



Werribee Junction PSP - Hydrologic Impact Assessment

Final Report

IS288300-RPT-002 | RevB

1 December 2020

Melbourne Water

This report should be used for information purposes only and should not be used for any decision making.

The flood mapping of the area may be different if updated today. New Climate Change modelling is now available that was not available when this report was prepared.



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Appendix B. Scenario 1a flood depth and extent maps

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Appendix D. Scenario 2b flood impact and extent maps

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Appendix F. Scenario 2c flood impact and extent maps

Appendix G. Scenario 2d flood impact and extent maps

Appendix H. Scenario 2e flood impact and extent maps

Appendix I. Scenario 3a flood impact and extent maps

Appendix J. Scenario 3b flood impact and extent maps

1. Introduction

Jacobs was commissioned by Melbourne Water Corporation (MW) to undertake a hydrological impact assessment for the Werribee Junction Precinct Structure Plan (PSP) area. The objectives of this assessment are:

- To define the catchment area.
- To define the expected changes to the catchment from development.
- Assessment of existing condition and future development scenarios.
- Provide flood flows at key locations in the PSP.
- Define existing conditions flood extents throughout the PSP for the 18.13% (0.2 EY), 10%, 5%, 2% and 1% Annual Exceedance Probability (AEP) events under both current and future (1% AEP only) climate conditions.
- Consideration of environmental constraints through integration with the 'Riparian Values Risk Assessment'.
- Developed condition flood extents for all modelled design flood events, with accompanying management options concept designs.

This assessment has been undertaken in accordance with the 2019 release of Australian Rainfall and Runoff (ARR 2019) (Ball, et al. 2019), Melbourne Water Corporation Flood Mapping Projects Guidelines and Technical Specifications (Tech Specs) (MW 2018) and the Interim RORB Notes for Precinct Structure Plans (MW 2019).

This report details the methodology and assumptions used to develop the flood model and presents the outcomes of the development scenario modelling.

1.1 Site and catchment description

The Werribee Junction PSP site (the Site) (Figure 1.1) is located west of Werribee between the Princes Freeway to the south and the Geelong-Melbourne railway line to the north. Bounding the Site on the east is the King's Leigh Estate, while the immediately north of the Geelong-Melbourne railway line is the Harpley Estate. Presently the Site consists of rural open space with limited low-density residential properties. At the west of the Site there is a large quarry and tip complex.

The Site can be categorised as a broad floodplain, and due to the small capacity of Lollypop Creek, Cherry Creek and Tributary of Cherry Creek, the floodplain is activated in frequent events. Hydraulically the Site is constrained by the Geelong-Melbourne railway line upstream and the Princes Freeway downstream.

Lollypop Creek, Cherry Creek and Tributary of Cherry Creek flow through the Site with a total catchment area of approximately 110 km². In flood events of 1% Annual Exceedance Probability (AEP) and greater on the Werribee River breakout flows enter Lollypop Creek via the Presidents Park floodway.

The majority of landuse in the catchments is rural conservation and some areas of the Lollypop Creek, Cherry Creek and Werribee River catchments are within the urban growth boundary and have recently been developed or will be in the near future. The towns of Bacchus Marsh, Wyndham Vale, Melton and the western portion of Werribee are also located in the catchment.

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0 0.5 1 km

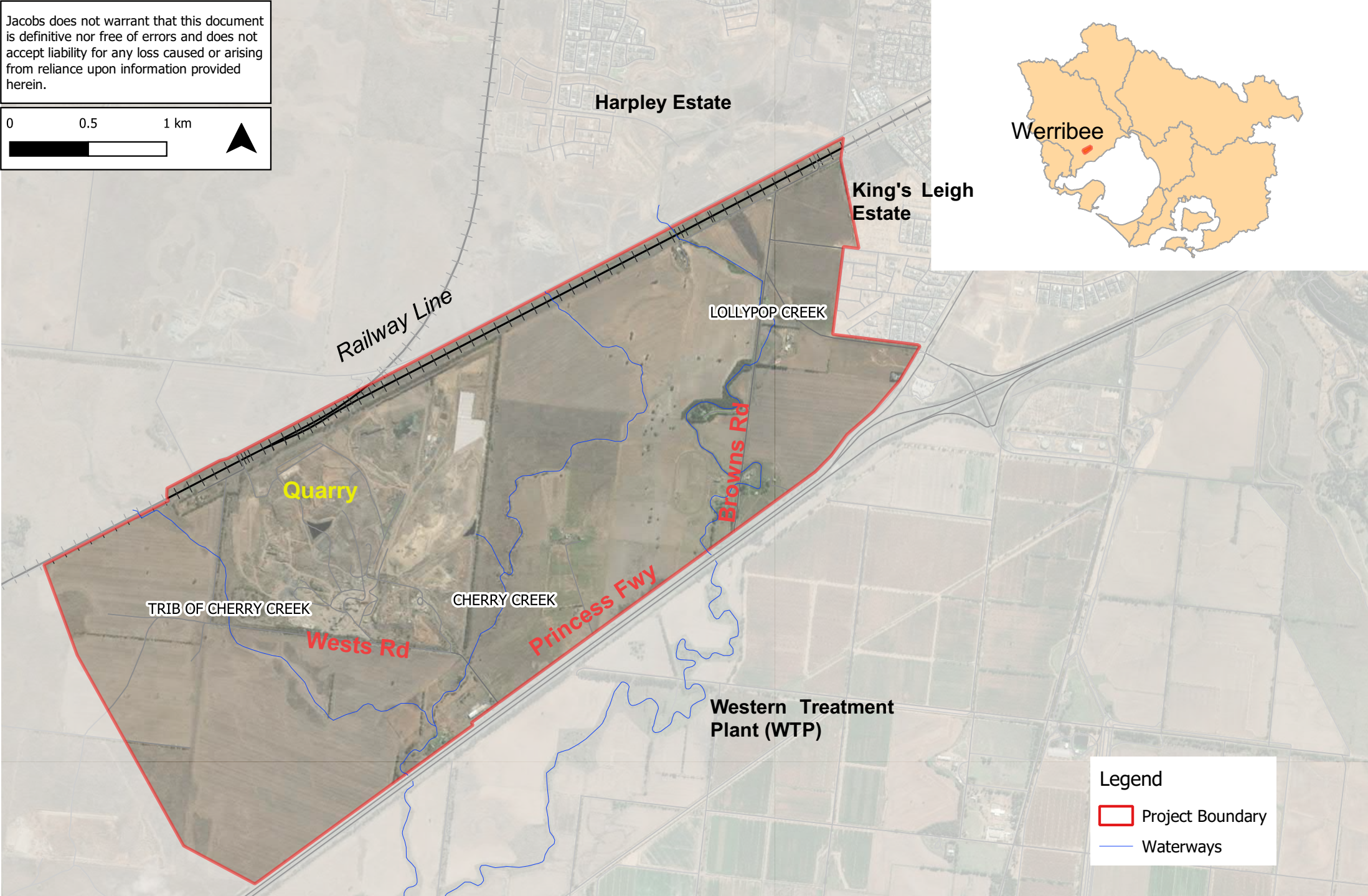


Figure 1.1: Site Location and Layout

2. Data collection and review

Table 2.1 details all data collected and reviewed for the assessment, including a description of its application in the assessment.

Table 2.1: Data collection and review

Dataset	Application
LiDAR DTM	- Catchment, sub-catchment and reach alignment definition for RORB modelling - Base topography for TUFLOW model - Captured in November 2017, will require alterations in TUFLOW to represent existing conditions development conditions
GIS Contours	Catchment, sub-catchment and reach alignment definition for RORB modelling
Aerial Photography (Summer and Spring 2018)	- Definition of fraction impervious - Identification of hydraulic features - GIS mapping
Drainage Scheme GIS Data	Identification of upstream drainage scheme areas and layouts/assets
PSP GIS Boundaries	Definition of study area
Railway Structure Survey	Details of drainage structures under railway for inclusion in the TUFLOW model
Ison Road TUFLOW Model	- Inputs into the TUFLOW model for the King's Leigh development area - Railway structure details from Lollypop Creek culverts/bridge east to for inclusion in the TUFLOW model
Western Treatment Plant 2016 Flood Model and Report	- Existing RORB models for review and update to provide inflow hydrographs - RORB model validation parameter documentation - Princes Freeway structure details for inclusion in the TUFLOW model
Victorian GIS Database	- Planning scheme zones for definition of fraction impervious - Cadastral (property), road and rail layers for GIS mapping
Streamflow Data	Werribee River at Werribee Diversion Weir streamflow records for flood frequency analysis
Surrounding Developments Hydrological Assessment/Design Data	- RORB models, drainage drawings and reports for retarding basins constructed or designed for upstream developments - Inputs into the TUFLOW model for the Harpley development area

2.1 Site visit

On the 24th of May 2019 Jacobs undertook a Site Visit with Melbourne Water representatives to:

- Gain an understanding of the Site and local catchments topography and hydrologic characteristics
- Identify and confirm the size of key hydraulic structures (road and rail structures)

- Confirm the type of vegetation and other materials present in the waterways and floodplain for determination of surface roughness in the hydraulic model
- Confirm status of upstream developments

3. Hydrologic modelling

Hydrologic modelling was undertaken using RORB for the purpose of calculating the probability of a given flood peak or flood quantile and generating inflow hydrographs for the TUFLOW hydraulic model (Section 4). A modified version of the RORB model, originally developed for the Western Treatment Plant Waterway Mapping – Final report (BMT WBM 2017), was used for the basis of this assessment. The model was validated against standard regional equations and an at-site flood frequency analysis (FFA) on the Werribee River at Werribee Diversion Weir gauge.

Due to the broad nature of the Site's floodplain and the Princes Highway acting as a downstream hydraulic control, critical flood events are likely to be driven by a combination of peak flow and hydrograph volume. Therefore, the critical events were determined using the TUFLOW model (refer to Section 5).

3.1 Model development

3.1.1 RORB version

RORB Version 6.45 was used for this assessment.

3.1.2 Catchment and sub-catchment definition

The catchment and sub-catchment boundaries were initially defined by the BMT WBM (2017) model for the Werribee River, Lollypop Creek, Cherry Creek and Tributary of Cherry Creek catchments. To represent current development conditions the Lollypop Creek and Cherry Creek sub-catchments were altered to represent current drainage paths in the Wyndham Vale area. Sub-catchments in the TUFLOW model extent were also altered to provide appropriate model inflows. To allow for parameters to be validated (refer to Section 3.2) interstation areas were included at each sub-catchment.

In addition, to the Werribee River, Lollypop Creek, Cherry Creek and Tributary of Cherry Creek catchments, sub-catchments covering the Site and downstream in the Western Treatment Plant were also included to provide local model inflows.

The catchment and sub-catchments are shown in Figure 3.1.

3.1.3 Reach types

The following reach types were used for this assessment:

- Reach Type 1 – natural channels
- Reach Type 2 – for excavated but unlined channels, flow paths across cleared land and flows through developed urban areas
- Reach Type 4 – drowned reaches used to represent permanent water bodies

Reach alignments are shown in Figure 3.1.

3.1.4 Storages

There are four major reservoirs in the Werribee River catchment; Pykes Creek, Merrimu, Djerriwarrh and Melton. These reservoirs were represented in RORB as storages, using storage-discharge and elevation-storage relationships, as per the BMT WBM (2017) modelling.

Following a review of the available data, it was determined that sufficient information was not available to represent the retarding basins associated with developments in the Wyndham Vale and Werribee areas. To not over estimate flows in these areas, pre-development fraction impervious values were adopted to represented

managed development outflows. Further discussion of the adopted fraction impervious values is provided in Section 3.1.6.

3.1.5 Diversions

Upstream of the Site, near the Werribee River Diversion Weir, there is a high flow breakout from the Werribee River into the Lollypop Creek catchment via the President Park floodway. The breakout was represented in RORB as a diversion (Inflow/Outflow), using the flow relationship adopted in BMT WBM (2017).

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0 0.5 1 km



Catchment extends North

Werribee River @ Werribee Diversion Weir Gauge
Presidents Park Floodway Diversion

Trib. Cherry Creek Interstation Area
Cherry Creek Interstation Area

Lollypop Creek Interstation Area

Werribee River Interstation Area

Legend

- Reach Alignment
- ▭ Project Boundary
- ▭ RORB Sub-catchment Boundary

Figure 3.1 :RORB Model Layout

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3.1.6 Fraction impervious

The fraction impervious (FI) values were determined using the planning scheme zones, cross checked against aerial photography. As per the Interim RORB Notes for Precinct Structure Plans. FI has been defined as total impervious area (TIA) in accordance with the values presented in Appendix M of the Tech Specs. The adopted FI values for each planning scheme zone are provided in Table 3.1.

Table 3.1: Adopted FIs

Planning Scheme Zone	Adopted FI
ACZ1	0.9
C1Z	0.9
CDZ1	0.6
FZ, FZ1, FZ2	0.1
GRZ1, GRZ2, GRZ3, NRZ1, NRZ2, NRZ3, NRZ4, NRZ5, RCZ1, UGZ, UGZ2, UGZ3, UGZ4, UGZ6, UGZ7, UGZ8, UGZ9, UGZ11, UGZ13, UGZ14	0.6
GWAZ, GWZ	0.1
INZ1, INZ2, INZ3	0.9
LDRZ, LDRZ1, RLZ, RLZ1, RLZ2, RLZ3, RLZ5	0.2
MUZ	0.7
PCRZ, PPRZ, PUZ1, RCZ, RCZ1, RCZ2, RCZ3, RCZ4, UFZ	0.05
PUZ2, PUZ5, PUZ6	0.7
PUZ3	0.8
PUZ4	0.75
PUZ7	0.05 – 0.9
RDZ1	0.8
RDZ2	0.7
SUZ1, SUZ2, SUZ3, SUZ4, SUZ6, SUZ7, SUZ8, SUZ9	0.05 – 0.75
TZ	0.4

3.2 Model parameter validation

The approach adopted for validation of the RORB model was detailed in the Werribee Junction PSP Flood Impact Assessment - Study Approach Report (IS288300-MEM-001-StudyApproach-RevA) and included validation of the K_c parameter against previous studies and regional K_c equations; and validation of losses against an at-site flood frequency analysis (FFA) at the Werribee River at Werribee Diversion Weir stream gauge.

3.2.1 K_c parameter

The RORB model used for BMT WBM (2017) was validated against Regional Flood Frequency Estimates (RFFE) and compared to regional K_c equations. Given the good agreement between the adopted K_c values and the regional K_c equations these K_c values were adopted for this study and using the K_c/D_{av} relationship for Cherry Creek and Catchment Outlet interstation areas, for the revised model schematisation. A comparison between the adopted K_c values, BMT WBM (2017) and regional K_c equations is shown in Table 3.2.

Table 3.2: Adopted K_c parameters comparison

Interstation Area	Adopted	BMT WBM (2017)	ARR Rainfall < 800 mm	RORB V6 Manual	Pearse et al. (2002)
Werribee River	72.6	72.6	54.6	82.6	92.9
Trib. of Cherry Creek	7.5	7.5	3.6	10.2	9.7
Cherry Creek	3.2	3.0	2.1	6.7	5.7
Lollypop Creek	23.7	23.7	8.4	19.6	24.2
Catchment Outlet	13.3	10.5	6.2	15.5	5.5

3.2.2 Loss values

The regional loss values from the ARR 2019 Data Hub vary significantly across the catchment. For example, the initial and continuing losses at Blackwood in the upper catchment are 29 mm and 3.7 mm/hr respectively compared to those at the Site of 5 mm and 0.6 mm/hr. To provide greater certainty around the adopted design event losses the following approach was used:

- **Initial Losses:** An initial loss of 20 mm was adopted. This value was adopted for BMT WBM (2017) and is within the limits of the ARR 2019 Data Hub regional losses and the Tech Spec recommended range of between 10-25 mm.

For the design modelling an allowance was made for median pre-burst rainfall depths. The adopted median pre-burst rainfall from the ARR 2019 Data Hub are shown in Table 3.3.

Table 3.3: Median pre-burst depths

Duration (hr)	Median Pre-burst Depth (mm)				
	0.2 EY	10% AEP	5% AEP	2% AEP	1% AEP
1.0	2.7	2.8	3.0	2.0	1.2
1.5	1.2	1.0	0.9	1.2	1.4
2.0	2.7	2.5	2.4	3.2	3.8
3.0	1.5	1.5	1.5	2.1	2.5
6.0	1.3	1.8	2.2	3.0	3.6
12	0.8	1.1	1.4	4.9	7.5
18	0.8	1.4	1.9	2.8	3.5
24	0.3	0.6	0.8	1.9	2.8
36	0.0	0.0	0.0	0.3	0.6
48	0.0	0.0	0.0	0.1	0.1
72	0.0	0.0	0.0	0.0	0.0

- **Continuing Losses:** The adopted continuing losses, shown in Table 3.4, were validated by comparing peak flows for each modelled AEP to the flood quantiles produced from the FFA for the Werribee River @ Werribee Diversion Weir (231204), stream gauge (refer to Section 3.2.2.1).

Table 3.4: Adopted continuing losses

AEP	Continuing Loss (mm/hr)
0.2 EY	1.2
10%	1.1
5%	1.1
2%	1.4
1%	1.7

3.2.2.1 Werribee River at Werribee Diversion Weir at-site flood frequency analysis

At-site FFA was undertaken at the Werribee River, Werribee Diversion Weir (231204). At-site FFA was completed in accordance to guidance outlined in ARR 2019 using the Bayesian Framework incorporated into the Flike software package.

This involved:

- Extracting the Annual Maximum series for the water year (January to December)
 - Fitting a statistical distribution in Flike using a Bayesian fitting technique
 - Censoring Probable Influential Low Flows (PILF)
- Prior parameter information from the RFFE model
- Producing flood quantiles (peak flows verses probability)

Streamflow for the Werribee Diversion Weir gauge was obtained from the Department of Environment, Land Water and Planning's Water Management Information System. Gauge records are available from 1946, however a continuous data series is only available from 1960 to 2018 (Figure 3.2). This provides a 59 year recorded of annual maximum flows.

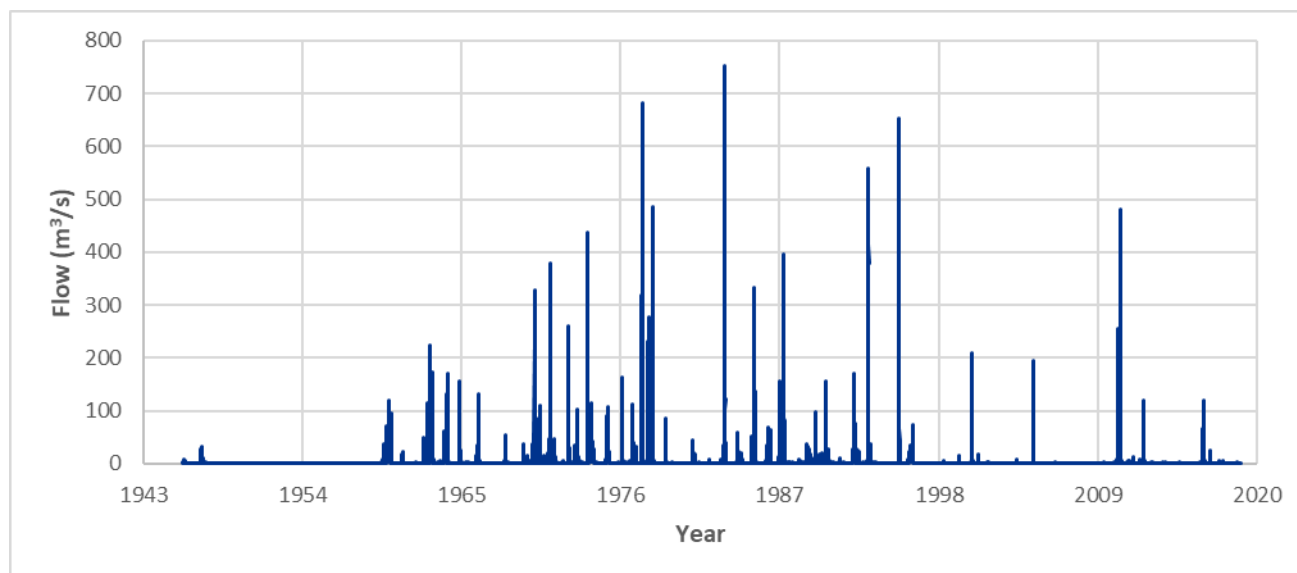


Figure 3.2: Werribee River at Werribee Diversion Weir flow series

From the observed values, PILFs were censored using multiple Grubbs Best Test (mGBt) within Flike. This procedure identified a threshold value of 45.3 m³/s, censoring 26 years of flood peaks.

Of the probability models available in Flike, the Log Pearson Type III (LP3) distribution gave the best to the recorded data in regards to the expected quantile fitting the recorded data with the tightest 90% confidence limits. The best fit was achieved without the use of prior parameters information from the RFFE model.

The resulting FFA is shown in Figure 3.3 and the resulting flow quantiles are shown in Table 3.5.

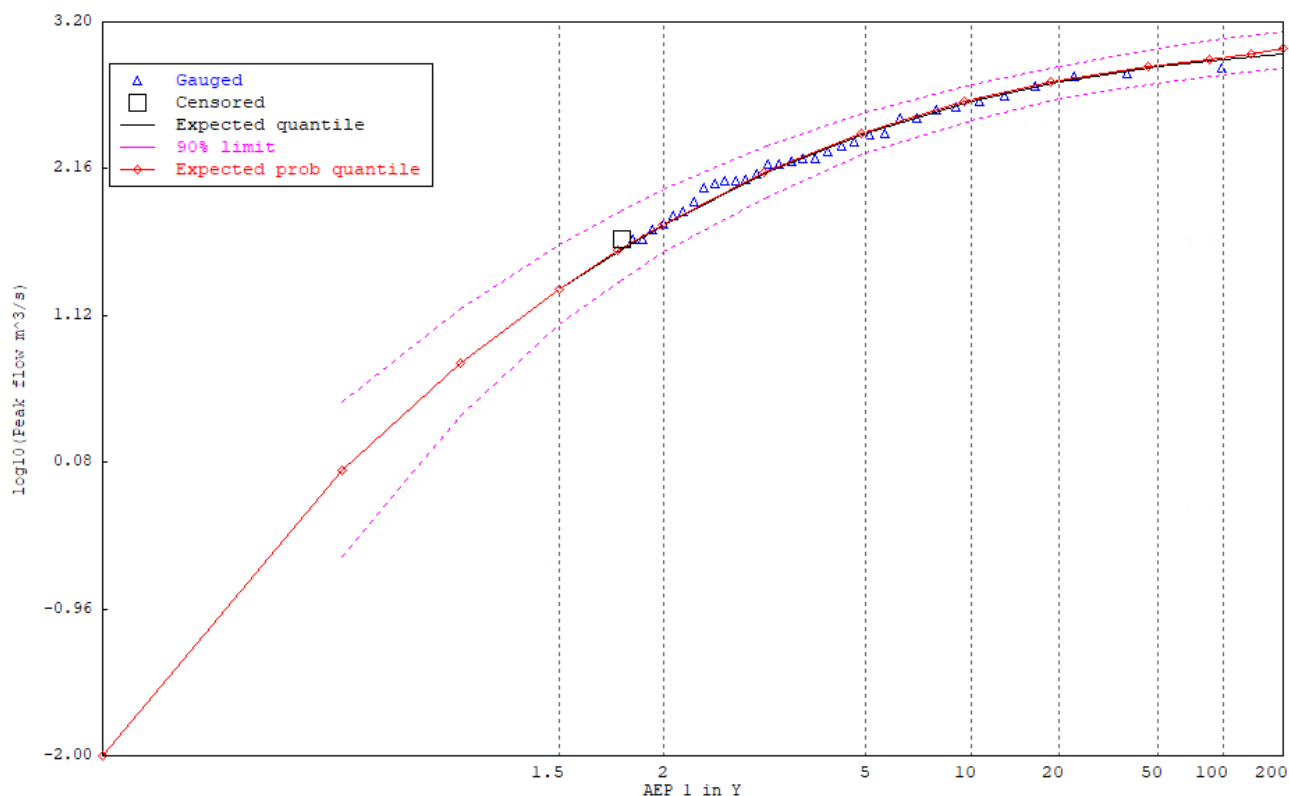


Figure 3.3: Flood Frequency Analysis for Werribee River at Werribee Diversion Weir

Table 3.5: Flood Frequency Analysis Quantiles for Werribee River at Werribee Diversion Weir

AEP	Expected Quantile (m ³ /s)	Lower 90% Confidence Limit (m ³ /s)	Upper 90% Confidence Limit (m ³ /s)
20%	257	186	363
10%	431	316	573
5%	592	458	766
2%	767	582	1020
1%	867	675	1197

3.3 Design storm event modelling

Design event modelling was undertaken for the 18.13%, 10%, 5%, 2% and 1% AEP events under both current and future (1% AEP only) climate conditions.

The Site is subject to flooding from two types of rainfall events:

- **Local Catchment** – Rainfall events centralised over the local catchments; Lollypop Creek, Cherry Creek and Tributary of Cherry Creek.
- **Werribee River Catchment** – Rainfall events centralised over the Werribee River Catchment resulting in cross-catchment flows via the Presidents Park floodway in conjunction with local catchment flows from; Lollypop Creek, Cherry Creek and Tributary of Cherry Creek.

Both above rainfall types were modelled in RORB with the critical events determined in TUFLOW (refer to Section 5).

3.3.1 IFD data

Intensity-Frequency-Duration (IFD) rainfall data was sourced from the Bureau of Meteorology's Design Rainfall Data System (2016) (www.bom.gov.au/water/designRainfalls/revised-ifd/) for both the local catchment and Werribee River catchment. The rainfall depths are presented in Appendix A.

Increased rainfall intensity under 2100 climate change conditions was calculated in accordance with the Tech Specs. The data for ARR 2019 Representative Concentration Pathway (RCP) 8.5 was extrapolated to 2100 for both the temperature and percentage increase in rainfall. The extrapolated temperature increase was 3.46 degrees and using equation 1.6.1 from ARR 2019 Chapter 6.35 (replicated below) the extrapolated rainfall intensity was 18.4% which was adopted for the climate change scenario.

$$p = 100(1.05^{\Delta T} - 1)\%$$

Where,

ΔT is the temperature increase to 2100

p is the percentage increase in rainfall intensity

3.3.2 Temporal patterns

Temporal patterns for the Southern Slopes (mainland) region were used. For storm durations 12 hours and longer areal temporal patterns were applied, while storms of duration less than 12 hours point temporal patterns were applied.

3.3.3 Areal reduction factors

Areal reduction factors the southern temporal zone were used.

To model areal reduction factors for the local catchment storm events, the RORB function to replace the total catchment area with the size of the local catchment was used. This allowed for local storm events to be modelled without having to establish a local catchment only RORB model and corresponding TUFLOW model. However, to not over-estimate flows in the Werribee River catchment during local catchment rainfall events, unintentionally activating the Presidents Park floodway artificially high losses were used for the Werribee River interstation area.

3.3.4 1% AEP RORB flows

The 1% AEP median temporal pattern and corresponding flows for each duration based on peak flow at the Lollypop Creek-Cherry Creek junction is presented in Table 3.6. Table 3.6 shows that the critical event derived from the RORB model is the 9-hour local catchment event.

Table 3.6: 1% AEP RORB Median temporal pattern flows at Lollypop Creek-Cherry Creek junction

Duration	Local Catchment		Werribee River Catchment ²	
	Temporal Pattern	Flow (m ³ /s)	Temporal Pattern	Flow (m ³ /s)
2 hr	25 ¹	110	-	-
3 hr	28 ¹	128	-	-
4.5 hr	27 ¹	157	-	-
6 hr	29 ¹	165	-	-
9 hr	24 ¹	174	-	-
12 hr	4	168	10	112
18 hr	10	149	8	114
24 hr	4	134	6	100
36 hr	6	104	6	89
48 hr	7	102	7	91
72 hr	3	72	3	73

¹ Point temporal patterns were used for shorter durations.

² Short duration Werribee River catchment flood events were not assessed.

4. Hydraulic modelling

TUFLOW, a fully 2D hydraulic modelling package with the ability to dynamically link 1D elements was adopted for this study. As shown in Figure 4.1 the model covers an area of approximately 24 km², extending beyond the Sites to incorporate the Harpley and King's Leigh Estates, the railway upstream and the Western Treatment Plant downstream.

4.1 TUFLOW version

TUFLOW version 2018-03-AD-iSP-w64 was used for this assessment. The model was run using TUFLOW Classic computational scheme.

4.2 Grid size and orientation

To balance the model run times whilst still providing an accurate representation of the creek channels, the model is based on a 5 m grid. Each square grid element contains information on ground topography sampled from the DEM at 2.5 m spacing, surface resistance to flow (Manning's n value) and initial water level. 1D elements were embedded in the 2D domain to represent culvert and drainage structures.

At least 4-5 grid cells across the catchment are recommended to allow for the accurate calculation of channel flow. There are channel widths in the model area smaller than 20 m, such as the modified section of Lollypop Creek, but they convey very little flow as the floodplain is activated in frequent flood events. Other major channels such as Cherry Creek and Lollypop Creek downstream of the Site through the Western Treatment Plant which convey a more significant volume of flows are wider with widths up to 50 m allowing for more than 4-5 grids across channel.

As there is no overarching physical orientation of the Site, for example a gridded road network, hence a north-south grid was adopted.

4.3 Topography

MW provided a 1 m gridded DEM of LiDAR captured in November 2017. The 2017 LiDAR data provided the base topography for the 2D model domain but was supplemented with the following topography modifications:

- TUFLOW terrain modifications (design DEM and 2d_zsh) for the Harpley Estate development (Spiire 2018)
- TUFLOW terrain modifications (design DEM and 2d_zsh) for the King's Leigh Estate development (Water Technology 2018)

Where required, the base topography was reinforced in TUFLOW using 3D breaklines.

4.4 Manning's 'n' coefficients

The roughness layer, or Manning's 'n' layer, is based on areas of different land-use types, which are determined from planning maps, aerial photography and site inspections. The adopted values are summarised in Table 4.1. The values used are based on the previous calibrated TUFLOW models (BMT WBM 2008), (Water Technology 2018) and (Spiire 2018), the Tech Spec and standard texts, originating from Chow (1959).

Table 4.1: 2D domain Manning's 'n' values

Land Use	Manning's 'n'
Open Space – unmaintained grass	0.045
Residential	0.400
Quarry	0.050
Roads	0.020
Railway	0.070
Waterway – minimal vegetation	0.035
Waterway – moderate vegetation	0.050
Waterway – heavy vegetation	0.060
Lakes – no vegetation	0.020
Constructed Wetland – submerged vegetation	0.030
Constructed Wetland – emergent vegetation	0.065
Constructed Waterway Reserve Edge	0.080

4.5 Hydraulic structures

There are many culvert structures located throughout model area, primarily under the railway and Princes Highway, and along the constructed waterways in the Harpley and King's Leigh Estates. These culverts were included in the model as embedded 1D elements. The flow through the structures has been assumed to be unimpeded by the presence of flood debris (there are no blockage factors applied to any structures).

There were also two bridge structures modelling in the Harpley Estate (Water Technology 2018). These structures were modelled in the 2D domain as 2D layered flow constrictions. The adopted form loss coefficients for the bridges were checked against the methodology outlined in AustRoads (1994).

4.6 Boundary conditions

External inflows were applied to the TUFLOW model at boundaries shown in Figure 4.1. These represent routed external inflows from the RORB model applied as 2D QT (flow-time) boundaries. Internal rainfall boundaries were applied to the model as SA (source-area) boundaries applied to the 2D domain (Figure 4.1). A combination of both routed and excess rainfall hydrographs are used for the internal flow boundaries depending on the distribution of flow to model across the RORB sub-catchments.

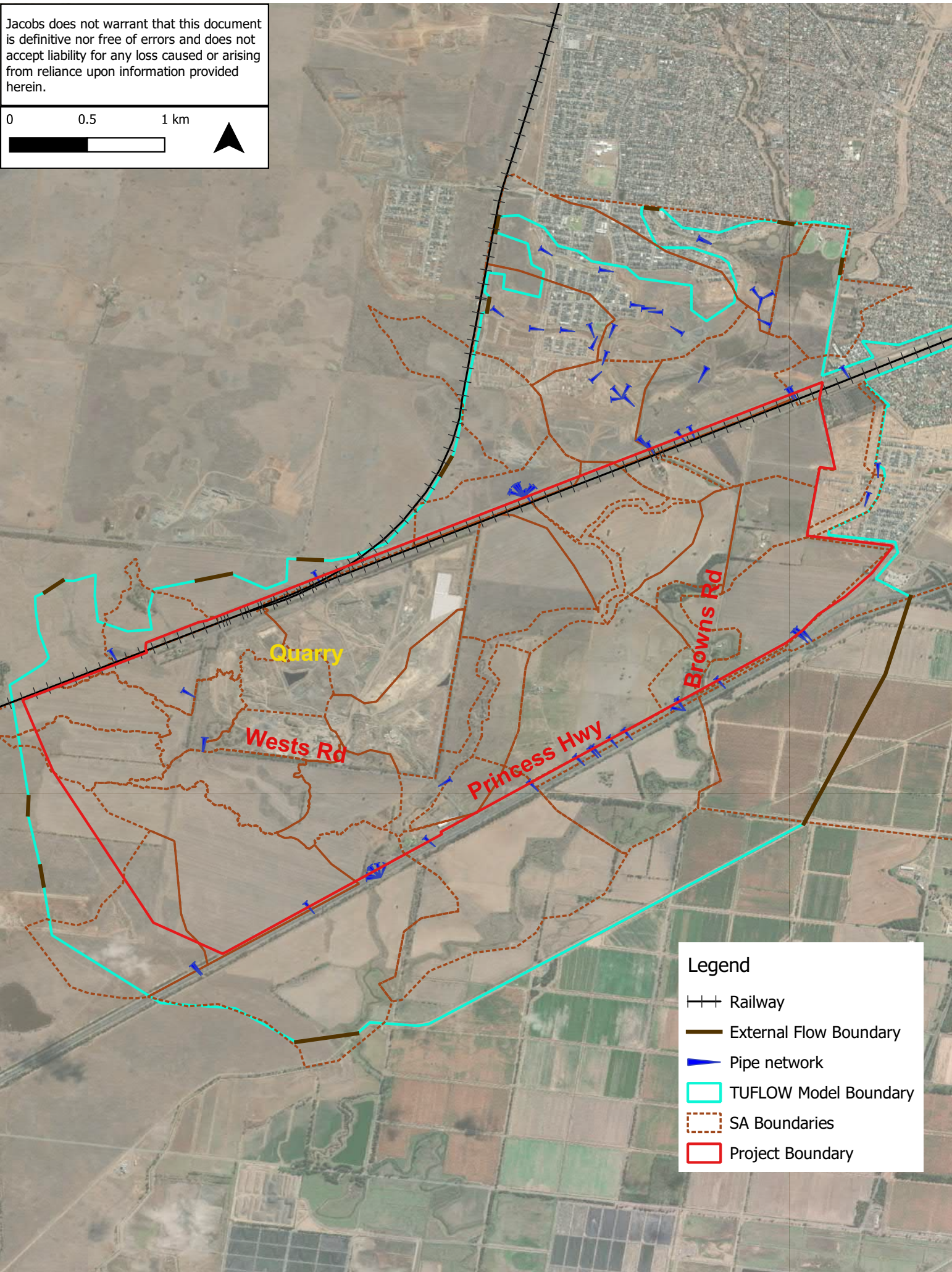
Automatically generated 2D HQ (height-flow) downstream boundaries are used. The downstream boundaries are located sufficiently downstream of the Site (Figure 4.1), to minimise the influence of boundary assumptions on the flood model results immediately downstream of the Site.

4.7 Initial water levels

Initial water levels were set in the Harpley Estate to model the operating water levels of the constructed waterway and wetland system. The initial water levels adopted were sourced from Water Technology (2018).

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0 0.5 1 km



Legend

- +—+— Railway
- External Flow Boundary
- Pipe network
- TUFLOW Model Boundary
- - - SA Boundaries
- Project Boundary

Figure 4.1 : TUFLOW Model Layout

Jacobs

5. Critical event selection

Both the local catchment and the Werribee River catchment flows were used in the determination of critical events.

Due to the broad nature of the Site's floodplain and Princes Highway acting as a downstream hydraulic control, critical flood events are likely to be driven by a combination of peak flow and hydrograph volume. Therefore, the TUFLOW model, as opposed to the RORB model, was used to determine the critical duration and temporal patterns using the following steps:

- 1) Model all temporal pattern for each duration both the local and whole catchment flood events in TUFLOW (the HPC engine was used as greater than 100 runs were required)
- 2) Create median temporal flood grids for each duration (local and whole of catchment) using the StatMedian function in ASC_to_ASC
- 3) Create maximum flood level grids by creating a maximum flood level envelop of the median temporal pattern grids
- 4) Interrogate the grids to determine the critical event (local or whole catchment), duration and temporal pattern

The above process was repeated for the 18.13% ,10%, 5%, 2%, 1% AEP events.

The maximum flood level envelops indicated that the local catchment 12-hour event was critical across the majority of the Site. As presented in Table 5.1 the temporal patterns 4 and 10 were critical for all events. For the 5% and 2% AEP events where two temporal patterns were identified as been critical across the catchment, both events have been model and mapped as maximum grids.

The sensitivity of the selected critical events was checked and for the 1% AEP event there was an area on Cherry Creek immediately downstream of the railway line where the 3 hour duration was critical but the difference between the 12 hour and 3-hour duration peak flood levels was less than 30 mm. As presented in Table 5.1, for the 1% AEP event medium flood level envelops indicated that temporal pattern 4 is the median across the majority of the Site. However, along Tributary of Cherry Creek temporal pattern 10 is the median temporal pattern, but there is less than 50 mm difference between the peak flood levels.

Table 5.1: Adopted critical events

Event	Duration	Temporal Pattern
18.13% Local Catchment	12 hour	10
10% Local Catchment	12 hour	10
5% Local Catchment	12 hour	4, 10
2% Local Catchment	12 hour	4, 10
1% Local Catchment	12 hour	4
1% + CC Local Catchment	12 hour	4

6. Scenario 1a - existing conditions modelling

The 1% AEP flood depth and extent map with flow direction arrows is presented in Figure 6.1, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix B.

6.1 Scenario 1a results

Figure 6.1 shows that in the 1% AEP event there is broad flooding across the Site on the east side of the quarry, while flooding in the Tributary of Cherry Creek to the west and south of the quarry is more confined. Outside of the creek channels, the 1% AEP flood depth is primarily below 0.5 m with the exception of areas of ponding behind the Princes Fwy.

The flow behaviour observed in the 1% AEP event is observed in the more frequent events, with Figure B.1 for the 18.13% AEP event highlighting that major breakout flows across the floodplain occur both side of Lollypop Creek.

6.1.1 1% AEP climate change impacts

The 1% AEP 2100 increase in rainfall intensity scenario results in a 13%, 17% and 18% increase in peak flow entering the site through the primary railway structures on Lollypop Creek, Cherry Creek and Tributary of Cherry Creek respectively. This results in an increase in peak flood level of 25-100 mm along the main creek flow paths. Where flow ponds on the floodplain behind Princes Freeway the increase in peak flood level is generally between 25-60 mm.

As shown in Figure B.7, in comparison to Figure B.5 the 1% AEP 2100 increase in rainfall intensity scenario does not significantly increase the flood extent across the site. The exception is the railway is overtopped at the Tributary of Cherry Creek rail crossing.

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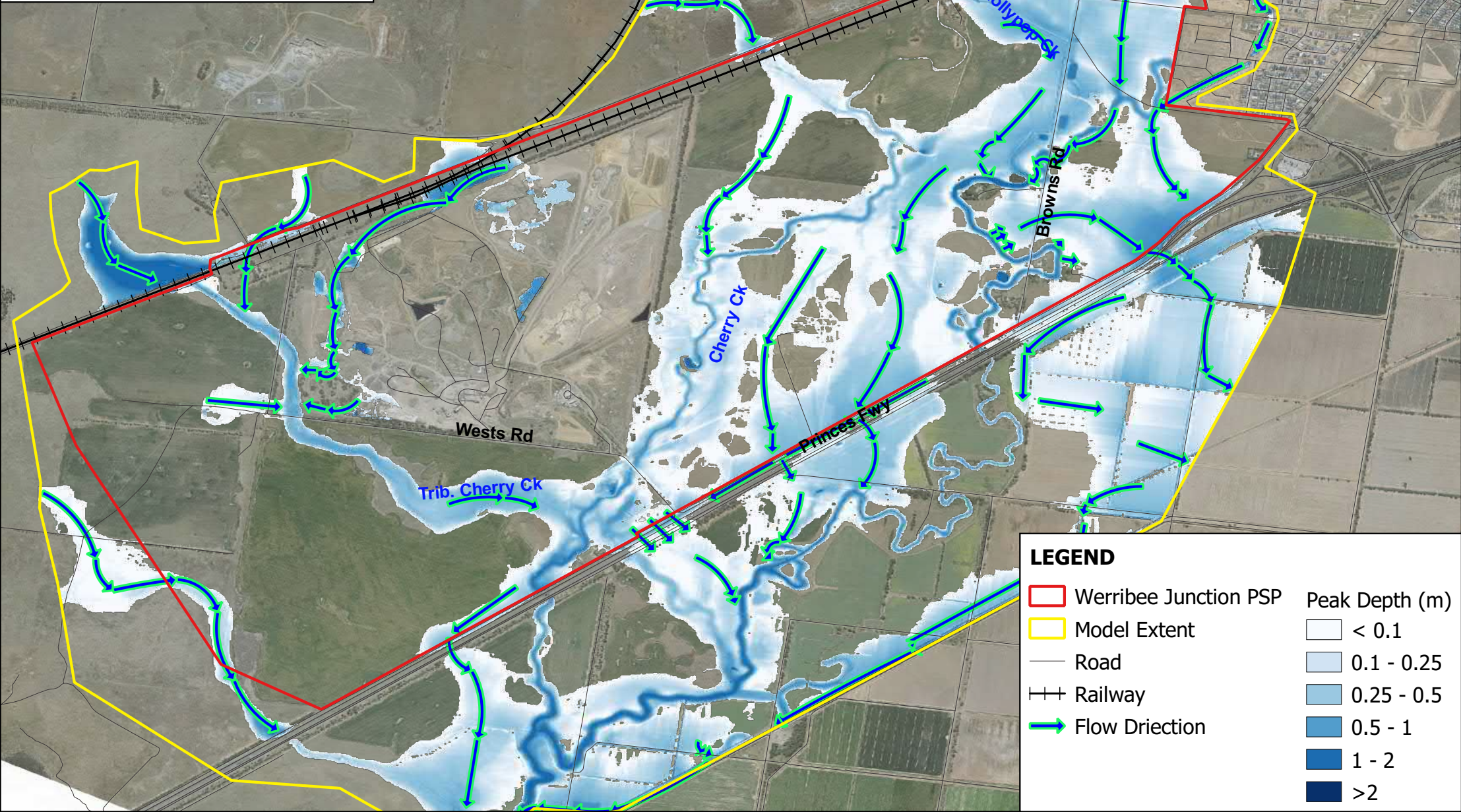
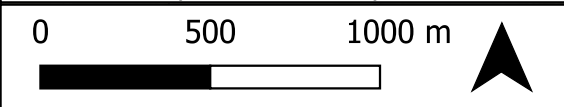


Figure 61.1: Scenario1a – 1% AEP Flood Depth and Extent

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7. Developed scenario modelling

Developed conditions scenario modelling has been undertaken for five scenarios:

- Scenario 2a – developed conditions flows
- Scenario 2b – developed conditions flows, Ison Road
- Scenario 2c – developed conditions flows, Ison Road, fill platform scenario 1
- Scenario 2d – developed conditions flows, Ison Road, fill platform scenario 2
- Scenario 2e – developed conditions flows, Ison Road, fill platform scenario 3
- Scenario 3a – developed conditions flows, Ison Road, fill platform scenario 4
- Scenario 3b – developed conditions flows, Ison Road, fill platform scenario 5

The details of each scenario are described in the following sections.

