Appendix H

Stormwater Management Plan

umwelt

MOUNT HOPEFUL BATTERY

Stormwater Management Plan

Umwelt on behalf of Neoen Pty Ltd

24 September 2025

2390-01-B3

DETAILS

Report Title	Mount Hopeful Battery, Stormwater Management Plan
Client	Umwelt on behalf of Neoen Pty Ltd

THIS REVISION

Report Number	2390-01-B3
Date	24 September 2025
Author	Tarkan Pasin
Reviewer	Lindsay Millard

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1 INTRODUCTION

1.1 OVERVIEW

The Mount Hopeful Battery is a proposed grid-scale battery energy storage system (BESS) in Central Queensland (the Project). With a planned capacity of up to 600 megawatts (MW) of power for a duration of up to four hours, the Project will enhance the delivery of clean, reliable electricity to the National Electricity Market (NEM), while supporting grid stability and flexibility.

The Project is located near the rural town of Bajool, approximately 50 kilometres (km) south of Rockhampton and 70 km west of Gladstone, Queensland, within the Rockhampton Region Local Government Area (LGA). The Project is mapped within the Rural Zone of the Rockhampton Region Planning Scheme 2015 (Planning Scheme) and predominantly used for low-intensity agricultural activities, including cattle grazing. The Project is proposed to occur within the bounds of the 'Study Area', which covers an area of 49 hectares (ha) and occurs across three freehold land parcels and two local roads, being South Ulam Road and an unnamed road reserve. The Study Area also accommodates a Powerlink transmission easement that comprises an existing 275 kilovolt (kV) transmission line, into which the Project will connect. The Study Area is sparsely vegetated with predominantly non-remnant vegetation and is intersected by an unnamed tributary of Eight Mile Creek. The Project gains access via South Ulam Road to the east of the Study Area, as shown on Figure 1.1.

The Project is proposed to be delivered over two stages, which are described as follows:

- Stage 1: Indicative capacity of 430 MW, with construction expected to commence mid-2026 and be completed by the end of 2028.
- Stage 2: An indicative additional capacity of 170 MW, with construction expected to commence in 2028 and be completed by the end of 2029.

Key components of the Project include:

- Up to 650x Battery Modules
- Up to 170x Medium Voltage (MV) Transformers
- 2x High Voltage (HV) Transformers
- A HV Switching Station.

The Project will also encompass associated ancillary infrastructure necessary to the operation of the BESS, including:

- Site access track
- Overhead and underground electrical cables
- Inverters
- High voltage substation
- Earthing and lightning protection
- Security fencing, closed-circuit television (CCTV) and lighting
- O&M building
- Water retention pond
- Lay down areas

Umwelt commissioned WRM Water & Environment Pty Ltd (WRM) to assist with the stormwater management aspects to support the Project. The purpose of this technical assessment is to help with the lodgement of a development application to the Rockhampton Council.

1.2 PROJECT CONTEXT

The Project will connect to Powerlink's 275kV Feeder 812, between Bouldercombe and Calliope River substations, through a new switching station that will be delivered as part of the Project and will unlock the connection of additional generation, including the windfarm.

The Project will also support the grid as Powerlink is looking at options to ensure ongoing reliability and security of supply in the anticipation of closure of the Gladstone Power Station and to support the electrification of major industry in the Gladstone region.

The Project has received development approvals from the Queensland Government and the Commonwealth (through DCCEEW) under the assumption that the battery will be ancillary to the wind farm. Since the Project was approved, Neoen has identified an opportunity to use the battery as a standalone asset to provide system strength services to Powerlink. A new development permit application for the project will be made to the RRC to allow standalone operations of the battery.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides details on the regulatory framework;
- Section 3 outlines the proposed infrastructure and catchment context;
- Section 4 describes the development of the hydraulic modelling;
- Section 5 presents the modelling results and impacts of the proposed development;
- Section 6 discusses the stormwater impacts as they relate to environmental values;
- Section 7 provides the erosion and sediment control principles and control measures;
- Section 8 is the contamination risk assessment;
- Section 9 contains the development outcomes table;
- Section 10 summarises the findings of the study; and,
- Section 11 is a list of references.

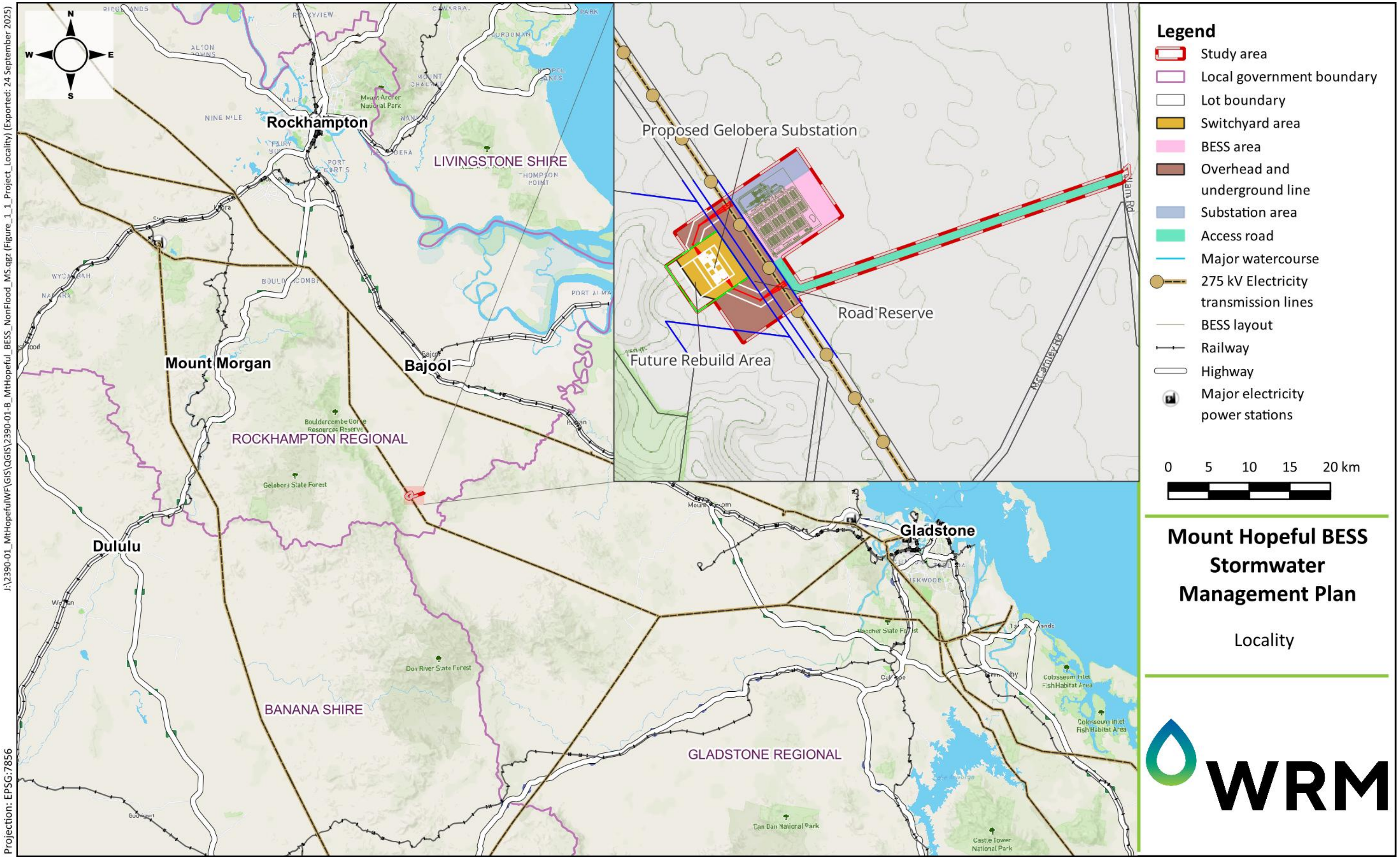


Figure 1.1 Project Locality

2 REGULATORY FRAMEWORK

2.1 OVERVIEW

This section outlines the regulatory framework (including legislation, policies, and standards) at the State level that applies to surface water management for the Project. In undertaking these assessments, the key relevant Acts of Queensland include:

- *Water Act* 2000 (Water *Act*);
- *Planning Act* 2016 (Planning Act);
- *Environmental Protection Act* 1994 (EP *Act*); and
- *Environmental Protection* (Water and Wetland Biodiversity) *Policy* 2019 (EPP Water).

2.2 ENVIRONMENTAL PROTECTION ACT

All persons have a legal duty under the *EP Act* Section 319 to take all reasonable and practicable measures to minimise or prevent environmental harm. Such harm can be caused if sediment from a construction site enters (washes, blows, falls or otherwise) into drains or waterways. Section 443 of the EP Act stipulates that a person must not cause or allow a contaminant to be placed in a position where it could reasonably be expected to cause serious or material environmental harm or environmental nuisance (e.g. placing a stockpile adjacent to a waterway). Section 440ZG of the *EP Act* requires that a person must not unlawfully deposit a prescribed water contaminant or at another place, and in a way so that the contaminant could reasonably be expected to wash, blow, fall or otherwise move into waters or stormwater drainage.

The Principal Contractor who becomes aware of serious or material harm in association with their work (e.g. significant loss of sediment from their site works into a watercourse) has a legal duty under Section 320A of the EP Act to notify the Department of Environment, Tourism, Science and Innovation (DETSI).

2.2.1 EPP Water and Wetland Biodiversity

The *EPP Water* is subordinate legislation under the EP Act. The EPP Water seeks to protect Queensland's waters while allowing for ecologically sustainable development. Queensland waters include water in rivers, streams, wetlands, lakes, aquifers, estuaries, and coastal areas. This purpose is achieved within a framework that includes:

- identifying environmental values (EVs)
- determining water quality guidelines (WQGs), and
- water quality objectives (WQOs) to enhance or protect the environmental values.

The EVs and WQOs applying to the Project are outlined in Section 6.2.

2.3 WATER ACT

In Queensland, the Water Act is the primary statutory document that establishes a system for planning, allocating and using non-tidal water. The Department of Local Government, Water and Volunteers (DLGWV) administer the Water Act.

The *Water Act* prescribes the process for preparing Water Plans (WPs) and Water Management Protocols (WMPs) for specific catchments within Queensland. Under this process, WPs are prepared to identify:

- desired outcomes, measures and strategies for achieving the outcomes;
- performance indicators;
- amounts of water available for consumptive use and future use;
- specifications of water management areas and trading zones; and
- criteria for deciding water licences.

The WMPs provide details of:

- water dealing/trading rules;
- water sharing rules for unsupplemented water;
- seasonal water assignment rules; and
- any volumes of unallocated water reserved for particular purposes or stated locations.

The WPs and WMPs determine the conditions for granting water allocation licences, permits, and other authorities, as well as the rules for water trading and sharing. The WP sets Environmental Flow Objectives (EFOs) to protect waterway health, and Water Allocation Security Objectives (WASOs) to maintain community water supplies.

The majority of the flow through the Study Area could be described as occurring within "drainage features" and would not be considered watercourses. None of the activities proposed for The Project would disturb the bed and banks, and therefore, as no watercourses will be disturbed, licensing will not be required under the Water Act.

2.4 PLANNING ACT

The Planning Act is the mechanism for assessing all developments within Queensland. The Planning Act is supported by the *Planning Regulation* 2017 (the Planning Regulation), the State Planning Policy, and the Planning Scheme. The Planning Act provides the overarching principles for managing stormwater within the Study Area.

The Planning Scheme provides a strategic framework for planning and development and is the primary instrument governing surface water resources (specifically stormwater) within the Study Area. Assessment benchmarks are based on principles of ecological sustainability established by the Planning Act and are the basis for the measures of Planning Schemes.

2.5 STATE PLANNING POLICY

Section 2.1 of the Planning Scheme states that state interests, including Water quality, Natural hazards, risk, and resilience, have been appropriately integrated into the planning scheme. Stormwater management for the Project will comply with the following desired outcomes under the State Planning Policy 2017.

2.5.1 Drainage control desired outcomes:

- Manage stormwater flows around or through areas of exposed soil to avoid contamination;
- Manage sheet flows to avoid or minimise the generation of rill or gully erosion;
- Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works, which, for a design life >24 months, requires drainage structures to pass the 10% Annual Exceedance Probability (AEP) flood event, and culvert crossings to pass the 63% AEP flood event;

- Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins, which require spillway capacity for a 2% AEP flood event.

2.5.2 Waterway stability and flood flow management desired outcomes:

- Where measures are required to meet post-construction waterway stability objectives, the reduction in mean annual load is to reduce: total suspended solids by 85%, total phosphorous by 60%, total nitrogen by 45% and gross pollutants by 90%;
- Earthworks and the implementation of erosion and sediment controls are undertaken in ways that ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 10% AEP.

2.5.3 Litter, hydrocarbons and other contaminants: desired outcomes:

- Remove gross pollutants and litter;
- Avoid the release of oil or visible sheen to released waters; and,
- Dispose of waste containing contaminants at authorised facilities.

2.6 ROCKHAMPTON REGIONAL COUNCIL PLANNING SCHEME

2.6.1 Overview

The Planning Scheme is the current local planning instrument that regulates the management of stormwater for the Study Area within the RRC LGA. Section 3.4.1 Strategic Outcomes of the Planning Scheme states that:

- The community highly values the natural environment and landscape for their contribution to the planning scheme area’s biodiversity, economic prosperity, culture, character, and sense of place. These areas are to be protected from incompatible development;
- Development does not create unsustainable impacts on:
  - The natural functioning of floodplains;
  - Environmentally significant areas, including areas of state and locally significant vegetation, which provide fauna habitat and support biodiversity; and
  - The quality of water entering waterways, wetlands, and local catchments;
- Development does not increase the risk to human life and property in areas that are affected, or potentially affected, by storm-surge, erosion, sea-level rise or other coastal processes, flooding, bushfire, or landslide. This occurs through the avoidance of natural hazards in new development areas;
- Strategic and iconic scenic landscape values are protected from potential adverse impacts of development.

Specific outcomes for the water resources, catchment management and healthy waters element detailed in the Planning Scheme are as follows:

1) The Fitzroy River and other waterways and floodplains in the planning scheme area are recognised for their multiple values, including hydrologic functioning, ecological processes, nature conservation and outdoor recreation. They continue to be maintained for the quality and quantity of water available for both natural processes and consumptive uses;

2) New development occurs following the identified settlement pattern (SFM-1 to SFM-4) to ensure efficient water treatment and distribution;

3) Development within urban, new urban and future urban areas (SFM-1 to SFM-4) minimises the disturbance to natural drainage and flow rates, impact on groundwater levels and landscape features. Development does not increase the risk of erosion;

4) Water quality and the health of associated ecosystems are achieved by:

    a. protecting water resource catchments, in particular the Fitzroy River, including all feeder systems upstream of the barrage and Dam 7 at Mount Morgan from development;

    b. necessary regulation and continued monitoring and controls on the quality of water entering the Fitzroy River from western tributaries, in particular control of the quality and timing of water discharging from industry and mining;

    c. incorporating total water cycle management, water sensitive urban design and wastewater quality management measures; and

    d. efficient water use and improved demand management;

5) The release of acid sulphate soils and associated metal contaminants into the environment is avoided;

6) Land development enables sustainable stormwater infrastructure which protects water quality, environmental values and maintains or enhances community health, safety and amenity;

7) Natural waterways and nutrient hazard areas are not disturbed or diminished by development unless there is an overriding community benefit for the development and the impacts are mitigated.

8) Public access and use of the state coastal land, watercourses and water bodies is maintained, but does not diminish the environmental values, water supply reliability and recreational benefit for future generations.

Performance outcomes within the Planning Scheme relating to the Stormwater Management Code are listed in *Table* 9.3.6.3.1 *Development Outcomes* for *Assessable Development*[1] which is reproduced in Section 10.

[1] https://rockeplan.rockhamptonregion.qld.gov.au/Pages/Plan/Book.aspx?exhibit=current

3 PROJECT AND CATCHMENT CONTEXT

3.1 OVERVIEW

The following provides a brief explanation of infrastructure as it relates to flooding. The BESS and switchyard infrastructure will be installed on a bench with a finished level that provides 300 mm of freeboard to the peak modelled 1% AEP water surface.

Figure 1.1 shows the Project locality, and provides mapping of the critical infrastructure assets within the Study Area. The Project includes the construction and operation of BESS, ancillary infrastructure, and site access. Figure 3.4 shows the topographic and drainage features in the vicinity of the Study Area.

3.2 EXISTING ENVIRONMENT

The Project is located on a freehold rural property traversed by a 275kV transmission line, allowing direct connection to the grid. The project's location in a sparsely populated area, outside mapped agricultural land, has allowed for the minimisation of its social and environmental impacts.

3.3 PROPOSED INFRASTRUCTURE

Key components of the Project include:

- Up to 650x Battery Modules
- Up to 170x Medium Voltage (MV) Transformers
- 2x High Voltage (HV) Transformers
- A HV Switching Station.

The Project will also encompass associated ancillary infrastructure necessary to the operation of the BESS, including:

- Site access track
- Overhead and underground electrical cables
- Inverters
- High voltage substation
- Earthing and lightning protection
- Security fencing, closed-circuit television (CCTV) and lighting
- O&M building
- Water retention pond
- Lay down areas

3.3.1 Construction

The Project will be delivered in two stages to provide a total capacity of up to 600MW at the connection point and a storage duration of approximately four hours. Construction is anticipated to commence by mid-2026, pending development approval from the RRC and final investment decision.

The construction timeline for the Project is as follows:

- Stage 1: indicative capacity of 430 MW, with construction expected to commence mid-2026 and to be completed by the end of 2028.

- Stage 2: Indicative additional capacity of 170 MW, with construction expected to commence in 2028 and to be completed by the end of 2029.

Material will be sourced from nearby quarries, and no onsite excavation is planned.

3.3.2 Personnel

Construction of the Project is anticipated to be completed in two (2) stages, over an overall period of 40 months, commencing in Q3 (September) 2026 (pending approvals) and concluding in Q4 (December) 2029, with this overall period noted to include provision for 3 months Project float. Construction personnel are expected to vary between 20 and 150, with around 75 to 150 personnel during the 20-month installation period. The staff will be based in Rockhampton and travel either by passenger car or bus.

Once the site is operational, daily staff numbers are expected to vary between five and ten. Staff will travel from Rockhampton.

3.4 PROPOSED ACTIVITIES ON THE SITE

The activities during the construction, operational and decommissioning phases are listed below.

3.4.1 Construction phase

- Civil works, including vegetation removal, earthworks, construction of two benches (one for the batter infrastructure, one for the switchyard), drainage, erosion and sediment controls;
- Temporary site amenities;
- Construction of a new 1.7 km access road linking to South Ulam Road.
- Staggered delivery of shipping containers and equipment;
- Mechanical installation of the mounting structure and modules;
- Installation of battery modules;
- Installing electrical cabling, inverters and associated electrical equipment; and,
- No major chemical stores are required.

3.4.2 Operational phase

- Full servicing of substation equipment;
- No major chemical stores are required; however, minor storage of hazardous goods and materials will be managed through an approved Environmental Management Plan (EMP).
- Permanent staff members required for the ongoing operation of the facility; and
- Vehicle movements generated by the facility once operational will be minimal, limited to staff movements.

3.4.3 Decommissioning phase

- The Project is proposed to be operational for between 20 and 30 years. After this time, the facility will either be upgraded or decommissioned.
- Decommissioning would consist of the removal of all above-ground infrastructure for recycling or disposal, the revegetation of all disturbed land, and the return of the land to agricultural use.

3.5 AVAILABLE DATASETS

3.5.1 Climate data

Climate data was obtained from the SILO database of historical climate records for Australia hosted by the Queensland Government's Department of Environment, Tourism, Science and Innovation (DETSI). This service interpolates raw rainfall and evaporation records from the Bureau of Meteorology (BoM) to provide a spatially and temporally complete climate dataset. Climate data was obtained for the SILO grid point closest to the Study Area between 01/01/1889 and 31/05/2025.

Climate statistics showing the annual and monthly variation are shown in Figure 3.1 (monthly rainfall and evaporation), Table 3.1 and in Figure 3.2(annual rainfall). The variability of climate rainfall is also shown as a time series trace in Figure 3.3, which demonstrates the variability of rainfall sequences at the site. Large annual rainfall totals were recorded for the water years 1956, 2010, and 1973. Conversely, the lowest rainfall totals occurred in 1957, 1919, and 2019.

