WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Flood Impact Assessment

Moreton Hill Wind Farm

MHWF Nominees Pty Ltd

25 August 2025

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Project Details

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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. In particular, we acknowledge the Wadawurrung People as the Traditional Custodians of the waters and land upon which this project is undertaken.

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*

25 August 2025

Peter Lausberg
Executive Director
RE Future Pty Ltd
PO Box 739, Geelong, Vic 3220

Via email: peter.lausberg@refuture.com.au

Dear Peter,

Moreton Hill Wind Farm

Please see the attached Flood Impact Assessment for the Moreton Hill Wind Farm. This report is intended to inform the layout of the proposed wind farm and to assist the planning and approvals for the project.

If you have any queries, please don't hesitate to contact me.

Yours sincerely

Yours sincerely

Elin Olsson
Senior Engineer
Elin.olsson@watertech.com.au
WATER TECHNOLOGY PTY LTD

EXECUTIVE SUMMARY

Moreton Hill Wind Farm Nominees Pty Ltd commissioned Water Technology to conduct an investigation of flood risk and surface water impacts to inform a planning permit application for the Moreton Hill Wind Farm project, located in south western Victoria. The proposed wind farm consists of 62 wind turbines (WTGs) and supporting ancillary infrastructure. Technical assessments prepared to support the environment report and planning permit application have assessed a wind turbine layout consisting of 68 WTGs. Six additional WTGs beyond the proposed 62 WTGs have been assessed in order to allow for flexibility in the project design and respond to environmental and heritage constraints that may arise. The project will only seek planning approval to construct and operate up to 62 WTGs.

The proposed project site is within the Corangamite Catchment Management Authority (CCMA) management area. The site is characterised by Hoyles Creek and its tributaries originating in the northern end of the site and flowing south, as well as a number of large ponds and wetlands. Mount Emu Creek (within the Hopkins River Basin) flows adjacent to the subject site. Land use within development area and direct upstream catchments is largely private land, used for agriculture, predominantly sheep and cattle grazing with some cereal and fodder crops.

Surface water investigations were undertaken and included:

- Flood modelling of waterways originating within the subject site as well as direct rainfall onto the site.
- An assessment of 1% and 10% AEP flood depth, velocity and hazard at the proposed turbine locations.
- Calculation of 1% AEP flow rates at each of the proposed waterway crossing locations.
- An assessment of the 1% AEP water level difference caused by implementing the proposed development in the hydraulic model.
- An assessment of the flood risk during construction of the proposed underground transmission line.

The surface water modelling enabled identification of flood risk and potential impacts to drainage characteristics across the site. The most relevant surface water impacts were identified as:

- Flood risk areas:
  - Water can enter excavations during construction.
  - Hazardous water levels observed at proposed internal access tracks.
- Hydrological changes to surface water flows due to:
  - Project infrastructure with the introduction of raised impermeable surfaces – turbines and hardstands.
  - Physical disturbance - waterway crossings for tracks and cables.
- Water quality reductions (e.g., turbidity, dissolved oxygen) due to:
  - Surface water runoff (erosion) and sedimentation due to earthworks for infrastructure, tracks and hardstands.
  - Damage to stream beds and banks leading to surface water runoff (erosion) and sedimentation - waterway crossings for tracks and cables.
  - Disposal of poor quality water into waterways or waterbodies - collected during construction of project elements.
  - Accidental spills of hazardous waste during construction and operation.

Management measures were recommended based on the flood impact assessment results, including:

- Use the modelling detailed in this report to inform the siting of infrastructure and access tracks to avoid areas of potential flooding unless designed for that flood level protection, minimise construction in areas of flooding and minimise number of crossing points.
- Culvert sizing should be informed by the modelling in this report.
- Hydrological buffers may be required around waterways and wetlands for infrastructure other than at crossings.
- Watercourse crossings at the proposed access tracks need to be appropriately sized to reduce flood risk and hazard and enable safe access to project infrastructure, as well as reduce impacts to flood extent, flood levels and drainage patterns. Crossing structures also need to conform to relevant local council, CMA and DEECA guidelines.
- Construction in risk areas where water pooling is likely will likely require local, temporary bunding, drainage channels and/or pumps to divert upstream surface water flows and prevent flooding of construction areas, to be detailed in the construction management plan. This may also include sediment control devices.
- Planning must consider inundation conditions at the time of construction (i.e. having a flood response plan and potential mitigation)
- Works on Waterways licenses may be required for construction within 20m of a designated waterway.
- Avoid contamination from accidental spills of hazardous waste by implementing a spills risk assessment and response plan, appropriate storage of liquid fuels and chemicals, making spill response kits available and incorporate spill containment measures into design where required.

The modelling undertaken as part of this assessment can be used to guide the location and detailed design of each proposed asset by MHWF. It is anticipated that where turbines/hardstands are inundated, risk can be addressed through elevation of the hardstand areas and drainage. The specifics of the design will be determined during detailed design.

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1 INTRODUCTION

Water Technology was engaged by Moreton Hill Wind Farm Nominees Pty Ltd (MHWF) to undertake a flood impact assessment to assist the planning and approval process for the proposed Moreton Hill Wind Farm, located 5 km east of Skipton and 5 km west of Linton, VIC (Figure 1-1) (the subject site). This report details the findings of surface water modelling for the subject site, modelling both pre and post development. A comparison is made between the pre and post development scenarios to determine potential changes to surface water flows and flood levels caused by the proposed development.

1.1 Objectives

To provide MHWF with a better understanding of the flooding and drainage behaviour on and near the subject site, the following tasks were completed:

- A pre-development assessment to determine the existing subject site flood risks. This has assisted with the facility layout design, e.g., location of turbines and other infrastructure.
  - Review of the existing Upper Mt Emu Creek Flood Investigation[1].
  - Development of a 2D (two-dimensional) hydraulic flood model (using TUFLOW) to assess flood risk at the site from localised/direct catchment inundation.
- A 'worst-case' post development assessment to determine if any adverse flood impacts or change to flood risk is caused by raising the proposed wind farm layout and design. This primarily focuses on the impact to flood levels and extents on neighbouring properties. Post development modelling was undertaken using the following steps:
  - Inclusion of a raised high-level representation of the proposed development in the model to assess flood impacts.
  - Provision of high-level recommendations for any mitigation or design alterations which may be required to reduce the risk associated with flooding and drainage.

1.2 Site description

The 67 km^2 proposed MHWF subject site is located in south west Victoria, in the Lake Corangamite Basin and within the Corangamite Catchment Management Authority (CCMA) management area. The site is characterised by Naringhil and Hoyles Creeks and their tributaries originating in the northern end of the site and flowing south, as well as a number of large ponds and wetlands. Mount Emu Creek (within the Hopkins River Basin) flows approximately 1.3 km north of the subject site. Only a minor part of the subject site drains towards Mount Emu Creek. Land use within development area and direct upstream catchments is a mixture of private and public land, largely used for agriculture, predominantly sheep and cattle grazing with some cereal and fodder crops.

The site is located on the border between the Corangamite Shire and Golden Plains Shire councils.

[1] Water Technology, 2020 - Upper Mt. Emu Creek Flood Investigation, report prepared for Glenelg Hopkins CMA

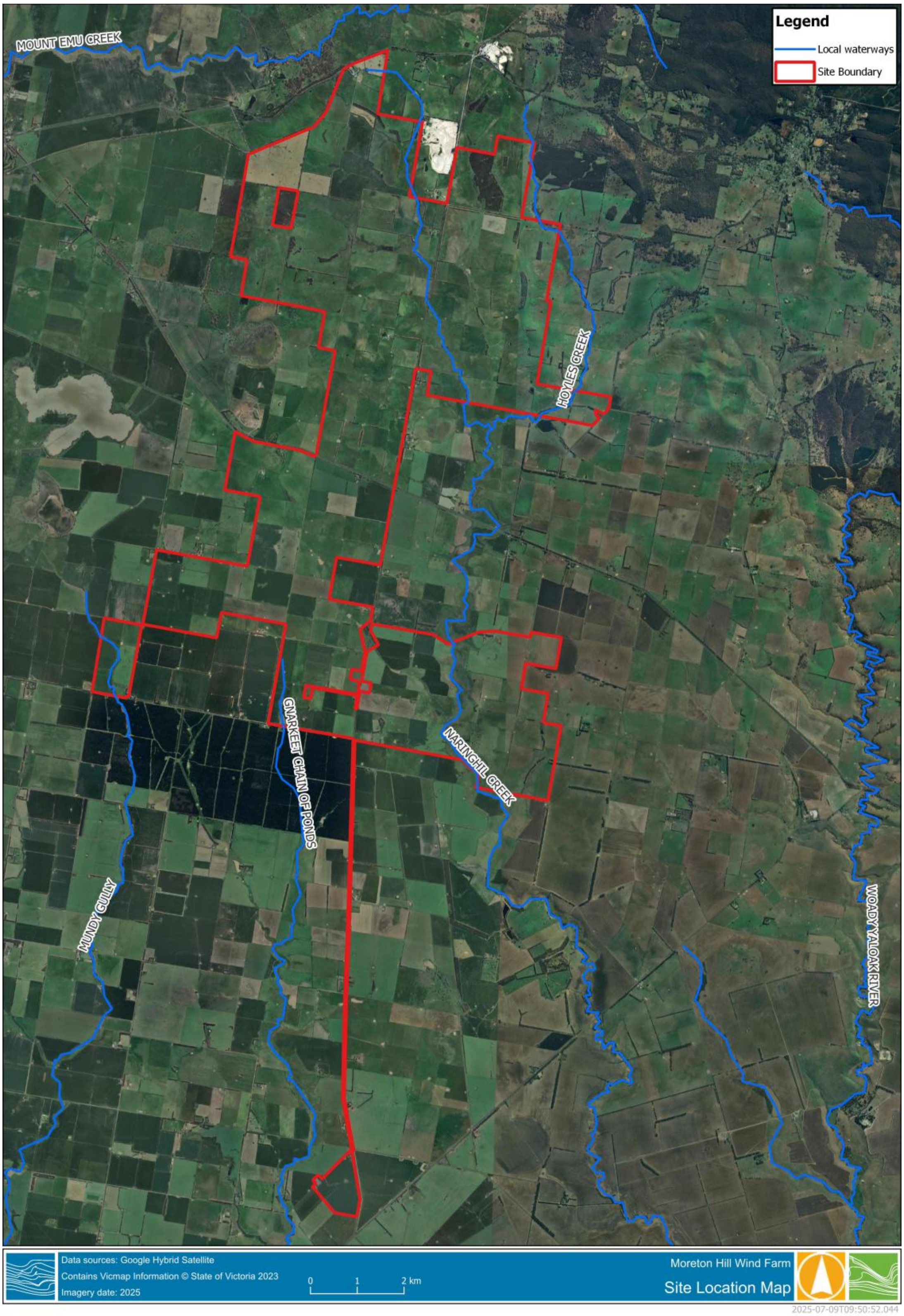

Figure 1-1 Moreton Hill site location

2 LEGISLATION, POLICY, GUIDELINES AND CRITERIA

The key legislation, regulations and guidelines that apply to the surface water impact assessment for the project are summarised in Table 2-1.

Table 2-1 Key legislation and policy

Legislation, policy, guidelines	Relevance to technical discipline
Commonwealth	
Australian Rainfall and Runoff (2019)	The recommendations set out in ARR2019 are used as the base methodology for hydrology and hydraulics technical assessment.
Victorian State	
Catchment and Land Protection Act 1994 (Vic)	Provides a framework for the integrated management and protection of catchments. Considers adverse groundwater effects due to extraction on receptors. Guidance for works on waterways
Environment Protection Act 2017	Established the legislative framework for protecting the environment in Victoria. Regulations regarding protection of environmental values and of the environment ensuring the project demonstrates its implementing measures so far as 'reasonably practicable' to meet the general environmental duty.
Water Act 1989	Provides the legal framework for managing Victoria's water resources. Authorises Catchment Management Authorities (CMAs) various powers for the control, management and authorisation of works and activities in or over designated waterways in the CMA's waterway management district.
By-Law No. 5 Waterways Protection 2024	Makes provision for: ▪ the control, management and authorisation of works and activities in, under, on or over designated waterways and designated land or works; ▪ the protection and care of designated waterways and designated land or works; and ▪ the conservation and preservation of flora, fauna and habitat in designated waterways and designated land or works.
Catchment Management Authorities (CMAs)	
Corangamite Catchment Management Authority	The Corangamite Catchment Management Authority has developed the following relevant strategies: ▪ '2021-27 Corangamite Regional Catchment Strategy'. Each CMA prepares the RCS on behalf of their region. It's the overarching strategy for all involved in managing land, water and biodiversity. Works would be undertaken in accordance with Corangamite CMA Works on a Waterway permit licence requirements. ▪ 'Corangamite Waterway Strategy 2014-2022', which provides a single planning document for river, estuary and wetland management in the region. ▪ 'Corangamite Regional Floodplain Management Strategy 2018-2028', outlines how the ecological and cultural values of the natural floodplains

<table>
<tr><th>Legislation, policy, guidelines</th><th>Relevance to technical discipline</th></tr>
<tr><td></td><td>can be protected while also managing the risks to life, property and assets associated with flooding.

The CMA authorises works on designated waterways via an authority permit in accordance with By-law Number 5 Waterways Protection 2024.</td></tr>
<tr><th colspan="2">Local Government Areas (LGAs)</th></tr>
<tr><td>Corangamite Shire Council and Golden Plains Shire Council</td><td>The Corangamite and Golden Plains planning schemes contain policies and provisions that control land use and development, presented as written clauses and maps depicting where zones and overlays apply within a planning scheme area.

The following zones and overlays relevant to surface water apply to the Subject site:
■ Farming Zone – entire site
■ Environmental significance – along waterways in the southern part of the site including Naringhil Creek and Gnarkeet Chain of Ponds.
■ Vegetation Protection Overlay – along Rokewood-Skipton Road, Lismore-Pittong Road and Willowvale Road
■ Land Subject to Inundation Overlay (LSIO) – Along Hoyles Creek and upper tributaries

The following clauses of the Planning Schemes are relevant to surface water and the site:
■ Corangamite Shire:
  ■ Environmental and landscape values
    ■ 12.03 Water Bodies and Wetlands
    ■ 13.03 Floodplains
    ■ 13.04 Soil Degradation
    ■ 14.02 Water
  ■ Zones - this clause sets out the requirements for development within this zone depending on use
    ■ 35.07 Farming Zone
  ■ Overlays – these clauses set out the requirements for development within these overlays depending on use
    ■ 42.01 Environmental significance overlay
    ■ 42.02 Vegetation protection overlay
    ■ 44.04 Land Subject to Inundation Overlay
  ■ Provisions that require, enable or exempt a permit
    ■ 52.32 Wind Energy Facility</td></tr>
</table>

3 CHARACTERISATION OF EXISTING HYDROLOGICAL ENVIRONMENT

The existing conditions of the assets, values and uses being considered throughout this assessment are described in the following sections.

3.1 Overview

The project is located on the Western District Plains and is within in the Lake Corangamite Basin and within the Corangamite Catchment Management Authority (CCMA) management area. The Project sits south of the Mt Emu Creek but outside of the Mt Emu Creek floodplain, instead located in the Lake Corangamite Basin

There are several waterways in proximity to the project area, the dominant land use within the catchments to these waterways is sheep/cattle grazing and cereal cropping. There are also smaller vegetated areas planted for forestry or as environmental works. The major waterways interacting with the proposed development include:

- Mt Emu Creek (joins the Hopkins River at Hopkins Falls) - flowing northwest of the project area with limited interaction with the development.
- Naringhil Creek (a tributary of the Woady Yaloak River) - flowing through the southern part of the project area towards the south.
- Hoyles Creek (Tributary of Naringhil Creek) - flowing south through the north part of the project area and joining Naringhil Creek south of Rokewood-Skipton Road.
- Gnarkeet Chain of Ponds and Mundy Gully - originating in the southern part of the project area and flowing south towards Lake Corangamite.