Following the integration meeting with riparian values assessment some key environmental considerations were identified:

- Cherry Creek is in good condition with high environmental values
- Due to channel re-alignment and degradation Lollypop Creek has low environmental values but provides fauna passage between the WTP and the waterways upstream of the Site
- There is a row of Red Gums running down the centre of the Site between Lollypop Creek and Cherry Creek
- Changes in the water cycle (water cycle modelling is beyond the scope of this assessment which focuses on are to extreme flood events) of the area degrade the riparian vegetation present both within the Site and downstream in the WTP

A fill platform buffer distance of 50 m on each bank for Lollypop Creek and Cherry Creek has been investigated. This is based on the Guidelines for Greenfield Development Areas within the Port Phillip and Westernport Region (MW 2013) for 4th order streams. Lollypop Creek and Cherry Creek could be considered 3rd order streams through the Site in which case a 30 m setback would be required. Please note that setbacks referenced above are minimum setbacks and for other site-specific reasons, a wider corridor may be appropriate (eg. managing flood storage, special landscape values, other unique values such as physical form, flora, fauna, etc).

The fill platforms have been modelled in TUFLOW with arbitrarily high levels to represent a 600 mm freeboard above the 1% AEP event. Considering the 5 m grid, no batter has been modelled for the fill platforms.

Development was not considered west of West Road as it is understood that this land is subject to potential expansion of the existing quarry.

7.1 Scenario 2a – developed conditions flows

7.1.1 Scenario 2a description

Scenario 2a represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area. The hydrologic and hydraulic elements of Scenario 2a are described in Table 7.1.

Table 7.1: Scenario 2a description

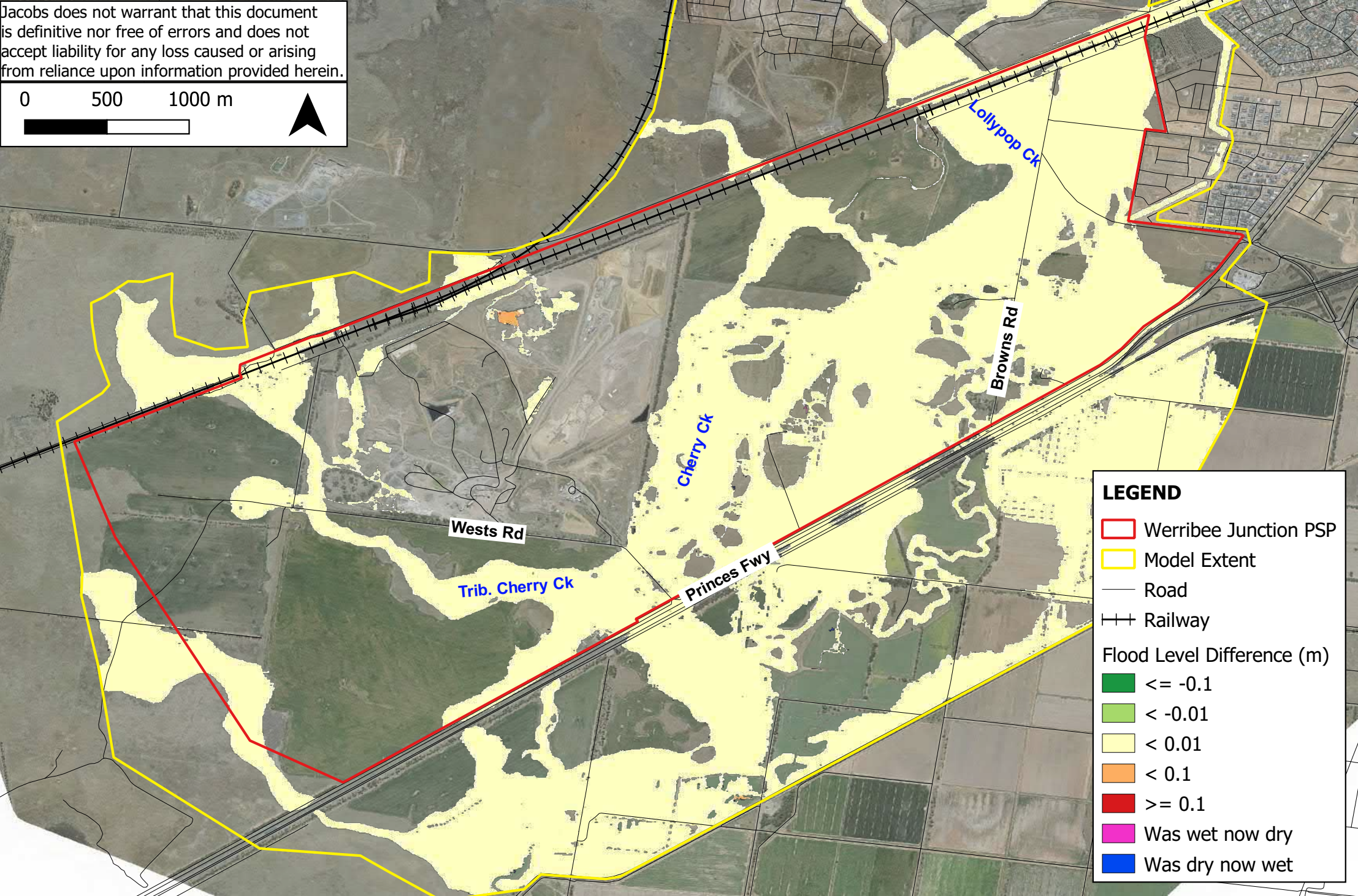
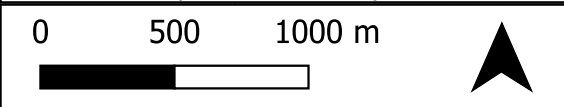
Element	Description
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.

7.1.2 Scenario 2a results

The Scenario 2a 1% AEP peak flood level impacts are shown in Figure 7.1, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix C.

As shown in Figure 7.1 the increase in impervious fraction results in minor increases in peak flood level across the Site with increases primarily below 10 mm. This is replicated in the other events, indicating that peak levels across the Site are controlled by upstream inflows rather than stormwater runoff within the Site. The impacts observed in the 18.13% (Figure C.1) and 10% (Figure C.2) AEP events in the WTP may be influenced by the model downstream boundary and reality be smaller as flow is spread across the entire WTP area.

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LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway

Flood Level Difference (m)

- ≤ -0.1
- < -0.01
- < 0.01
- < 0.1
- ≥ 0.1
- Was wet now dry
- Was dry now wet

Figure 7.1: Scenario 2a – 1% AEP flood level impacts

7.2 Scenario 2b - developed conditions flows, Ison Road

7.2.1 Scenario 2b description

Scenario 2b represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line. The layout of Scenario 2b is shown in Figure 7.2. The hydrologic and hydraulic elements of Scenario 2a are described in Table 7.2.

Table 7.2: Scenario 2b description

Element	Description				
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.				
Ison Road	Ison Road design as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) including the road surface and two culvert crossings: <table border="1"> <tr> <td>Culvert 1</td><td>9 3000 x 1500 mm Box Culverts</td></tr> <tr> <td>Culvert 2</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1	9 3000 x 1500 mm Box Culverts	Culvert 2	3 3000 x 1500 mm Box Culverts
Culvert 1	9 3000 x 1500 mm Box Culverts				
Culvert 2	3 3000 x 1500 mm Box Culverts				

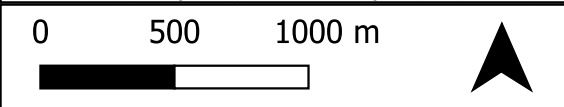
7.2.2 Scenario 2b results

The Scenario 2b 1% AEP peak flood level impacts are shown in Figure 7.2, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix D.

As shown in Figure 7.2 the Ison Road alignment blocks flows from Lollypop Creek breaking out across the floodplain east of Browns Road. This results in approximately an additional 15 m³/s being redistributed west towards Cherry Creek part of the floodplain resulting in significant 1% AEP flood level impacts across the Site and the WTP of up to 160 mm. This redistribution of flows to the west is observed across all modelled AEP events.

The 1% AEP flood level impacts described above are consistent with those documented in Spiire (2018).

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LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway
- Ison Road
- Culvert

Flood Level Difference (m)

- ≤ -0.1
- < -0.01
- < 0.01
- < 0.1
- ≥ 0.1
- Was wet now dry
- Was dry now wet

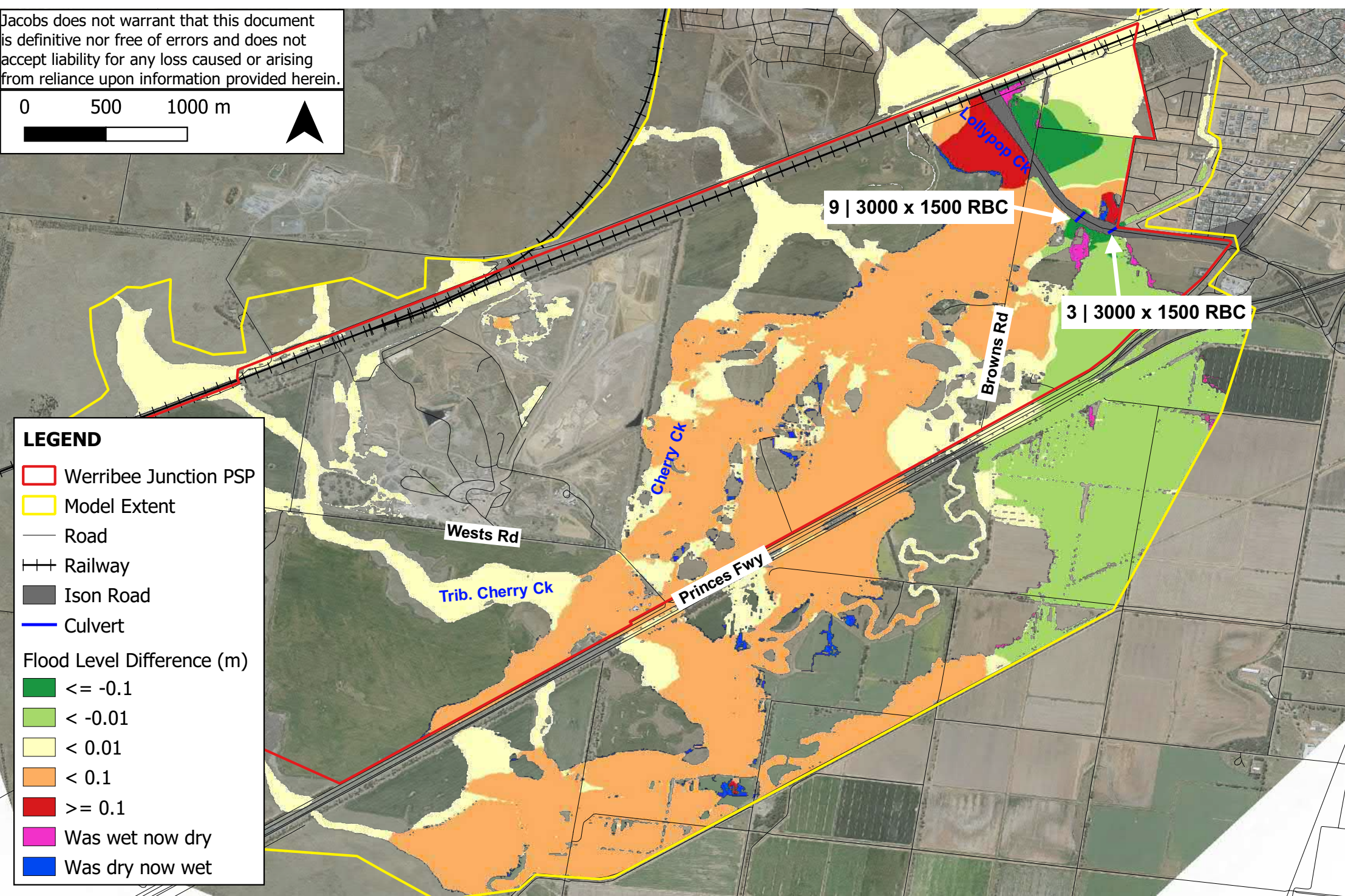


Figure 7.2: Scenario 2b – 1% AEP flood level impacts

7.2.3 Ison Road flood impacts mitigation

To reduce the flood impacts associate with Ison Road within the Site, an additional option has been assessed which consists of a floodway downstream of the Ison Road culverts to direct more flow to the eastern portion of the floodplain. The layout of Scenario 2b with additional mitigation works is shown in Figure 7.3. The hydrologic and hydraulic elements of Scenario 2a are described in Table 7.3.

Table 7.3: Scenario 2b with addition mitigation works description

Element	Description				
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.				
Ison Road	Ison Road design as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) including the road surface including two culvert crossings: <table border="1"> <tr> <td>Culvert 1</td><td>9 3000 x 1500 mm Box Culverts</td></tr> <tr> <td>Culvert 2</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1	9 3000 x 1500 mm Box Culverts	Culvert 2	3 3000 x 1500 mm Box Culverts
Culvert 1	9 3000 x 1500 mm Box Culverts				
Culvert 2	3 3000 x 1500 mm Box Culverts				
Floodways	The details of the floodway are: <table border="1"> <tr> <td>Floodway 1</td><td>A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.</td></tr> </table>	Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.		
Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.				

The Scenario 2b with mitigation 1% AEP peak flood level impacts are shown in Figure 7.3, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix E.

Figure 7.3 shows that floodway is successful in redistributing flows to the east mitigating the downstream impacts on the WTP. Figure E.2 shows that in the 10% AEP there are downstream increases in flood level in the Cherry Creek / Lollypop Creek channels of up to 24 mm.

To constrain flood level impacts within the road corridor, a significant increase in cross-drainage capacity would be required, or the road grade could be reduced at the expense of road immunity design requirements.

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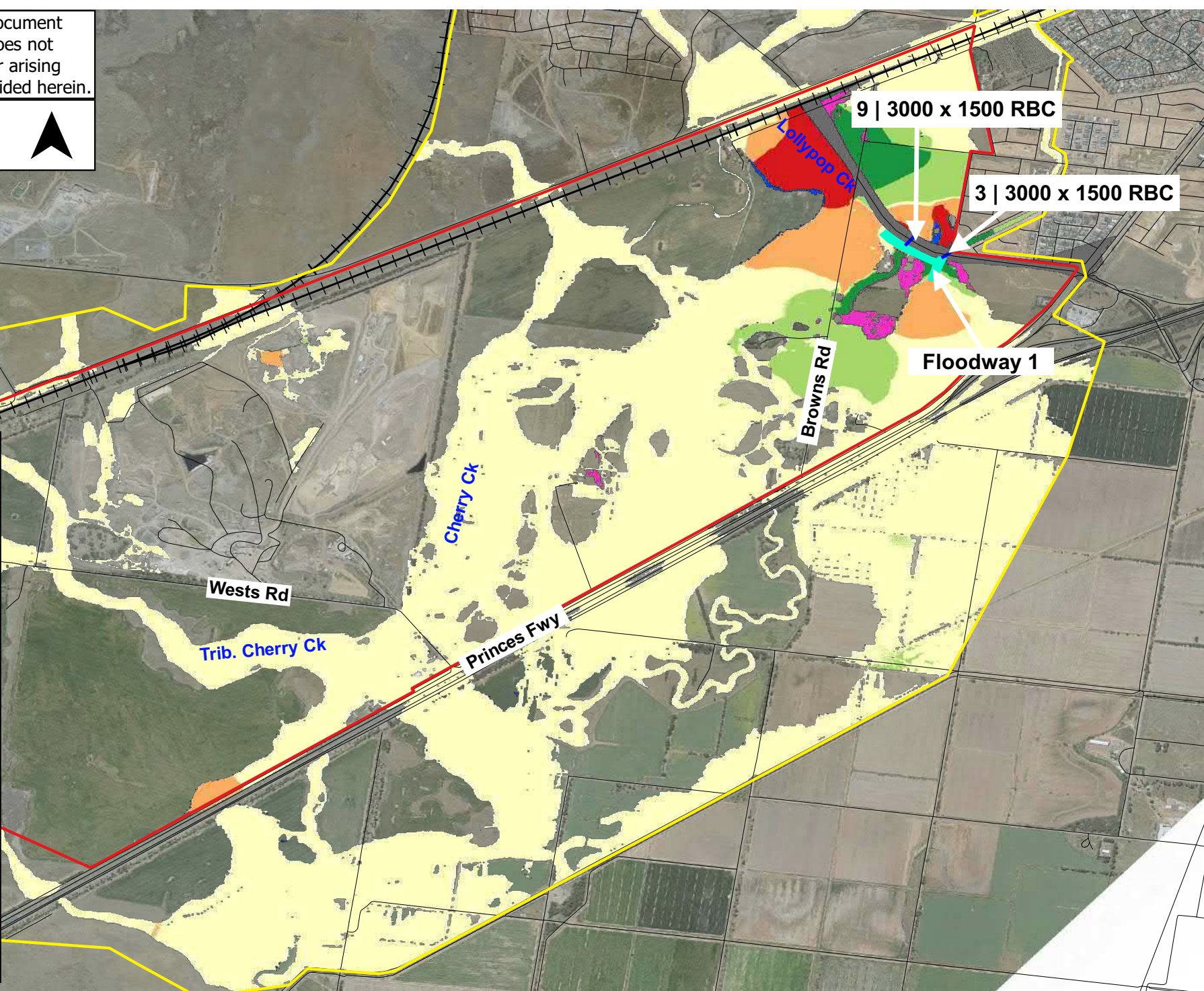
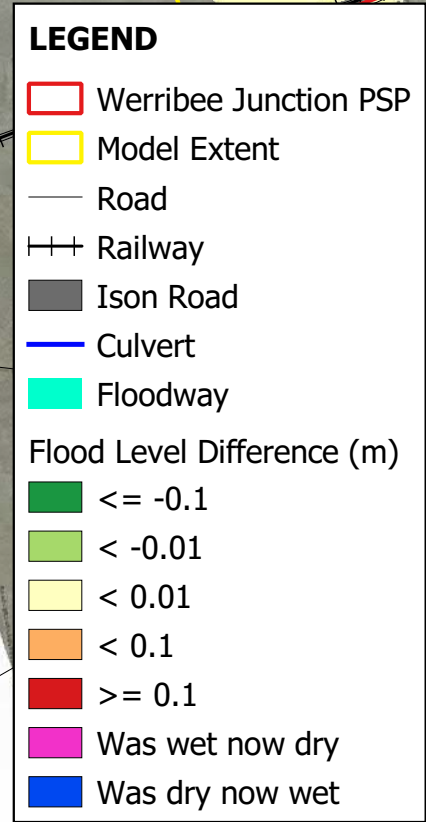
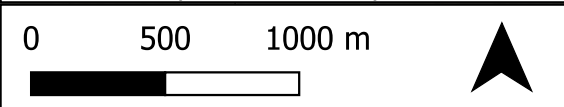


Figure 7-3: Scenario 2b Mitigation – 1% AEP flood level impacts

7.3 Scenario 2c – developed conditions flows, Ison Road, fill platform Scenario 1

7.3.1 Scenario 2c description

Scenario 2c represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line and fill platform Scenario 1. The layout of Scenario 2c is shown in Figure 7.4. The hydrologic and hydraulic elements of Scenario 2c are presented in Table 7.4.

Table 7.4: Scenario 2c description

Element	Description								
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.								
Ison Road	Ison Road design as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) including the road surface and two culvert crossings: <table border="1"> <tr> <td>Culvert 1</td><td>9 3000 x 1500 mm Box Culverts</td></tr> <tr> <td>Culvert 2</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1	9 3000 x 1500 mm Box Culverts	Culvert 2	3 3000 x 1500 mm Box Culverts				
Culvert 1	9 3000 x 1500 mm Box Culverts								
Culvert 2	3 3000 x 1500 mm Box Culverts								
Fill Platforms	Four fill platforms raised above the 1% AEP flood event located in the higher parts of the floodplain that either outside the 1% AEP flood extent or are subject to shallow flooding. The areas of the fill platforms are: <table border="1"> <tr> <td>Platform 1</td><td>65 ha</td></tr> <tr> <td>Platform 2</td><td>61 ha</td></tr> <tr> <td>Platform 3</td><td>43 ha</td></tr> <tr> <td>Platform 4</td><td>13 ha</td></tr> </table>	Platform 1	65 ha	Platform 2	61 ha	Platform 3	43 ha	Platform 4	13 ha
Platform 1	65 ha								
Platform 2	61 ha								
Platform 3	43 ha								
Platform 4	13 ha								
Storages	The details of the compensatory storage are: <table border="1"> <tr> <td>Storage 1</td><td>An offline compensatory storage of 57,000 m³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.</td></tr> </table>	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.						
Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.								
Floodways	The details of the floodway are: <table border="1"> <tr> <td>Floodway 1</td><td>A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.</td></tr> </table>	Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.						
Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.								

7.3.2 Scenario 2c results

The Scenario 2c 1% AEP peak flood level impacts are shown in Figure 7.4, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix F.

As shown in Figure 7.4, the additional flood storage and floodway have effectively mitigated the 1% AEP flood level impacts downstream in the WTP where the increases are restricted to 20 mm. The increases in peak flood level shown Figure 7.4 at the model outlet may be overestimated, as in reality the flow may spread across a larger area of the WTP.

In the 1% AEP flood event the floodway adjacent to Ison Road conveys 34.5 m³/s from the Lollypop Creek section of the floodplain to the eastern portion of the floodplain.

Figure F.1, Figure F.2 and Figure F.3 show that in the 18.13%, 10% and 5% AEP events respectively there are flood impacts downstream of the Site. To manage these impacts in more frequent events, outlet structures on the on the storage will require consideration for all flow events during detailed design.

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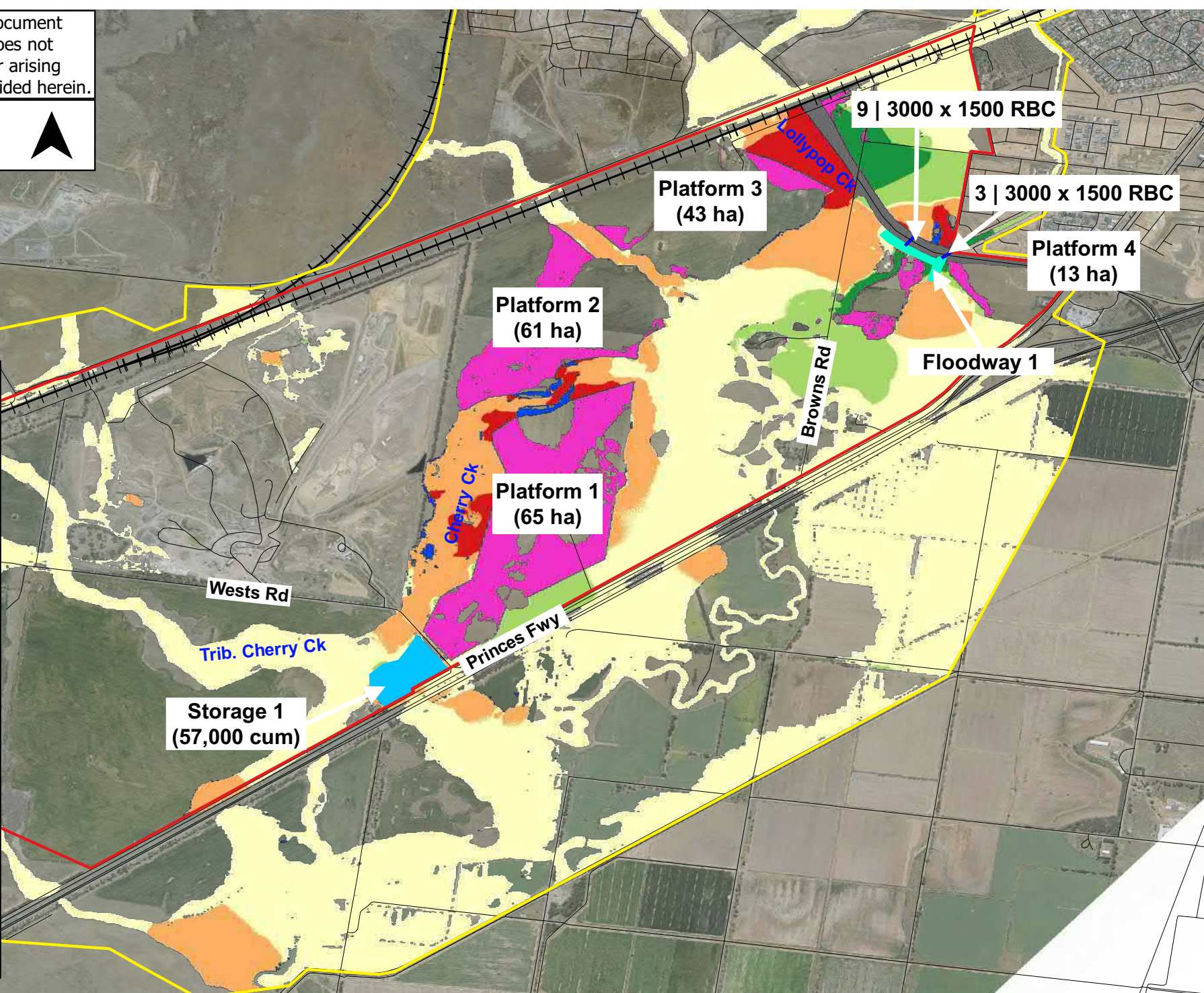
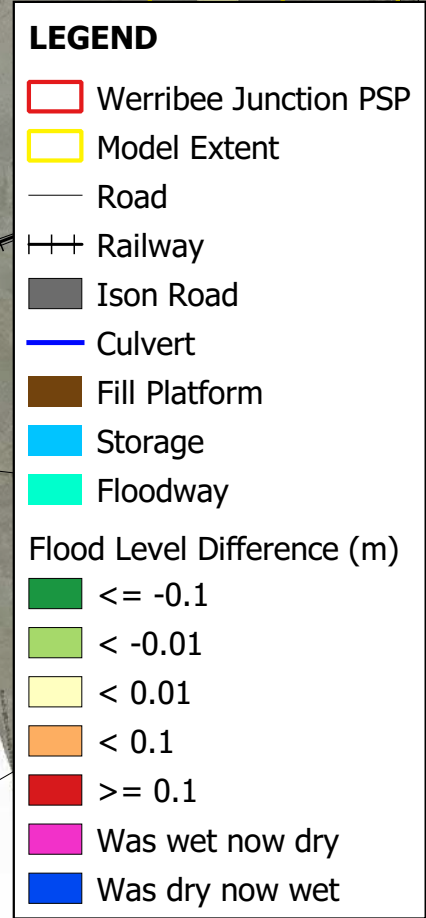
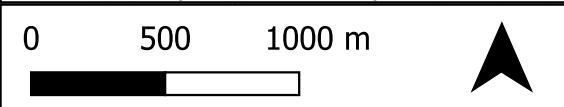


Figure 7.4: Scenario 2c – 1% AEP flood level impacts

7.4 Scenario 2d – developed conditions flows, Ison Road, fill platform Scenario 2

7.4.1 Scenario 2d description

Scenario 2d represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line and fill platform Scenario 2. The layout of Scenario 2d is shown in Figure 7.5. The hydrologic and hydraulic elements of Scenario 2d are presented in Table 7.5.

Table 7.5: Scenario 2d description

Element	Description										
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.										
Ison Road	Ison Road design as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) including the road surface and two culvert crossings: <table border="1"> <tr> <td>Culvert 1</td><td>9 3000 x 1500 mm Box Culverts</td></tr> <tr> <td>Culvert 2</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1	9 3000 x 1500 mm Box Culverts	Culvert 2	3 3000 x 1500 mm Box Culverts						
Culvert 1	9 3000 x 1500 mm Box Culverts										
Culvert 2	3 3000 x 1500 mm Box Culverts										
Fill Platforms	From Scenario 2c an additional fill platform (5) has been added between Ison Road and the King's Leigh Estate. Fill platforms 1 and 4 have also been extended into deeper areas of the floodplain requiring compensatory storage. The areas of the fill platforms are: <table border="1"> <tr> <td>Platform 1</td><td>69 ha</td></tr> <tr> <td>Platform 2</td><td>61 ha</td></tr> <tr> <td>Platform 3</td><td>43 ha</td></tr> <tr> <td>Platform 4</td><td>24 ha</td></tr> <tr> <td>Platform 5</td><td>42 ha</td></tr> </table>	Platform 1	69 ha	Platform 2	61 ha	Platform 3	43 ha	Platform 4	24 ha	Platform 5	42 ha
Platform 1	69 ha										
Platform 2	61 ha										
Platform 3	43 ha										
Platform 4	24 ha										
Platform 5	42 ha										
Storages	From Scenario 2c two additional compensatory storages are required. The details of the storages are: <table border="1"> <tr> <td>Storage 1</td><td>An offline compensatory storage of 57,000 m³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.</td></tr> <tr> <td>Storage 2</td><td>An offline storage of 37,000 m³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.</td></tr> <tr> <td>Storage 3</td><td>An offline storage of 132,000 m³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts.</td></tr> </table>	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.	Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.	Storage 3	An offline storage of 132,000 m ³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts.				
Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.										
Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.										
Storage 3	An offline storage of 132,000 m ³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts.										

Element	Description	
Floodways	From Scenario 2c an additional floodway has been added. The details of the floodways are:	
	Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.
	Floodway 2	A 60 m wide floodway to convey upstream flows entering the Site via the railway culverts (and overtopping the railway) north of the King's Leigh Estate around fill platform 5 to discharge under Ison Road. The alignment modelled was running along the eastern side of Ison Road, however the alignment is not critical, rather ensure a flow path is maintained through/around is important.

7.4.2 Scenario 2d results

The Scenario 2d 1% AEP peak flood level impacts are shown in Figure 7.5, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix G.

As shown in Figure 7.5 the additional flood storage and floodway have effectively mitigated the 1% AEP flood level impacts downstream in the WTP where the increases are restricted to 23 mm. The increases shown Figure 7.5 at the model outlet may be overstated as the model boundary is located at a narrow point of the Lollypop Creek floodplain and in reality the increases flow may spread across the broader floodplain downstream of the model extent resulting in smaller increases in flood level.

In the 1% AEP flood event the floodway between Ison Road and Platform 5 conveys 19.8 m³/s.

Figure G.2 and G.3 show that in the 10% and 5% AEP events respectively that there are flood impacts in the WTP downstream of Storage 2. To manage these impacts in more frequent events, outlet structures on the on the storage will require consideration for all flow events during detailed design.

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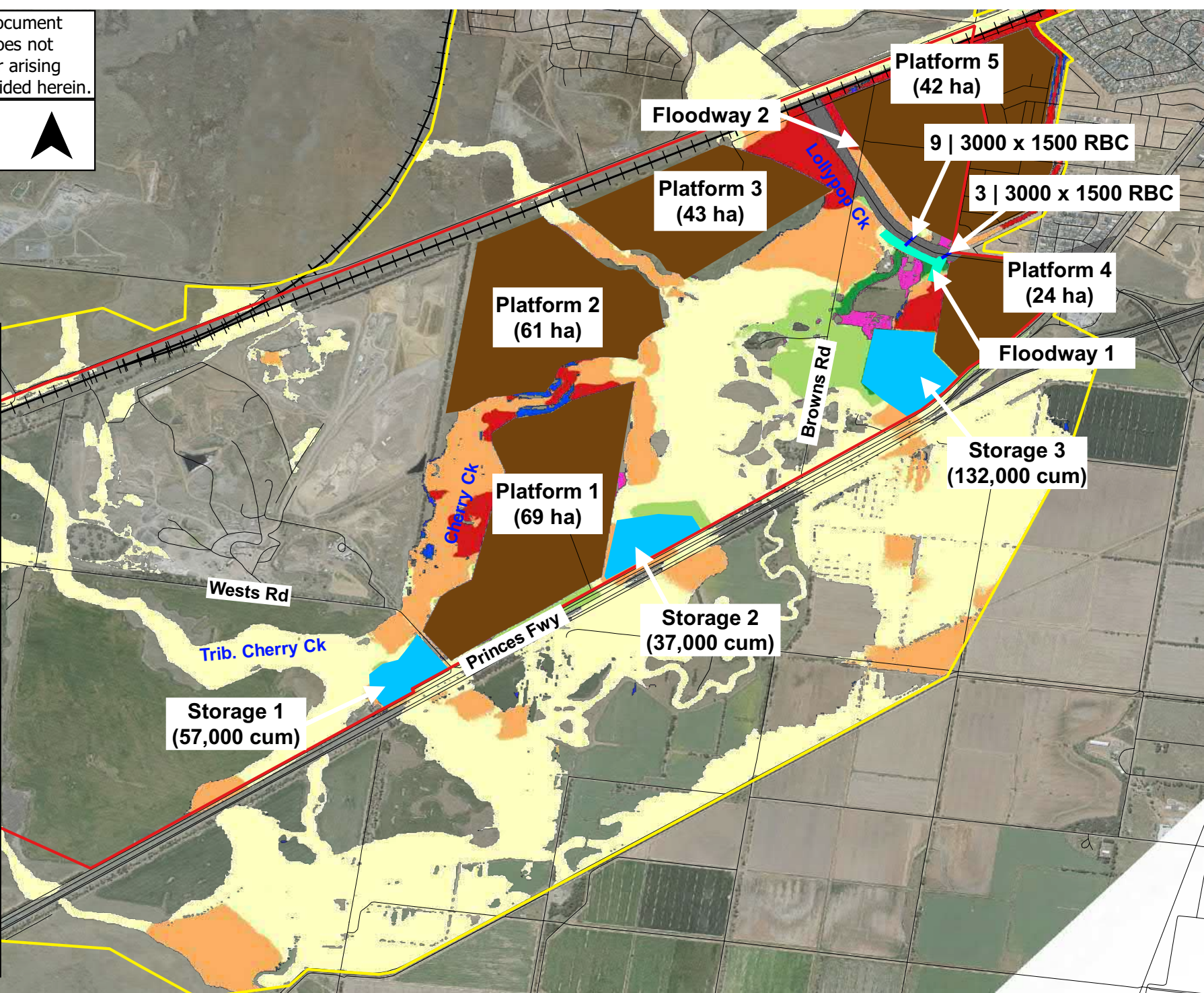
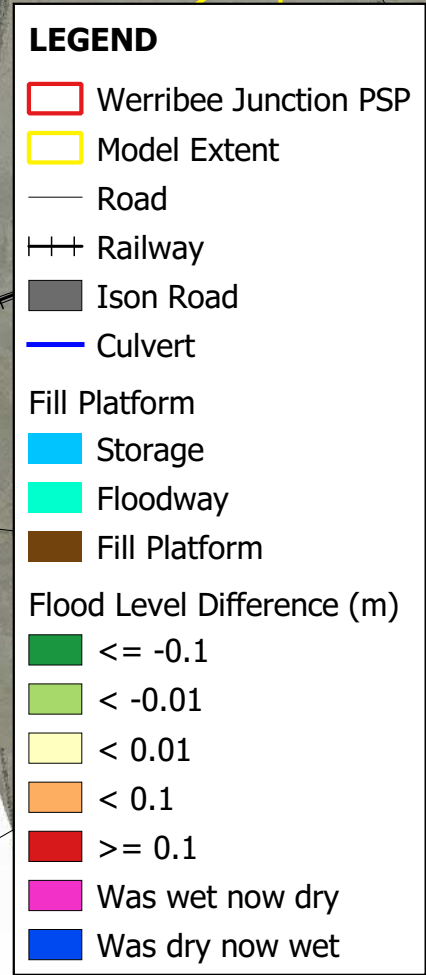
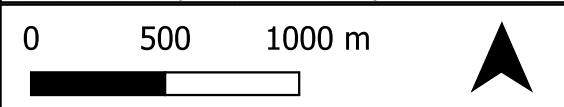


Figure 7.5: Scenario 2d – 1% AEP flood level impacts

7.5 Scenario 2e – developed conditions flows, Ison Road, fill platform Scenario 3

7.5.1 Scenario 2e description

Scenario 2e represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line and fill platform Scenario 3. The layout of Scenario 2e is shown in Figure 7.6. The hydrologic and hydraulic elements of Scenario 2e are presented in Table 7.6.

Table 7.6: Scenario 2e description

Element	Description										
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.										
Ison Road	Ison Road design as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) including the road surface and two culvert crossings: <table border="1"> <tr> <td>Culvert 1</td><td>9 3000 x 1500 mm Box Culverts</td></tr> <tr> <td>Culvert 2</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1	9 3000 x 1500 mm Box Culverts	Culvert 2	3 3000 x 1500 mm Box Culverts						
Culvert 1	9 3000 x 1500 mm Box Culverts										
Culvert 2	3 3000 x 1500 mm Box Culverts										
Fill Platforms	From Scenario 2d Platforms 1 and 4 have also been further extended. The areas of the fill platforms are: <table border="1"> <tr> <td>Platform 1</td><td>78ha</td></tr> <tr> <td>Platform 2</td><td>61 ha</td></tr> <tr> <td>Platform 3</td><td>43 ha</td></tr> <tr> <td>Platform 4</td><td>35 ha</td></tr> <tr> <td>Platform 5</td><td>42 ha</td></tr> </table>	Platform 1	78ha	Platform 2	61 ha	Platform 3	43 ha	Platform 4	35 ha	Platform 5	42 ha
Platform 1	78ha										
Platform 2	61 ha										
Platform 3	43 ha										
Platform 4	35 ha										
Platform 5	42 ha										
Storages	From Scenario 2c two additional compensatory storages are required. The details of the storages are: <table border="1"> <tr> <td>Storage 1</td><td>An offline compensatory storage of 57,000 m³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.</td></tr> <tr> <td>Storage 2</td><td>An offline storage of 37,000 m³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.</td></tr> <tr> <td>Storage 3</td><td>An offline storage of 245,000 m³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund</td></tr> </table>	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.	Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.	Storage 3	An offline storage of 245,000 m ³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund				
Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.										
Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts.										
Storage 3	An offline storage of 245,000 m ³ is required to compensate for extending Platform 4. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund										

Element	Description	
		is also required to the west of the storage to ensure breakout flows from Lollypop Creek are directed into the storage.
	Storage 4	The extension of Platform 1 east directs additional flow down Cherry Creek. To compensate the area between the quarry and Cherry Creek providing an additional 44,000 m³ of floodplain storage. This involves re-grading the floodplain to a level of 13.25 m AHD, resulting in cut of the floodplain up to 1.5 m but generally in the order of 0.4 – 0.6 m.
Floodways	From Scenario 2c an additional floodway has been added. The details of the floodways are:	
	Floodway 1	A 40 m wide floodway to direct the flows blocked by Ison Road back into the eastern portion of the floodplain to discharge through the large bank of culverts under the Princes Freeway under the Princes Highway interchange. The purpose of the floodway is to remove the highpoint created by the old perched waterway east of Browns Road allowing flows from Lollypop Creek and the Ison Road culverts to into the eastern part of the floodway.
	Floodway 2	A 60 m wide floodway to convey flow across the railway line north of the King’s Leigh Estate around fill platform 5 to discharge under Ison Road. The alignment modelled was running along the eastern side of Ison Road, however the alignment is not critical, rather ensure a flow path is maintained through/around is important.

7.5.2 Scenario 2e results

The Scenario 2d 1% AEP peak flood level impacts are shown in Figure 7.6, while the full suite of flood depth mapping for the 18.13% ,10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix H.

As shown in Figure 7.6 the additional flood storage and floodway have effectively mitigated the 1% AEP flood level impacts downstream in the WTP where the increases are restricted to 22 mm. The increases shown Figure 7.5 at the model outlet may be overstated as the model boundary is located at a narrow point of the Lollypop Creek floodplain and in reality the increases flow may spread across the broader floodplain downstream of the model extent resulting in smaller increases in flood level.

Figure H.2 and H.3 show that in the 10% and 5% AEP events respectively that there are flood impacts in the WTP along the Lollypop Creek/Cherry Creek. Figure H.3 and H.4 show that in the 5% and 2% AEP events respectively there also a minor redistribution of flow across the WTP on the eastern side of the site.

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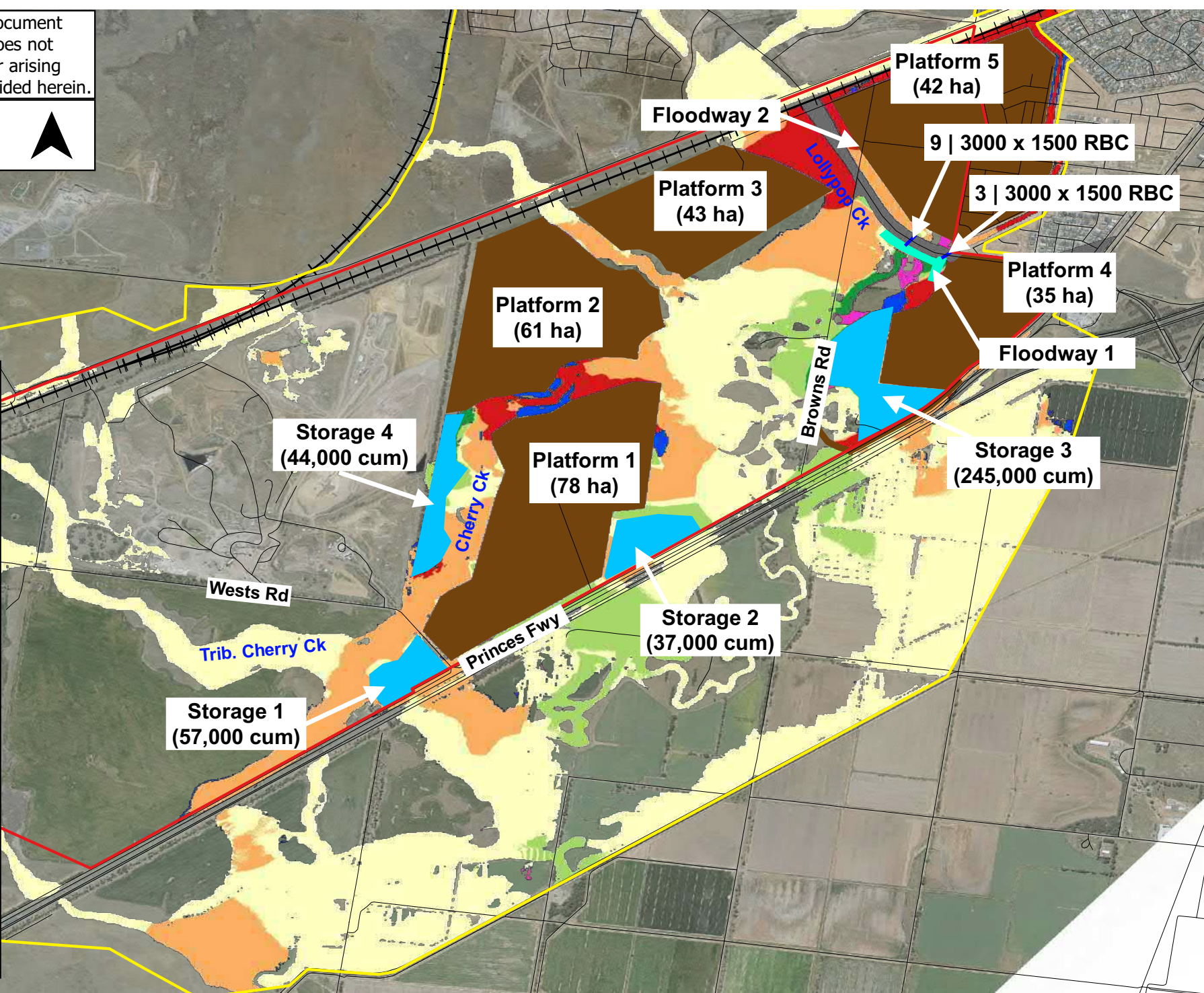
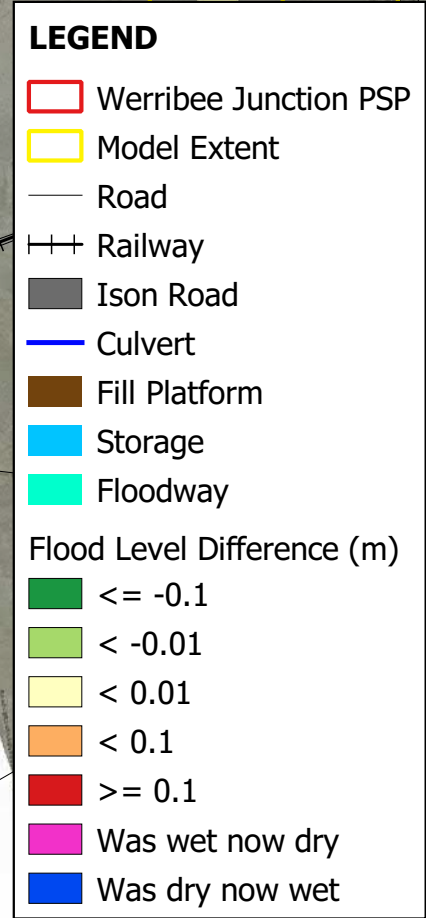
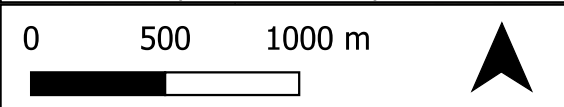


Figure 7.6: Scenario 2e – 1% AEP flood level impacts

7.6 Scenario 3a - developed conditions flows, Ison Road, fill platform Scenario 4

7.6.1 Scenario 3a description

Scenario 3a represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line and fill platform Scenario 4. Fill platform 4 involves a larger platform for Platforms 3, 4 and 5 and an additional platform 6. Specifically, this scenario includes the channelization of Lollypop Creek adjacent to Browns Road.

