



MERRI-BEK CITY COUNCIL  
Creating the Local Drainage Authority's  
Stormwater Map

**TECHNICAL REPORT**

VC2023\_006-REP-002-4

2 NOVEMBER 2023



# DISCLAIMER

*This Report has been prepared on behalf of and for the exclusive use of Merri-bek City Council and is subject to and issued in accordance with Merri-bek City Council instruction to Engeny Australia Pty Ltd (Engeny). The content of this report was based on previous information and studies supplied by Merri-bek City Council.*

*Engeny accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party. Copying this report without the permission of Merri-bek City Council or Engeny is not permitted.*

| Rev | Date       | Description  | Author         | Reviewer   | Project Mgr.   | Approver     |
|-----|------------|--------------|----------------|------------|----------------|--------------|
| 0   | 15/08/2023 | Client Issue | Matt Lazarides | Scott Dunn | Matt Lazarides | Glenn Ottrey |
| 1   | 23/08/2023 | Client Issue | Matt Lazarides | Scott Dunn | Matt Lazarides | Glenn Ottrey |
| 2   | 20/10/2023 | Client Issue | Matt Lazarides | Scott Dunn | Matt Lazarides | Glenn Ottrey |
| 3   | 24/10/2023 | Client Issue | Matt Lazarides | Scott Dunn | Matt Lazarides | Glenn Ottrey |
| 4   | 2/11/2023  | Client Issue | Matt Lazarides | Scott Dunn | Matt Lazarides | Glenn Ottrey |

Signatures:

# CONTENTS

|                                                                                                               |           |
|---------------------------------------------------------------------------------------------------------------|-----------|
| <b>Executive Summary</b>                                                                                      | <b>1</b>  |
| <b>1. Acknowledgements</b>                                                                                    | <b>2</b>  |
| <b>2. List of Terms &amp; Abbreviations</b>                                                                   | <b>3</b>  |
| <b>3. Purpose</b>                                                                                             | <b>5</b>  |
| <b>4. Introduction</b>                                                                                        | <b>6</b>  |
| 4.1 Study Overview                                                                                            | 6         |
| 4.2 Objectives                                                                                                | 8         |
| 4.3 Study Area                                                                                                | 8         |
| <b>5. Context</b>                                                                                             | <b>13</b> |
| 5.1 Institutional Arrangements                                                                                | 13        |
| 5.2 Engeny's Role                                                                                             | 15        |
| 5.3 History of Stormwater Studies in Merri-Bek                                                                | 15        |
| <b>6. Method</b>                                                                                              | <b>17</b> |
| 6.1 Step 1 – Initial Models and Maps for Local Catchments (2017-2020)                                         | 17        |
| 6.2 Step 2 – Integrated Whole of Catchment Models (2020-2023)                                                 | 18        |
| 6.3 Step 3 – Validating for New Information (2023)                                                            | 19        |
| 6.4 Step 4 – Updated Models and Maps for Local Catchments (2023)                                              | 19        |
| 6.5 Step 5 – Map Extent Review and Amended Stormwater Map (2023)                                              | 21        |
| <b>7. Results</b>                                                                                             | <b>22</b> |
| 7.1 Part A - Stormwater Overland Flow Maps                                                                    | 22        |
| 7.2 Part B – Comparison of 2017 and 2023 Stormwater Overland Flow Maps                                        | 24        |
| 7.3 2023 Mapping Extent Review                                                                                | 43        |
| <b>8. Conclusion</b>                                                                                          | <b>45</b> |
| <b>9. Qualifications</b>                                                                                      | <b>47</b> |
| <b>Appendices</b>                                                                                             |           |
| <b>Appendix A: 2017 Merri-bek stormwater overland flow mapping report</b>                                     | <b>48</b> |
| <b>Appendix B: Melbourne Water and Merri-bek City Council Mapping Project Report (November 2022)</b>          | <b>49</b> |
| <b>Appendix C: Data Validation Report</b>                                                                     | <b>50</b> |
| <b>Appendix D: TUFLOW Model Layouts</b>                                                                       | <b>51</b> |
| <b>Appendix E: 1% AEP Depth and Hazard Maps</b>                                                               | <b>52</b> |
| <b>Appendix F: 2023 amended Stormwater Overland Flow Extent Maps (wider scale)</b>                            | <b>53</b> |
| <b>Appendix G: 2023 amended Stormwater Overland Flow Extent Maps (local scale)</b>                            | <b>54</b> |
| <b>Appendix H: 2023 mapping extent review outcomes</b>                                                        | <b>55</b> |
| <b>Appendix I: 2023 amended map compared to 2021 map</b>                                                      | <b>56</b> |
| <b>Tables</b>                                                                                                 |           |
| Table 5.1: History of Stormwater Studies in Merri-bek .....                                                   | 16        |
| Table 6.1: Newly constructed pipe summary .....                                                               | 20        |
| Table 7.1: Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014) ..... | 24        |