There is also a number of ephemeral wetlands within and surrounding the project area. The catchment generally slopes towards the southeast and the Hopkins River with some exceptions along the project boundary with the topography generally sloping away from the centre of the site.

3.2 Hydrological data

3.2.1 Rainfall data

Daily and sub-daily rainfall gauges exist across Australia at relatively high densities. Rainfall data was accessed via the Bureau of Meteorology (BoM) for several gauges nearby the site. This data is used to generate Intensity Frequency Duration (IFD) curves discussed in 3.2.2. The available active gauges closest to the project site are listed below and show in Figure 3-1.

- Skipton Post Office (89025)
  - Available from 1897, located 11 km northwest of the site centre
- Berrybank (89006)
  - Available from 1877, located 24 km south of the site centre
- Lismore Post Office (89018)
  - Available from 1919, located 25 km southwest of the site centre
- Trawalla (89030)
  - Available from 1888, located 30 km north of the site centre

The average annual rainfall within the project area is around 600 mm/yr, compared to an average annual pan evaporation of 1300 mm.

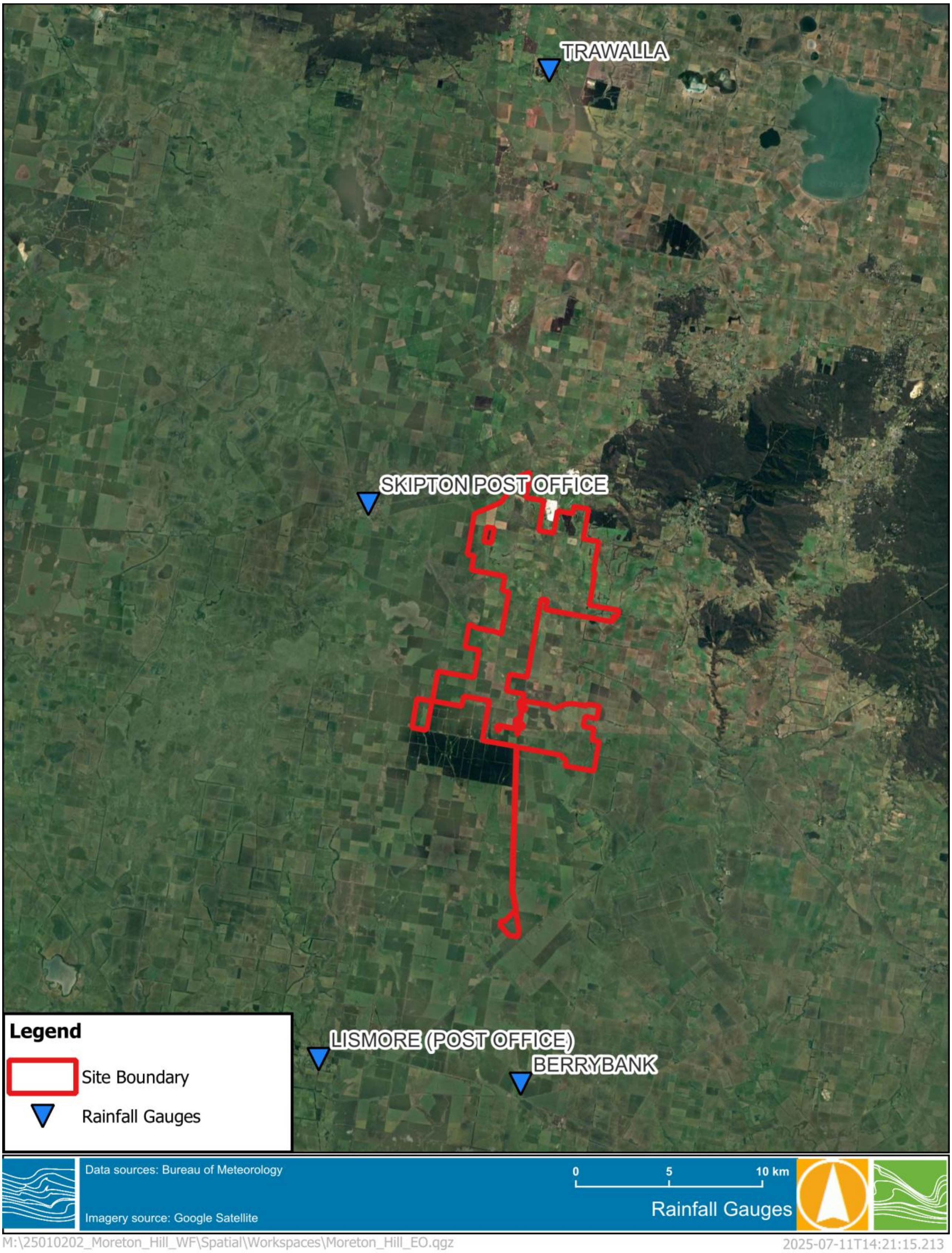

Figure 3-1 Rainfall gauges near the Project

3.2.2 IFD data

IFD curves and underpinning data for the project area were downloaded from the BoM website[2]. The IFD curves are presented in Figure 3-2 showing the relationship between rainfall duration and intensity for each Annual Exceedance Probability (AEP) event. Each AEP is represented as a % probability of exceedance. For example, a 1% AEP event is an event that has a probability of 1% of occurring in any given year. It is equivalent to a 1 in 100 year event. For the general area, rainfall intensity reaches 7.33 millimetres per hour (mm/hr) for a 1% AEP, 12 hour storm event, equal to a total rainfall depth of 87.9 mm. IFD curves are used to determine the likelihood of rainfall and, in combination with other factors (infiltration losses etc) inundation. They were used to define design rainfall depths for the hydraulic modelling.

The 1-hour to 24-hour rainfall intensities for the 1% AEP event are as follows:

- 1% AEP
  - 1-hour event: 39.6 mm/hr (39.6 mm total rainfall)
  - 12-hour event: 7.33 mm/hr (87.9 mm total rainfall)
  - 24-hour event: 4.70 mm/hr (113 mm total rainfall)

[2] Bureau of Meteorology. Design Rainfall Data System (2016), http://www.bom.gov.au/water/designRainfalls/revised-ifd/

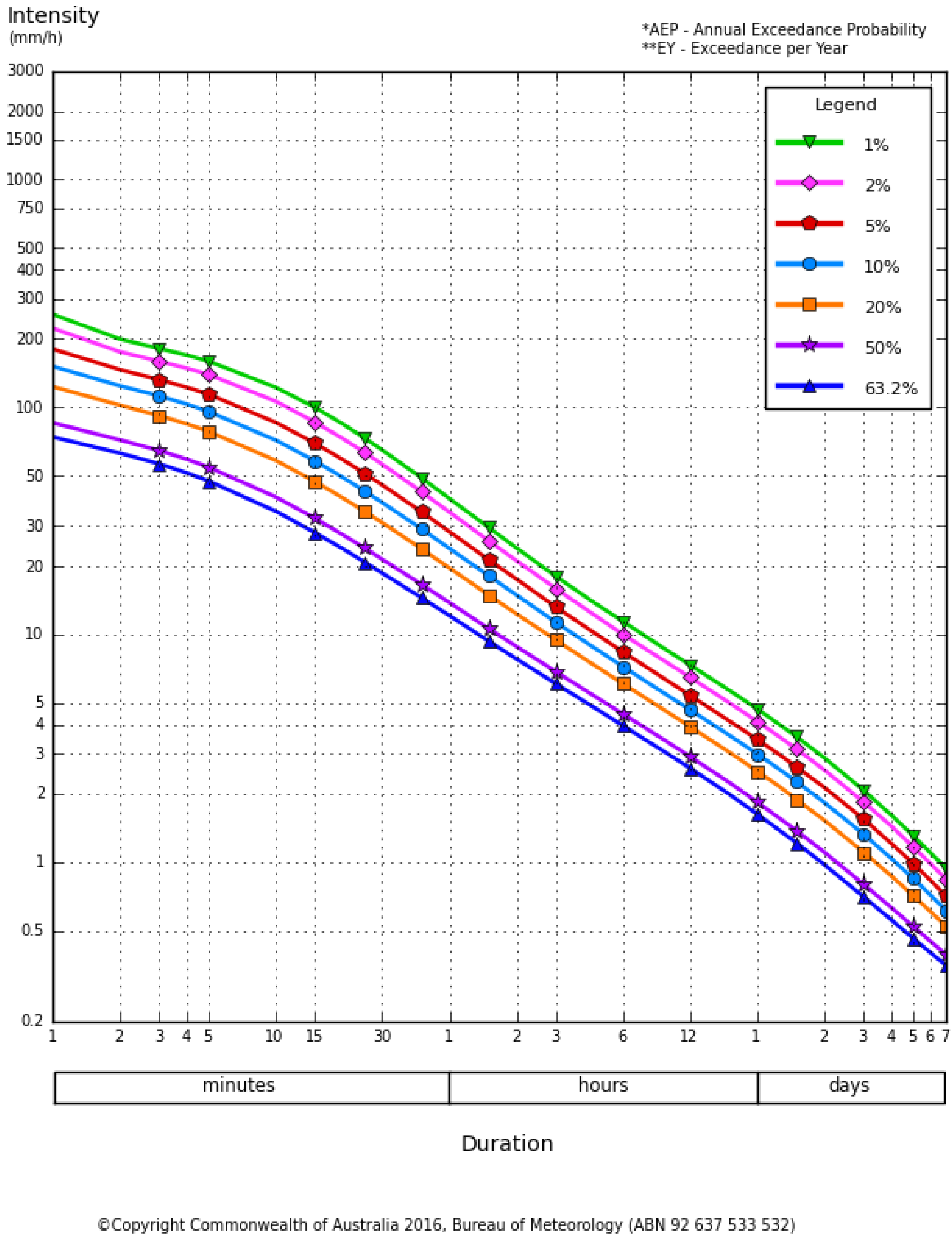

Figure 3-2 IFD curves at the project site

3.2.3 Streamflow data

There are no active streamflow gauges relevant to the project area.

3.3 Topographic data and regional catchment and drainage features

A Light Detection and Ranging (LiDAR) dataset with a 0.5-metre resolution topographic dataset extending across the entire Project area was provided by MHWF. It provided a raster representation of the area capturing details of the topography across the catchment. Areas outside the project boundary were represented using the 2003-04 National Action Plan for Salinity and Water Quality Corangamite 5-metre LiDAR available through the Victorian Department of Energy, Environment and Climate Action (DEECA - formerly known as DELWP and DEPI). Figure 3-3 shows the extent of each topographic dataset within the study area.

Other features, such as major roads, railways, waterways, water bodies, townships and alignment details were available through other VicMap data.

The Project area is characterised by relatively flat open agricultural space used for grazing and cropping, sloping from 400 m AHD in the site's northeast to 270 m AHD in the south The site is characterised by Naringhil and Hoyles Creeks and their tributaries originating in the northern end of the site and flowing south. A number of wetlands have also been identified. Surface water in the area generally flows towards the creeks.

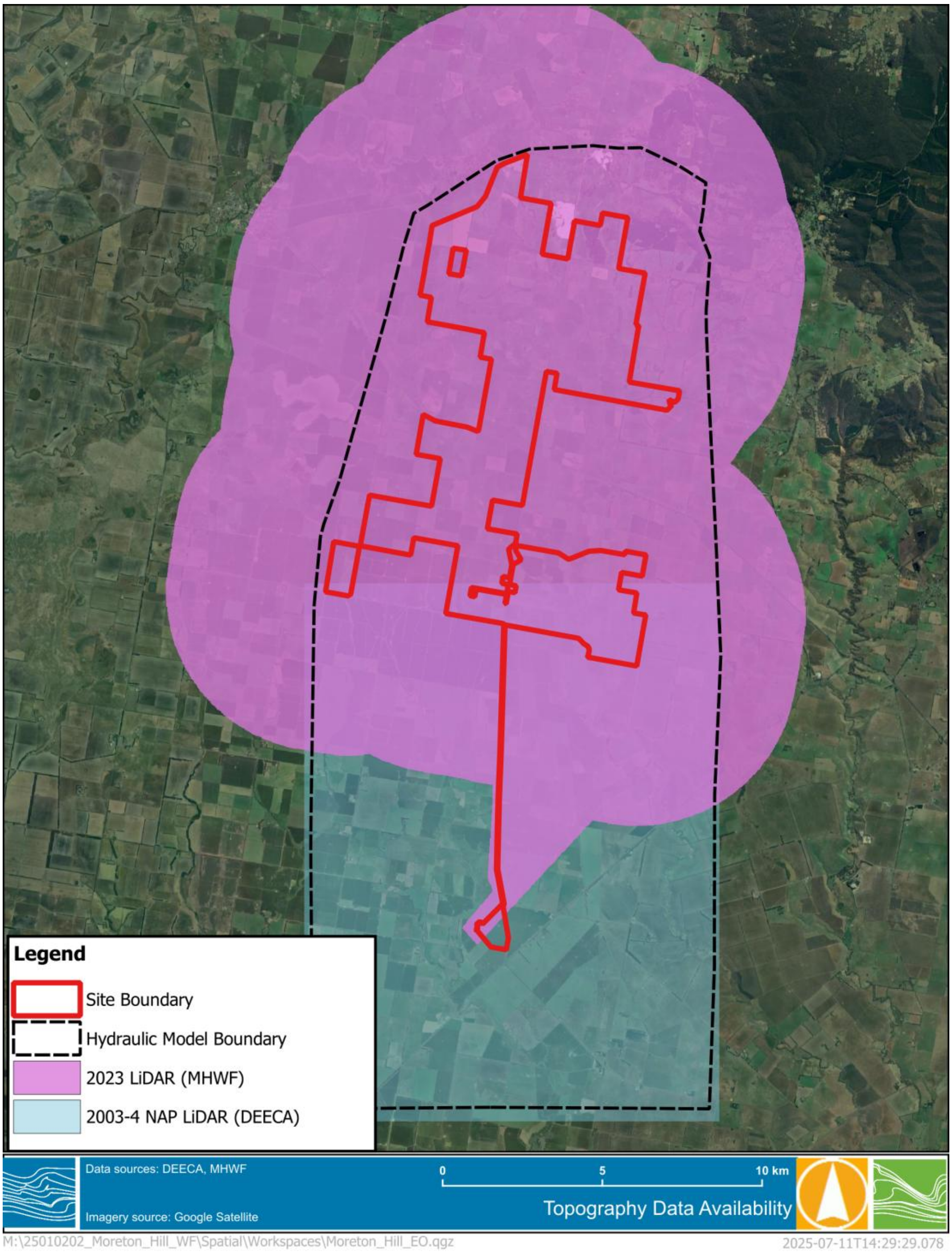

Figure 3-3 Topography data availability

3.4 Waterway classification

Mapping of waterways/watercourses and wetlands can be separated into two distinct types:

- *VicMap watercourses* - VicMap watercourses are a spatial dataset which provides a visual representation of drains, channels, creeks, rivers and water storages. The layer is maintained by DEECA and is purely indicative. The layer generally includes, but is not limited to, Designated Waterways (see below) and constructed channels. VicMap waterways are generally displayed in figures and maps as "Waterways" and are included in some maps within this report. Where available the dataset also indicates named waterways. The VicMap watercourses layer gives a better representation of potential overland flow paths than Designated Waterways because it covers drainage lines and smaller flow paths which are not included in the Designated Waterway definition. Figure 3-4 shows the VicMap watercourses near the project area.
- *Designated Waterways* - The *Water Act 1989* defines a 'designated waterway' as "a natural channel in which water regularly flows, whether or not the flow is continuous". Within Victoria, each CMA has a mapping of its designated waterways. Corangamite CMA has statutory responsibilities under the *Water Act 1989* and 'By-law No.5 Waterway Protection 2024' to monitor, manage, enforce, and administer control over all works which may impact upon designated waterways throughout the Corangamite region to ensure works undertaken do not adversely affect the health of those waterways.

Not only natural waterways fall within the classification of a designated waterway, man-made channels can also feature in the Corangamite CMA designated waterway mapping.