The layout of Scenario 3a is shown in Figure 7.7. The hydrologic and hydraulic elements of Scenario 3a are presented in Table 7.7.

Table 7.7: Scenario 3a description

Element	Description												
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.												
Ison Road	Ison Road design road surface as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) and revised culvert crossings to account for the extension of Fill Platform 5 to abut Ison Road: <table> <tr> <td>Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.</td><td>10 3000 x 2100 mm Box Culverts</td></tr> <tr> <td>Culvert 2 – Unchanged from Spiire (2018)</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.	10 3000 x 2100 mm Box Culverts	Culvert 2 – Unchanged from Spiire (2018)	3 3000 x 1500 mm Box Culverts								
Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.	10 3000 x 2100 mm Box Culverts												
Culvert 2 – Unchanged from Spiire (2018)	3 3000 x 1500 mm Box Culverts												
Fill Platforms	From Scenario 2e Platforms 3 and 5 have been extended while Platform 6 has been added with a corresponding reduction in Platform 4 to account for a floodway. The areas of the fill platforms are: <table> <tr> <td>Platform 1</td><td>78ha</td></tr> <tr> <td>Platform 2</td><td>61 ha</td></tr> <tr> <td>Platform 3</td><td>51 ha</td></tr> <tr> <td>Platform 4</td><td>32 ha</td></tr> <tr> <td>Platform 5</td><td>49 ha</td></tr> <tr> <td>Platform 6</td><td>20 ha</td></tr> </table>	Platform 1	78ha	Platform 2	61 ha	Platform 3	51 ha	Platform 4	32 ha	Platform 5	49 ha	Platform 6	20 ha
Platform 1	78ha												
Platform 2	61 ha												
Platform 3	51 ha												
Platform 4	32 ha												
Platform 5	49 ha												
Platform 6	20 ha												
Storages	From Scenario 2e Storage 3 has been revised to accommodate the revisions in Fill Platforms 3 to 6. The details of the storages are: <table> <tr> <td>Storage 1</td><td>An offline compensatory storage of 57,000 m³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.</td></tr> <tr> <td>Storage 2</td><td>An offline storage of 37,000 m³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m</td></tr> </table>	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.	Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m								
Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.												
Storage 2	An offline storage of 37,000 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m												

Element	Description	
		deep) which allows it to freely discharge into the existing Princes Freeway culverts.
	Storage 3	An offline storage of 257,000 m ³ is required to compensate for extending Platform 4 and 6 and manage flows from the Browns Road floodway. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund is also required to the west of the storage to ensure breakout flows from Lollypop Creek are directed into the storage.
	Storage 4	The extension of Platform 1 east directs additional flow down Cherry Creek. To compensate the area between the quarry and Cherry Creek providing an additional 44,000 m ³ of floodplain storage. This involves re-grading the floodplain to a level of 13.25 m AHD, resulting in cut of the floodplain up to 1.5 m but generally in the order of 0.4 – 0.6 m.
Floodways	The floodways developed for Scenario 3a represent a change methodology from Scenario 2e, where the reaches of Lollypop Creek that have historically been altered from natural conditions have been channelised. The details of the floodways are:	
	Floodway 1	A 40 m wide floodway between Fill Platforms 4 and 6 to convey flows from the Kingleigh Estate floodway (via the Ison Road culverts) to Storage 3. The floodway has been modelled with a constant grade between the Culvert 2 inverts (~16.3 m AHD) to the Storage 3 invert (13.1 m AHD).
	Floodway 2	A 40 m wide floodway from the Lollypop Creek culverts under the railway along the north-eastern edge of Fill Platform 3. From the south-eastern corner of Fill Platform 3 (Ison Road – Browns Road intersection) the width of the channel is reduced to 10 m where it runs along the west side of Browns Road and discharges into Storage 3. The reduction in channel width ensures that flows breakout of the channel and activate the floodplain. A low flow channel has also been included to connect the new channelised section of Lollypop Creek into the existing “natural” Lollypop Creek channel through the lower portion of the floodplain.

7.6.2 Scenario 3a results

The Scenario 3a 1% AEP peak flood level impacts are shown in Figure 7.7, while the full suite of flood depth mapping for the 18.13%, 10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix I.

As shown in Figure 7.7 there are broad flood level impacts across WTP downstream of the Princes Highway major culvert crossing on the east of the site of up 30 mm, but generally under 20 mm. This is as a result of the channelisation of Lollypop Creek diverting more flow to the east, via Storage 3. This is replicated in all modelled design flood events (Appendix I).

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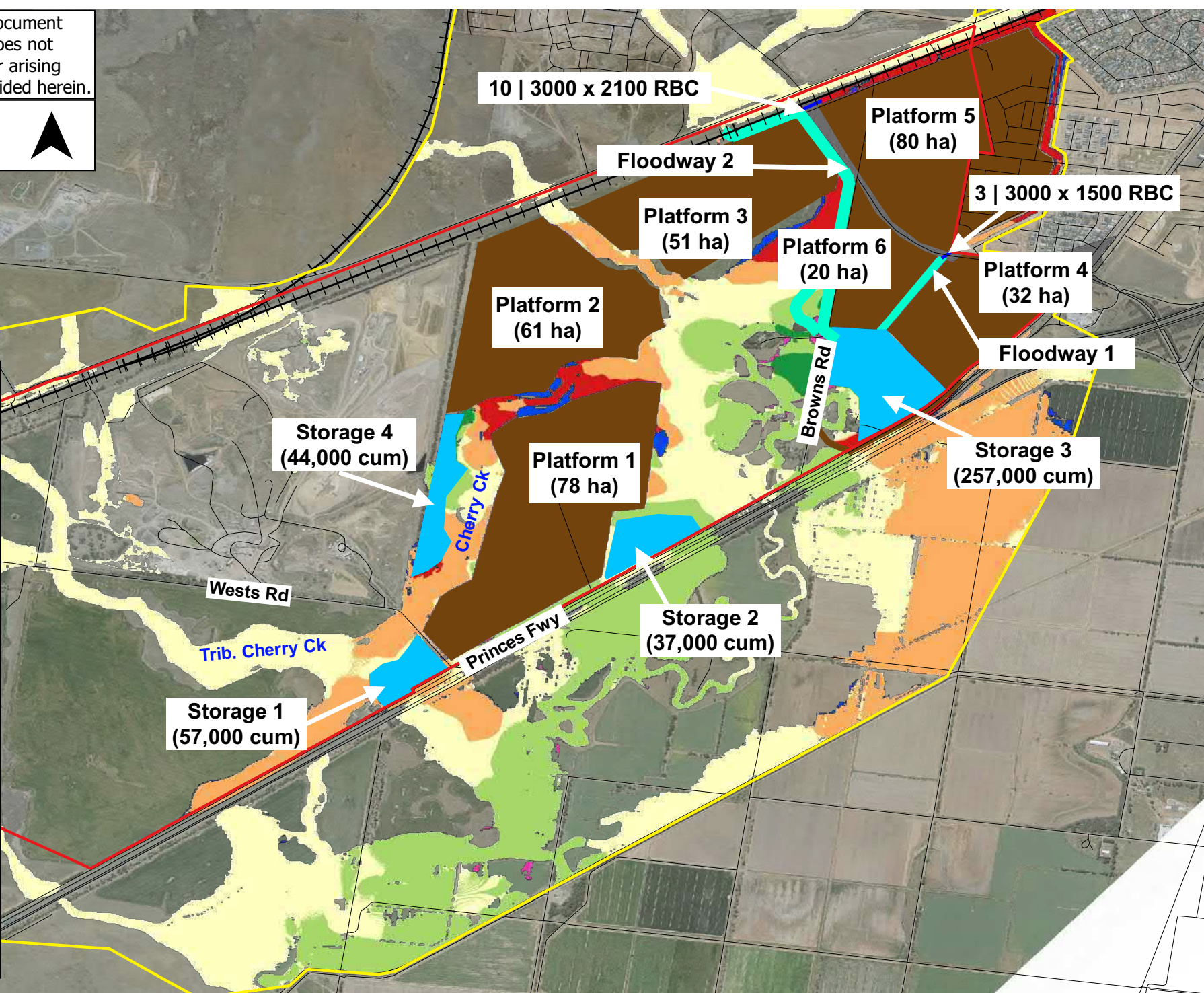
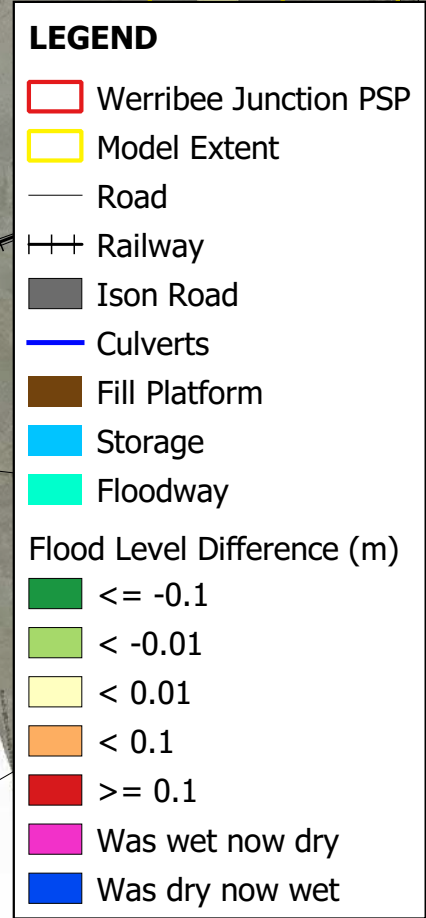
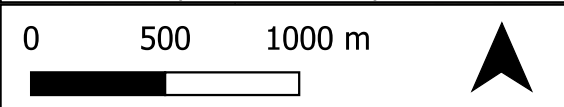


Figure 7.7: Scenario 3a – 1% AEP flood level impacts

7.7 Scenario 3b - developed conditions flows, Ison Road, fill platform Scenario 5

7.7.1 Scenario 3b description

Scenario 3b represents flood conditions under developed fraction impervious conditions across the Werribee Junction PSP area, with the inclusion of Ison Road south of the railway line and fill platform Scenario 5. This fill platform Scenario has larger platforms 4 and 6. From Scenario 3a, Scenario 3b includes a diversion channel from the Loolypop Creek channel into the central floodplain.

The layout of Scenario 3b is shown in Figure 7.7 The hydrologic and hydraulic elements of Scenario 3b are presented in Table 7.7.

Table 7.8: Scenario 3b description

Element	Description												
Developed Conditions FI	TIA fraction of 0.9 been applied uniformly across the whole Werribee Junction PSP Site to represent a commercial/industrial landuse type.												
Ison Road	Ison Road design road surface as detailed in Flood Impact Assessment Ison Road, Werribee (Spiire 2018) and revised culvert crossings to account for the extension of Fill Platform 5 to abut Ison Road: <table> <tr> <td>Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.</td><td>10 3000 x 2100 mm Box Culverts</td></tr> <tr> <td>Culvert 2 – Unchanged from Spiire (2018)</td><td>3 3000 x 1500 mm Box Culverts</td></tr> </table>	Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.	10 3000 x 2100 mm Box Culverts	Culvert 2 – Unchanged from Spiire (2018)	3 3000 x 1500 mm Box Culverts								
Culvert 1 – Located on a floodway adjacent to the railway at the northern edge of the Site to connect flows under the railway into the Lollypop Creek floodway.	10 3000 x 2100 mm Box Culverts												
Culvert 2 – Unchanged from Spiire (2018)	3 3000 x 1500 mm Box Culverts												
Fill Platforms	From Scenario 3a Platforms 4 and 6 have been extended. The areas of the fill platforms are: <table> <tr> <td>Platform 1</td><td>78ha</td></tr> <tr> <td>Platform 2</td><td>61 ha</td></tr> <tr> <td>Platform 3</td><td>51 ha</td></tr> <tr> <td>Platform 4</td><td>37 ha</td></tr> <tr> <td>Platform 5</td><td>49 ha</td></tr> <tr> <td>Platform 6</td><td>25 ha</td></tr> </table>	Platform 1	78ha	Platform 2	61 ha	Platform 3	51 ha	Platform 4	37 ha	Platform 5	49 ha	Platform 6	25 ha
Platform 1	78ha												
Platform 2	61 ha												
Platform 3	51 ha												
Platform 4	37 ha												
Platform 5	49 ha												
Platform 6	25 ha												

Element	Description			
Storages	From Scenario 3a the capacity of Storage 2 has been increased, while the capacity of Storage 3 has been decreased to represent the re-direction of more flow into the western portion of the floodplain. The details of the storages are:			
	<table><tr><td>Storage 1</td><td>An offline compensatory storage of 57,000 m³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.</td></tr></table>	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.	
	Storage 1	An offline compensatory storage of 57,000 m ³ is required at the intersection of Wests Road and the Princes Freeway. The storage has an invert level of 11.05 m AHD (approximately 1 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 1m high bund along the Princes Freeway edge of the storage.		
	<table><tr><td>Storage 2</td><td>An offline storage of 93,400 m³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a bund along the Princes Freeway edge of the storage set to a level higher than the 1% AEP event including a 600 mm freeboard allowance.</td></tr></table>	Storage 2	An offline storage of 93,400 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a bund along the Princes Freeway edge of the storage set to a level higher than the 1% AEP event including a 600 mm freeboard allowance.	
	Storage 2	An offline storage of 93,400 m ³ is required to compensate for extending Platform 1. The storage has an invert level of 11.7 m AHD (approximately 0.5 m deep) which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a bund along the Princes Freeway edge of the storage set to a level higher than the 1% AEP event including a 600 mm freeboard allowance.		
<table><tr><td>Storage 3</td><td>An offline storage of 106,700 m³ is required to compensate for extending Platform 4 and 6 and manage flows from the Browns Road floodway. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund is also required to the west of the storage to ensure breakout flows from Lollypop Creek are directed into the storage.</td></tr></table>	Storage 3	An offline storage of 106,700 m ³ is required to compensate for extending Platform 4 and 6 and manage flows from the Browns Road floodway. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund is also required to the west of the storage to ensure breakout flows from Lollypop Creek are directed into the storage.		
Storage 3	An offline storage of 106,700 m ³ is required to compensate for extending Platform 4 and 6 and manage flows from the Browns Road floodway. The storage has an invert level of 13.1 m AHD which allows it to freely discharge into the existing Princes Freeway culverts. To maximise storage there is a 0.3 m high bund along the Princes Freeway edge of the storage. A 0.7m high bund is also required to the west of the storage to ensure breakout flows from Lollypop Creek are directed into the storage.			
<table><tr><td>Storage 4</td><td>The extension of Platform 1 east directs additional flow down Cherry Creek. To compensate the area between the quarry and Cherry Creek providing an additional 44,000 m³ of floodplain storage. This involves re-grading the floodplain to a level of 13.25 m AHD, resulting in cut of the floodplain up to 1.5 m but generally in the order of 0.4 – 0.6 m.</td></tr></table>	Storage 4	The extension of Platform 1 east directs additional flow down Cherry Creek. To compensate the area between the quarry and Cherry Creek providing an additional 44,000 m ³ of floodplain storage. This involves re-grading the floodplain to a level of 13.25 m AHD, resulting in cut of the floodplain up to 1.5 m but generally in the order of 0.4 – 0.6 m.		
Storage 4	The extension of Platform 1 east directs additional flow down Cherry Creek. To compensate the area between the quarry and Cherry Creek providing an additional 44,000 m ³ of floodplain storage. This involves re-grading the floodplain to a level of 13.25 m AHD, resulting in cut of the floodplain up to 1.5 m but generally in the order of 0.4 – 0.6 m.			
Floodways	The floodways developed for Scenario 3b are based on those developed for Scenario 3b with an additional diversion channel into the central portion of the floodplain from Lollypop Creek. The details of the floodways are:			
	<table><tr><td>Floodway 1</td><td>A 40 m wide floodway between Fill Platforms 4 and 6 to convey flows from the Kingleigh Estate floodway (via the Ison Road culverts) to Storage 3. The floodway has been modelled with a constant grade between the Culvert 2 inverts (~16.3 m AHD) to the Storage 3 invert (13.1 m AHD).</td></tr><tr><td>Floodway 2</td><td>A 40 m wide floodway from the Lollypop Creek culverts under the railway along the north-eastern edge of Fill Platform 3. From the south-eastern corner of Fill</td></tr></table>	Floodway 1	A 40 m wide floodway between Fill Platforms 4 and 6 to convey flows from the Kingleigh Estate floodway (via the Ison Road culverts) to Storage 3. The floodway has been modelled with a constant grade between the Culvert 2 inverts (~16.3 m AHD) to the Storage 3 invert (13.1 m AHD).	Floodway 2
Floodway 1	A 40 m wide floodway between Fill Platforms 4 and 6 to convey flows from the Kingleigh Estate floodway (via the Ison Road culverts) to Storage 3. The floodway has been modelled with a constant grade between the Culvert 2 inverts (~16.3 m AHD) to the Storage 3 invert (13.1 m AHD).			
Floodway 2	A 40 m wide floodway from the Lollypop Creek culverts under the railway along the north-eastern edge of Fill Platform 3. From the south-eastern corner of Fill			

Element	Description	
		Platform 3 (Ison Road – Browns Road intersection) the width of the channel is reduced to 10 m where it runs along the west side of Browns Road and discharges into Storage 3. The reduction in channel width ensures that flows breakout of the channel and activate the floodplain. A low flow channel has also been included to connect the new channelised section of Lollypop Creek into the existing “natural” Lollypop Creek channel through the lower portion of the floodplain.
	Floodway 3	A 20 m wide diversion channel from Lollypop Creek to discharging into the central floodplain. The upstream invert of the channel is 1 m above the invert of the Lollypop Creek channel while at the downstream end the channel matches into the natural floodplain levels.

7.7.2 Scenario 3b results

The Scenario 3b 1% AEP peak flood level impacts are shown in Figure 7.8, while the full suite of flood depth mapping for the 18.13% ,10%, 5%, 2%, 1% and 1% + CC AEP events is presented in Appendix J.

As shown in Figure 7.8 the addition of the diversion channel from Scenario 3b has mitigated the 1% AEP flood impacts downstream of the eastern side of the Site. However, immediately downstream of Storage 2 there is a small area flood level impacts on the Princes Hwy and on the WTP.

Figure J-1 to Figure J-4 show that in the more frequent events, 18.13% to 2% AEP events the downstream flood impacts on the eastern side of the Site are still present. This indicates that the offtake structure on Floodway 2 into the diversion channel (Floodway 3) needs to be constructed to account for lower flow conditions as well as rare events.

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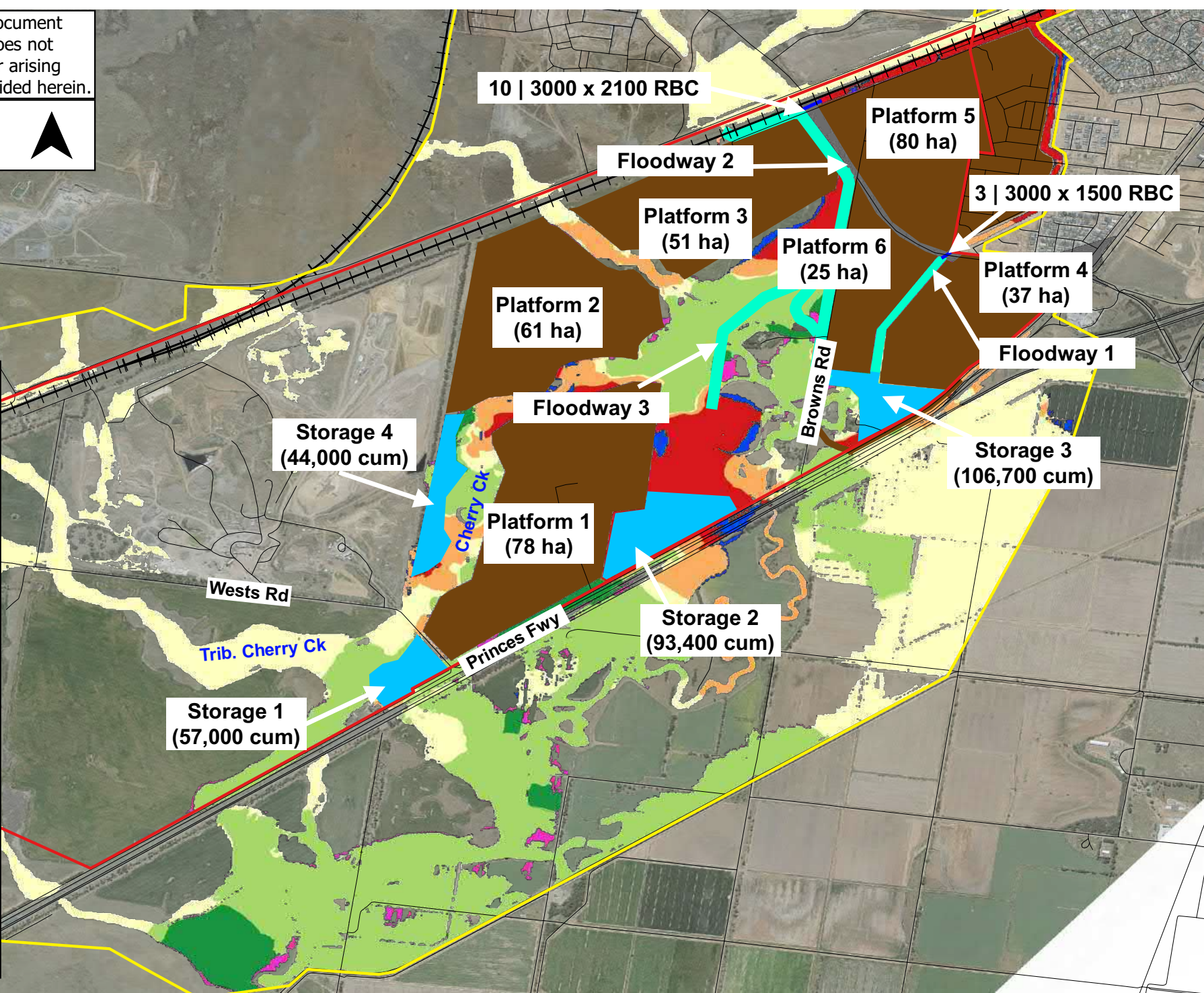
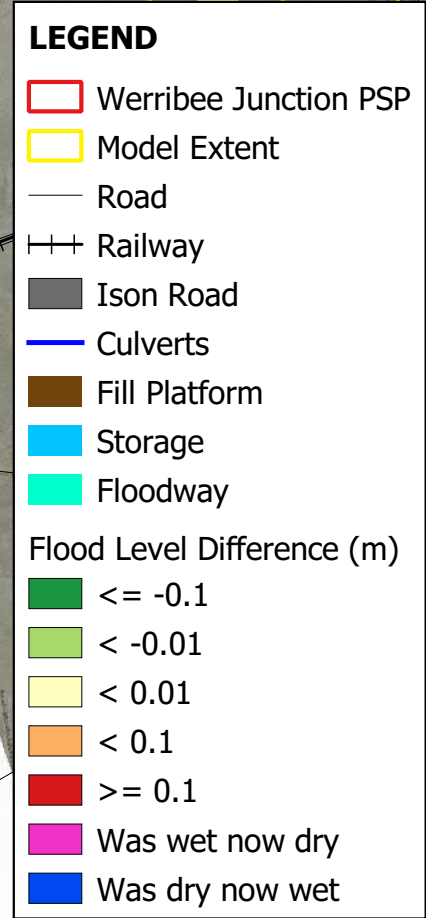
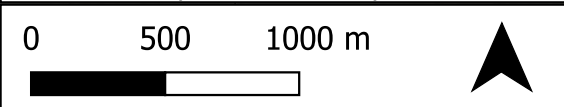


Figure 7.8: Scenario 3b – 1% AEP flood level impacts

8. Summary

This report details the methodology and assumptions used to develop the flood model for the Werribee Junction PSP area, and presents the existing conditions flood mapping.

Seven different concept development scenarios were developed and assessed including; increased site fraction imperviousness, construction of the Ison Road extension and five fill platform scenarios. The concept development scenarios were informed by the flooding behaviour of the Site and the Riparian Values Risk Assessment.

With the exception of Scenario 3a, the modelling indicates that all of the development scenarios assessed are feasible regarding flood level impacts. Scenario 3b provides the largest developable area, however requires the alteration of the current Lollypop Creek channel through the Site.

Scenario 2b confirmed the documented flood level impacts Spiire (2018) associated with the development of Ison Road in isolation from other development works. To constrain flood level impacts within the road corridor, a significant increase in cross-drainage capacity would be required, or the road grade could be reduced at the expense of road immunity design requirements.

The development scenarios assessed in the flood model as presented in this report are concept design only for the purpose of informing the precinct structure planning for the site. Further assessment of these development options should incorporate further development considerations such as development layout including access and egress requirements, environmental considerations and water balance (environmental flow regime) and quality requirements.

9. References

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Appendix A. IFD rainfall depths

Local catchment rainfall depths

Duration	Rainfall Depth (mm)					
	18.13%	10%	5%	2%	1%	1% CC
15 min	13.7	16.5	19.7	24.3	28.3	33.5
20 min	15.6	18.7	22.3	27.6	32.1	38.0
25 min	17.1	20.5	24.5	30.2	35.1	41.6
30 min	18.3	22	26.2	32.4	37.6	44.5
45 min	21.2	25.4	30.3	37.4	43.4	51.4
1 hour	23.5	28	33.4	41.1	47.7	56.5
1.5 hour	26.8	32	38	46.7	54.1	64.1
2 hour	29.4	35	41.5	51	59	69.9
3 hour	33.5	39.7	47	57.7	66.7	79.0
4.5 hour	38.2	45.1	53.3	65.4	75.5	89.4
6 hour	41.9	49.4	58.4	71.5	82.6	97.8
9 hour	47.6	56.3	66.5	81.4	93.8	111
12 hour	52.1	61.7	73	89.3	103	122
18 hour	58.9	70.1	83.2	101	116	137
24 hour	64	76.5	91.1	111	126	149
30 hour	67.9	81.6	97.4	118	134	159
36 hour	71.1	85.7	103	124	141	167
48 hour	76	92.1	111	133	150	178
72 hour	82	100	121	144	162	192
96 hour	85.5	104	127	150	168	199
120 hour	87.5	107	130	153	171	202
144 hour	88.8	108	131	155	172	204
168 hour	89.5	108	131	155	172	204

Werribee River catchment rainfall depths

Duration	Rainfall Depth (mm)					
	18.13%	10%	5%	2%	1%	1% CC
15 min	12.1	14.5	17.2	21	24	28.4
20 min	13.6	16.3	19.4	23.7	27.1	32.1
25 min	14.8	17.7	21.1	25.7	29.4	34.8
30 min	15.7	18.9	22.4	27.3	31.3	37.1
45 min	17.8	21.3	25.3	30.9	35.4	41.9
1 hour	19.3	23.1	27.4	33.4	38.3	45.3
1.5 hour	21.7	25.9	30.6	37.3	42.7	50.6
2 hour	23.7	28.1	33.2	40.4	46.4	54.9
3 hour	27	31.9	37.7	45.8	52.6	62.3
4.5 hour	31.2	36.9	43.4	52.7	60.5	71.6
6 hour	35	41.2	48.4	58.8	67.4	79.8
9 hour	41.5	48.8	57.3	69.5	79.6	94.2
12 hour	47.1	55.4	65	78.7	90	107
18 hour	56.3	66.3	77.8	94.1	107	127
24 hour	63.6	75	88.1	106	121	143
30 hour	69.5	82.2	96.7	116	132	156
36 hour	74.4	88.2	104	125	141	167
48 hour	81.9	97.4	115	138	155	184
72 hour	90.9	109	129	154	173	205
96 hour	95.4	115	136	162	182	215
120 hour	97.6	118	139	166	186	220
144 hour	98.5	119	141	168	188	223
168 hour	98.6	119	141	168	189	224

Appendix B. Scenario 1a flood depth and extent maps

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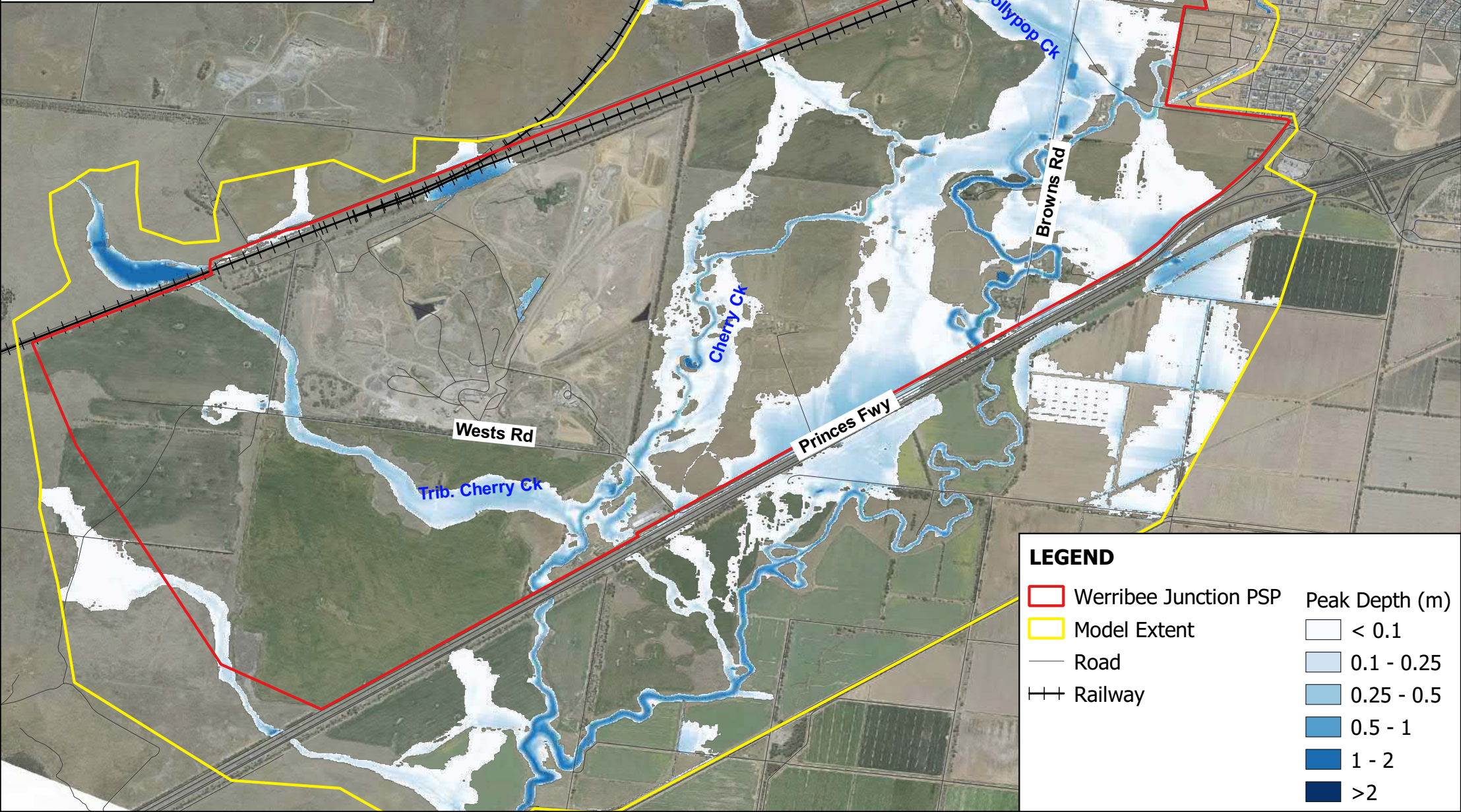
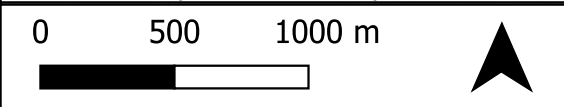


Figure B.1: Scenario1a – 18.13% AEP Flood Depth and Extent

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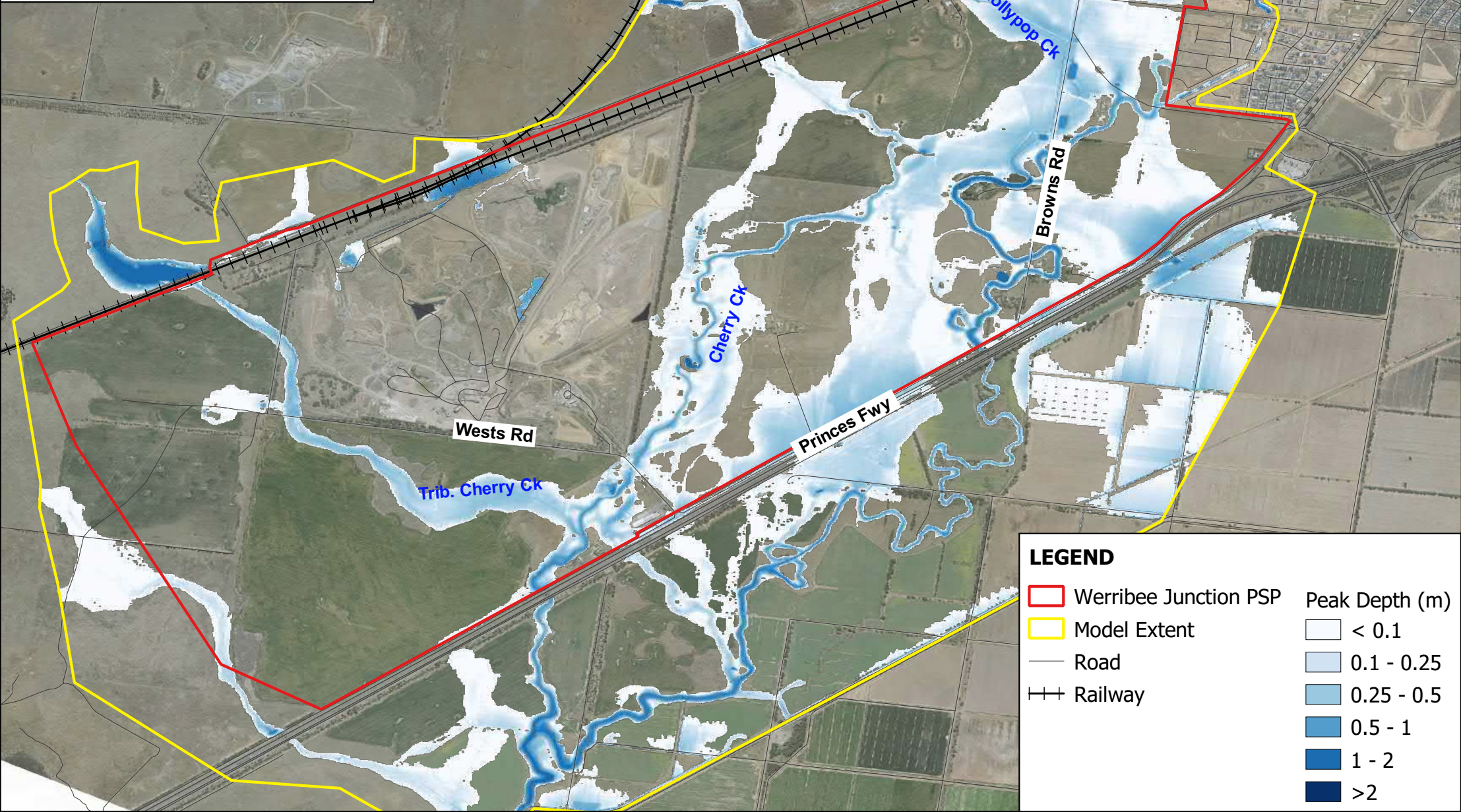
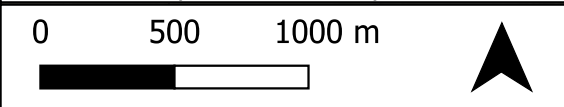


Figure B.2: Scenario1a – 10% AEP Flood Depth and Extent

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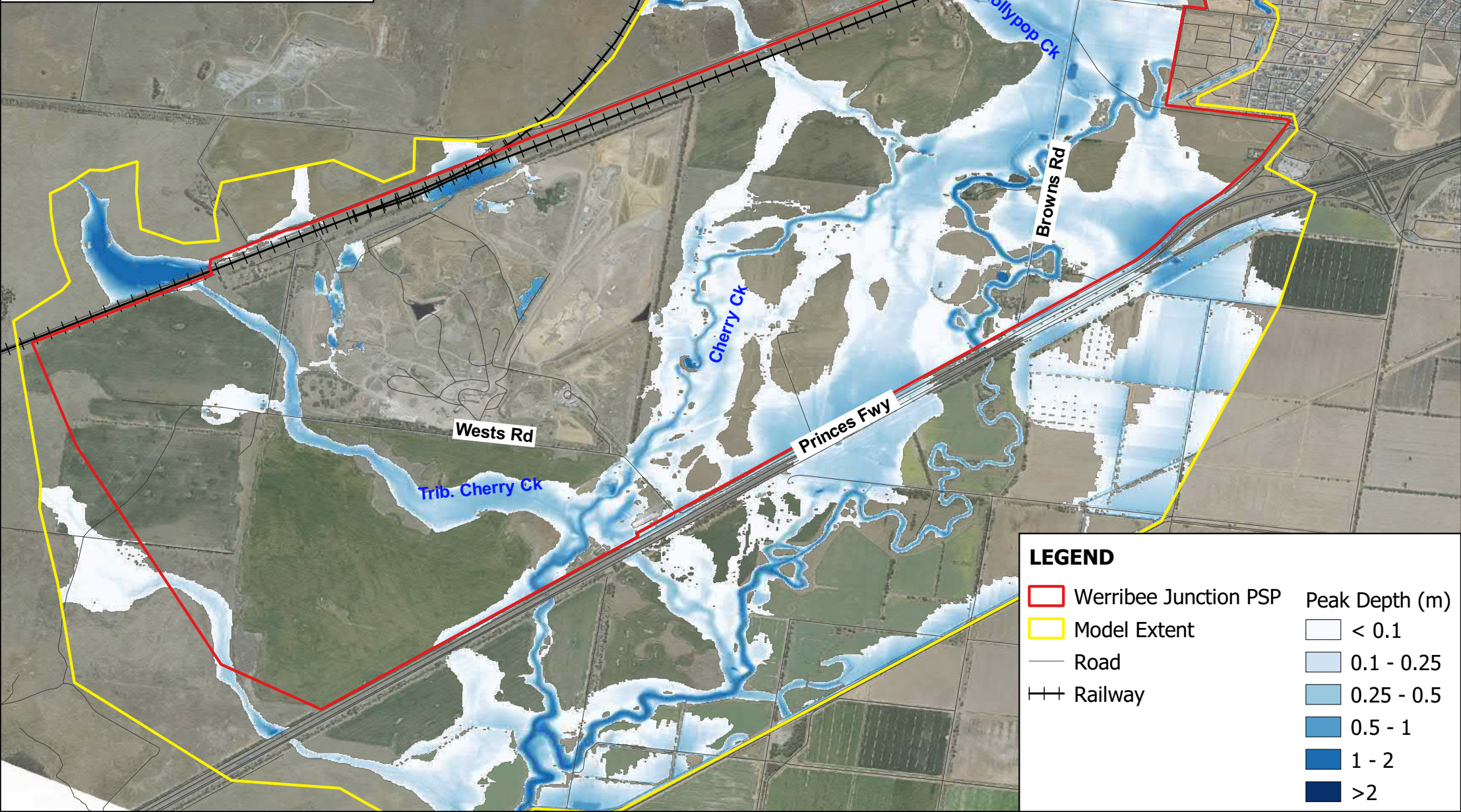
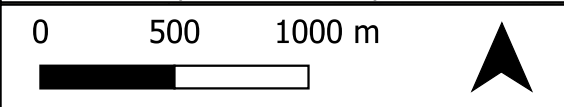


Figure B.3: Scenario1a – 5% AEP Flood Depth and Extent

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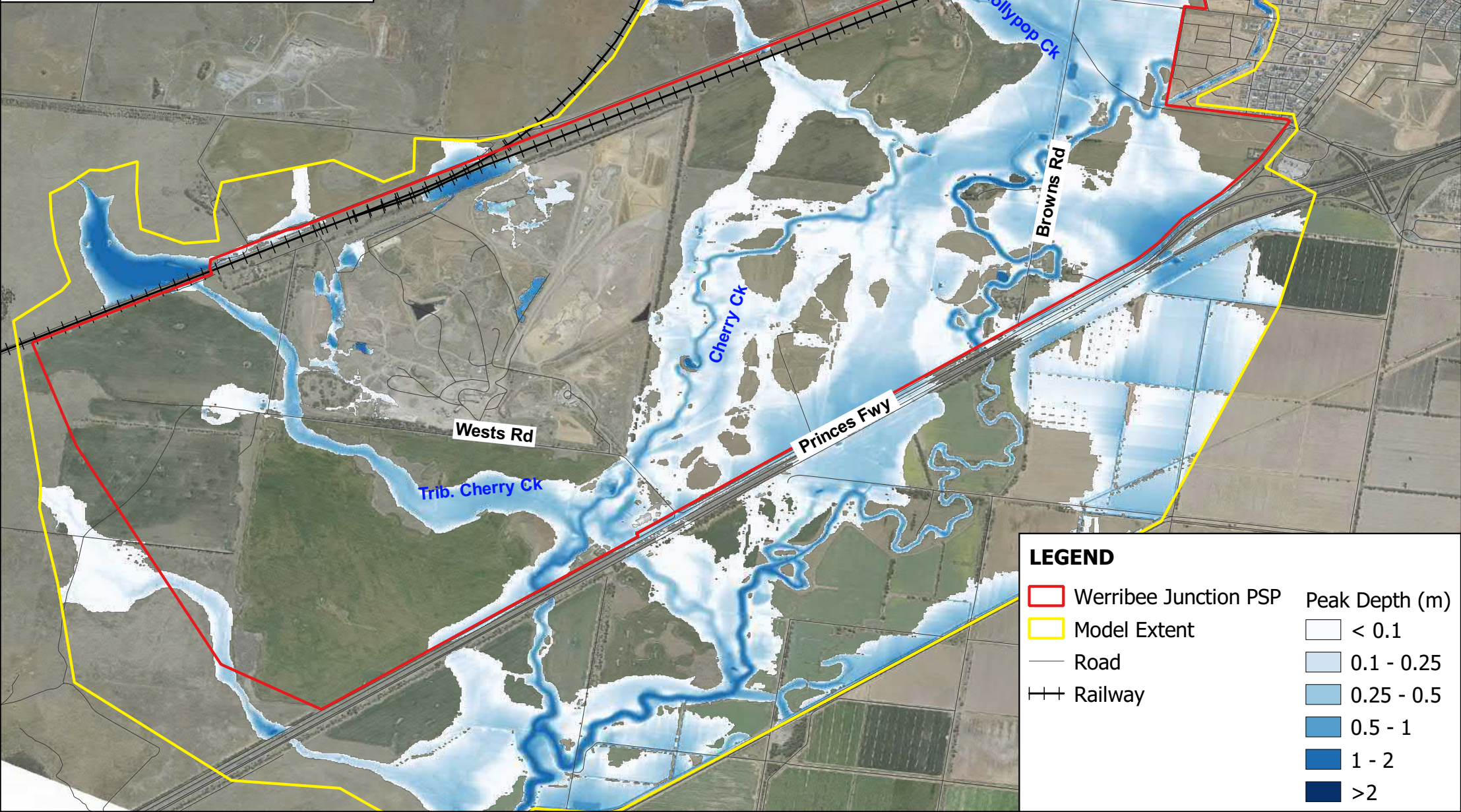
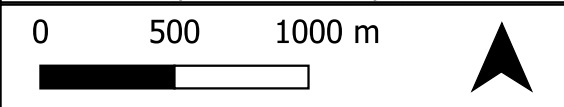