## Figures

|                                                                                                        |    |
|--------------------------------------------------------------------------------------------------------|----|
| Figure 4-1: Five step technical process .....                                                          | 7  |
| Figure 4-2: MUNICIPAL 1% AEP (1 in 100-YEAR) STORMWATER MAP (all catchments) .....                     | 10 |
| Figure 4-3: MUNICIPAL Drainage ASSET MAP .....                                                         | 11 |
| Figure 4-4: EXISTING MERRI-BEK PLANNING SCHEME, SBO & LSIO MAP .....                                   | 12 |
| Figure 5-1: Melbourne Water Area of responsibility .....                                               | 13 |
| Figure 5-2: Melbourne Water drainage, channels and waterway assets within Merri-bek City Council ..... | 14 |
| Figure 6-1: Map checking methodology .....                                                             | 21 |
| Figure 7-1: COMBINED Hazard Curves, (Smith et al, 2014) .....                                          | 23 |
| Figure 7-2: Example of flow path along a road with properties removed .....                            | 28 |
| Figure 7-3: CLOSER INSPECTION OF property removed from extent .....                                    | 28 |
| Figure 7-4: Example 1 of flow path along a road with SOME SHARP EDGES .....                            | 29 |
| Figure 7-5: Example 2 of flow path along a road with SOME SHARP EDGES .....                            | 29 |
| Figure 7-6: Example 3 of flow path along a road with SOME SHARP EDGES .....                            | 30 |
| Figure 7-7: Location 1 - West of Sydney Road .....                                                     | 31 |
| Figure 7-8: Location 2 – Glenlyon Road / Alister Street .....                                          | 32 |
| Figure 7-9: Location 3 – North of Dawson Street / Near Halpin Street .....                             | 33 |
| Figure 7-10: Location 4 – Near Brunswick Road / Coronation Street .....                                | 34 |
| Figure 7-11: Location 5 – East of Tullamarine Fwy / Citylink .....                                     | 35 |
| Figure 7-12: Location 6 – Melville Road / Reynard Street .....                                         | 36 |
| Figure 7-13: Location 7 – Various Locations in Hadfield .....                                          | 37 |
| Figure 7-14: Location 8 – Various Locations East of Hume Fwy .....                                     | 38 |
| Figure 7-15: Case Study example Location 1 .....                                                       | 40 |
| Figure 7-16: Case Study example Location 2 .....                                                       | 42 |
| Figure 7-17: Map checking methodology .....                                                            | 43 |
| Figure 8-1: Five step modelling and mapping process .....                                              | 46 |

# EXECUTIVE SUMMARY

*Most established suburbs in metropolitan Melbourne have areas affected by stormwater overland flows. These flows come from intense rainfall when major storms affect urban areas. Merri-bek City Council (Council) is the local drainage authority for the city's smaller catchments, less than 60 hectares. Council has a role to manage stormwater risk in these catchments. This includes having a stormwater map, which is imbedded into statutory mechanisms. Then, risks can be managed when land development is proposed.*

In recent years Council has done various technical studies, to identify and manage risks for stormwater overland flows. Collectively, these represent a robust approach to informing a Stormwater Map, for the city's smaller catchments. These studies also inform how Council does drainage improvements in these catchments. A chronological summary of these studies and associated events, is given below.

