

Kyneton Flood Study

Climate Change
Addendum 2024



North
Central
CMA



Acknowledgment of Country

The North Central Catchment Management Authority acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

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Front cover photo: Campaspe River at the Greenway Lane Weir during the September 2016 flood.

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1. Introduction

This report outlines the methodology and results of the modelling update for the Kyneton Flood Study 2019 to incorporate recent climate change recommendations in accordance with Australian Rainfall and Runoff 2019 Version 4.2 (ARR2019). The climate change scenario adopted for this update is shared socio-economic pathway 5-8.5 (SSP5-8.5) based on a planning horizon of 2100 for the 1% AEP design flood event. The report also recommends updates to the planning scheme overlays along the Campaspe River and Post Office Creek based on this updated climate change modelling. Additionally, it is recommended that mapping from a recently completed flood risk assessment for Kyneton Commercial Estate be used to extend the available flood information and controls along Post Office Creek. This report should be read in conjunction with the Kyneton Flood Study 2019 (North Central CMA) and Kyneton Commercial Estate Flood Risk Assessment 2020 (Water Modelling Solutions).

2. Background

In August 2024, updates were introduced to Book 1, Chapter 6 of ARR2019 to reflect current climate science, which has significantly changed the parameters used to consider the effects of climate change in flood estimation. The general methodology to incorporate consideration of climate change remains the same, with the increase in design rainfall intensity and catchment losses scaled proportionally to global surface temperature. The equation used to calculate the projected design rainfall intensity is shown below.

$$I_p = I \times \left(1 + \frac{\alpha}{100}\right)^{\Delta T}$$

Where,

- I_p is the projected (current or future) design rainfall depth (mm) or intensity (mm/hr).
- I is the historical design rainfall depth (mm) or intensity (mm/hr).
- α is the rate of change relative to global temperature change (%/°C).
- ΔT is the most up-to-date estimate of global temperature projection for the design period of interest and selected climate scenario relative to a baseline time period.

In determining the projected global temperature increase, ARR2019 presents four potential climate scenarios based on shared socioeconomic pathways (SSP). These pathways range from low emissions scenarios (SSP1-1.9) to very high emissions scenarios (SSP5-8.5) as shown in Figure 1, with SSP5-8.5 resulting in the highest projected temperature increase. The overall temperature increase is dependent on the SSP adopted and the planning horizon. This climate change analysis adopted climate scenario SSP5-8.5 relative to a planning horizon of 2100, resulting in a 4.5°C increase in global temperature. This is relative to a baseline global average temperature recorded between 1961-1990. This baseline period is recommended by ARR2019 as the best estimate of the midpoint of the historical rainfall data period used in estimating the Intensity-Frequency-Duration (IFD) curves developed by the Bureau of Meteorology in 2016 for design flood estimation.

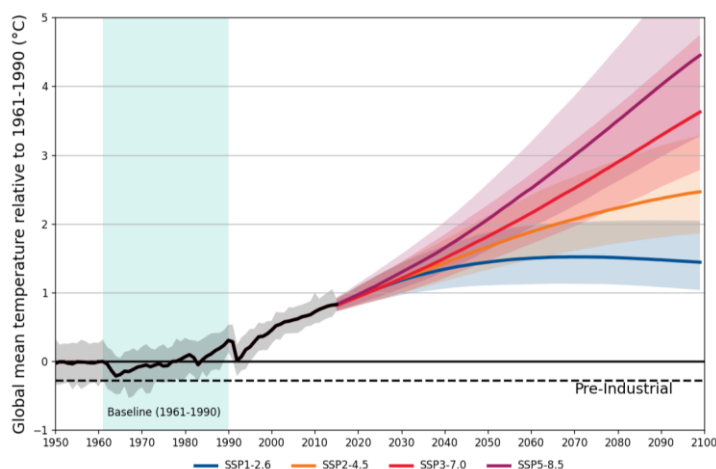


Figure 1 – Projected global temperature increases associated with each SSP relative to 1961-1990 baseline time period (ARR2019, Book 1 Chapter 6, Figure 1.6.2)

3. Hydrologic Model Update

This study adopted the calibrated RORB models for the Campaspe River and Post Office Creek which were developed by the original Kyneton Flood Study 2019. Subarea delineation, RORB modelling parameters, fraction impervious data, spatial distribution, storm duration and temporal pattern all remained unchanged for this climate change analysis. The rainfall intensity and catchment losses were updated in accordance with the recommendations of ARR2019 as detailed below.