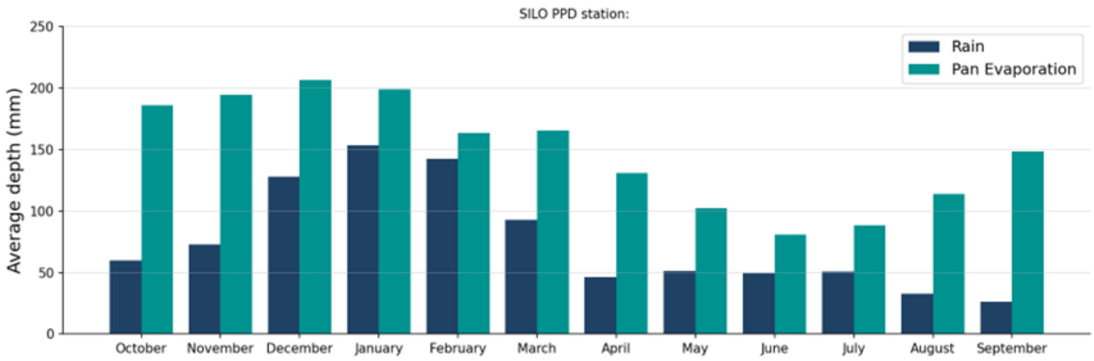


Figure 3.1 Monthly variance for rainfall and pan evaporation

Table 3.1 Annual Rainfall and Evaporation (mm) for Study Area

Percentile	Annual Rain (mm)	Pan Evaporation (mm)
10th percentile	567.68	1676
25th percentile	703.0	1756
50th percentile	890.5	1756
75th percentile	1064.5	1794
90th percentile	1198.9	1909

Data source: https://www.longpaddock.qld.gov.au/silo/

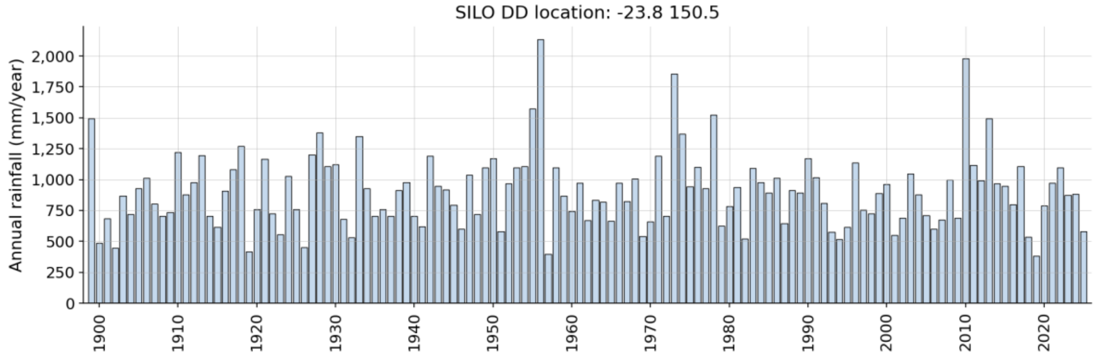


Figure 3.2 Annual rainfall totals

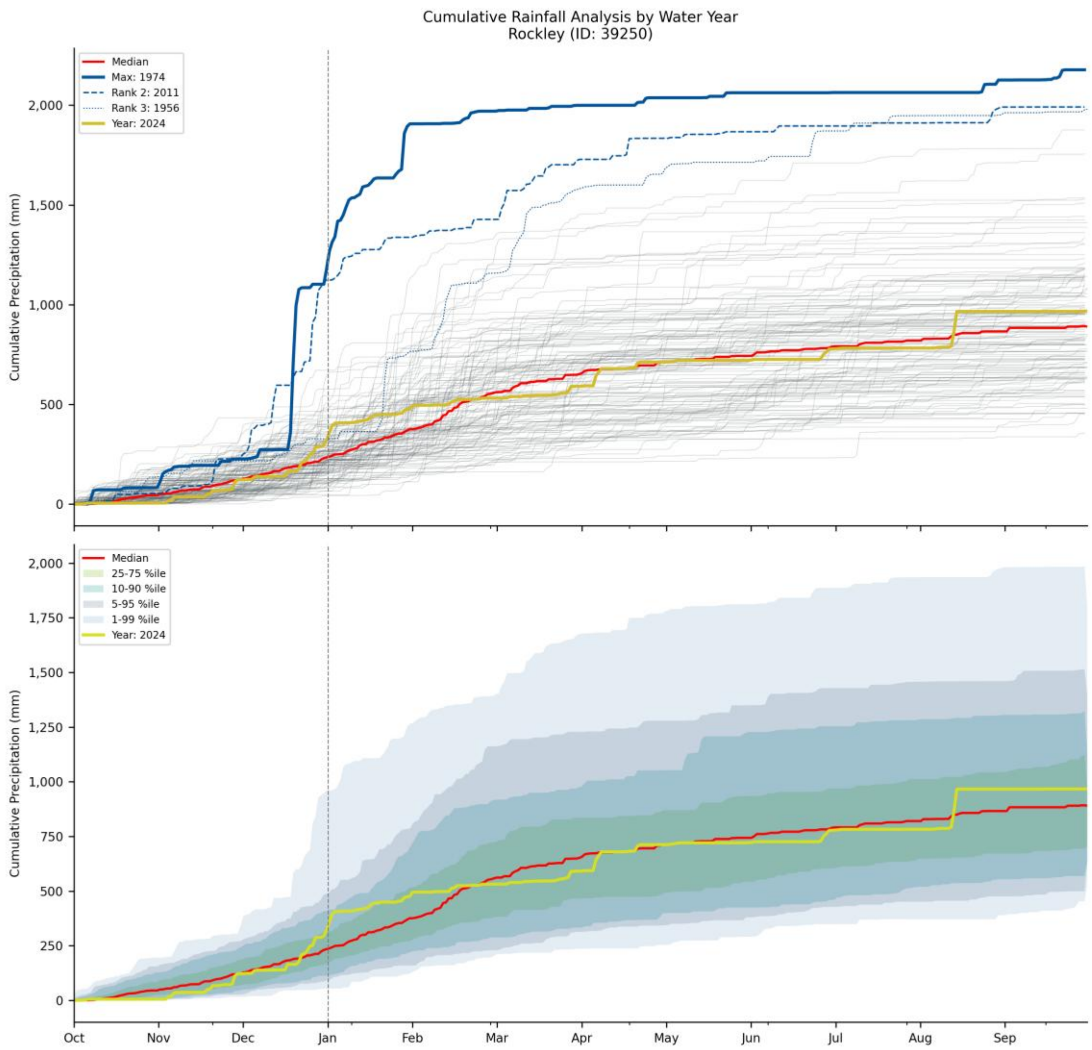


Figure 3.3 Climate observation and total rainfall variance

3.5.2 Topographic data

Neoen provided LiDAR survey data at a 0.5 m, 1.0 m and 5.0 m grid resolution covering most of the Study Area. The remaining gaps were filled with Copernicus (30 m) data to ensure continuity between datasets. Streamlines were identified and burned into drainage paths between the various data sources.

The switching station is situated at the base of the mountain range, with slopes that run from west to east. The highest elevation within the switching station development corridor is around 168 m AHD. The access road has an average slope of 2.3%

3.5.3 Watercourses

The waterway network adjacent to the Study Area is shown in Figure 3.4. As shown, there are limited mapped streams within the Study Area, and no major watercourses are present. Streams that were identified within the Study Area were either drainage features (zero) or minor streams of first and second Strahler order. Within the Study Area, State Code 18's waterway barrier works layer mapped the watercourses as low (green) see Figure 3.5. Outside of the Study Area, some tributaries of Eight Mile Creek are mapped as moderate (amber) watercourses. The Study Area includes an access road and overhead transmission lines that will traverse the flow paths. Construction works for the access road will be conducted in accordance with State Code 18's Acceptable Development Requirements (ADR).

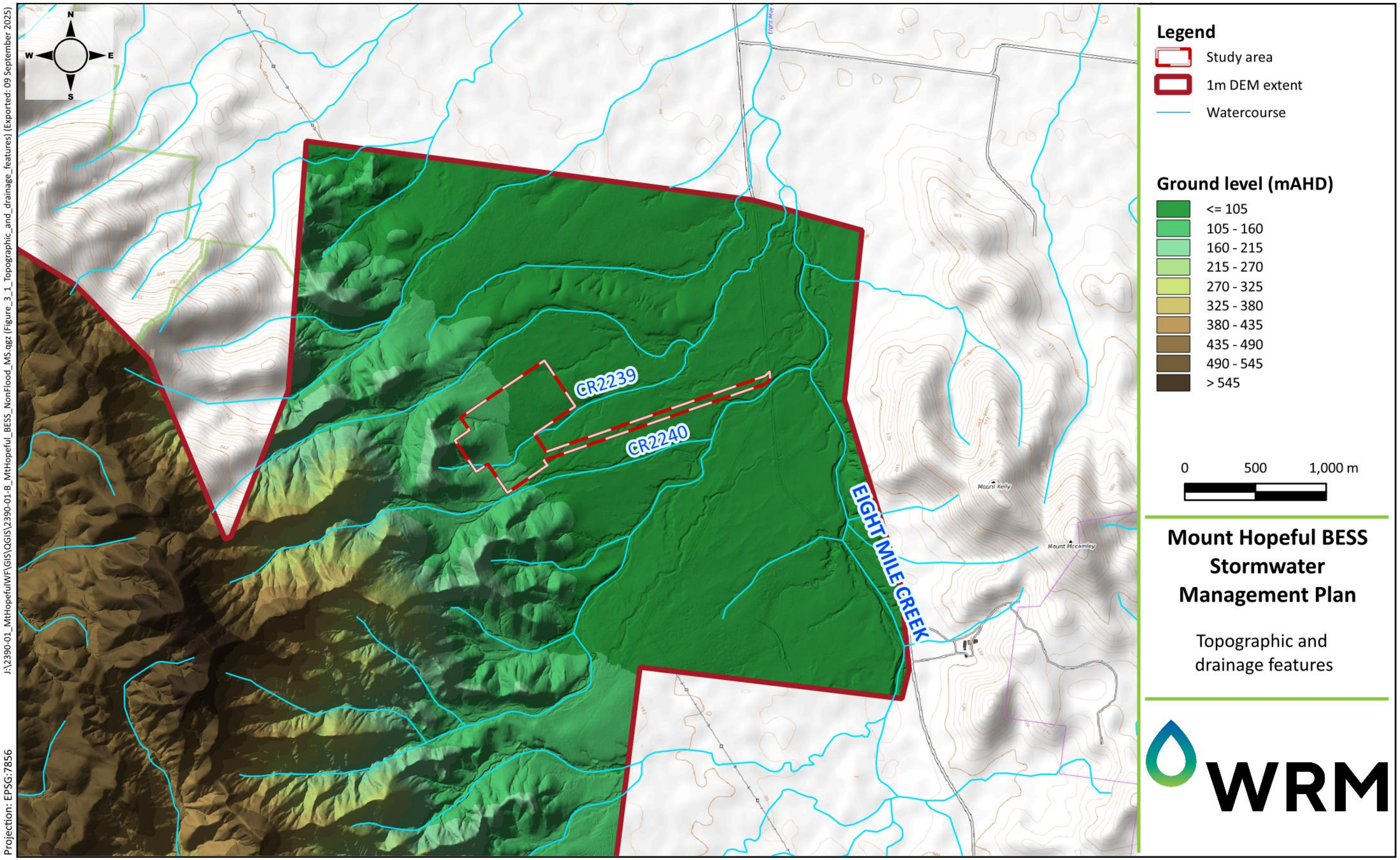


Figure 3.4 Topography and drainage features

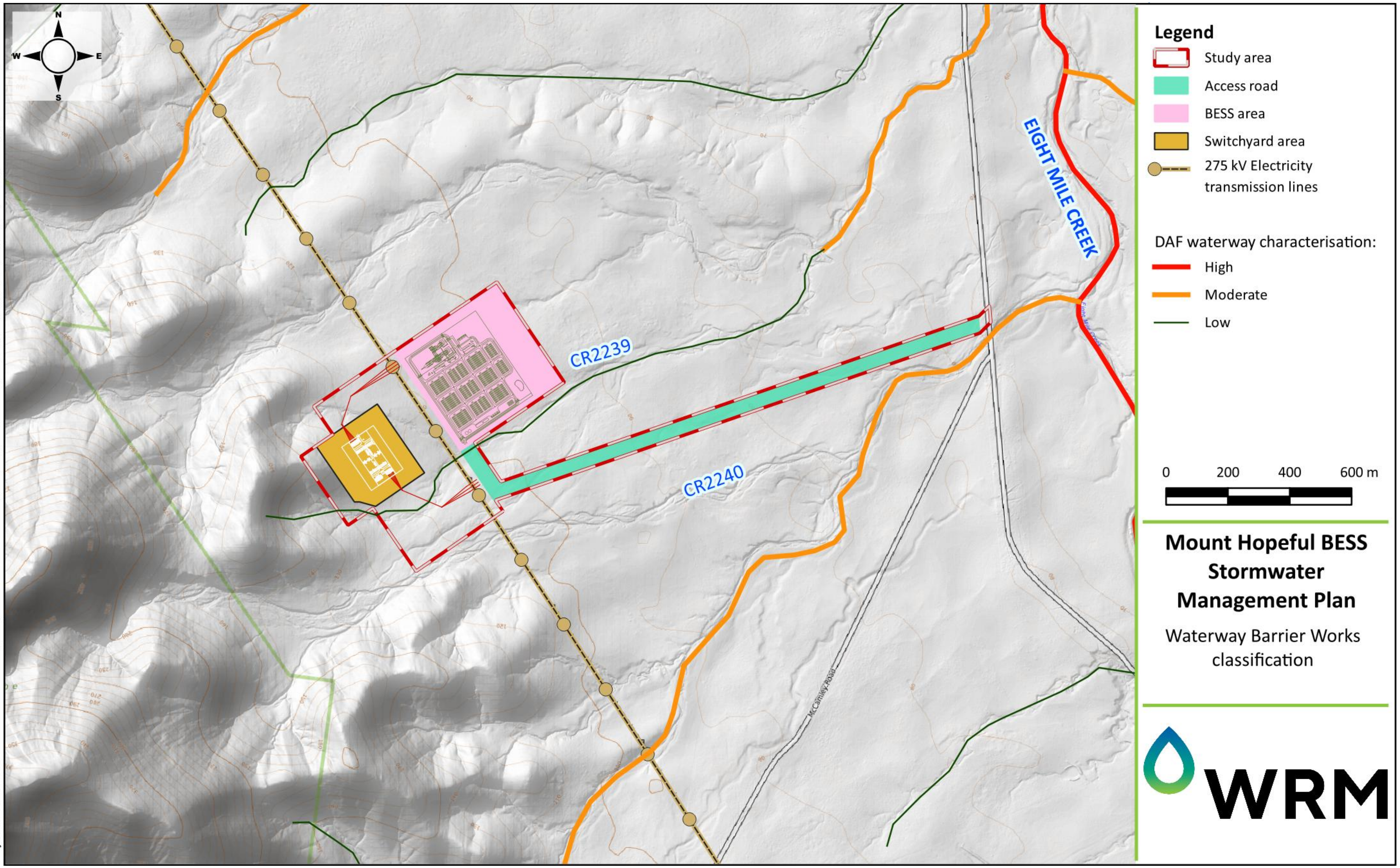


Figure 3.5 Waterway Barrier Works classification

4 MODELLING APPROACH

4.1 OVERVIEW

A TUFLOW hydrodynamic model was developed to simulate the existing conditions' flow behaviour in the Study Area for the 50%, 10%, and 1% AEP events under the current climate. Discharges within the Study Area were estimated by applying rainfall directly to the topographic surface in the hydraulic model. Design discharges were determined using the ensemble methodology described in Australian Rainfall & Runoff (ARR) (Ball et al., 2019). An ensemble of 10 temporal patterns is modelled for each storm duration to derive a range of estimated peak discharges for storms of different severity, represented by an annual exceedance probability (AEP). The storm duration with the highest median peak discharge of the ensemble is selected, and the temporal pattern that produces the median peak discharge is used for design event modelling.

The direct rainfall (rain-on-grid) approach was adopted for the assessment, and design rainfall depth data, as well as design losses, and storm pre-burst details were obtained from Australian Rainfall and Runoff (ARR) datahub, following the ARR v4.2 guidelines.

Preliminary TUFLOW hydraulic model runs for a range of durations and temporal patterns were used to identify the critical storm durations for the Study Area, and relevant design storm temporal patterns.

Design storm modelling results were post-processed to derive design flood characteristics (e.g., peak flood depths and extents) for each climate scenario for the existing catchment. The impacts of climate change for each AEP event were assessed by subtracting the current climate event results from the future climate event results. This difference map showed the location and magnitude of predicted climate impacts.

Details of the direct rainfall hydraulic modelling are described in Section 5.4.

4.2 NOTE ON FLOOD TERMINOLOGY

This report discusses concepts related to flood risk. A design flood is a probabilistic or statistical estimate, typically based on a probability analysis of flood or rainfall data. An AEP is assigned to this estimate. The frequency of flood events is expressed as an AEP; for example, a flood with a 10% AEP means there is a 10% probability (or 1 in 10 chance) that floods of that magnitude or greater will occur each year. While the related concept of Annual Recurrence Interval (ARI) is now outdated due to the confusion it causes, a flood with a 10-year ARI refers to floods of equal or greater magnitude occurring once every ten years on average.

The frequency of flood events can be categorised into five broad descriptive groups: ‘Very Frequent’, ‘Frequent’, ‘Rare’, ‘Very Rare’, and ‘Extreme’. This report classifies a 1% AEP flood as Very Rare, but acknowledges it remains within the credible limit when extrapolating from historical climate records. In recent years, climate data has shown the influence of non-stationarity, with evidence indicating that flood magnitudes—based on historical data—are becoming more frequent. This trend is expected to continue as our climate warms, leading to increased atmospheric moisture.

Very rare design flood events are beneficial for planning purposes due to their remote likelihood of occurrence. Extreme floods are considered well beyond the credible limits of historical records and contain significant uncertainty, serving mainly as theoretical upper bounds. Very rare flood events are essential for planning as they present a remote chance of occurring within the asset's lifetime. For long-lived, high-consequence assets, it may be appropriate to determine a design flood probability related to potential consequences over the asset’s lifespan. For example, the 0.2% AEP (1 in 500) derived from historical data can be used as a proxy for the expected future climate conditions at a 1% AEP level, considering the planning horizon.

Estimating an actual or historic flood resulting from a specific rainfall event is inherently different; it is a deterministic process. All causes and effects are directly linked to the particular event under analysis. The antecedent conditions present at the time of the rainfall are reflected in the resulting flood, and these conditions must be taken into account in the estimate. No definitive information about the probability of a historic flood can be obtained from considering a single flood event alone.

4.3 DESIGN RAINFALL DEPTHS

Design rainfall depths were obtained using the following methodology:

- Design rainfalls based on historic climate, for the 50%, 10% and 1 % AEP events were obtained from the Design Rainfall Data System[2] based on a single point location at the centroid of the Study Area.
- Current climate rainfall estimates were increased in line with the ARR v4.2 climate change guidance. The increase in rainfall depths increases, depending on duration, by 9 to 18% at 2030, using SSP2. Areal reduction factors derived for the Study Area's catchment were applied to these design rainfalls. Table 4.1 shows the areally reduced design rainfall depths for the 50% (1 in 2) to 1% (1 in 100) AEP for durations from 30 minutes to 24 hours.

Table 4.1 Adopted design rainfall depths – historic and current climate estimates

Duration (mins)	Design rainfall depths (mm)					
	50% AEP	10% AEP	1% AEP	50% AEP	10% AEP	1% AEP
	Historic Climate 2016 IFD			Current Climate IFD 2030 SSP2		
30	27.2	41.1	59	32.2	48.6	69.8
60	36.3	55	79.6	42.9	65.1	94.2
90	41.5	63.5	92.7	48.4	74.1	108.1
120	45.5	70	102.9	52.6	80.9	118.9
180	51.5	80.3	119.9	58.9	91.8	137.0
270	58.2	93.2	144.3	65.8	105.4	163.2
360	63.8	104.9	167.5	71.7	117.9	188.3
540	72.8	123.6	206.4	81.2	137.9	230.2
720	80.1	139.7	239.1	88.9	154.9	265.2
1080	92	167.6	296.6	101.4	184.6	326.7
1440	101.1	189.7	345.5	110.9	208.0	378.9

Source: BOM.gov.au, Latitude: -23.8029, Longitude: 150.6139
Note: Adopted values reflect adjustments to BoM depths subject to ARR Data Hub adjustments for areal reduction explained below.

[2] http://www.bom.gov.au/water/designRainfalls/revised-ifd/

4.3.1 ARR data hub

Recommended design event parameters were based on current ARR guidelines (referred to as ARR 2019) (Ball et al, 2019), available from the ARR Data Hub portal[3]. Key design event parameters include:

- Initial and continuous loss rates;
- Design storm pre-burst depths;
- Areal reduction factors; and
- Design storm temporal patterns.

4.3.2 Design rainfall losses and pre-burst rainfall

The Storm initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted based on ARR Data Hub recommendations. An initial loss (IL) and a continuing loss (CL) were adopted, with median pre-burst depths obtained from the Data Hub used to adjust the initial loss with 1% AEP. IL and CL were derived by extrapolating between rainfall losses adopted for infrequent events (up to 1% AEP) and the minimum rainfall loss, noting that:

- Initial losses (ILs) for infrequent events were derived based on the Probability Neutral Burst ILs provided by ARR datahub. This approach results in a unique Initial Loss for each duration;
- Continuing losses (CLs) for infrequent events were derived based on the suggested data hub and regional flood study CLs.

Table 4.2 provides the initial and continuing losses for the infrequent events used to interpolate the 0.5% and 0.2% AEP rainfall losses. Table 4.3 provides the Probability Neutral Burst Initial Loss values referred to by Table 4.2.

Table 4.2 Adopted design rainfall losses

Losses	Infrequent (to 1% AEP)
Initial loss (mm)	Probability Neutral Burst Initial Loss (see Table 4.3)
Continuing loss (mm/h)	1.6

Table 4.3 Probability Neutral Burst Initial Loss (Current Climate)

Storm duration	Probability Neutral Burst Initial Loss (mm)		
	50% AEP	10% AEP	1% AEP
30 minutes	9.9	8.9	6.3
1 hour	19.8	17.8	12.7
2 hours	20.0	18.1	7.8
3 hours	18.7	17.9	9.0
4.5 hours	18.7	14.3	1.1
6 hours	18.6	10.8	-6.8

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

9 hours	19.6	11.3	-17.3
12 hours	20.5	11.9	-27.9

4.3.3 Design temporal patterns

Design event hydrology was modelled using the ensemble of temporal patterns approach following ARR 2019. The design temporal patterns were adopted from the areal temporal patterns from ARR 2019. Temporal patterns were obtained from the ARR data hub based on a point location at the centroid of the catchment. The ARR guidelines provide 10 temporal patterns, resulting in 10 unique design storms for each critical duration and each AEP. The model was run using the representative temporal patterns for storm durations between 10 minutes and 24 hours for the 50%, 10% and 1% AEP events. The critical storm duration was identified as the duration that produces the highest median peak discharge from the 10 design storms for each storm duration.

4.4 HYDRAULIC MODELLING

The 2023-03-AF version of the two-dimensional TUFLOW hydrodynamic model was used to simulate the existing catchment flow behaviour in the Study Area for the 50%, 10%, and 1% AEP events under current climate conditions.

The direct rainfall (rain-on-grid) approach was adopted for the assessment. The TUFLOW hydraulic model was run for durations and temporal patterns to identify the critical storm duration and median temporal pattern within the Study Area.

4.4.1 Topography and grid cell size

The 0.5 m and 1 m survey data provided by Neoen (resampled as 1 m data) were used, with the Copernicus satellite 30 m dataset used to fill gaps in the data. Figure 3.4 shows the combination of the mentioned data sources applied in the model. A 20 m grid size resolution was adopted for hydraulic modelling in combination with TUFLOW's sub-grid sampling (SGS) (Method C) functionality at 2 m sampling distance. The 20 m cell size (with 2 m SGS) provided adequate resolution to capture key drainage features and overland flow paths, while maintaining reasonable simulation times.

4.4.2 Boundary conditions

Figure 4.1 shows the TUFLOW hydraulic model domain. Within the domain, the direct rainfall (rain-on-grid) approach was applied, with flows reported to outflow boundaries upstream of Eight Mile Creek. A normal depth rating curve (HQ) type boundary condition was implemented as the downstream model boundaries. The model boundaries were set well downstream of the Study Area to minimise any influence on predicted flood behaviour near the Study Area. The downstream boundary conditions assumed normal depth slopes between 0.01 and 0.02 m/m, calculated from the channel slopes extracted from topographic data. This normal depth slope is typical of the water surface slopes.

4.4.3 Hydraulic structures

No hydraulic structures were identified or surveyed within the Study Area. The proposed design does not require any hydraulic structures to be included within the model.

4.4.4 Hydraulic resistance

The TUFLOW model represents hydraulic resistance using Manning's 'n' values. Analysis of available aerial imagery showed seven general land use classifications of relevance in the Study Area. The adopted Manning's 'n' values for each land use classification are listed in Table 4.4. These values are typical for models constructed in Southern Queensland.