## **2016 – Pilot Study**

A pilot study was initially done in the Moreland Road catchment to demonstrate that available data and modelling software could suitably reproduce known stormwater overland flow issues in a smaller catchment.

## **2017-2020 – Initial Stormwater Map**

Initial stormwater overland flow modelling and mapping was done in a study for the city's smaller catchments.

## **2018-2020 – Mitigation Assessment**

Structural (engineering) mitigation options were assessed and prioritised for the 10% annual exceedance probability (AEP) event, otherwise known as the 1 in 10 year event. These options were described in a Drainage Investigation Study, which now gives direction to Council's annual capital works program for drainage upgrade works.

## **2021 - Building Act Designation**

After sharing the initial Stormwater Map with affected landowners, Council activated the Building Regulations 2018 and designating the initial map. This triggered a reporting and consenting process for building surveyors.

## **2020-2023 – Melbourne Water Involvement**

Melbourne Water picked up Council's work to pursue a 'whole-of-catchments' approach for both the smaller (local) and larger (main) drainage catchments. This included an independent peer review of the models for the municipality's four urbanised catchments, where there are stormwater overland flows.

## **2023 – Data Validation**

Updated drainage, topographic data and technical guidelines were then reviewed and integrated into the modelling.

## **2023 – Updated Stormwater Map**

All the work done was then used to prepare an updated Stormwater Map for the city's local drainage catchments, where Council is the relevant drainage authority. This resulted in reviewed stormwater modelling mapping for the 1% annual exceedance probability (1 in 100 year) event. Climate change was factored into this work.

## **Late 2023 – Landowner Consultation**

The updated Stormwater Map will be shared with affected landowners, then Council intends to pursue statutory mechanisms. This includes a planning scheme amendment process so a final map can inform better land development outcomes, where there is a clear stormwater risk linked with an overland flow path in the Council's local drainage areas.

## **Late 2023 – Map Extent Review and Amended Stormwater Map**

The updated stormwater map was used to consult affected landowners and a review of resident responses was completed in collaboration with municipal-wide field observations and a visual check of the mapping extent to produce an amended Stormwater Map for Council's local catchments.

# 1. ACKNOWLEDGEMENTS

Engeny acknowledges the Wurundjeri Woi-wurrung people are the Traditional Owners of the lands and waterways in Merri-bek City Council.

Engeny also acknowledges the assistance provided by Merri-bek City Council officers and Melbourne Water staff in sourcing data used in the preparation of this report, the modelling and mapping that underpins the report's findings.

## 2. LIST OF TERMS & ABBREVIATIONS

The following terms and abbreviations are used in this report.