3.1. Rainfall

The most recent ARR2019 climate change recommendations were applied to generate the long-term (2100) rainfall intensities for the SPP5-8.5 climate scenario. Table 1 below illustrates the increase in 1% AEP rainfall intensity relative to the IFD obtained from the Bureau of Meteorology and used in the original 2019 Kyneton Flood Study for both the Campaspe River and Post Office Creek models. It should be noted that the increase in rainfall intensity is dependent on the critical storm duration, with shorter duration predicted to experience greater increases. The critical storm durations for the Campaspe River and Post Office Creek catchments were determined to be 24 hours and 12 hours respectively.

Table 1 – 1% AEP design rainfall comparison

	Kyneton Flood Study 2019 - 1% AEP Rainfall (mm)	Climate Change Scenario (SSP5-8.5, 2100) – 1% AEP Rainfall (mm)	Difference (%)
Campaspe River Model	132.5	186.8	41%
Post Office Creek Model	99.5	146.3	47%

3.2. Losses

As temperatures increase with climate change, catchments will dry out. This is reflected in the RORB models by increasing both initial and continuing loss parameters based on the projected global temperature increase. Table 2 shows the design loss increases relative to climate scenario SSP5-8.5 at 2100 as recommended in ARR2019.

Table 2 – 1% AEP design losses comparison

		Kyneton Flood Study 2019	Climate Change Scenario (SSP5-8.5, 2100)	Difference (%)
Campaspe River Model	Initial Loss (mm)	31.5	36.2	15%
	Continuing Loss (mm/hr)	1.0	1.33	33%
Post Office Creek Model	Initial Loss (mm)	26.9	30.9	15%
	Continuing Loss (mm/hr)	1.0	1.33	33%

3.3. Design Flows

Based on the updated climate change parameters, the 1% AEP peak design flows have increased by 63% and 66% for the Campaspe River and Post Office Creek respectively. It is also noted that the 1% AEP climate change peak flows significantly exceed even the 1 in 200 AEP peak flows determined in the Kyneton Flood Study 2019 which were based on the 2016 Bureau of Meteorology IFD. A comparison of these flows is provided in Table 3.

Table 3 – 1% AEP design flow comparison

	Kyneton Flood Study 2019 - 1% AEP Peak Flow (m ³ /s)	Kyneton Flood Study 2019 – 0.5% AEP Peak Flow (m ³ /s)	Climate Change Scenario (SSP5-8.5, 2100) – 1% AEP Peak Flow (m ³ /s)	Difference (%)
Campaspe River Model	297.0	364.4	468.8	63%
Post Office Creek Model	44.2	52.3	66.8	66%

5. Hydraulic Model Update

The calibrated TUFLOW model developed by the Kyneton Flood Study 2019 was utilised to produce the climate change scenario modelling. This model covers both the Campaspe River and Post Office Creek study areas. The model parameters such as roughness and outlet boundary conditions remained the same as the original study. However, the model inflows were replaced with the 1% AEP climate change design flows determined by the RORB model as detailed in the previous section. The model outputs generated include flood extents, levels, depths and velocities. These results will be used to update the available flood information for the township of Kyneton.

A comparison of the 1% AEP peak flood levels produced by the Kyneton Flood Study 2019 and the climate change scenario are shown in Figures 2 and 3 below. In general, flood levels along Post Office Creek have increased by up to 0.5 metres while the Campaspe River levels have increased by up to 1.0 metre.