Works and activities on or near a designated waterway require a 'Works on waterways permit' from the CMA. Works and activities relevant to the project include:

- Building a crossing – culverts, bridge or ford.
- Connecting to a waterway by pipe or drain.
- Cleaning out the waterway – removing weeds and silt.

Unfortunately, there is no digital (i.e., Geographic Information Systems (GIS) layer) of designated waterways within the Corangamite CMA management area, only an online map of the entire CMA available as an image[3]. A map of the designated waterways within the project area is show in Figure 3-5.

[3] https://ccma.vic.gov.au/wp-content/uploads/2022/07/CCMA_Regional_Wall_Map_A0_DesigWater_v1_1.pdf

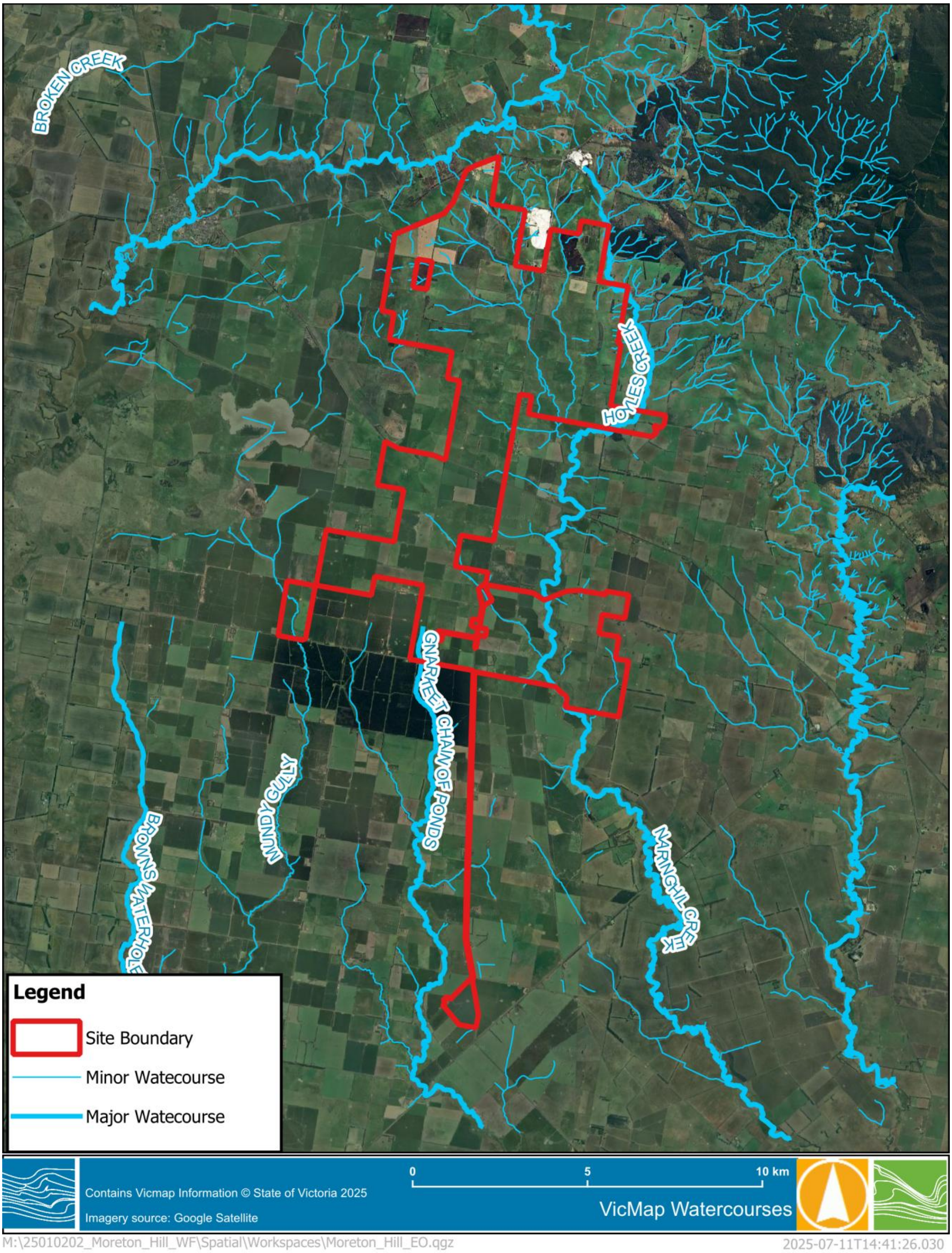

Figure 3-4 VicMap watercourses near the project area

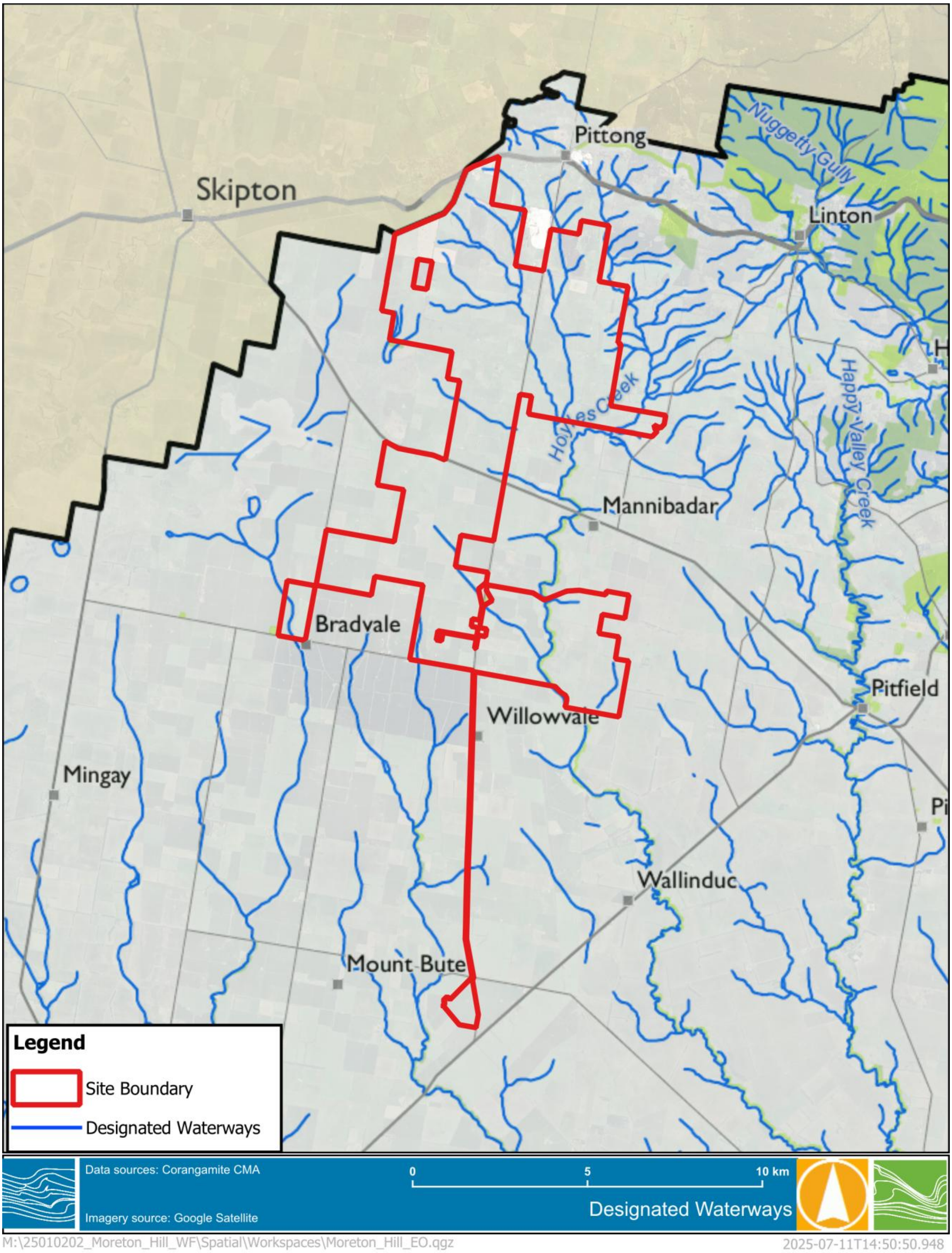

Figure 3-5 Designated waterways within the project area

3.5 Wetlands

A number of wetlands have been identified by DEECA within and surrounding the site, as shown in Figure 3-6. There are no Ramsar listed wetlands located within the project site, with the closest being the Western District Lakes Wetlands approximately 30 kilometres south of the project site centre.

Wetlands within the project area are generally located along the existing waterways or smaller tributaries and capture runoff from the upstream catchments. Some of the wetlands have constructed dam walls downstream to provide water capture for agriculture.

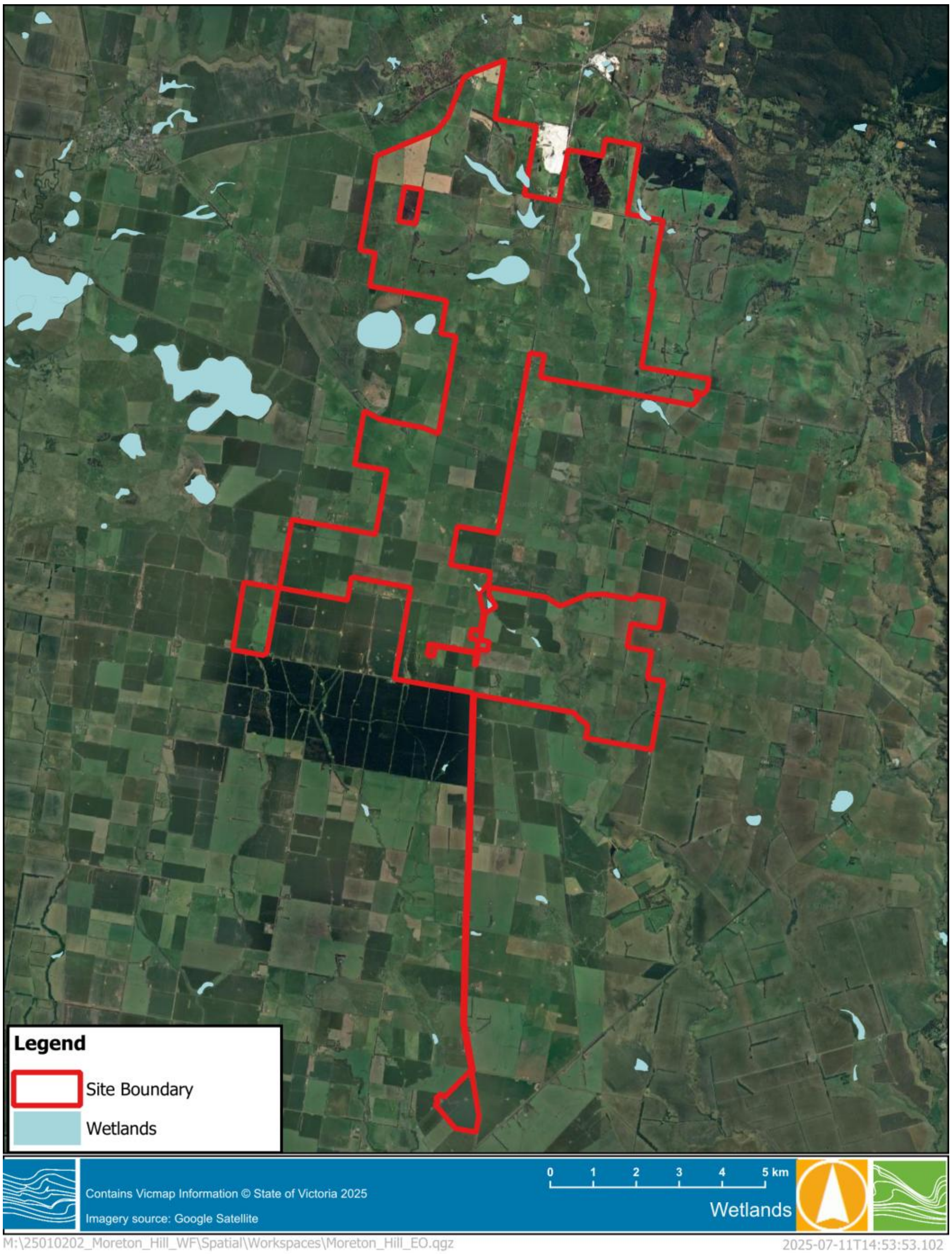

Figure 3-6 Project area wetlands

3.6 Land and water use

Grazing of sheep and cattle is the main land use within the site which is classed as 'Grazing Modified Pastures'. Farm dams are common across the site. The generally agricultural land use has a mixed impact on the surface water attributes of the project area. In some areas it has the potential to increase or decrease runoff dependent on paddock specific use. Waterway and water quality is generally degraded by agricultural use with stock and fertilisers increasing organic loads.

3.7 Groundwater/surface water interaction

There are inherent links between groundwater and surface water within the hydrologic cycle. The surface water assessment carried out for the Project included estimation of infiltration losses; however, these were represented as a loss from surface water and may not necessarily contribute to groundwater. A large proportion of infiltration loss is retained as subsoil moisture to be taken up by plants (evapotranspiration) in the weeks following each rainfall event.

4 PRE-DEVELOPMENT ASSESSMENT

4.1 Overview

Flood risk at the site was assessed in two stages:

- Hydraulic modelling of direct/localised catchment inundation covering the site and directly connected upstream catchments.
- Assessment of riverine flood risk from Mt Emu Creek by comparing to flood extents from the Upper Mt Emu Creek Flood Investigation mapping.

The hydraulic model was built using the TUFLOW HPC software modelling package. TUFLOW is an industry standard one and two-dimensional modelling package which has been used across numerous flood modelling projects across Victoria.

4.2 Direct/localised catchment inundation

Inundation caused by the waterways originating within the subject site as well as direct rainfall onto the site was assessed simultaneously using a TUFLOW hydraulic model with a direct rainfall modelled using a Rain on Grid (RoG) approach.

RoG modelling directly applies rainfall to a topographic grid of the catchment area, identifying all major flow paths through modelling of surface water runoff and then mapping of resulting depth, velocity and hazard (mapped as per the Australian Rainfall and Runoff 2019 (ARR2019) recommendations). RoG modelling is a robust method to determine both runoff volumes, peak flow rates and areas of high flood risk in sites with complex topography. RoG models can identify major flow paths, depressions/wetlands and the complex interactions of overland flow. A traditional rainfall runoff model (RORB, URBS etc.) would not be able to resolve these within the subject site due to its inability to represent the complex terrain. Rainfall runoff modelling requires separation of flow paths and has no ability to hydraulically model discontinuous flow paths or wetland interactions (aside from a simple stage storage relationships).

The modelling completed focused on using infiltration losses, hydraulic roughness (modelled as Manning's 'n') and design rainfall intensities to produce runoff volumes (rainfall minus infiltration losses) and discharge rates covering the site, within upstream and downstream catchment areas.

The development of the TUFLOW model for the subject site consisted of the following components:

- Model extent.
- Topography.
- Material layer – representing hydraulic roughness.
- Model boundaries – representing external flows into the model as well as flows out of the model extent.
- Rainfall.

There are many farm dams and depressions in the subject site. To represent that these areas are likely already inundated prior to the start of a rainfall event, a wet start was included in the model. A water depth grid from a more frequent event (4 times yearly) was used as initial level of water in depressions and farm dams, to avoid underestimating the water levels in these areas.

4.2.1 Model extent and topography

The hydraulic model extent was selected to cover the site and direct upstream catchment areas. A 0.5-metre resolution topographic LiDAR dataset was available for the entire model extent, flown specifically for the proposed development, enabling detailed modelling of the rainfall onto the site. This high-resolution dataset was able to represent the topography including open drains, using a model grid resolution of 4 m to reduce model runtime. The extent and Digital Elevation Model (DEM) used in the TUFLOW model is shown in Figure 4-1.

