section 5 to 8.

Input from the Biodiversity, Conservation and Science Group (BCS) [11] at the NSW Department of Climate Change, Energy, The Environment and Water (DCCEEW) also recommended further requirements as part of the flood risk assessment. These detailed requirements are tabulated below.

Table 5-2 Recommended Environmental Assessment Requirements items and responses

DCCEEW Standard EARs		Responses
Water and Soils		
6	The EIS must map the following features relevant to water and soils including:	Addressed in Section 1.2 and mapping in Appendix B. Only features relevant to surface water addressed within this report.
a.	*Rivers, streams, wetlands, estuaries (as described in s4.2 of the BAM)*	Addressed in Section 1.2. The Site is located upstream of Burying Ground Creek and a small unnamed tributary transects a valley within the Site.
e.	*Proposed intake and discharge locations.*	There is a confluence of two branches of Burying Ground Creek that transect the site, downstream and to the west of the BESS facility. Inflows from the contributing catchments have been incorporated into the hydraulic model, as mentioned in Section 2.4.5.2.
7	The EIS must describe background conditions for any water resource likely to be affected by the project, including:	See details below.

[11] BCD advice on SEARs to the Department of Planning, Housing and Infrastructure and Environment; dated 19th June 2024 (DOC24/45504-3)

DCCEEW Standard EARs		Responses
a	*Existing surface and groundwater.*	Existing surface water conditions mapped in Section 3.2 and mapping in Appendix B
a.	*Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations*	Covered in Section 2.4.5
8	The EIS must assess the impacts of the project on water quality, including:	Water quality not assessed within this report. There is a proposed water quality treatment basin incorporated into the preliminary design topography included in the developed scenario.
a.	*The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the project protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction*	Groundwater risk is not assessed as part of this report. The impact associated with stormwater is discussed in Section 3.4 with recommendations for mitigation provided in Section 4.
	The EIS must assess the impact of the project on hydrology, including:	
b	*Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.*	Discussed in Section 3.4
d.	*Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)*	Groundwater not assessed in this report. Impacts to floodplains and river systems addressed in Section 3.4.
e.	*Changes to environmental water availability, both regulated/licensed and unregulated/rules based sources of such water.*	Not covered as part of this assessment.
f.	*Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options*	Addressed in Section 4.
Flooding		
10	The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:	

DCCEEW Standard EARs		Responses
a.	*Flood prone land*	Covered in Section 3.2 and the maps in Appendix B
b.	*Flood planning area, the area below the flood planning level.*	The Site is situated outside of the Flood Planning level as discussed in Section 6.
c.	*Hydraulic categorisation (floodways and flood storage areas).*	The Site sits within a low hazard area from surface water risk due to the shallow depth and low velocity. See Section 3.2 and the maps in Appendix B
d.	*Flood hazard*	Section 3.2 and the maps in Appendix B.
11.	The EIS must describe flood assessment and modelling undertaken in determining the project's design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.	Section 2.4 details the hydraulic model and Section 2.4.5 hydrology development.
12.	The EIS must model the effect of the project (including fill) on the current flood behaviour for a range of design events as identified in 11 above including 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.	Covered in Section 2.4.9 and the maps in Appendix B
13.	Modelling in the EIS must consider and document:	
a.	*Existing council flood studies in the area*	Section 2.2. No other studies were found on surface water flood risk in the region. Armidale Flood Study for losses
b.	*The impact on existing flood behaviour for a full range of flood events*	Covered in Section 3.4
c.	*Impacts of the development on flood behaviour*	Covered in Section 3.4 and the maps in Appendix C
d.	*Relevant provisions of the Flood Risk Management Manual*	Discussed in Section 8
14	The EIS must assess the impacts on the proposed development on flood behaviour, including:	
a.	*Whether there will be detrimental increases on other properties, assets or infrastructure*	Covered in Section 3.4. The maps in Appendix C showcase the relative change in flood risk as a result of the proposed Site.
b.	*Consistency with Council Floodplain Risk Management Plans*	The assessment has been conducted in accordance with relevant guidelines.
c.	*Consistency with any Rural Floodplain Management Plans*	The assessment has been conducted in accordance with relevant guidelines.
d.	*Compatibility with the flood hazard of the land.*	Covered in Section 3 and the maps in Appendix B.

DCCEEW Standard EARs		Responses
e.	*Compatibility with the hydraulic functions of flow conveyance.*	The project is expected to have no/minimum changes to the hydraulic functions of watercourses and storages.
f.	*Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.*	Covered in Section 3.4. No detriment is predicted to nearby receptors or downstream of the Site.
g.	*Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*	There is no predicted impact on riparian vegetation due to increased flood risk as a result of the development footprint.
h.	*Any impacts the development may have upon existing community emergency management arrangements for flooding.*	Detriment is not predicted to influence local emergency management. The Site is located outside the riverine PMF extent and access is not likely to be affected due to the proposed development. See Section 3.4.
i.	*Whether the proposal incorporates specific measures to manage risk to life from flood*	Risk to life is not predicted at the Site as the proposed BESS sits outside of the riverine flood fringe and is only susceptible to shallow surface water flooding.
j.	*Emergency management, evacuation and access, and contingency measures*	Access and egress are assessed in Section 3.4.
k.	*Any impacts the development may have on the social and economic costs to the community as consequence of flooding.*	Considered in Section 3.4.

6 ARMIDALE REGIONAL LOCAL ENVIRONMENTAL PLAN 2012

The proposed Site is within Armidale LGA and therefore it is within the area to which the Armidale Regional Local Environmental Plan 2012 applies.

The Site sits within the rural primary production (RU1) and rural primary production small lots (RU4) zoning and falls outside of the Flood Planning Map for the Armidale LGA. As a consideration for the consent authority, assessment against the Section 5.21 of the LEP 2013[12] provisions have been provided below. Table 6-1 outlines the flood planning controls that apply to developments within the LGA.

Table 6-1 Table identifying floodplain related controls in the Armidale Regional LEP 2012

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 is situated outside of the flood planning level (See Section 2.2). **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 quantitative 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 BESS project does not require permanent occupation during construction or operation and can be de-activated remotely during adverse conditions. Main access to the Site is also by Waterfall Way (Grafton Road), which is located on the ridge of the catchment and not affected by riverine flooding. Likewise, the predicted flood risk to the Site is low risk. Therefore, there is no perceived need to develop a Flood Emergency Plan. **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 compound and access roads. Recommendations The predicted peak surface water flood depths and hazards within the lease area are not anticipated to pose a risk to life in the event of a flood. The Site is also located outside the PMF extent modelled for Burying Ground Creek. **Complies.**
	(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.**

[12] https://legislation.nsw.gov.au/view/html/inforce/current/epi-2012-0589#sec.2.1

Flood planning controls		Response
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 against the 0.5% and 0.2% AEP flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to 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, power conversion units, substation, switch-room, control room and maintenance container. 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,	As per response to 5.21.2 (c) Due to the shallow flooding and low hazard at the Site, risk to life is not predicted because of surface water flooding. **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 an existing property and is close to Waterfall Way (Grafton Road) to facilitate access/egress. The site is not subject to coastal erosion. **Complies.**

7 ARMIDALE DUMARESQ DEVELOPMENT CONTROL PLAN 2012

The proposed Site is a State Significant Development Application (SSDA) within the Armidale LGA and therefore it is within the area to which the Armidale Dumaresq Development Control Plan (DCP) 2012[13] applies. However, Clause 2.10.1 of the State Environment Planning Policy 2021 states that:

> *Development control plans (whether made before or after the commencement of this Chapter) do not apply to: State significant development*

As good practice, consideration has been given to DCP provisions for guidance.

The Site is located outside Armidale, and there has been no flood study undertaken for the local catchment of Burying Ground Creek. The Site is also outside the Armidale LGA flood planning area. The Site is not affected by riverine flooding in extreme events up to the PMF. With regards to surface water flooding, the proposed Site experiences shallow sheet flow across the project area up to the 0.2% and 0.5% AEP events. The DCP 2012 provisions therefore do not apply.

[13]Armidale Dumaresq Development Control Plan 2012 – Edited Version, accessed September 19, 2024, https://ehq-production-australia.s3.ap-southeast-2.amazonaws.com/7e451d0bc8d056e5254ae1ec352a7f59444b49f3/documents/attachments/000/126/612/original/Armidale_Dumaresq_DCP_2012_-_edited_version.pdf.

8 NSW FLOOD RISK MANAGEMENT MANUAL 2023

The NSW Flood Risk Management Manual 2023 (FRMM) is a guide developed by NSW DPE and intended for local and state government on implementation of flood risk management strategies. It provides recommendations, but these are not legal requirements. The FRMM is an update of the NSW Floodplain Development Manual 2005 and includes a number of tools/guides such as the Flood Risk Management Guideline FB01 – Understanding and Managing Flood Risk, the Flood Risk Management Guideline MM01 – Flood Risk Management Measures and the Flood Risk Management Guideline EM01 – Support for Emergency Management Planning.

8.1.1 Merit-Based Approach

The FRMM recommends:

> *using a merit-based approach in preparing and implementing flood risk management (FRM) plans to address riverine and local overland flooding.*

This assessment has qualitatively assessed local overland flooding and reviewed the risk from riverine sources.

8.1.2 Battery Storage

Battery storage is not explicitly mentioned within Table 10 in Section 2.8.3 of *Flood Risk Management Guideline FB01 - Understanding and Managing Flood Risk*. However, it is assumed that the type of use falls within the Hazardous industry with the contents being highly susceptible to flood waters.

The Site is outside the extent of the Armidale Flood Study and not covered by any other published flood studies for the Burying Ground Creek catchment. Riverine flood modelling undertaken for this assessment indicates that the Site is outside the PMF extent from Burying Ground Creek. The proposed development will not adversely impact riverine flood behaviour on neighbouring properties in events up to and including the PMF.

8.1.3 Flood Impact and Risk Assessment

The *Flood Risk Management Guideline LU01 – Flood Impact and Risk Assessment* indicates that:

> *A FIRA may… be undertaken to support an activity … where the activity is affected by flooding.*

Given that the Site will likely experience shallow inundation by surface water flooding in all simulated events including the 5% AEP up to the PMF, the preparation of a Flood Impact and Risk Assessment (FIRA) is appropriate.

The *Guideline LU01* lists the aims of a FIRA as to identify and analyse:

- the impacts of the proposed development on the flood risk to the existing community
- the impacts and risks of flooding on the development and its users
- how these impacts can be managed to minimise the growth in risk to the community due to the development.

This report produced for ACEnergy assessed the impacts and risk of flooding from surface water and details the relative changes in peak water levels as a result of the Site within the lease area. As the proposed BESS is still under design development, the hydraulic model and analysis will likely need to be updated once a final design has been settled on to detail and assess the adopted design solutions (e.g., infrastructure/compound levels, access road crests).

The *Guideline LU01* states that:

> *All assessments need to demonstrate compatibility of the development with any existing relevant state environmental planning policies (SEPPs), local environmental plans (LEPs), DCPs or policies, as well as existing industry guidance, government guidance and reference documents.*

This flood risk report includes a discussion of the proposed development's consistency with the DCP 2012, existing industry guidance, and government guidance.

The *Guideline LU01* provides a list of issues that a flood impact assessment should provide an understanding of. It should be again noted that the FRMM and its associated Guidelines are not legal requirements.

Table 8-1 Issues that FIRA should provide an understanding of

Issue	Advice
The full range of flood risk. To achieve this, flood behaviour would be examined for a range of events. Typical events examined may include the 10%, 5%, 1%, 0.5% or 0.2% AEP and probable maximum flood (PMF)	This flood risk report prepared for the proposed Gara BESS considers the 5% AEP up to the PMF event. The 10% AEP event was not simulated however the 5% gives a good indication of flood behaviour in a smaller event. **Complies.**
The potential for coincidence with downstream tailwater levels or ocean inundation levels where the area is influenced by backwater flooding from downstream waterways or the ocean	Addressed in methodology in Section 2.4.5.2. A conservative approach was adopted for riverine inflows at the northern end of the model. It should also be noted that the Site is elevated at 970 mAHD, approximately 30 m above the confluence of Burying Ground Creek to Commission Waters 12 km downstream. It is unlikely that coincidence flooding of Commissioners Waters would affect inundation levels at the Site. The Site is also located above the PMF for Burying Ground Creek modelled as part of this report. **Complies**
The constraints that flood places on the land (floodways, flood storage, flood hazard and emergency response issues) determined for a number of events, typically 5%, 1%, 0.2% or 0.5% AEP and PMF	This flood risk report prepared for the proposed development considers the constraints that flood places on the land, including flood hazard, the implications of flood fringe and discussion of emergency response issues for a range of relevant floods up to and including the PMF. **Complies.**
The appropriateness of the development or development types for the location based on the flood constraints on the land	Addressed in Section 3.4 above. The proposed development is proposed at a suitable location from a flood risk perspective.. **Complies.**

Issue	Advice
The adequacy of management measures and controls to: effectively address these constraints to ensure the flood risks to the proposed development and its users are acceptable ■ manage flood and associated emergency management (EM) impacts to the existing community effectively address these constraints to ensure the flood risks to the proposed development and its users are acceptable ■ manage flood and associated emergency management (EM) impacts to the existing community due to the development due to the development	This flood risk report prepared for the proposed development includes a discussion of potential flood risk mitigation measures and their effectiveness in addressing flood risk. This should be updated once a final design is decided on. The proposed BESS is not predicted to cause any downstream detriment from flooding to the existing community. Likewise, access and egress from the Site in the event of a flood event is not anticipated to be restricted or require a Flood Emergency Plan[14] **Complies.**
The choice of Australian Rainfall and Runoff (ARR) data version to use	The hydrological input into the hydraulic modelling utilised the latest ARR rainfall and loss methods. **Complies.**
Climate change impacts. Both existing and post-development flood behaviour needs to consider climate change impacts on flood behaviour so the robustness of decisions over time can be understood. Climate change impacts can influence outcomes and requirements for developments.	This flood risk report does not consider explicit climate change impacts on the 1% AEP event, however the 0.5% and 0.2% AEP events were simulated as proxies for assessing sensitivity to climate change. **Complies, as assessed another way.**

[14] New South Wales Government, *Armidale Regional Local Flood Plan*, October 2023, https://www.ses.nsw.gov.au/media/6696/armidale-regional-lfp-oct-2023-endorsed.pdf.