Table 4.4 Adopted hydraulic roughness coefficients

Land use description	Manning's 'n' coefficient
Medium vegetation	0.060
Light vegetation	0.045
Exposed dirt/unsealed road	0.025
Roads	0.020
Water body/lake	0.020
Bed channel	0.025

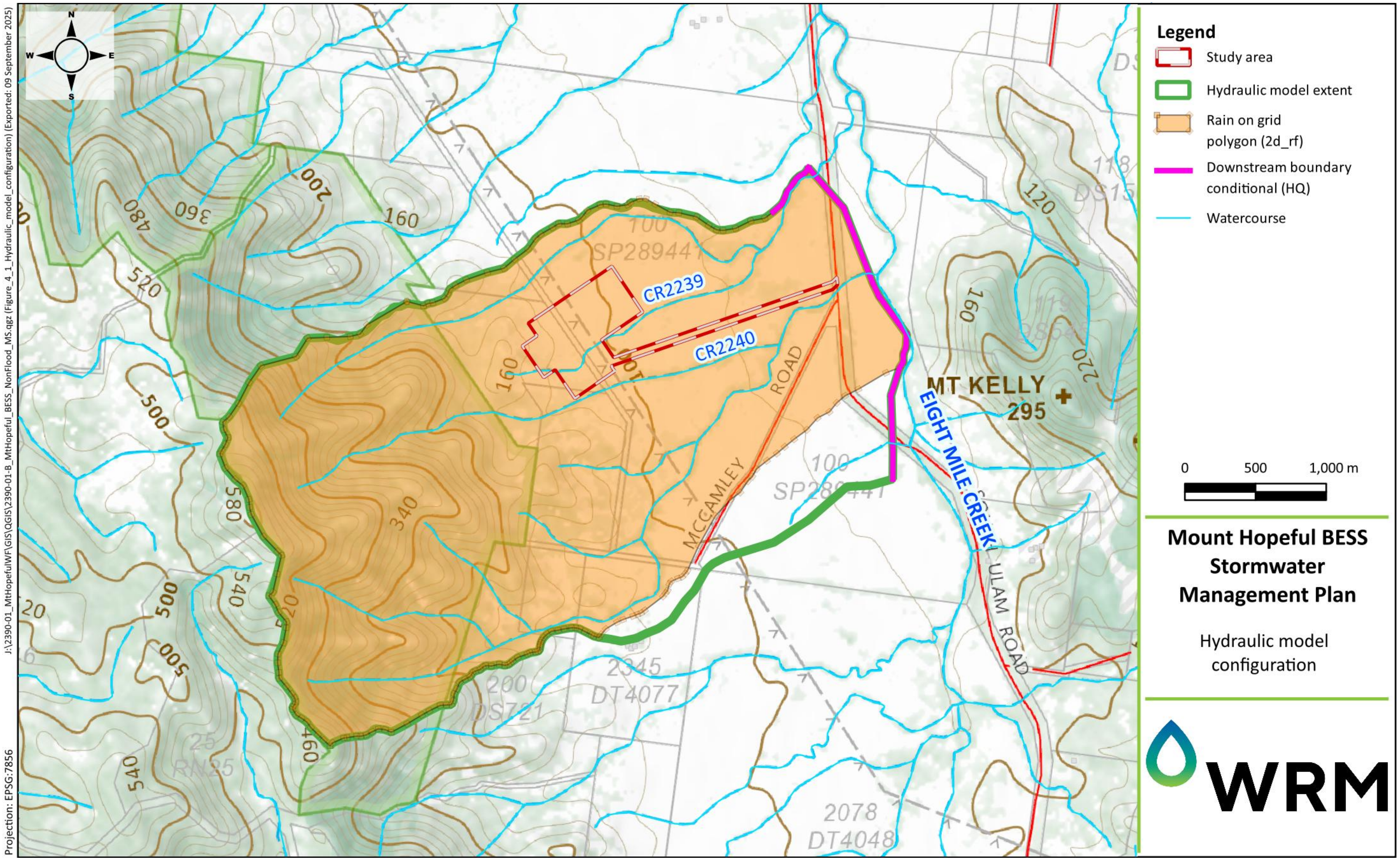


Figure 4.1 Hydraulic model configuration

5 HYDRAULIC MODEL RESULTS AND ANALYSIS

5.1 OVERVIEW

This section discusses the likely impact on flood behaviour for the current climate scenario. Flood modelling was undertaken to estimate the change in flood flows for the 50%, 10% and 1% AEP future climate. This section appraises surface water flooding behaviour concerning the infrastructure shown in Figure 1.1.

Due to the minor modifications to landform and hydrological regime, the impacts of the development on flood depth and velocities are negligible. The site infrastructure is to be located outside of the primary flow paths. As a result, flood impacts are considered to be minor in all modelled events. Key locations are shown in Figure 5.1.

5.2 LIMITATIONS

Modelling accuracy is subject to numerous sources of uncertainty. Some potential sources of inaccuracy leading to uncertainty in the hydraulic model are as follows:

- Inaccurate topographic information – The hydraulic model relies upon the representation of the ground topography to model the movement of water across the land. The DEM used to inform the model topography was captured at different times and with differing resolutions. This also implies a variance in vertical and horizontal accuracy for the survey. The accuracy of the DEM may impact the accuracy of model results. For example, the model may not be well-represented in minor flow paths smaller than the DEM resolution.
- No calibration to historical events—It is best practice to calibrate a hydraulic model to a historical event. However, calibration data for historical events is not available, making model calibration impossible. While the model parameters have been chosen in line with ARR 2019 recommendations and within industry-accepted bounds, the ability of the model to reproduce actual flood behaviour is untested.
- Critical duration—A representative critical duration and temporal pattern have been selected to represent the flood behaviour within the Study Area. However, future detailed design (e.g., of waterway crossings at South Ulam Road) may need to model additional durations to determine the critical duration for that location of interest.

5.3 DESIGN FLOOD EVENTS

The flood assessment has estimated flood extents, depths and velocities for the 50%, 10% and 1% AEP events for the current climate scenario. The flood maps, available in Appendix C, show overland flow paths. For clarity, minor shallow depths (< 50mm) were removed from the maps. This depth would typically be managed via stormwater infrastructure. The purpose was a preliminary investigation to appraise flood risk that can inform the layout of site infrastructure.

The resulting output grids are statistically analysed to generate maximum water surface (depth), velocity values, and flood hazard from the critical infrastructure of the Study Area.

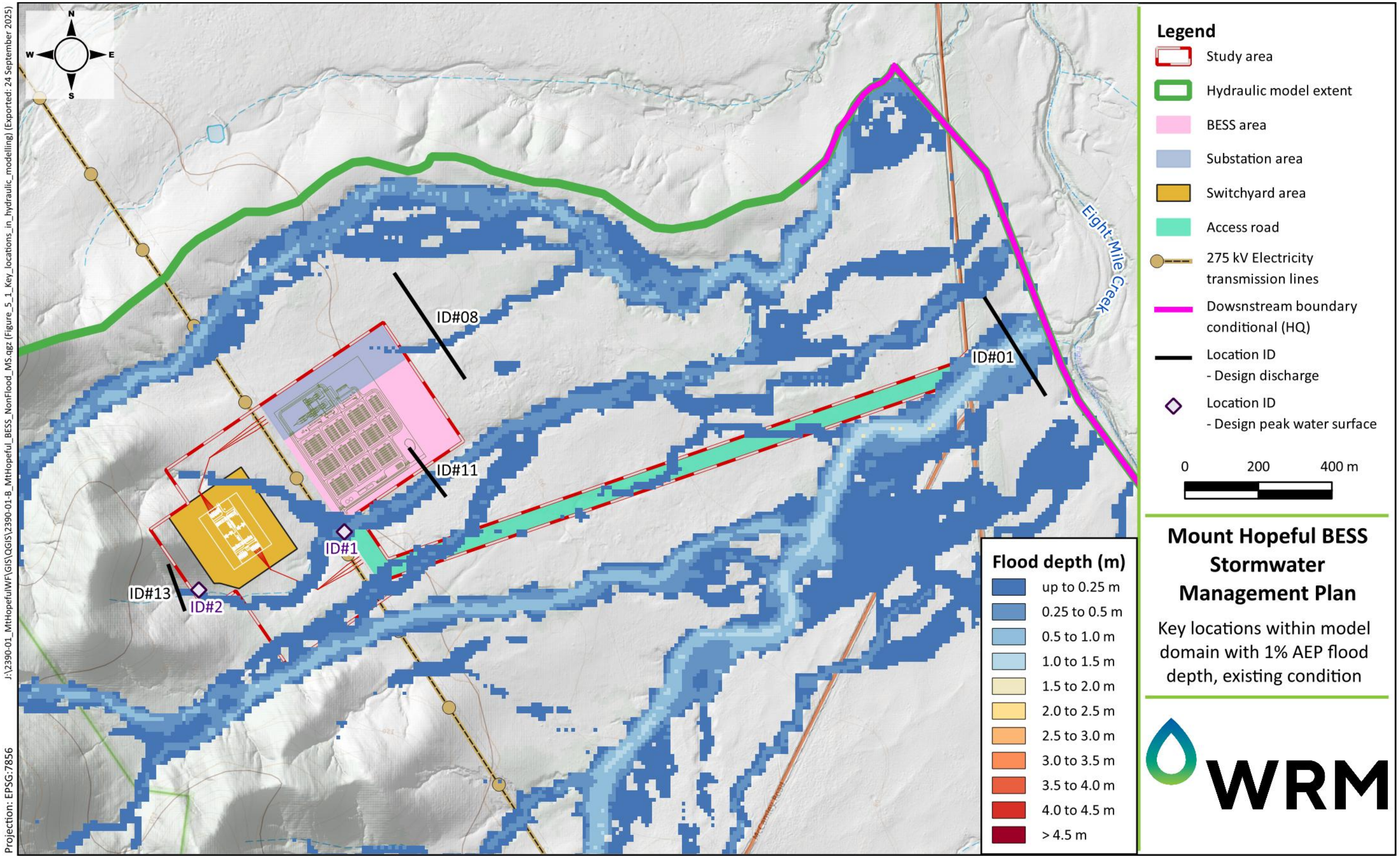


Figure 5.1 Key locations in hydraulic modelling

Summary observations about the existing condition flood behaviour are as follows:

- 50% AEP: Results show the water is confined to the minor drainage features within the model extent. General overland flood flow depths outside the drainage features are minimal and shallow. The drainage features within the BESS and Switchyard Area have confined and shallow depths.
- 10% AEP: The active flow paths through the model's extent remain as shallow and confined within the drainage features. General drainage feature flood flow depths are increasing, but remain short-lived due to the storm's duration being short. Minor drainage lines at the northern and southern corners of the switchyard area are forming but remain shallow. These flow paths will be considered and allowed for during the detailed design phase; this will ensure conveyance is uninterrupted.
- 1% AEP: The active flow paths within the model extent are becoming deep and are breaking out of the drainage feature's top of bank. Access along South Ulam Road and McCamley Road is inundated. The location of flooding within the BESS and Switchyard areas remains contained within the Study Area. Flood hazard near the BESS and Switchyard areas is considered (H1 and H2) as being unsuitable for small vehicles. General overland flood flow depths and velocities are becoming significant, and erosive flows are likely to cause impact to surrounding areas, which may impact post-flood event access. The drainage feature flowing through South Ulam Road to Eight Mile Creek is mapped as being H5 and H6, and so care with the road access interface at this location should be considered.

Table 5.1 presents the design discharge results for key locations, see Figure 5.1 under the current climate scenario (2030) using the SSP2 pathway. The flows shown are representative of the catchment area and slope reporting to the key location.

Table 5.1 Design discharge at key locations - Current Climate

Location ID	Nearby Location	50% AEP (m^3/s)	10% AEP (m^3/s)	1% AEP (m^3/s)
ID#13	Switchyard area	0.63	1.03	1.44
ID#08	Substation area	1.85	3.25	5.02
ID#11	BESS area	5.63	8.6	12.78
ID#01	Outlet to Eight Mile Creek	44.11	73.75	139.25

Table 5.1 presents the critical duration results for key locations.

Table 5.2 Critical durations at key locations - Current Climate

Location ID	Nearby Location	50% AEP	10% AEP	1% AEP
ID#13	Switchyard area	30 min	30 min	30 min
ID#08	Substation area	30 min	30 min	30 min
ID#11	BESS area	30 min	30 min	30 min
ID#01	Outlet to Eight Mile Creek	30 min	45 min	20 min

Table 5.1 presents the peak modelled elevations for the current climate scenario (2030) using the SSP2 pathway. The peak modelled depths are mapped on Figure 5.1 and within Appendix C.

Table 5.3 Design peak water surface at key locations - Current Climate

Location ID	Nearby Location	50% AEP (mAHD)	10% AEP (mAHD)	1% AEP (mAHD)
ID#1	BESS area	98.92	100.65	100.68
ID#2	Switchyard area	117.24	117.36	117.4

5.4 MODEL VALIDATION

5.4.1 Regional Flood Frequency Flows

The Regional Flood Frequency Estimation approach, described in ARR2019 (Ball et al, 2019), was used to validate the model estimates. The Regional Flood Frequency Estimation (RFFE) is an online tool. [4] developed for Australian Rainfall and Runoff to estimate design flows for ungauged catchments. It is based on gauged data using a region-of-influence approach. Figure 5.2 is a plot of the comparison between model design peak discharges, RFFE estimates and the nearby gauges. These flow estimate values are also in Table 5.4. These flows were estimated based on a two km^2 catchment located through the BESS and switchyard area.

Table 5.4 Regional Flood Frequency Estimation

AEP	TUFLOW model (m^3/s)	Predicted flow (m^3/s)	Confidence Interval 5th %ile	Confidence Interval 95th %ile
1%	28.9	1550	370	6340
10%	19.9	408	151	1080
50%	12.7	85.5	33.8	215

[4] https://rffe.arr-software.org/

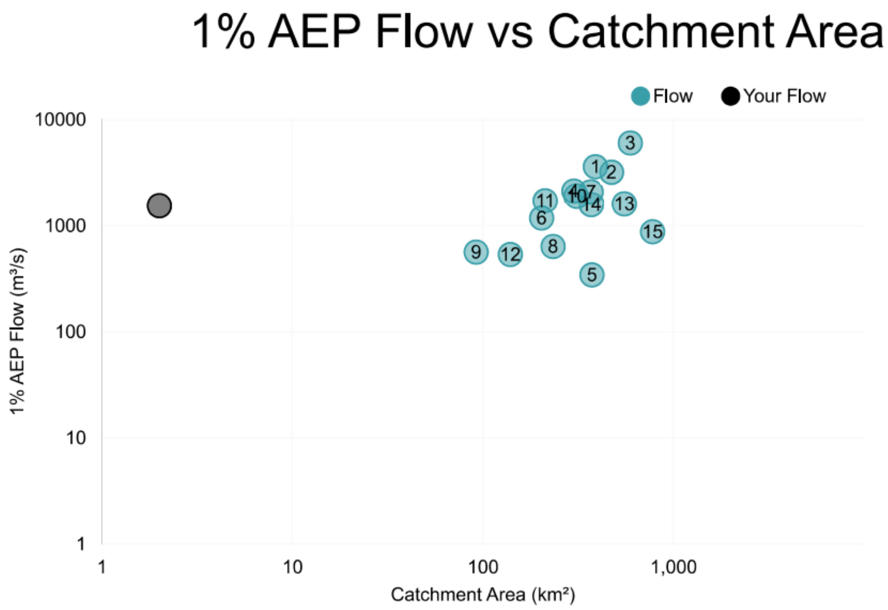


Figure 5.2 RFFE results compared to nearby gauged regional flood frequency locations

Visually, the flows estimated by RFFE are too high to be sensible. An alternative approach compared the TUFLOW model results against a suite of calibrated URBS models from throughout Australia. The peak modelled flows from TUFLOW are shown as a magenta line on Figure 5.3. This approach provides comfort that the RFFE values can be disregarded and that the model results do validate against other similar-sized catchments.

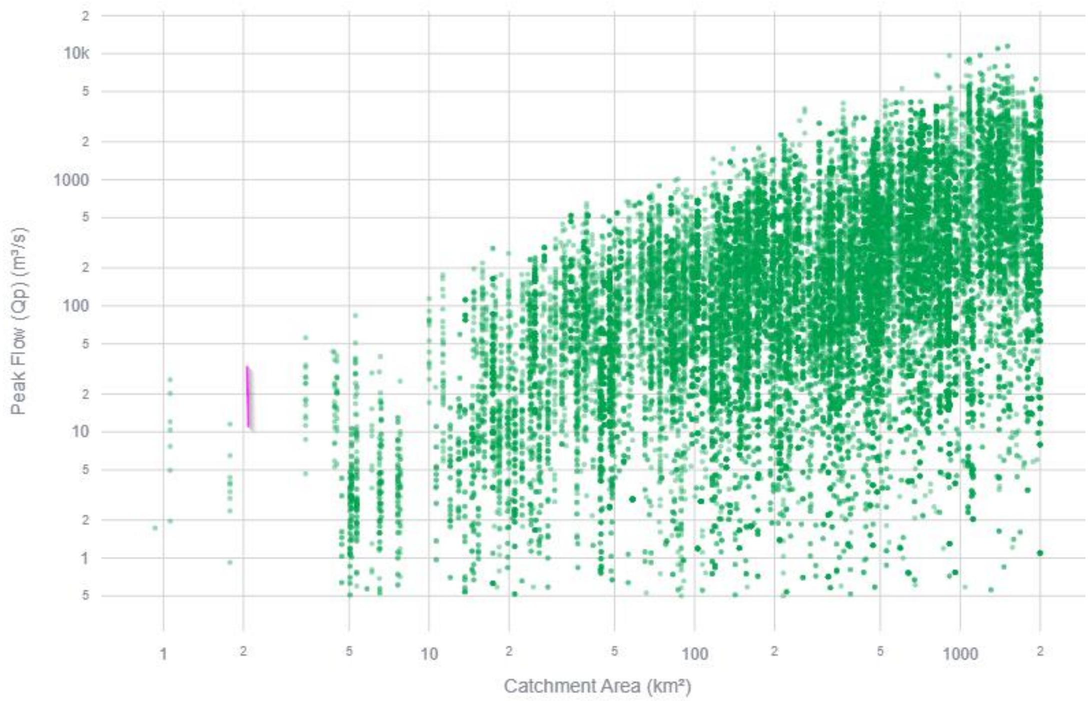


Figure 5.3 Calibrated Australian URBS model results compared with TUFLOW (magenta) peak values

5.4.2 Rational Method calculation

The peak discharges estimated from the TUFLOW model were validated against the Rational Method estimated peak discharges for the 50%, 10% and 1% AEP design events at a flow path near the BESS area, see Table 5.5. The adopted values of Manning's 'n' roughness and rainfall losses were refined during model validation to obtain design discharges generally consistent with the Rational Method. Details of the Rational Method calculation are presented in Appendix A.

Overall, the validation demonstrates that the TUFLOW model provides reasonable estimates of design discharges compared to those obtained using the Rational Method. On this basis, the model is suitable to assess the flood characteristics for the study area.

Table 5.5 Comparison between TUFLOW and the Rational Method

Location ID	Nearby Location	50% AEP (m^3/s)	10% AEP (m^3/s)	1% AEP (m^3/s)
ID#11	TUFLOW flow at BESS area	5.63	8.6	12.78
	Rational Method check	4.65	8.49	15.10

5.5 FLOOD MAPPING

The future climate flood extents, depths and velocities for the Study Area are shown in Appendix C. These flood maps show a variety of overland flow paths.

Flood hazards were considered in accordance with Australian Emergency Management guidelines, which present several hazard categories for flood modelling results, as shown in Figure 5.4.

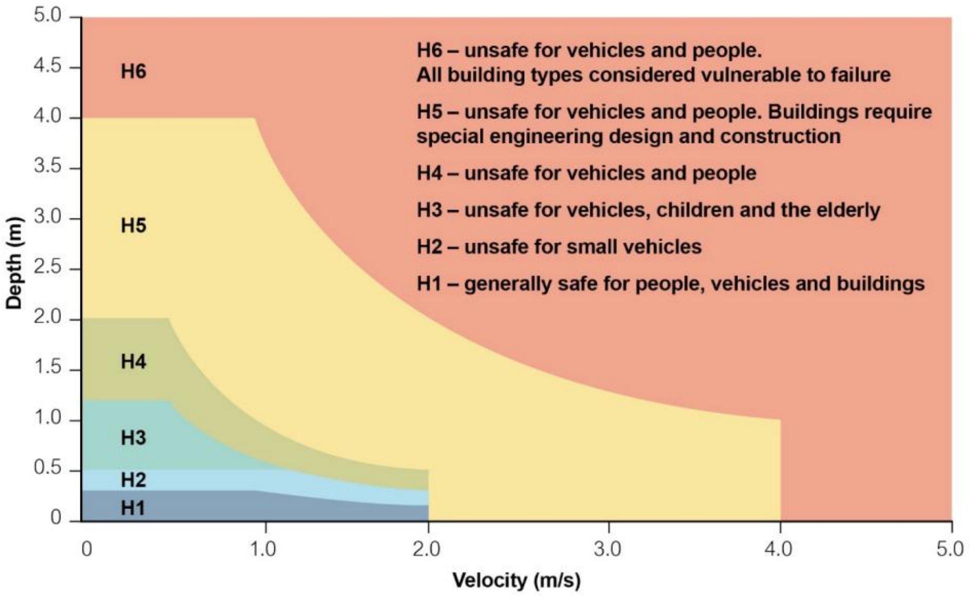


Figure 5.4 Flood Hazard Classification

Summary observations related to flood behaviour, flood maps are provided in Appendix A, are as follows:

- 50% AEP: The flood-mapped results indicate that the flows are confined to the minor drainage features within the Study Area. Flow paths are developing on the south and north of the Study

Area, though peak modelled flood depths and velocities remain low. The Flood Hazards are typically categorised as H1 to H3 within the Study Area extent.

- 10% AEP: The flow paths through the Study Area are beginning to spread outside their natural watercourses. In general, flood flow depths and velocities are becoming slightly more hazardous throughout the Study Area. The flow paths north and south of the Study Area are becoming more prominent. The Flood Hazards are typically categorised as H1 to H4 within the Study Area extent.
- 1% AEP: The flow paths have spread outside of their natural watercourses. Flood flow depths and velocities have become more hazardous throughout the Study Area. Additionally, the flow paths on the north and south of the Study Area have become less prominent due to spilling. The Flood Hazards are typically categorised as H1 to H4 within the Study Area extent.