4.2.2 Land use and roughness

A material layer was created based on planning and parcel layers available through VicMap and verified using aerial imagery. The hydraulic roughness coefficients (i.e. Manning's 'n') and the rainfall loss values were assigned to each use type. The catchment primarily consists of rural farm land, with roads, open water surfaces and some vegetated areas. Table 4-1 gives the Manning's 'n' values adopted for the overland flow model based on land use type and standard industry values (e.g. VicRoads road design guidelines).

Figure 4-2 shows the land use types corresponding with the adopted Manning's 'n' and infiltration loss values. 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.

Starting values of 10mm for initial loss (IL) and 2.5mm/h for continuing loss (CL) for 10% AEP and starting values of 9.95mm for initial loss (IL) and 2.5mm/h for continuing loss (CL) for 1% AEP were taken from ARR datahub based on the site location. The initial loss was varied for each storm duration by subtracting the pre-burst values from the initial storm loss based on ARR19 guidelines. The continuing loss were uniform in all durations at 2.5 mm/h. Table 2-2 summarises the rainfall losses of open space for the hydraulic modelling in each duration within the model.

The adopted rainfall losses of other land use were adopted from nearby RoG studies.

Table 4-1 Manning's 'n' roughness values

Land Uses	Manning's 'n'	Initial Loss (mm)	Continuing Loss (mm/hr)
Open space (Minimal Vegetation)	0.04	See Table 2-2	See Table 2-2
Open space (Heavy Vegetation)	0.12	See Table 2-2	See Table 2-2
Open water (with submerged vegetation)	0.02	0	
Waterway	0.04	0	
Pavements	0.02	2.5	0.5
Industrial	0.3	2	0.5
Gravel	0.05	10	2

Table 4-2 Manning's 'n' roughness values of open spaces

Durations	Initial Loss (mm)		Continuing Loss (mm/hr)
	1% AEP	10% AEP	
30 m	4.8	4.15	2.5
60 m	9.6	8.35	2.5
120 m	8.75	8.65	2.5
180 m	9.25	8.95	2.5
360 m	8.4	9.5	2.5
720 m	8.8	9.35	2.5

Durations	Initial Loss (mm)		Continuing Loss (mm/hr)
	1% AEP	10% AEP	
1440 m	9.95	10.0	2.5

4.2.3 Rainfall input and outlet boundary

Direct rainfall inputs to the TUFLOW model were derived from ARR2019. They were extracted via the QGIS ARR2019 plugin tool which downloads data from the ARR Data Hub and Bureau of Meteorology (BoM). A range of durations were run to capture the critical duration. Each duration applied a front-loaded, a median and a back-loaded temporal pattern to represent the range of temporal patterns.

The downstream hydraulic model outflow boundaries were represented using a stage-discharge relationship (i.e. HQ type). These boundaries allowed water to leave the model domain without influencing flood levels.

4.2.4 Model summary

Table 4-3 TUFLOW model summary

Terrain	The base terrain of the model was derived from client LiDAR captured in 2023 with a 0.5 m resolution and merged with resampled lidar based on the in-house 5m LiDAR.
Inflow Boundary Regime	A rainfall boundary covering the entire extent applying ARR2019 rainfall Intensity-Frequency-Duration (IFD) curves and temporal patterns.
Rainfall depths	1% AEP 2-hour event: 48.5 mm 1% AEP 6-hour event: 67.8 mm 1% AEP 12-hour event: 86.9 mm 10% AEP 2-hour event: 30.0 mm 10% AEP 6-hour event: 43.2 mm 10% AEP 12-hour event: 55.5 mm
Tailwater Boundary	2d_bc – Type HQ (water level-flow)
Model Type	TUFLOW HPC
Model Build	2023-03-AF-iSP
Hydraulic Roughness	Manning's 'n' values were attributed to different land use or surface types, see Table 4-1
Model Cell Size	4 x 4 m with sub-grid sampling.

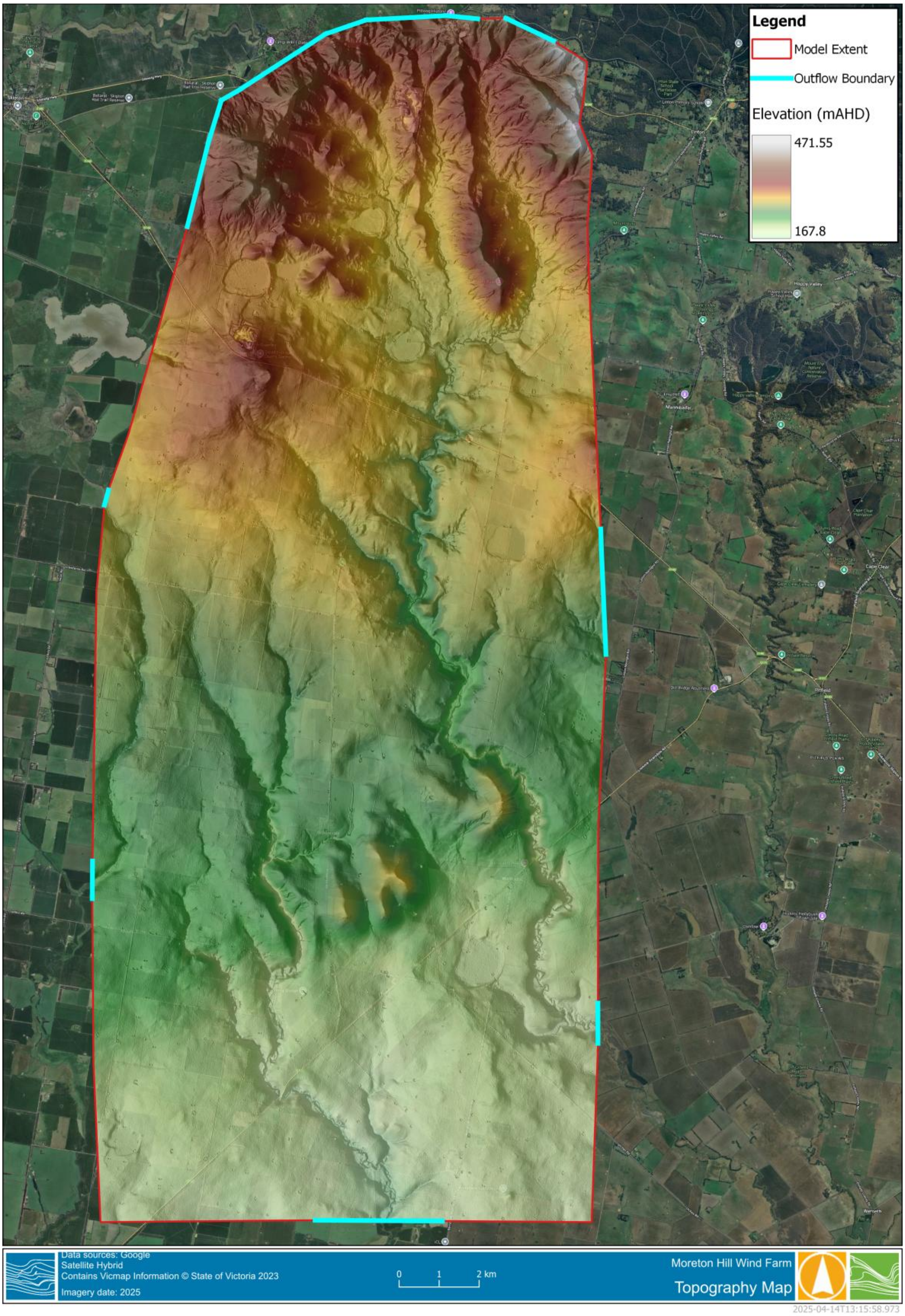

Figure 4-1 Hydraulic model extent, topography and boundaries

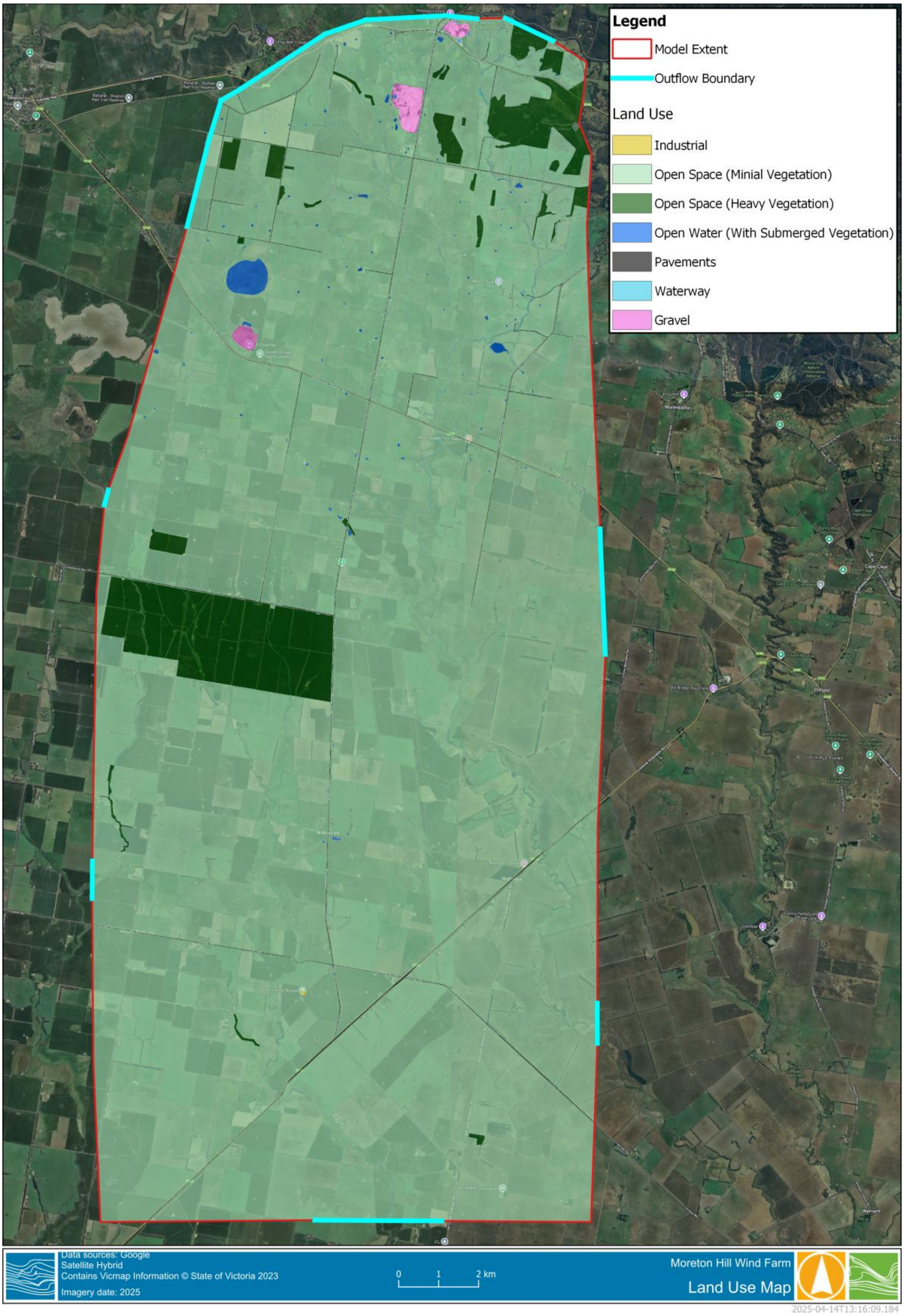

Figure 4-2 Hydraulic model land use

4.2.5 Flood hazard classification

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 subject site several factors were considered, as outlined in ARR 2019 (Book 6, Chapter 7). The assessment of flood hazard considered the following:

- Velocity.
- Depth.
- A combination of velocity and depth.

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 4-3and the 1% AEP flood hazard results are shown in Figure 4-3.

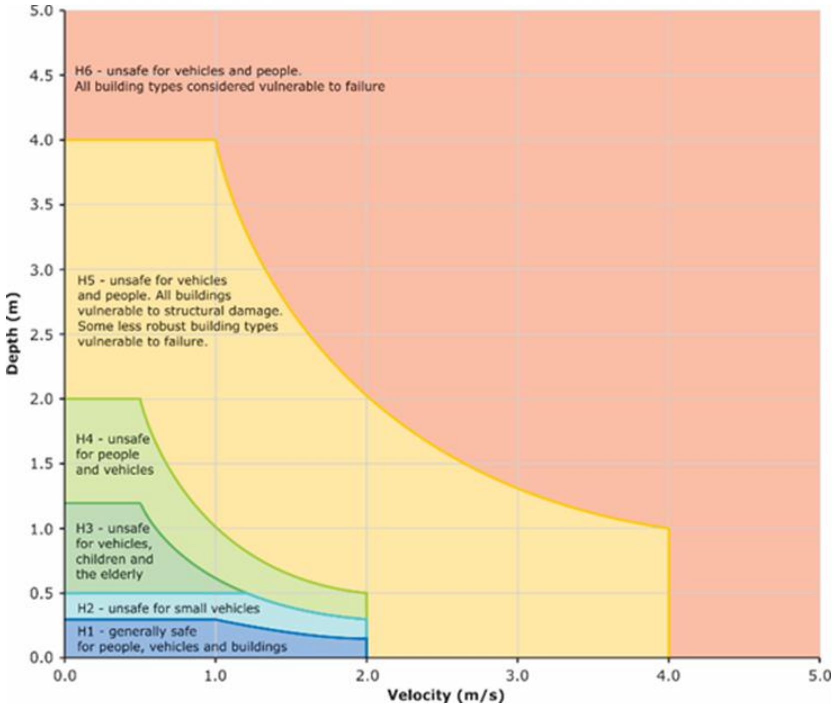

Figure 4-3 Flood hazard curves

4.2.6 Critical duration

Analysis of peak depth in overland flow paths and waterways across the site indicated four of the analysed scenarios were contributing the peak depths for 1% AEP and two of the analysed scenarios contributing the peak depth for 10% AEP, see Figure 4-4, Figure 4-5 and Table 4-4. Final result grids were obtained by combining the results into maximum grids for each variable.