9 SUMMARY

9.1 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. Modelling of the Subject Site investigated the potential for the site to be inundated from direct (local catchment) flooding and the potential for the development to alter the hydrological regime on neighbouring properties.

9.2 Key Findings

9.2.1 Riverine flooding

Riverine flooding from the Burying Ground Creek was assessed for this study. Modelled flood results in the developed scenario demonstrate that the Site is outside the extent of the PMF. Coincidence flooding and backwater effects from Commissioners Waters are also unlikely, due to the distance downstream and change in elevation.

9.2.2 Direct catchment runoff

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

Developed conditions modelling was undertaken for the proposed raised layout. This scenario showed limited potential for the development to influence regional surface water levels, with local changes to flood level observed outside of the project area. No detriment to nearby receptors is predicted as a result of this development.

9.2.3 1% AEP Results and Recommendations

Developed flood scenario results for the 1% AEP event are discussed and presented in Section 3.4. Flood results under developed conditions for other modelled events are presented in Appendix C. The predicted maximum depth of flooding within the proposed BESS area does not exceed 0.1 m in the 1% AEP event, which is considered low and does not encroach above the concrete footings. Access and egress from the Site are not expected to be impacted by surface water flood risk up to the 1% AEP event.

Discussion on the minimisation of flood risk is included in Section 4 but the key design recommendations are the following:

- Any sensitive infrastructure such as inverters and battery storage etc, should be located on raised concrete footings to 300mm elevation above finished ground level at the site.
- The footings should be designed to withstand the flood velocities described in this report, which are mostly low in the Development Footprint.
- Extension of existing 300 mm diameter pipe under the existing access tract at the intersection with Waterfall Way (Grafton Road).
- Incorporate drainage channels in a north to south direction within the BESS area to control surface runoff within the proposed facility, and
- The location of the proposed electricity poles/towers within the development extent should be outside any mapped flood depth in all modelled events, if practical.

10 REFERENCES

Armidale Dumaresq Development Control Plan 2012 – Edited Version, accessed September 19, 2024, https://ehq-production-australia.s3.ap-southeast-2.amazonaws.com/7e451d0bc8d056e5254ae1ec352a7f59444b49f3/documents/attachments/000/126/612/original/Armidale_Dumaresq_DCP_2012_-_edited_version.pdf.

New South Wales Government, *Armidale Regional Local Flood Plan*, October 2023, https://www.ses.nsw.gov.au/media/6696/armidale-regional-lfp-oct-2023-endorsed.pdf.

BCD advice on SEARs to the Department of Planning, Housing and Infrastructure and Environment; dated 19th June 2024 (DOC24/45504-3)

APPENDIX A – TEMPORAL PATTERN SELECTION

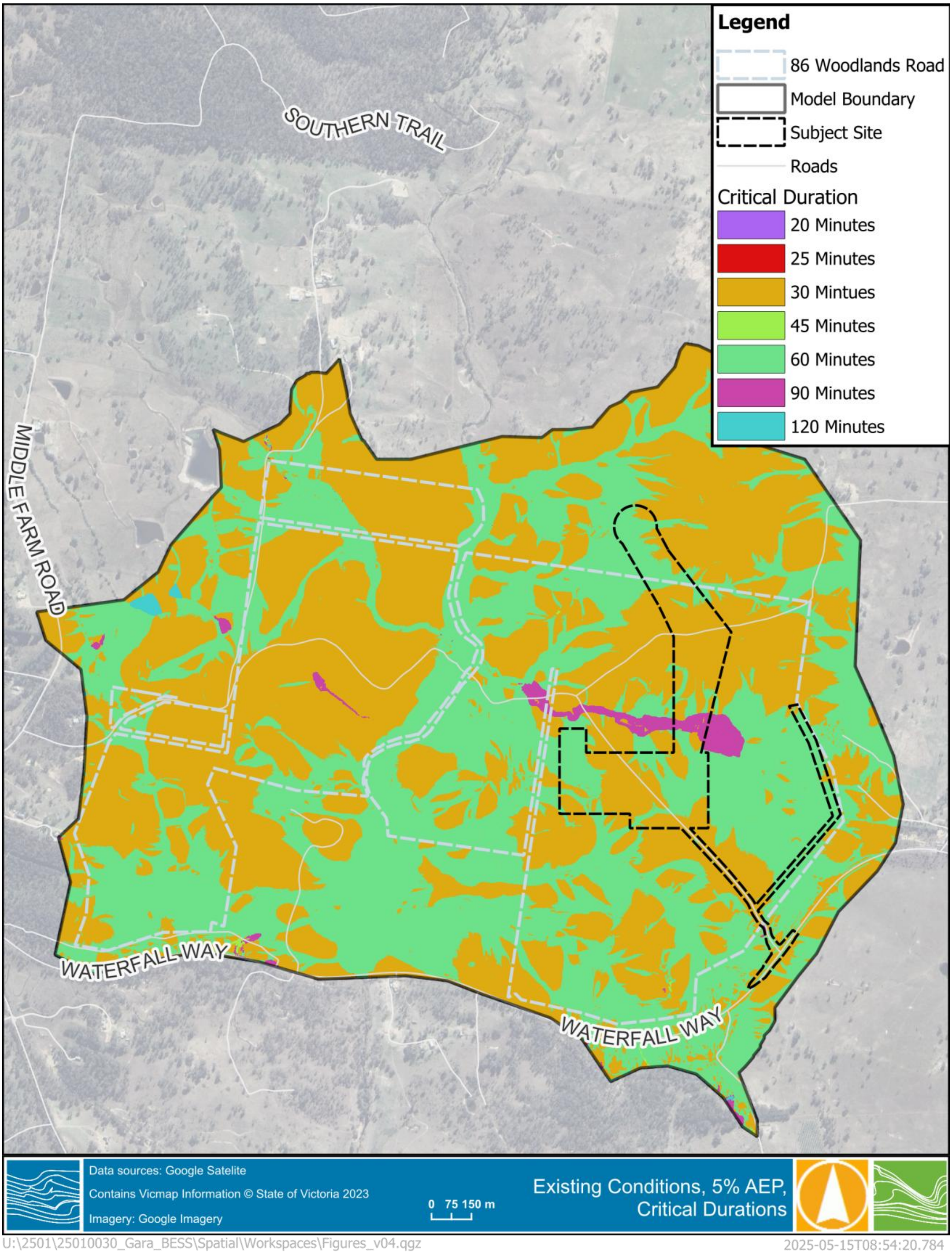

Figure A 1 Critical Duration (5% AEP)

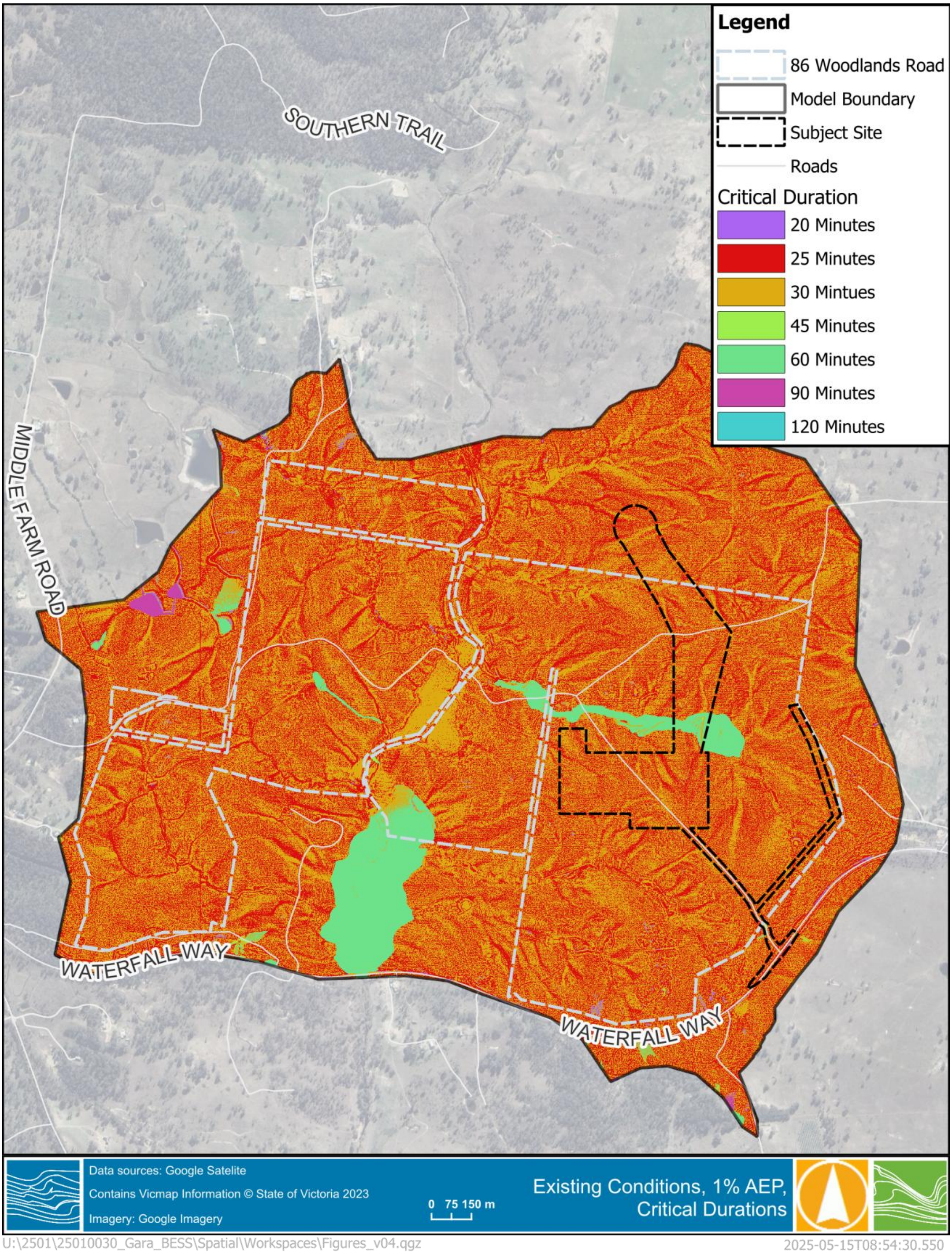

Figure A 2 Critical Duration (1% AEP)

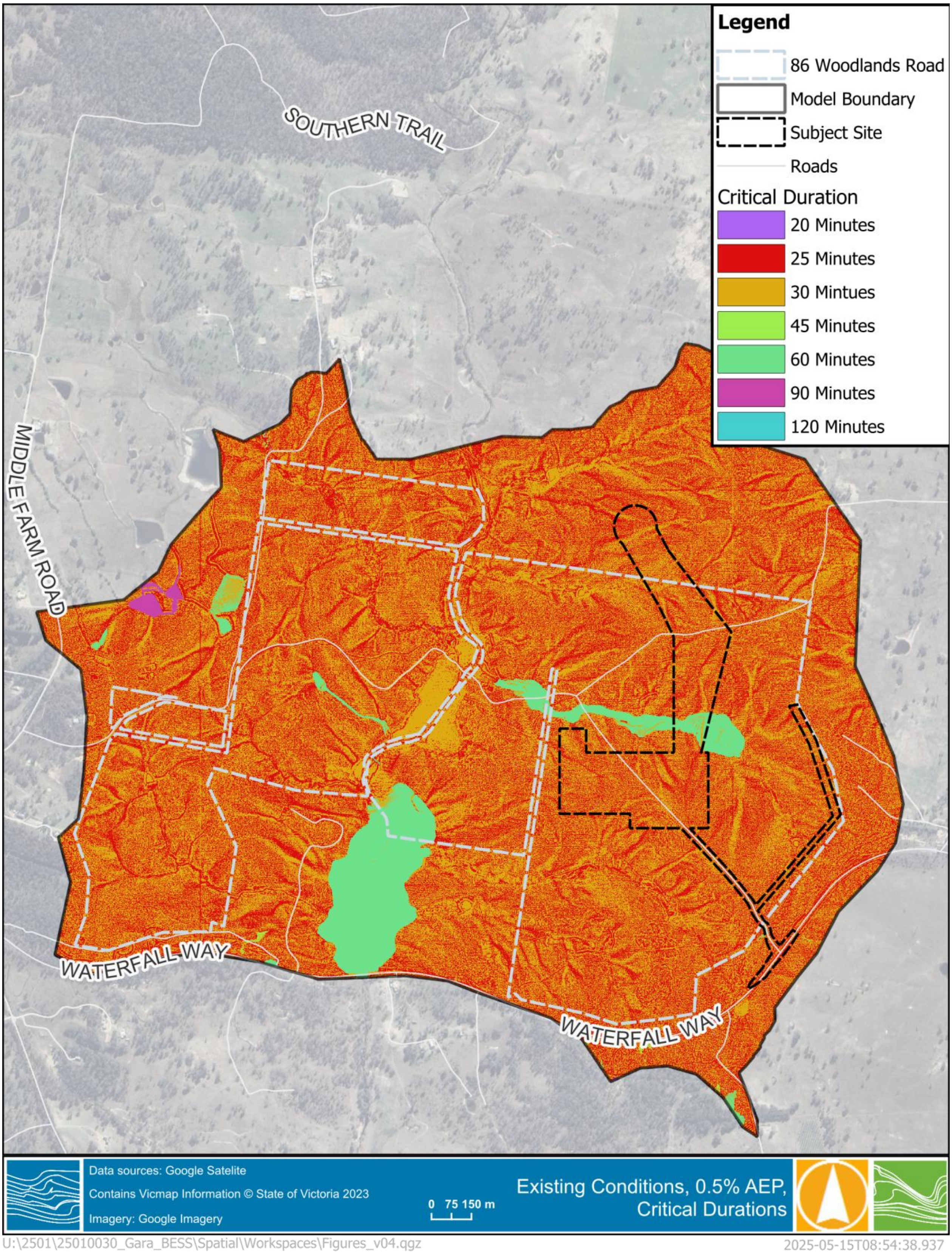

Figure A 3 Critical Duration (0.5% AEP)