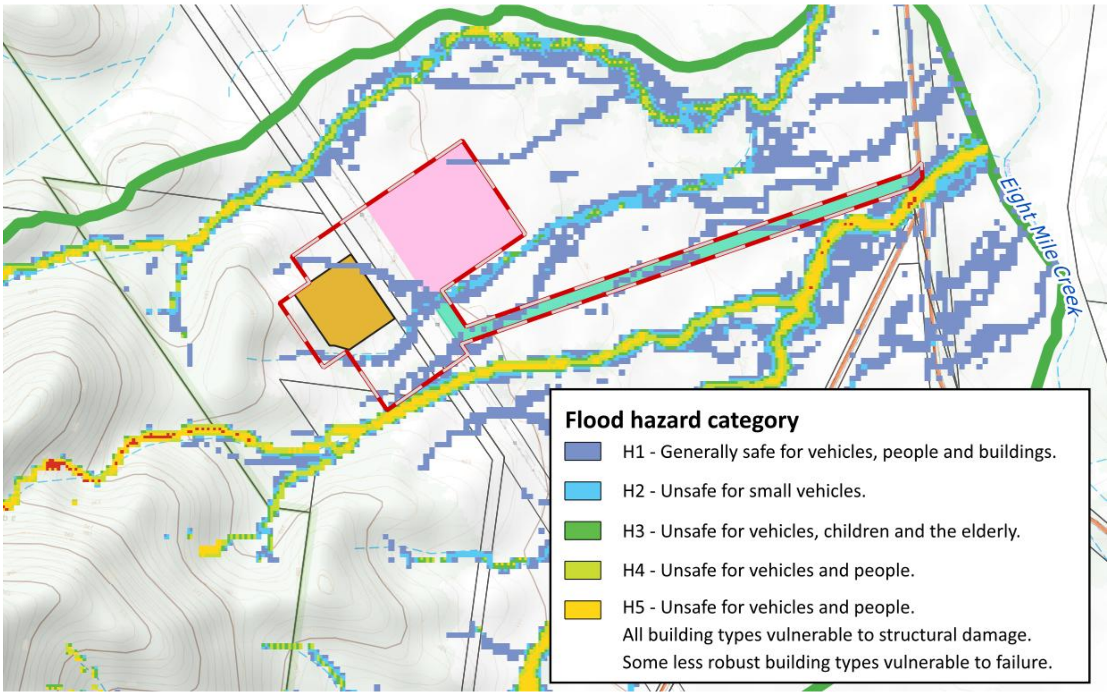


Figure 5.5 Extract of 10% AEP flood hazard map

6 STORMWATER IMPACT ASSESSMENT

6.1 OVERVIEW

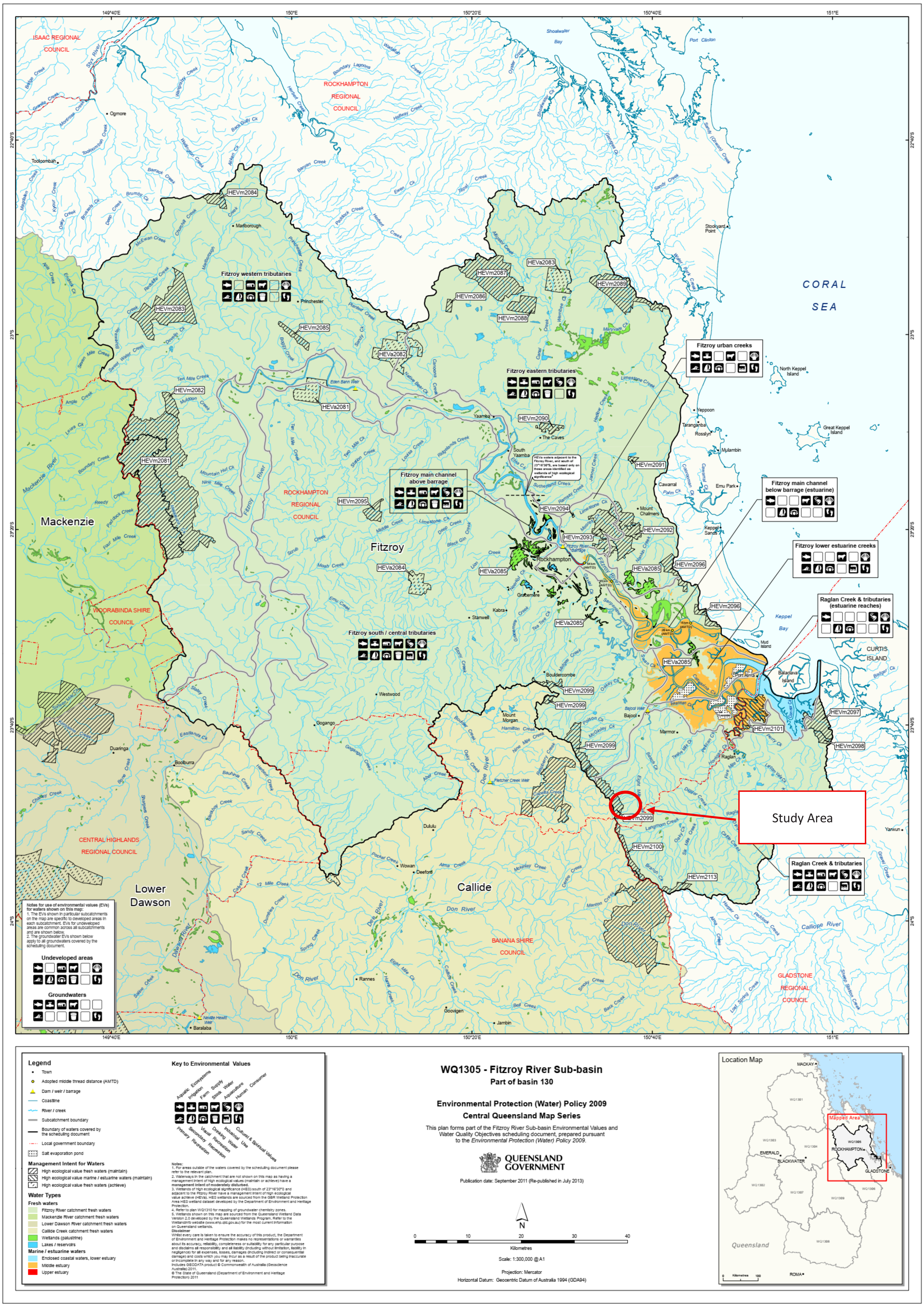
The Study Area is shown on map WQ1305 as being located in Basin 130 in the Fitzroy River Basin (WQ1305). Schedule 1 of the *EPP Water*[5] (EP Policy) locates the Study Area within Fitzroy South/Central tributaries[6], see Figure 6.1. The applicable Environmental Values and Water Quality Objectives were written in accordance with the provisions of the EP Act. The EP Policy provides a framework for identifying environmental values (EVs) for Queensland waters and deciding the water quality objectives (WQOs) to protect or enhance those EVs, including the identified EVs and WQOs under Schedule 1.

6.2 ENVIRONMENTAL VALUES

The Fitzroy River Sub-basin Environmental Values and Water Quality Objectives document contains EVs for waters in the South/Central tributaries, fresh waters as listed under Schedule 1 of the EPP (Water). The applicable Environmental Values are as follows:

- Aquatic ecosystems - intrinsic value of aquatic ecosystems, habitat in waterways;
- Irrigation - water supply for irrigation;
- Farm supply/use - non-potable farm water supply;
- Stock water - water supply for the production of healthy livestock;
- Human consumer - producing aquatic foods from natural waterways;
- Primary recreation - full body contact and frequent immersion;
- Visual recreation – uses that require no direct contact with water;
- Drinking water - suitable as a supply to the water treatment plant; and
- Cultural and spiritual values – scientific, social or cultural heritage.

[5] https://www.legislation.qld.gov.au/view/pdf/2023-10-20/sl-2019-0156



WQ1305 - Fitzroy River Sub-basin
Part of basin 130
Environmental Protection (Water) Policy 2009
Central Queensland Map Series
This plan forms part of the Fitzroy River Sub-basin Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the Environmental Protection (Water) Policy 2009.
QUEENSLAND GOVERNMENT
Publication date: September 2011 (Re-published in July 2013)
N
Kilometres
Scale: 1:300,000 @ A1
Projection: Mercator
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
Study Area
CORAL SEA
Fitzroy
Mackenzie
Lower Dawson
Callide
Rockhampton
ROCKHAMPTON REGIONAL COUNCIL
ISAAC REGIONAL COUNCIL
WOORABINDA SHIRE COUNCIL
CENTRAL HIGHLANDS REGIONAL COUNCIL
BANANA SHIRE COUNCIL
GLADSTONE REGIONAL COUNCIL
Fitzroy western tributaries
Fitzroy eastern tributaries
Fitzroy urban creeks
Fitzroy main channel above barrage
Fitzroy main channel below barrage (estuarine)
Fitzroy lower estuarine creeks
Raglan Creek & tributaries (estuarine reaches)
Fitzroy south / central tributaries
Raglan Creek & tributaries
Undeveloped areas
Groundwaters
Legend
Key to Environmental Values
Location Map

6.3 WATER QUALITY OBJECTIVES

Water Quality Objectives (WQOs) are defined under the Water Act and EPP Water to protect the identified EVs for a particular receiving environment. Relevant local guideline values are determined at a sub-basin level. Relevant aquatic ecosystem WQOs for baseflow conditions for the Surface Fresh Waters (Management Intent – Moderately Disturbed) are outlined as follows, and the values are based on:

The Fitzroy South / Central tributaries Fresh Waters water quality guidelines values:

ammonia N:	<30 µg/L
oxidised N:	<8 µg/L
total nitrogen:	<1300 µg/L
filterable reactive phosphorus (FRP):	<7 µg/L
total phosphorus:	<130 µg/L
chlorophyll a:	<8 µg/L
dissolved oxygen:	60%–110% saturation
turbidity:	<110 NTU
suspended solids:	< 35 mg/L
pH:	6.5–7.5

6.4 SURFACE WATER QUALITY

No direct water quality measurements or qualitative water quality information is available for any watercourses relevant to the Study Area. Water quality within the Study Area is expected to be commensurate with moderately disturbed streams nearby that are subject to limited vegetation clearing, grazing and erosion.

During the detailed design phase, the contractor will prepare a site stormwater management plan (SMP), and an erosion and sediment control plan (ESCP) with consideration of the construction methodology.

6.5 STORMWATER IMPACT ASSESSMENT

The base case and developed case peak flows for the catchment were assessed using the Rational Method, as outlined in the Queensland Department of Transport and Main Roads Drainage Manual. While the site is rural, the urban method was used as it allows for an assessment of an increase in runoff due to an increase in impervious areas. The rainfall intensities were extracted from the 2016 Intensity Frequency Duration (IFD) tool as provided by the Bureau of Meteorology and discussed in Section 4.2.

6.5.1 Development impacts on existing catchment

The hardstand and other impervious areas being introduced by this Project total around 12,000 m^2 (one hectare). The immediate stormwater catchment draining to this area is 60 ha and is part of the 200 hectares of local catchment draining past the BESS and switchyard area. This means that only 1.6% of the development site will be converted into an impervious area. The total size of the Eight Mile Creek catchment that this site drains to is around 33 km^2.

Table 6.1 Assessment of Peak Stormwater Flow

	Impervious Coverage	Mainstream Length	Equal area slope (%)	Time of Concentration (mins)	Runoff Coefficient (C_{10})	1% AEP Peak Flow (m^3/s)
Base Case	0%	1.4 km	2.51	25	0.70	88.94
Developed	1.6%	1.4 km	2.51	25	0.73	89.27

A review of the peak flow calculations indicates an increase of 0.33 m^3/s in the 1% AEP peak flow arriving at Eight Mile Creek. It must be noted that the development area is substantially smaller than the Eight Mile Creek catchment, and is expected to generate a peak outflow well before the peak flow flows past the site. As a result, any additional flow of the site to the peak flow is expected to be negligible. Therefore, the Study Area's impact on stormwater runoff is not likely to have any significant effect on the receiving environment.

As a result, any additional flow from the Study Area is expected to be negligible. Therefore, changes to the stormwater runoff from the development site are not likely to have any significant impact on the receiving environment.

7 EROSION AND SEDIMENT CONTROL PRINCIPLES

7.1 PURPOSE

At the time of writing, detailed design information is not available to WRM; as such, this is not intended to be the construction ESCP. This document does not include detailed engineering design of controls and structures, and it does not provide plans showing the layout of all erosion controls across the site. However, the International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Guidelines (2012) was considered in the preparation of this document as a foundation for best practice to be adopted.

The scope and purposes are to provide:

- Initial indication of the potential erosion and sedimentation hazards of the Project through a desktop review of the existing environment and planned Project activities.
- Suitable control measures and determine whether erosion and control maintenance and monitoring requirements need to be adopted for the Project.
- The foundation for the detailed ESCP, which will be developed later as the Project progresses into the detailed design phase.

7.2 EROSION AND SEDIMENT CONTROL

The detail in this section was developed to guide the management, reduction and mitigation of enhanced erosion and sediment transport in the design phase of the Project. This plan was prepared following industry standards and developed based on the following hierarchy of control measures:

1. Drainage Control
2. Erosion Control
3. Sediment Control

It is preferable to manage erosion through drainage control and erosion control as this will prevent or minimise the generation of dislodged sediments. Sediment control measures aim to trap sediments to prevent them from leaving the Study Area. Therefore, the most efficient and cost-effective way to minimise sedimentation is to minimise the extent, duration and severity of soil erosion as this will reduce the amount of sediment control measures required. For erosion and sediment control to be effective, the following are required:

- Ensure erosion and sediment control measures are designed and constructed effectively.
- Ensure that erosion and sediment control techniques are site-specific and take into account local soils, weather and construction conditions as discussed in Section 3.
- Minimise soil erosion, wherever possible, instead of relying on down-slope sediment control methods.
- Control water movement through the Study Area.

- Minimise the duration and extent of bare soil exposure through prompt stabilisation of disturbed areas and implementation of groundcover as soon as practicable.
- Utilise existing topography and adopt construction practices that minimise soil erosion and sediment discharge from the Study Area.
- Maximise sediment retention on site.
- Integrate erosion and sediment control issues/measures into the planning phases of the Study Area.
- Maintain erosion and sediment control measures in proper working order at all times.
- Monitor the Study Area and adjust erosion and sediment control practices to maintain the required performance standard.

7.2.1 Erosion and Sediment Control Criteria

The selection of suitable control measures is typically made once the stormwater drainage plan is known and before works commencing on-site.

The choice of overall strategy and suitable control measures can be informed based on the detailed design drawings and runoff calculations. The strategy and approach is to notify the Principal Contractor, and their suitably qualified representative is to be appointed by the site supervisor with input from a suitable environmental team member. Appropriate control measures will be applied to all stages of a project, may be constructed from on-site materials, are cost-effective and durable, and perform to the required standard. When deciding on a control measure, it is also essential to take into account site-specific aspects such as:

- The site topography;
- The properties of the surface where the control measures will be implemented, as well as the material downstream of the control measure;
- Type of disturbance;
- Length of disturbance;
- Site-specific constraints, e.g. proximity of local watercourse; and
- Overall purpose of implementing erosion and sediment control at a particular location.

Control measures should be specific to the site location and the phase of the Project and be planned and installed by a suitably qualified person, following best practice guidelines and industry standards.

7.3 DRAINAGE CONTROL MEASURES

A brief overview of the drainage control measures that the detailed design may consider adopting is provided below. The detailed design and construction erosion and sediment control plan is to ensure that the drainage control desired outcomes are addressed:

- Manage stormwater flows around or through areas of exposed soil to avoid contamination.

- Manage sheet flows to avoid or minimise the generation of rill or gully erosion.
- Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works, which, for a design life >24 months, requires drainage structures to pass the 10% AEP flood event, and culvert crossings to pass the 63% AEP flood event.
- Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins, which require spillway capacity for a 2% AEP flood event.

7.3.1 Drainage Channels

Temporary drainage channels should be designed and constructed with a grade that generates flow velocities not exceeding the maximum allowable flow velocity for the given surface material. Suppose the flow velocity is above the speed that a surface material can sustain. In that case, the drainage channel may erode, often along the invert of the drain, and result in bank slumping and widening of the channel. Measures that may be implemented to decrease flow velocities are:

- Increasing the channel width;
- Reducing the channel slope;
- Reducing the catchment area;
- Increasing channel roughness; and
- Installing rock check dams, coir log rolls, check dams or similar in the channel.

The scour resistance of a drainage channel may also be increased through a channel liner. It is currently unknown whether permanent drainage diversions will be required; therefore, controls relating to this have not been discussed. If the detailed design phase of the Project determines that permanent drainage lines or diversion channels are necessary, controls for these will be outlined in the ESCP of the detailed design phase.

7.3.2 Drainage Control for Unsealed Roads

To reduce the erosion risk of an unsealed road, the following practices may be applicable:

- Stormwater runoff should be allowed to shed in regular intervals. Depending on the road material and the surrounding environment, runoff can either be discharged into a sediment trap or via a level spreader into adjacent vegetation.
- Stormwater collected in table drains should be discharged in regular intervals. This may not always be possible, and some environments may require different control measures.
- Table drains should be constructed in a U shape rather than a V shape.
- If road construction is required across a slope, the road should be positioned as close as possible to the contour of the land, as this will avoid concentrated flows.
- If road construction is required diagonally across a slope, it is likely that upslope stormwater runoff will be collected as concentrated flow. The collected runoff should be shed at regular intervals using a level spreader or drainage channels constructed

7.4 EROSION CONTROL MEASURES

During construction activities, the most common forms of water erosion are splash erosion, sheet erosion, rill erosion and gully erosion. Several erosion control measures are available to minimise erosion. The appropriate erosion control method will vary from site to site as well as within the Study Area. Factors that should be considered are the upstream catchment, slope, topography, climate, soil type, underlying geology, disturbance type and the receiving environment.

The detailed design and Construction Erosion and Sediment Control Plan are to ensure that the desired erosion control outcomes are addressed:

- Stage clearing and construction works to minimise the area of exposed soil at any one time.
- Effectively cover or stabilise exposed soils before predicted rainfall.
- Prior to completion of works for the development, and before removal of sediment controls, all site surfaces must be effectively stabilised using methods that will achieve effective short-term stabilisation.

While the physical methods may vary, all erosion control measures aim at providing ground cover to the disturbed land. A list of erosion control measures that may be adopted is provided below.

- Cellular Confinement Systems
- Compost Blanket
- Gravelling
- Hydromulching
- Mulching
- Revegetation
- Soil Binders
- Mesh/Jute Matting

7.5 SEDIMENT CONTROL MEASURES

Sediment control measures should not solely be relied on and should always be used in combination with the drainage control and erosion control measures outlined above. Priority should be placed on erosion and drainage control measures to prevent soil dislocation and sediment generation.

The detailed design and Construction Erosion and Sediment Control Plan are to ensure that the sediment control desired outcomes are addressed:

- Direct runoff from exposed site soils to sediment controls that are appropriate to the extent of disturbance and level of erosion risk.
- All exposed areas greater than 2500 m^2 must be provided with sediment controls which are designed, implemented and maintained to a standard which would achieve at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50mg/L Total Suspended Solids (TSS) or less, and pH in the range (6.5–8.5).

- Earthworks and the implementation of erosion and sediment controls are undertaken in ways that ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1% AEP.

Sediment control measures trap the coarser sediment fractions, but smaller sediments such as silts and clays are not retained. Sediment basins are designed to collect runoff still laden with finer sediments. These sediments settle out in the sediment basin. If dispersive soils are present, a flocculation agent is required to settle sediments. A list of sediment control techniques that can be adopted is provided below.

- Check Dam
- Grass Filter Strips
- Rock Filter Dam
- Sediment Basin
- Sediment Fence

7.6 EROSION RISK ASSESSMENT

To understand the requirement for erosion and sediment control measures, the erosion potential for an area needs to be assessed through a risk assessment process. For this assessment, the following aspects, which all influence the erosion potential of a site and the appropriate management practices, should be included:

- Soil classification;
- Average slope of disturbance area;
- Location within the catchment;
- Proximity to waterways;
- Extent and duration of soil disturbance; and
- Whether run-off from upslope areas can be controlled.

A potential erosion risk identification is carried out to assess the possible risks stemming from proposed activities required for the construction of the Project. At a high level, the assessment considered the temporal and spatial erosion risks that may occur and identified the risk location that will require erosion control measures during the construction phase.

7.7 SOIL ERODIBILITY RISK

An assessment of soil erodibility was undertaken in 2017 by the Department of Science, Information Technology and Innovation (Zund, 2017) in the Fitzroy Natural Resource Management (NRM) region. A site-specific report for the Study Area using this assessment process was obtained in the form of a FORAGE Erodible Soils report (Queensland Government 2024). The FORAGE Erodible Soils report contains three risk maps and is available in Appendix B:

- Map 1 - Overall Soil Erodibility,
- Map 2 - Surface Soil Erodibility and

- Map 3 - Subsoil Erodibility.

Soil erodibility refers to the likelihood that a particular soil is susceptible to erosion by water and wind. The overall FORAGE soil erodibility classification is created by combining surface soil stability and subsoil dispersiveness. Surface soil stability is influenced by surface cover, which is a function of climate, soil fertility, rockiness and land management. Subsoil dispersiveness is influenced by subsoil attributes such as cation balance, clay type and salinity. **Table 7.1** below identifies the mapped surface soil and subsoil dispersibility conditions for the Study Area.

Table 7.1 Site FORAGE Report Description

FORAGE Report	Description
Surface Soil	Moderately stable surface soils across most of the Study Area, with a few isolated areas of non-cohesive surface soils located on the higher ridge areas within the Study Area.
Subsoil Dispersibility	Predominantly weakly dispersive subsoils are present, with non-dispersive subsoils located centrally and on the eastern site boundary, and some highly dispersive subsoils located in the higher ridge areas within the Study Area.

As shown in Appendix B, the overall soil erodibility of the area is mapped as having very low erosion vulnerability across most of the area, with areas of moderate erosion vulnerability soils located on the higher ridges.

The soil erodibility dataset helps identify soils susceptible to gully and stream bank erosion. Gullies typically develop when the protective surface soil is disturbed and erosive forces encounter subsoil, particularly those that are dispersive in nature.

Whether the occurrence of soil erosion occurs depends on a variety of factors, including soil properties, topography, land use, rainfall intensity, surface cover and land management practices. However, the assessment provided above does not incorporate external influences affecting erosion rates.

7.8 RECOMMENDATIONS

Erosion is dependent on the likelihood and intensity of predicted and/or expected rainfall. Where construction activities are scheduled during the dry season when rainfall is unlikely or limited, the required erosion protection measures may be significantly less than if construction were to occur during the wet season (IECA, 2012).

Erosion control devices should be employed as soon as reasonably practicable to limit soil erosion and to protect the exposed areas of soil from raindrop impact erosion. Best practice land erosion control and site rehabilitation are mainly dependent on the likelihood and timing of rainfall and wind events.

All control measures are to be installed, managed and maintained in general accordance with the Best Practice Erosion and Sediment Control (BPESC) guidelines for Australia (International Erosion Control Association) to:

- Divert clean water around construction activities;
- Reduce water velocity and capture sediment on site;

- Prevent sediment from moving off-site and sediment-laden water from entering any watercourse, drainage line, or drain inlet; and,
- Minimise the amount of material transported from the site.

The Principal Contractor is responsible for implementing all erosion and sediment control measures, and these must be implemented following best practice principles. A range of control measures is available for use across the Study Area, and those recommended in this section are based on the IECA's 'Best Practice Erosion and Sediment Control' documents (2012).

The selection and implementation of appropriate ESC measures are dependent on several factors, including the anticipated disturbance duration, slope, soil characteristics, and availability of materials, among others.

All erosion, sediment and drainage control measures must remain in place until all construction works are completed and surfaces are stabilised and revegetated.

Control measures to be implemented as part of the Project to manage and minimise impacts on water resources for each risk area identified above. The identified control measures will be confirmed and amended as necessary in a detailed ESCP before construction commences.

7.8.1 CONTROL MEASURE STANDARD DRAWINGS AND FACT SHEETS

Standard drawings and fact sheets for the proposed control measures outlined above can be found via Best Practice Erosion and Sediment Control, International Erosion Control Association (Australasia) (IECA 2012). Links to each are provided below.