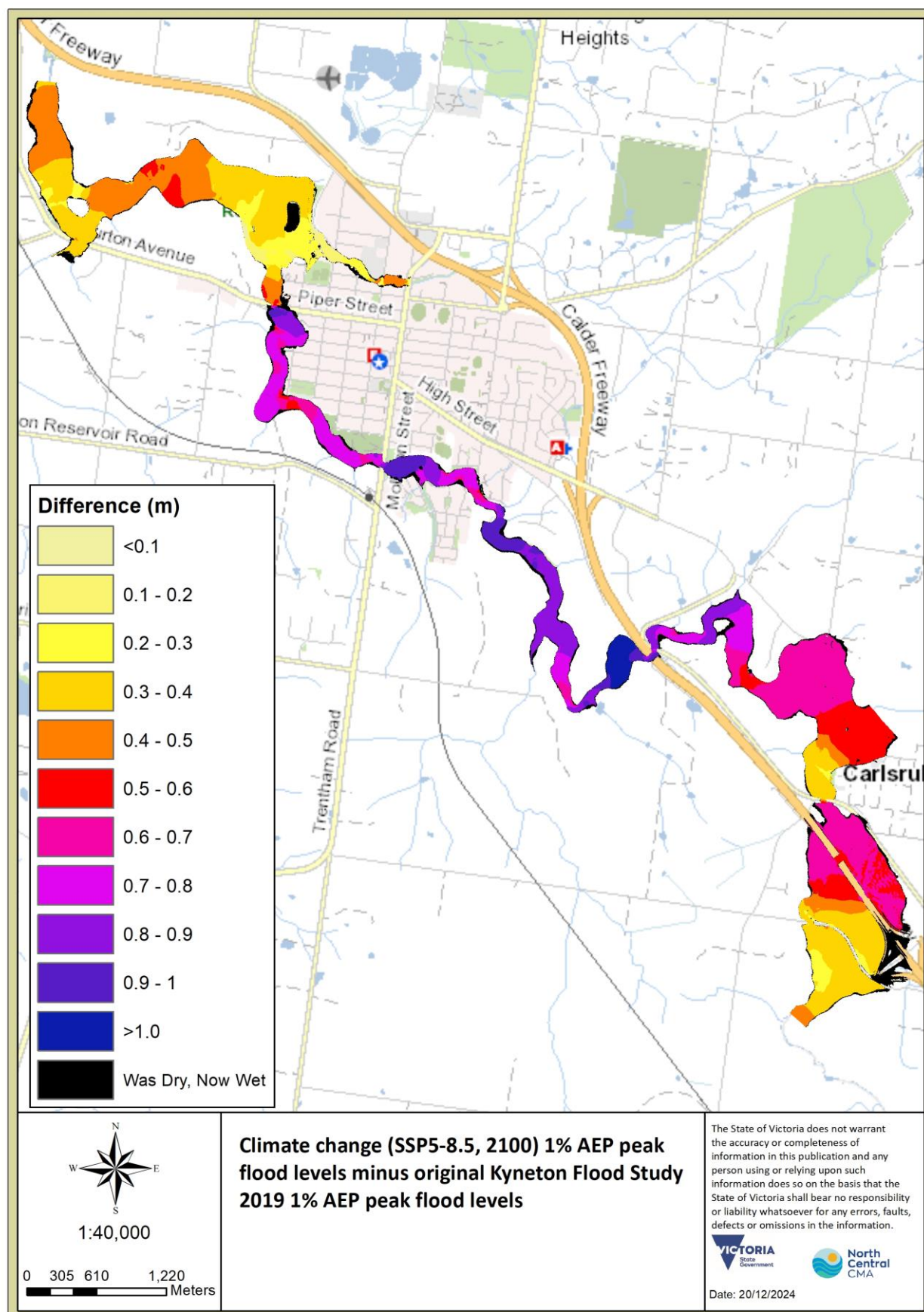


Figure 2 – Comparison between the 1% AEP peak flood levels for the climate change scenario (SSP5-8.5) and the original Kyneton Flood Study 2019