Figure B.4: Scenario1a – 2% AEP Flood Depth and Extent

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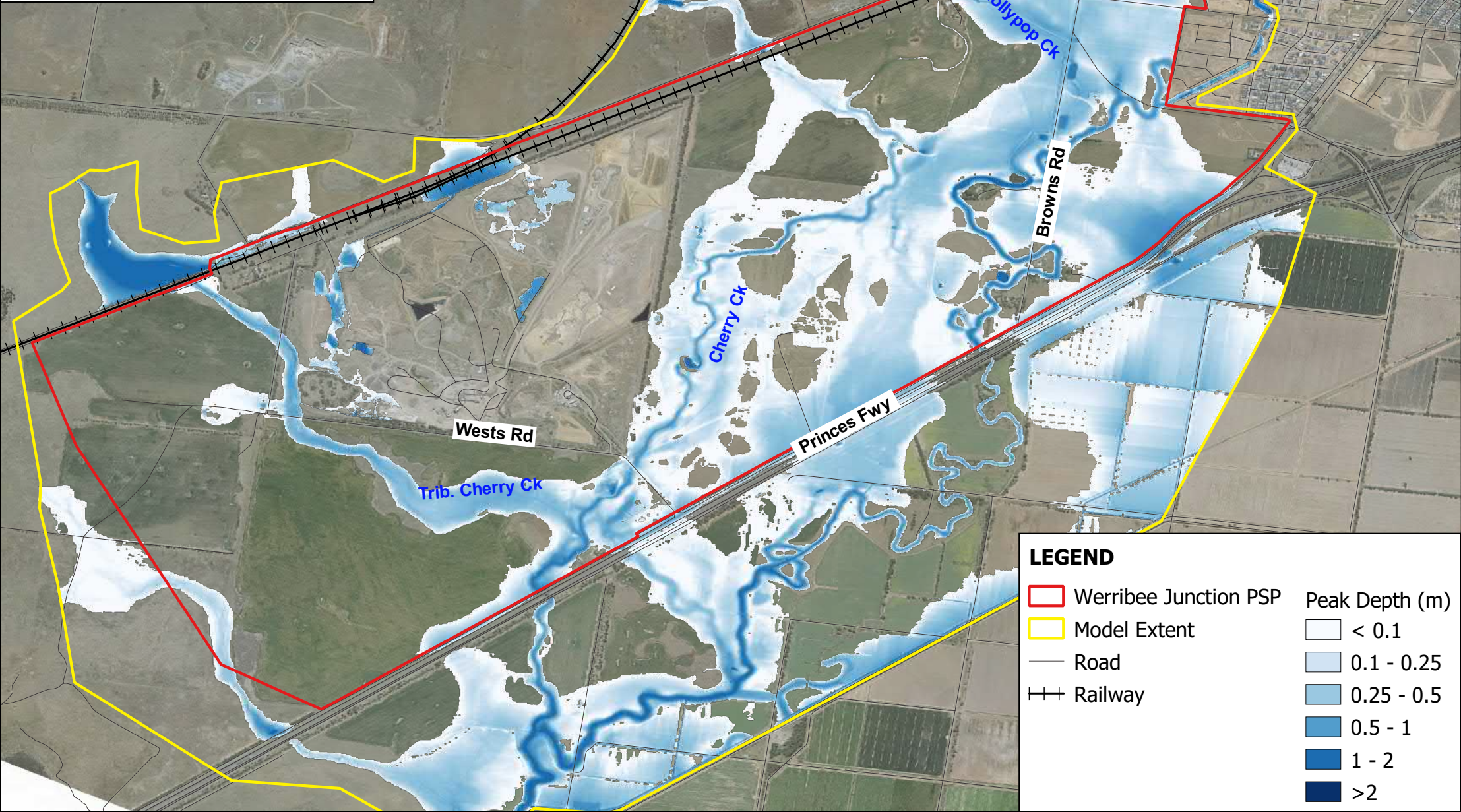
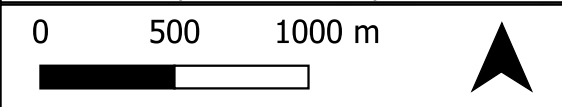


Figure B-5: Scenario1a – 1% AEP Flood Depth and Extent

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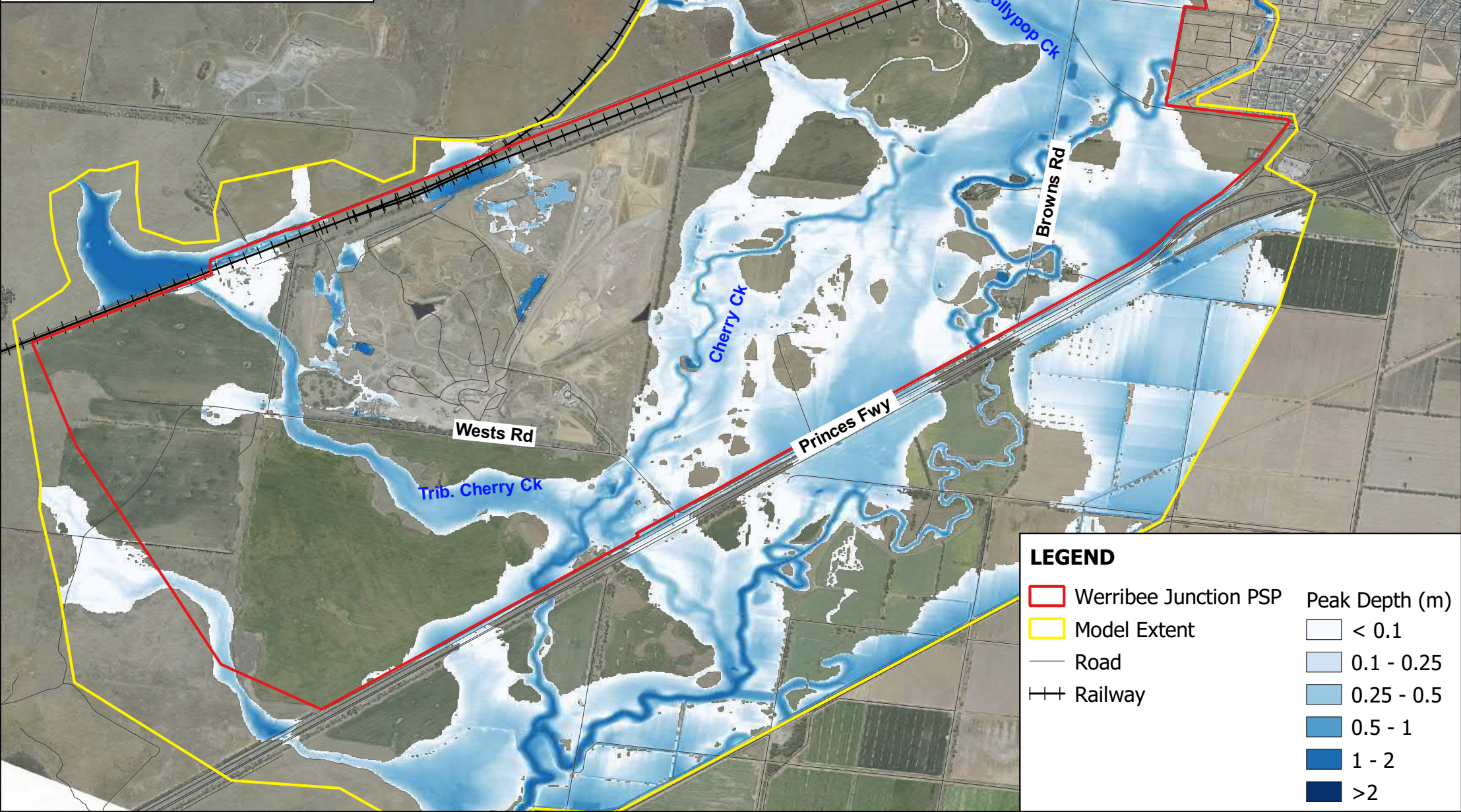
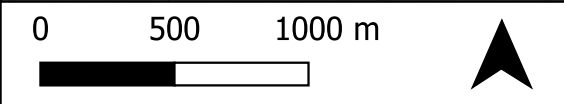
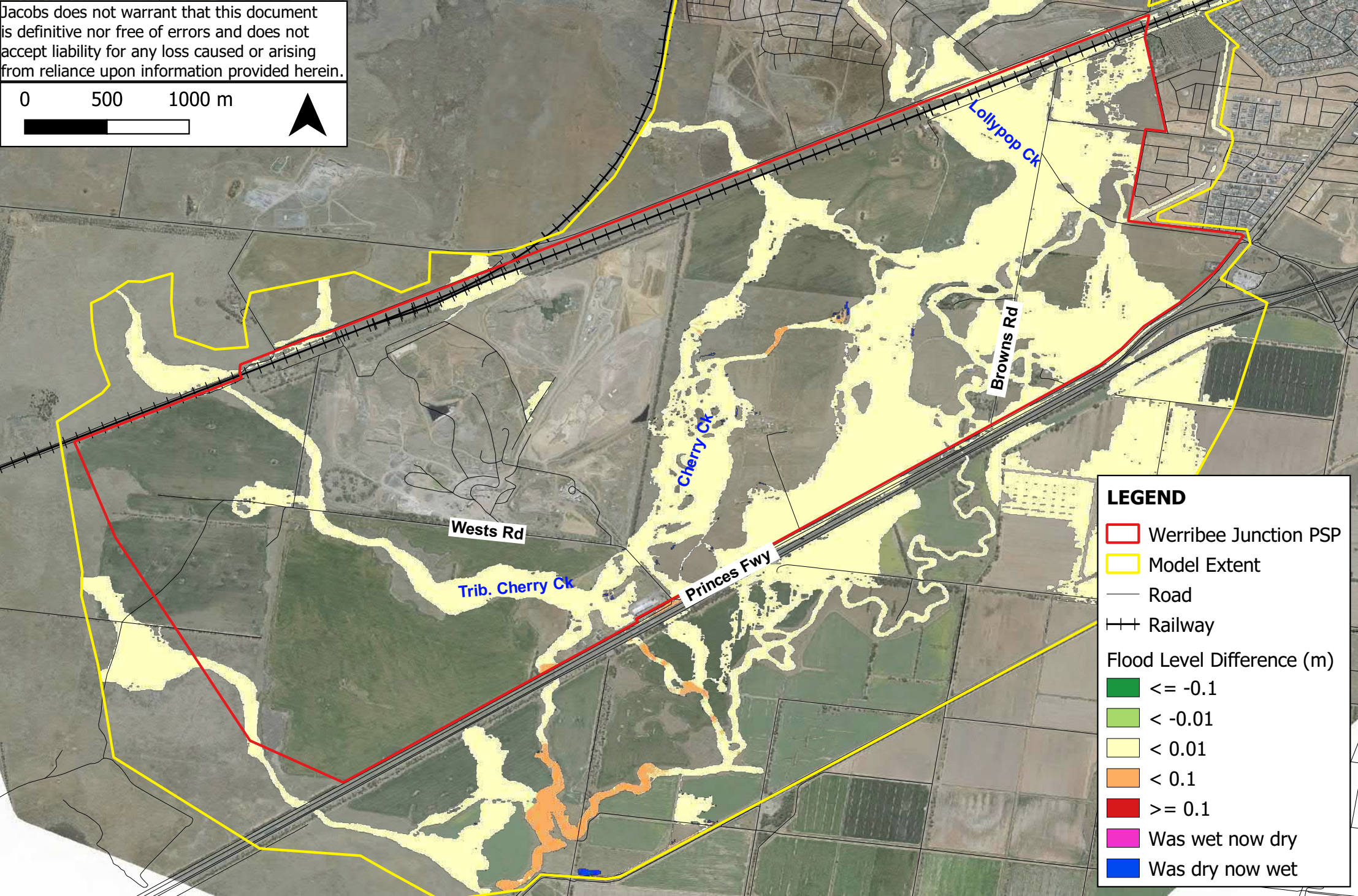
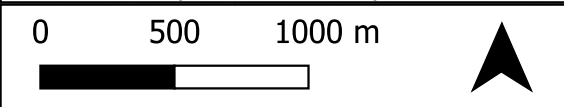


Figure B.6: Scenario1a – 1% AEP Climate Change Flood Depth and Extent

Appendix C. Scenario 2a flood impact and extent maps

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LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway
- Flood Level Difference (m)
 - ≤ -0.1
 - < -0.01
 - < 0.01
 - < 0.1
 - ≥ 0.1
- Was wet now dry
- Was dry now wet

Figure C.1: Scenario 2a – 18.13% AEP flood level impacts

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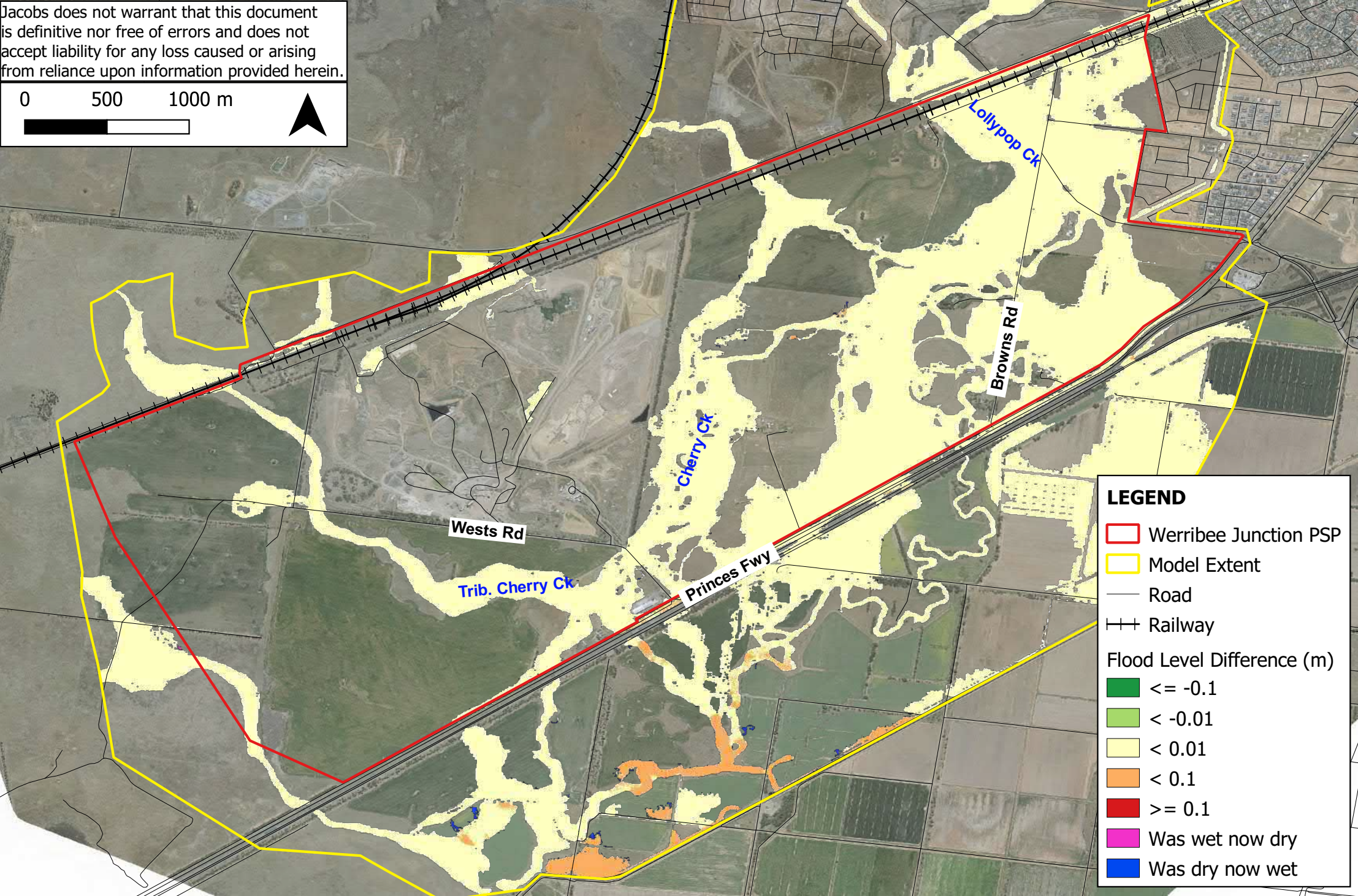
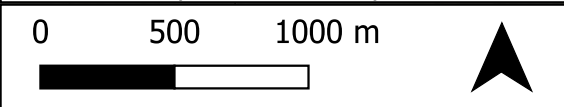


Figure C.2: Scenario 2a –10% AEP flood level impacts

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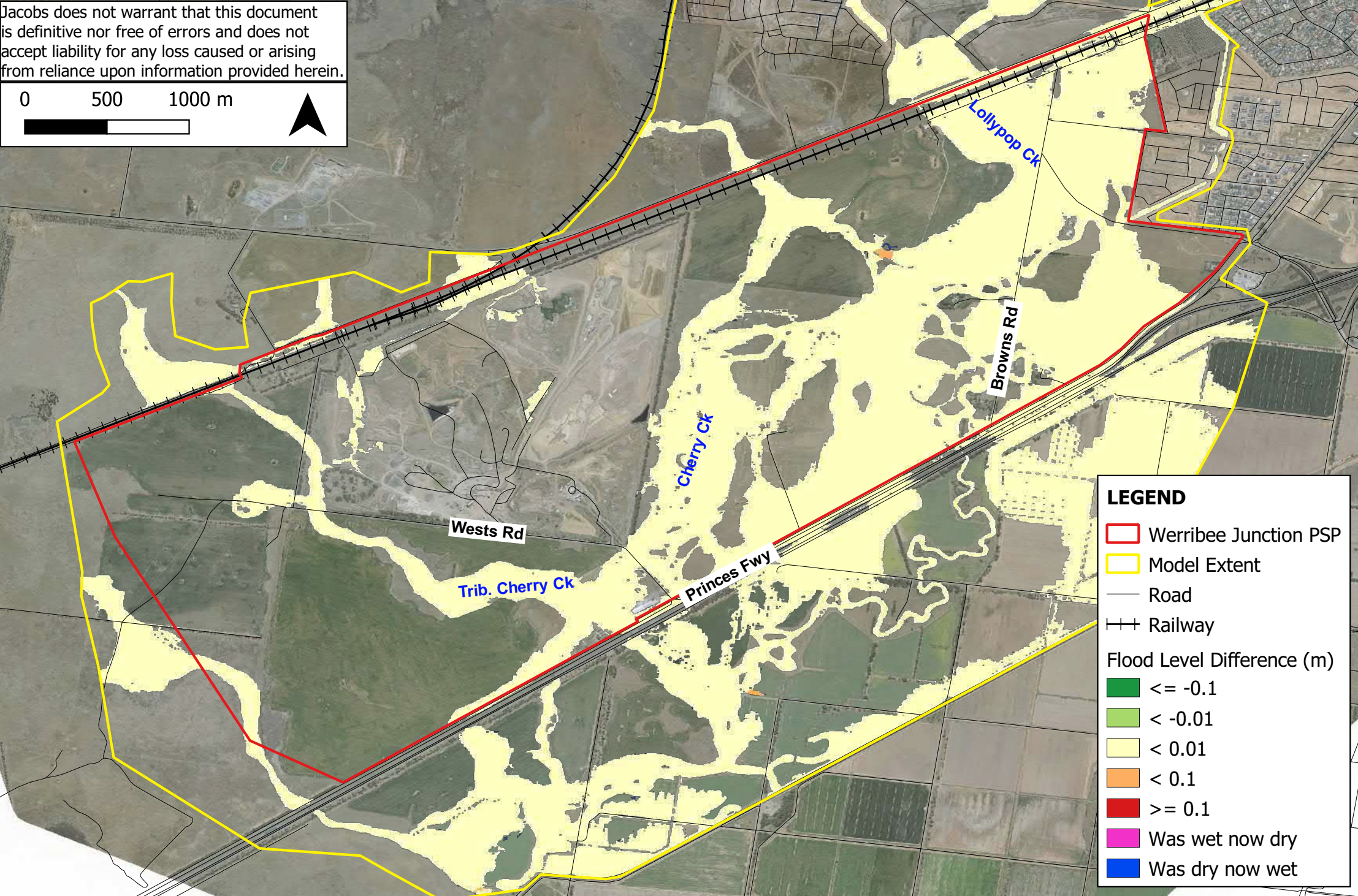
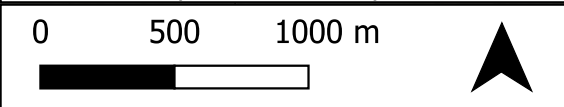
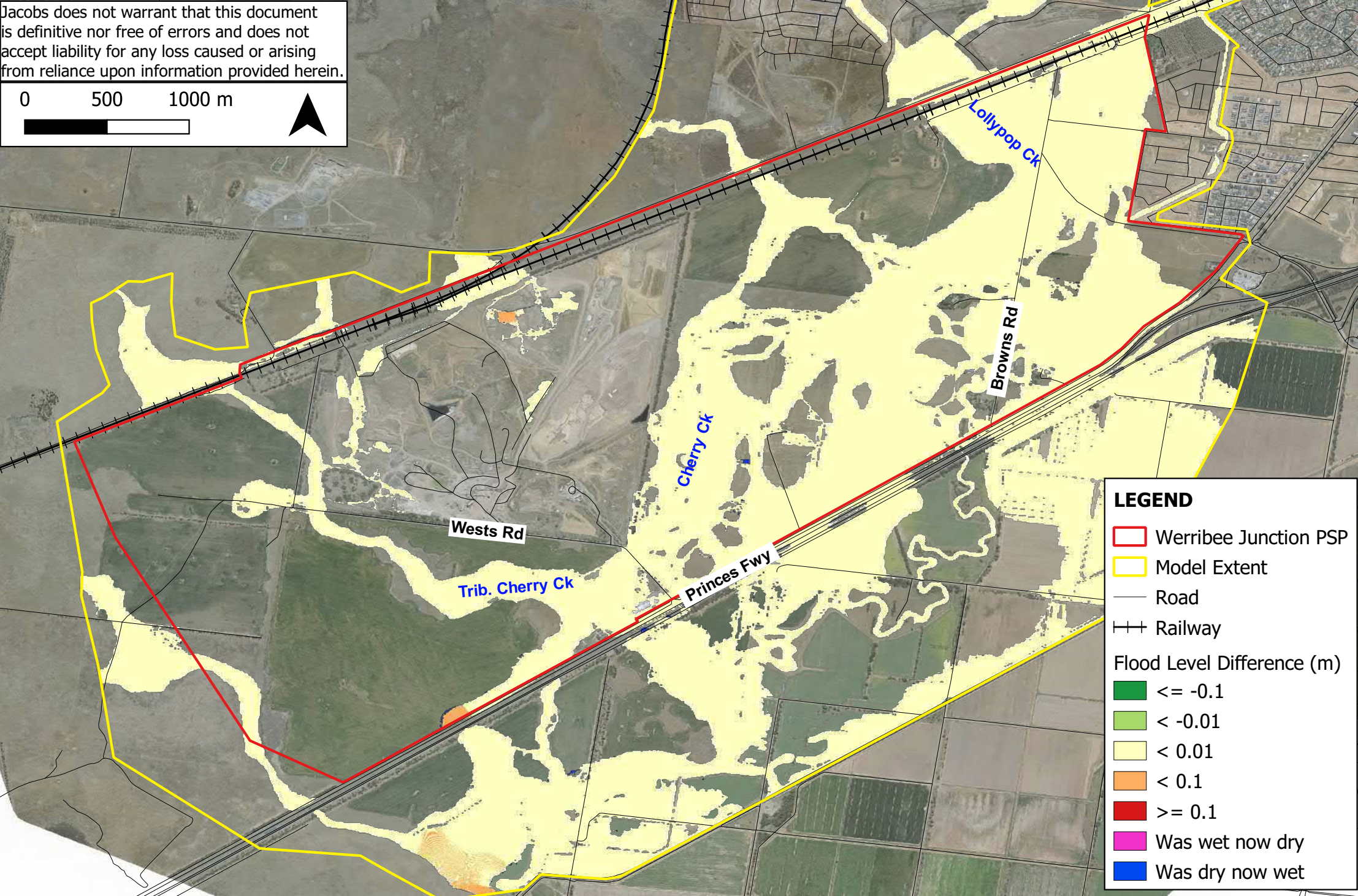
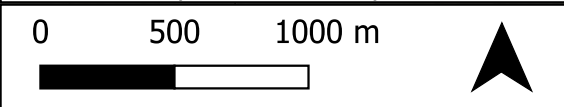


Figure C.3: Scenario 2a –5% AEP flood level impacts

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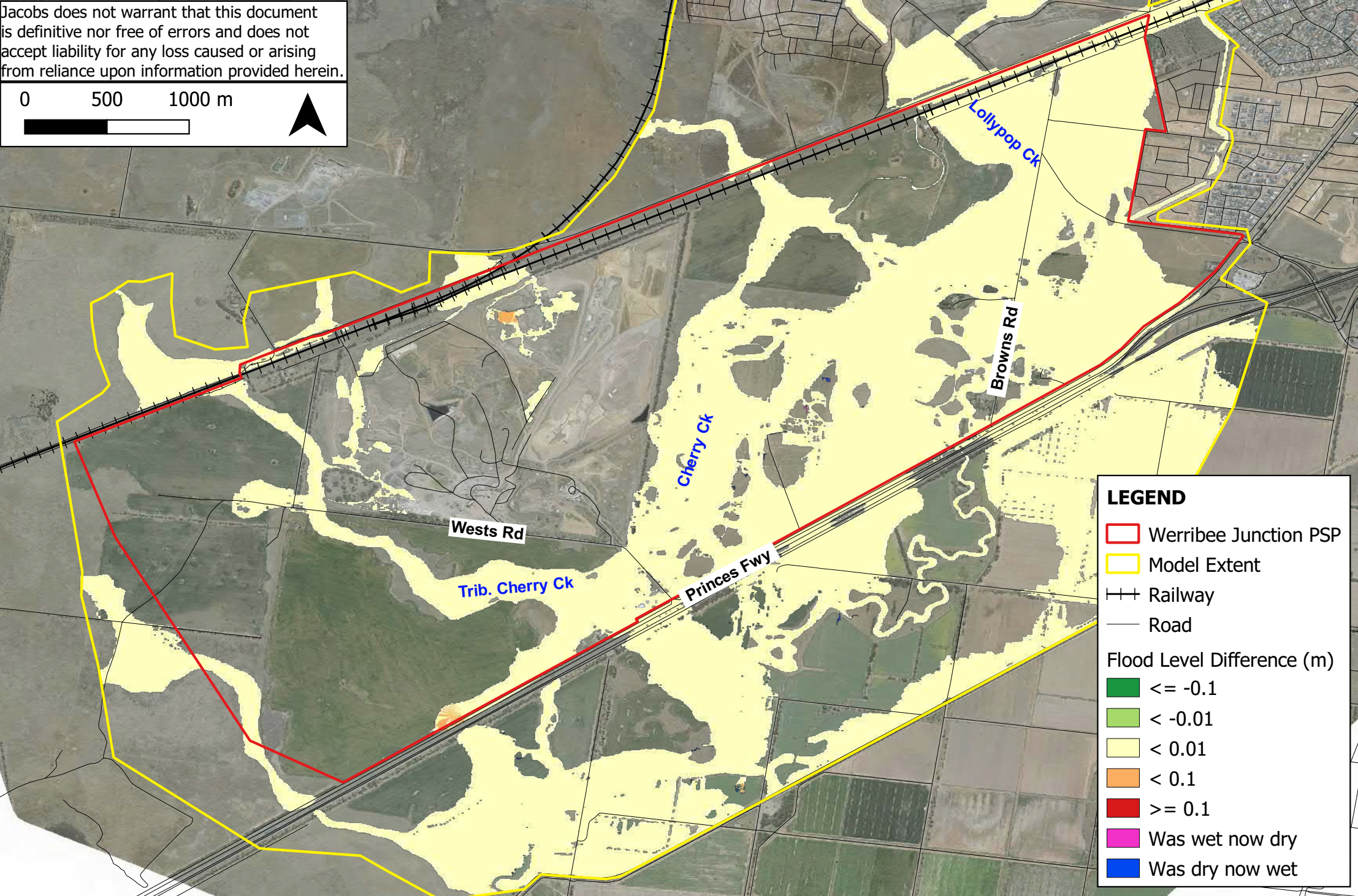
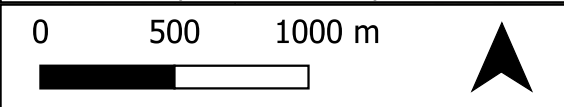


LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway
- Flood Level Difference (m)
 - ≤ -0.1
 - < -0.01
 - < 0.01
 - < 0.1
 - ≥ 0.1
- Was wet now dry
- Was dry now wet

Figure C.4: Scenario 2a –2% AEP flood level impacts

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LEGEND

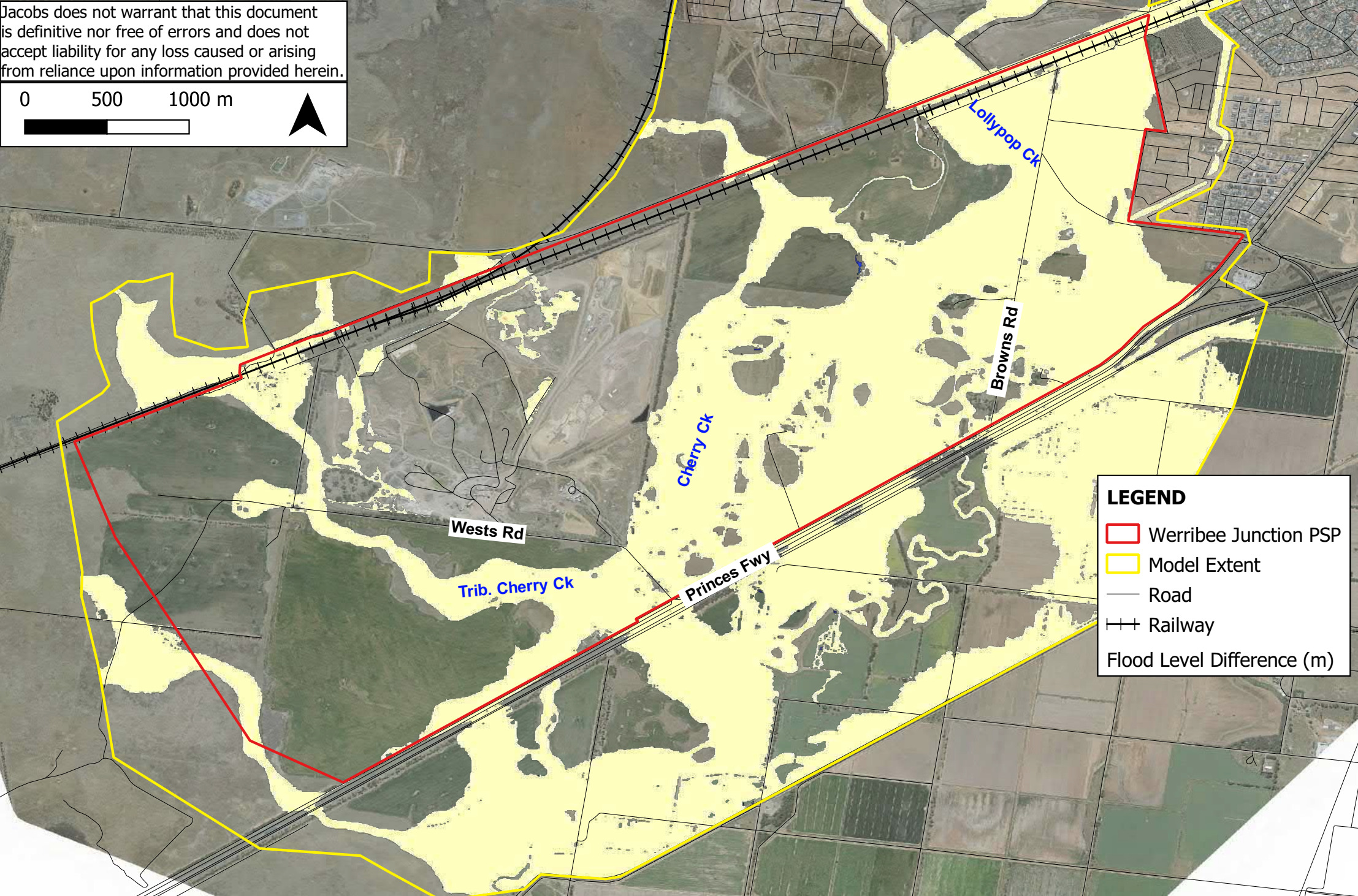
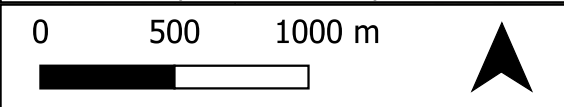
- Werribee Junction PSP
- Model Extent
- Railway
- Road

Flood Level Difference (m)

- ≤ -0.1
- < -0.01
- < 0.01
- < 0.1
- ≥ 0.1
- Was wet now dry
- Was dry now wet

Figure C.5: Scenario 2a –1% AEP flood level impacts

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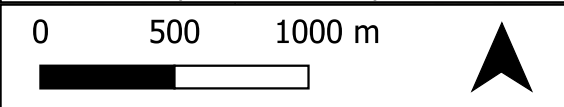
LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway
- Flood Level Difference (m)

Figure C.6: Scenario 2a –1% AEP climate change flood level impacts

Appendix D. Scenario 2b flood impact and extent maps

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LEGEND

- Werribee Junction PSP
- Model Extent
- Road
- Railway
- Ison Road
- Culvert

Flood Level Difference (m)

- ≤ -0.1
- < -0.01
- < 0.01
- < 0.1
- ≥ 0.1
- Was wet now dry
- Was dry now wet

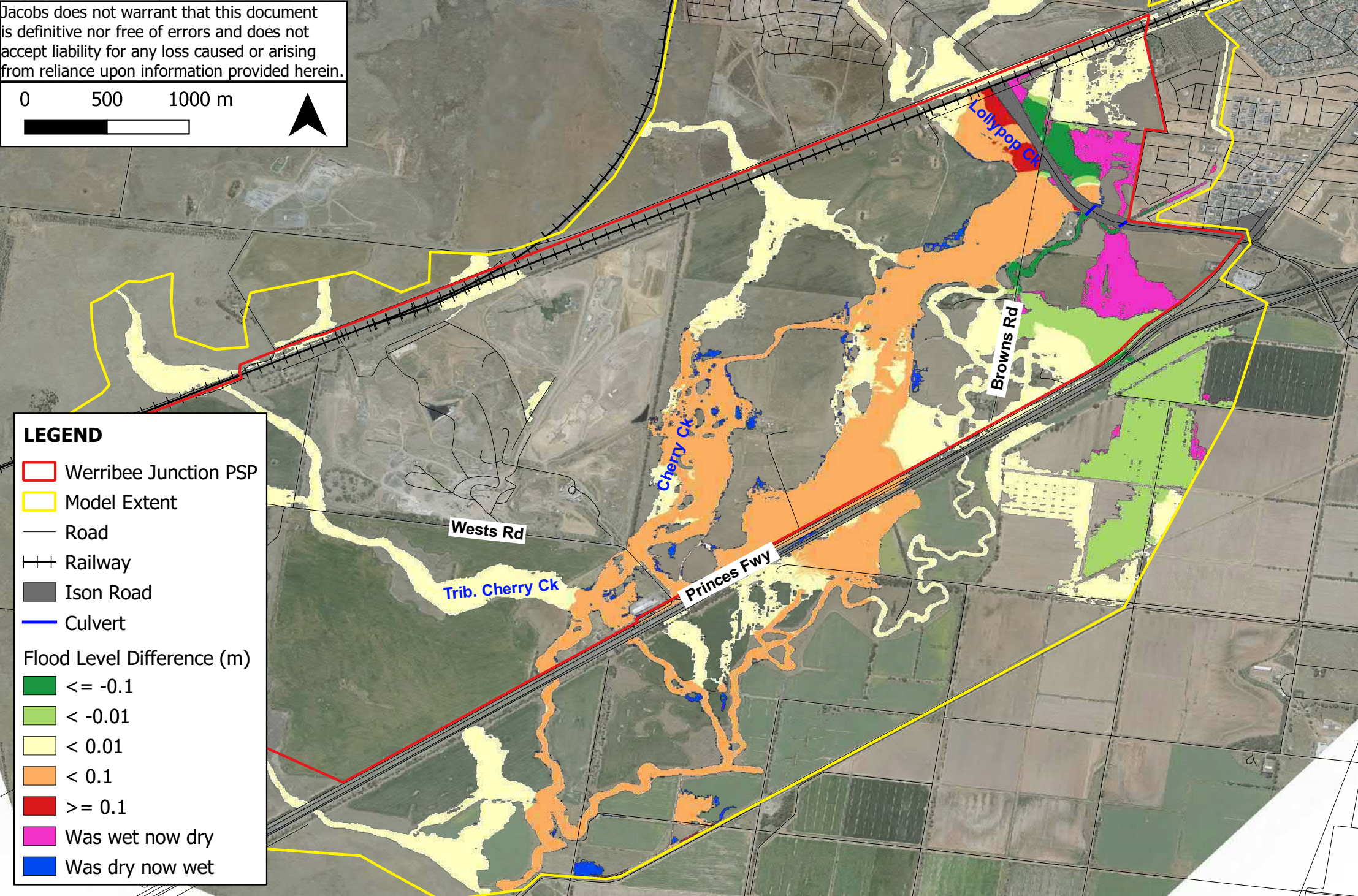


Figure D.1: Scenario 2b – 18.13% AEP flood level impacts

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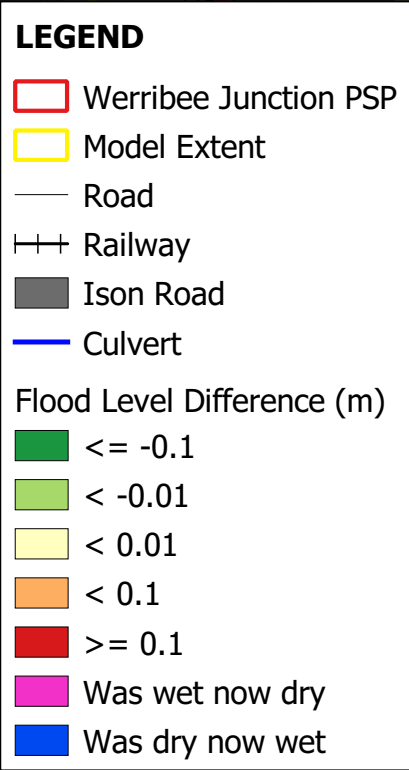
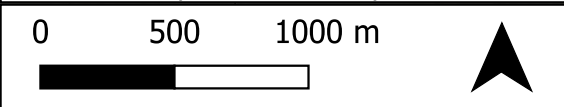


Figure D.2: Scenario 2b – 10% AEP flood level impacts

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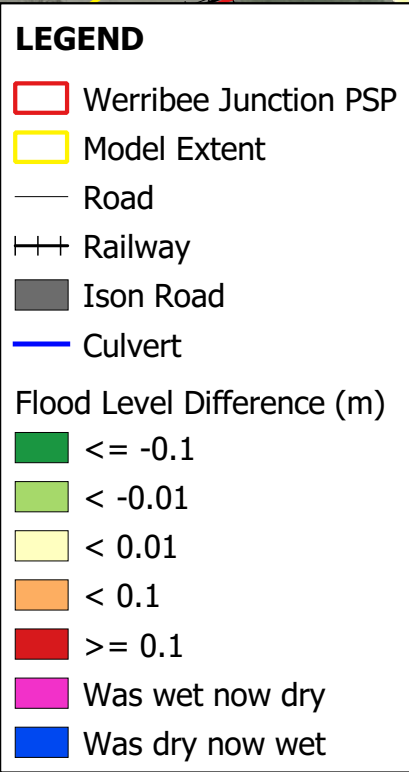
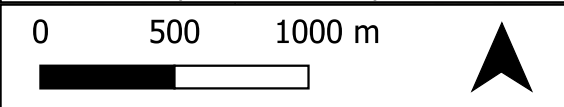


Figure D.3: Scenario 2b – 5% AEP flood level impacts

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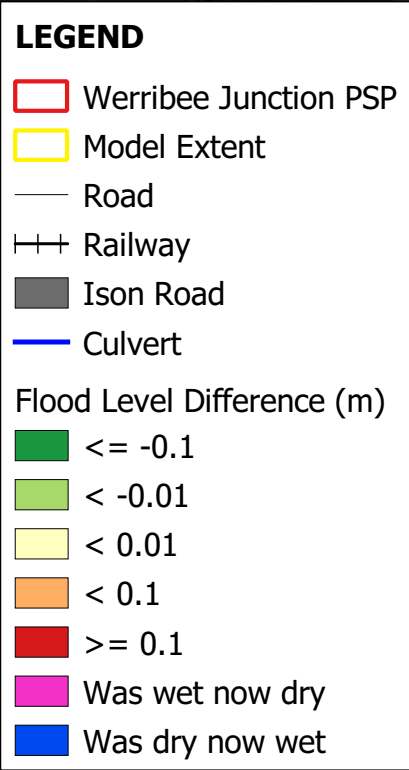
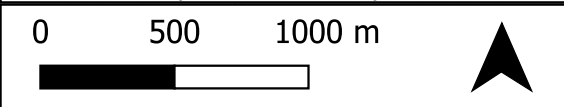


Figure D.4: Scenario 2b – 2% AEP flood level impacts

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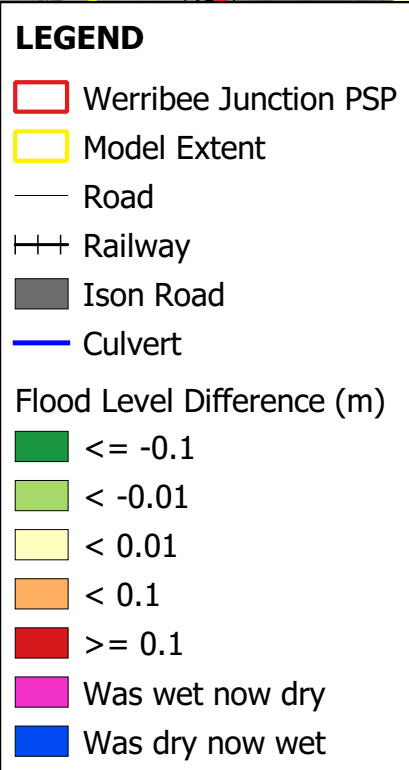
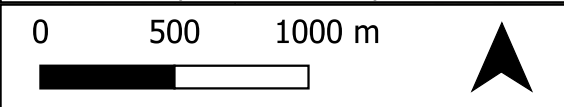


Figure D.5: Scenario 2b – 1% AEP flood level impacts

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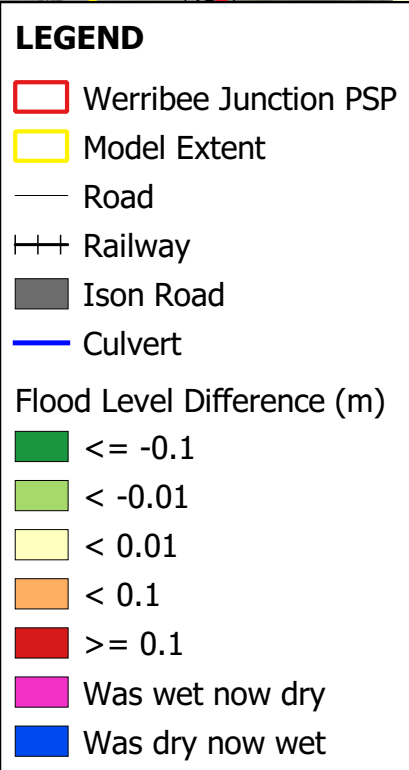
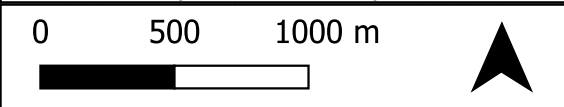