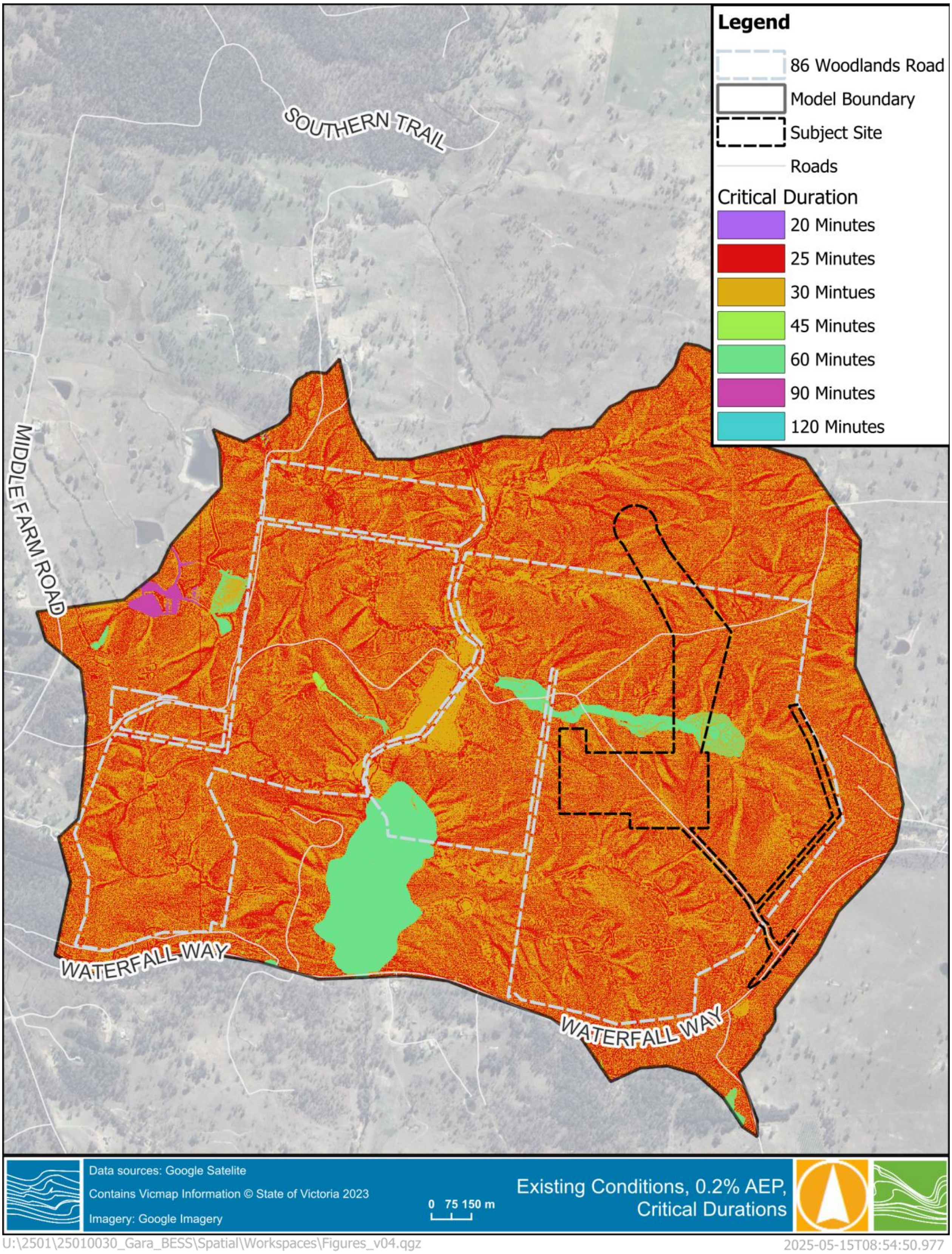

Figure A 4 Critical Duration (0.2% AEP)