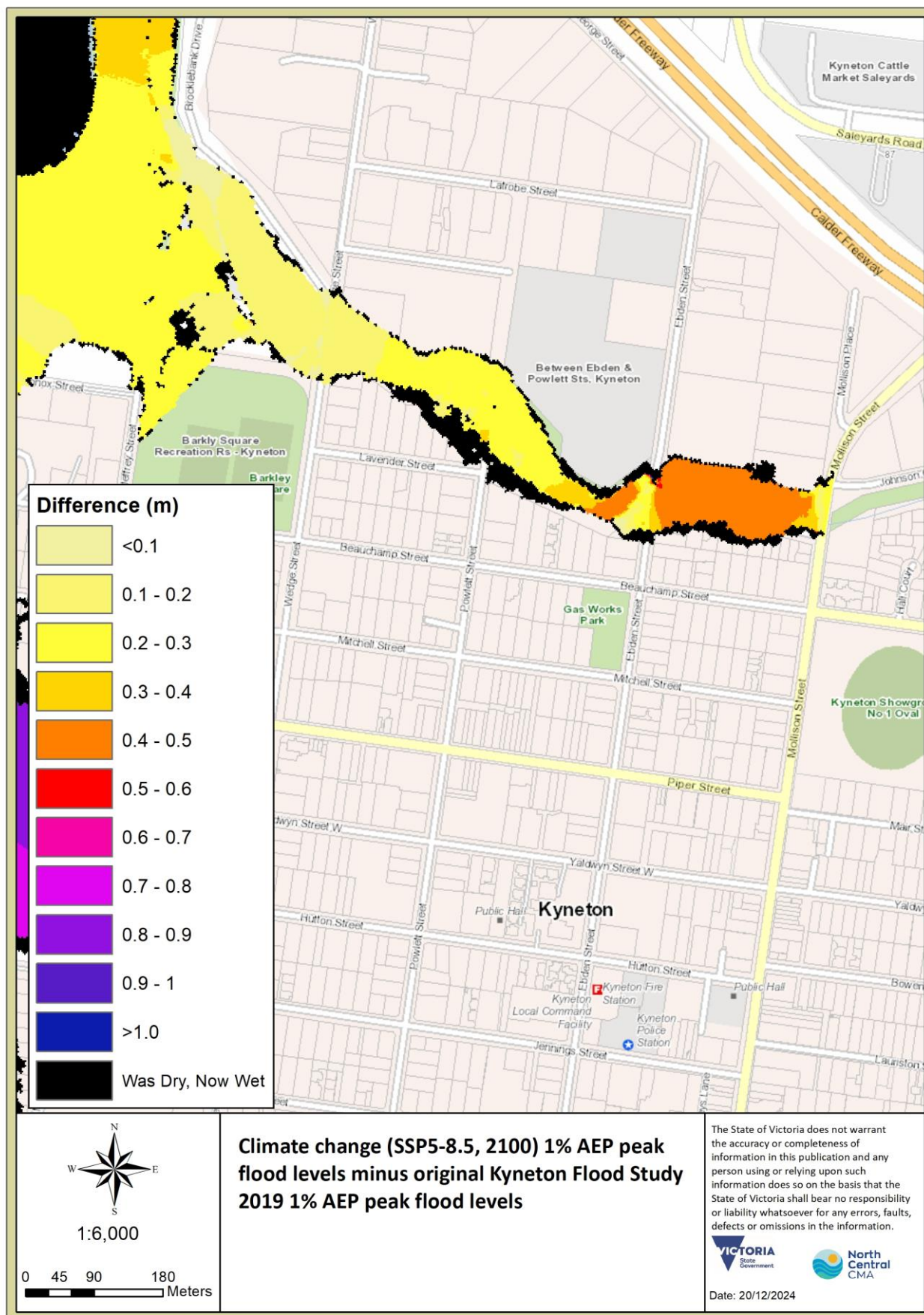


Figure 3 – Comparison between the 1% AEP peak flood levels for the climate change scenario (SSP5-8.5) and the original Kyneton Flood Study 2019 on Post Office Creek

6. Additional Post Office Creek Flood Mapping

In May 2020, the flood modelling consultants Water Modelling Solutions prepared the Kyneton Commercial Estate Flood Risk Assessment. The report was required to inform a planning permit application for subdivision of land located northeast of Kyneton township which is traversed by Post Office Creek. The mapping provided by the Kyneton Flood Study 2019 did not extend this far upstream due to a lack of LiDAR (Light Detection And Ranging) data required to inform the modelling. Hence, the permit applicant engaged Water Modelling Solutions to undertake flood modelling.

Details of the modelling methodology and results are provided in the Kyneton Commercial Estate Flood Risk Assessment 2020 report. Although the study was completed prior to the recent release of the ARR2019 updated climate change considerations, the 1% AEP peak flow modelled exceeded that of the climate change scenario detailed in Table 3 for Post Office Creek. Therefore, it is considered that the mapping produced by the Kyneton Commercial Estate Flood Risk Assessment 2020 is suitable for extending the available flood information upstream along Post Office Creek. Figure 4 shows the extent of this mapping in comparison to the extent of the updated Kyneton Flood Study climate change mapping.