- Fact Sheets:

https://www.austieca.com.au/publications/book-4-design-fact-sheets

- Standard Drawings:

https://www.austieca.com.au/publications/book-6-standard-drawings

8 CONTAMINATION RISK ASSESSMENT

8.1 SOIL CONTAMINATION MANAGEMENT

The identification and correct handling of potentially hazardous substances is an essential consideration during the construction phase. Spills/leaks from any chemical or hydrocarbon sources will be managed through prescribed controls and measures documented in a site-specific EMP. Best Practice Erosion and Sediment Control Handbook[7] (IECA, 2008) outlines well-established approaches to mitigate contamination risks that will be included within the construction methodology. During the detailed design phase, the contractor will prepare an erosion and sediment control plan (ESCP) in consideration of their construction methodology.

At a high level, a range of mitigation measures identified to minimise contamination risk are as follows:

- Design, construction and maintenance of control measures will follow IECA's Best Practice handbook for guidelines (2008) (also known as the White Book), which Queensland Local Councils and State Agencies such as Department of Transport and Main Roads and Department of Local Government, Water and Volunteers endorse;
- Disturbance Footprint drainage works will aim to minimise potential impacts on the existing overland flow paths. Where possible, stream crossings will be built in accordance with the IECA's Best Practice Erosion and Sediment Handbook (2008), Book 4, which provides Design Facts Sheets. In particular, the factsheets titled Temporary Watercourse Crossing Culverts TCC-1 and Temporary Watercourse Crossing Fords (TFC-1).
- A construction management plan and ESCP will be developed for the Project, detailing methods for minimising contaminant-bearing runoff following the IECA Best Practice Erosion and Sediment Handbook (IECA, 2008).
- Safe storage of chemicals and hydrocarbon materials (e.g. away from waterways and drainage lines), to ensure that any spillages are contained;
- Inspections will be undertaken at least daily during periods of inclement weather, 24 hours before forecast rain, and within 24 hours following a rain event. During dry periods, a suitably qualified person will inspect control measures weekly.
- Use of glyphosate-based products (or similar non-residual and non-persistent herbicides) to manage weeds on-site to minimise the potential risk of harmful herbicide by-products entering the surface water receiving environment;
- Installation and operation of a septic tank to service the operations and maintenance building; this will be designed and operated in accordance with Queensland Plumbing and Wastewater Code guidelines, relevant statutory requirements and Australian Standards (AS/NZS 1546). Regulated wastes will be removed from the site and disposed of in a suitable facility by a licensed operator.

[7] Available at: https://www.austieca.com.au//publications/best-practice-erosion-and-sediment-control-bpesc-document

9 DEVELOPMENT OUTCOMES FOR ASSESSABLE DEVELOPMENT

9.1 OVERVIEW

The section outlines the application as it relates to the stormwater management code. Part 5 of the Planning Scheme outlines the categories of development and provides the tables of assessment for the Development Code. Table 9.1 presents and responds to the Performance and Acceptable Outcomes of the stormwater management development code in the Planning Scheme's Section 9.3.6.

The purpose of the stormwater management code is to provide for sustainable stormwater infrastructure which protects water quality, environmental values and maintains or enhances community health, safety and amenity.

The purpose of the stormwater management code is to ensure that the proposed development achieves the following outcomes:

- Acceptable levels of stormwater run-off quality and quantity are achieved by applying water-sensitive urban design principles;
- Public health and safety are protected, and development avoids damage or nuisance caused by stormwater flows;
- Development includes a stormwater management system which minimises impacts on natural catchment hydrological processes;
- Development ensures that the environmental values of waterways are protected or enhanced;
- Development maintains or enhances the efficiency and integrity of the stormwater infrastructure network;
- The whole life-cycle cost of stormwater infrastructure is minimised; and,
- New development infrastructure is designed to support and complement existing and planned stormwater infrastructure.

Table 9.1 Extract of Table 9.3.6.3.1 Development Outcomes for assessable development

Source: Rockhampton Region Planning Scheme 2015 rockeplan.rockhamptonregion.qld.gov.au

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO1 Development provides a stormwater management system that achieves the integrated management of stormwater to: a) ensure that flooding impacts do not increase, including upstream or downstream of the development site; b) avoid net worsening of stormwater peak discharges and runoff volumes; c) utilises the use of water-sensitive urban design principles; and d) ensure the site maximises opportunities for capture and reuse.	**AO1.1** Development provides a stormwater management system designed in compliance with SC6.18—Stormwater management planning scheme policy, SC6.10—Flood hazard planning scheme policy, the Queensland Urban Drainage Manual, Capricorn Municipal Development Guidelines, and Australian Rainfall and Runoff. **AO1.2** Stormwater is conveyed to a lawful point of discharge in accordance with the Queensland Urban Drainage Manual.	**Complies with AO1.1 and AO1.2**. Stormwater modelling was undertaken and complies with QUDM, CMDF, and ARR 2019. Stormwater is lawfully discharged. The development will implement an integrated stormwater management system that effectively manages stormwater flows and quality while providing environmental protection. The design will maintain floodplain storage capacity and detention system functionality, ensuring no increase in flooding impacts upstream or downstream of the site. The system incorporates water-sensitive urban design principles while strategically locating treatment systems to safeguard people and property, enable safe maintenance access, and minimise environmental impact on natural waterways.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO2 Development provides a stormwater management system which: a) has sufficient capacity to safely convey run-off, taking into account increased run-off from impervious surfaces and flooding in local catchments; b) maximises the use of natural waterway corridors and natural channel design principles; and c) efficiently integrates with existing stormwater treatments upstream and downstream.	**AO2.1** Development provides a stormwater management system which is designed in compliance with ***SC6.18 — Stormwater management planning scheme policy, Queensland Urban Drainage Manual***, Capricorn Municipal Development Guidelines and Australian Rainfall and Runoff.	**Complies with AO2.1**. The stormwater system adheres to ***SC6.18***, and hydrologic and hydraulic modelling was completed following ARR 2019 v4.2. The development will deliver a stormwater management system with the capacity to convey runoff from impervious surfaces and local catchment flooding safely. The design will maintain flood plain storage capacity and incorporate natural waterway corridors and channel design principles, while seamlessly integrating with upstream and downstream flow paths. The system's design will safeguard people and property, enable safe maintenance access, and enhance environmental outcomes through water-sensitive urban design principles.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO3 Development ensures that the location and design of stormwater detention and water quality treatment facilities: a) minimise risk to people and property; b) provide for safe access and maintenance; and c) provide for the safe recreational use of stormwater management features.	**AO3.1** Development provides for stormwater detention and water quality treatment facilities, which are located outside of a waterway. **AO3.2** Development provides for stormwater detention in accordance with SC6.18 — Stormwater management planning scheme policy, Queensland Urban Drainage Manual, Capricorn Municipal Development Guidelines and Australian Rainfall and Runoff. **AO3.3** Development provides a stormwater quality treatment system designed in accordance with the State Planning Policy - Water Quality.	**Complies with AO3.1, AO3.2 and AO3.3**. No detention of stormwater is proposed within the waterway. Development modelling complies with SMP, QUDM and ARR 2019. Proposed water quality management is undertaken in line with best practices and SPP-WQ. ***Refer to Section 6***

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO4 Development and drainage works, including stormwater channels, creek modification works, bridges, culverts and major drains, protect and enhance the environmental values of the waterway corridors and drainage paths and permit terrestrial and aquatic fauna movement.	**AO4.1** Development ensures natural waterway corridors and drainage paths are retained. **AO4.2** Development incorporates the use of natural channel design principles in constructed components to maximise environmental benefits and waterway stability in accordance with the Queensland Urban Drainage Manual, Capricorn Municipal Development Guidelines and Australian Rainfall and Runoff. **AO4.3** Development provides stormwater outlets into waterways, creeks, wetlands, and overland flow paths with energy dissipation to minimise scour, in accordance with the Queensland Urban Drainage Manual, Capricorn Municipal Development Guidelines, and Australian Rainfall and Runoff.	**Complies with AO4.1, AO4.2 and AO4.3.** Development retains natural waterway corridors and incorporates components to ensure waterway stability by maintaining stream channel velocities. Stormwater is lawfully discharged, and the risk of scour is managed by avoiding concentrated flow paths. ***Refer to Section 5.*** Modelling was undertaken following guidelines in ARR 2019, QUDM and CMDG.
PO5 Development protects and enhances the environmental and water quality values of waterways, creeks and estuaries within or external to the site.	No acceptable outcome is nominated.	**Complies with PO5** Waterway environmental qualities are maintained. The proposed Project is designed to safeguard people and property, enable safe access for maintenance, and minimise environmental impact on natural waterways.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO6 All overland flow paths are maintained under tenure arrangements that facilitate efficient infrastructure and enhance environmental sustainability.	No acceptable outcome is nominated.	**Complies with PO6**: Overland flow paths are not diverted and do not pose a risk to infrastructure or the environment.
PO8 Development ensures that the location and design of stormwater detention and water quality treatment minimise risk to people and property, provide for safe access and maintenance, and minimise ecological impacts to creeks and waterways.	**AO8.1** Development provides a stormwater management system designed in accordance with SC6.10 Flood hazard planning scheme policy and SC6.18 Stormwater management planning scheme policy.	**Complies with AO8.1** Proposed works are in accordance with the Flood Hazard planning scheme and Stormwater planning scheme***. Refer to Sections 5 and 6***.. The development's stormwater treatment systems will be strategically located and designed to safeguard people and property, enable safe access for maintenance, and minimise environmental impact on natural waterways.
PO11 Development ensures that there is sufficient site area to accommodate an effective stormwater management system.	No acceptable outcome is nominated.	**Complies with PO11**. Proposed works have ample room available to accommodate the Stormwater management system. ***Refer to Sections 5 and 6.***

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO12 Development provides for the orderly development of stormwater infrastructure within a catchment, having regard to the: a) existing capacity of stormwater infrastructure within and external to the site, and any planned stormwater infrastructure upgrades; b) safe management of stormwater discharge from existing and future upslope development; and c) implications for adjacent and down-slope development.	No acceptable outcome is nominated.	**Complies with PO12**. Proposed works can be completed to ensure the safe management of stormwater discharge from existing and future developments, both upslope and downslope. ***Refer to Sections 5 and 6.***
PO13 Development provides proposed stormwater infrastructure, which: a) remains fit for purpose for the life of the development and maintains full functionality in the design storm event; and b) can be safely accessed and maintained in a cost-effective way.	No acceptable outcome is nominated.	**Complies with PO13**, Proposed stormwater infrastructure that is fit for purpose for the life of the development and maintains full functionality in the design storm event; and can be safely accessed and maintained in a cost-effective manner.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO14 Development ensures that all reasonable and practicable measures are taken to manage the impacts of erosion, turbidity and sedimentation, both within and external to the development site, from construction activities, including vegetation clearing, earthworks, civil construction, installation of services, rehabilitation, revegetation and landscaping to protect: a) the environmental values and water quality objectives of waters; b) waterway hydrology; and c) the maintenance and serviceability of stormwater infrastructure.	**AO14.1** The erosion and sediment control plan is to be designed and implemented in accordance with the Capricorn Municipal Development Guidelines.	**Complies with AO14.1** The development of a conceptual ESCP development and adheres to the principles outlined in IECA Best Practice for Erosion & Sediment Control (2008) as well as those provided in CMDG. ***Refer to Section 6***.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO15 For development proposals within the Fitzroy River sub-basin, relevant environmental values are recognised and enhanced, and appropriate water quality objectives are addressed.	**AO15.1** Development complies with the provisions of the State Planning Policy - Guideline - Water Quality. **AO15.2** Development adjoining the full supply height above the Fitzroy River Barrage includes the provision of an effective buffer that assists in filtering runoff, including: a) a buffer distance of 100 metres to the water supply height of the barrage, which excludes cropping or grazing of a low intensity nature; and b) fencing and water troughs installed on the land to prevent encroachment of animals within 100 metres of the full supply height above the barrage.	**Complies with AO15.1 and AO15.2**. The proposed design adheres to the principles outlined in the SPP, specifically the state interest in Water Quality Policy. ***Refer to Section 6.*** The development is well above the FSL of the Fitzroy River tidal barrage.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO16 The development is compatible with the land use constraints of the site for: a) achieving stormwater design objectives; and b) avoiding or minimising the entry of contaminants into, and transport of contaminants in, stormwater.	**AO16.1** Development is undertaken in accordance with a stormwater management plan that: a) incorporates stormwater quality control measures to achieve the design objectives set out in the State Planning Policy – Guideline – Water Quality; b) provides for achievable stormwater quality treatment measures reflecting land use constraints, such as soil type, landscape features (including landform), nutrient hazardous areas, acid sulphate soil and rainfall erosion potential; and c) accounts for development type, construction phase, local landscape, climatic conditions and design objectives.	**Complies with AO16.1** The proposed Project incorporates stormwater quality control measures that achieve the design objectives set out in SPP Water Quality. ***Refer to Sections 3 and 6***. These sections detail soil type, landscape features, rainfall erosion potential, local landscape, climatic conditions and design objectives.

Performance Outcomes	Acceptable Outcomes	Assessment for the Project
PO17 The waterway is designed for stormwater flow management, stormwater quality management and the following end-use purposes: a) amenity including aesthetics, b) landscaping and recreation; c) flood management; d) stormwater harvesting as part of an integrated water cycle management plan; e) as a sustainable aquatic habitat; and f) the protection of water environmental values.	No acceptable outcome is nominated.	**Complies with PO17.** The design and construction will deliver a waterway that effectively manages stormwater flows and quality while providing aesthetic value, recreational opportunities, flood mitigation, water harvesting capabilities, aquatic habitat preservation, and environmental water protection. ***Refer to Sections 3 and 6***.
PO19 The construction phase for the waterway is compatible with protecting water environmental values in existing natural waterways.	**AO19.1** Erosion and sediment control measures are incorporated during construction to achieve design objectives set out in State Planning Policy - Guideline - Water Quality.	**Complies with AO19.1**. The cESCP has outlined principles that will achieve design objectives in SPP - Water Quality. ***Refer to Section 6***.
PO20 Stormwater overflows from the waterway do not result in lower water quality objectives in existing natural waterways.	**AO20.1** Stormwater run-off entering non-tidal waterways is pre-treated before release in accordance with the guideline design objectives, water quality objectives of local waterways, and any relevant local area stormwater management plan.	**Complies with AO20.1** As required by design objectives, the stormwater run-off discharging from the Study Area will achieve the water quality objectives of local waterways, and any relevant local area stormwater management plan. ***Refer to Sections 5 and 6***

10 SUMMARY OF FINDINGS

This Stormwater Management Plan has considered the potential impacts on surface water associated with the Mount Hopeful Battery Project. The Project will have minimal impact on stormwater quality or quantity as it involves limited ground disturbance, does not store or handle large volumes of pollutants, and once constructed, does not increase stormwater runoff.

For these reasons, the key potential risks to surface water are only associated with the Project's construction. These risks can be adequately managed through the application of well-established construction environmental management practices and appropriate design.

Key issues relevant to the surface water impacts of the Project are summarised below:

- Impacts to surface water resources occur during the construction; however, these potential impacts can be mitigated to present negligible risk.
- Operational phase of the Project presents minimal risk provided that by the conclusion of the construction phase, appropriate groundcover and drainage are established;
- While the core area does not contain any areas of major flood hazard, significant flood hazard was identified adjacent to the access road that reaches the Project.
- The localised and confined nature of the Project is likely to result in minor impacts (if any) that do not pose a risk to drainage features, downstream watercourses or receiving waters.

Overall, it is considered that the potential contamination impacts associated with the Project can be appropriately managed by developing and implementing an erosion and sediment control plan that contains best practice drainage, erosion and sediment controls for the various stages of work.

This study assessed the likely impact on surface water flows for the current climate. Rain on grid flood modelling was undertaken for the flows generated during the 50%, 10% and 1% AEP design flood events. The location of infrastructure should be determined depending on the consequences of the flood risk. Where vital infrastructure, such as the BESS, switchgear and substation should, at a minimum, be located outside the 1% AEP future climate flood extent. The flood risk of as-constructed infrastructure should be assessed to determine the impacts that the introduction of hydraulic structures has had on flow paths. Current guidance, ARR 2019 v4.2, provides a method for determining an allowance of debris blockage at hydraulic structures. The Project also assessed the Planning Scheme's Stormwater Management Code and concluded the project complies with all relevant performance outcomes.

11 REFERENCES

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BOM, 2024	Design Rainfall Data System (2016), Commonwealth of Australia. http://www.bom.gov.au/water/designRainfalls/revised-ifd/
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Zund, P.R. 2017,	*Fitzroy NRM Region Soil Erodibility: User Guide,* Department of Science, Information Technology, Innovation, Queensland Government, Brisbane.

APPENDIX A ARR DATA HUB

A.1 DURATIONS LESS THAN ONE HOUR - ARR DATA HUB

[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-23.803200
Longitude,150.615150
[END_INPUTDATA]

River Region
[RIVREG]
Division, North East Coast
River Number,30
River Name, Fitzroy River (Qld)
[RIVREG_META]
Time Accessed,31 July 2025 04:23PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone, East Coast North
a,0.327
b,0.241
c,0.448
d,0.36
e,0.00096
f,0.48
g,-0.21
h,0.012
i,-0.0013
[LONGARF_META]
Time Accessed,31 July 2025 04:23PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,16076.0
Storm Initial Losses (mm),20.0
Storm Continuing Losses (mm/h),1.6
[LOSSES_META]
Time Accessed,31 July 2025 04:23PM

Version,2016_v1
[END_LOSSES]

Temporal Patterns
[TP]
code, ECnorth
Label, East Coast North
[TP_META]
Time Accessed,31 July 2025 04:23PM
Version,2016_v2
[END_TP]

Areal Temporal Patterns
[ATP]
code, ECnorth
arealabel, East Coast North
[ATP_META]
Time Accessed,31 July 2025 04:23PM
Version,2016_v2
[END_ATP]

Median Preburst Depths and Ratios
[PREBURST]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.7 (0.018),1.8 (0.035),2.6 (0.043),3.3 (0.048),5.8 (0.072),7.6 (0.085)
90 (1.5),1.8 (0.041),1.5 (0.026),1.3 (0.019),1.1 (0.014),6.0 (0.065),9.6 (0.093)
120 (2.0),0.5 (0.010),1.5 (0.024),2.3 (0.030),2.9 (0.034),8.3 (0.082),12.4 (0.109)
180 (3.0),1.7 (0.032),2.2 (0.030),2.5 (0.029),2.8 (0.028),7.6 (0.065),11.2 (0.085)
360 (6.0),1.8 (0.028),6.4 (0.071),9.5 (0.087),12.4 (0.097),20.5 (0.133),26.6 (0.150)
720 (12.0),0.0 (0.001),5.1 (0.044),8.4 (0.059),11.7 (0.068),32.0 (0.150),47.2 (0.191)
1080 (18.0),0.1 (0.001),6.9 (0.051),11.5 (0.067),15.8 (0.076),25.1 (0.096),32.0 (0.105)
1440 (24.0),0.0 (0.000),6.2 (0.041),10.3 (0.053),14.3 (0.060),41.9 (0.139),62.6 (0.176)
2160 (36.0),0.0 (0.000),4.8 (0.027),8.0 (0.035),11.1 (0.039),27.7 (0.075),40.1 (0.092)
2880 (48.0),0.0 (0.000),3.4 (0.017),5.6 (0.022),7.8 (0.024),16.7 (0.040),23.5 (0.047)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),3.2 (0.007),5.6 (0.010)
[PREBURST_META]
Time Accessed,31 July 2025 04:23PM
Version,2018_v1
Note, Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST]From preburst class

10% Preburst Depths
[PREBURST10]
min (h)\AEP(%),50,20,10,5,2,1
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90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.4 (0.002),0.6 (0.003)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),1.0 (0.003),1.8 (0.005)
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2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
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[PREBURST10_META]
Time Accessed,31 July 2025 04:23PM
Version,2018_v1
Note, Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST10]From preburst class

25% Preburst Depths
[PREBURST25]
min (h)\AEP(%),50,20,10,5,2,1
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90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.3 (0.003),0.5 (0.005)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.5 (0.005),0.8 (0.007)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.2 (0.002),0.3 (0.002)
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1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),4.3 (0.017),7.6 (0.025)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),4.5 (0.015),7.8 (0.022)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),10.8 (0.029),18.9 (0.043)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST25_META]
Time Accessed,31 July 2025 04:23PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST25]From preburst class

75% Preburst Depths
[PREBURST75]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),6.9 (0.176),12.3 (0.238),15.9 (0.264),19.4 (0.281),26.6 (0.332),32.1 (0.359)
90 (1.5),11.0 (0.250),14.4 (0.246),16.6 (0.242),18.8 (0.239),30.9 (0.335),40.0 (0.389)
120 (2.0),10.4 (0.217),16.0 (0.250),19.7 (0.262),23.3 (0.270),43.7 (0.430),59.1 (0.518)
180 (3.0),20.0 (0.374),23.2 (0.321),25.3 (0.296),27.3 (0.277),52.3 (0.445),71.0 (0.537)
360 (6.0),18.7 (0.285),37.3 (0.412),49.6 (0.456),61.5 (0.481),86.0 (0.556),104.4 (0.591)

720 (12.0),16.9 (0.208),35.7 (0.307),48.2 (0.336),60.1 (0.349),106.5 (0.499),141.2 (0.571)
1080 (18.0),13.7 (0.147),31.7 (0.233),43.7 (0.256),55.1 (0.265),96.7 (0.370),127.9 (0.418)
1440 (24.0),2.8 (0.027),34.9 (0.228),56.1 (0.290),76.6 (0.321),104.4 (0.346),125.3 (0.352)
2160 (36.0),4.1 (0.035),28.0 (0.157),43.9 (0.191),59.1 (0.205),73.9 (0.201),85.0 (0.195)
2880 (48.0),5.3 (0.042),22.1 (0.112),33.3 (0.130),43.9 (0.135),61.8 (0.148),75.2 (0.151)
4320 (72.0),0.0 (0.000),15.5 (0.070),25.8 (0.088),35.7 (0.095),47.9 (0.098),57.1 (0.098)
[PREBURST75_META]
Time Accessed,31 July 2025 04:23PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST75]From preburst class

90% Preburst Depths
[PREBURST90]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),21.4 (0.549),35.4 (0.686),44.7 (0.741),53.6 (0.778),65.3 (0.813),74.1 (0.830)
90 (1.5),59.3 (1.343),59.3 (1.011),59.2 (0.862),59.2 (0.753),83.3 (0.903),101.3 (0.984)
120 (2.0),52.8 (1.103),57.9 (0.906),61.3 (0.816),64.6 (0.748),129.4 (1.272),178.0 (1.562)
180 (3.0),47.9 (0.894),69.4 (0.960),83.6 (0.978),97.2 (0.983),180.2 (1.533),242.4 (1.831)
360 (6.0),62.9 (0.961),99.6 (1.101),123.9 (1.139),147.2 (1.151),197.9 (1.278),235.9 (1.335)
720 (12.0),41.1 (0.504),79.7 (0.684),105.3 (0.735),129.9 (0.753),203.3 (0.953),258.3 (1.044)
1080 (18.0),65.6 (0.704),95.4 (0.699),115.2 (0.675),134.2 (0.644),174.6 (0.669),204.9 (0.670)
1440 (24.0),43.8 (0.428),95.9 (0.628),130.4 (0.674),163.5 (0.685),203.1 (0.672),232.8 (0.655)
2160 (36.0),41.2 (0.354),104.0 (0.584),145.6 (0.635),185.5 (0.645),177.5 (0.482),171.5 (0.393)
2880 (48.0),33.7 (0.266),78.3 (0.397),107.8 (0.420),136.2 (0.419),144.3 (0.345),150.4 (0.301)
4320 (72.0),18.6 (0.132),47.0 (0.211),65.8 (0.224),83.8 (0.223),100.0 (0.205),112.2 (0.192)
[PREBURST90_META]
Time Accessed,31 July 2025 04:23PM
Version,2018_v1
Note,Preburst interpolation methods for catchment-wide preburst have been slightly altered. Point values remain unchanged.
[END_PREBURST90]From preburst class