Figure D.6: Scenario 2b – 1% AEP climate change flood level impacts

Appendix E. Scenario 2b (Mitigated) flood impact and extent maps

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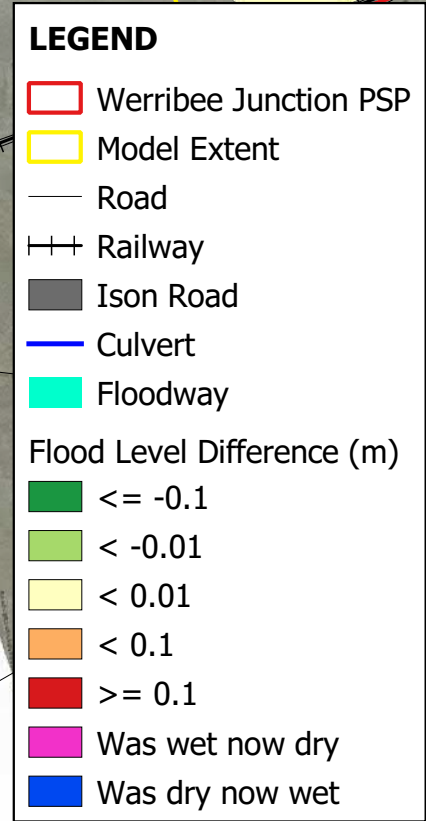
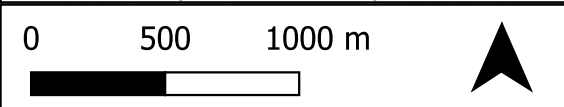


Figure E.1: Scenario 2b(mitigation) – 18.13% AEP flood level impacts

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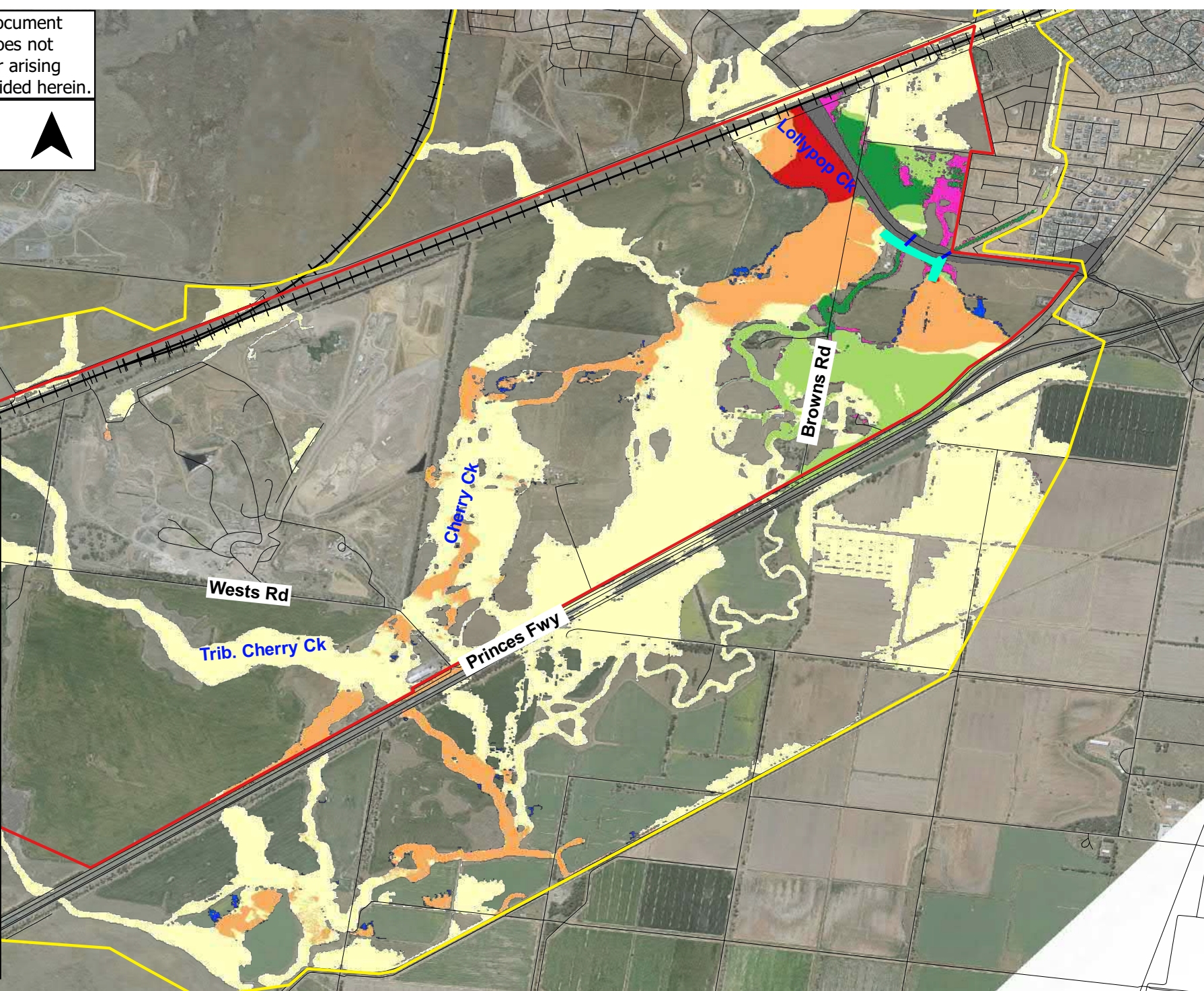
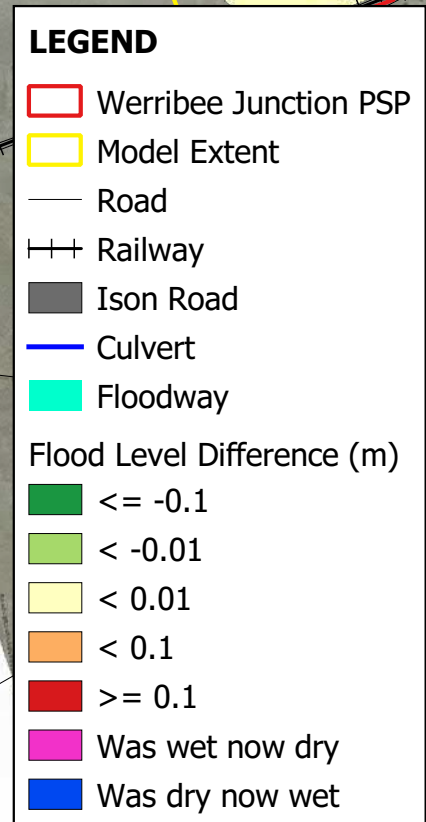
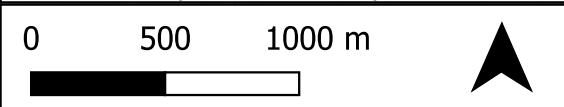


Figure E.2: Scenario 2b(mitigation) – 10% AEP flood level impacts

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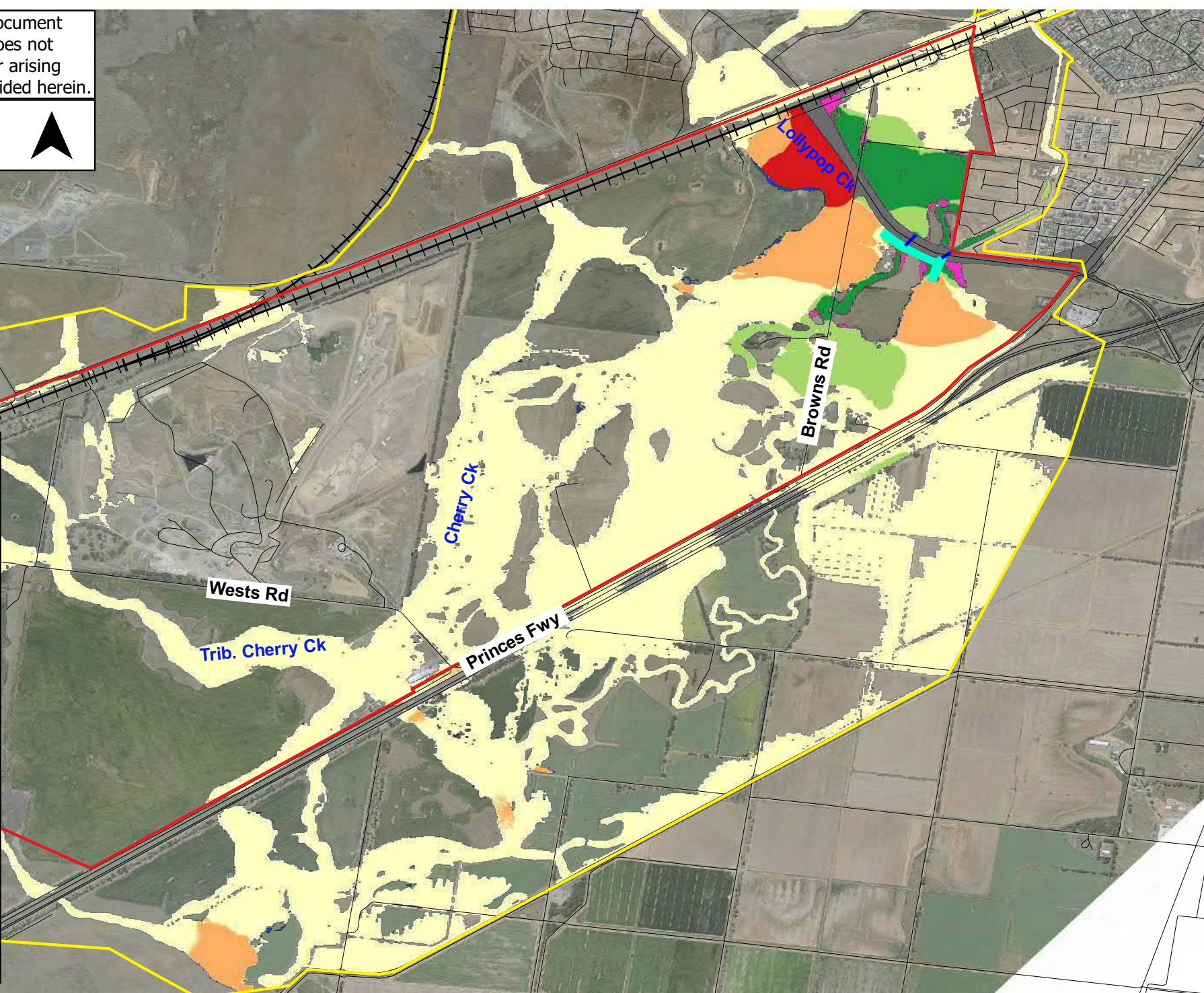
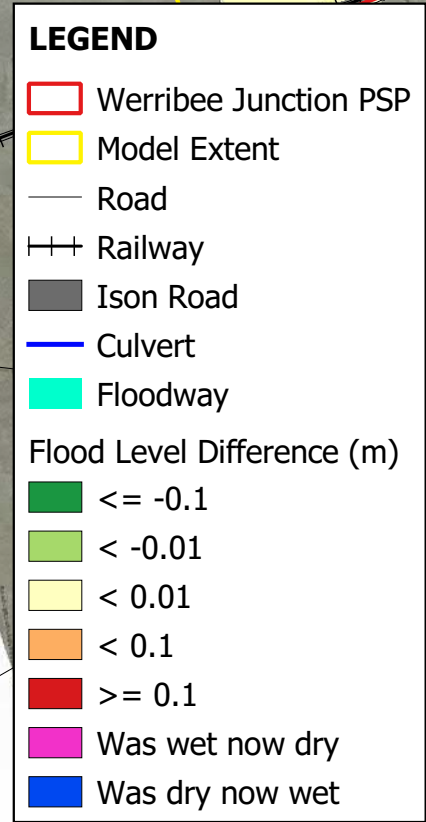
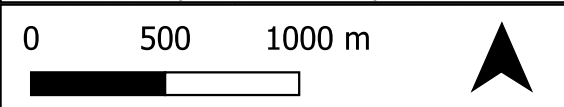


Figure E.3: Scenario 2b(mitigation) – 5% AEP flood level impacts

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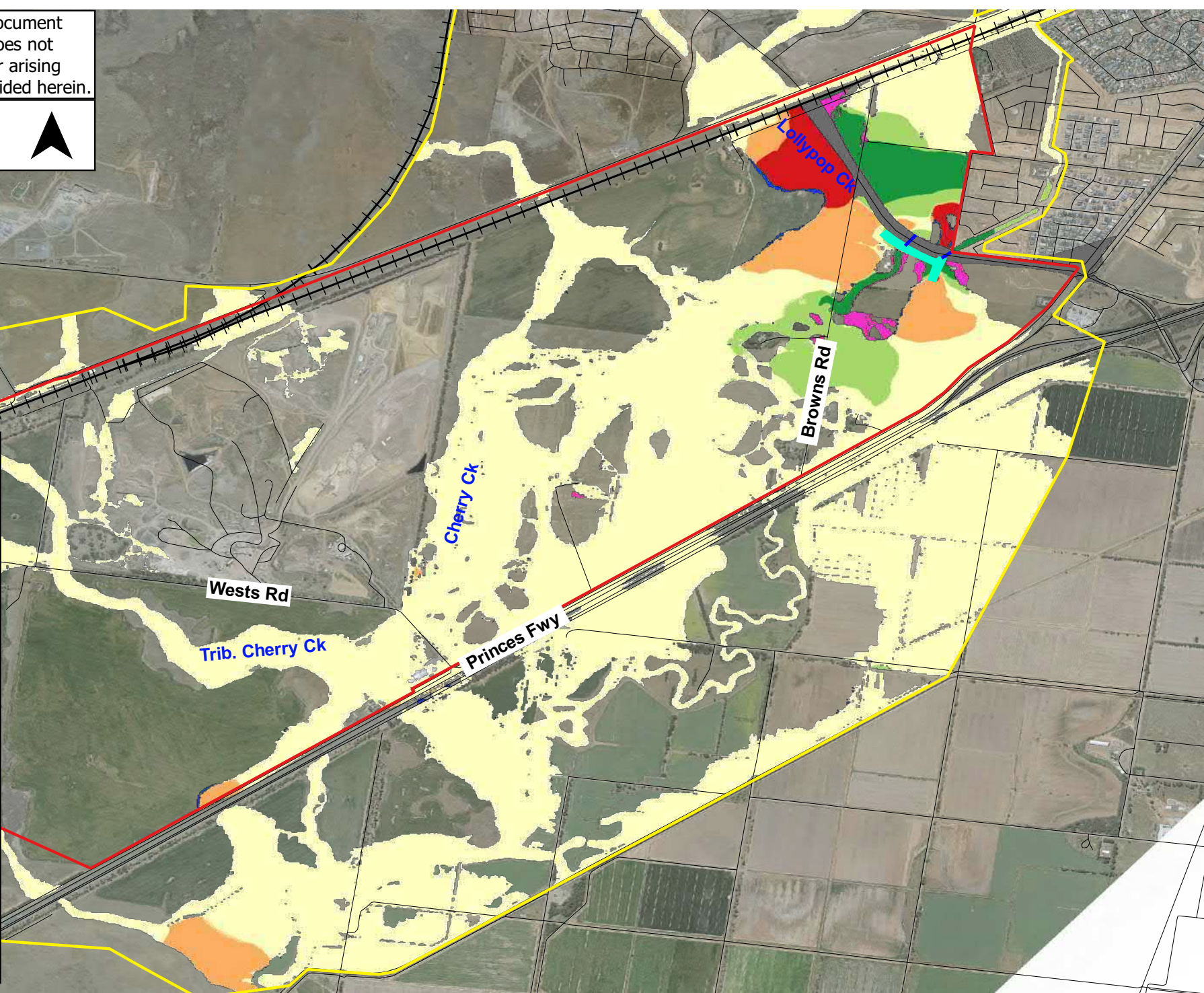
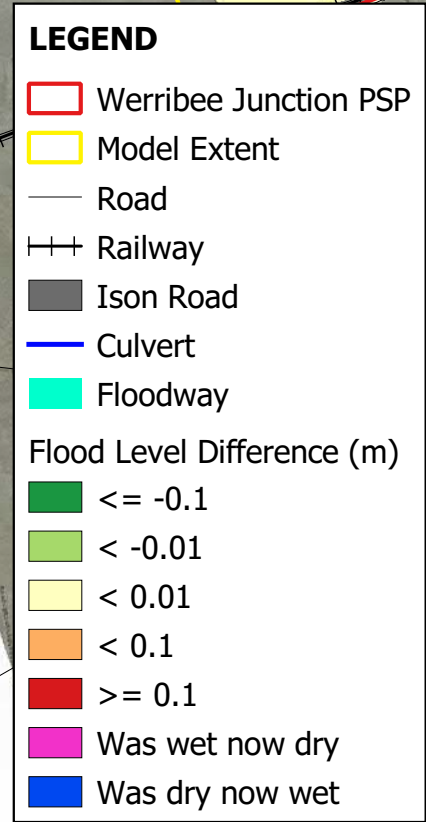
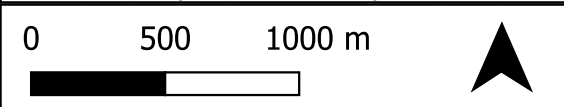


Figure E.4: Scenario 2b(mitigation) – 2% AEP flood level impacts

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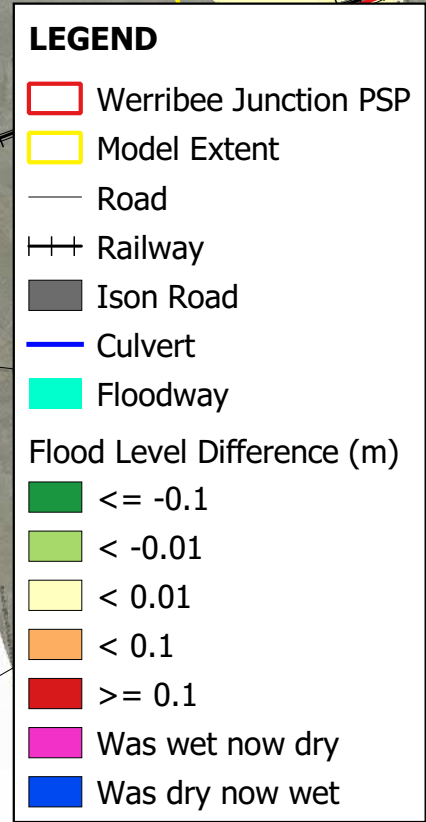
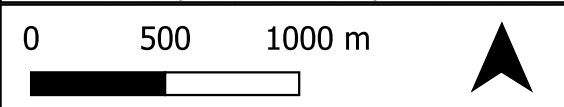


Figure E.5: Scenario 2b(mitigation) – 1% AEP flood level impacts

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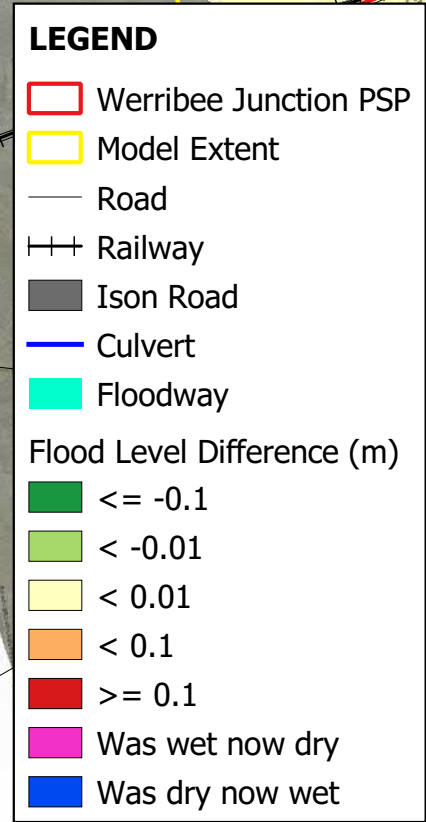
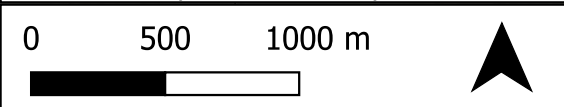


Figure E.6: Scenario 2b(mitigation) – 1% AEP climate change flood level impacts

Appendix F. Scenario 2c flood impact and extent maps

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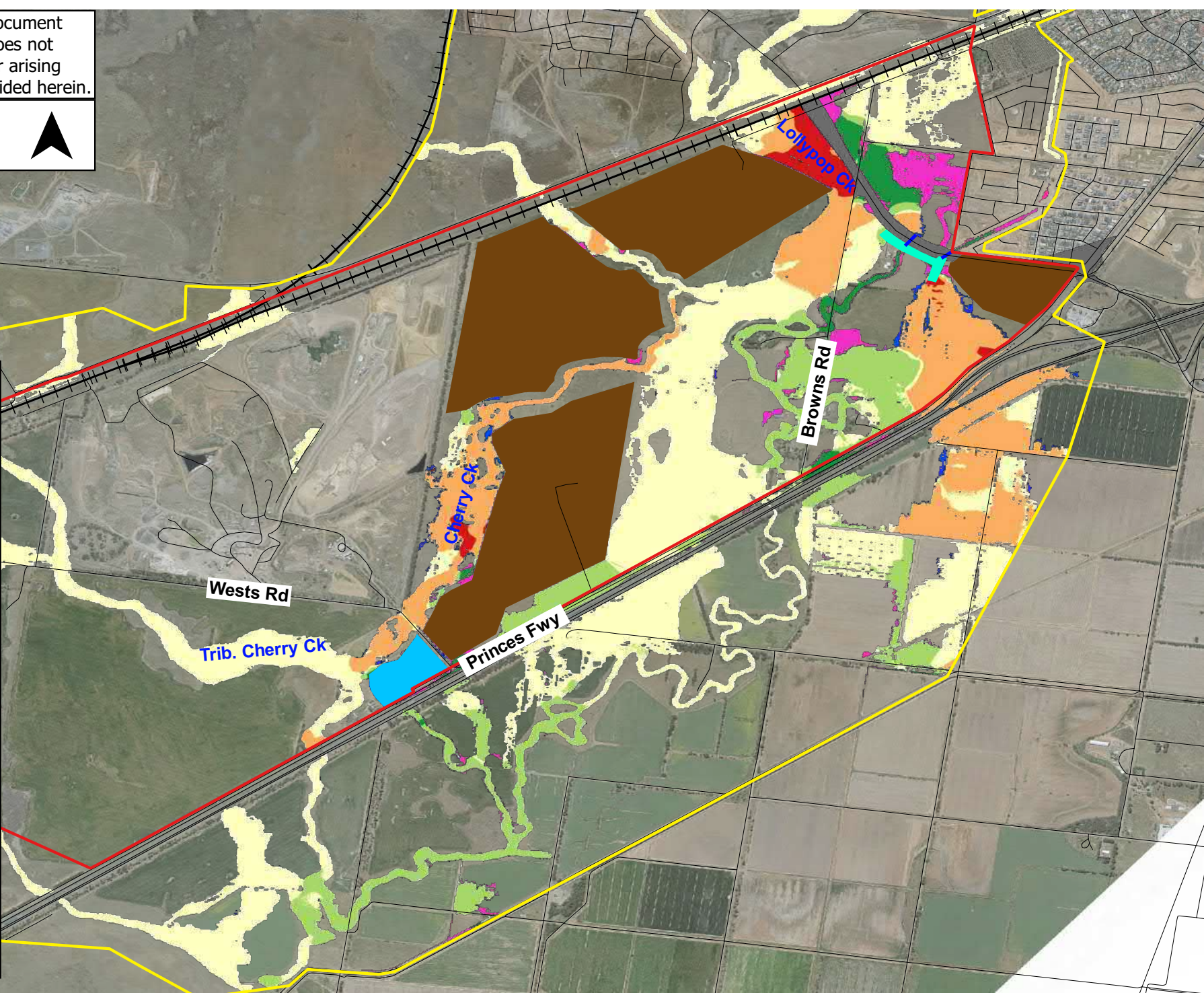
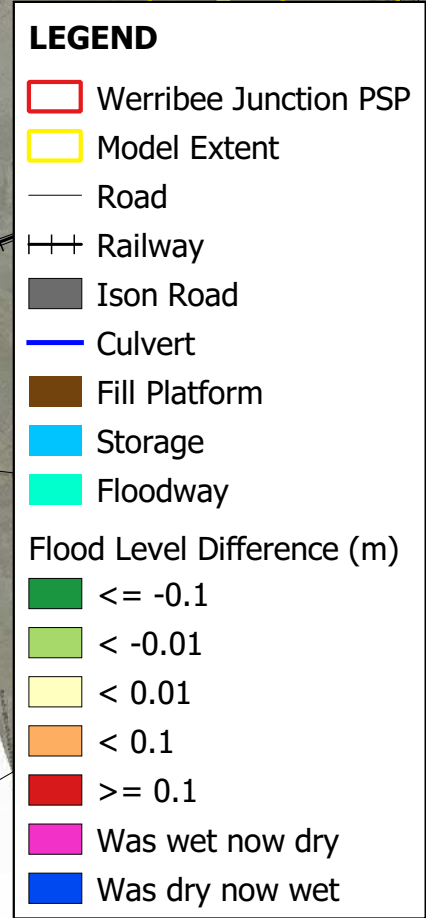
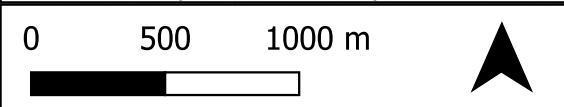


Figure F.1: Scenario 2c – 18.13% AEP flood level impacts

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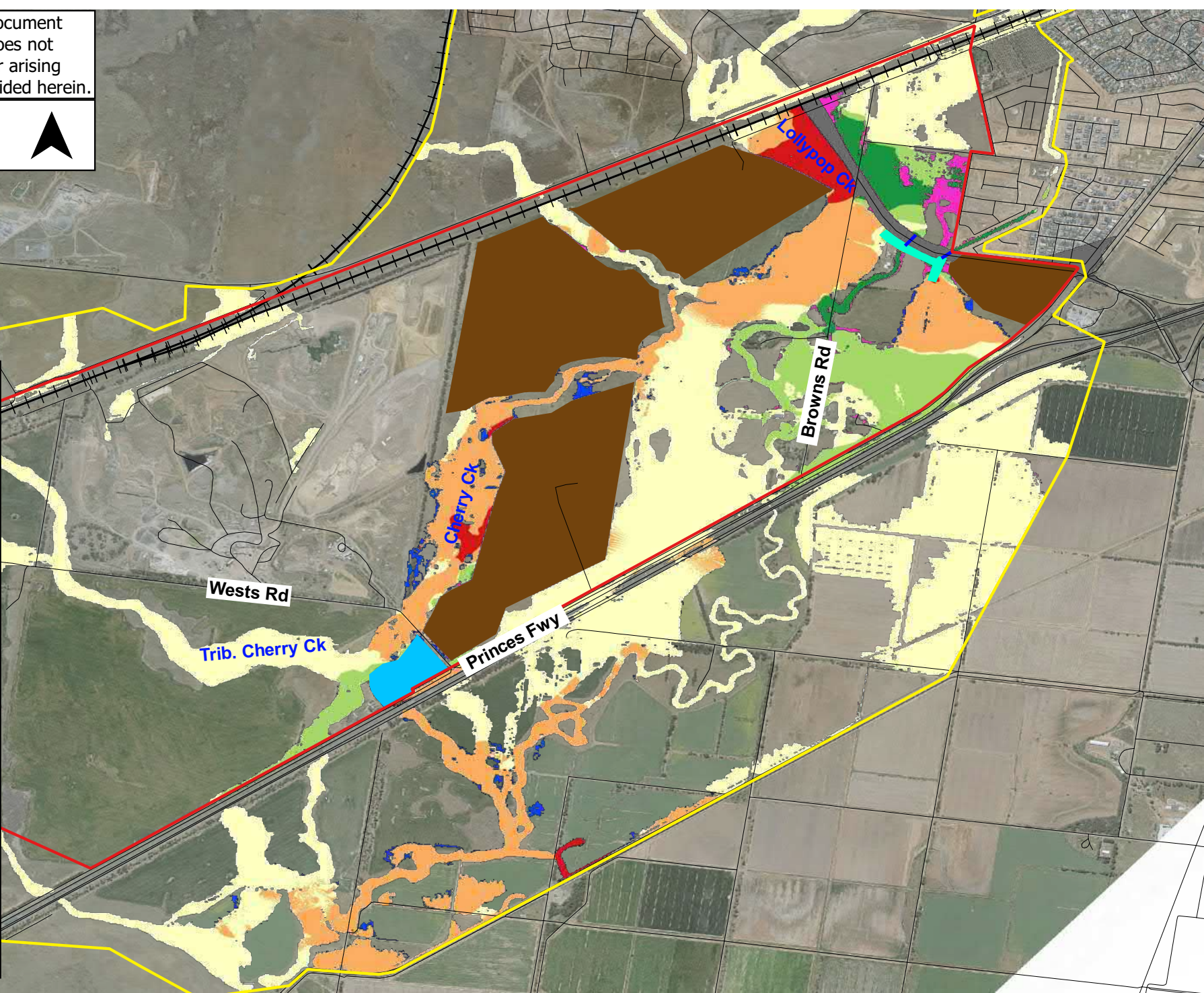
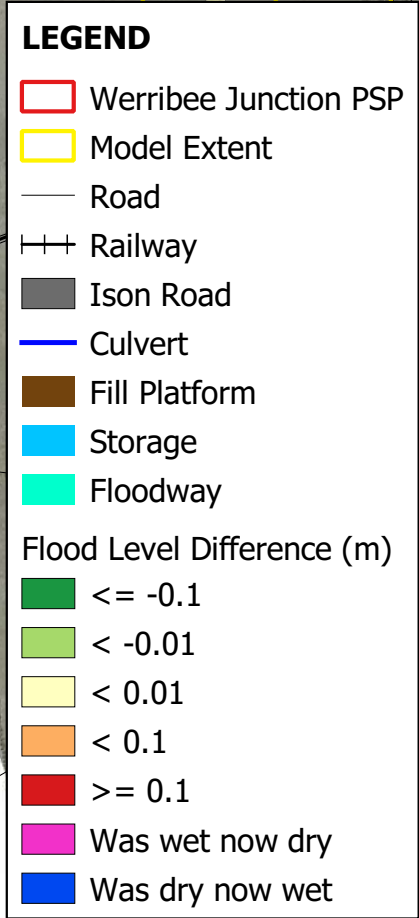
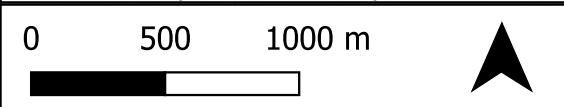


Figure F.2: Scenario 2c – 10% AEP flood level impacts

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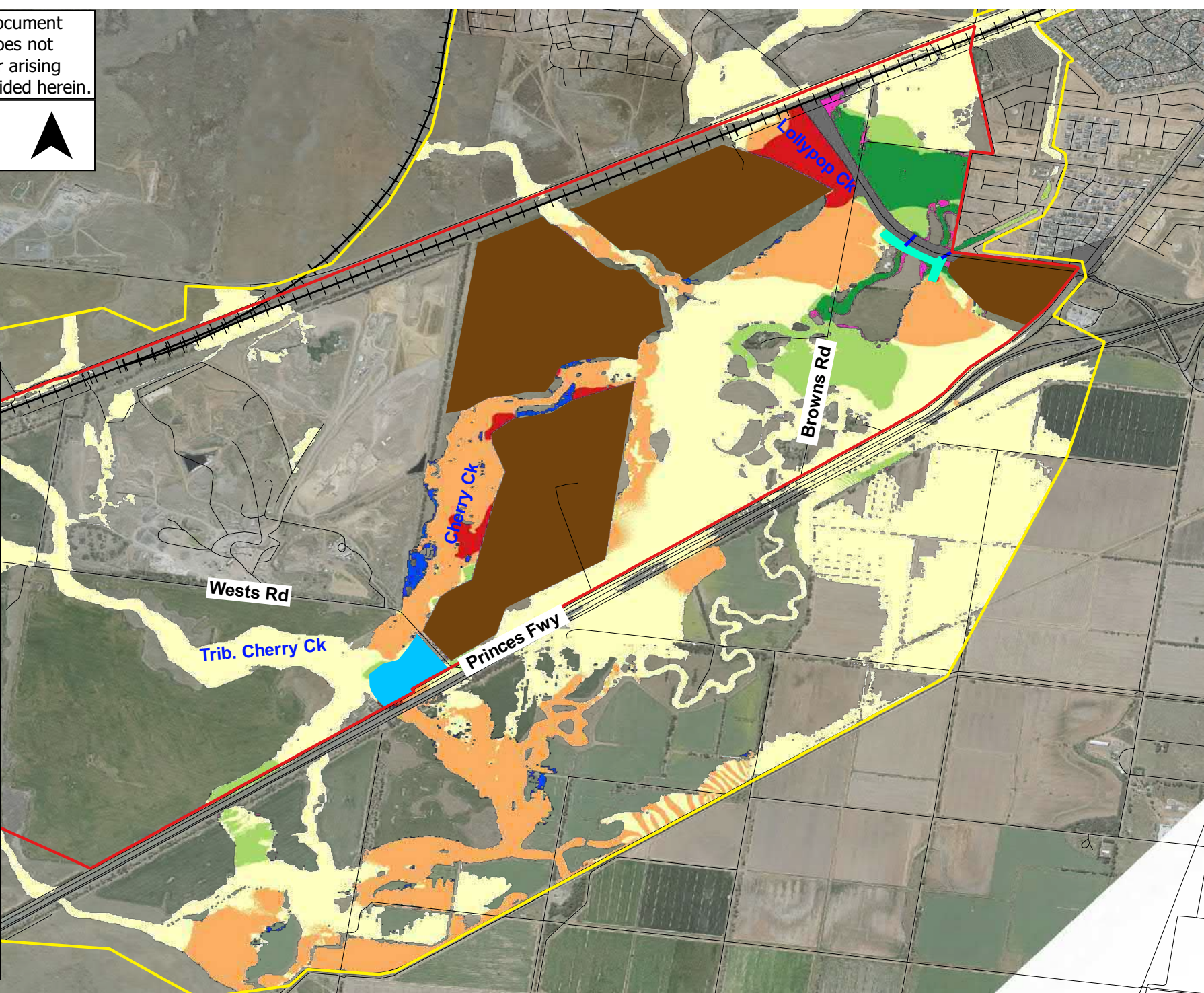
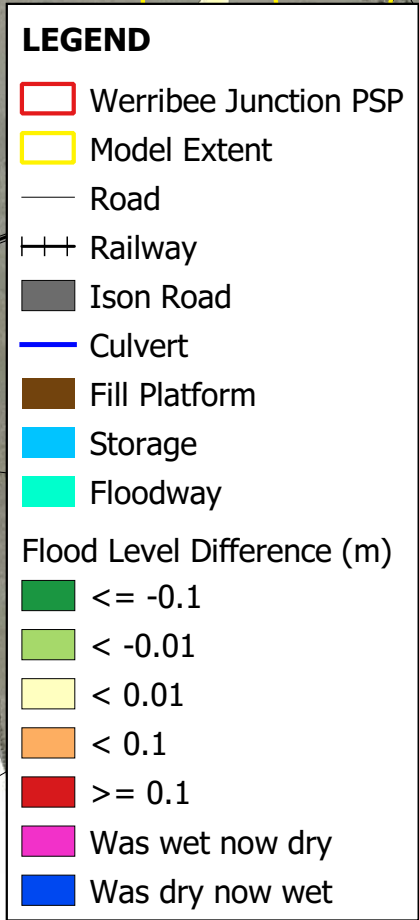
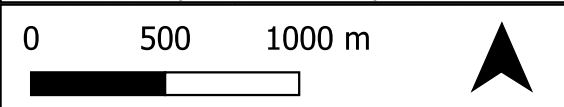


Figure F.3: Scenario 2c – 5% AEP flood level impacts

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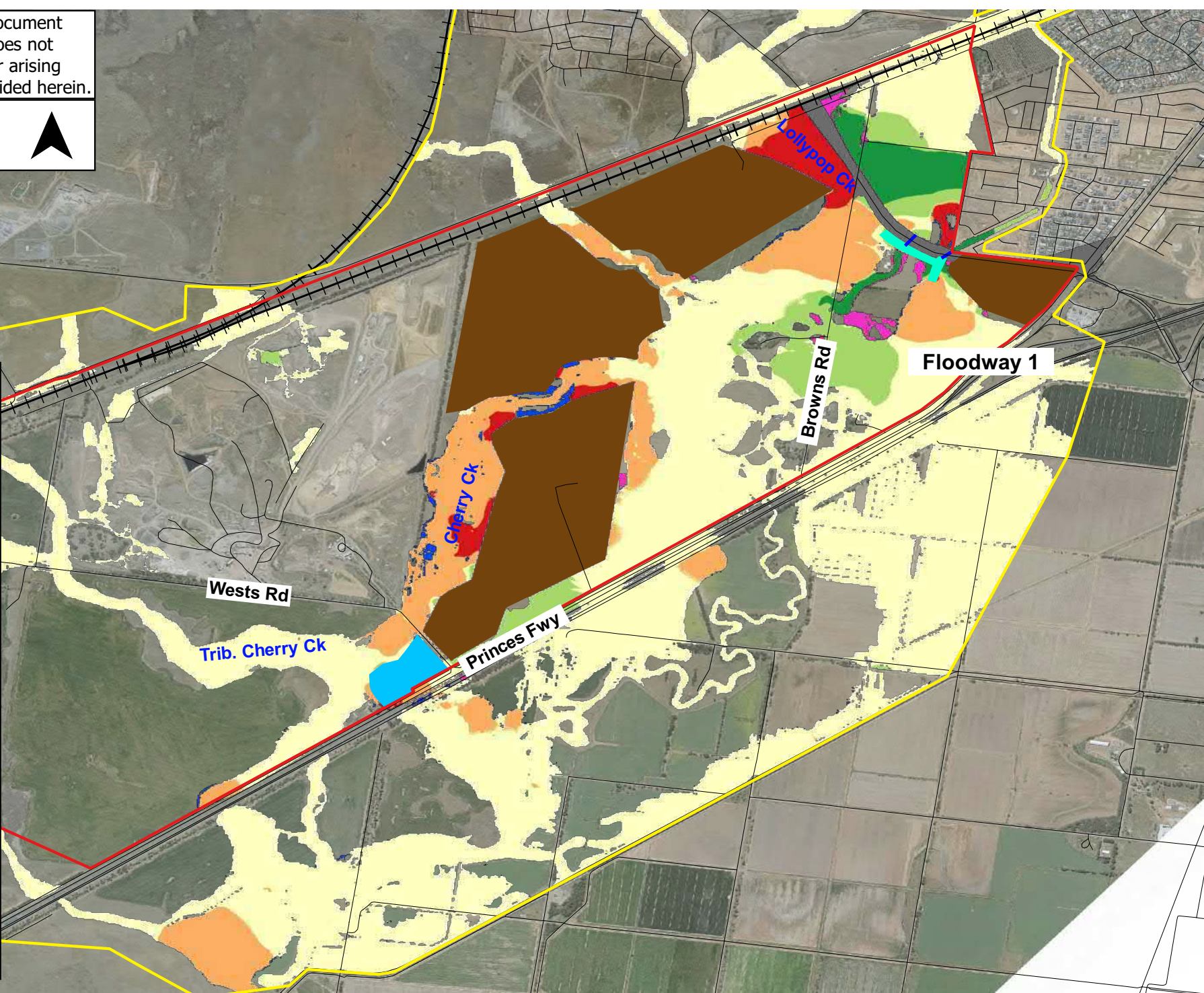
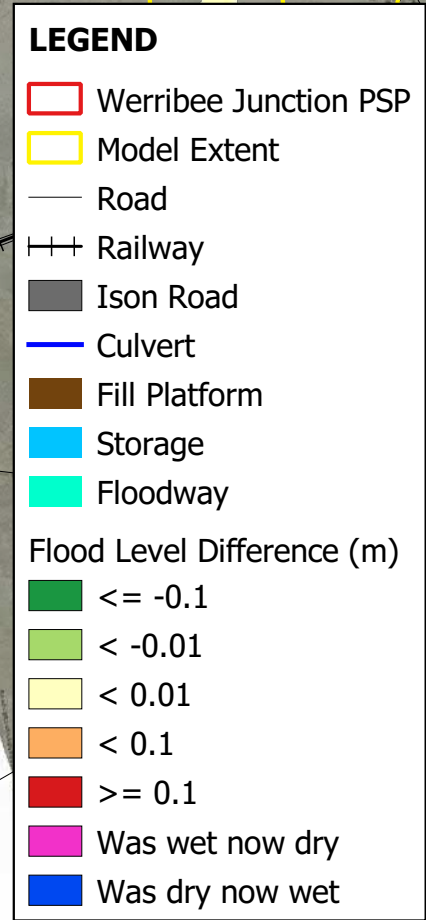
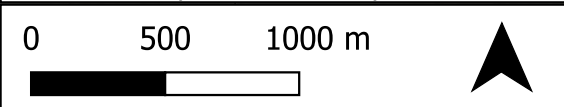


Figure F.4: Scenario 2c – 2% AEP flood level impacts

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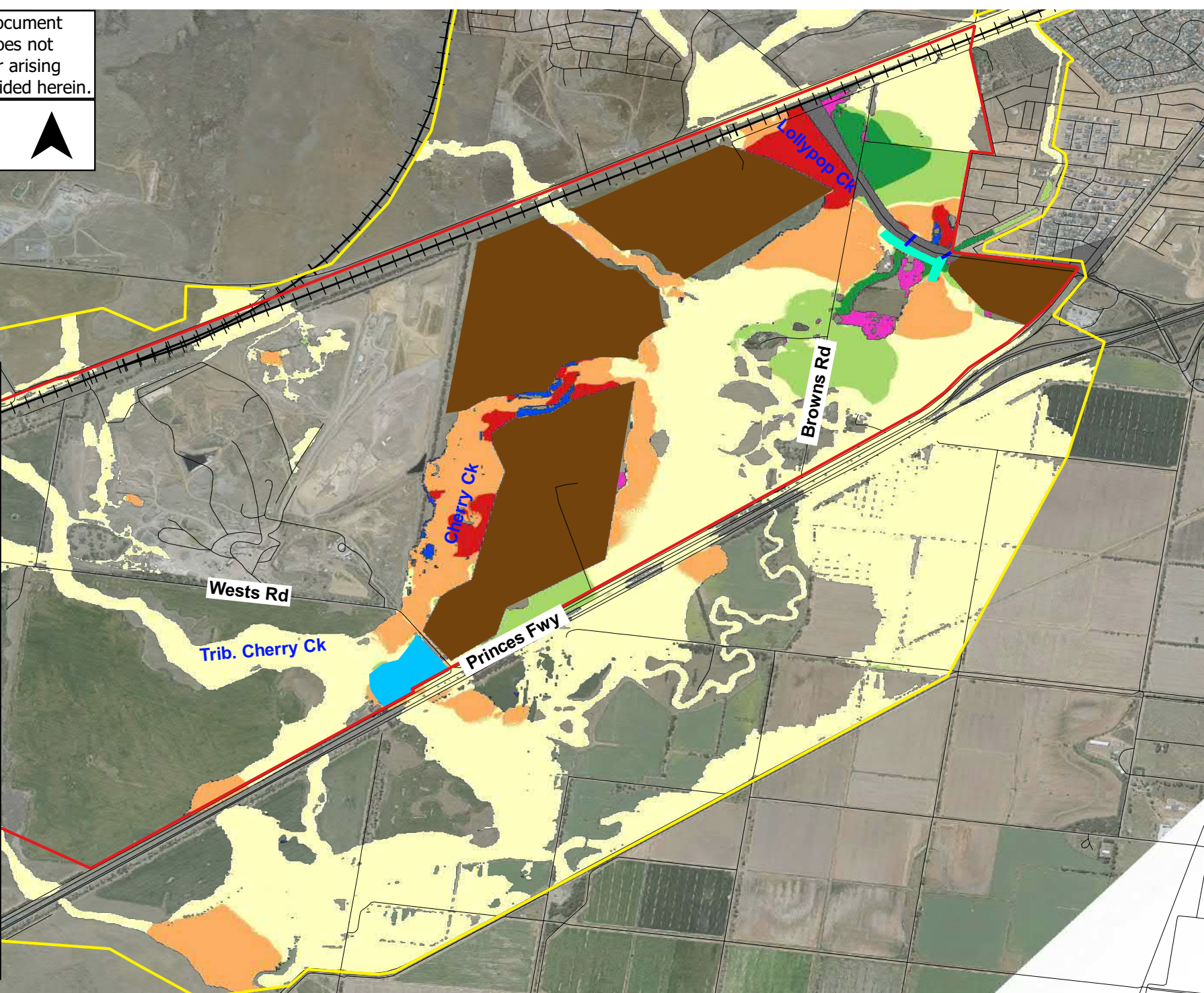
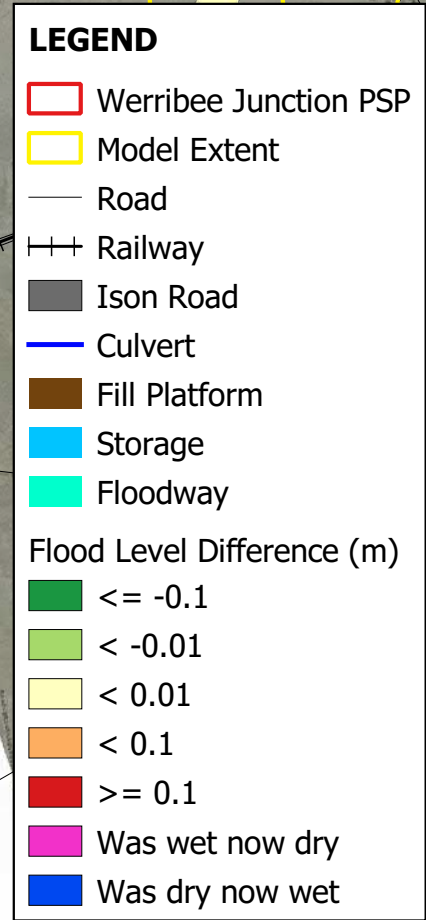
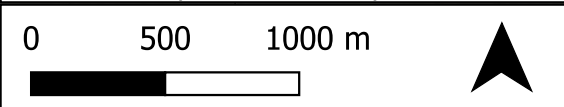