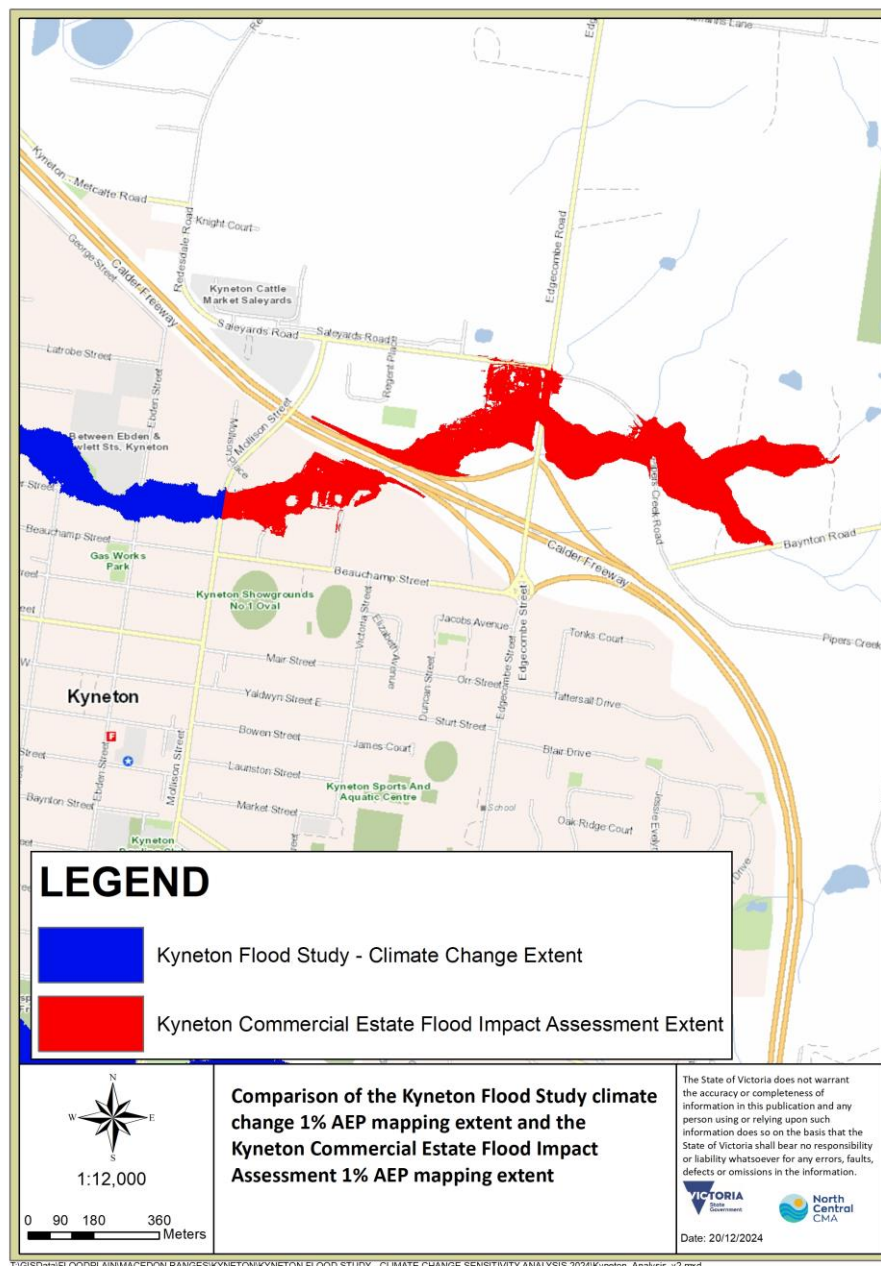


Figure 4 – Comparison of the Kyneton Flood Study climate change 1% AEP mapping extent and the Kyneton Commercial Estate Flood Impact Assessment 1% AEP mapping extent

7. Planning Overlay Recommendations

The results of the modelling detailed previously have been used to inform proposed flood planning overlays along the Campaspe River and Post Office Creek. The overlay extents were derived from the TUFLOW 1% AEP event mapping outputs and were assigned based on the following criteria:

- a) Floodway Overlay (FO)
 - i. Depth greater than 0.5 metres; and/or
 - ii. Velocity greater than 2 metres per second; and/or
 - iii. Product of depth and velocity greater than 0.4 square metres per second.
- b) Land Subject to Inundation Overlay (LSIO)
 - i. Land within the applicable flood extent which has a lower flood hazard than that of the Floodway Overlay.