Climate Change Factors
[CCF]
[SSP1-2.6]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.21,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.11,1.11
2050,1.22,1.2,1.18,1.17,1.15,1.15,1.14,1.13,1.12,1.11
2060,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2070,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2080,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2090,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2100,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12

[END_SSP1-2.6]
[SSP2-4.5]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12
2050,1.27,1.24,1.23,1.21,1.19,1.18,1.17,1.16,1.15,1.14
2060,1.3,1.27,1.25,1.23,1.21,1.2,1.19,1.18,1.16,1.16
2070,1.33,1.3,1.28,1.26,1.24,1.22,1.21,1.19,1.18,1.17
2080,1.37,1.33,1.31,1.28,1.26,1.24,1.22,1.21,1.2,1.19
2090,1.4,1.36,1.34,1.31,1.28,1.26,1.24,1.23,1.21,1.2
2100,1.41,1.37,1.35,1.32,1.29,1.27,1.25,1.24,1.22,1.21
[END_SSP2-4.5]
[SSP3-7.0]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1
2040,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12
2050,1.29,1.26,1.24,1.22,1.2,1.19,1.18,1.17,1.16,1.15
2060,1.35,1.32,1.3,1.27,1.25,1.23,1.22,1.2,1.19,1.18
2070,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21
2080,1.5,1.45,1.42,1.38,1.35,1.33,1.3,1.28,1.26,1.25
2090,1.59,1.53,1.49,1.44,1.4,1.38,1.35,1.33,1.3,1.29
2100,1.66,1.59,1.55,1.5,1.45,1.42,1.39,1.37,1.34,1.32
[END_SSP3-7.0]
[SSP5-8.5]
,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours
2030,1.2,1.18,1.17,1.16,1.14,1.13,1.13,1.12,1.11,1.11
2040,1.26,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.14
2050,1.34,1.31,1.29,1.26,1.24,1.23,1.21,1.2,1.18,1.18
2060,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21
2070,1.52,1.47,1.43,1.4,1.36,1.34,1.31,1.29,1.27,1.26
2080,1.63,1.57,1.52,1.48,1.43,1.4,1.37,1.35,1.33,1.31
2090,1.77,1.69,1.64,1.58,1.52,1.49,1.45,1.42,1.39,1.37
2100,1.86,1.77,1.71,1.64,1.58,1.54,1.5,1.47,1.43,1.41
[END_SSP5-8.5]
[Climate_Change_INITIAL_LOSS]
,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5
2030,1.02,1.02,1.02,1.03
2040,1.03,1.03,1.03,1.03
2050,1.03,1.03,1.04,1.04
2060,1.03,1.04,1.04,1.05
2070,1.03,1.04,1.05,1.06
2080,1.03,1.05,1.06,1.07
2090,1.03,1.05,1.07,1.08
2100,1.03,1.05,1.07,1.09
[END_Climate_Change_INITIAL_LOSS]
[Climate_Change_CONTINUING_LOSS]

,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5
2030,1.04,1.05,1.05,1.05
2040,1.05,1.05,1.06,1.06
2050,1.06,1.06,1.07,1.08
2060,1.06,1.07,1.08,1.1
2070,1.06,1.08,1.1,1.12
2080,1.06,1.09,1.11,1.14
2090,1.06,1.09,1.13,1.16
2100,1.06,1.1,1.14,1.18
[END_Climate_Change_CONTINUING_LOSS]
[TEMPERATURE_CHANGES]
,SSP1-2.6,SSP2-4.5,SSP3-7.0,SSP5-8.5
2030,1.2,1.2,1.2,1.3
2040,1.3,1.4,1.5,1.6
2050,1.4,1.7,1.8,2.1
2060,1.5,1.9,2.2,2.5
2070,1.5,2.1,2.5,3.0
2080,1.5,2.2,2.9,3.5
2090,1.5,2.4,3.3,4.1
2100,1.4,2.5,3.6,4.5
[END_TEMPERATURE_CHANGES]

[CCF_META]
Time Accessed,31 July 2025 04:23PM
Version,2024_v1
Note,Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recomends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)
[END_CCF]

[ENDTXT]

A.2 DURATION BETWEEN 1 – 12 HOURS ARR DATA HUB

[STARTTXT]

Input Data Information

[INPUTDATA]

Latitude,-23.802900

Longitude,150.613850

[END_INPUTDATA]

River Region

[RIVREG]

Division,North East Coast

River Number,30

River Name,Fitzroy River (Qld)

[RIVREG_META]

Time Accessed,04 July 2025 01:58PM

Version,2016_v1

[END_RIVREG]

ARF Parameters

[LONGARF]

Zone,East Coast North

a,0.327

b,0.241

c,0.448

d,0.36

e,0.00096

f,0.48

g,-0.21

h,0.012

i,-0.0013

[LONGARF_META]

Time Accessed,04 July 2025 01:58PM

Version,2016_v1

[END_LONGARF]

Storm Losses

[LOSSES]

ID,16076.0

Storm Initial Losses (mm),20.0

Storm Continuing Losses (mm/h),1.6

[LOSSES_META]

Time Accessed,04 July 2025 01:58PM

Version,2016_v1

[END_LOSSES]

Temporal Patterns

[TP]

code,ECnorth

Label,East Coast North

[TP_META]

Time Accessed,04 July 2025 01:58PM

Version,2016_v2

[END_TP]

Areal Temporal Patterns

[ATP]

code,ECnorth

arealabel,East Coast North

[ATP_META]

Time Accessed,04 July 2025 01:58PM

Version,2016_v2

[END_ATP]

Median Preburst Depths and Ratios

[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.7 (0.018),1.8 (0.035),2.6 (0.043),3.3 (0.048),5.8 (0.072),7.6 (0.085)

90 (1.5),1.8 (0.041),1.5 (0.026),1.3 (0.019),1.1 (0.014),6.0 (0.065),9.6 (0.093)

120 (2.0),0.5 (0.010),1.5 (0.024),2.3 (0.030),2.9 (0.034),8.3 (0.082),12.4 (0.109)

180 (3.0),1.7 (0.032),2.2 (0.030),2.5 (0.029),2.8 (0.028),7.6 (0.065),11.2 (0.085)

360 (6.0),1.8 (0.028),6.4 (0.071),9.5 (0.087),12.4 (0.097),20.5 (0.133),26.6 (0.150)

720 (12.0),0.0 (0.001),5.1 (0.044),8.4 (0.059),11.7 (0.068),32.0 (0.150),47.2 (0.191)

1080 (18.0),0.1 (0.001),6.9 (0.051),11.5 (0.067),15.8 (0.076),25.1 (0.096),32.0 (0.105)

1440 (24.0),0.0 (0.000),6.2 (0.041),10.3 (0.053),14.3 (0.060),41.9 (0.139),62.6 (0.176)

2160 (36.0),0.0 (0.000),4.8 (0.027),8.0 (0.035),11.1 (0.039),27.7 (0.075),40.1 (0.092)

2880 (48.0),0.0 (0.000),3.4 (0.017),5.6 (0.022),7.8 (0.024),16.7 (0.040),23.5 (0.047)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),3.2 (0.007),5.6 (0.010)

[PREBURST_META]

Time Accessed,04 July 2025 01:58PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST]From preburst class

10% Preburst Depths

[PREBURST10]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.4 (0.002),0.6 (0.003)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),1.0 (0.003),1.8 (0.005)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST10_META]

Time Accessed,04 July 2025 01:58PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST10]From preburst class

25% Preburst Depths

[PREBURST25]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.1 (0.002),0.2 (0.003),0.2 (0.003),0.6 (0.007),0.9 (0.010)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.3 (0.003),0.5 (0.005)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.5 (0.005),0.8 (0.007)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.2 (0.002),0.3 (0.002)

360 (6.0),0.0 (0.000),0.1 (0.001),0.1 (0.001),0.2 (0.001),1.3 (0.008),2.1 (0.012)

720 (12.0),0.0 (0.000),0.1 (0.001),0.1 (0.001),0.2 (0.001),6.0 (0.028),10.4 (0.042)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),4.3 (0.017),7.6 (0.025)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),4.5 (0.015),7.8 (0.022)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),10.8 (0.029),18.9 (0.043)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST25_META]

Time Accessed,04 July 2025 01:58PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST25]From preburst class

75% Preburst Depths

[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),6.9 (0.176),12.3 (0.238),15.9 (0.264),19.4 (0.281),26.6 (0.332),32.1 (0.359)

90 (1.5),11.0 (0.250),14.4 (0.246),16.6 (0.242),18.8 (0.239),30.9 (0.335),40.0 (0.389)

120 (2.0),10.4 (0.217),16.0 (0.250),19.7 (0.262),23.3 (0.270),43.7 (0.430),59.1 (0.518)

180 (3.0),20.0 (0.374),23.2 (0.321),25.3 (0.296),27.3 (0.277),52.3 (0.445),71.0 (0.537)

360 (6.0),18.7 (0.285),37.3 (0.412),49.6 (0.456),61.5 (0.481),86.0 (0.556),104.4 (0.591)

720 (12.0),16.9 (0.208),35.7 (0.307),48.2 (0.336),60.1 (0.349),106.5 (0.499),141.2 (0.571)

1080 (18.0),13.7 (0.147),31.7 (0.233),43.7 (0.256),55.1 (0.265),96.7 (0.370),127.9 (0.418)

1440 (24.0),2.8 (0.027),34.9 (0.228),56.1 (0.290),76.6 (0.321),104.4 (0.346),125.3 (0.352)

2160 (36.0),4.1 (0.035),28.0 (0.157),43.9 (0.191),59.1 (0.205),73.9 (0.201),85.0 (0.195)

2880 (48.0),5.3 (0.042),22.1 (0.112),33.3 (0.130),43.9 (0.135),61.8 (0.148),75.2 (0.151)

4320 (72.0),0.0 (0.000),15.5 (0.070),25.8 (0.088),35.7 (0.095),47.9 (0.098),57.1 (0.098)

[PREBURST75_META]

Time Accessed,04 July 2025 01:58PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST75]From preburst class

90% Preburst Depths

[PREBURST90]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),21.4 (0.549),35.4 (0.686),44.7 (0.741),53.6 (0.778),65.3 (0.813),74.1 (0.830)

90 (1.5),59.3 (1.343),59.3 (1.011),59.2 (0.862),59.2 (0.753),83.3 (0.903),101.3 (0.984)

120 (2.0),52.8 (1.103),57.9 (0.906),61.3 (0.816),64.6 (0.748),129.4 (1.272),178.0 (1.562)

180 (3.0),47.9 (0.894),69.4 (0.960),83.6 (0.978),97.2 (0.983),180.2 (1.533),242.4 (1.831)

360 (6.0),62.9 (0.961),99.6 (1.101),123.9 (1.139),147.2 (1.151),197.9 (1.278),235.9 (1.335)

720 (12.0),41.1 (0.504),79.7 (0.684),105.3 (0.735),129.9 (0.753),203.3 (0.953),258.3 (1.044)

1080 (18.0),65.6 (0.704),95.4 (0.699),115.2 (0.675),134.2 (0.644),174.6 (0.669),204.9 (0.670)

1440 (24.0),43.8 (0.428),95.9 (0.628),130.4 (0.674),163.5 (0.685),203.1 (0.672),232.8 (0.655)

2160 (36.0),41.2 (0.354),104.0 (0.584),145.6 (0.635),185.5 (0.645),177.5 (0.482),171.5 (0.393)

2880 (48.0),33.7 (0.266),78.3 (0.397),107.8 (0.420),136.2 (0.419),144.3 (0.345),150.4 (0.301)

4320 (72.0),18.6 (0.132),47.0 (0.211),65.8 (0.224),83.8 (0.223),100.0 (0.205),112.2 (0.192)

[PREBURST90_META]

Time Accessed,04 July 2025 01:58PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST90]From preburst class

Climate Change Factors

[CCF]

[SSP1-2.6]

,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours

2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1

2040,1.21,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.11,1.11

2050,1.22,1.2,1.18,1.17,1.15,1.15,1.14,1.13,1.12,1.11

2060,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12

2070,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12

2080,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12

2090,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12

2100,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12

[END_SSP1-2.6]

[SSP2-4.5]

,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours

2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1

2040,1.22,1.2,1.19,1.17,1.16,1.15,1.14,1.13,1.12,1.12

2050,1.27,1.24,1.23,1.21,1.19,1.18,1.17,1.16,1.15,1.14

2060,1.3,1.27,1.25,1.23,1.21,1.2,1.19,1.18,1.16,1.16

2070,1.33,1.3,1.28,1.26,1.24,1.22,1.21,1.19,1.18,1.17

2080,1.37,1.33,1.31,1.28,1.26,1.24,1.22,1.21,1.2,1.19

2090,1.4,1.36,1.34,1.31,1.28,1.26,1.24,1.23,1.21,1.2

2100,1.41,1.37,1.35,1.32,1.29,1.27,1.25,1.24,1.22,1.21

[END_SSP2-4.5]

[SSP3-7.0]

,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours

2030,1.18,1.17,1.16,1.14,1.13,1.12,1.12,1.11,1.1,1.1

2040,1.23,1.21,1.2,1.18,1.17,1.16,1.15,1.14,1.13,1.12

2050,1.29,1.26,1.24,1.22,1.2,1.19,1.18,1.17,1.16,1.15

2060,1.35,1.32,1.3,1.27,1.25,1.23,1.22,1.2,1.19,1.18

2070,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21

2080,1.5,1.45,1.42,1.38,1.35,1.33,1.3,1.28,1.26,1.25

2090,1.59,1.53,1.49,1.44,1.4,1.38,1.35,1.33,1.3,1.29

2100,1.66,1.59,1.55,1.5,1.45,1.42,1.39,1.37,1.34,1.32

[END_SSP3-7.0]

[SSP5-8.5]

,<1 hour,1.5 Hours,2 Hours,3 Hours,4.5 Hours,6 Hours,9 Hours,12 Hours,18 Hours,>24 Hours

2030,1.2,1.18,1.17,1.16,1.14,1.13,1.13,1.12,1.11,1.11

2040,1.26,1.24,1.22,1.2,1.18,1.17,1.16,1.15,1.14,1.14

2050,1.34,1.31,1.29,1.26,1.24,1.23,1.21,1.2,1.18,1.18

2060,1.42,1.38,1.35,1.32,1.29,1.28,1.26,1.24,1.22,1.21

2070,1.52,1.47,1.43,1.4,1.36,1.34,1.31,1.29,1.27,1.26

2080,1.63,1.57,1.52,1.48,1.43,1.4,1.37,1.35,1.33,1.31

2090,1.77,1.69,1.64,1.58,1.52,1.49,1.45,1.42,1.39,1.37

2100,1.86,1.77,1.71,1.64,1.58,1.54,1.5,1.47,1.43,1.41

[END_SSP5-8.5]

[Climate_Change_INITIAL_LOSS]

,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5

2030,1.02,1.02,1.02,1.03

2040,1.03,1.03,1.03,1.03

2050,1.03,1.03,1.04,1.04

2060,1.03,1.04,1.04,1.05

2070,1.03,1.04,1.05,1.06

2080,1.03,1.05,1.06,1.07

2090,1.03,1.05,1.07,1.08

2100,1.03,1.05,1.07,1.09

[END_Climate_Change_INITIAL_LOSS]

[Climate_Change_CONTINUING_LOSS]

,Losses SSP1-2.6,Losses SSP2-4.5,Losses SSP3-7.0,Losses SSP5-8.5

2030,1.04,1.05,1.05,1.05

2040,1.05,1.05,1.06,1.06

2050,1.06,1.06,1.07,1.08

2060,1.06,1.07,1.08,1.1

2070,1.06,1.08,1.1,1.12

2080,1.06,1.09,1.11,1.14

2090,1.06,1.09,1.13,1.16

2100,1.06,1.1,1.14,1.18

[END_Climate_Change_CONTINUING_LOSS]

[TEMPERATURE_CHANGES]

,SSP1-2.6,SSP2-4.5,SSP3-7.0,SSP5-8.5

2030,1.2,1.2,1.2,1.3

2040,1.3,1.4,1.5,1.6

2050,1.4,1.7,1.8,2.1

2060,1.5,1.9,2.2,2.5

2070,1.5,2.1,2.5,3.0

2080,1.5,2.2,2.9,3.5

2090,1.5,2.4,3.3,4.1

2100,1.4,2.5,3.6,4.5

[END_TEMPERATURE_CHANGES]

[CCF_META]

Time Accessed,04 July 2025 01:58PM

Version,2024_v1

Note,Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recomends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)

[END_CCF]

Table A.1 Rational Method calculation worksheet

Catchment:	ID#11

Catchment area and coefficient of runoff	
Catchment Area (ha)	200.00
C_{10}	0.18

Standard inlet time	
Standard inlet time (mins)	30.0

Channel characteristics	
Channel length (m)	250
Channel slope (m/m)	0.015
Manning's 'n'	0.040
Channel bottom width (m)	15.00
Channel side slope (m/m)	0.050

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	Channel Velocity[a] (m/s)	Channel Travel Time (mins)	t_c[b] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.14	0.96	4.36	34.4	50.5	3.93
1.44	50	0.85	0.15	1.01	4.13	34.1	56.3	4.65
4.48	20	0.95	0.17	1.14	3.66	33.7	74.7	6.90
10	10	1.00	0.18	1.21	3.43	33.4	87.3	8.49
20	5	1.05	0.18	1.28	3.25	33.3	99.6	10.2
50	2	1.15	0.20	1.38	3.03	33.0	116.2	13.0
100	1	1.20	0.21	1.44	2.90	32.9	129.5	15.1

a - Channel velocity calculated using Mannings's equation

b - Time of Concentration (t_c) = Overland Flow Travel Time + Channel Travel Time

APPENDIX B ERODIBLE SOILS REPORT

B.1 ERODIBLE SOILS MATRIX

Surface soil stability (Map 2)

Increasing surface soil erodibility →

Subsoil dispersibility (Map 3)

Increasing subsoil erodibility ↓

	Moderately stable surface soils	Non-cohesive surface soils	Dispersive surface soils	Highly erodible surface soils
Rock	Loamy to clayey soils over rock	Sandy massive surface soils over rock	Weakly dispersive clay soils	Clayey soils that erode and/or slake readily
Non-dispersive subsoils	Loamy to clayey soils over non-dispersive subsoils	Sandy massive surface soils over non-dispersive subsoils		Clayey surface soils that erode and/or slake over weakly dispersive subsoils
Weakly dispersive subsoils	Loamy to clayey soils over weakly dispersive clay subsoils	Sandy massive surface soils over weakly dispersive subsoils		
Moderately dispersive subsoils	Loamy to clayey soils over moderately dispersive clay subsoils	Sandy massive surface soils over moderately dispersive subsoils	Moderately dispersive clay soils	Clayey surface soils that erode and/or slake over moderately dispersive subsoils
Highly dispersive subsoils	Loamy to clayey soils over highly dispersive clay subsoils	Sandy massive surface soils over highly dispersive subsoils	Dispersive loamy or clayey surface soils over highly dispersive clay subsoils	Clayey surface soils that erode and/or slake over highly dispersive subsoils

FORAGE REPORT: ERODIBLE SOILS

http://www.longpaddock.qld.gov.au/forage 18/07/2025 Lot on Plan: 33DT40123,38DT40131,100SP289441 Label: noLabel

Queensland Government

Overall soil erodibility

Soils have been ranked into five broad categories of erodibility (very low to very high). They have been derived from a combination of surface soil stability and subsoil erodibility. The table on the first page shows the possible combinations. Using the Table in the About the Maps section and Maps 2 and 3, you can determine the soils likely to occur.

Map 1 - Overall soil erodibility ranking

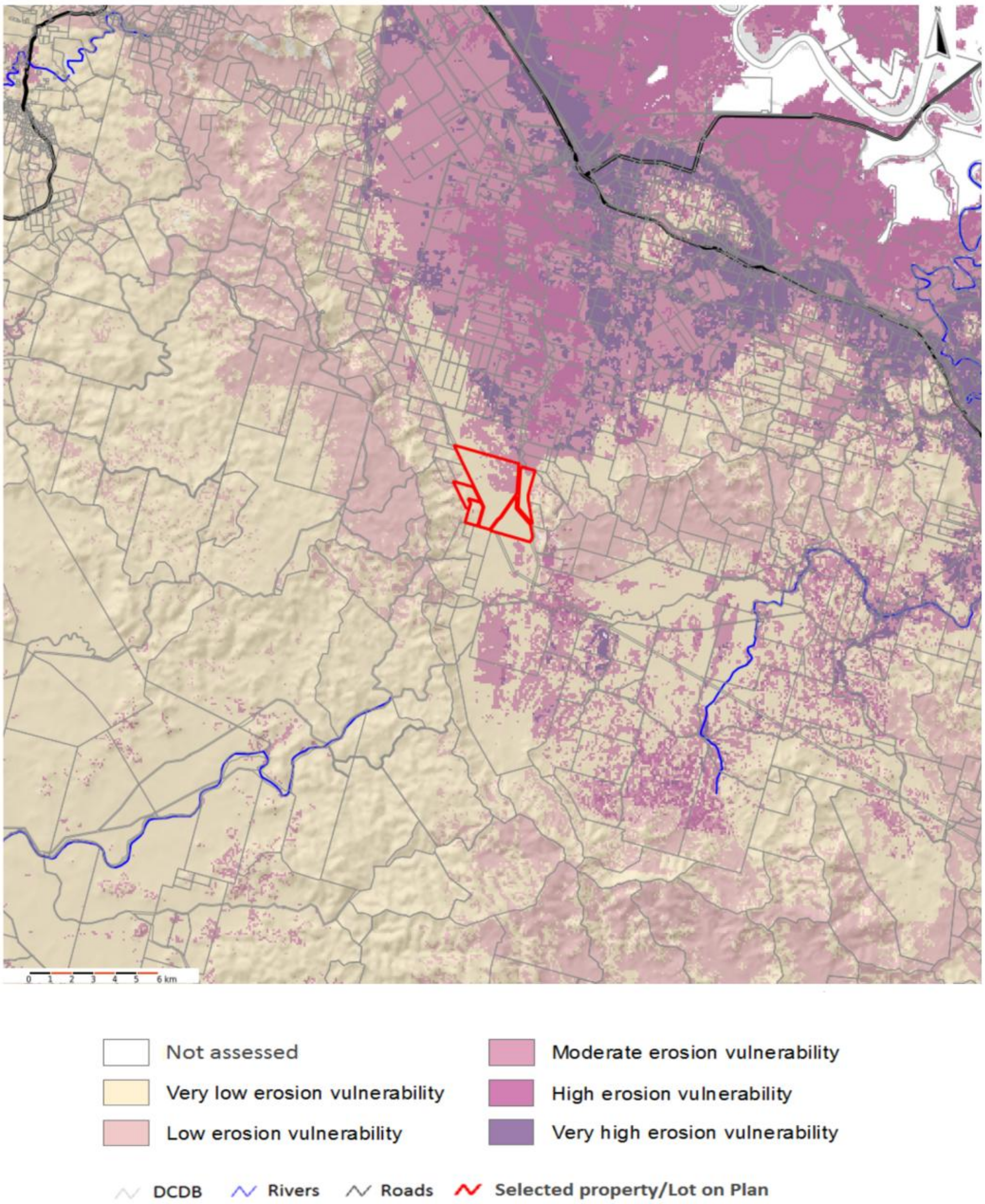


Figure B.1 Map 1 overall soil erodibility ranking

FORAGE REPORT: ERODIBLE SOILS

http://www.longpaddock.qld.gov.au/forage 18/07/2025 Lot on Plan: 33DT40123,38DT40131,100SP289441 Label: noLabel

Queensland Government

Surface soil

The surface soils have been classified into the following four categories. These categories generally relate to increasing surface soil erodibility:

1. Moderately stable surface soils are usually structured and resilient to degradation .
2. Non-cohesive surface soils are sandy soils that are not structured or only weakly so and non-cohesive. These soils are easily eroded.
3. Dispersive surface soils are loamy or clayey soils that are sodic, hardsetting and are likely to disperse in water.
4. Highly erodible surface soils are clayey soils that are sodic and dominated by shrink/swell clays that readily disperse.