APPENDIX B – EXISTING MODELLING RESULTS

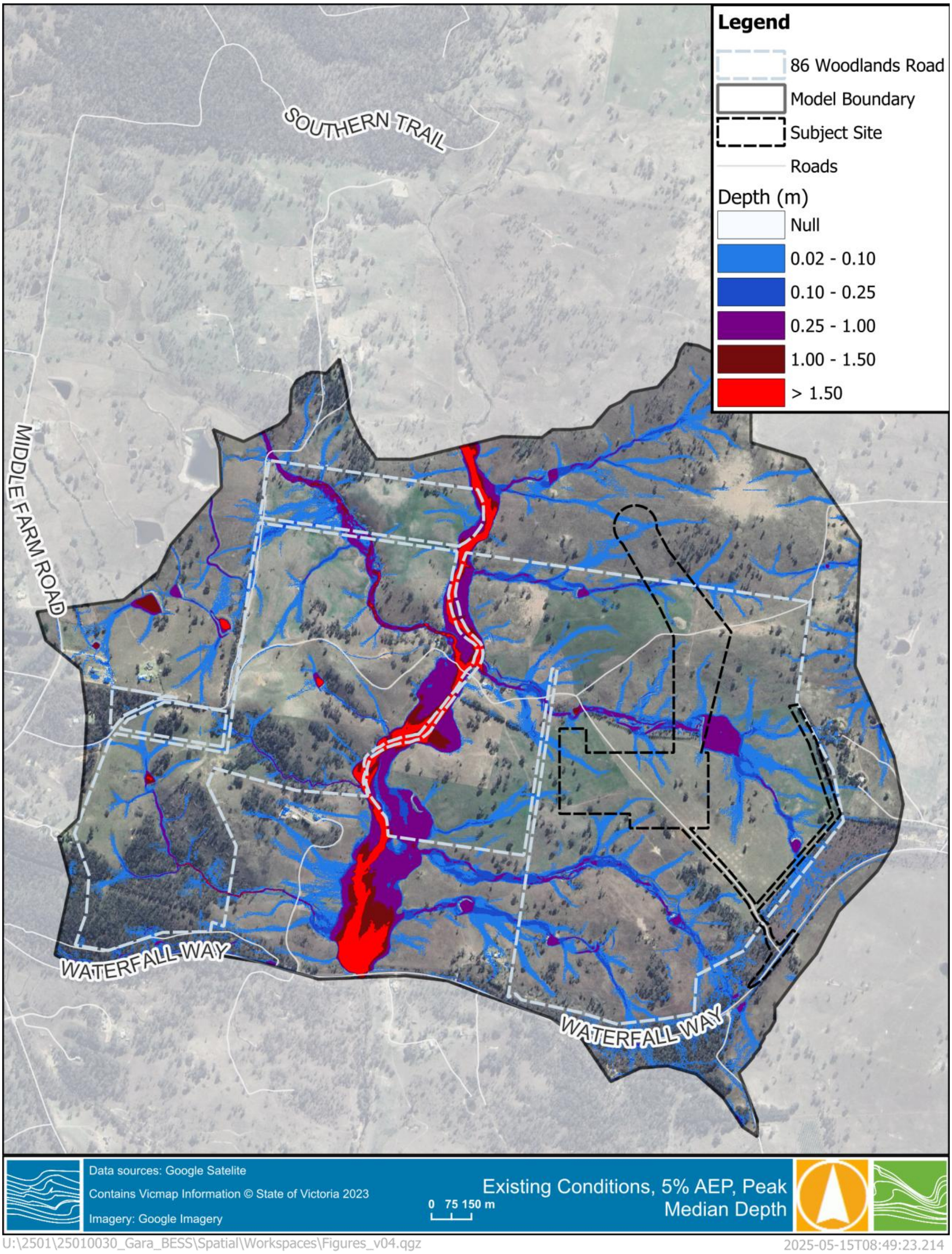

Figure B 1 Existing Conditions – 5% AEP flood depth

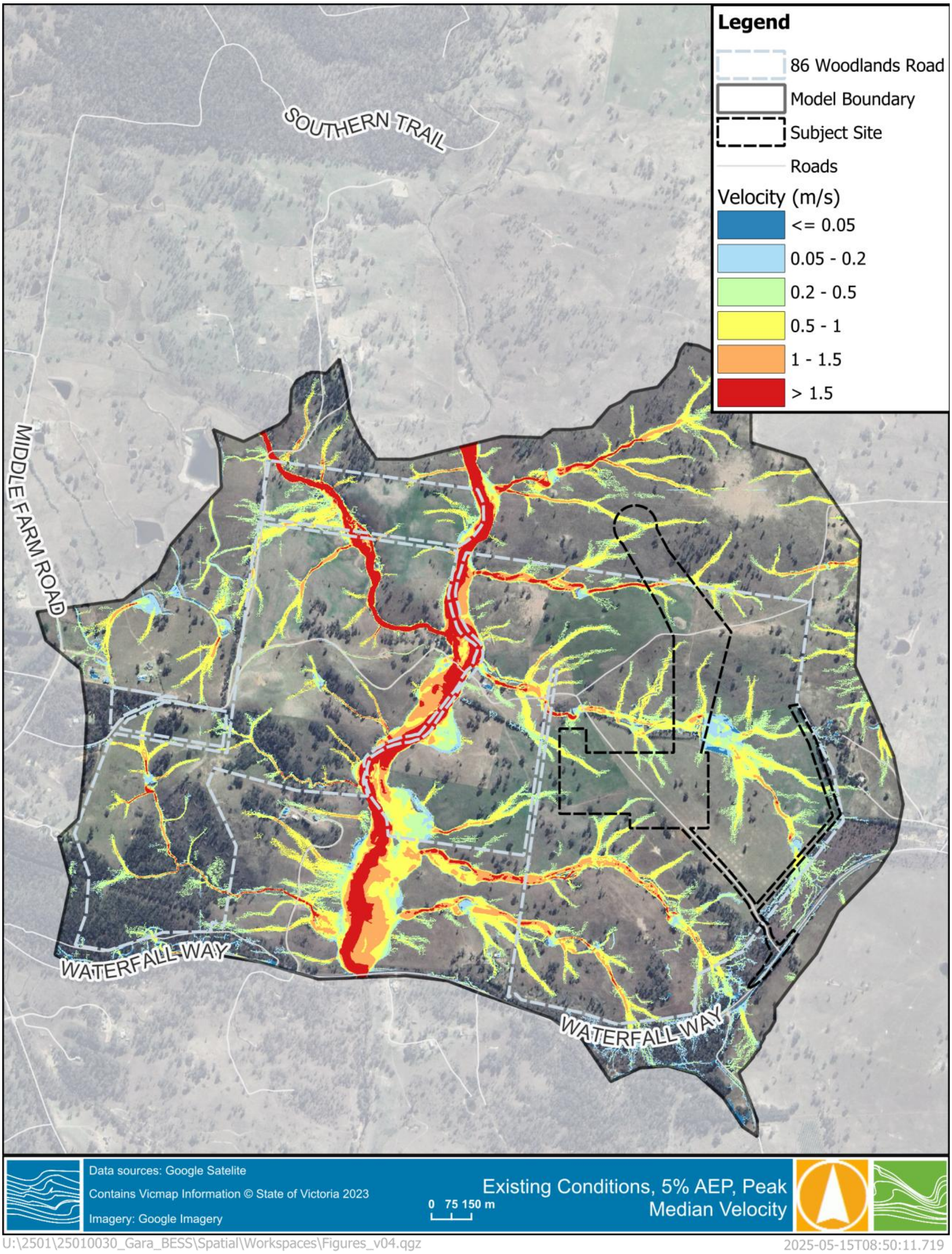

Figure B 2 Existing Conditions – 5% AEP flood velocity

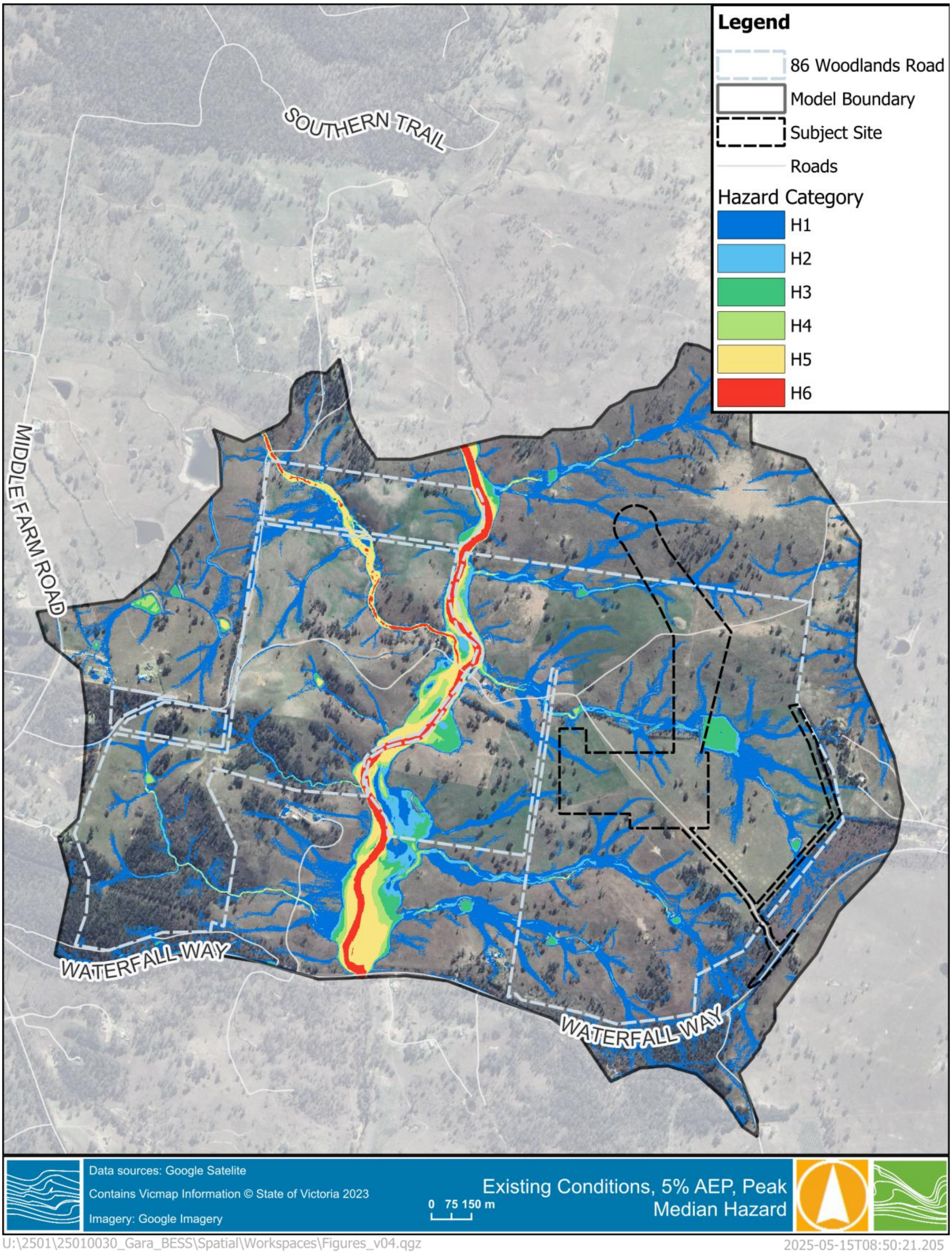

Figure B 3 Existing Conditions – 5% AEP flood hazard

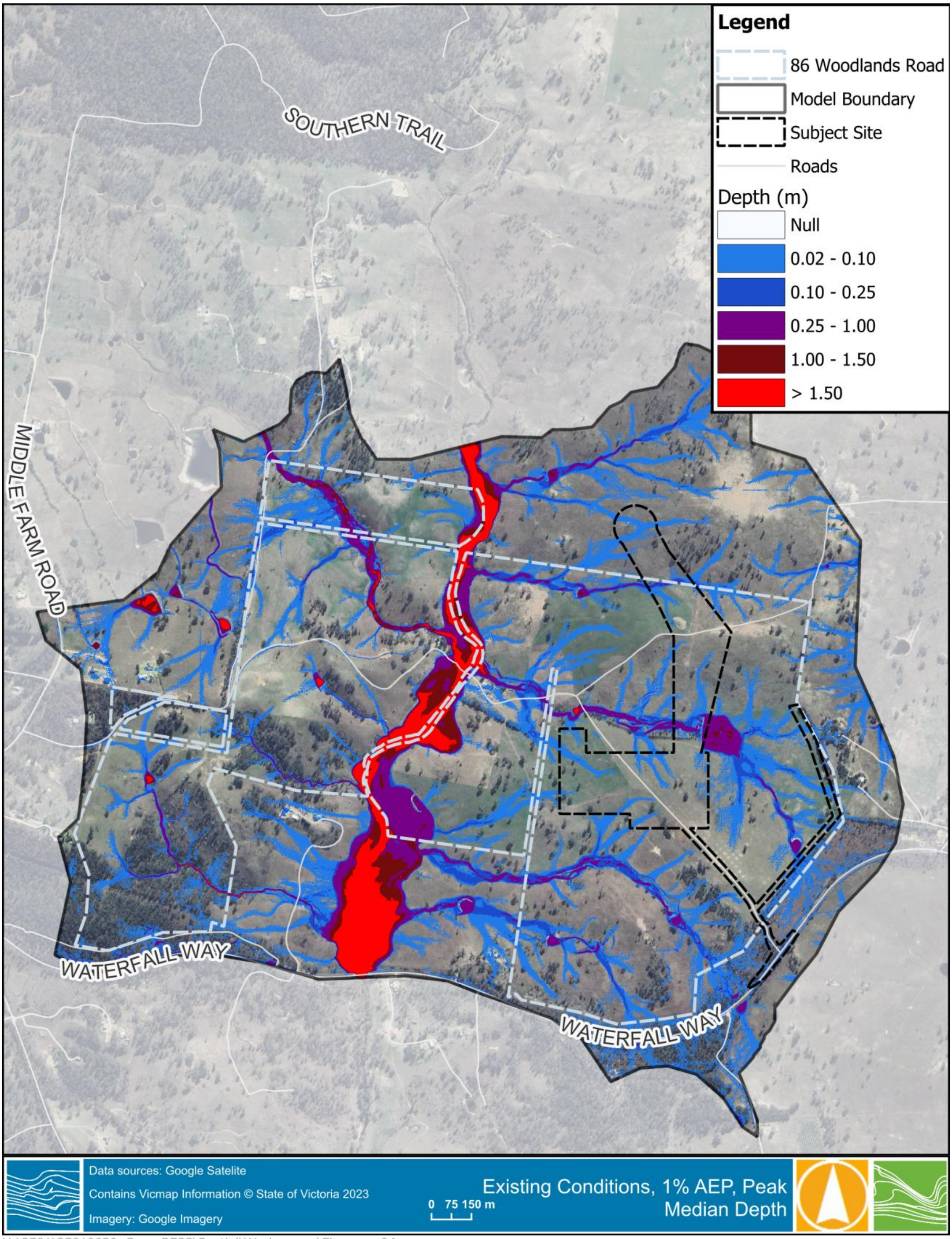

Figure B 4 Existing Conditions – 1% AEP flood depth