The final overlay extents were also refined by smoothing the extents based on a tolerance of 20 metres and isolated areas less than 1000 square metres were removed. Figures 5 and 6 show the extents of the proposed Land Subject to Inundation Overlay and the Floodway Overlay. Figures 7 and 8 compare the existing LSIO to the proposed LSIO extent.

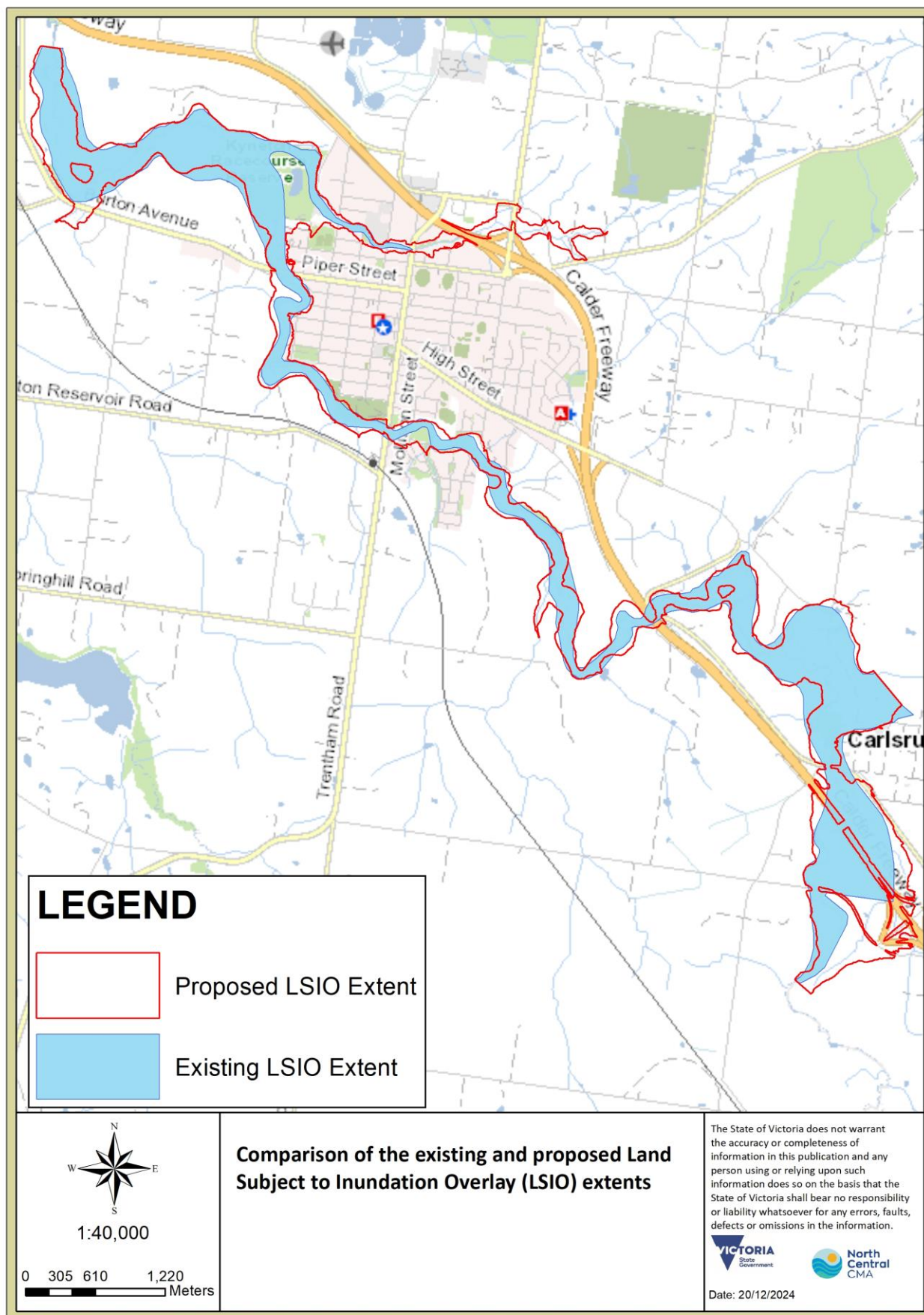


Figure 5 – Comparison of the existing and proposed Land Subject to Inundation Overlay (LSIO) extents



Figure 6 – Comparison of the existing and proposed Land Subject to Inundation Overlay (LSIO) extents along Post Office Creek