Map 2 - Surface soil stability

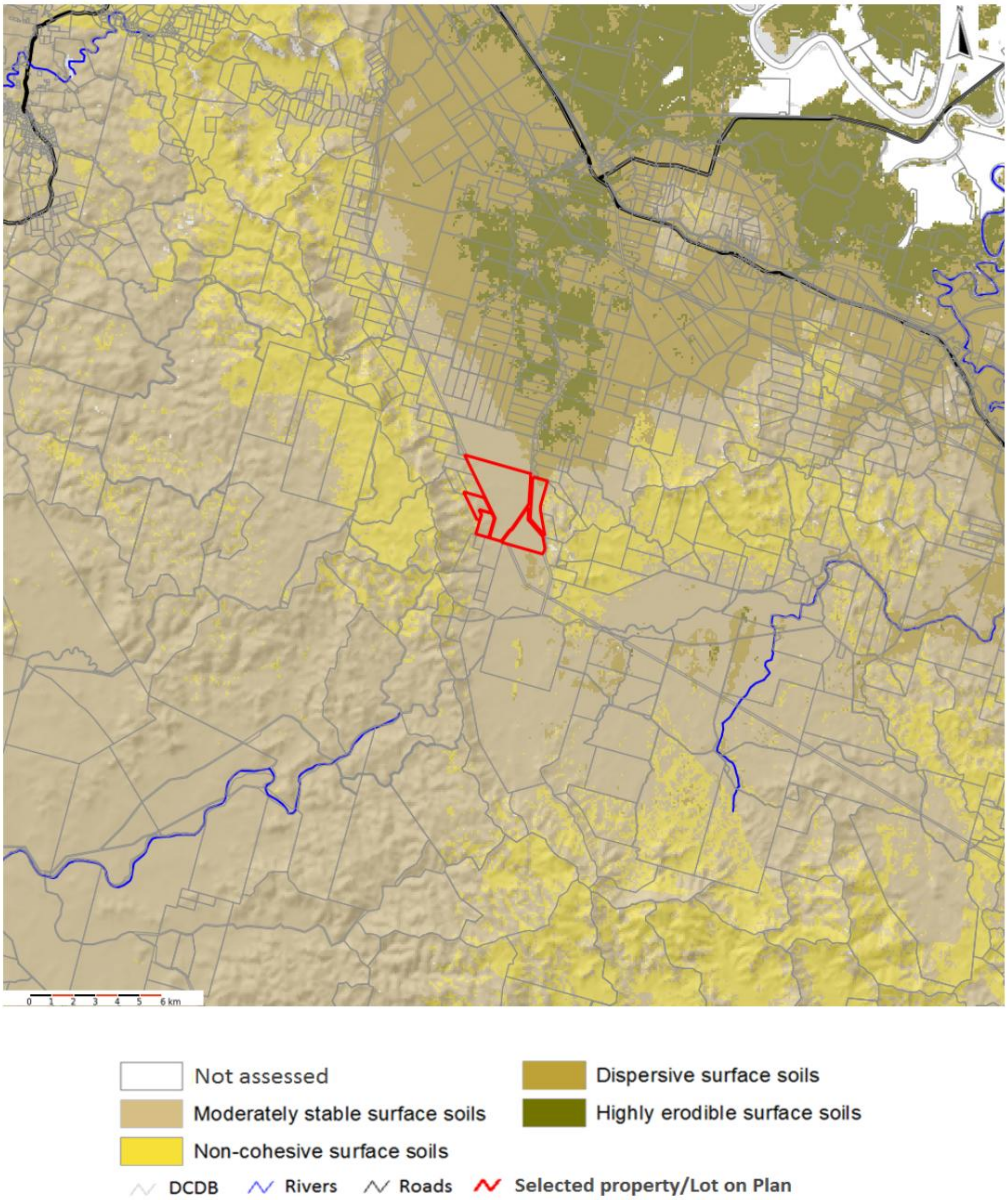


Figure B.2 Map 2 Surface Soil stability

FORAGE REPORT: ERODIBLE SOILS

http://www.longpaddock.qld.gov.au/forage 18/07/2025 Lot on Plan: 33DT40123,38DT40131,100SP289441 Label: noLabel

Queensland Government

Subsoil

The subsoils have been classified into the following four categories:

1. Non-dispersive subsoils that are non-sodic or only weakly sodic and are unlikely to disperse.
2. Weakly dispersive subsoils are sodic subsoils that are saline or dominated by carbonate nodules that prevent these subsoils from dispersing readily.
3. Dispersive subsoils are sodic subsoils that disperse readily.
4. Highly dispersive subsoils are sodic subsoils that are also dominated by magnesium ions that enhance the dispersive affect.

Map 3 - Subsoil dispersibility

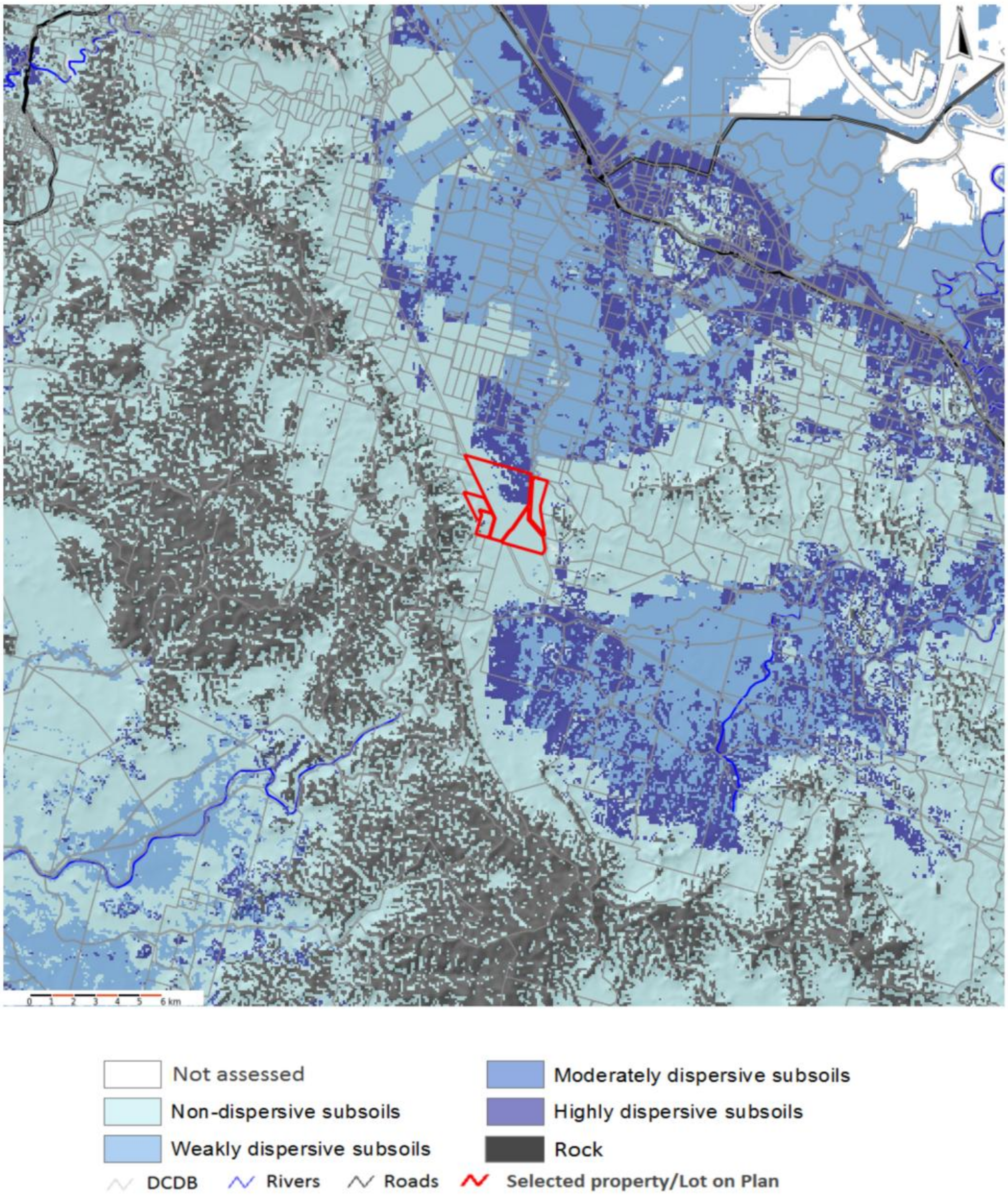


Figure B.3 Map 3 subsoil dispersibility

APPENDIX C FLOOD MAPS

C.1 PEAK MODELLED FLOOD DEPTH

C.1.1 1% AEP Flood Event

C.1.2 10% AEP Flood Event

C.1.3 50% AEP Flood Event

C.2 PEAK MODELLED FLOOD VELOCITY

C.2.1 1% AEP Flood Event

C.2.2 10% AEP Flood Event

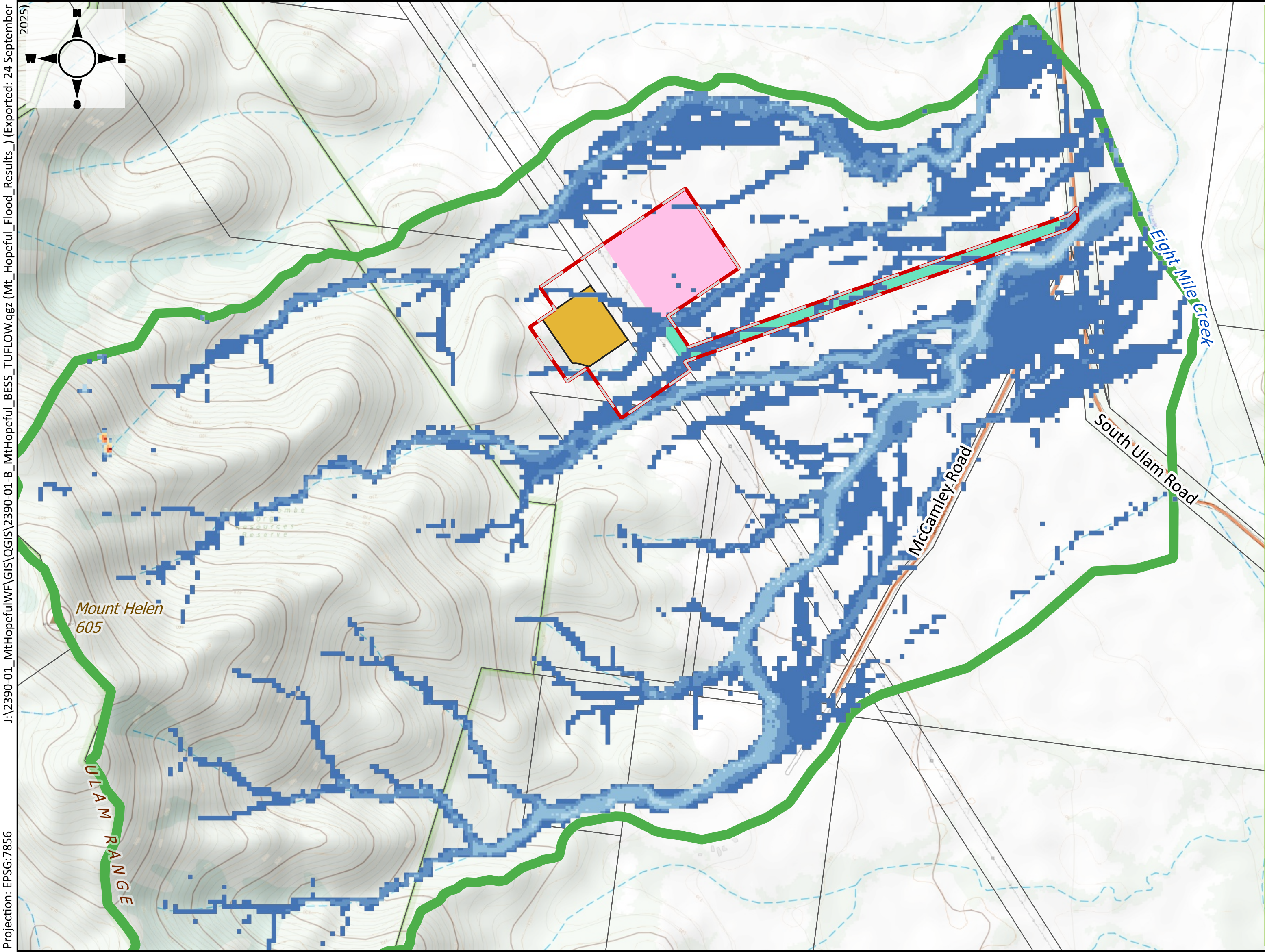
C.2.3 50% AEP Flood Event

C.3 PEAK MODELLED FLOOD HAZARD

C.3.1 1% AEP Flood Event

C.3.2 10% AEP Flood Event

C.3.3 50% AEP Flood Event



Legend

- Study area
- Hydraulic model extent
- BESS area
- Switchyard area
- Access road
- Lot boundary

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 200 400 600 800 m

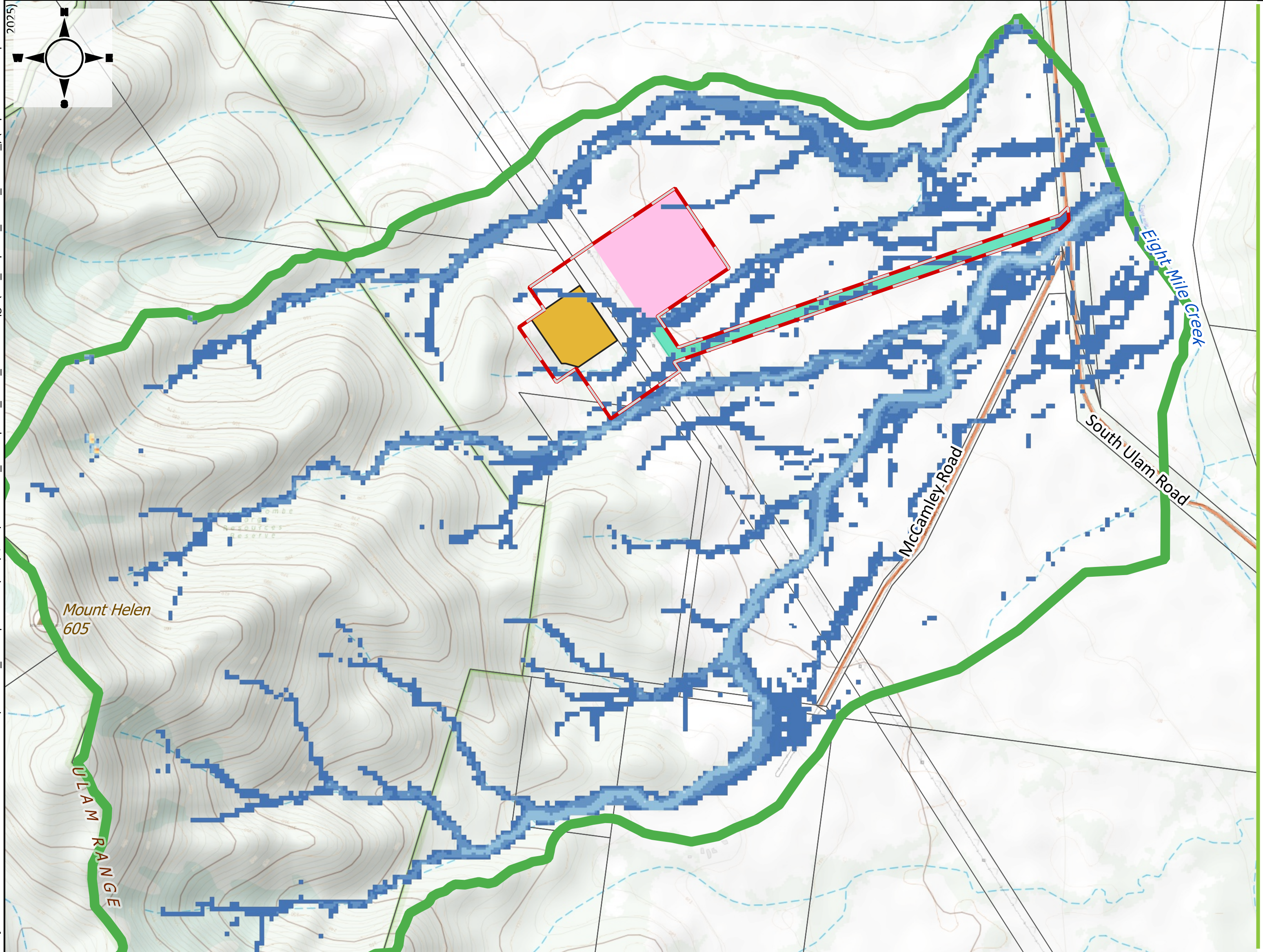
Mount Hopeful BESS Stormwater Management Plan

1% AEP flood depth, existing conditions

WRM

J:\2390-01_MtHopefulWF\GIS\QGIS\2390-01-B_MtHopeful_BESS_TUFLOW.qgz (Mt_Hopeful_Flood_Results_) (Exported: 24 September 2025)

Projection: EPSG:7856



Legend

- Study area
- Hydraulic model extent
- BESS area
- Switchyard area
- Access road
- Lot boundary

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 200 400 600 800 m

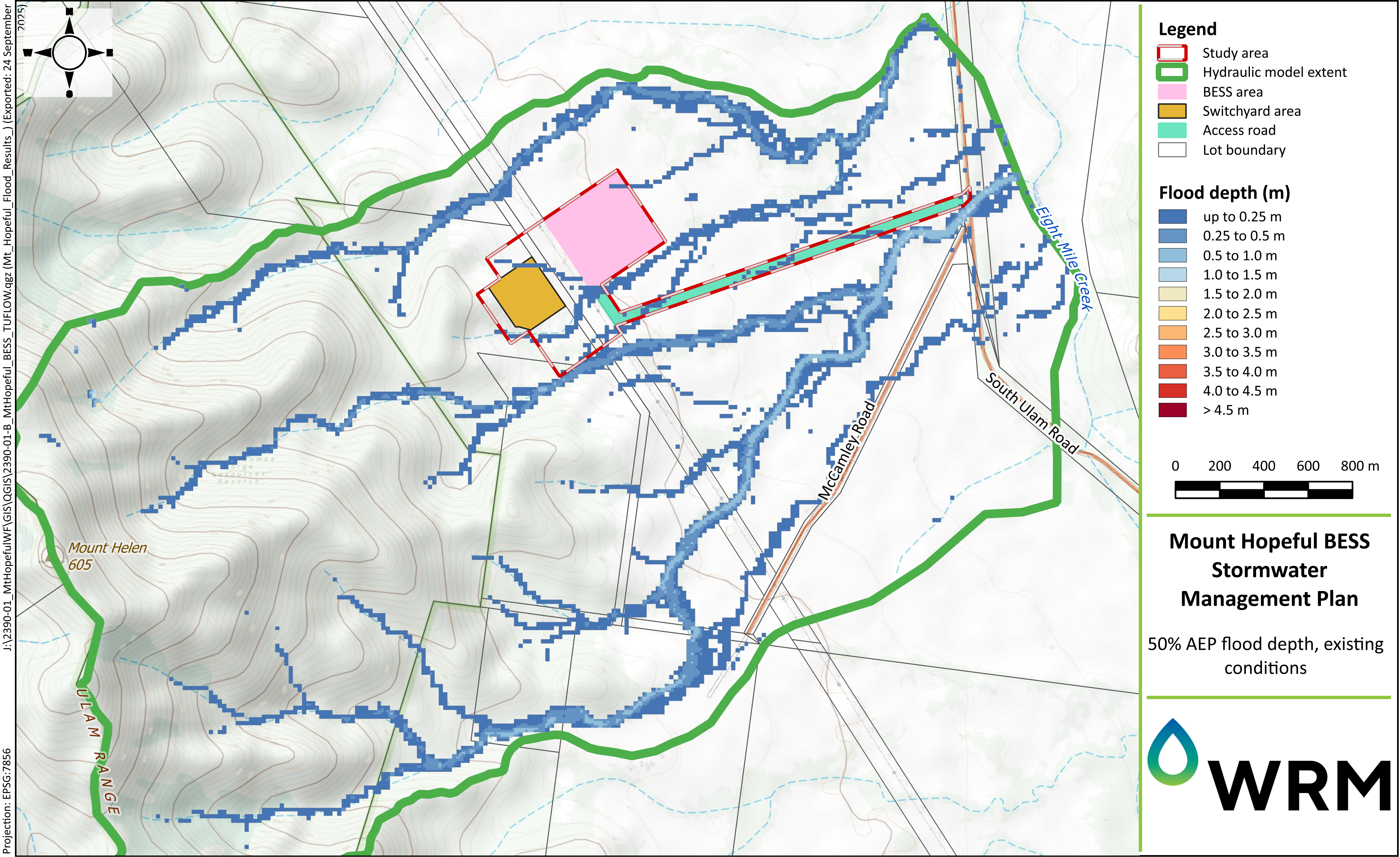
Mount Hopeful BESS Stormwater Management Plan

10% AEP flood depth, existing conditions

WRM

J:\2390-01_MtHopefulWF\GIS\QGIS\2390-01-B_MtHopeful_BESS_TUFLOW.qgz (Mt_Hopeful_Flood_Results_) (Exported: 24 September 2025)