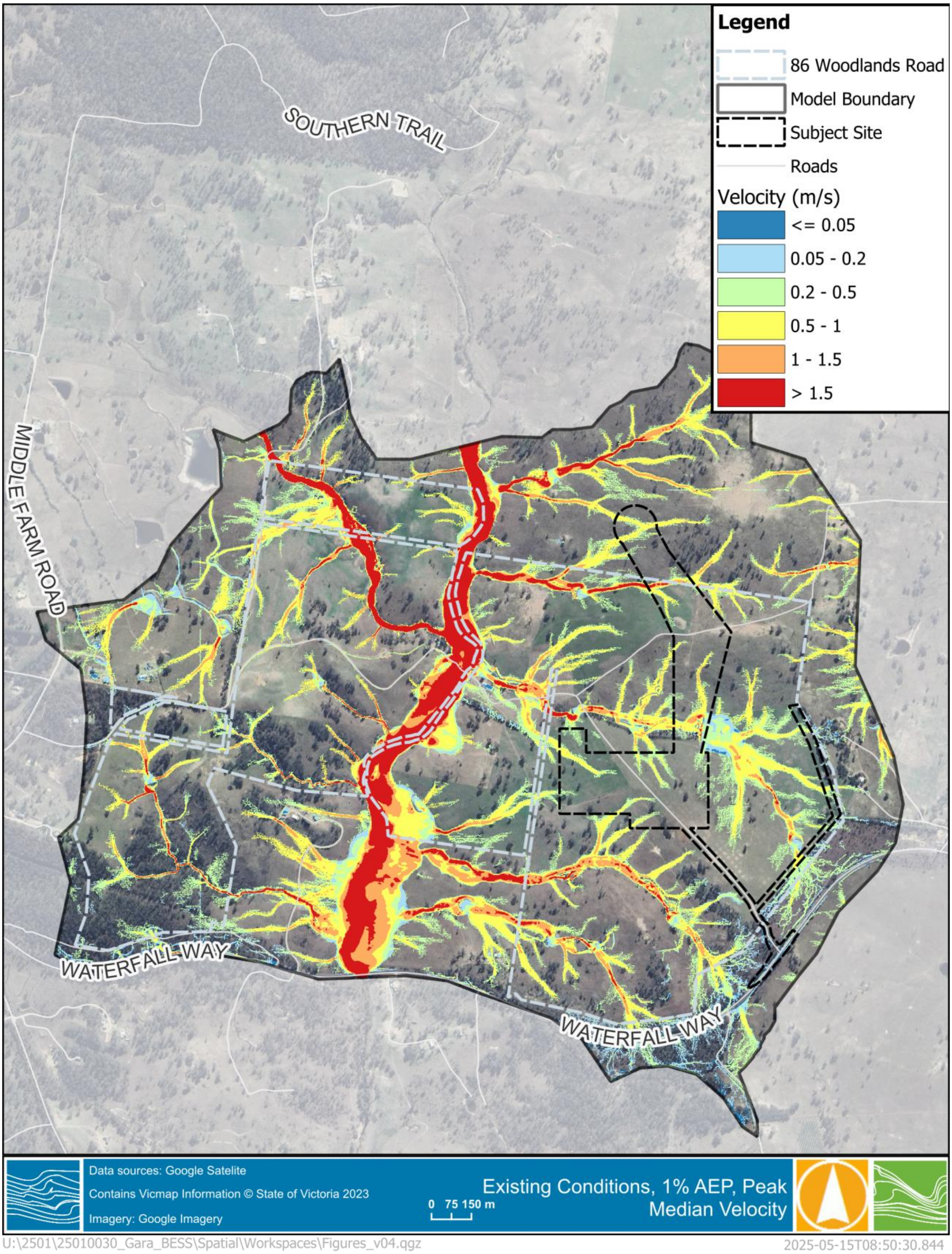

Figure B 5 Existing Conditions – 1% AEP flood velocity

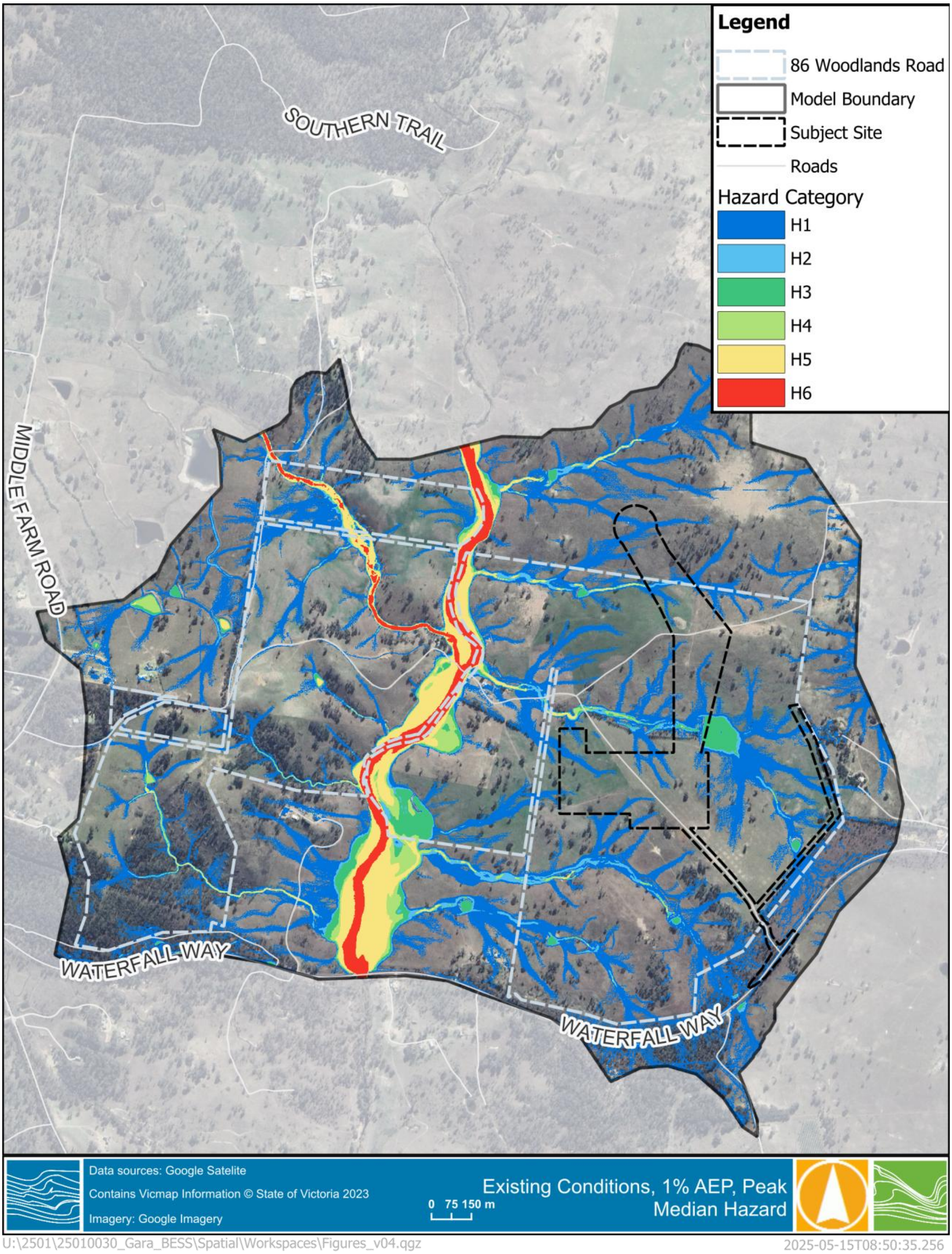

Figure B 6 Existing Conditions – 1% AEP flood hazard

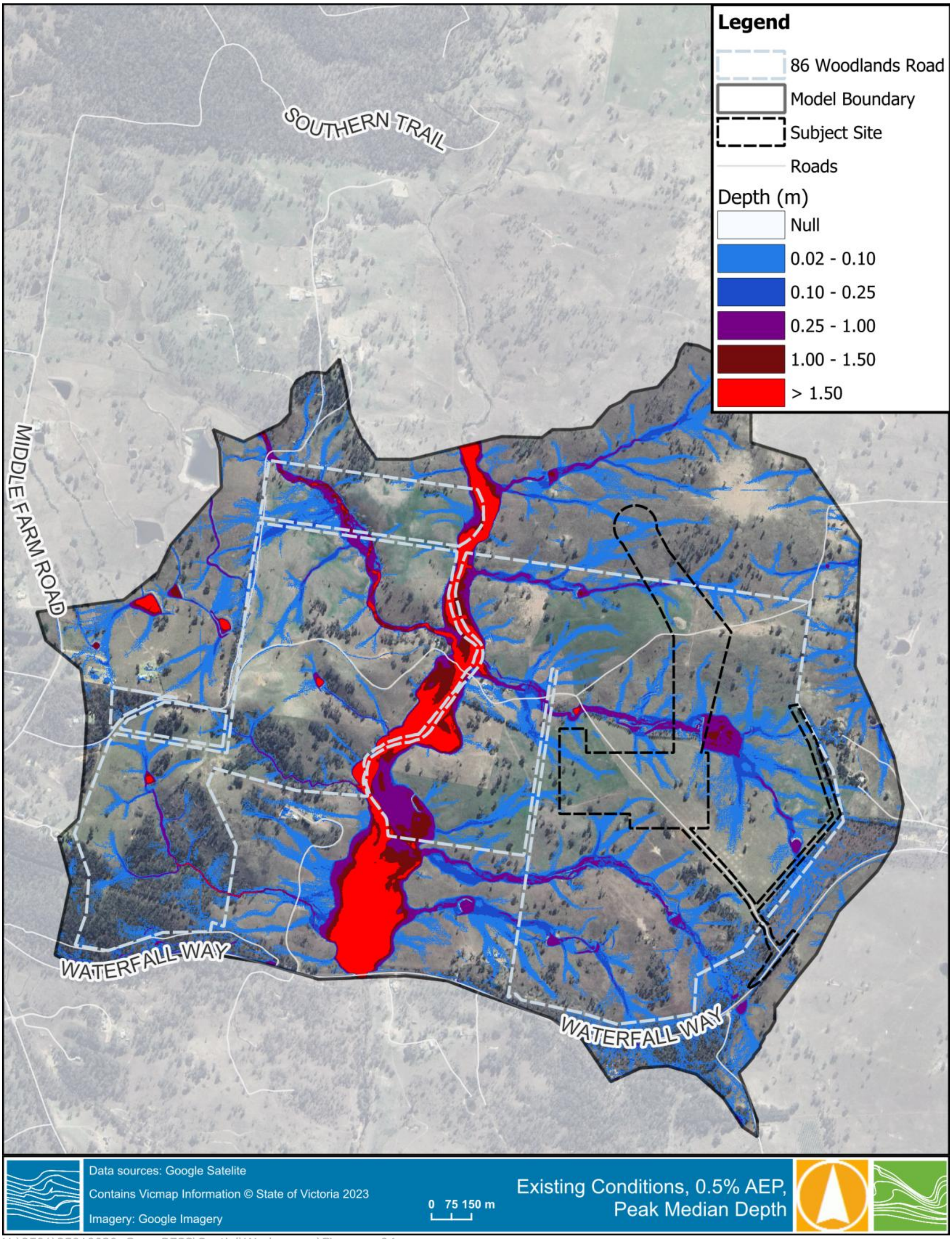

Figure B 7 Existing Conditions – 0.5% AEP flood depth

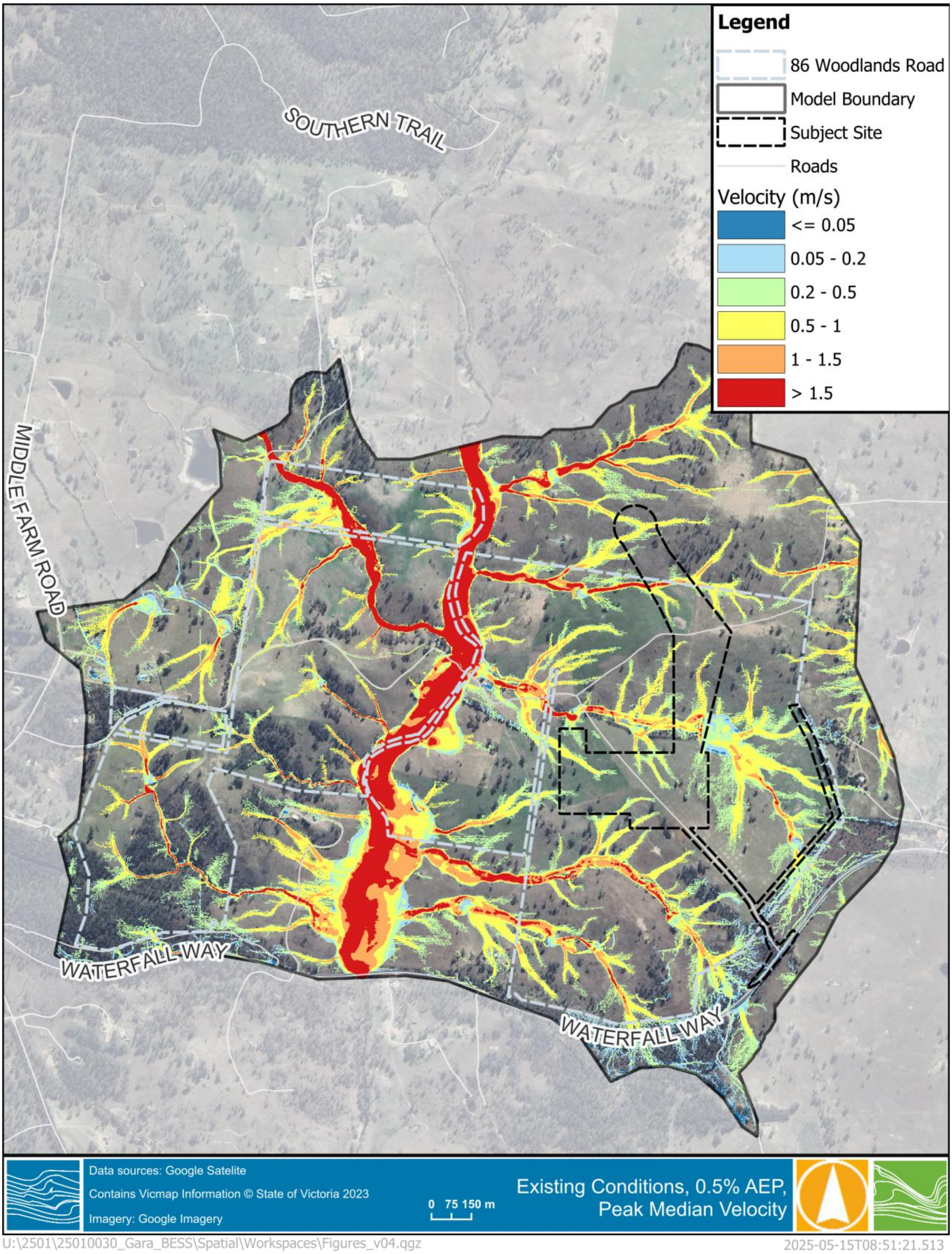

Figure B 8 Existing Conditions – 0.5% AEP flood velocity

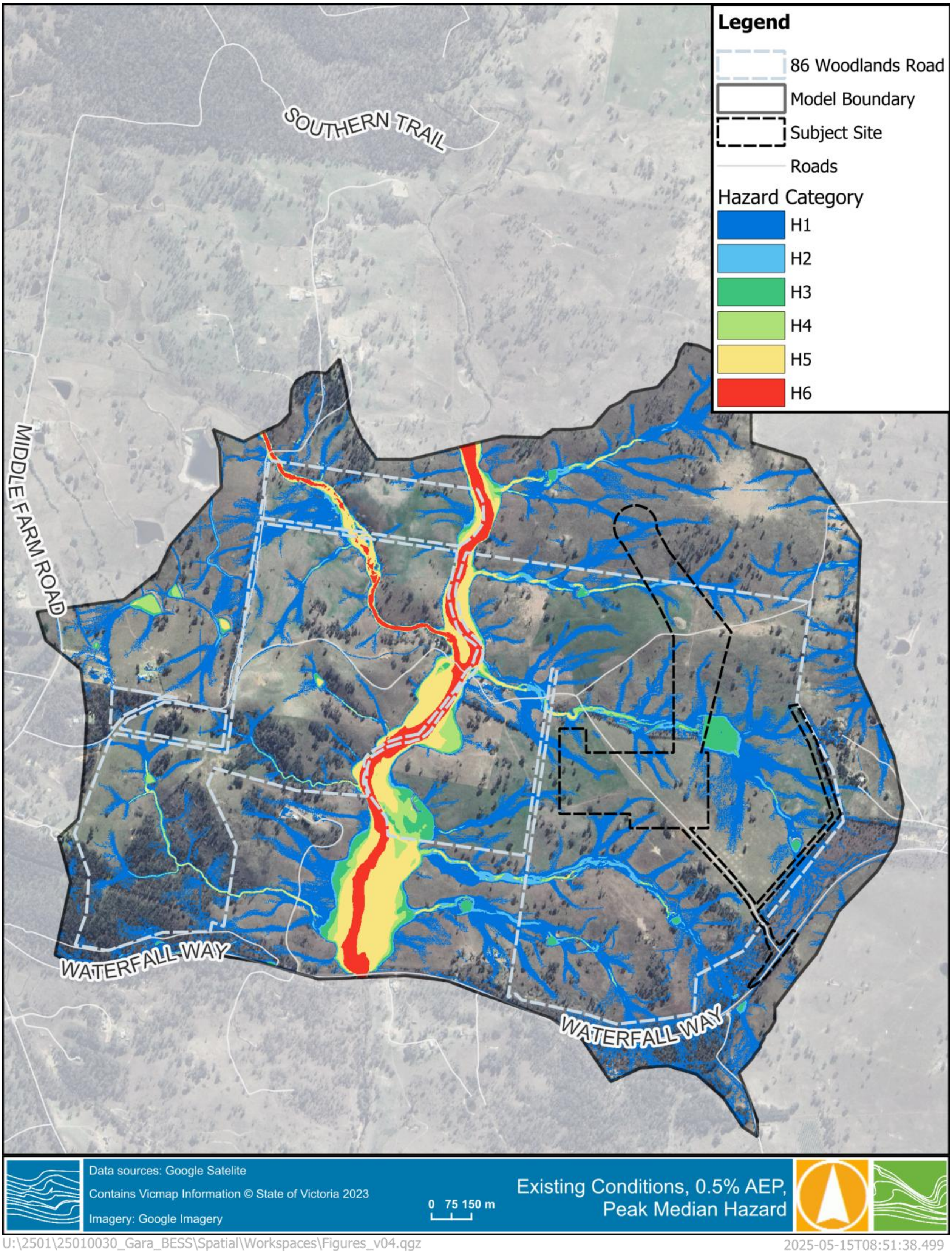