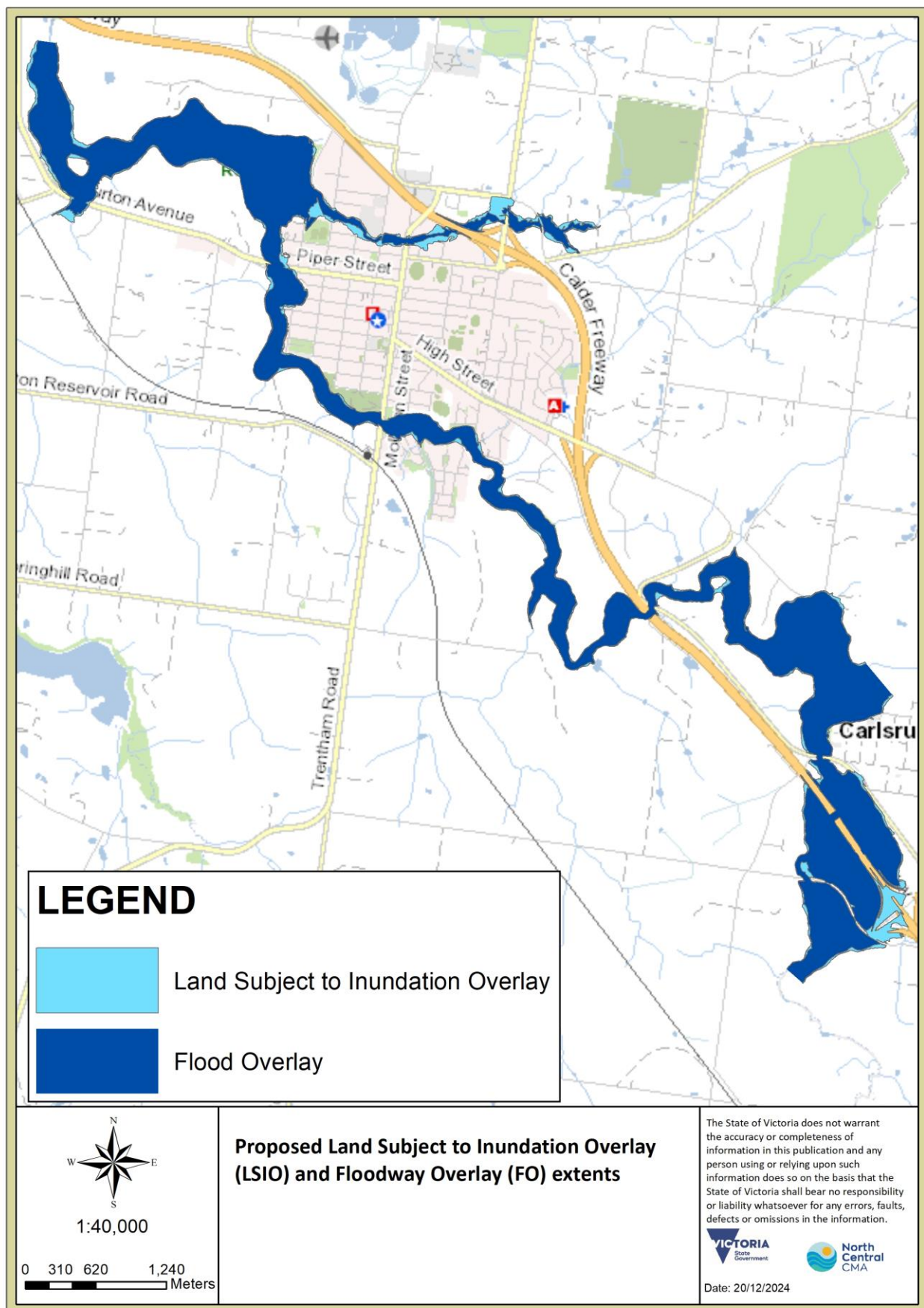


Figure 7 – Proposed Land Subject to Inundation Overlay (LSIO) and Floodway Overlay (FO) extents