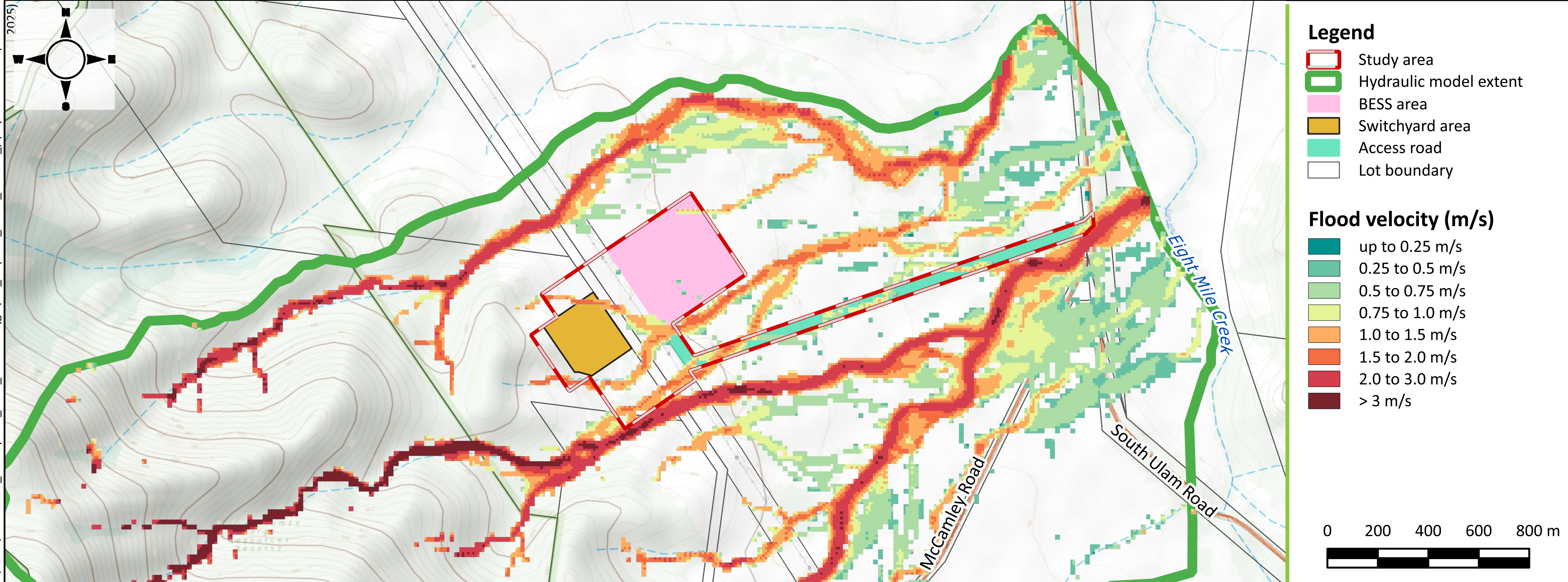
Projection: EPSG:7856



Mount Hopeful BESS Stormwater Management Plan

50% AEP flood depth, existing conditions

WRM



Mount Hopeful BESS Stormwater Management Plan

1% AEP flood velocity, existing conditions

WRM

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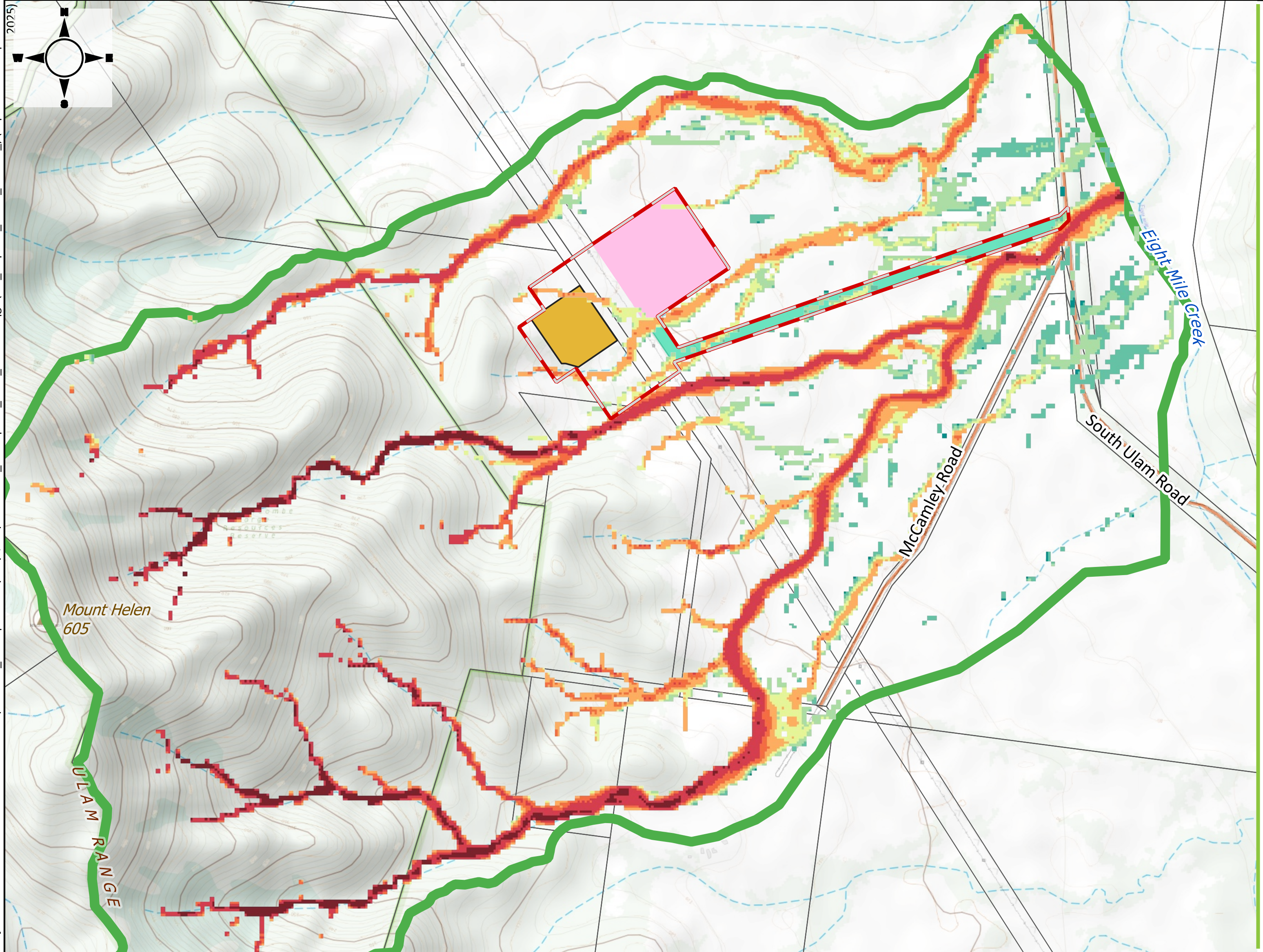
Projection: EPSG:7856



Legend

- Study area
- Hydraulic model extent
- BESS area
- Switchyard area
- Access road
- Lot boundary

Flood velocity (m/s)

- up to 0.25 m/s
- 0.25 to 0.5 m/s
- 0.5 to 0.75 m/s
- 0.75 to 1.0 m/s
- 1.0 to 1.5 m/s
- 1.5 to 2.0 m/s
- 2.0 to 3.0 m/s
- > 3 m/s

0 200 400 600 800 m

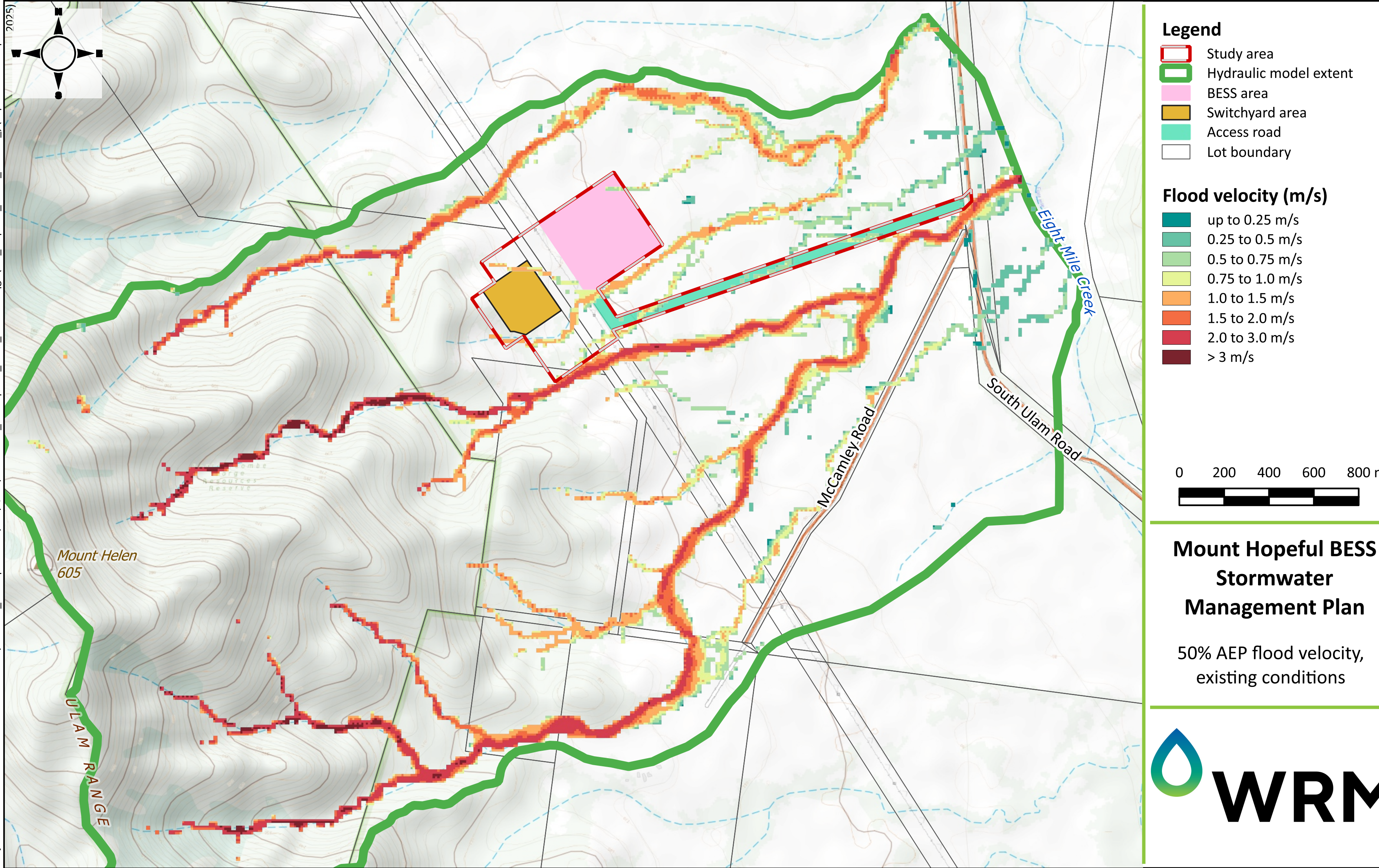
Mount Hopeful BESS Stormwater Management Plan

10% AEP flood velocity, existing conditions

WRM

J:\2390-01_MtHopefulWF\GIS\QGIS\2390-01-B_MtHopeful_BESS_TUFLOW.qgz (Mt_Hopeful_Flood_Results_) (Exported: 24 September 2025)

Projection: EPSG:7856



Mount Hopeful BESS Stormwater Management Plan

50% AEP flood velocity, existing conditions

WRM

Projection: EPSG:7856

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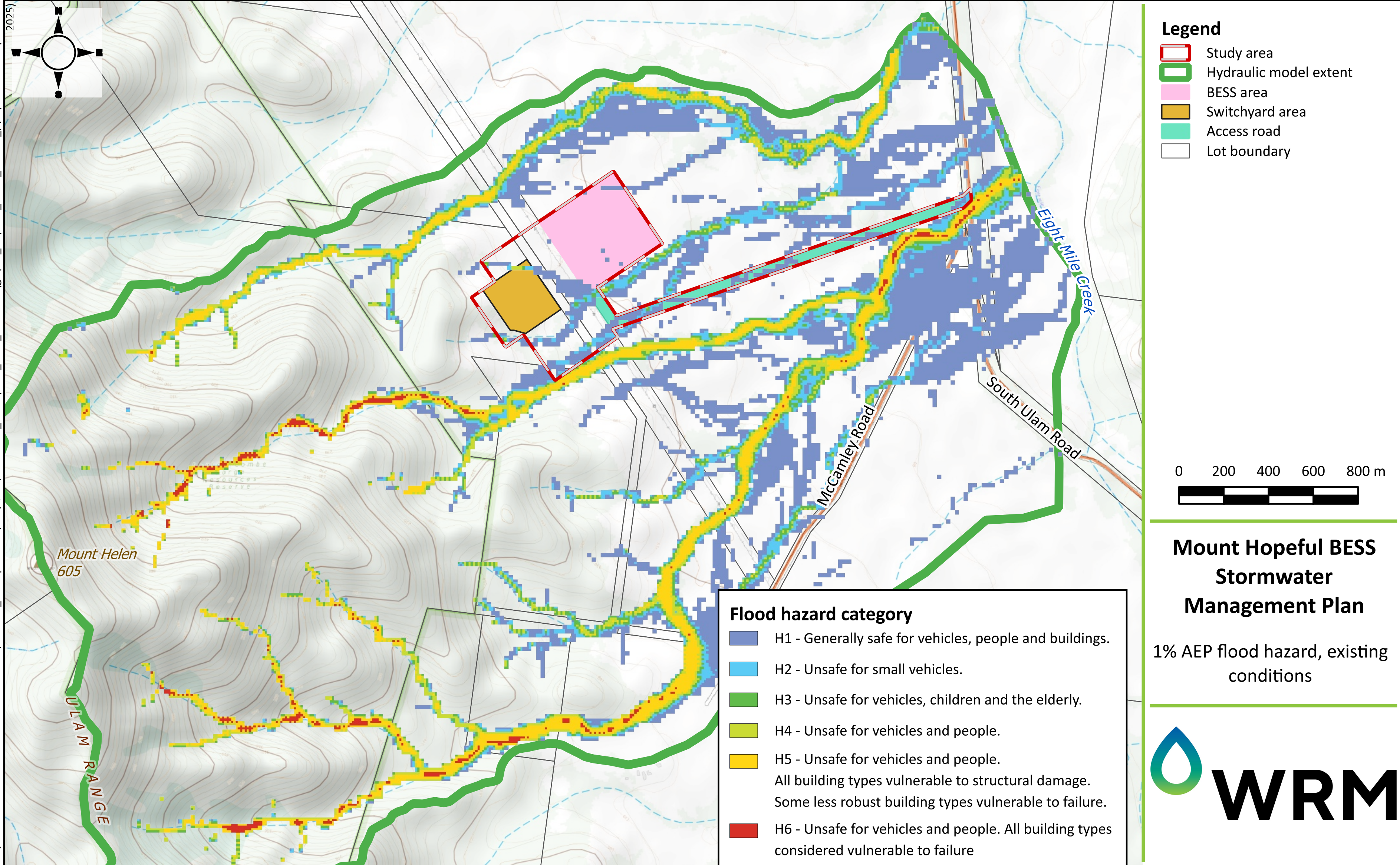

Mount Hopeful BESS Stormwater Management Plan

1% AEP flood hazard, existing conditions

WRM

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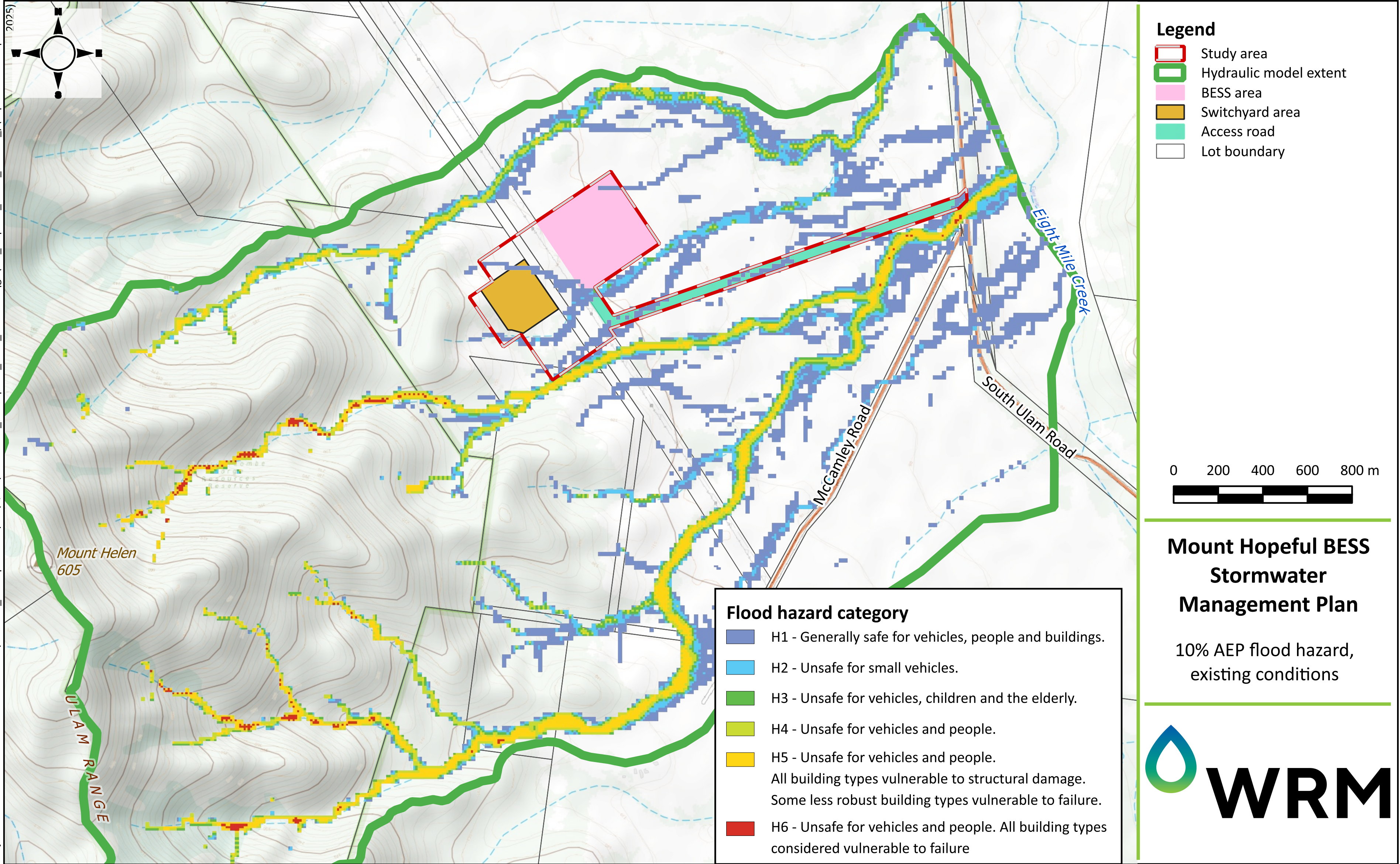

Mount Hopeful BESS Stormwater Management Plan

10% AEP flood hazard, existing conditions

WRM

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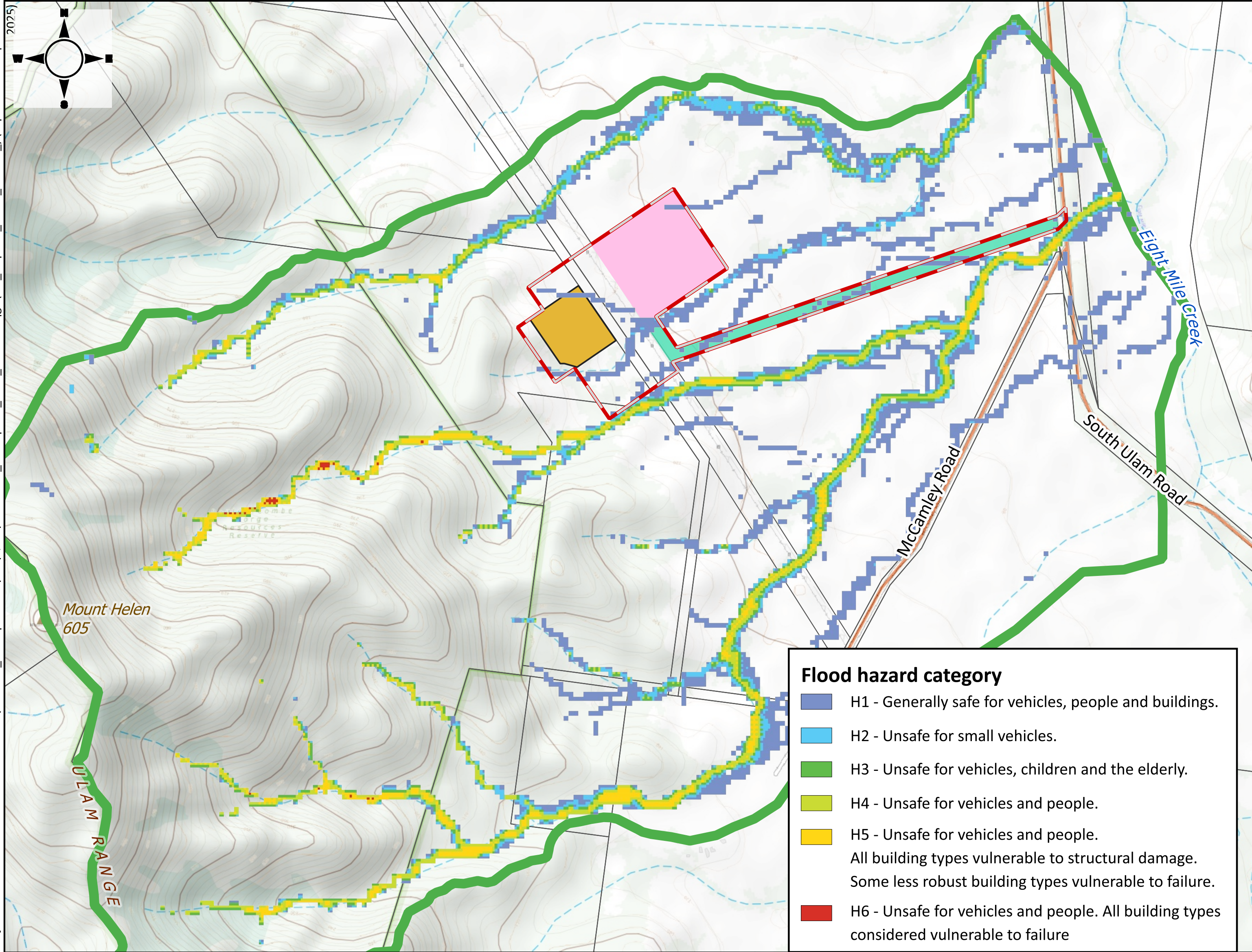

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Projection: EPSG:7856

Legend

- Study area
- Hydraulic model extent
- BESS area
- Switchyard area
- Access road
- Lot boundary

0 200 400 600 800 m

Mount Hopeful BESS Stormwater Management Plan

50% AEP flood hazard, existing conditions

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