Table 4-4 Critical durations and temporal patterns

AEP event	Critical scenarios
1%	0.5hr TP10, 1hr TP10, 2hrs TP10, 6hrs TP01
10%	2hrs TP10, 3hrsTP09,

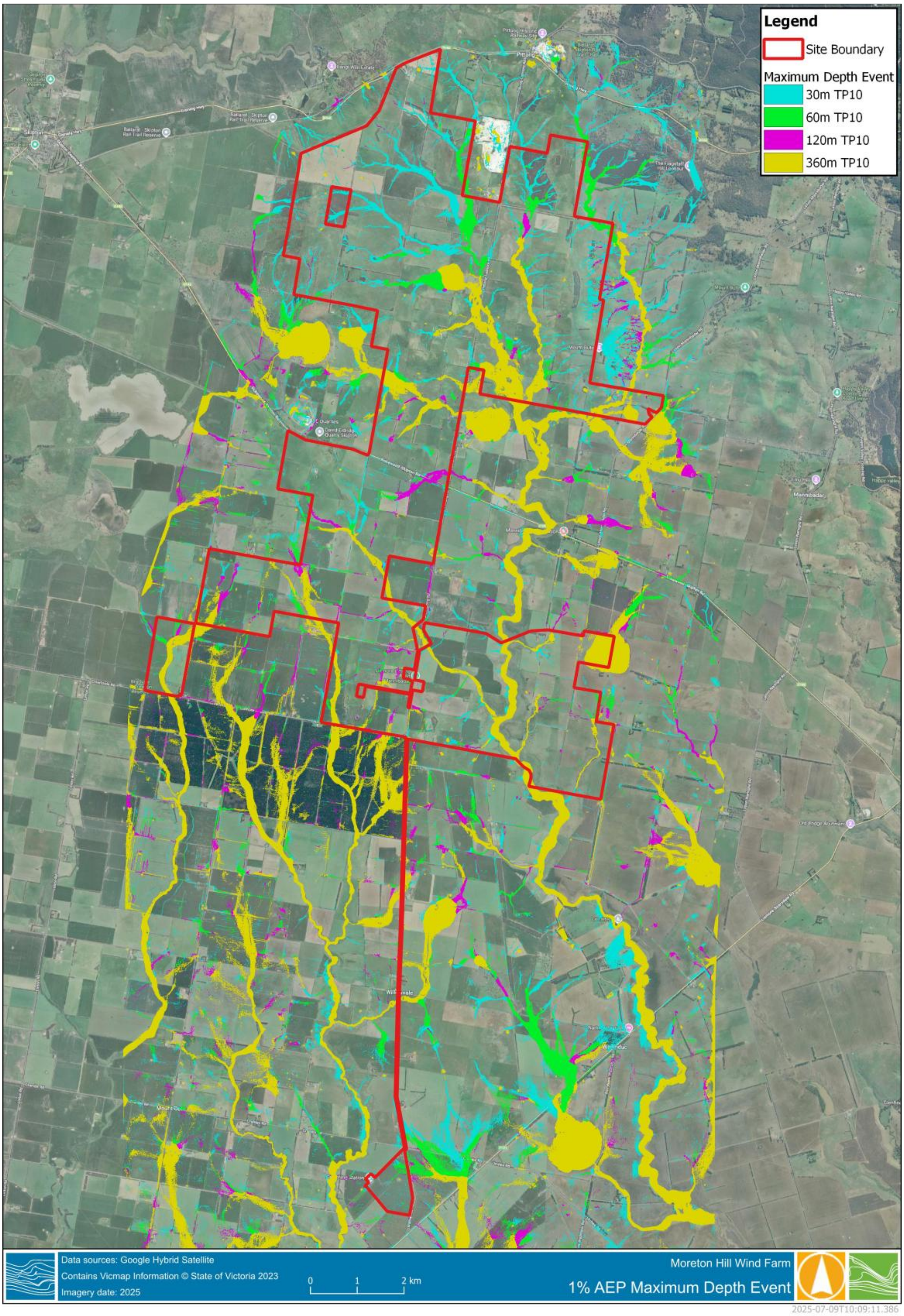

Figure 4-4 1% AEP maximum depth event

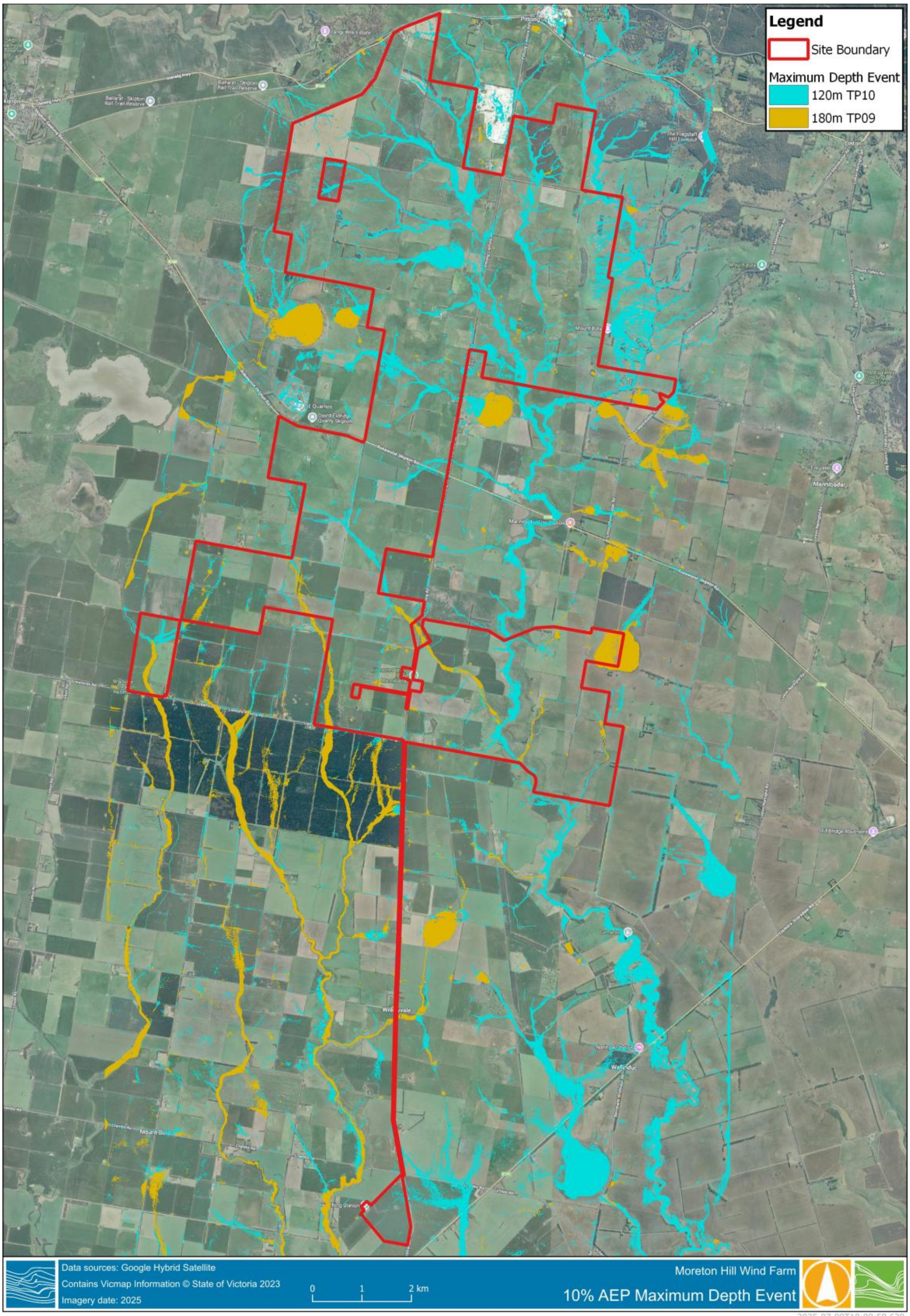

Figure 4-5 10% AEP maximum depth event

4.2.7 Model verification

The modelled 1% AEP peak flow was compared to a Regional Flood Frequency Estimate (RFFE) at the downstream end of the model. The modelled peak flows are within the confidence limits for the RFFE, see Table 4-5.

Table 4-5 1% AEP peak flow estimates

Catchment	Area (m^2)	RFFE (m^3/s)	RFFE Lower Confidence Limit (m^3/s)	RFFE Upper Confidence Limit (m^3/s)	Hydrological Recipes (Rural) (m^3/s)	Hydraulic model (m^3/s)
Hoyles Creek	348	150	50.3	452	437.7	205

4.2.8 Results

The existing conditions 1% and 10% AEP hydraulic model results are outlined in Figure 4-6 to Figure 4-11. Depths below 0.05 m were filtered in all presented results. The results indicated that most of the proposed development is located outside of overland flow paths and areas of ponding, with only seven proposed turbines located in areas with depths above 0.05 m in the 1% AEP event. The proposed access tracks intersect waterways or flow paths in a number of locations.

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

- The inundation across the site is characterised by flow paths originating within the site and running away from the site towards east, west and south. The largest depths and most widespread flooding within the site is observed in Hoyles Creek and its tributaries.
- Seven proposed turbines are located in areas with depths above 0.05 m in the 1% AEP event, with a maximum depth of 0.22 m at the turbine itself. (note: for existing conditions only the turbine location itself was assessed against the flood extent, not the entire hardstand). These are highlighted in Figure 4-6 and the depth at each turbine is as follows:
  - Turbine 20 - 0.08 m
  - Turbine 34 - 0.12 m
  - Turbine 41 – 0.06 m
  - Turbine 44 – 0.07 m
  - Turbine 48 – 0.06 m
  - Turbine 50 - 0.22 m
  - Turbine 54 – 0.17 m
- Velocities within waterways and major overland flow paths reach up to 4 m/s.
- A flood hazard map was created from the product of both depth and velocity as described in Section 4.2.5. In the 1% AEP event, there are areas intersecting access tracks classified as H5 ‘Unsafe for vehicles and people. All buildings vulnerable to structural damage’. This must be considered when designing road crossing infrastructure, alternatively roads should be closed when safe depth limits are exceeded.

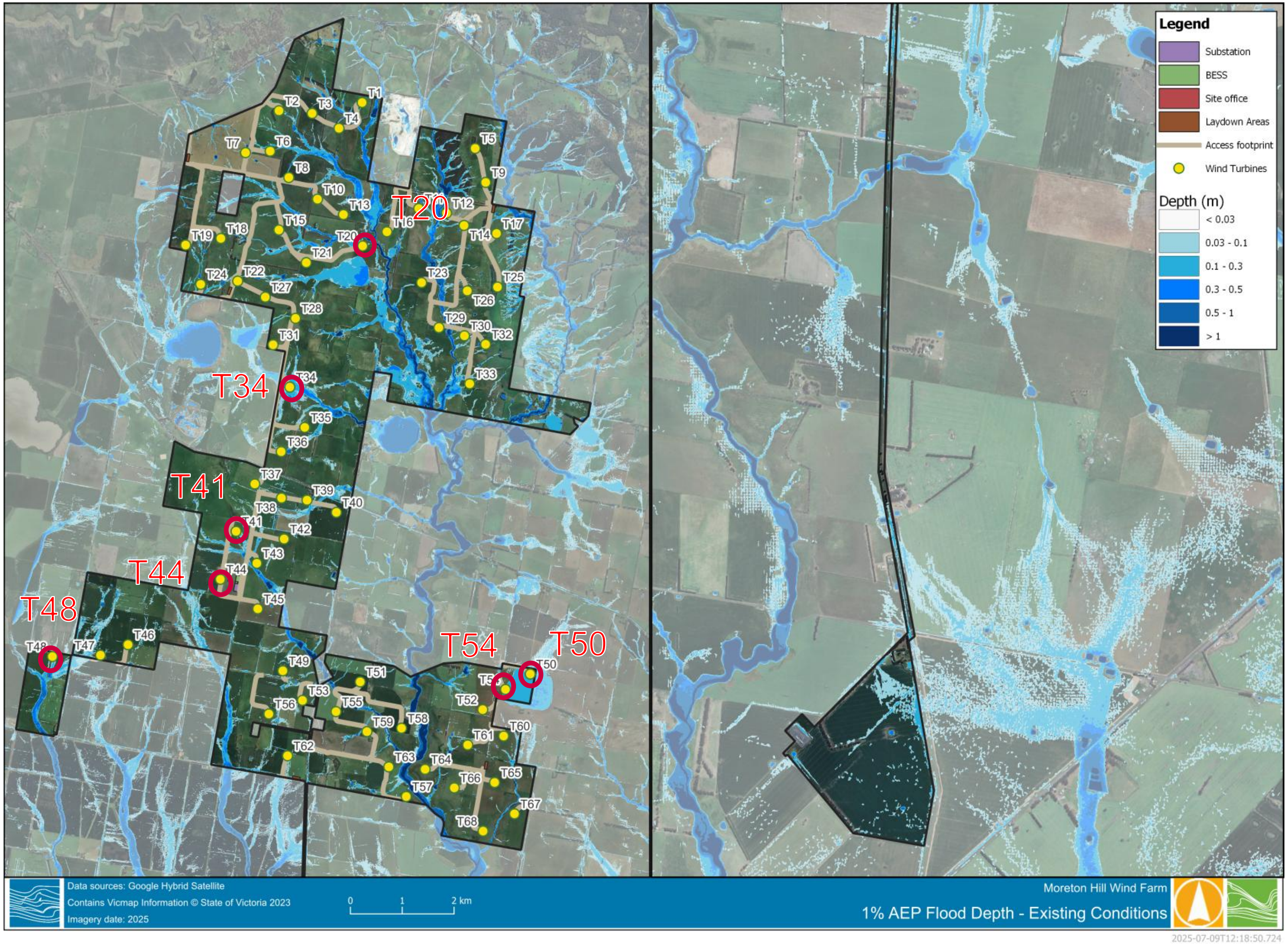

Figure 4-6 1% AEP flood depth – Existing conditions. Turbines located within inundation extent are highlighted by red circles.