| Term (Abbreviation)                 | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Annual Exceedance Probability (AEP) | <p>Refers to the probability or risk of a rainfall event of a given magnitude (intensity and duration) occurring or being exceeded in any given year. A 90 % AEP event has a high probability of occurring or being exceeded; it would occur quite often and would be a relatively minor rainfall event.</p> <p>A 1 % AEP event has a low probability of occurrence or being exceeded; but is likely to cause extensive damage. A 1 % AEP event has the same probability as a 1 in 100-year ARI.</p>    |
| Australian Height Datum (AHD)       | A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums.                                                                                                                                                                                                                                                                                                                                                     |
| Average Recurrence Interval (ARI)   | <p>Refers to the average time interval between a given storm event magnitude occurring or being exceeded. For instance, a 100-year ARI event is expected to be exceeded on average once every 100 years.</p> <p>The AEP is the ARI expressed as a percentage.</p>                                                                                                                                                                                                                                       |
| Freeboard                           | A factor of safety above the relevant design standard (e.g., 1 in 100 year) stormwater level. Is typically used for setting of floor levels or crest heights of levees. It is usually expressed as a height above the level of the design storm event.                                                                                                                                                                                                                                                  |
| Effective Impervious Area (EIA)     | Impervious areas which are directly connected to underground drains or concrete lined channels. Examples include roofs with downpipes connecting to drains, road pavement and large carparks.                                                                                                                                                                                                                                                                                                           |
| Hydraulics                          | The term given to the study of water flow in a river, channel, or pipe. In particular, for the evaluation of flow parameters - such as depth and velocity.                                                                                                                                                                                                                                                                                                                                              |
| 'Hot Spot'                          | An area which has a history of repeat stormwater impacts, highlighted through stormwater modelling, anecdotal information and / or customer complaints.                                                                                                                                                                                                                                                                                                                                                 |
| Hydrology / Hydrologic              | Terms given to the study of the rainfall and runoff. Determining how much rain is likely to fall in each event and how much of that rain will become runoff.                                                                                                                                                                                                                                                                                                                                            |
| Impervious                          | A ground covering or surface which water cannot pass through. Examples include roofs, concrete and asphalt. The opposite of impervious is pervious.                                                                                                                                                                                                                                                                                                                                                     |
| Indirectly Connected Area (ICA)     | Includes all small pervious areas within a catchment (gardens, nature strips, pocket parks, lawns) and impervious areas which are not directly connected to an underground drain or concrete channel (runoff flows onto a pervious surface). Examples of impervious areas which are not directly connected include footpaths next to a nature strip, concrete or gravel paths through parks, roof of a garden shed where water falls onto the garden, most residential driveways and landscaped paving. |
| Intensity Frequency Duration (IFD)  | Statistical analysis of rainfall, describing the rainfall intensity (mm/hr), frequency (probability measured by the AEP), duration (hrs). This analysis is used to generate design rainfall estimates.                                                                                                                                                                                                                                                                                                  |
| Light Detection and Ranging (LiDAR) | Airborne surveying technology that provides a regularly spaced grid (one metre horizontal interval in this case) of ground levels. The data allows for the representation of elevations along waterways and other key topographical features across the study area.                                                                                                                                                                                                                                     |
| Pervious                            | A ground covering or surface which water can pass through. Examples include gardens, grass (lawns, nature strips, ovals) and other green landscaped areas. The opposite of pervious is impervious.                                                                                                                                                                                                                                                                                                      |

| Term (Abbreviation)                        | Explanation                                                                                                                                                                                                                                                                                    |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Representative Concentration Pathway (RCP) | Greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change. These projections consist of four different climate futures relative to temperature and sea level rises possible depending on the volume of greenhouse gases emitted in the years to come. |
| RORB                                       | Hydrological modelling software used in this study to calculate the runoff generated for rainfall events.                                                                                                                                                                                      |
| Stormwater Map                             | A map showing the outcome of modelling work for the representation of the 1% AEP event on affected land. In this report this term is interchangeable with 'stormwater overland flow path map'                                                                                                  |
| TUFLOW                                     | Hydraulic modelling software used in this study to simulate the flow of stormwater through the study area. The model uses numerical equations to describe the water movement.                                                                                                                  |

### 3. PURPOSE

This report brings together the technical work done for stormwater mapping in the city's local drainage catchments, where Merri-bek City Council is the local drainage authority. It gives a timeline for the studies and shows a logical, sequential approach has happened. The studies give direction to reducing the risk of stormwater inundation, when land is being developed. To achieve this, the technical work is informing a Stormwater Map. Then, this map can be implemented into statutory mechanisms, such as a new Special Building Overland in the Merri-bek Planning Scheme. This outcome enables Merri-bek City Council to work with land developers and their consultants, to address stormwater issues when they prepare their proposals in Council's local drainage catchments.