Figure F.5: Scenario 2c – 1% AEP flood level impacts

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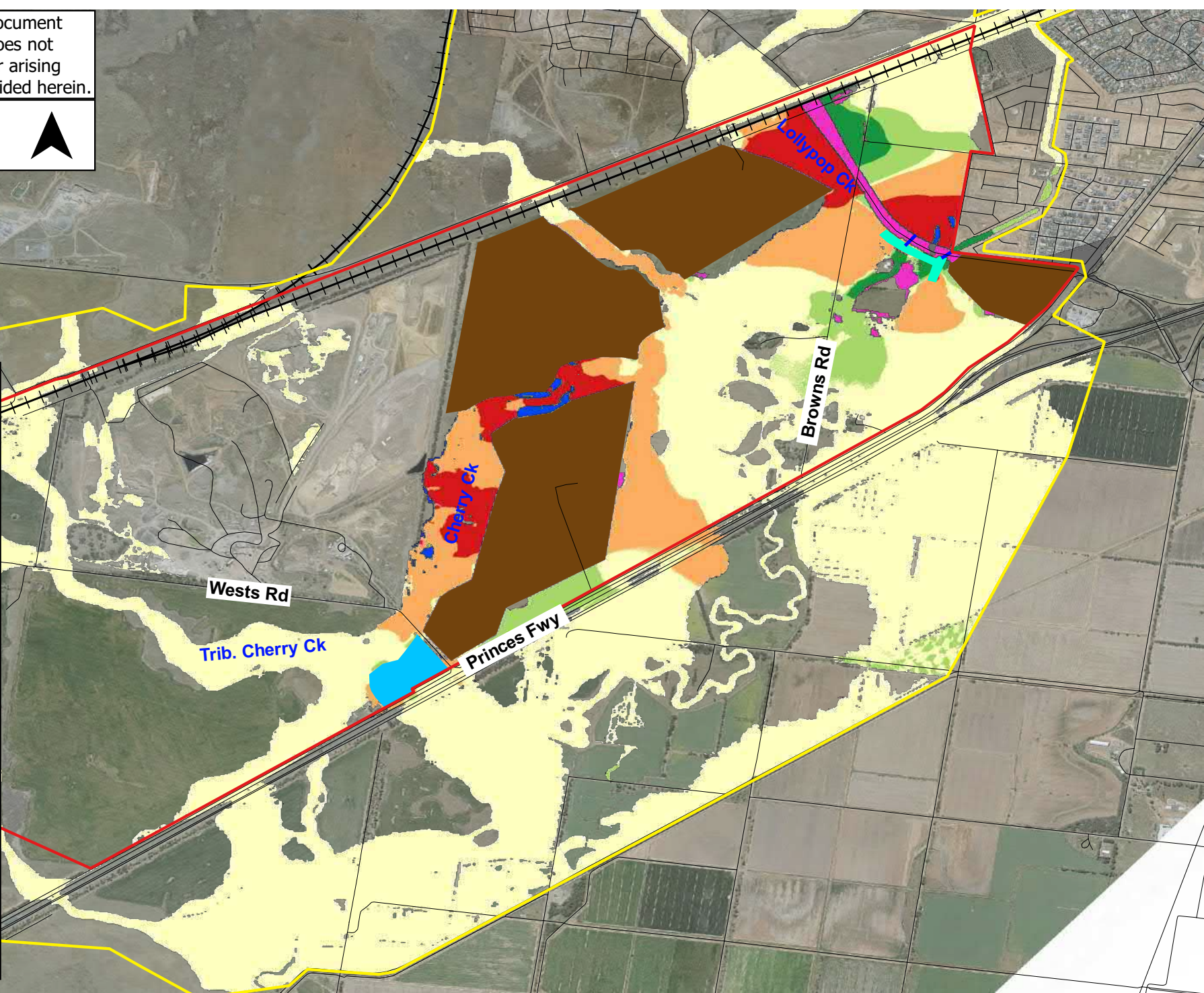
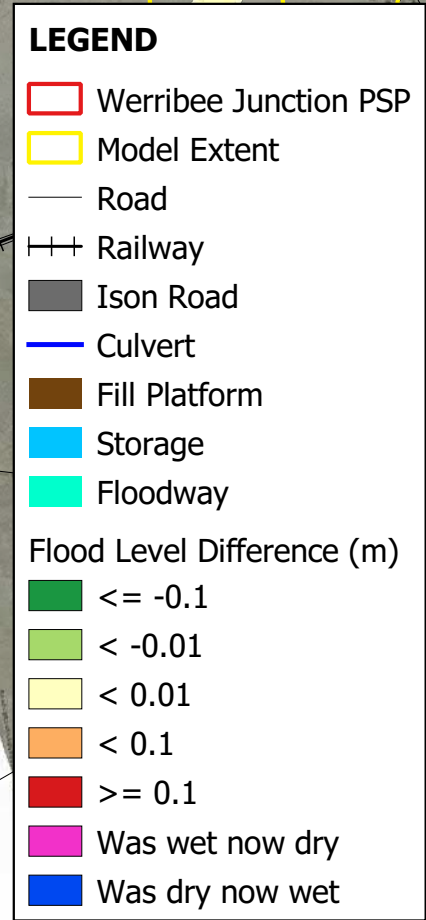
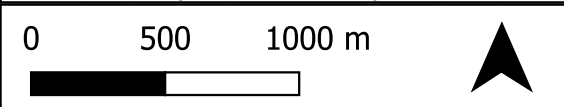


Figure F.6: Scenario 2c – 1% AEP climate change flood level impacts

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Appendix G. Scenario 2d flood impact and extent maps

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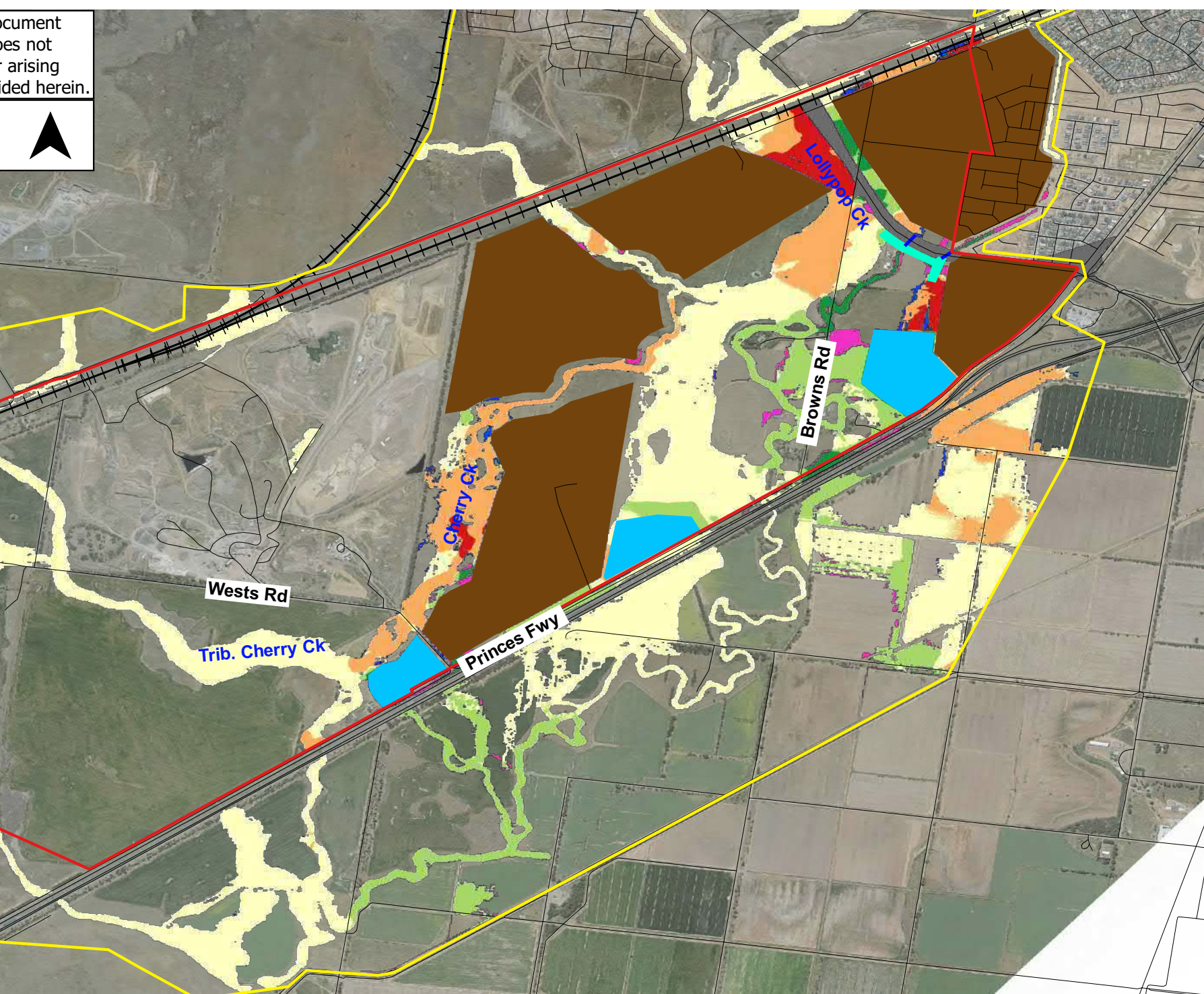
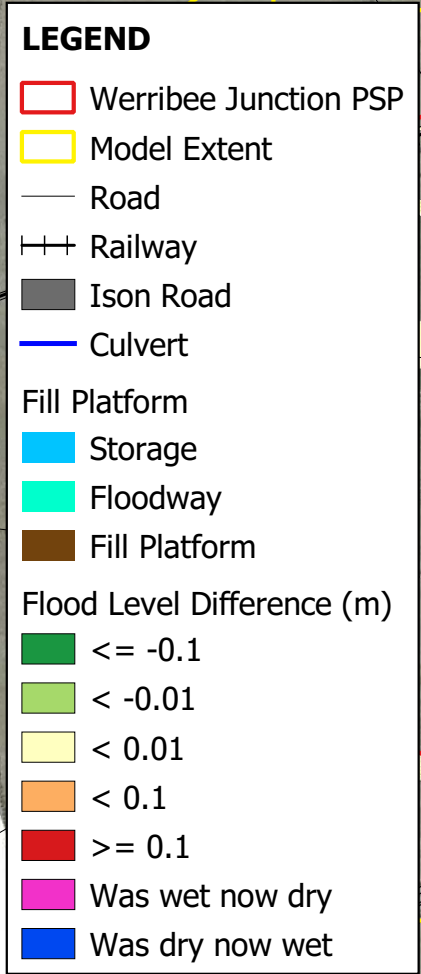
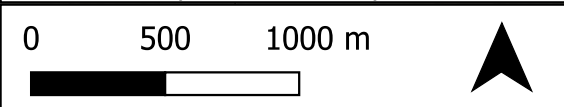


Figure G.1: Scenario 2d – 18.13% AEP flood level impacts

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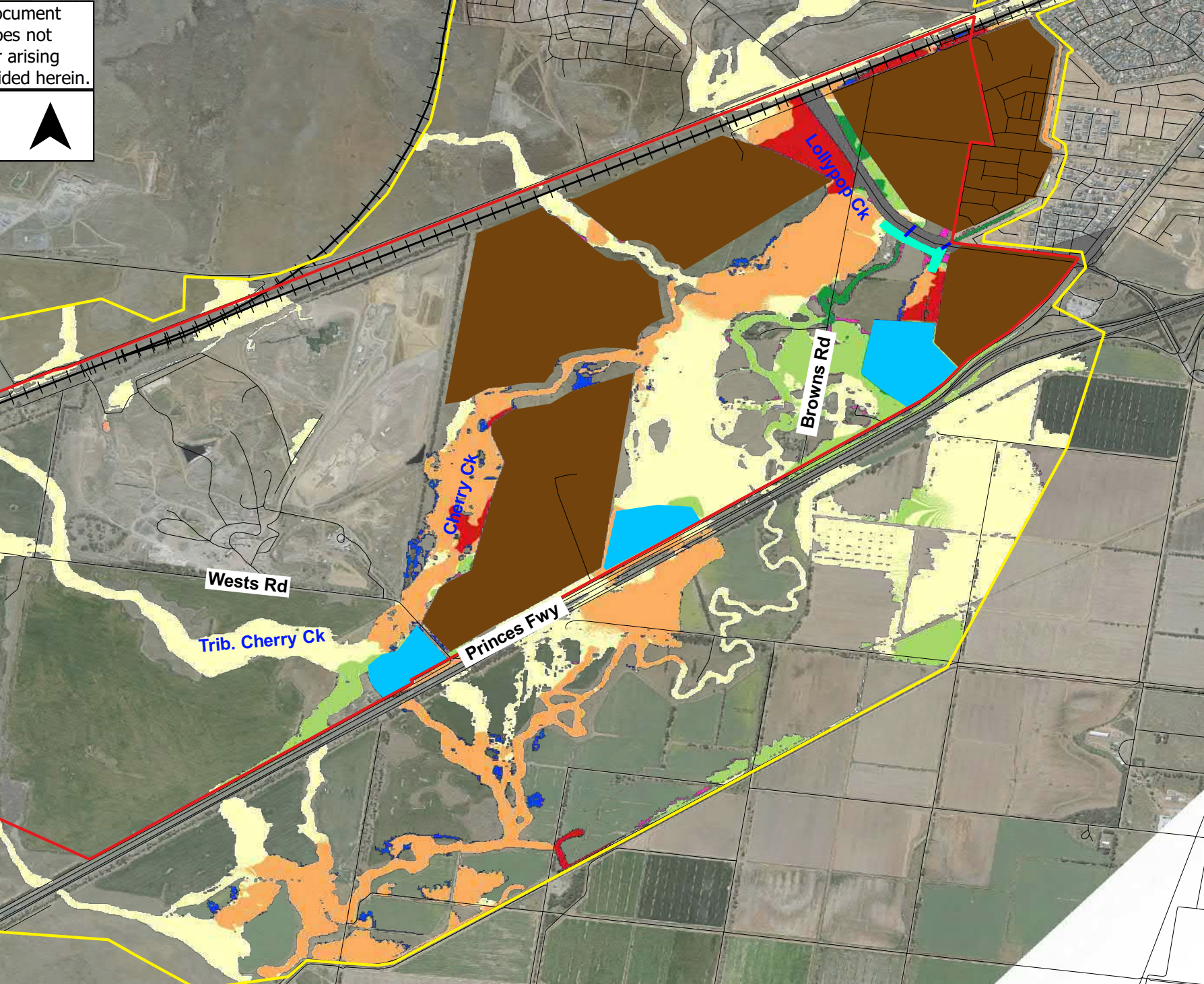
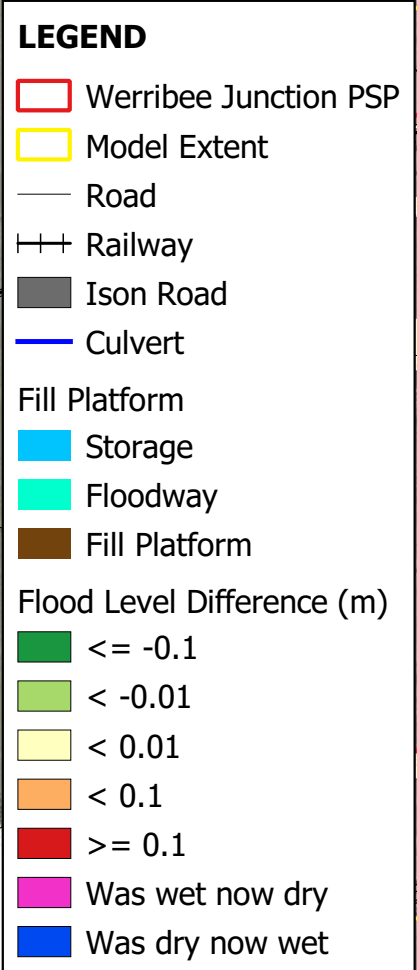
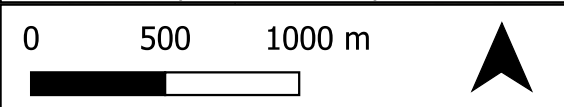


Figure G.2: Scenario 2d – 10% AEP flood level impacts

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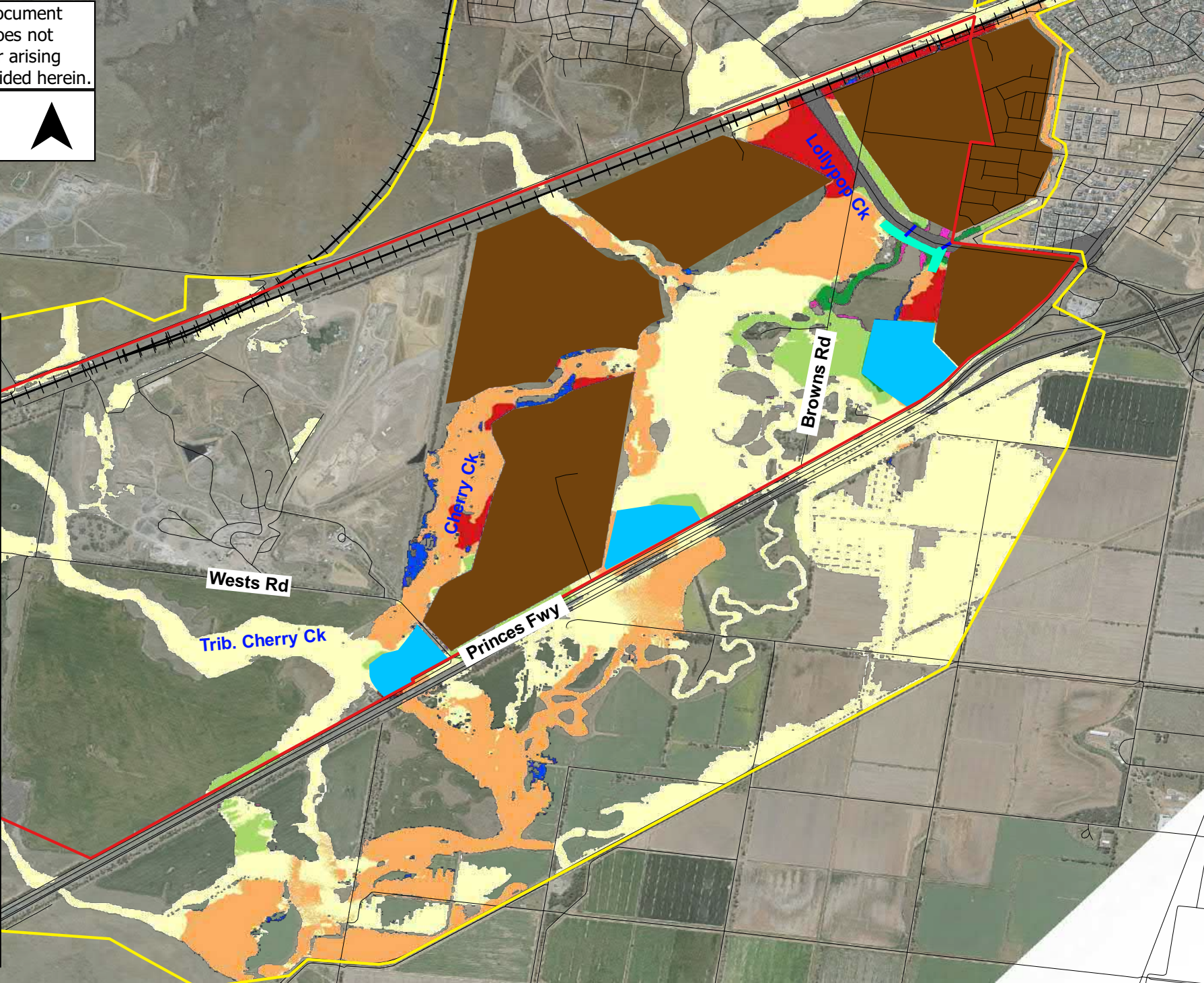
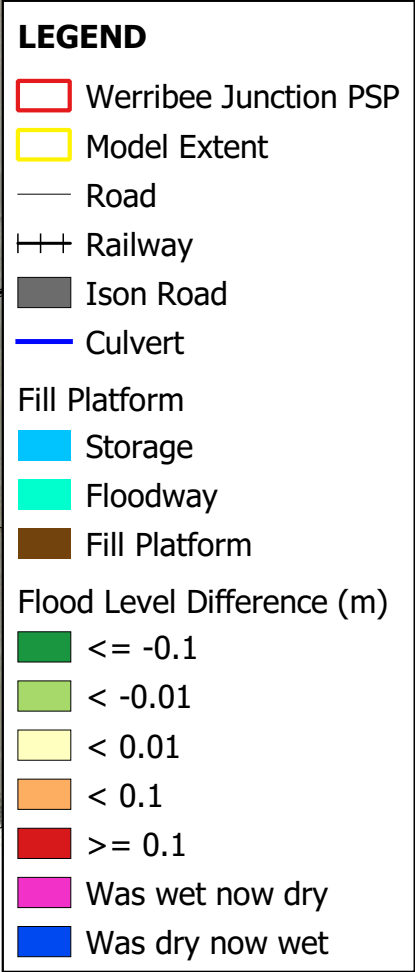
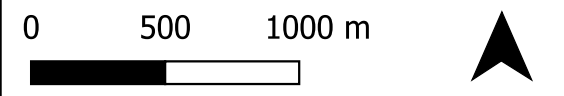


Figure G.3: Scenario 2d – 5% AEP flood level impacts

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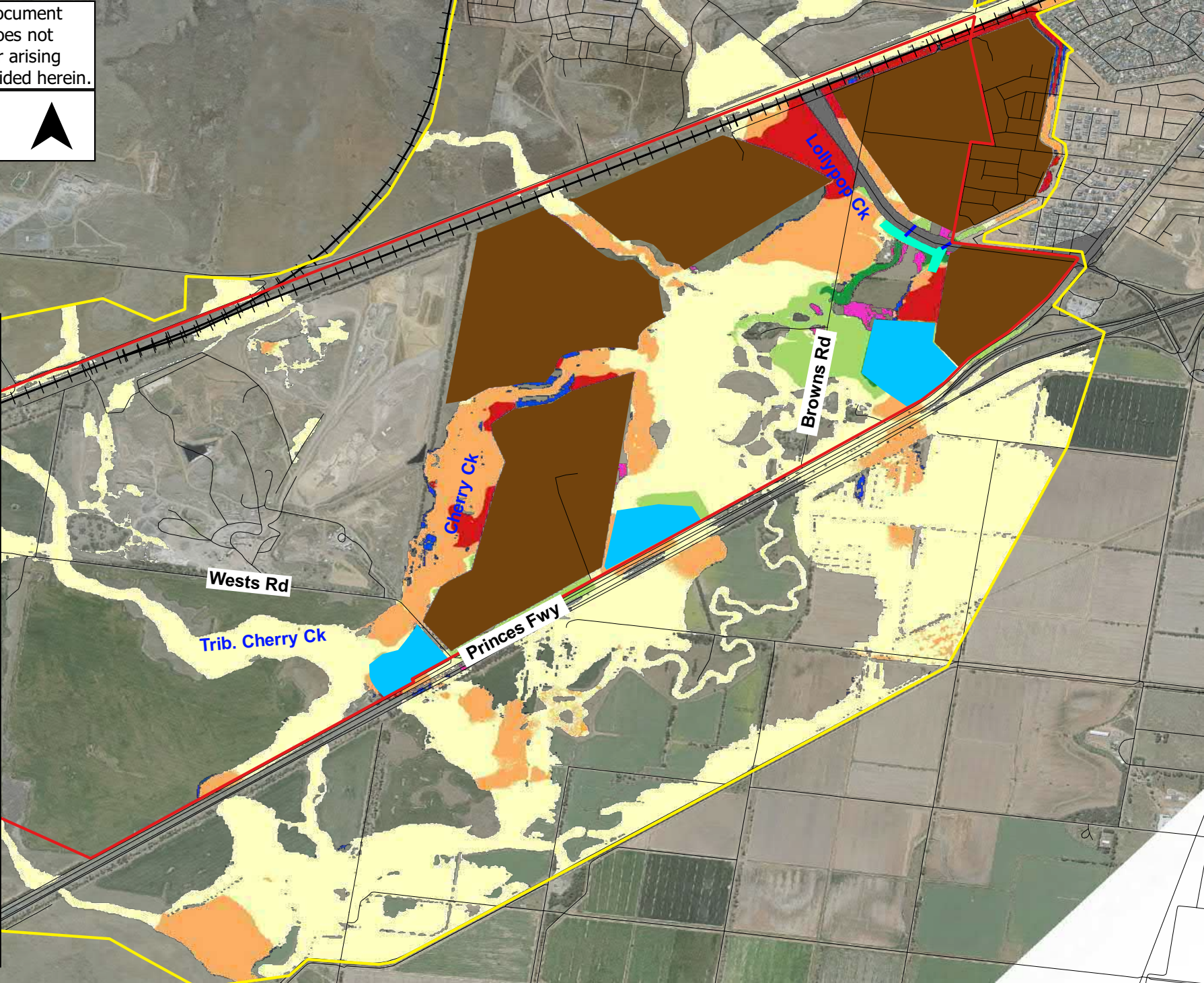
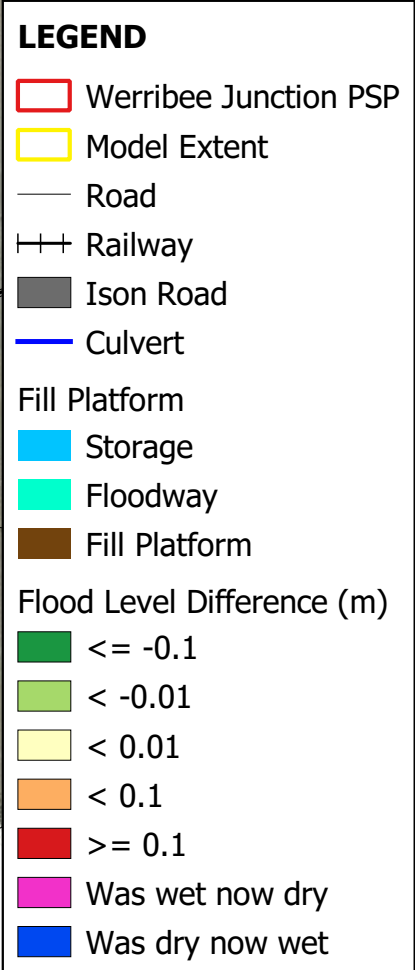
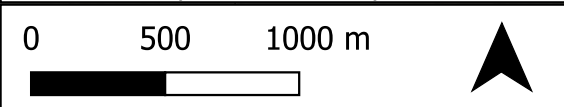


Figure G.4: Scenario 2d – 2% AEP flood level impacts

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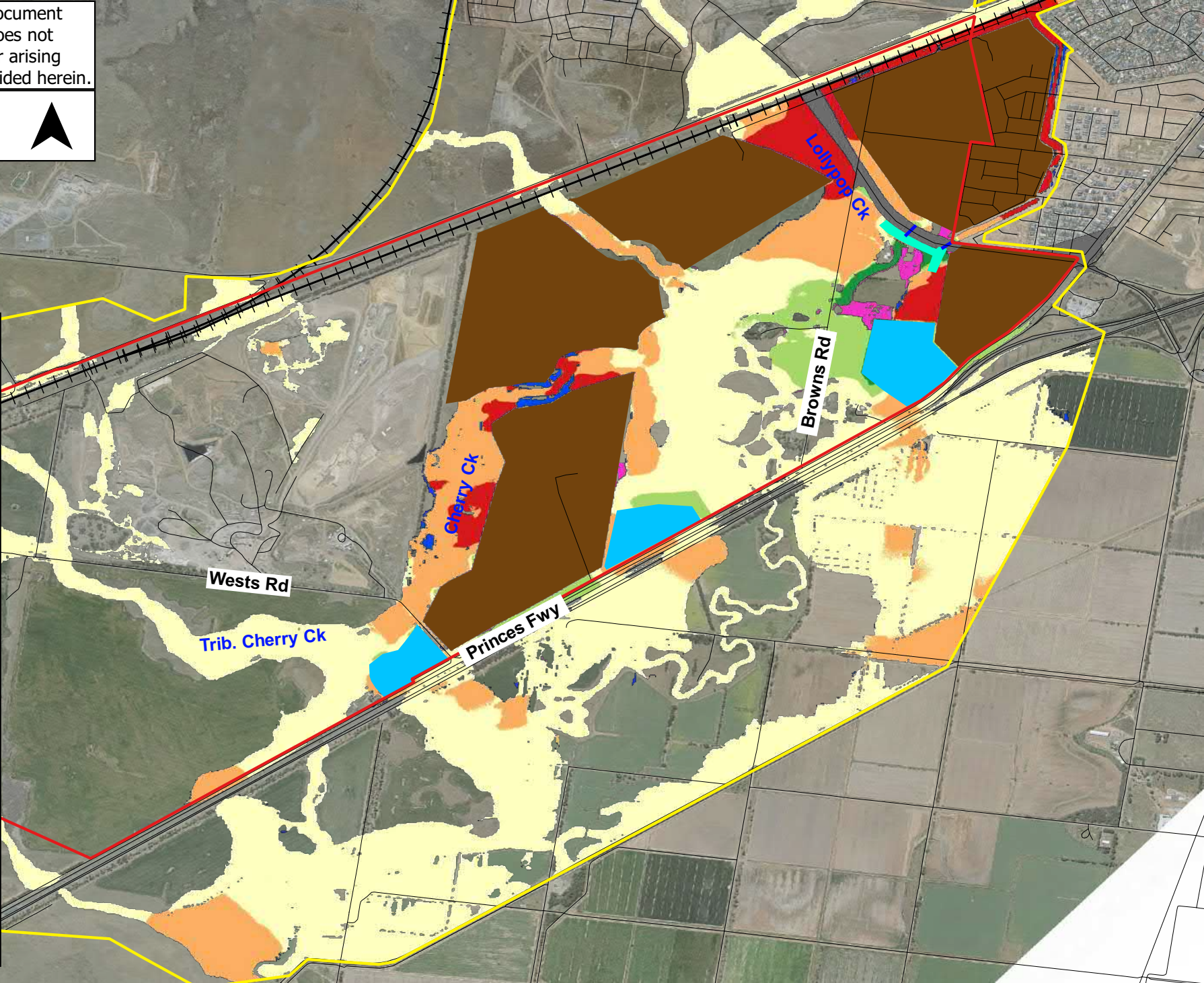
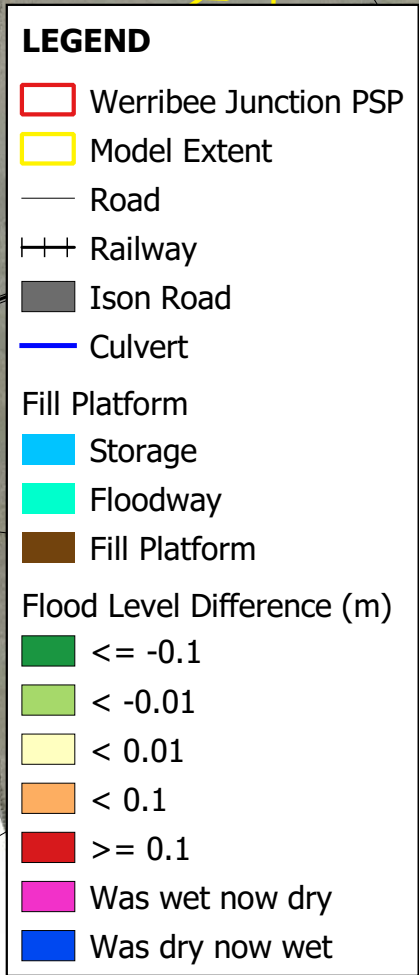
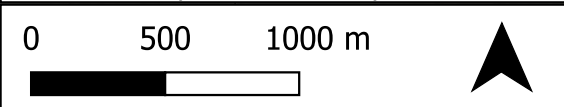


Figure G.5: Scenario 2d – 1% AEP flood level impacts

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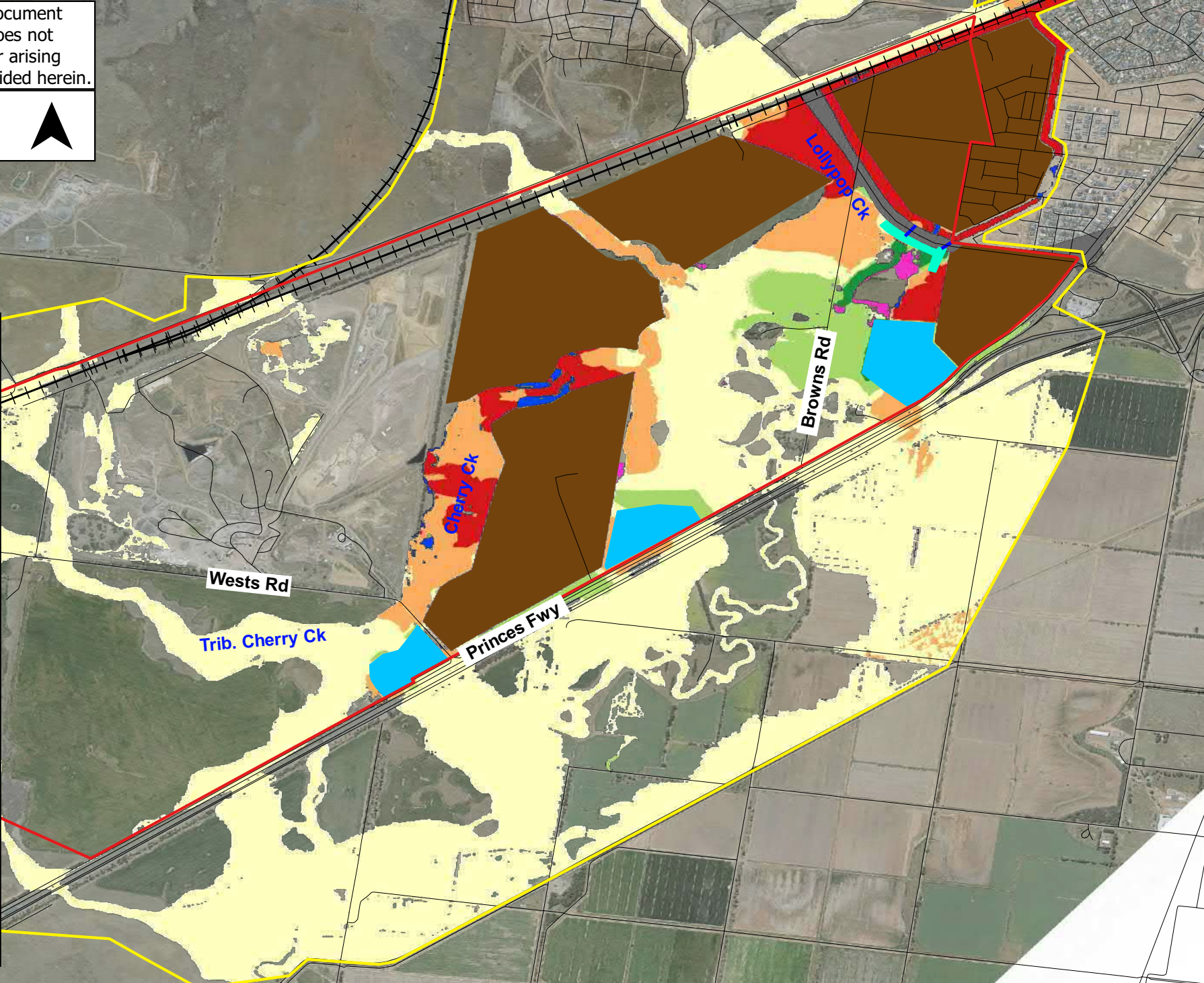
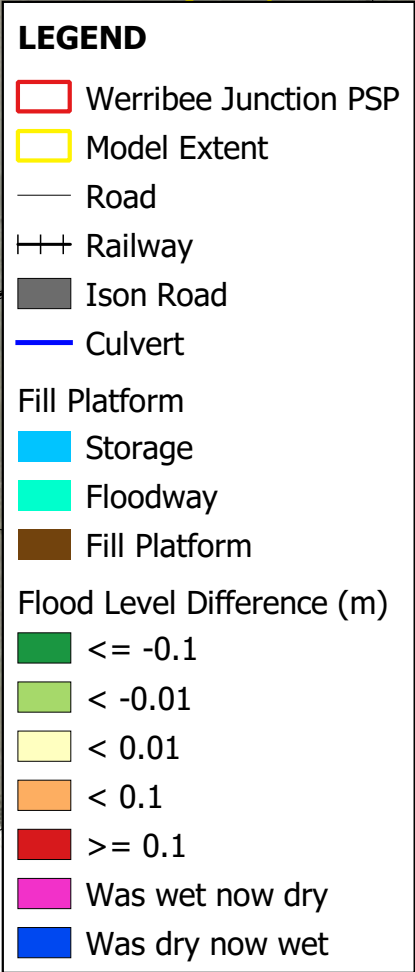
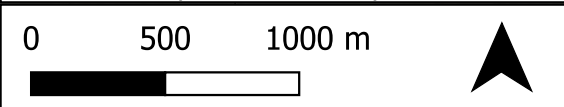


Figure G.6: Scenario 2d – 1% AEP climate change flood level impacts

Appendix H. Scenario 2e flood impact and extent maps

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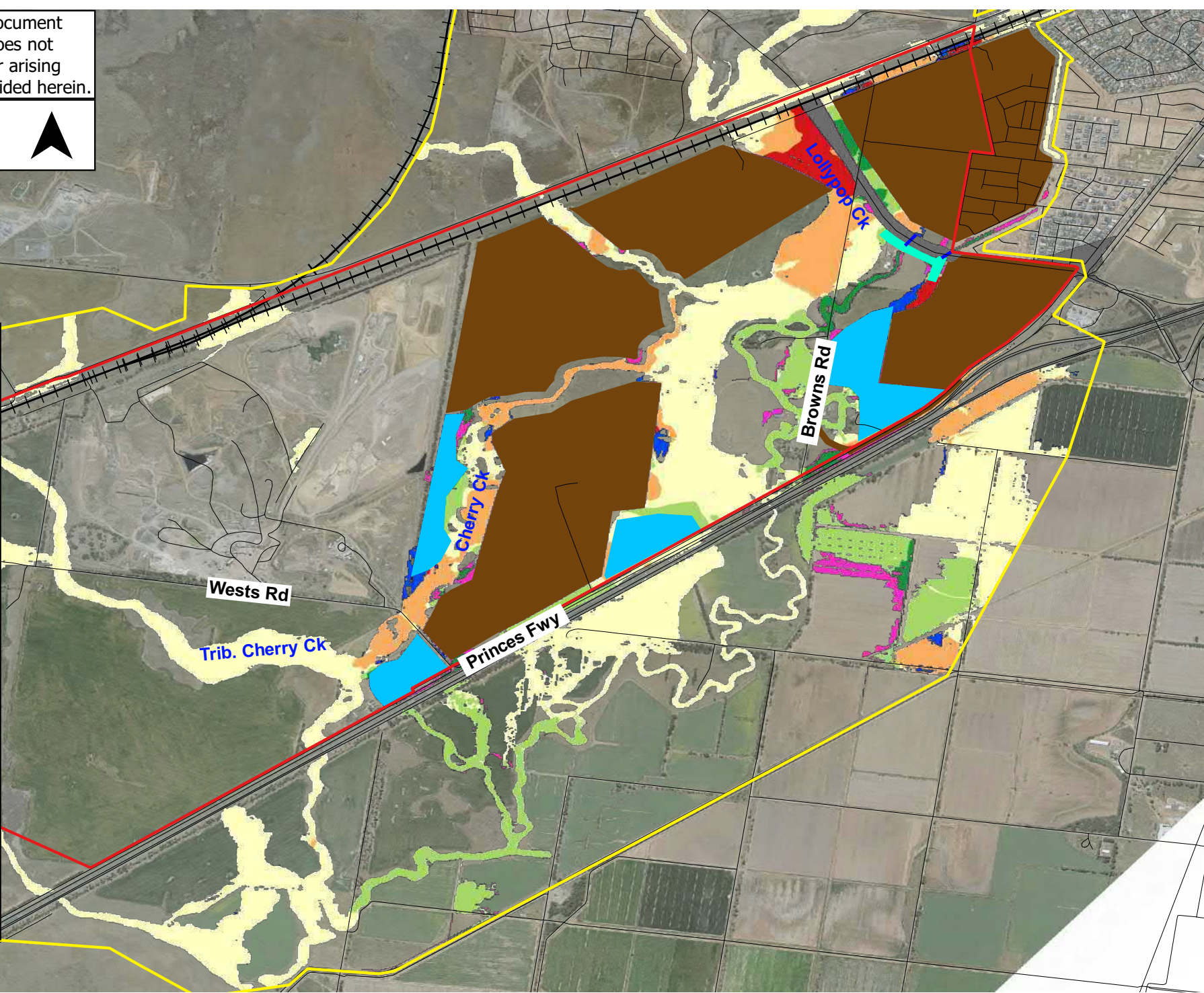
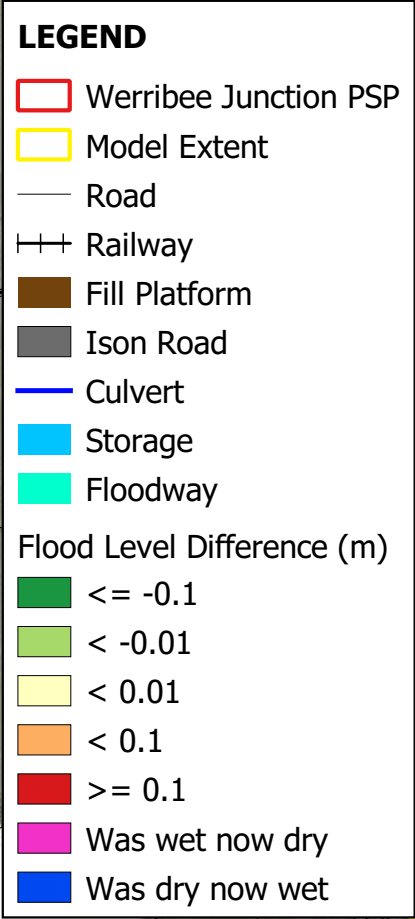
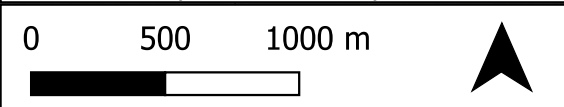