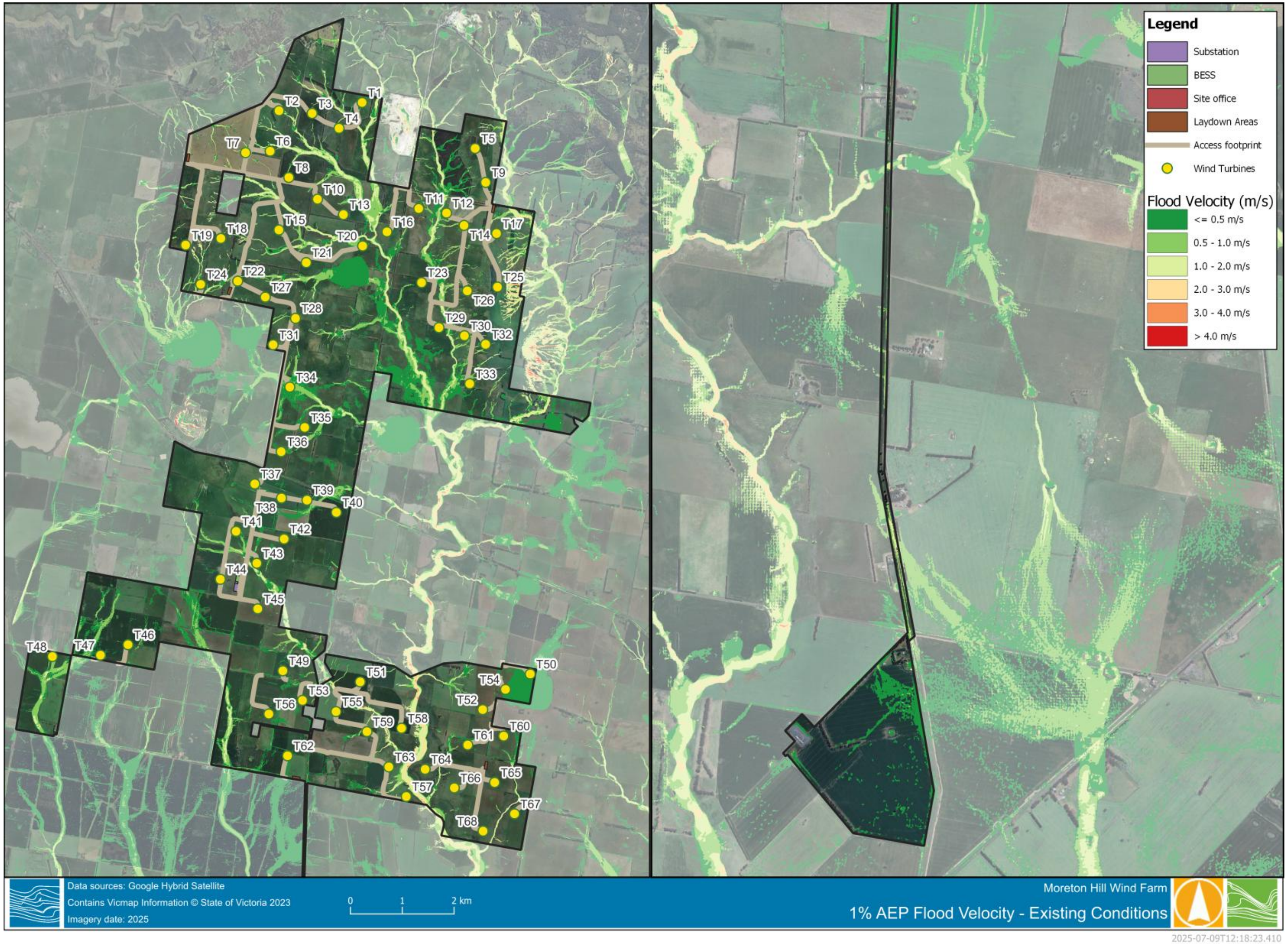

Figure 4-7 1% AEP flood velocity – Existing conditions

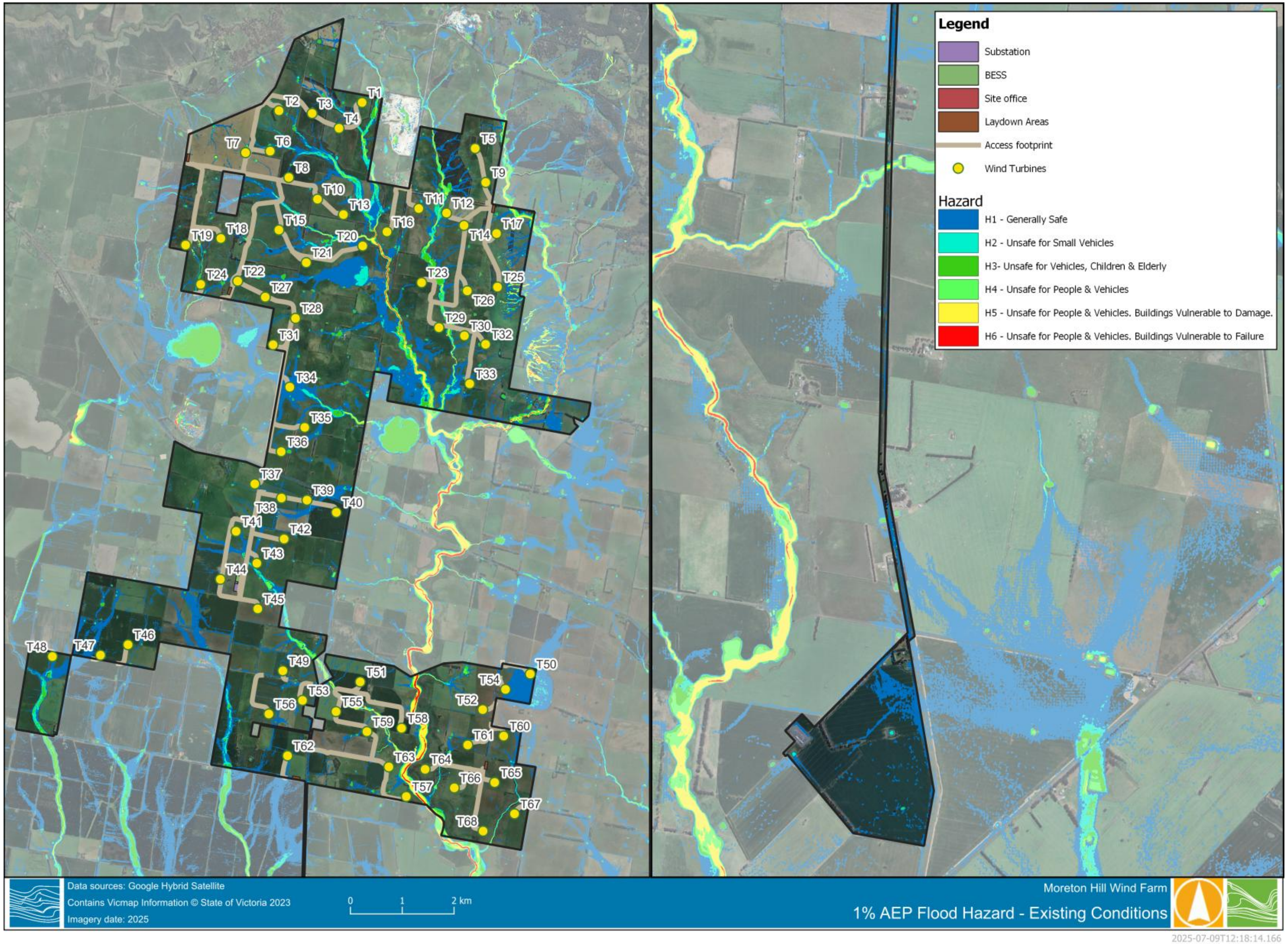

Figure 4-8 1% AEP flood hazard – Existing condition

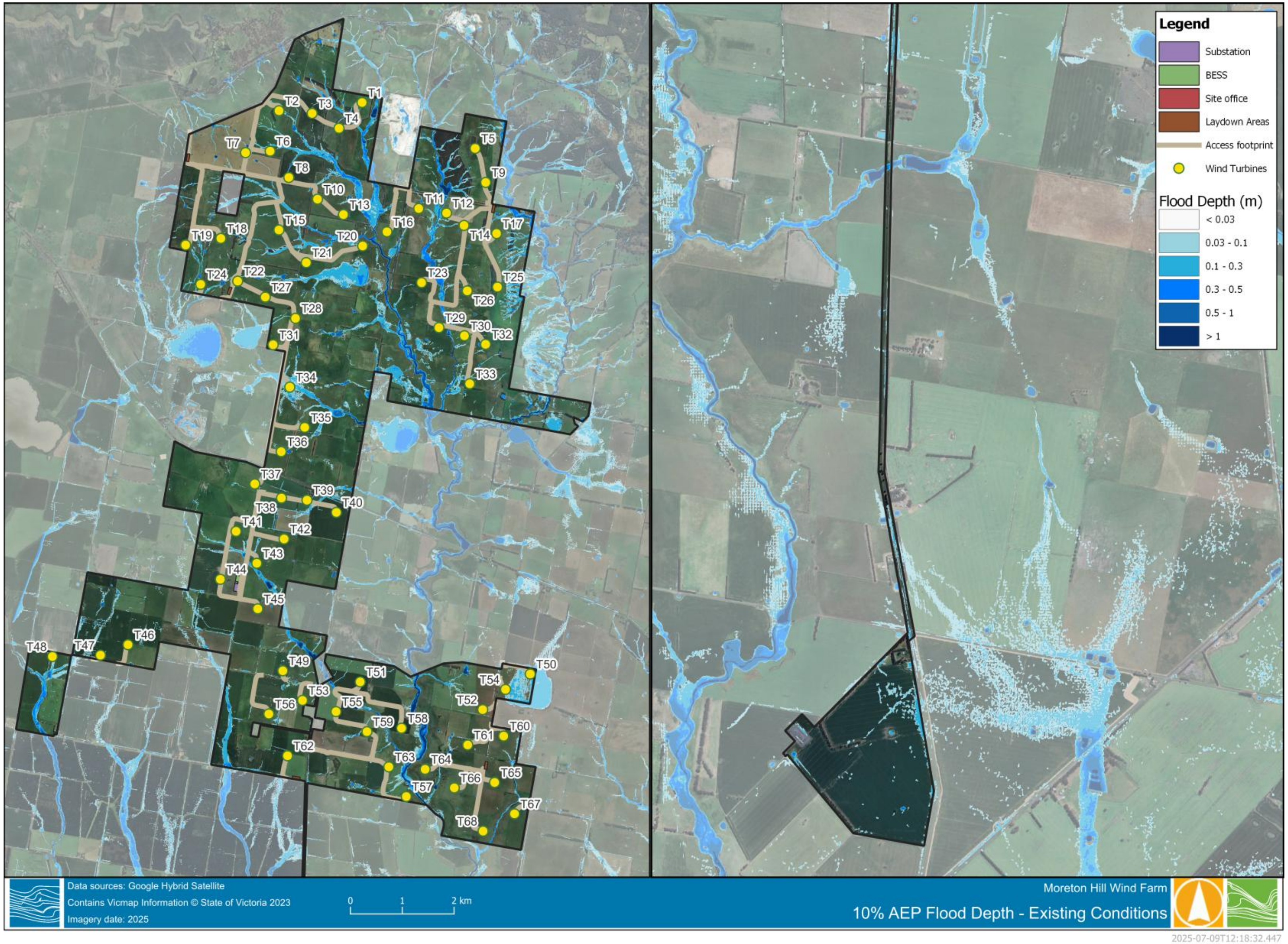

Figure 4-9 10% AEP flood depth – Existing conditions

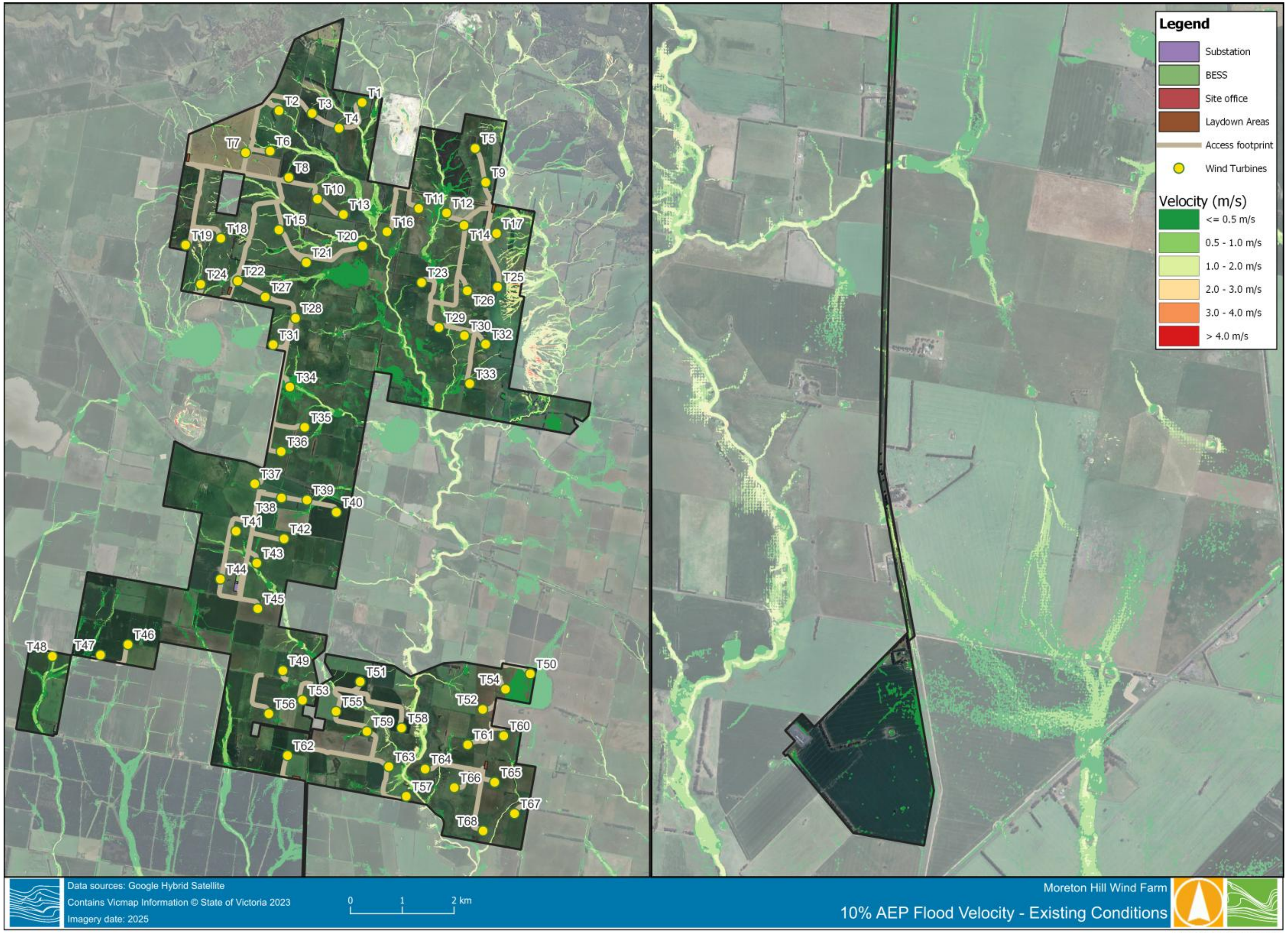

Figure 4-10 10% AEP flood velocity – Existing conditions

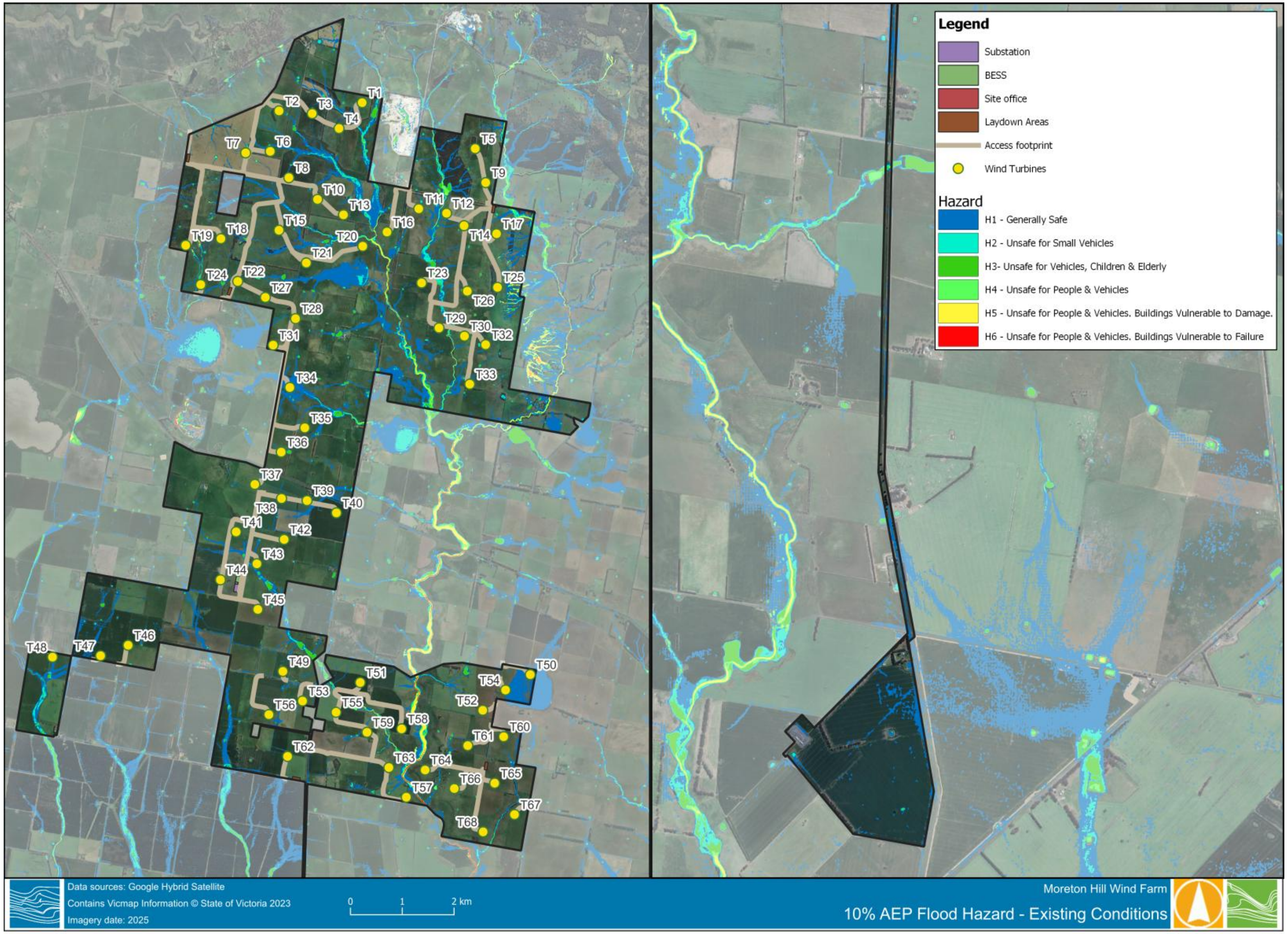

Figure 4-11 10% AEP flood hazard – Existing conditions

4.3 Mt Emu Creek flood assessment

The proposed wind farm layout was compared to the existing 1% AEP and the Probable Maximum Flood (PMF) event flood mapping from the Mt Emu Creek Flood Investigation[1], see Figure 4-12 and Figure 4-13 respectively. The mapping shows that the site is outside of both the 1% AEP and PMF flood extent from Mt Emu Creek.