## 4. INTRODUCTION

### 4.1 Study Overview

This report outlines a 5-step technical process that began in 2017 when Engeny was engaged by Moreland City Council (now Merri-bek City Council) to do stormwater flow modelling in local drainage catchments, where Council is the local drainage authority and has its drainage assets.

Figure 4-1 below gives a flow-chart of the 5-step process which informs this report. This process is summarised as:

- Step 1 (2017-20) – Initial Models and Maps for Local Catchments.

Engeny was engaged by Council to develop stormwater models for the city's smaller local drainage catchments, and produce an initial Stormwater Map which shows the overland flow paths in these catchments.

- Step 2 (2020-23) – Integrated Whole of Catchment Models.

Engeny was then engaged by Melbourne Water to review Council's (Step 1) modelling and include detailed modelling of all of Melbourne Water's larger drainage catchments in the city. This did not include modelling Melbourne Water's larger waterways, including Moonee Ponds Creek, Merri Creek and Edgars Creek. As part of this second step, the 2017 initial Council catchment models were integrated into new whole of catchment models, which incorporated Melbourne Water's overland flow paths for its main drainage catchments. The modelling was also independently peer reviewed. Section 5.1 explains the roles of the different government agencies in managing drainage within a catchment.

- Step 3 (Mid 2023) – Validating for New Information.

Since Council's independent modelling study in 2017, some of the data has been superseded with new information. There have also been major infrastructure projects, most notably two significant level crossing removal projects (LXRP) in Preston/Bell and Glenroy which have recently completed. Council has also done several drainage improvement projects since 2018, which were not included in the 2017 modelling. Also, Council has updated LiDAR data, captured in late 2021, which also needed to be considered.

- Step 4 (Mid 2023) – Updated Models and Maps for Local Catchments.

As a result of Step 3, the models have been validated and updated modelling has been done to incorporate the new information. This means the Council's models are up to date and captures the latest available data to understand stormwater overland flow paths. A preliminary version of the updated stormwater map was released for public comment.

- Step 5 (Late 2023) – Map Extent Review and Amended Stormwater Map.

As a result of Step 4, a municipal-wide review of the preliminary version of the updated stormwater map was undertaken by Council and Engeny to ensure the robustness and consistency of the updated stormwater overland flow extent. This includes a visual check for any anomalies or inconsistencies in the mapping extent. Separate to the visual extent checks, review requests of the stormwater overland flow extent were also undertaken based on responses from residents. Submitters requests for review have also been assessed by Engeny, including site visits to verify data in publicly accessible areas.

Arising from this step, an amended Stormwater Map superseding from the preliminary version released in Step 4 has been established for Council's local catchments.