Figure H.1: Scenario 2e – 18.13% AEP flood level impacts

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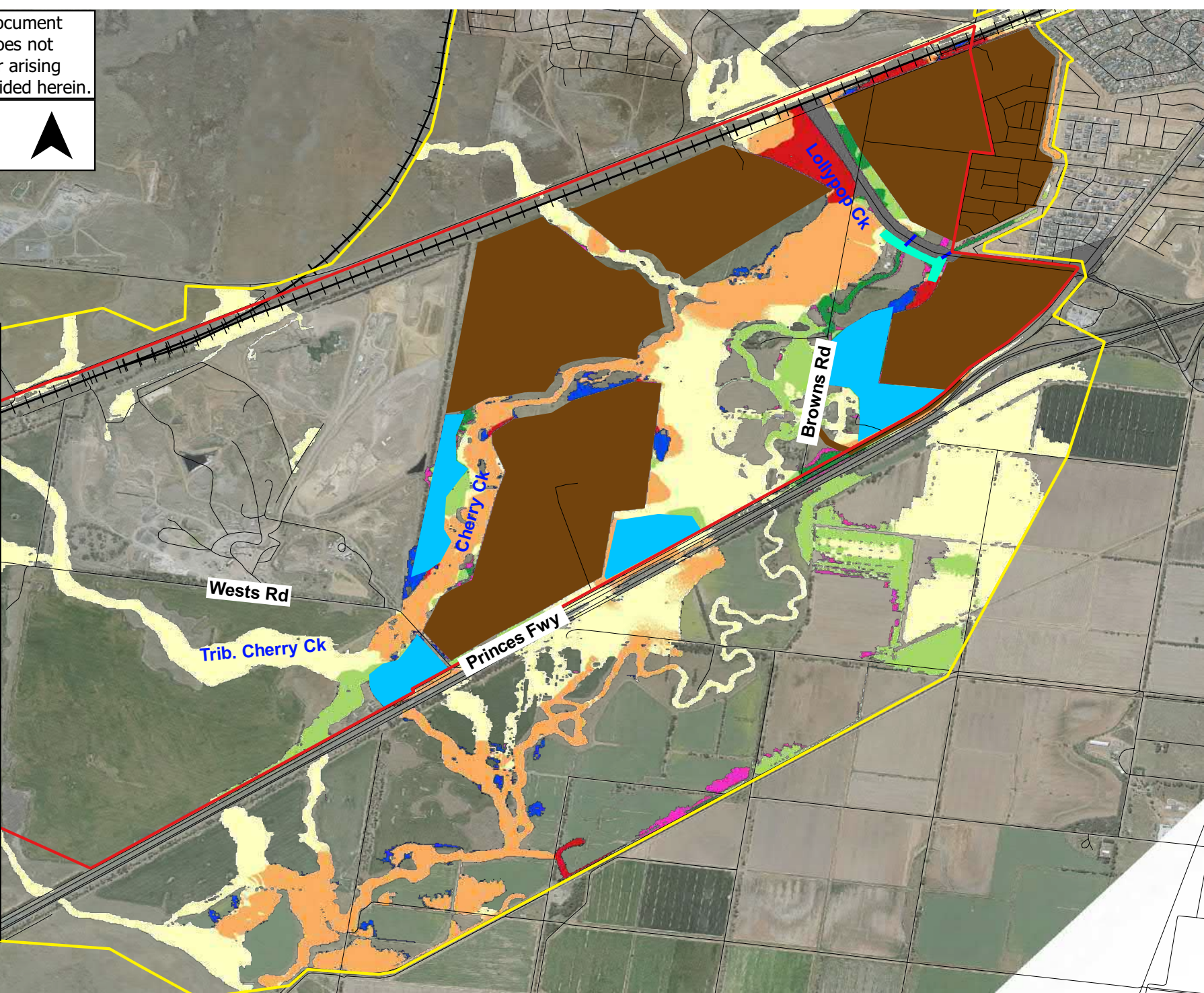
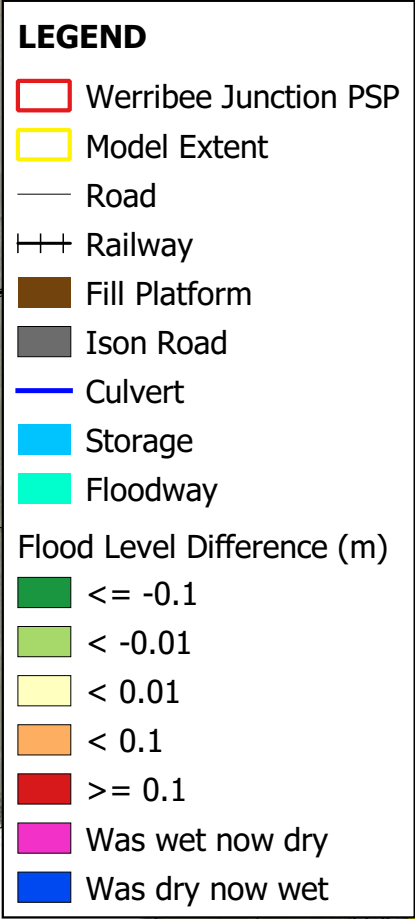
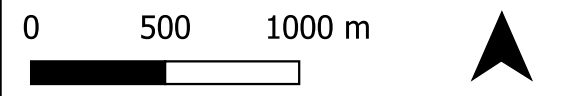


Figure H.2: Scenario 2e – 10% AEP flood level impacts

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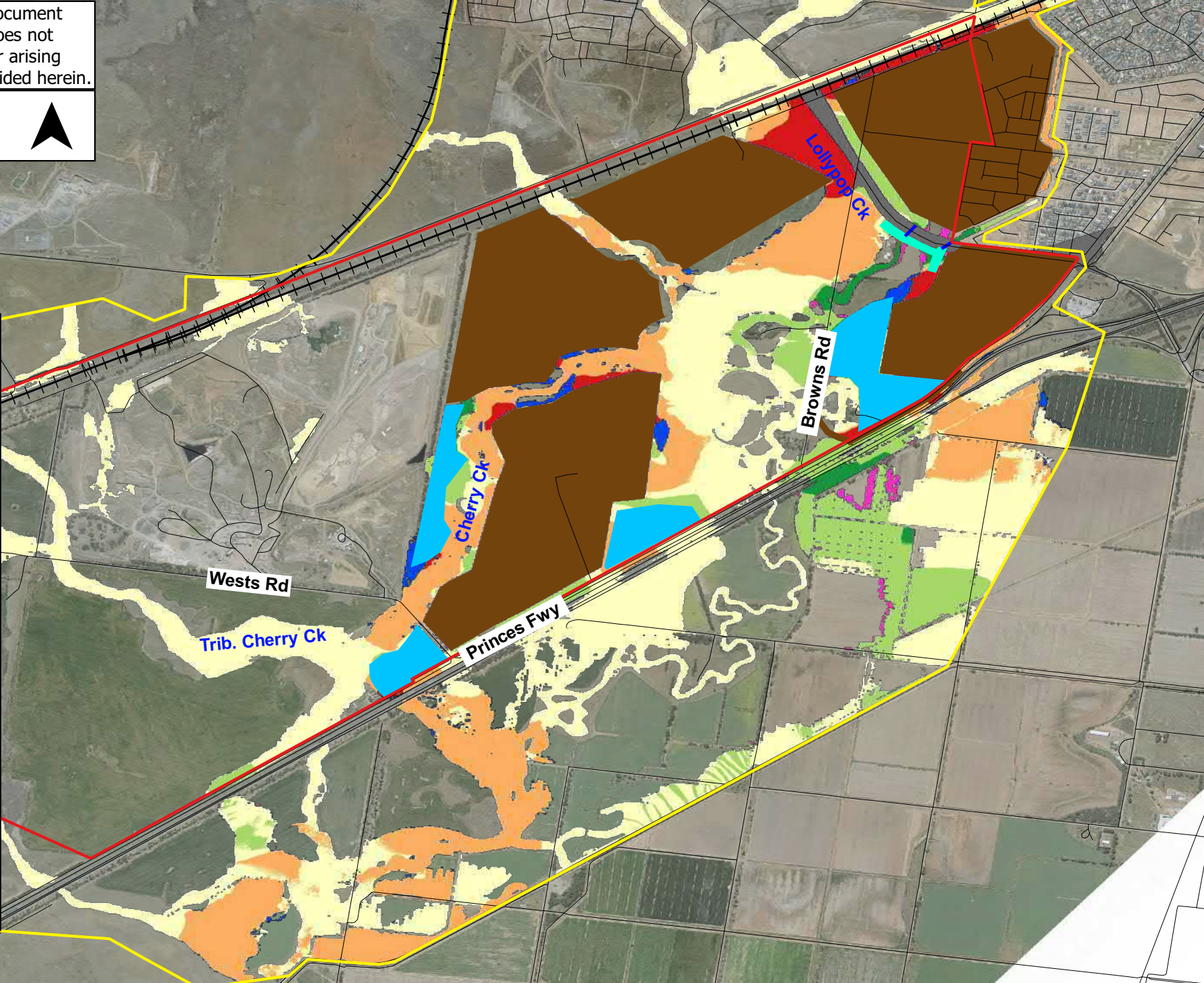
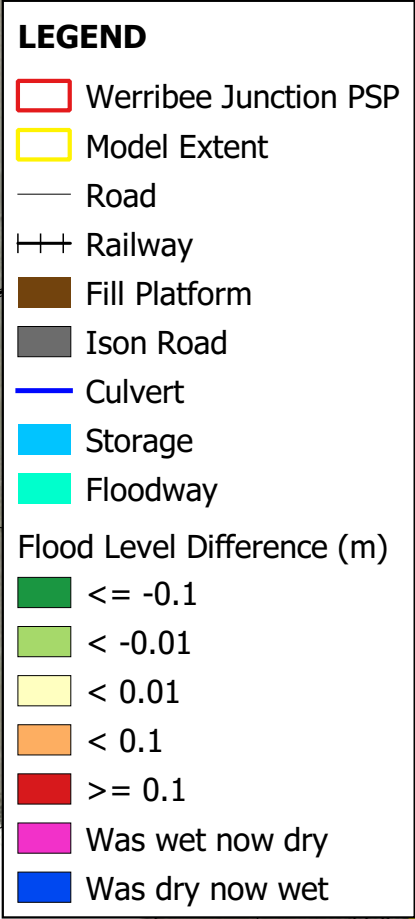
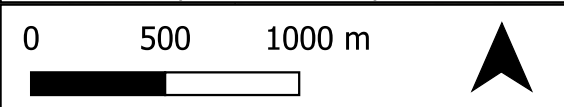


Figure H.3: Scenario 2e – 5% AEP flood level impacts

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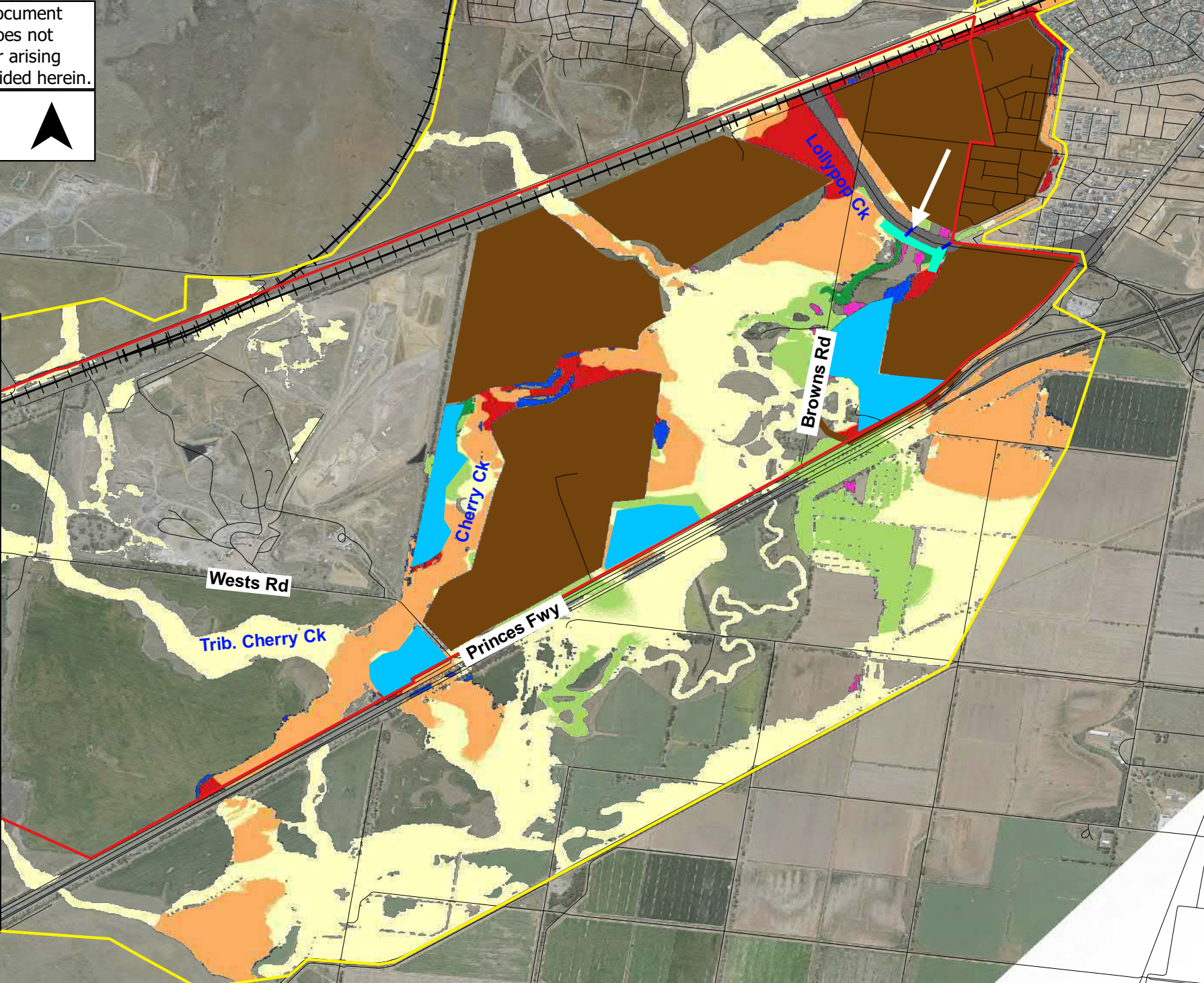
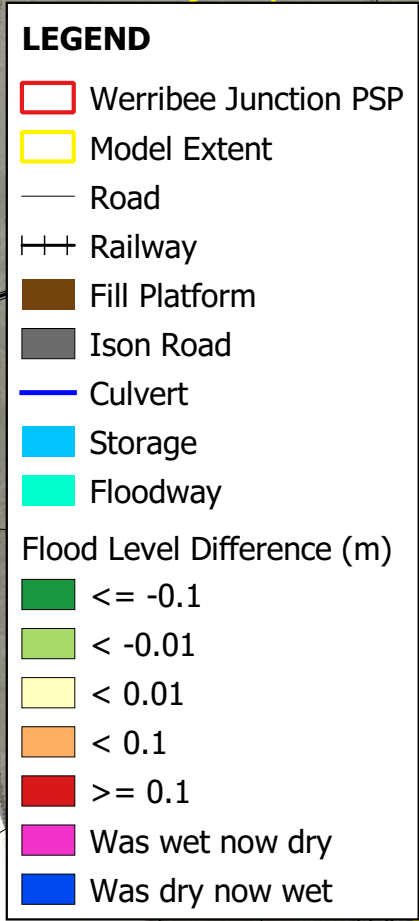
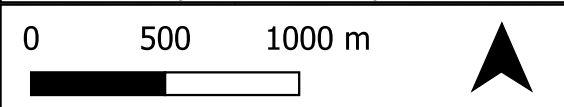


Figure H.4: Scenario 2e – 2% AEP flood level impacts

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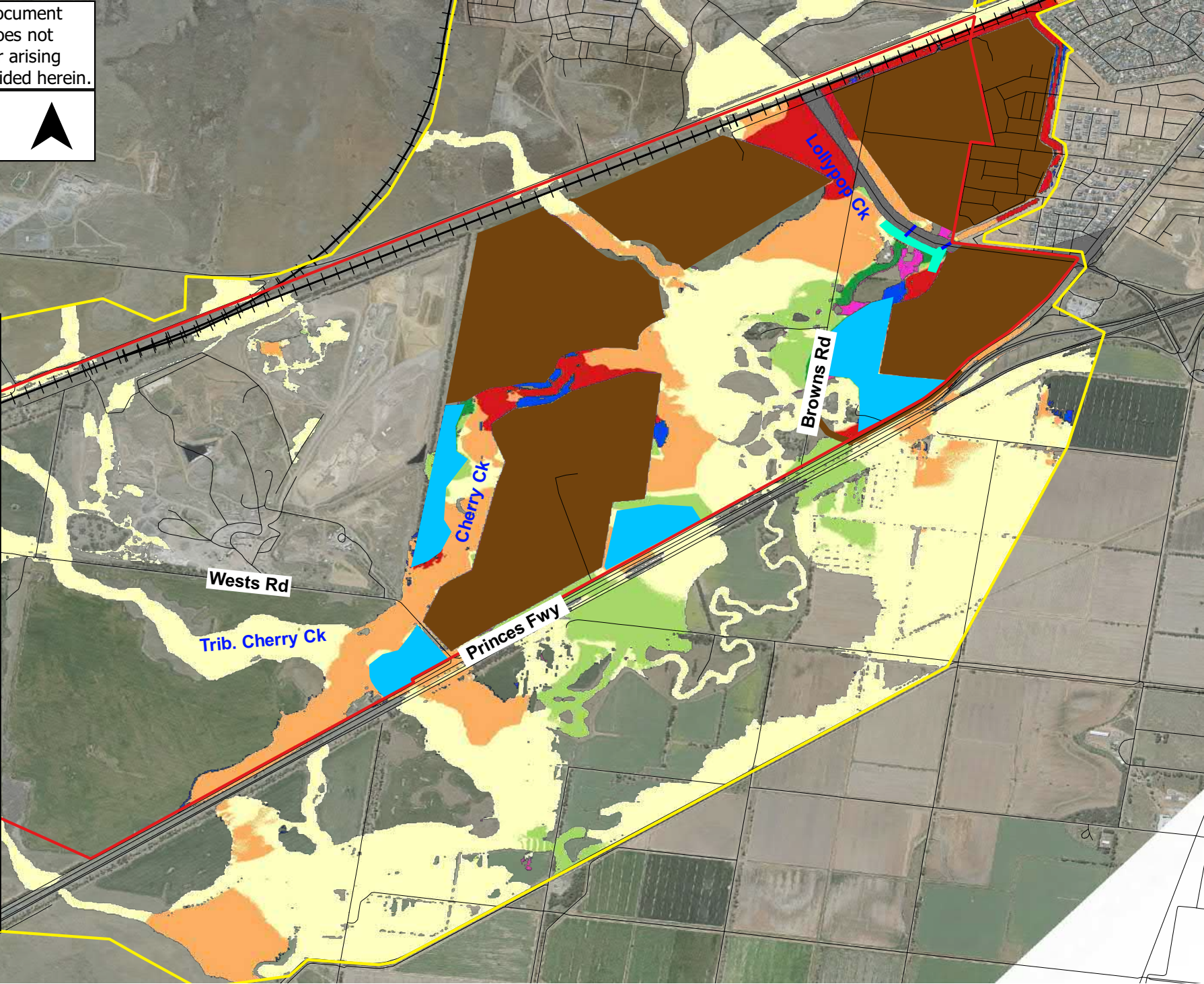
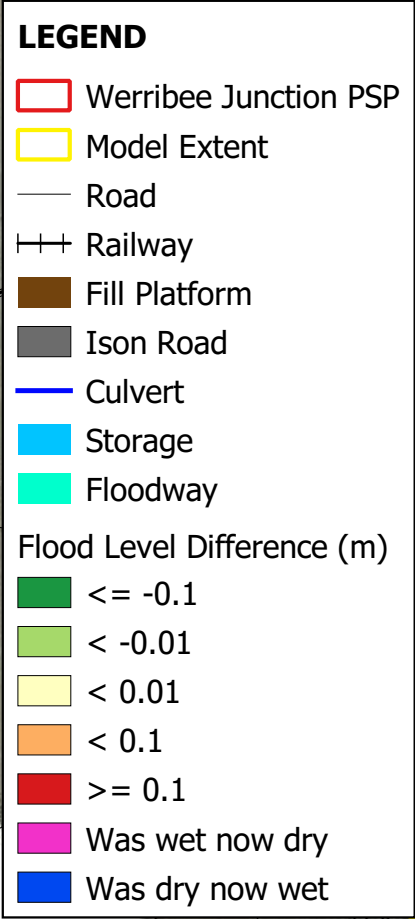
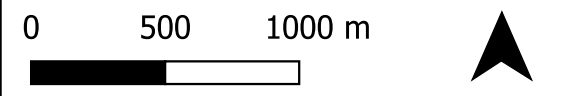


Figure H.5: Scenario 2e – 1% AEP flood level impacts

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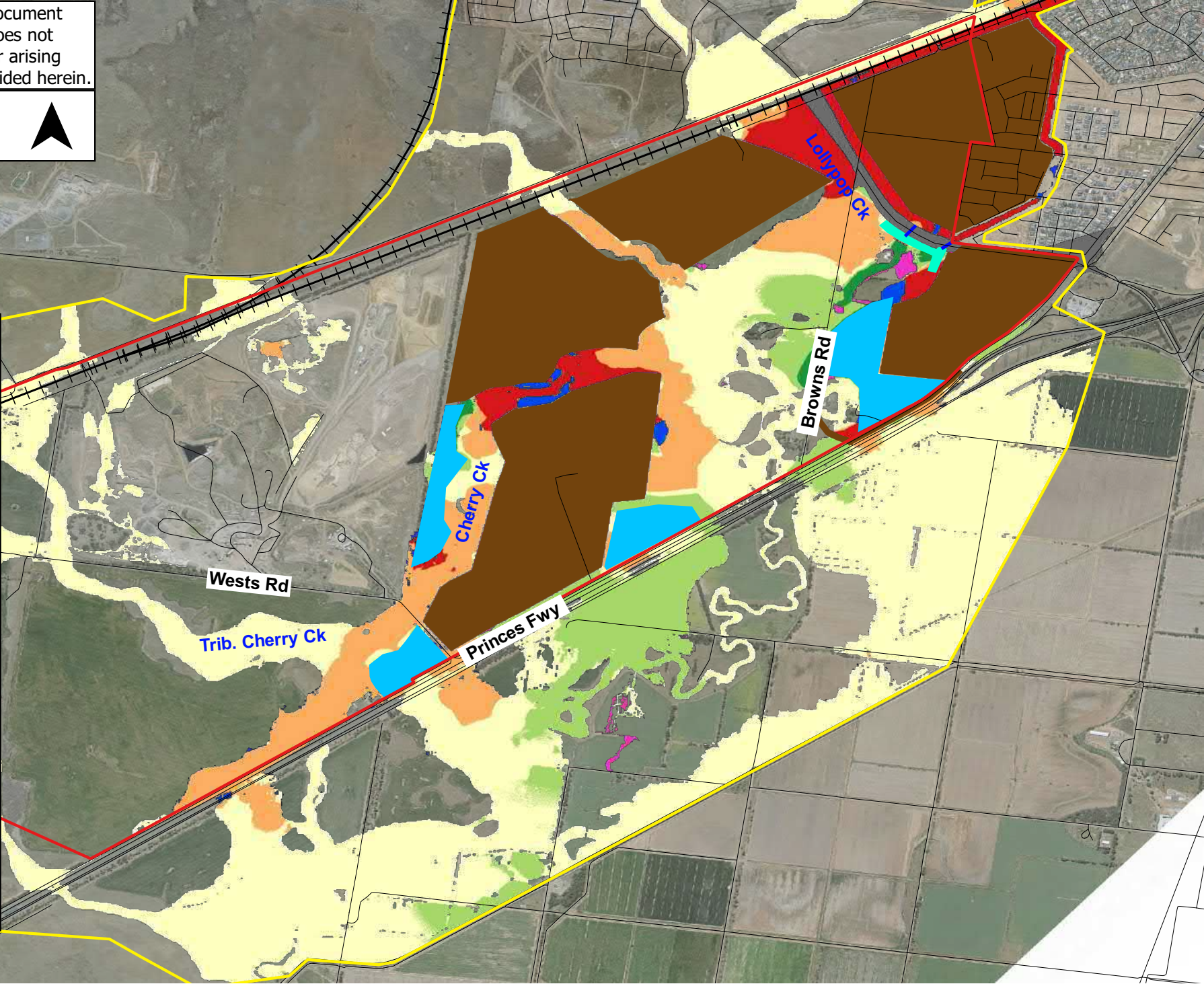
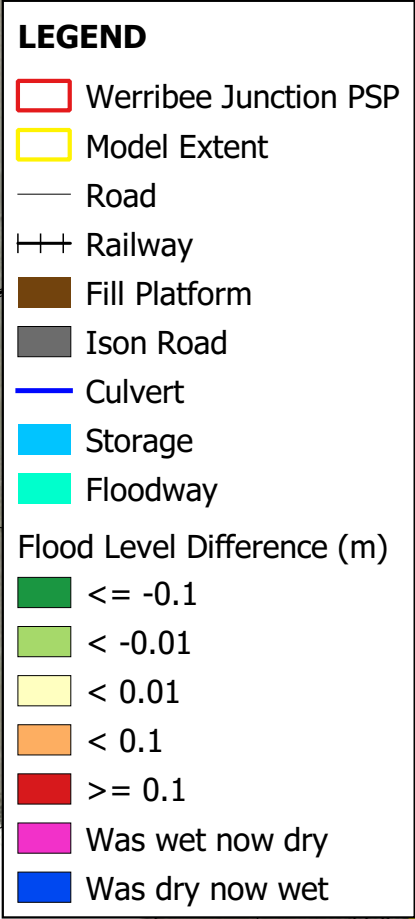
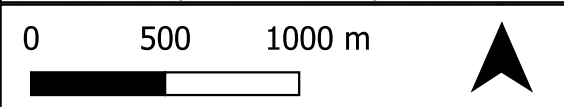


Figure H.6: Scenario 2e – 1% AEP climate change flood level impacts

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Appendix I. Scenario 3a flood impact and extent maps

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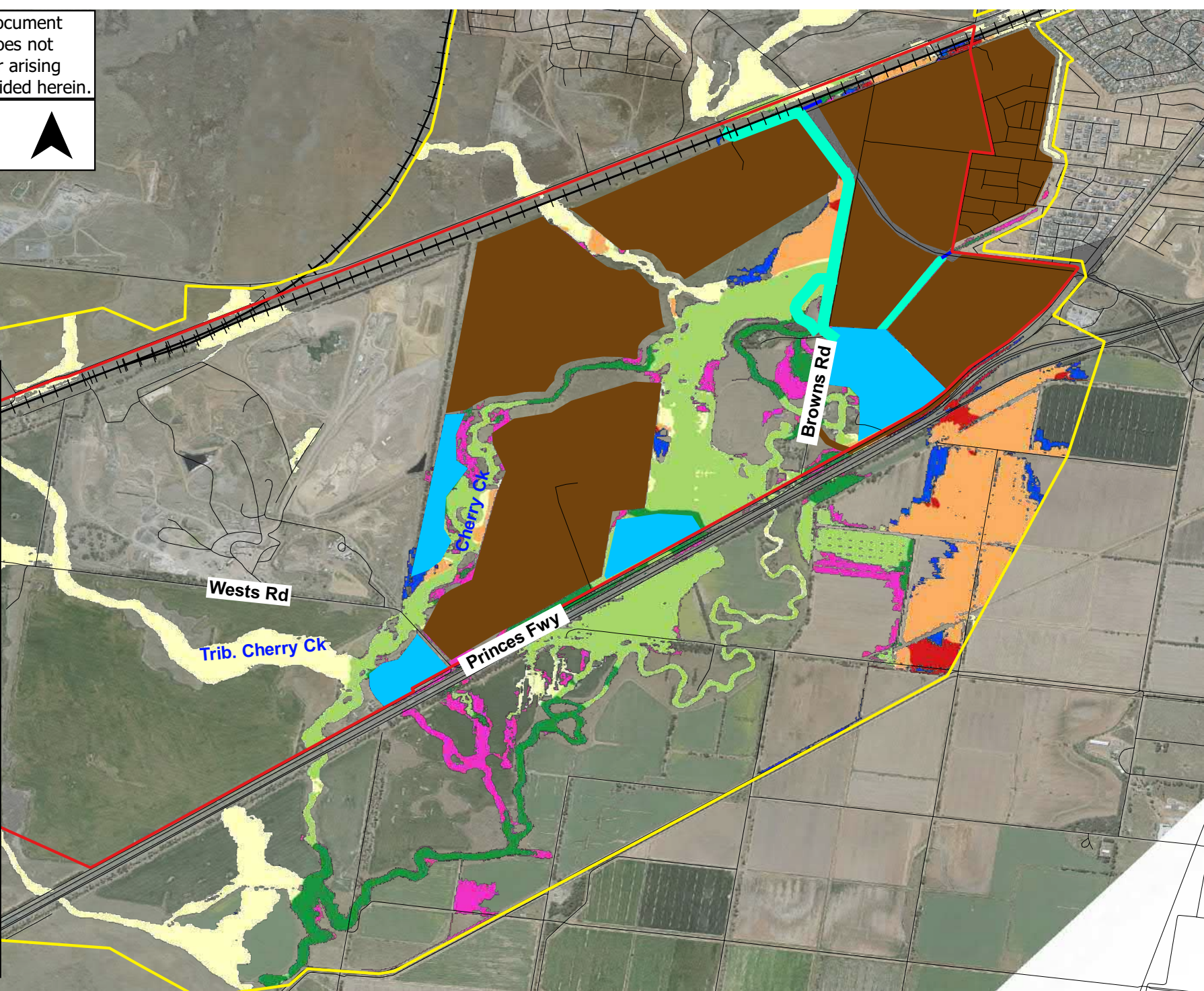
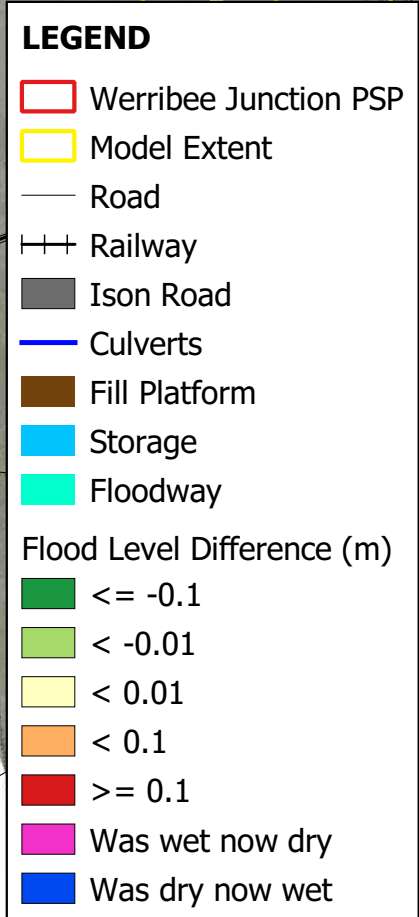
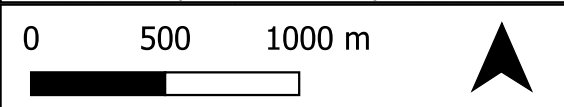


Figure I.1: Scenario 3a – 18.13% AEP flood level impacts

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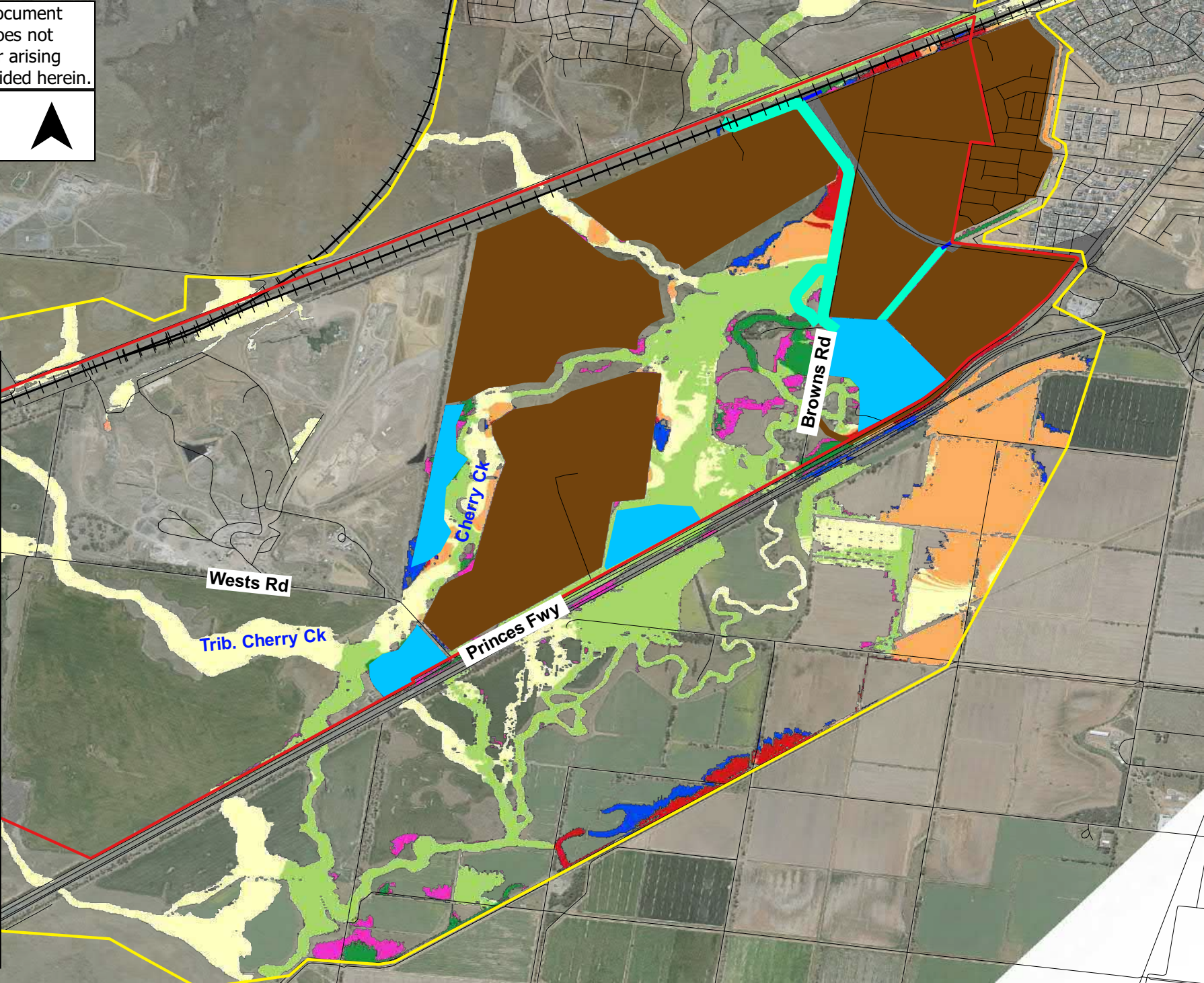
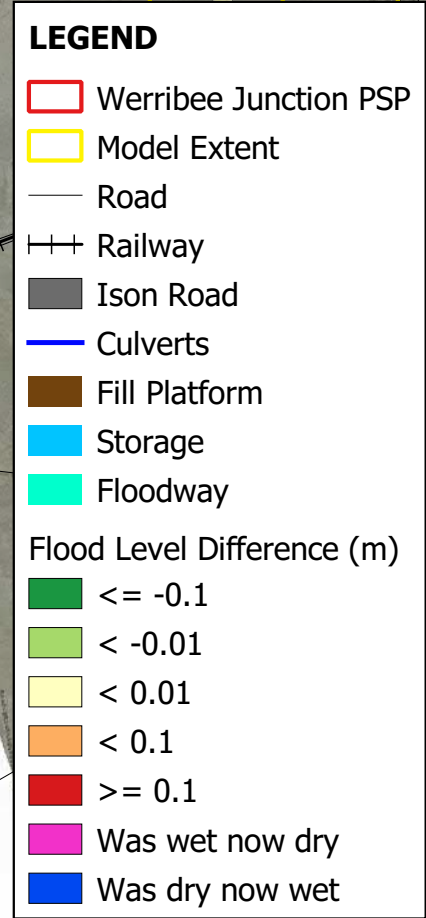
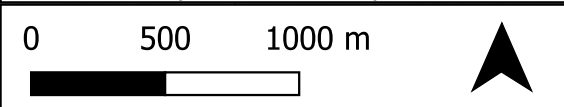


Figure I.2: Scenario 3a – 10% AEP flood level impacts

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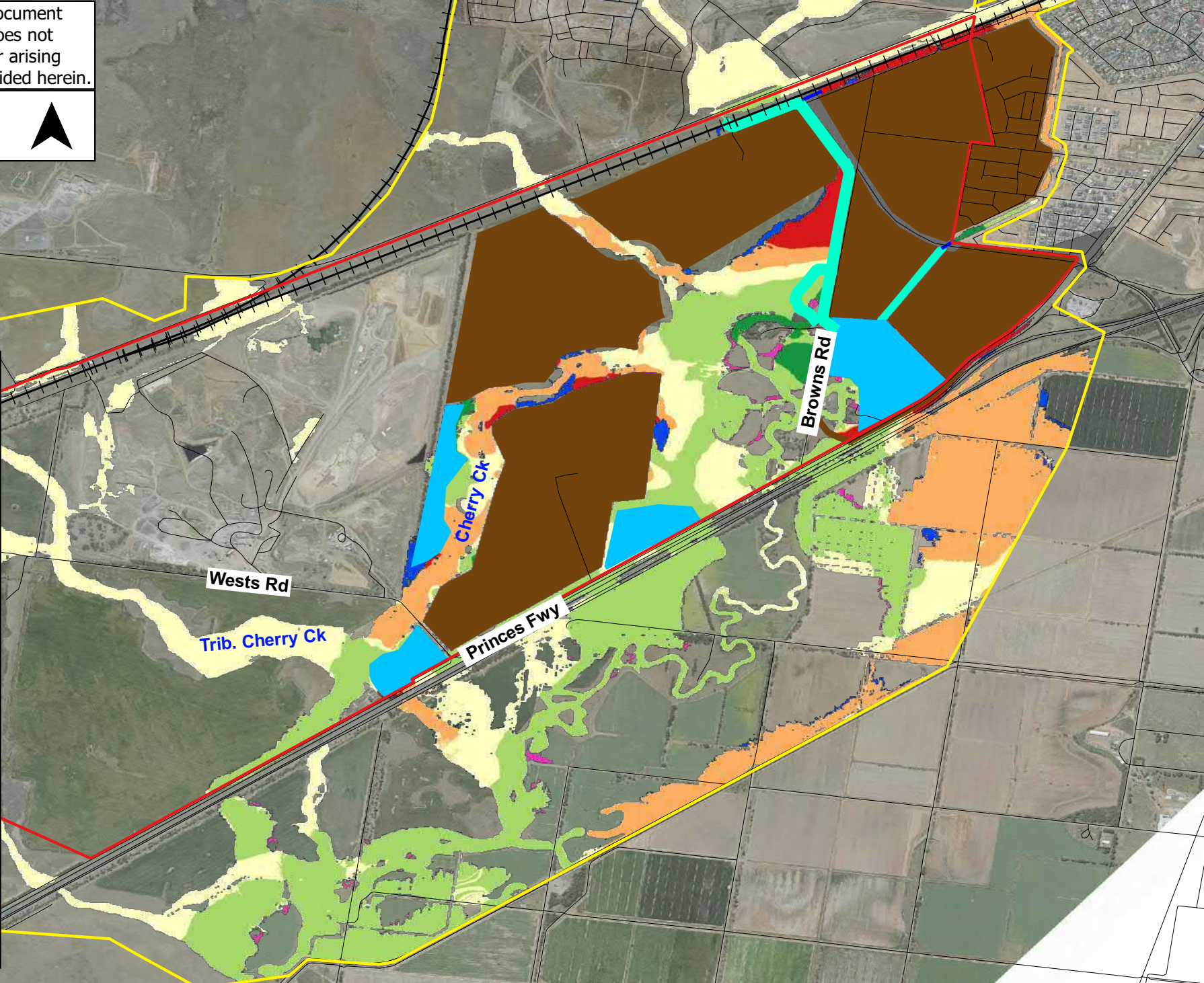
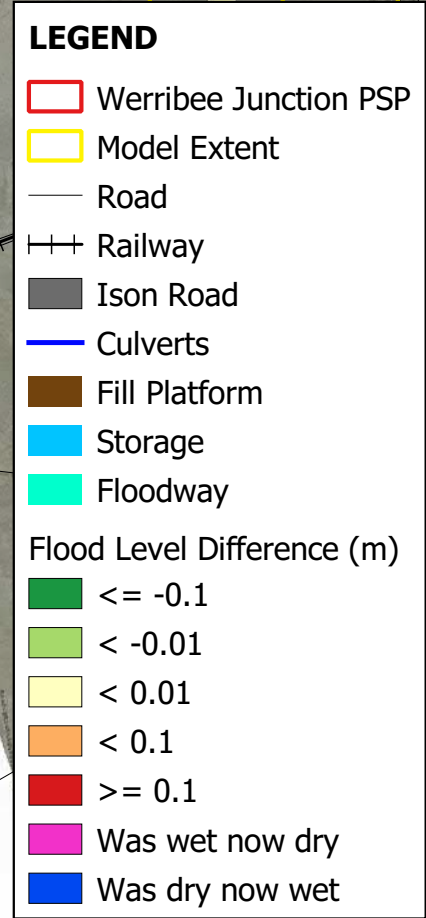
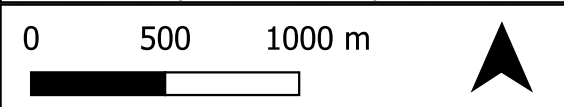


Figure I.3: Scenario 3a – 5% AEP flood level impacts

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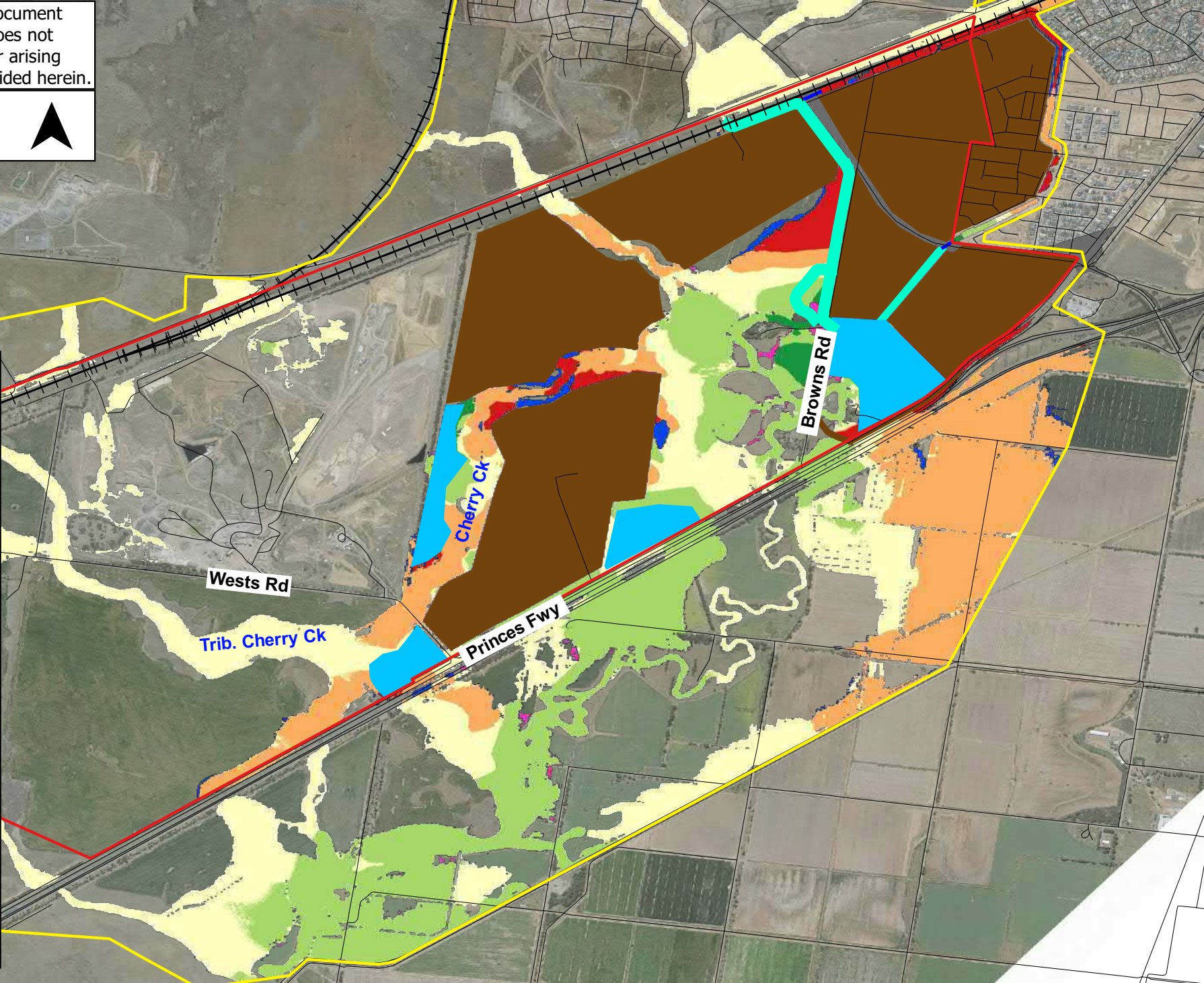
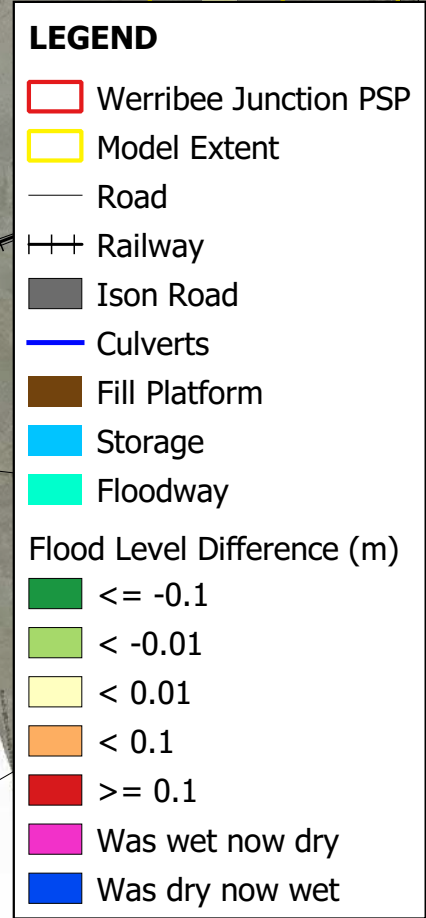
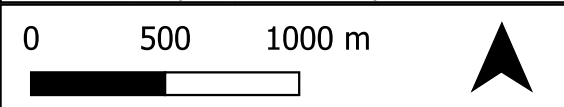