Figure B 9 Existing Conditions – 0.5% AEP flood hazard

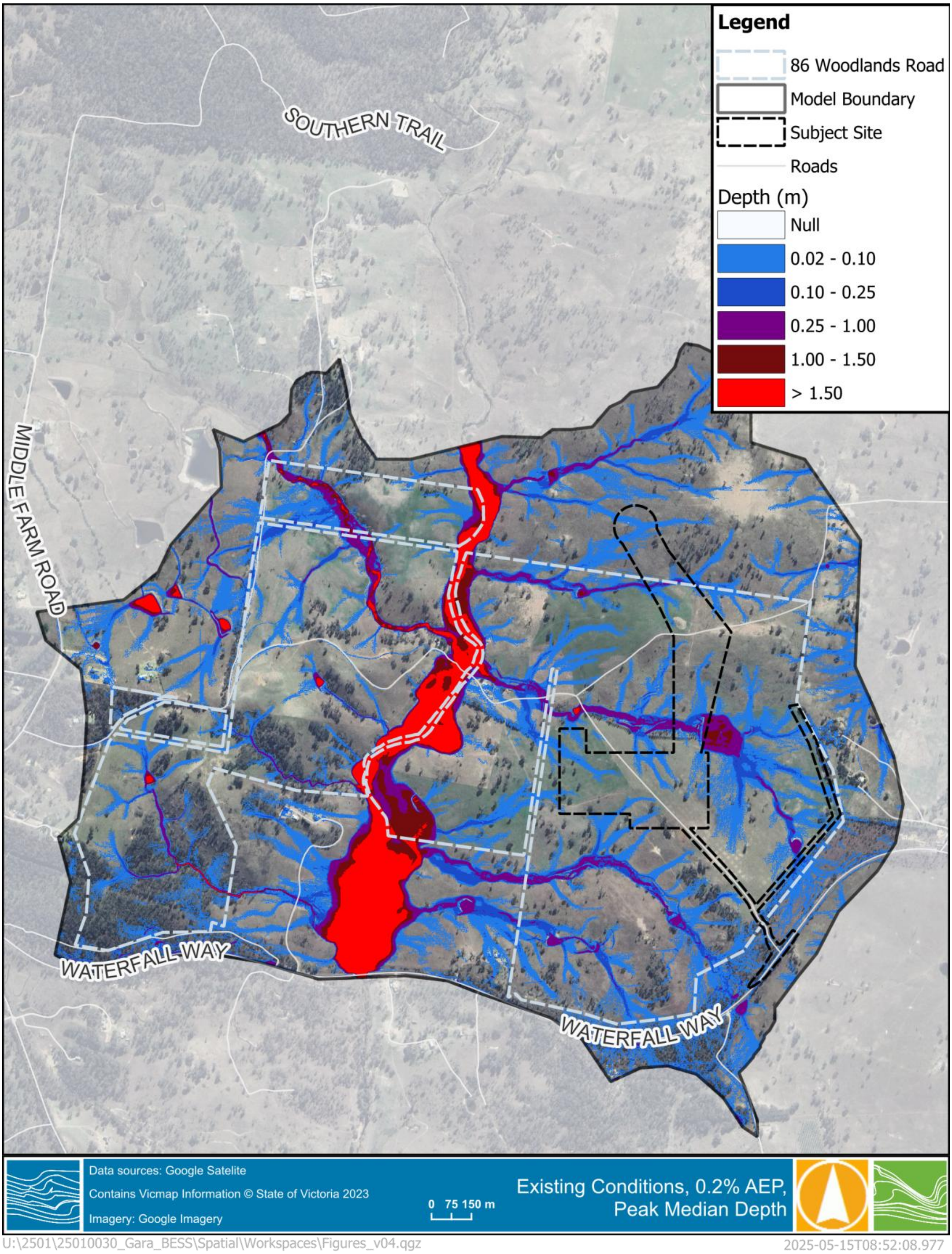

Figure B 10 Existing Conditions– 0.2% AEP flood depth

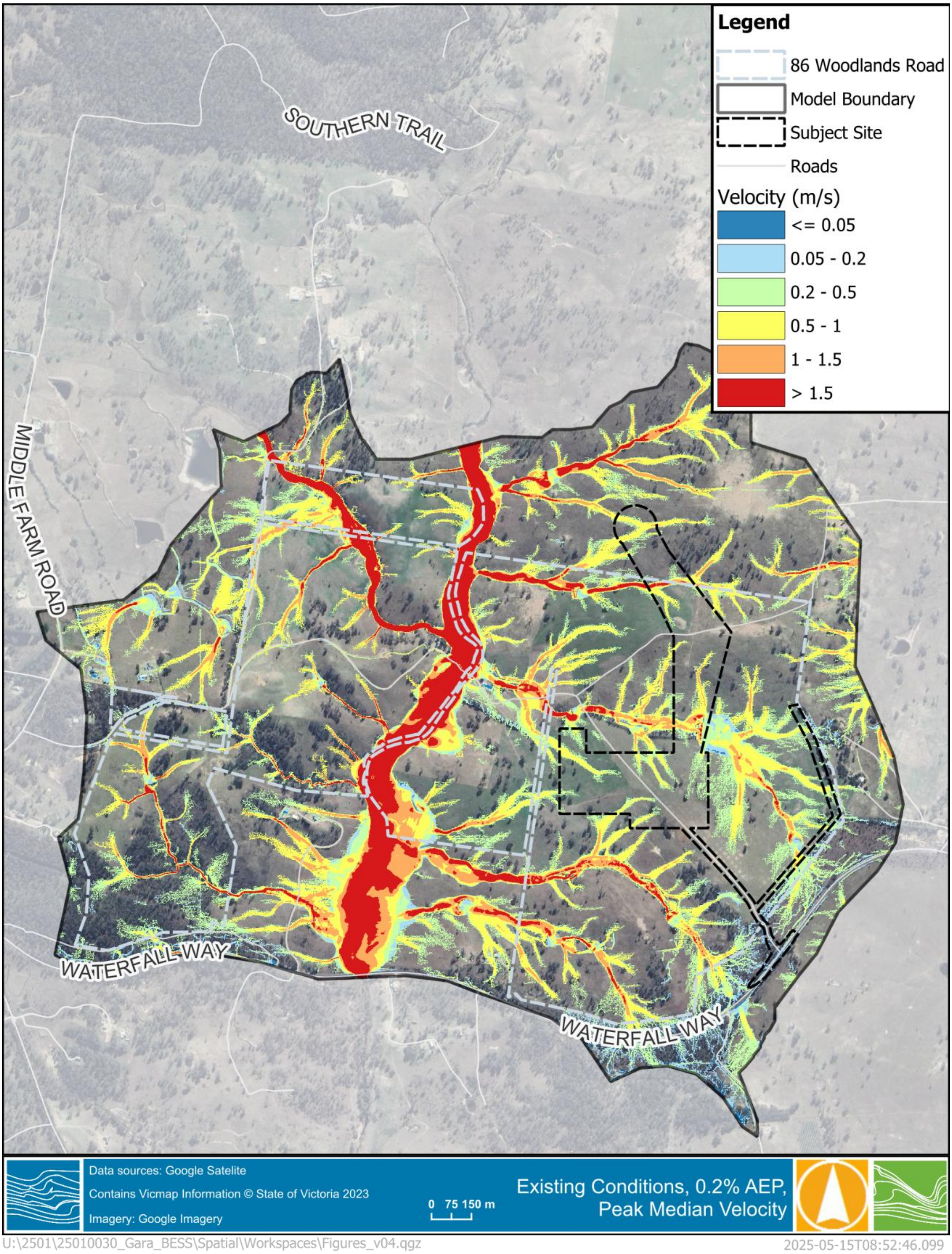

Figure B 11 Existing Conditions – 0.2% flood velocity

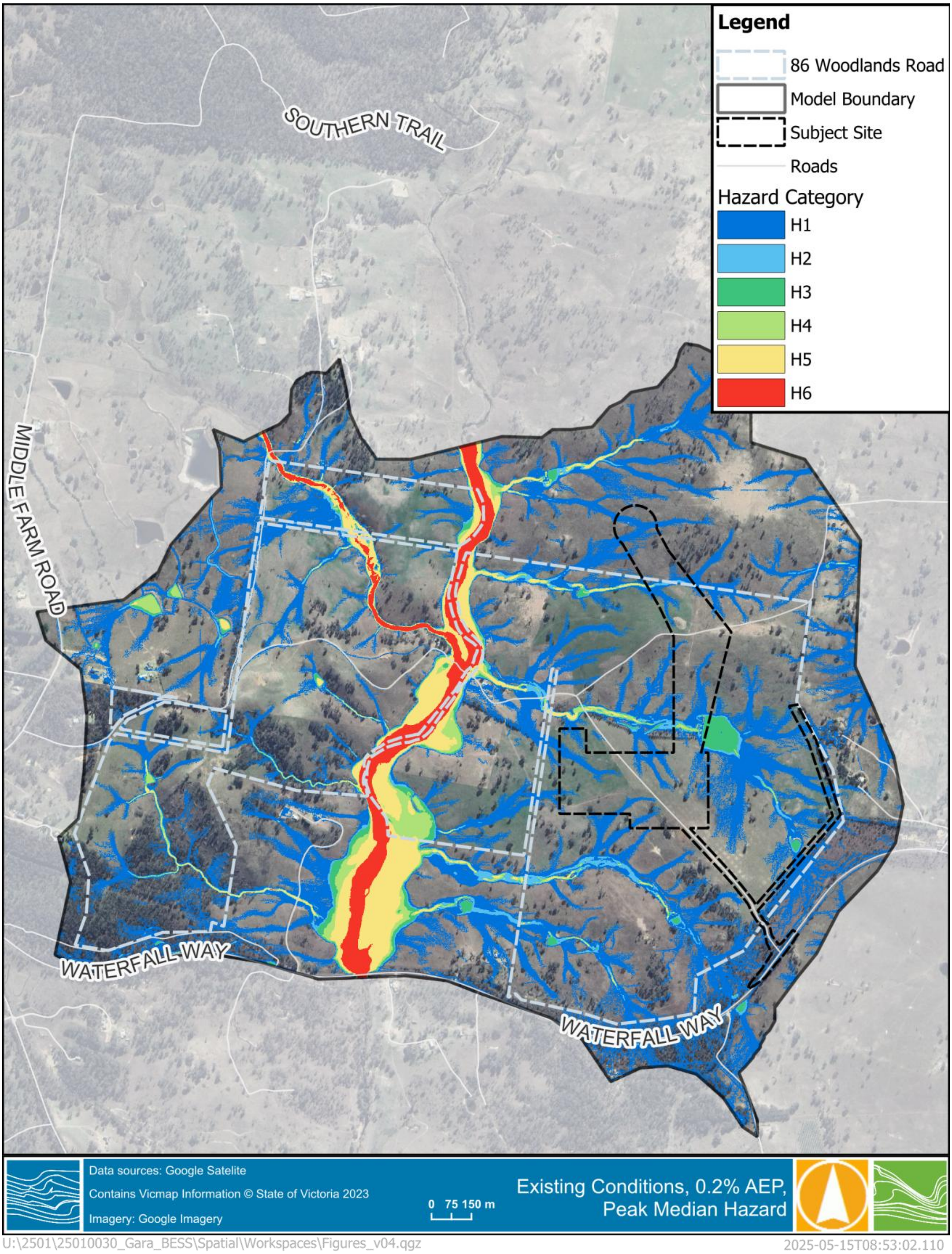

Figure B 12 Existing Conditions – 0.2% flood hazard

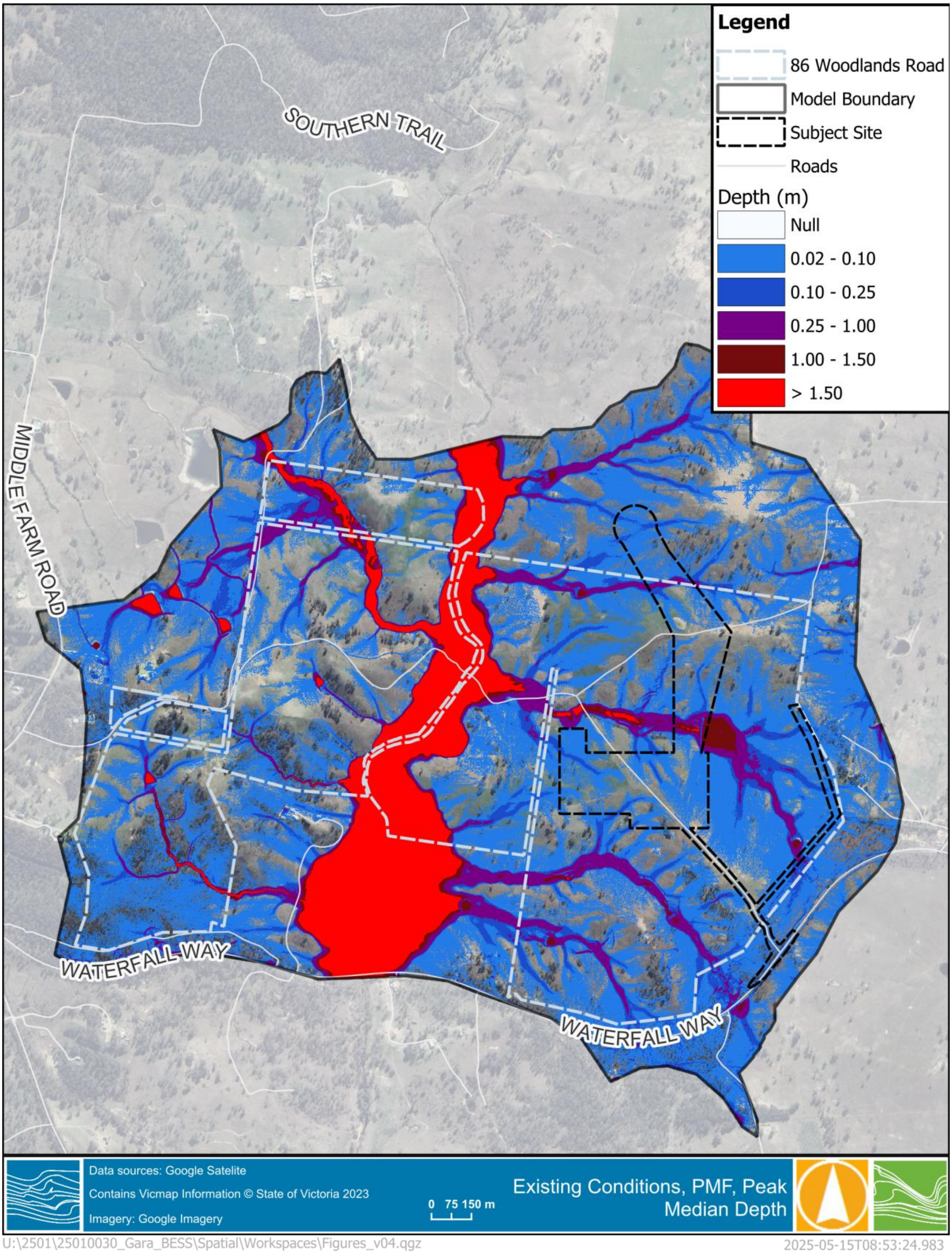

Figure B 13 Existing Conditions – PMF flood depth