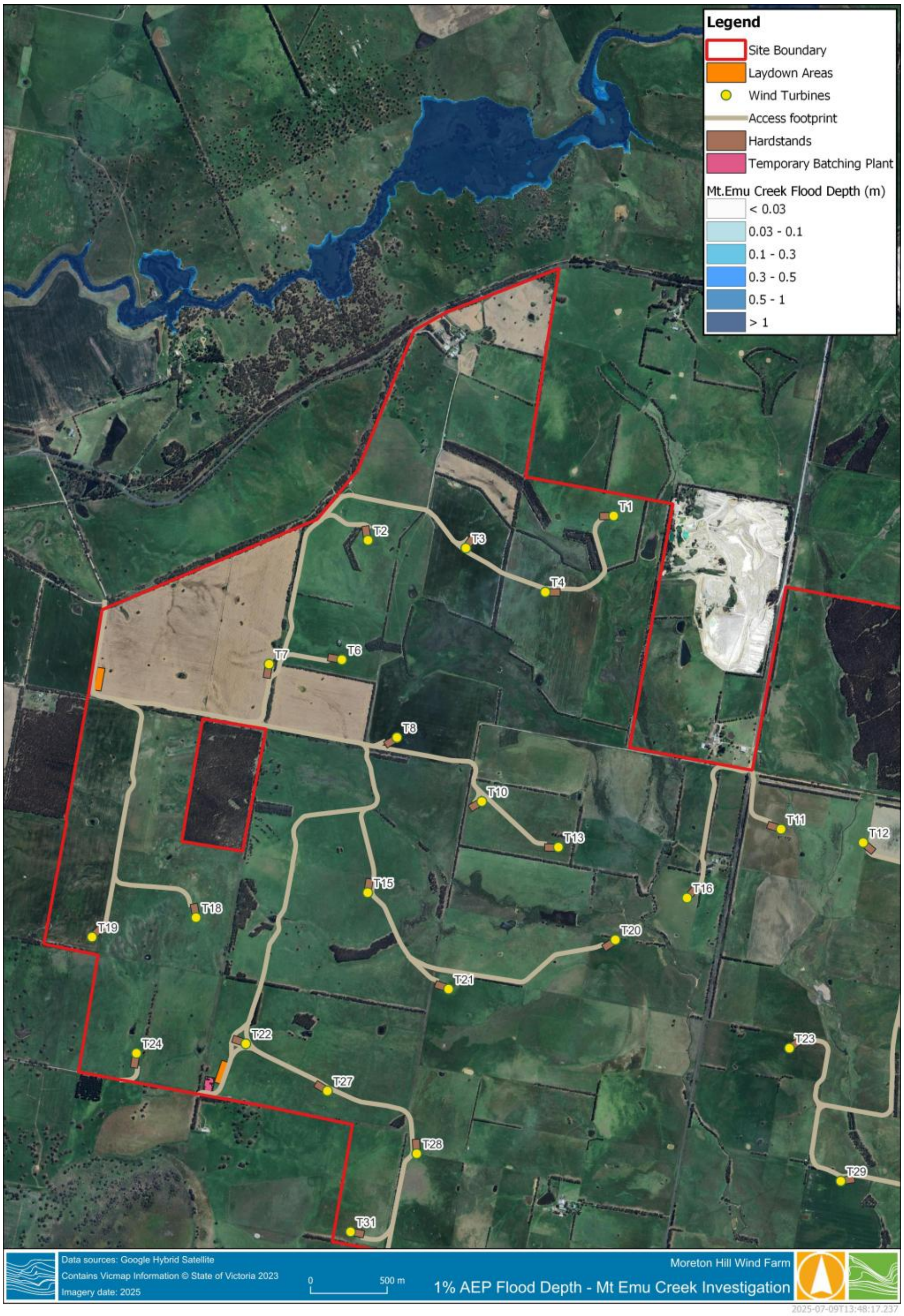

Figure 4-12 1% AEP Flood Depth – Mt Emu Creek

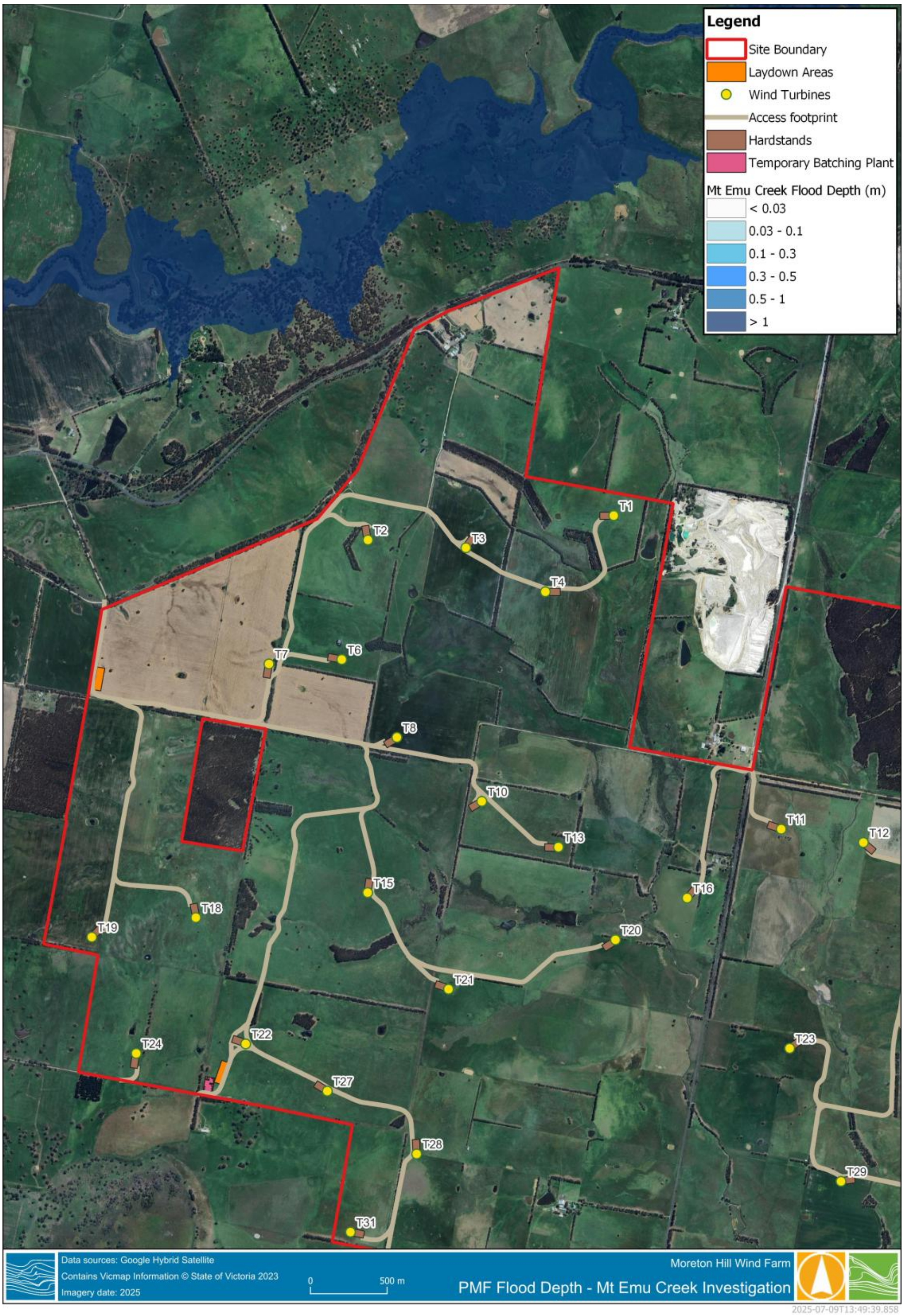

Figure 4-13 PMF Flood Depth – Mt Emu Creek

5 RAISED CONDITIONS MODELLING

5.1 Hydraulic model update

To model an indicative worst case wind farm topography, the proposed wind farm infrastructure including turbine hardstands, access tracks and laydown areas were raised by 300 mm. This was done as a conservative sensitivity assessment of surface water conditions post construction, noting that this is not representative of the detailed design. Additionally, the access tracks were cut open at locations where tracks intersected existing flow paths and waterways, to represent culvert crossings.

5.2 Results

5.2.1 Overview

The difference between existing conditions and raised conditions flood levels and extents is shown in Figure 5-1. For raised conditions, most of turbines are outside of the 1% AEP flood extent, except for Turbine 26, where the flood depth reaches 0.06m. The largest depth observed at any hardstand is 0.22m. Given that the turbine hardstands are likely above these depths, this is not considered a risk to the development.

There are small areas of increased and decreased flood levels, directly adjacent to raised access tracks. Additional culverts may be required at these locations to mitigate the flood extent increases. Also note that culvert crossings may not be required at all the proposed locations, depending on flood depth and hazard across the road at each location.

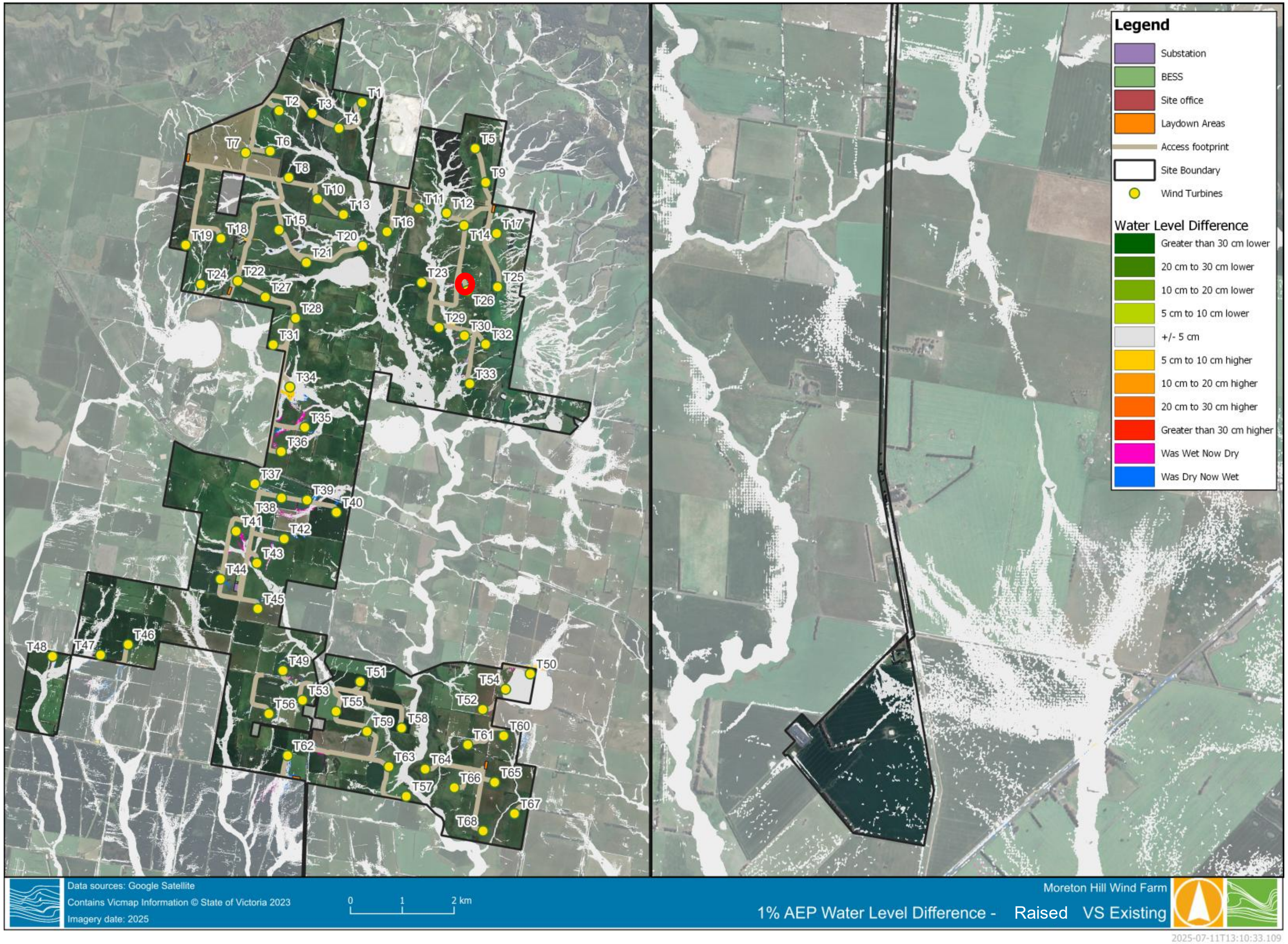

Figure 5-1 1% AEP flood level difference – raised VS existing. Turbines located within inundation extent are highlighted by red circles.

5.2.2 Culvert crossings

Table 5-1 shows the modelled flows at the proposed culvert crossings, with labelled culvert crossings shown in Figure 5-2. This information is intended to be used to aid the project culvert design.

Table 5-1 1% AEP peak flow at proposed culvert crossings

Crossing no.	Peak flow (m^3/s)	Crossing no.	Peak flow (m^3/s)
1	10.73	23	3.88
2	2.15	24	3.26
3	1.63	25	3.00
4	3.24	26	0.69
5	29.76	27	1.67
6	21.04	28	2.46
7	1.23	29	3.38
8	5.65	30	1.01
9	18.54	31	1.24
10	1.65	32	2.07
11	1.96	33	4.00
12	0.14	36	1.49
13	7.59	37	1.39
14	30.9	38	0.57
15	2.92	39	2.86
16	5.00	40	0.82
17	0.46	41	1.66
18	2.94	42	1.13
19	1.63	43	0.91
20	1.22	44	1.02
21	1.36	45	4.20
22	0.28	46	0.06

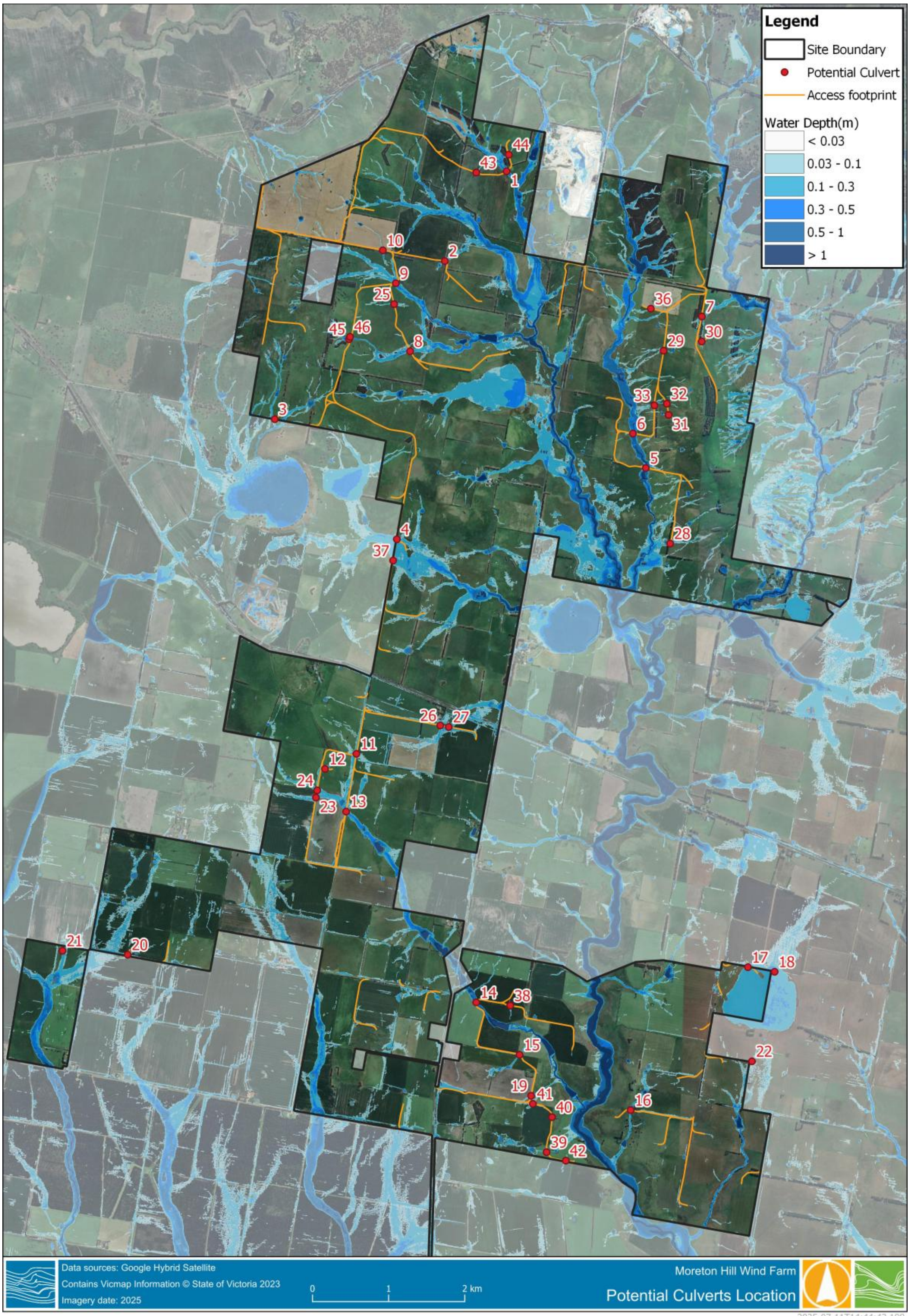

Figure 5-2 1% AEP flood depth – raised conditions and proposed culvert crossings

5.2.3 Transmission line

As part of the project, an underground transmission line will be constructed connecting MHWF with the Berrybank Terminal Station located 13 km south of the wind farm. The proposed transmission line intersects a number of unnamed creeks and overland flow paths.