Figure I.4: Scenario 3a – 2% AEP flood level impacts

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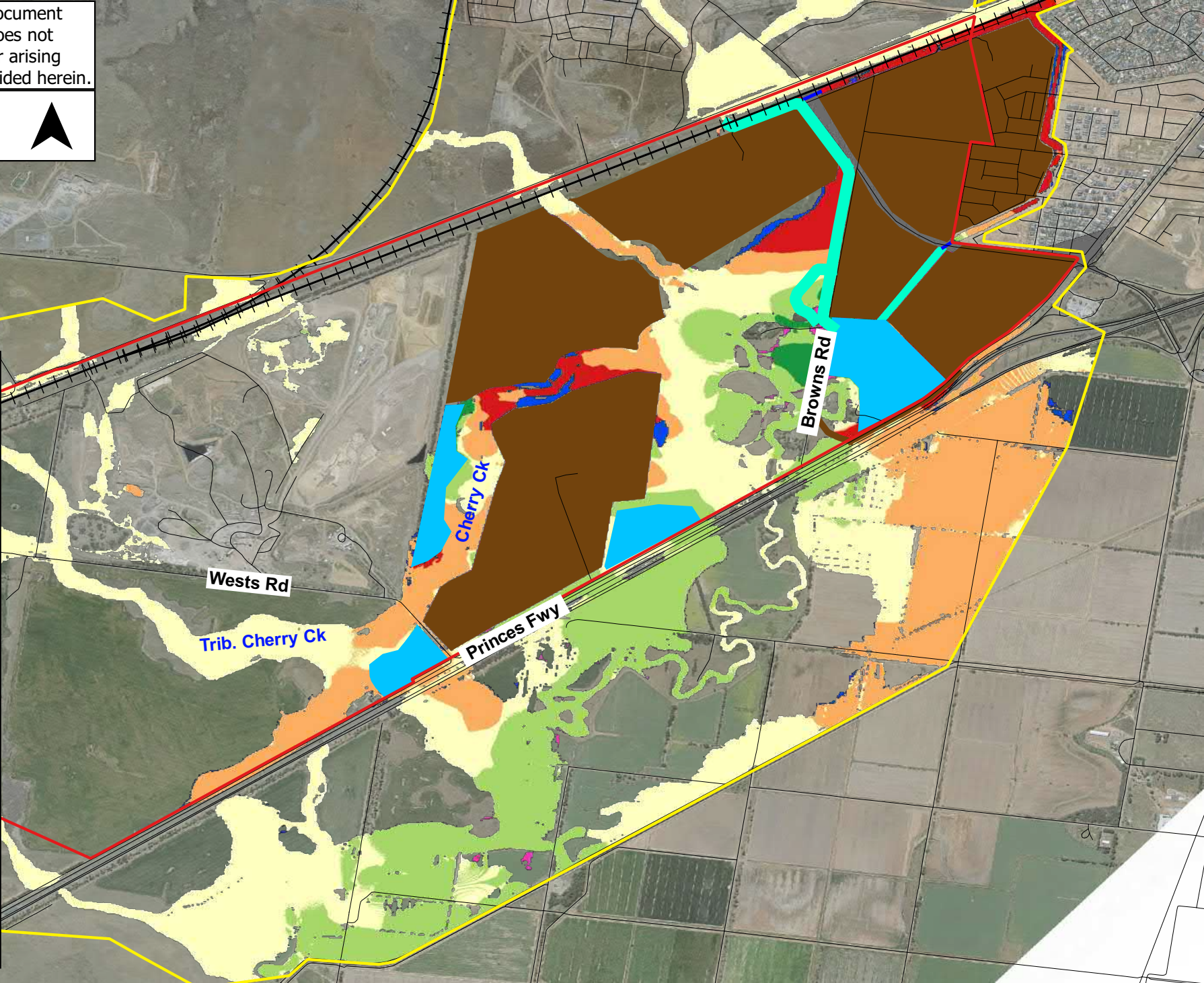
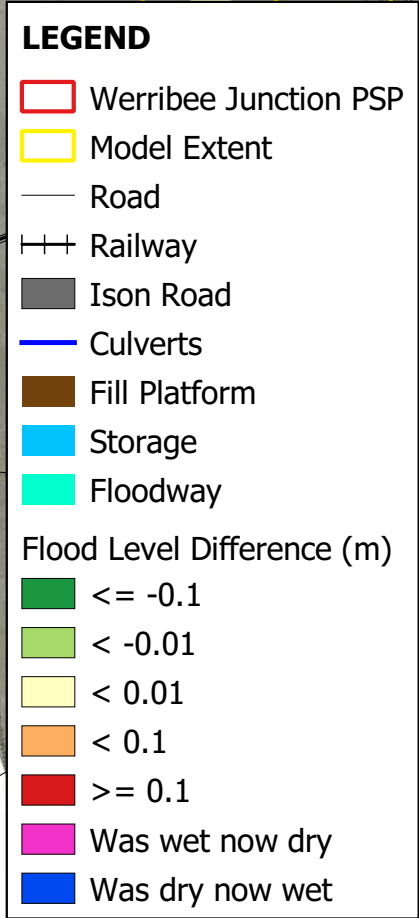
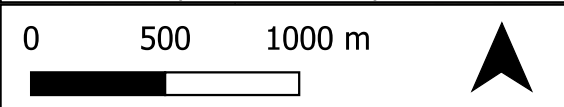


Figure I.5: Scenario 3a – 1% AEP flood level impacts

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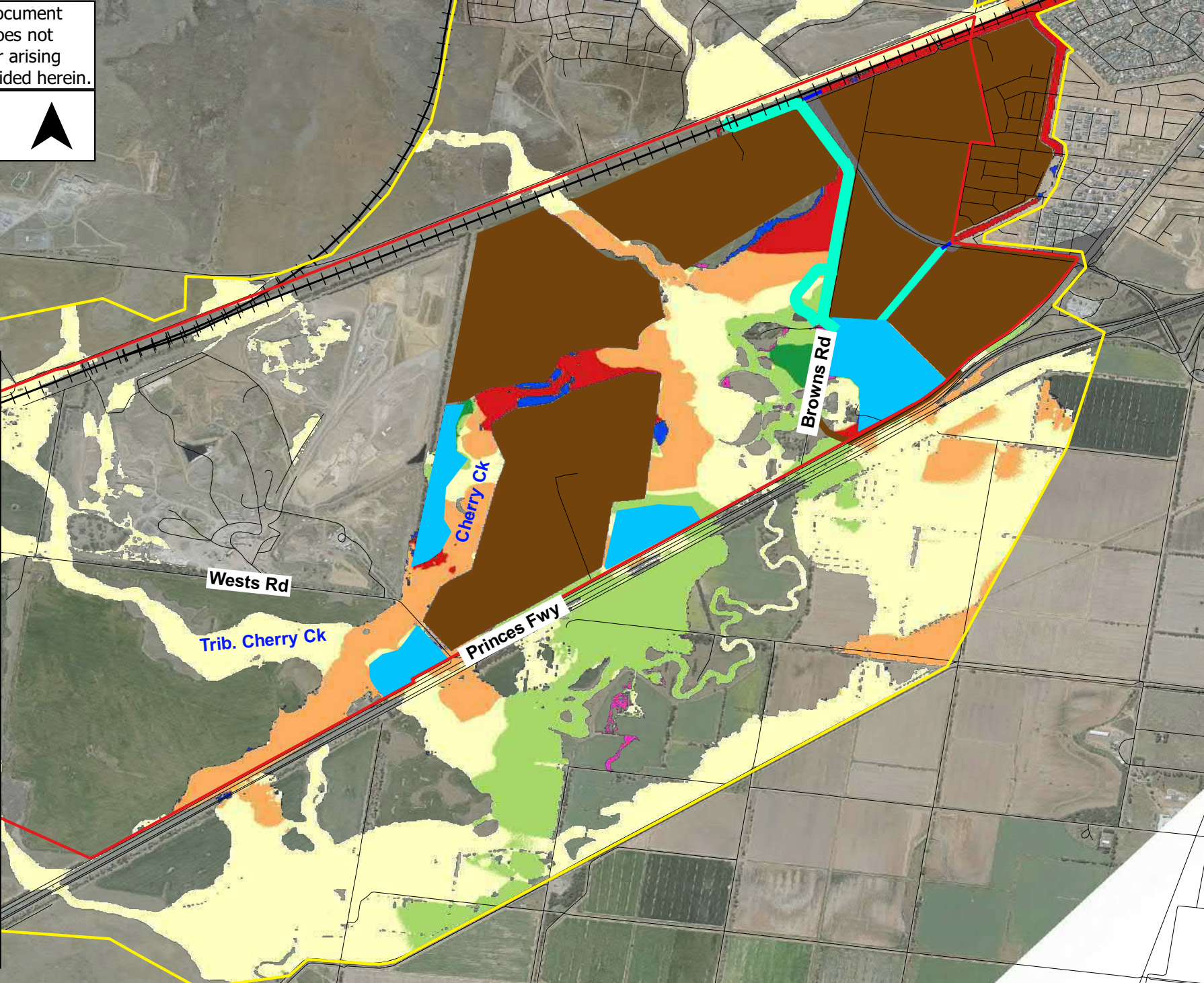
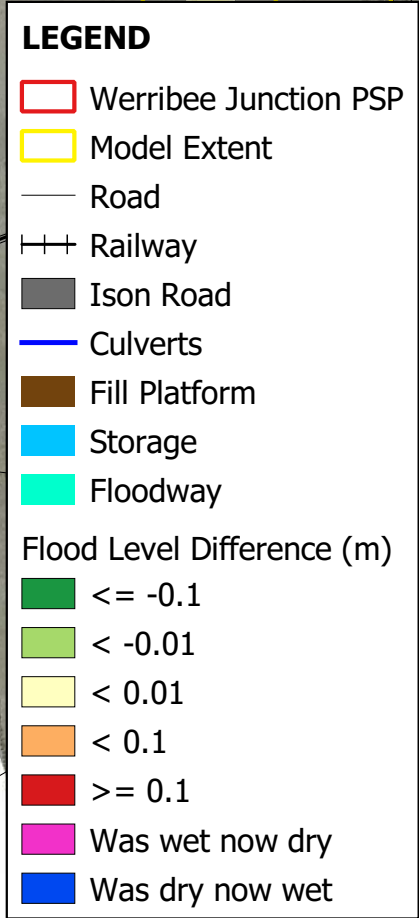
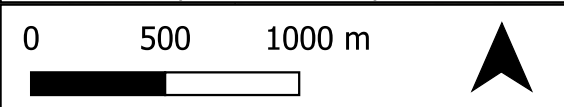


Figure I.6: Scenario 3a – 1% AEP climate change flood level impacts

Appendix J. Scenario 3b flood impact and extent maps

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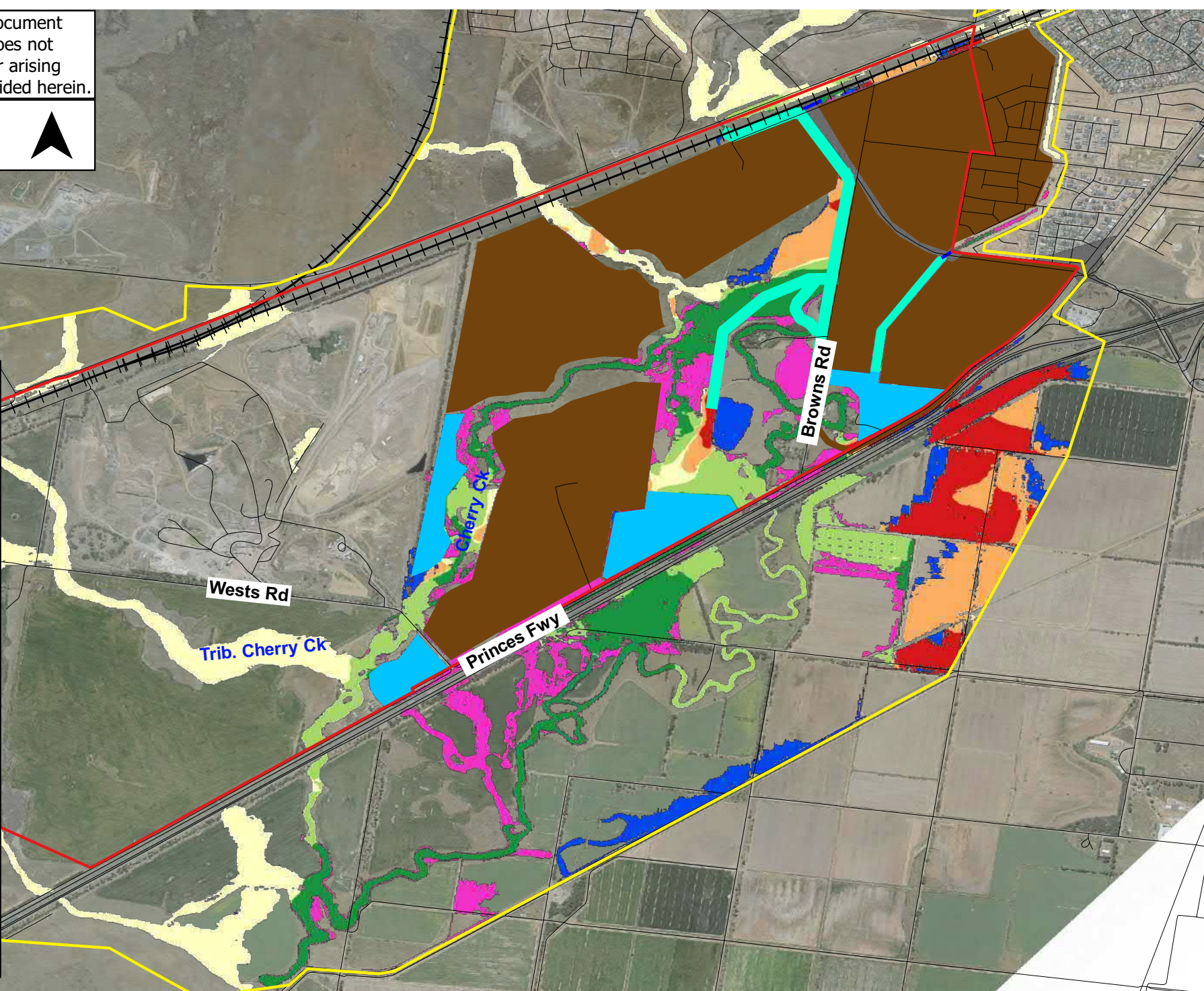
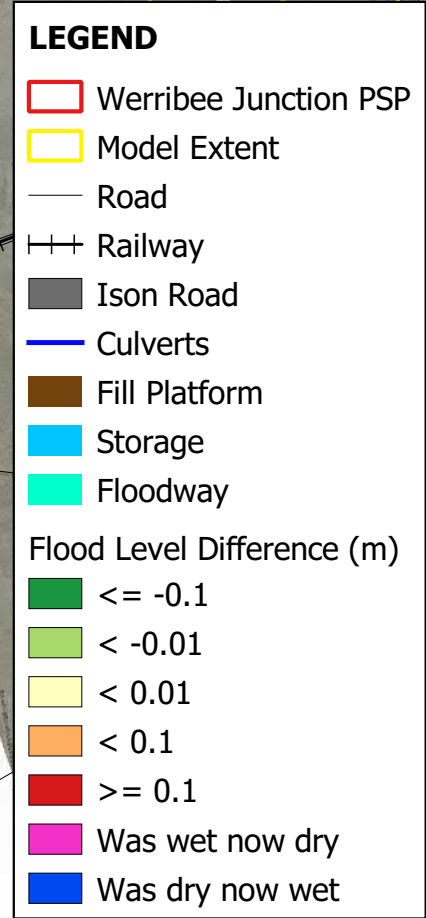
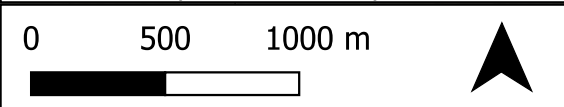


Figure J.1: Scenario 3b – 18.13% AEP flood level impacts

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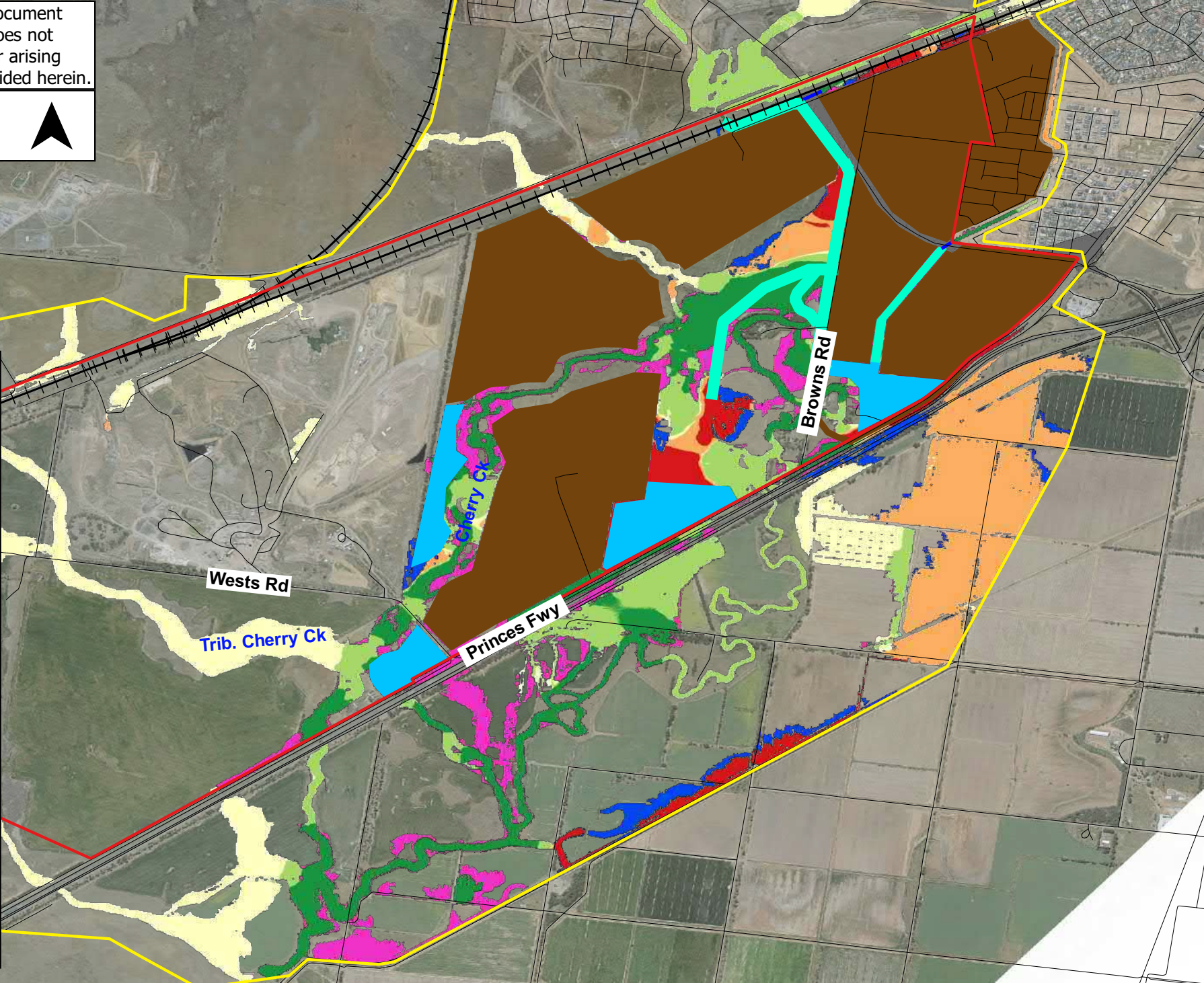
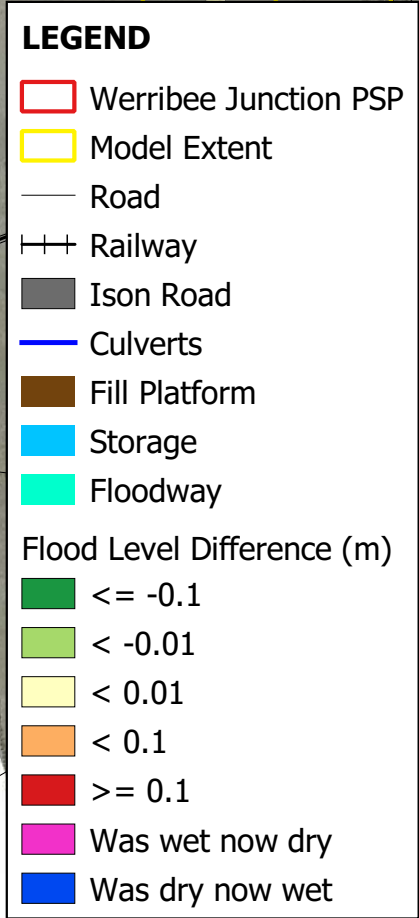
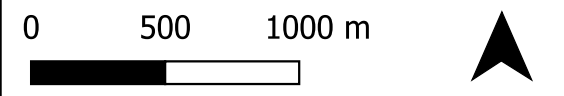


Figure J.2: Scenario 3b – 10% AEP flood level impacts

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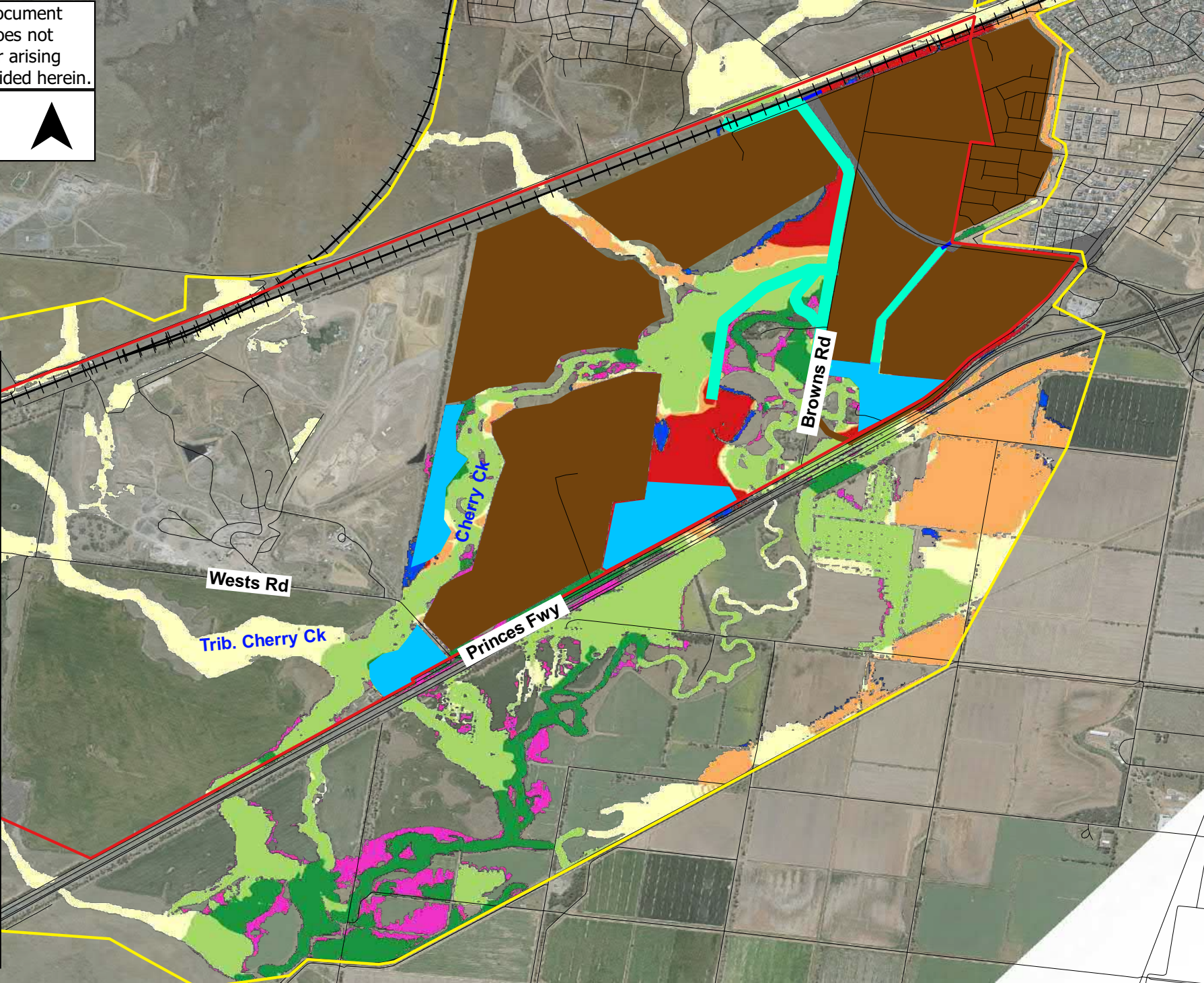
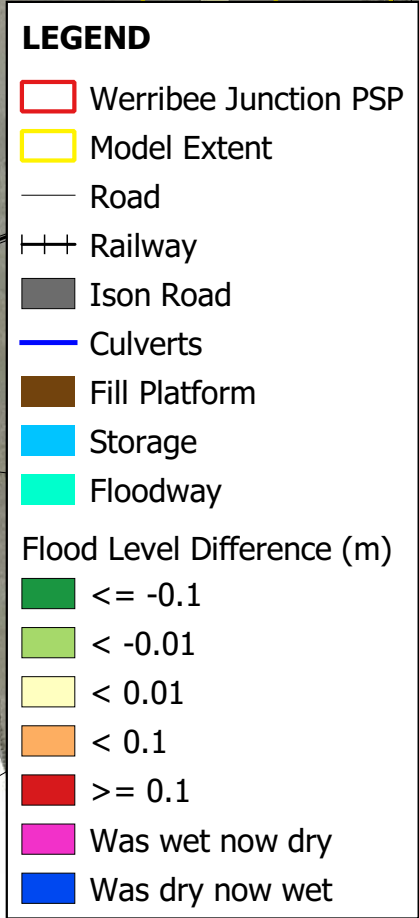
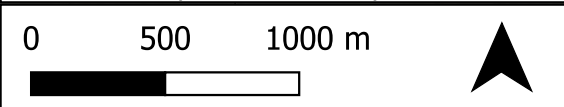


Figure J.3: Scenario 3b – 5% AEP flood level impacts

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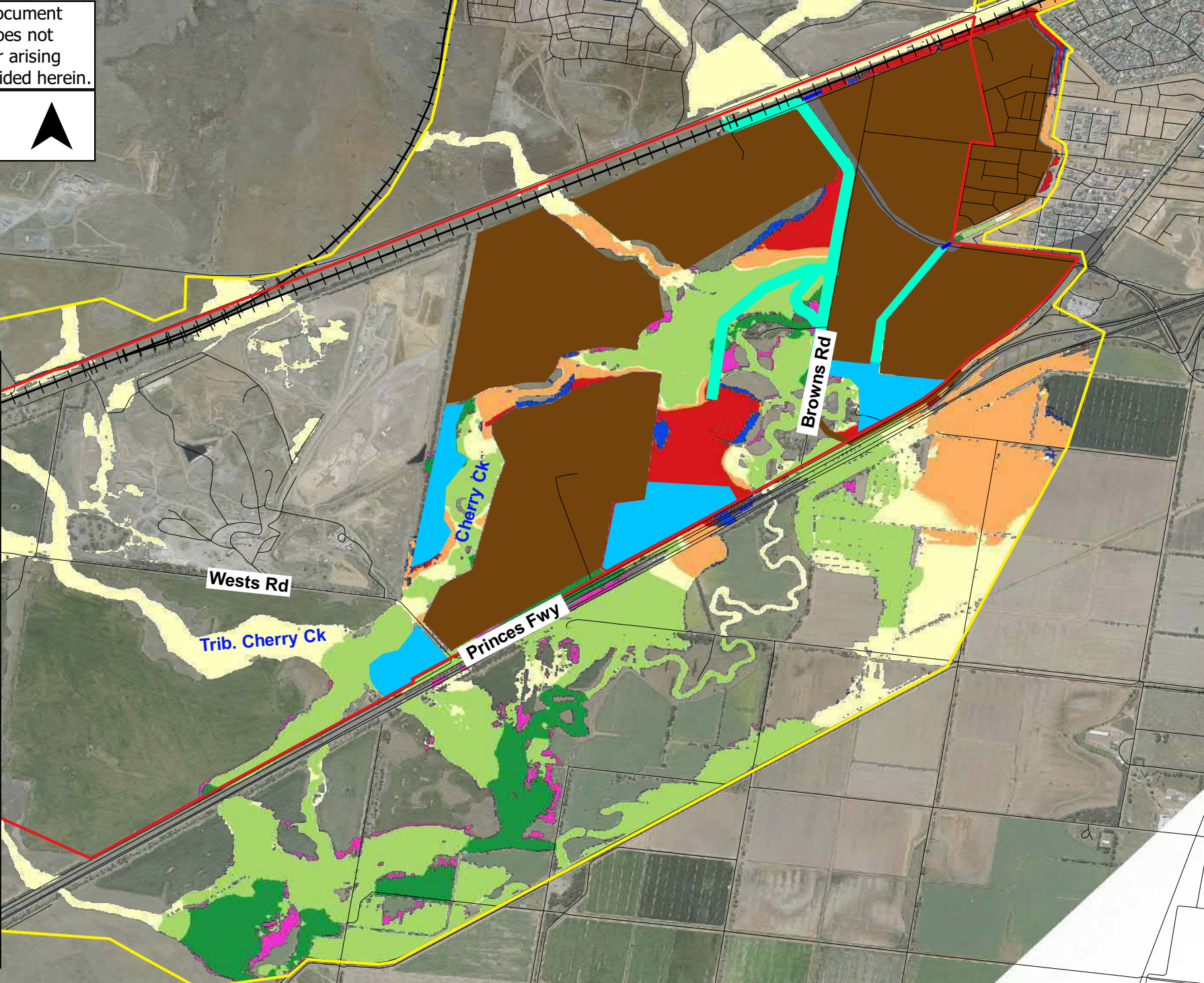
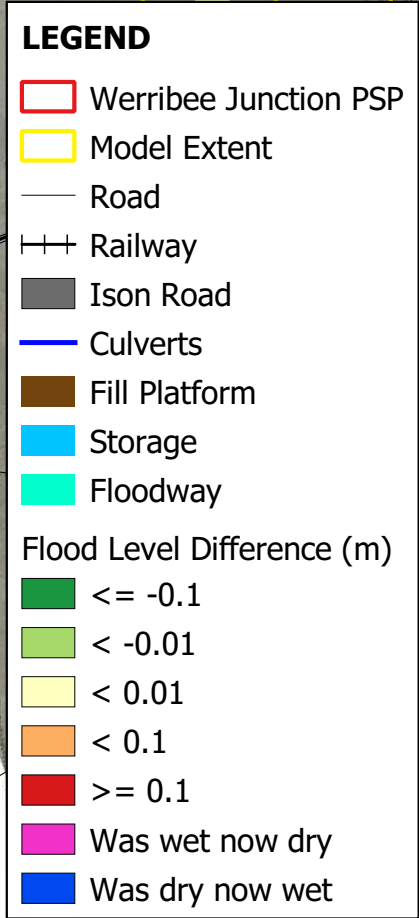
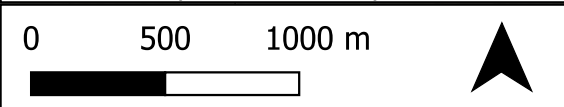


Figure J.4: Scenario 3b – 2% AEP flood level impacts

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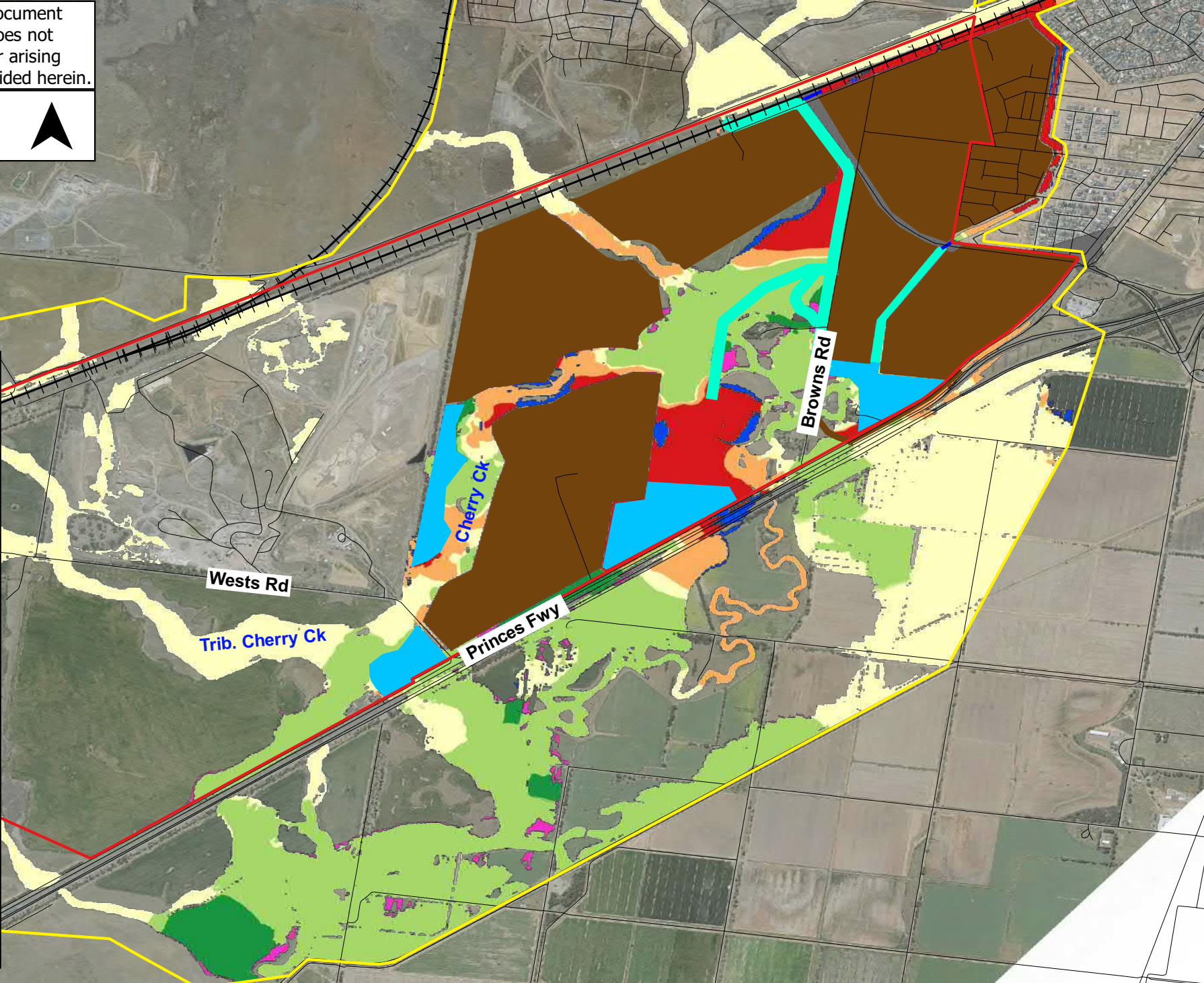
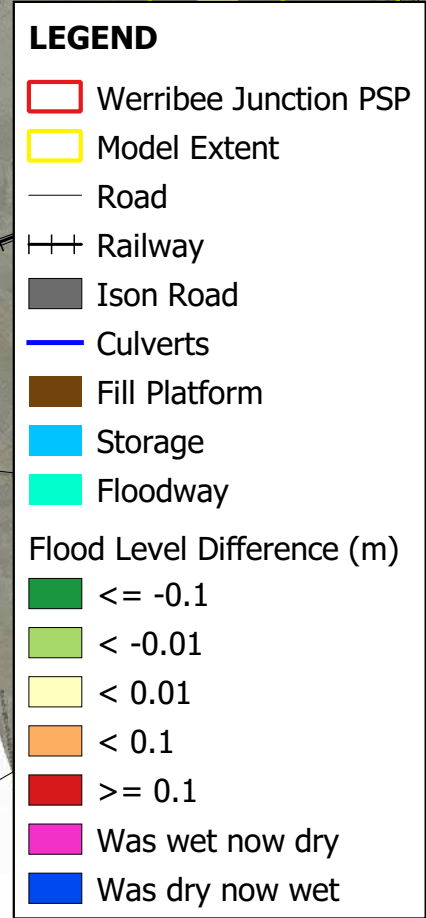
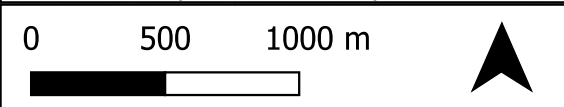


Figure J.5: Scenario 3b – 1% AEP flood level impacts

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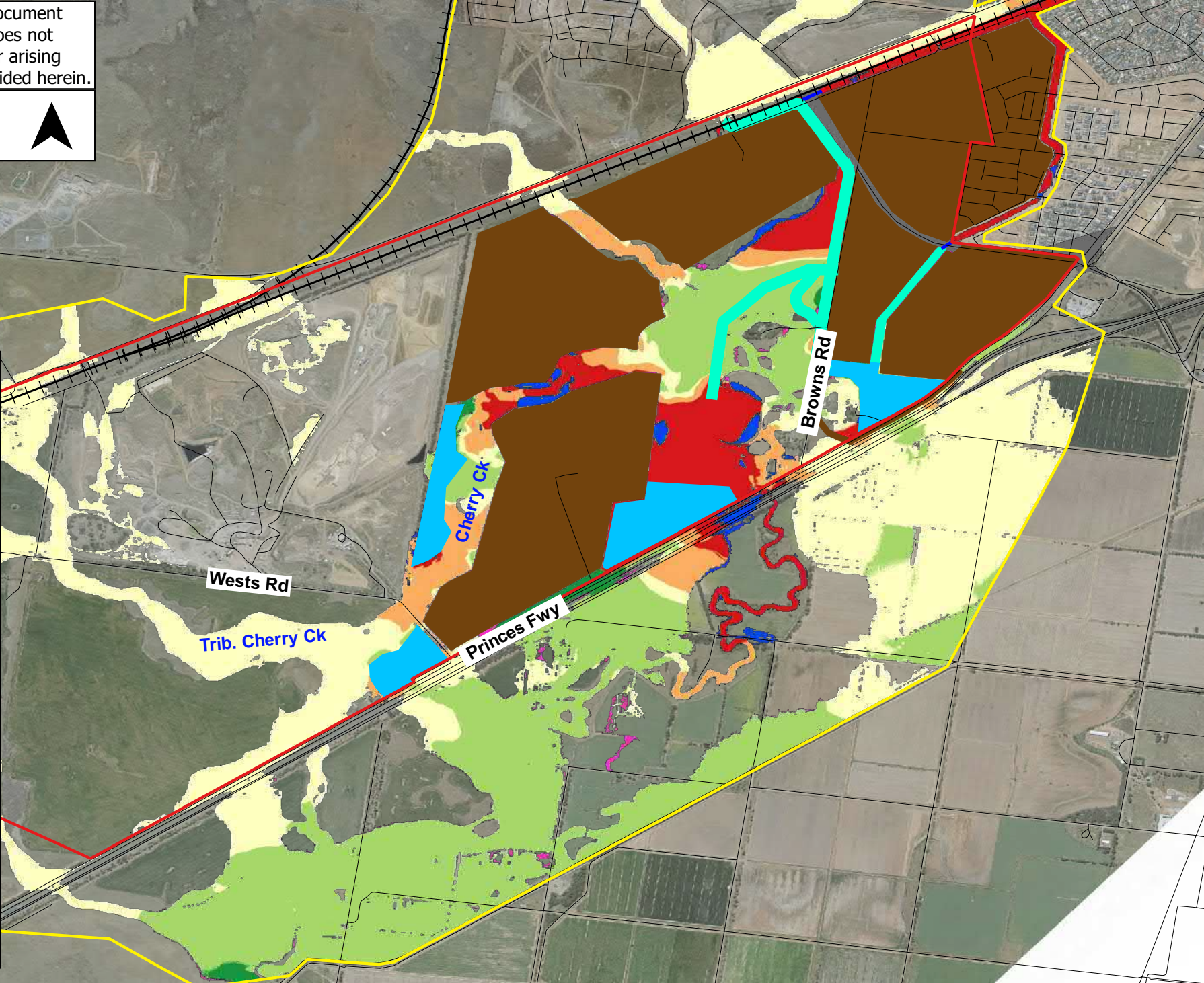
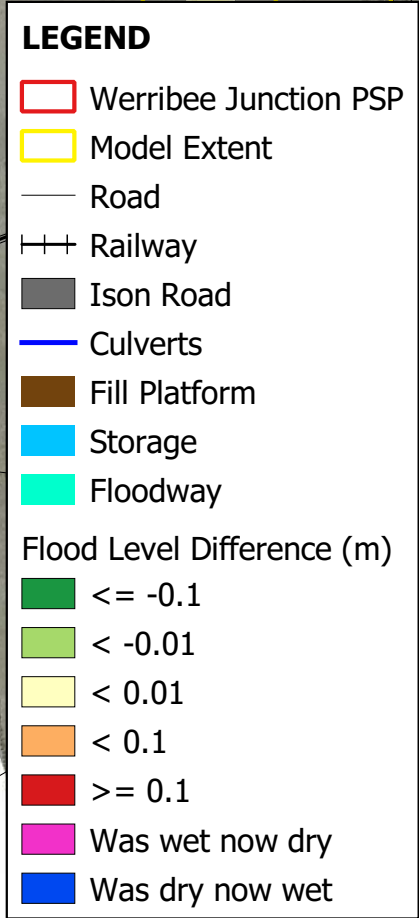
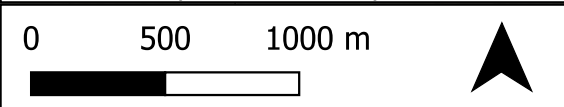


Figure J.6: Scenario 3b – 1% AEP climate change flood level impacts

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