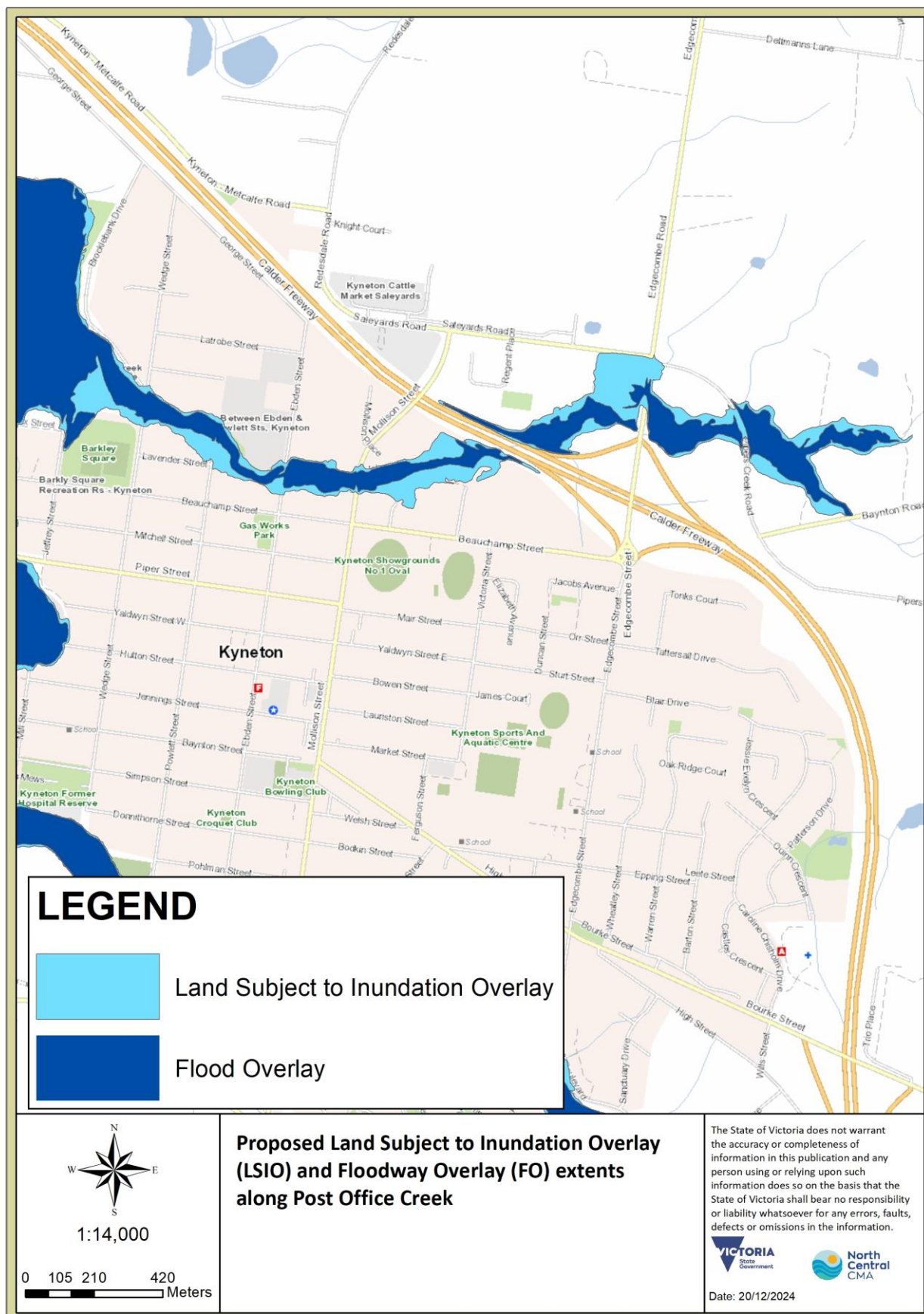


Figure 8 – Proposed Land Subject to Inundation Overlay (LSIO) and Floodway Overlay (FO) extents along Post Office Creek

8. Conclusion

This addendum has documented the methodology used to update the 1% AEP design flood determined by the Kyneton Flood Study 2019 to be in accordance with the recently revised climate change recommendations in ARR2019. This included adjusting the rainfall and catchment loss design parameters and rerunning the calibrated RORB and TUFLOW models. The model results will be used to update the available flood information for the township of Kyneton and enable consideration of the impacts of climate change on flood risk.

It is recommended that the 1% AEP Kyneton Flood Study climate change scenario flood extent and the Kyneton Commercial Estate Flood Impact Assessment 1% AEP extent be used to amend the existing overlays to ensure future development responds appropriately to flood risk and maintains or improves the flood resilience of existing development.