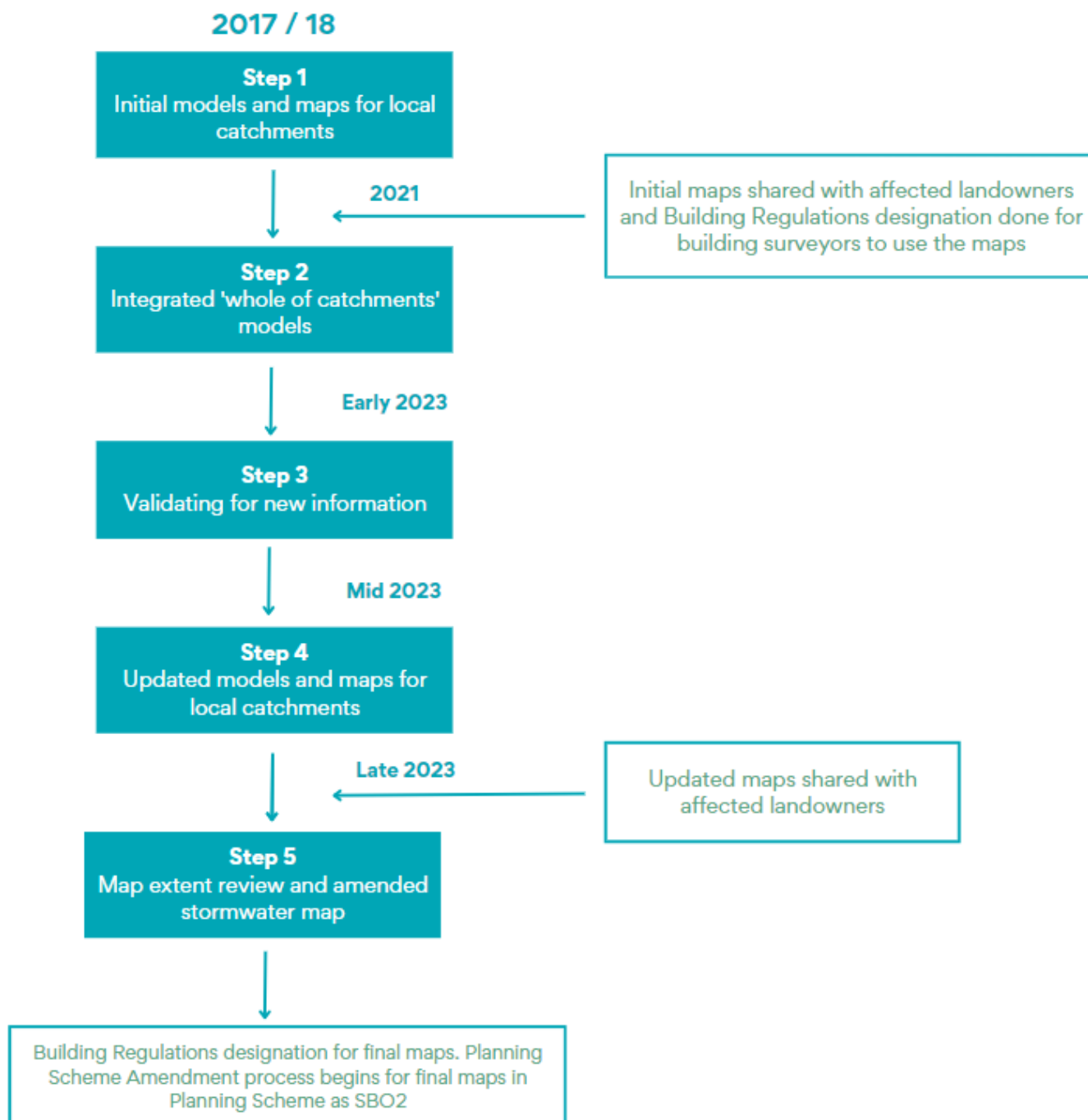


FIGURE 4-1: FIVE STEP TECHNICAL PROCESS

## 4.2 Objectives

The objectives of this report are:

- To enable a stepped modelling and mapping technical method for Council's local catchments stormwater mapping, to be informed by the best available information.
- To enable a technical method for Council's local catchments stormwater mapping, that integrates consideration of downstream main-drainage catchments.
- To enable a technical method that is informed by changing national guidelines, that integrates consideration of climate change.
- To enable a technical method that included initial landowner consultation before Council used any initial Stormwater Map for designation under the Building Regulations.
- To enable a technical method that is robust and defensible for any future independent Planning Panel, that sits to consider any submissions for final maps being included in the Merri-bek Planning Scheme.
- For this report to be an important technical background document to explain how the final maps were prepared, in a manner that is industry standard for contemporary stormwater modelling and mapping.