Since the transmission will be underground, with the natural ground level reinstated post construction, no surface water impacts are expected. One section of overhead transmission is planned within the subject site over Hoyles Creek to avoid the flood extent between crossing 16 and 19 (see Figure 5-2). Construction within the floodplain increases risks associated with flooding of works areas and erosion. A flood risk assessment was conducted along the proposed transmission line. The alignment sections were classified based on the modelled 1% AEP flood depth:

- <30 mm – very low risk.
- 30 to 300 mm – low to medium risk.
- Above 300 mm – medium to high risk.

Maps showing the risk along the alignment are presented in Figure 5-3 and Figure 5-4. Note that the classification has accounted for flooding on both sides on Willowvale Road, but the underground alignment is all on the western side of the road. This should inform the construction, likely to involve trenching and directional drilling. Construction in risk areas will likely require local, temporary bunding and drainage channels to divert upstream surface water flows and prevent flooding of construction areas, to be detailed in the construction management plan. Additionally, planning must consider inundation conditions at the time of construction (i.e. construction during a period of low flood risk, having a flood response plan and potential mitigation). Construction within or in close proximity (<20m) to a waterway may also require further permits (e.g. a Works on Waterways licence, administered by Corangamite Catchment Management Authority).

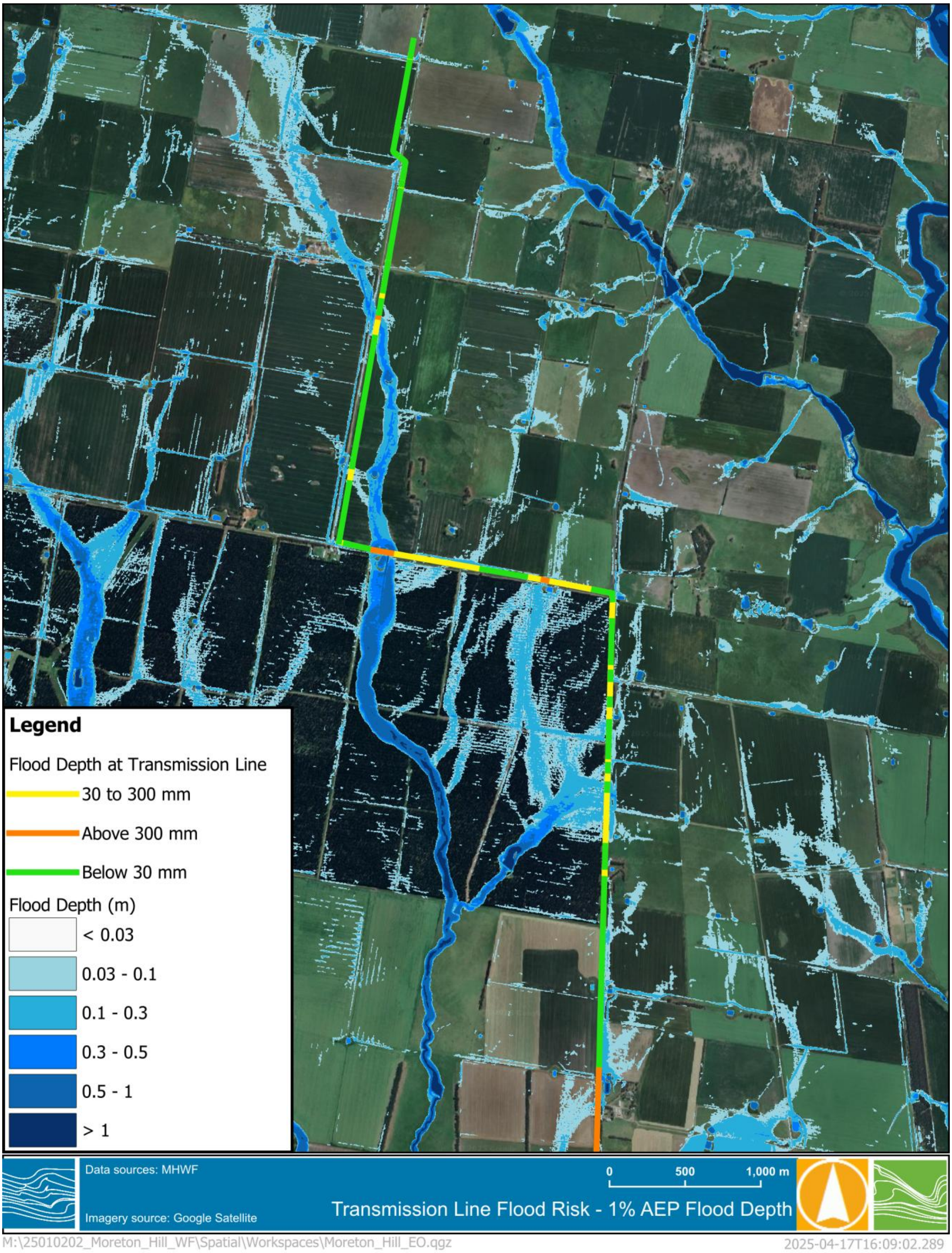

Figure 5-3 Transmission line flood risk – north

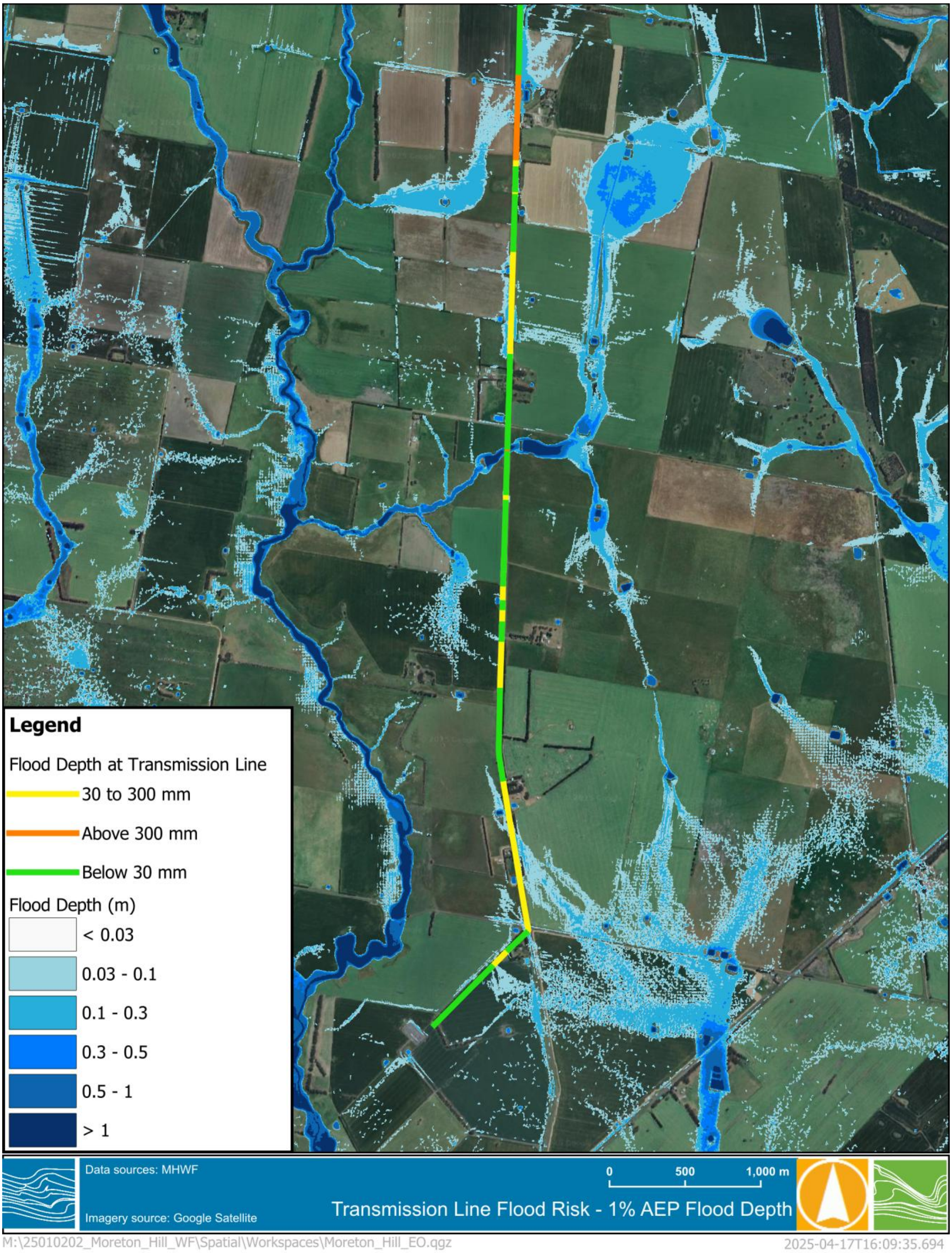

Figure 5-4 Transmission line flood risk - south

6 SURFACE WATER IMPACTS

6.1 Overview

By overlaying the surface water modelling results on the proposed infrastructure layout placement (turbines, roads, tracks, waterway crossings and ancillary facilities) an assessment of the inundation depth, velocity and flowrates can be made at each location. This provides an understanding of infrastructure requirements (i.e. culvert size, access track heights, if micro siting can remove inundation risk etc.) and the potential for construction, operation and decommissioning of the project to impact the inundation.

6.2 Flood risk

The turbine locations are spread across the subject site and are located on both rises and lower areas of topography. It is likely the construction of the turbines will require minor earth works to ensure a flat and stable base on which to construct the hardstand, in some cases this hardstand is within the 1% AEP flood extent.

Inundation across the development area is generally less than 0.3 m in a 1% AEP event, with depths exceeding 1.3 m in the major flow paths and in some localised areas due to ponding. Proposed infrastructure such as the site compound and laydown areas are all located outside the 1% AEP inundation extent. Access tracks were raised in the raised conditions scenario, but site offices, substations and BESS were not, There is some local ponding (up to 0.1 m) observed at the site office, substations and BESS areas which will require local roadside drainage to drain this area.

Inundation depths at the turbine locations and hardstands is less than 0.05 m, aside from seven locations in the existing conditions modelling. No turbine location is inundated by more than 0.22 m. As the level of hardstands were raised, there is some water ponding around hardstands. During construction of the inundated turbine locations, it will be particularly important to ensure no water is able to enter excavations during construction and impacted water unable to flow offsite. Specific flood risk reducing design measures during operation are not required for these locations given the limited flood depth, however standard drainage measures will be required to mitigate hydrological changes, see below.

There is level of inundation and flood risk at some proposed access track locations, including intersections with waterways as well as overland flow paths. There are 10 locations where the 1% AEP inundation depth exceeds 0.3 m observed in the existing conditions modelling. Some sections of access track would need to be raised to allow safe access and egress during flood events, with culverts required to limit impacts to drainage paths. The likelihood this inundation will happen more frequently should be considered (i.e., mapping shows the maximum 1% and 10% AEP inundation but may be inundated to a lower depth much more frequently), construction of culverts may also be required to provide access in frequent events.

The modelling undertaken as part of this assessment can be used to guide the location and detailed design of each proposed asset by MHWF. It is anticipated that where turbines/hardstands are inundated, risk can be addressed through elevation of the hardstand areas and drainage. The specifics of the design will be determined during detailed design. The impacts identified in the raised conditions scenario will inform detailed design flood mitigations.

6.3 Hydrological changes

The construction of roads and larger infrastructure has the potential to alter existing drainage patterns through diversion of flow. Changes to drainage patterns, either increasing or decreasing flow to a given area can lead to ecological changes.

Depending on the watercourse characteristics and construction crossing method, there may be temporary and/or permanent disruption to surface water flows. During construction, partial or complete diversion may be required if the watercourse is flowing at the time of construction. Construction of impervious hardstand areas and infrastructure (e.g., wind turbines) also has the potential to alter flow paths; however, most of the wind turbines are located outside of the inundation extent. The water level difference presented in Section 5.2.1 show ponding at a number of the raised hardstands as well as increased and decreased flood levels directly adjacent to raised access tracks access tracks. Depending on the detailed design layout, mitigation of these impacts will require standard drainage mitigation measures to be determined during detailed design, likely to include (but not be limited to) swales, diversion drains, bunds and culvert crossings (considering flows presented in Section 5.2.2).

Although not explicitly assessed in this flood impact assessment, construction within or adjacent to the floodplain may result in water quality impacts, caused by erosion and sedimentation, streambed damage, offsite discharge of poor quality water from disturbed areas and accidental spills during construction and operation. It is expected these risks can be readily mitigated through a Construction Management Plan.

7 RECOMMENDATIONS

Hydraulic modelling was completed for the proposed Moreton Hill Wind Farm for existing and raised conditions (modelled as a potential 300 mm change to existing levels), with results presented in this report. Raising the proposed footprint has a minor impact on flood levels within and outside of the project boundary, these can be mitigated by carefully designed access tracks and waterway crossings. The following design recommendations are proposed for the development:

- Use the modelling detailed in this report to inform the siting of infrastructure and access tracks to avoid areas of potential flooding, minimise construction in areas of flooding and minimise number of crossing points.
- Culvert sizing should be informed by the modelling in this report.
- Hydrological buffers may be required around waterways and wetlands for infrastructure other than crossings.
- Watercourse crossings at the proposed access tracks need to be appropriately sized to reduce flood risk and hazard and enable safe access to project infrastructure, as well as reduce impacts to flood extent, flood levels and drainage patterns. Crossing structures also need to conform to relevant local council, CMA and DEECA guidelines.
- Construction in risk areas where water pooling is likely will likely require local, temporary bunding, drainage channels and/or pumps to divert upstream surface water flows and prevent flooding of construction areas, to be detailed in the construction management plan. This may also include sediment control devices.
- Planning must consider inundation conditions at the time of construction (i.e. having a flood response plan and potential mitigation)
- Works on Waterways licenses may be required for construction within 20m of a designated waterway.
- Avoid contamination from accidental spills of hazardous waste by implementing a spills risk assessment and response plan, appropriate storage of liquid fuels and chemicals, making spill response kits available and incorporate spill containment measures into design where required.