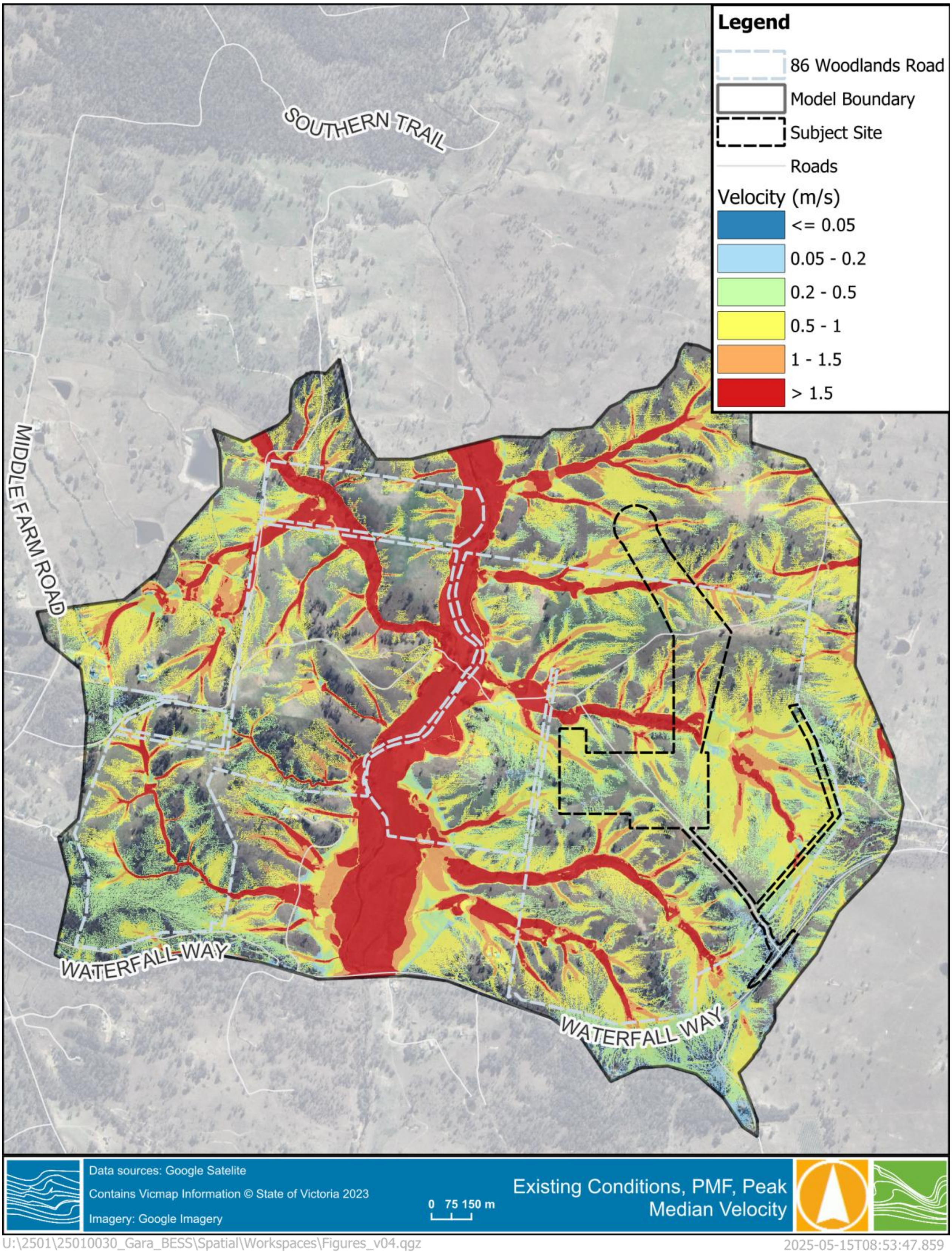

Figure B 14 Existing Conditions – PMF flood velocity

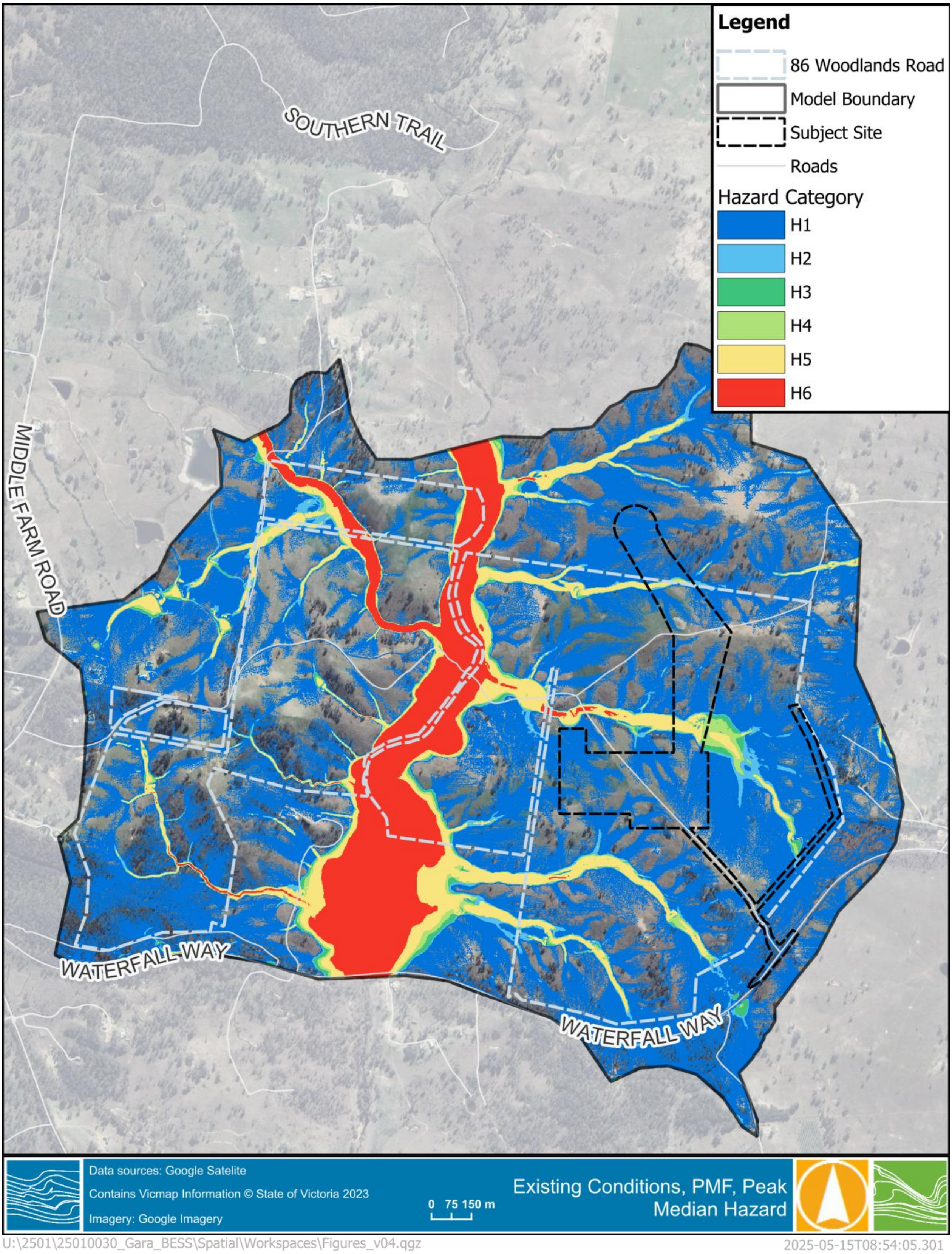

Figure B 15 Existing Conditions – PMF flood hazard

APPENDIX C– DESIGN MODELLING RESULTS

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

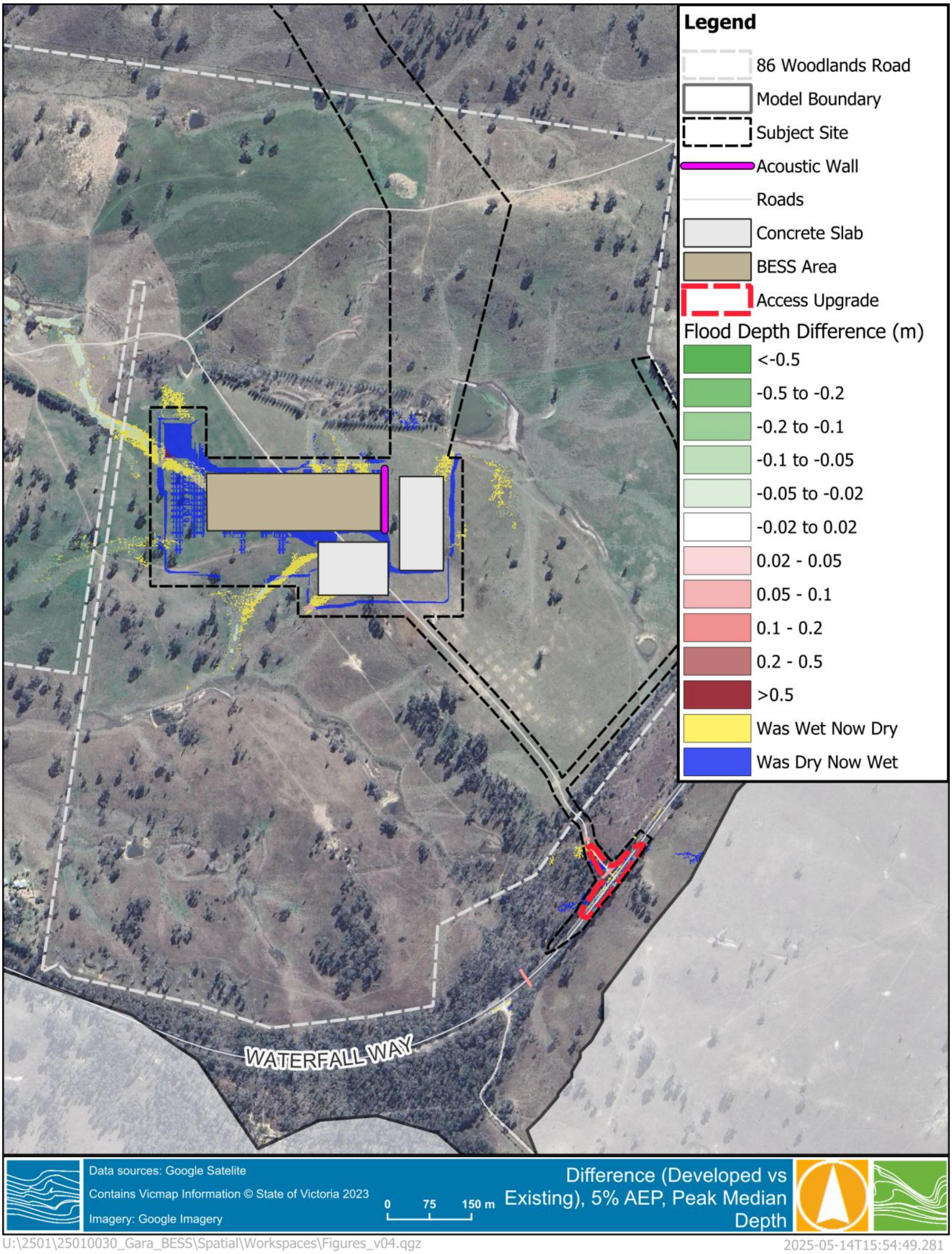

Figure C 1 Design Conditions – 5% AEP depth-difference

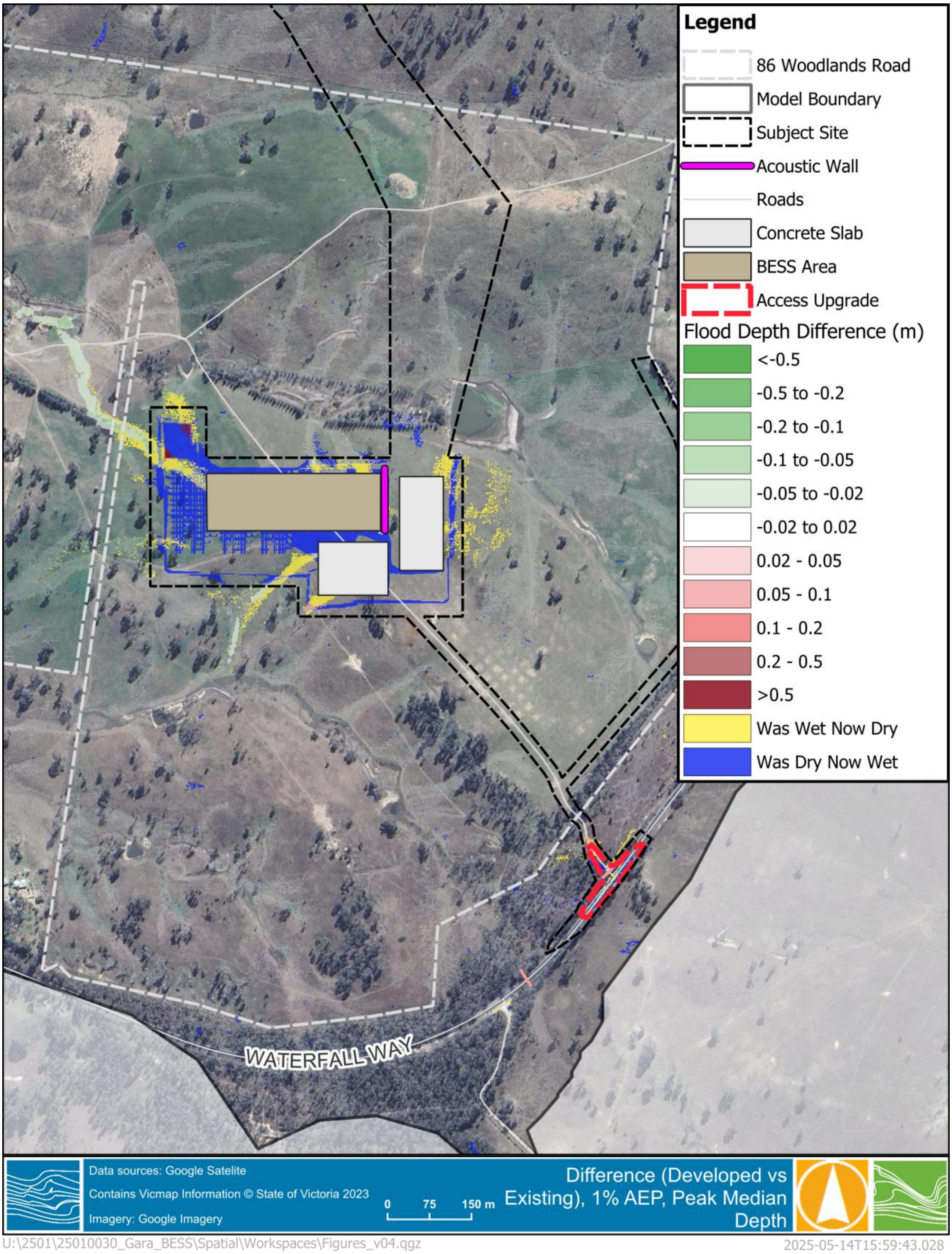