## 4.3 Study Area

This report is for a stormwater overland flow mapping work program for Merri-bek's urbanised drainage catchments. This excludes the larger waterway catchments for Moonee Ponds Creek, Merri Creek and Edgars Creek. This exclusion does not affect the work program, because waterway catchment modelling requires a different approach. Furthermore, these major waterways are associated with large, complex catchments where different inputs, models and maps would be prepared. Furthermore, waterways are managed by Melbourne Water and are not the responsibility of the local drainage authority.

The municipality has been separated into four distinct hydraulic model areas, these are named after the:

- main drain which takes stormwater from catchment to the downstream waterway, or
- general location of the catchment within the city, where multiple main drains traverse the catchment.

Figure 4-2 shows the location of the different hydraulic models used for the study. The hydrology models were setup using a finer catchment breakup with a total of 7 hydrology models created. The hydrology models provide inputs to the hydraulic models but do not need to match areas as multiple hydrology models can be read into one hydraulic model.

Figure 4-3 shows the existing drainage network layout. It shows the Council drains, Melbourne Water drains, waterways (all Melbourne Water managed) and the retarding basins (Melbourne Water managed).

Melbourne Water is typically responsible for the management of drains and waterways in catchments greater than 60 hectares. This typically means that Melbourne Water manages the largest underground drains and most waterways and retarding basins within a given catchment. This report focuses on the overland flow paths associated with the Merri-bek Council drainage system only (not the Melbourne Water drains or waterways).

Stormwater drainage systems are generally designed to convey flows from relatively common or frequent storm events up to a typical design storm of a 20% (1 in 5 year) or 10% (1 in 10 year) AEP (depending on land use, storms such as the 10% AEP can be used in the design of drainage networks for commercial or industrial areas). Flows for rarer or larger storm events such as a 1% (1 in 100 year) AEP are designed to be conveyed via roads or dedicated drainage reserves under current design standards. Drainage design methodologies, data and standards, and land use can also change over time.

The typical design life for an underground drain is at least 50 years, however many extend well beyond this to over 100 years, especially large main drains. This long asset life and changes in design methodologies, data and standards can result in some areas being serviced by drains which do not meet the current design criteria, i.e., the drain is not able to fully convey flows from a 20% (1 in 5 year) AEP storm event.

The consideration of provision of suitable means to convey overland flow paths has been common practice since the 1960s and 1970s, however before this time these flow paths were not always considered in the design and layout of subdivisions. Much of Merri-bek was subdivided before this time and so not all overland flow paths have been properly protected from development. The grid type street

alignment which is common in many Merri-bek suburbs is evidence that protecting overland flow paths from development was not a high priority when the subdivision was created. While the grid alignment of the roads does work reasonably well in some relatively flat areas for conveying overland flows, it also fails to suitably convey flows in areas with more defined topography. It is this lack of consideration of overland flow paths from previous historical subdivisions that is driving the implementation of statutory mechanisms, such as the Special Building Overlay (SBO).

Figure 4-4 shows the different Special Building Overlays for stormwater overland flow, and Land subject to Inundation Overlay (LSIO), for riverine flood maps. The SBO1 and LSIO is already part of the Merri-bek Planning Scheme. The SBO2 is Council's Stormwater Map for its local drainage catchments.

Council's future planning scheme amendment will be aiming to add SBO2 into the Merri-bek Planning Scheme.

It is understood Melbourne Water will be separately exploring a future planning scheme amendment to update its existing SBO1 map.

This report focuses only on Merri-bek City Council's Stormwater Map, which will inform a proposed SBO2. This report does not give technical information for any future changes to Melbourne Water's SBO1. Melbourne Water is separately doing technical study to consider the future need for updated main drainage maps.

Melbourne Water and Council have worked together to ensure an integrated modelling approach. This is also informing the future demarcation between separate Council and Melbourne Water overlays for the planning scheme.