Figure C 2 Design Conditions – 1% AEP depth-difference

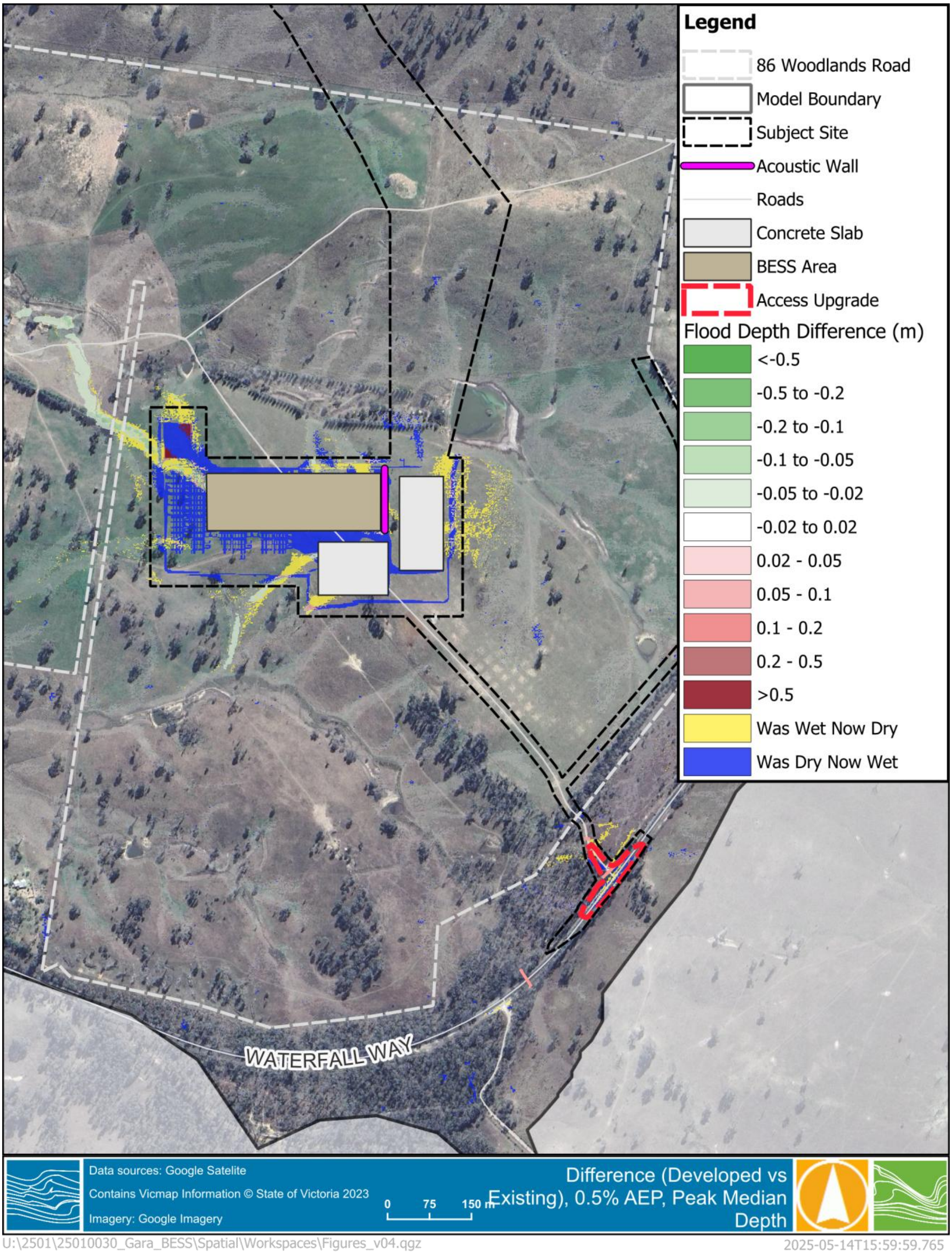

Figure C 3 Design Conditions – 0.5% AEP depth-difference

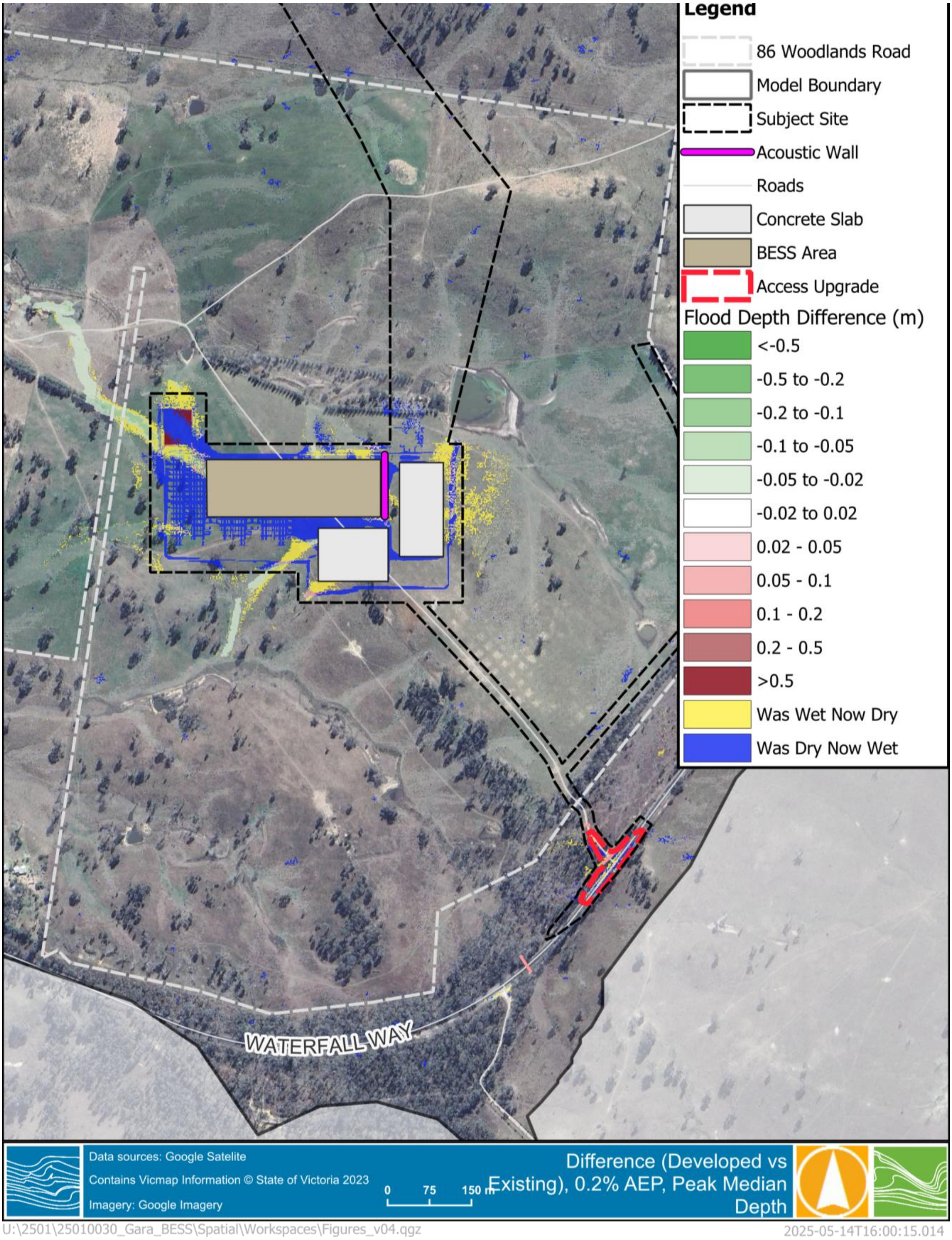

Figure C 4 Design Conditions – 0.2% AEP depth-difference

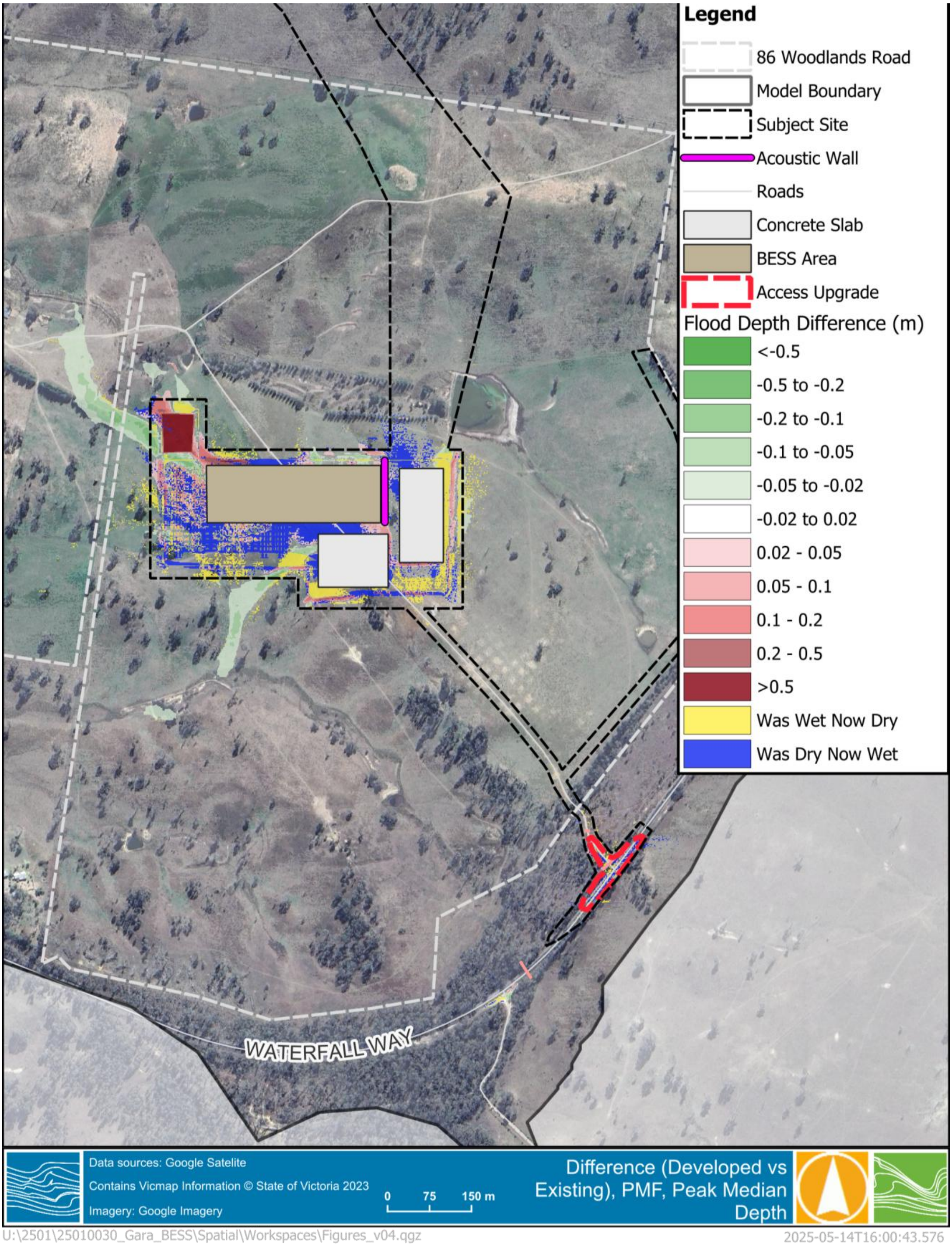

Figure C 5 Design Conditions – PMF depth-difference

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

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