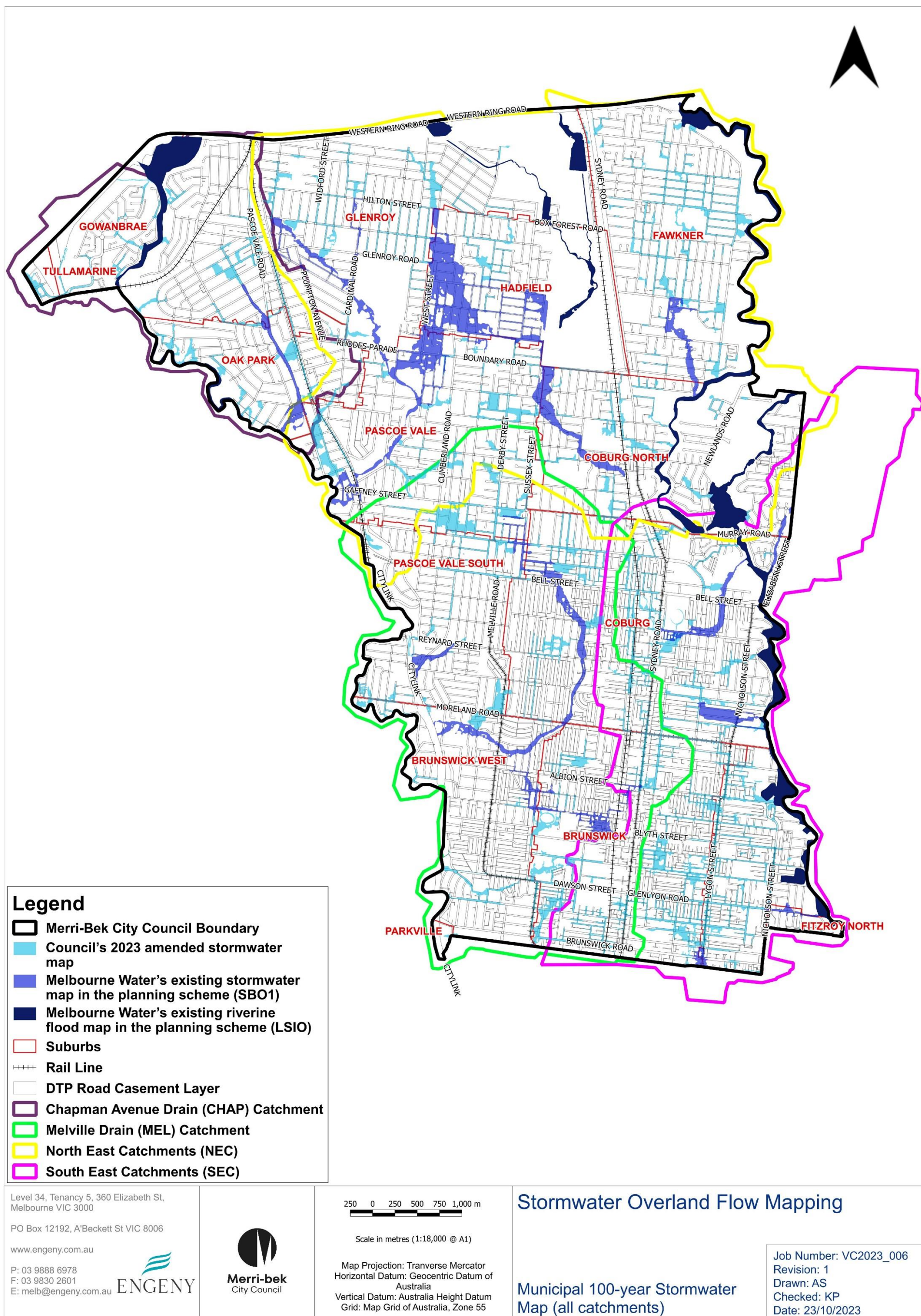


FIGURE 4-2: MUNICIPAL 1% AEP (1 IN 100-YEAR) STORMWATER MAP (ALL CATCHMENTS)

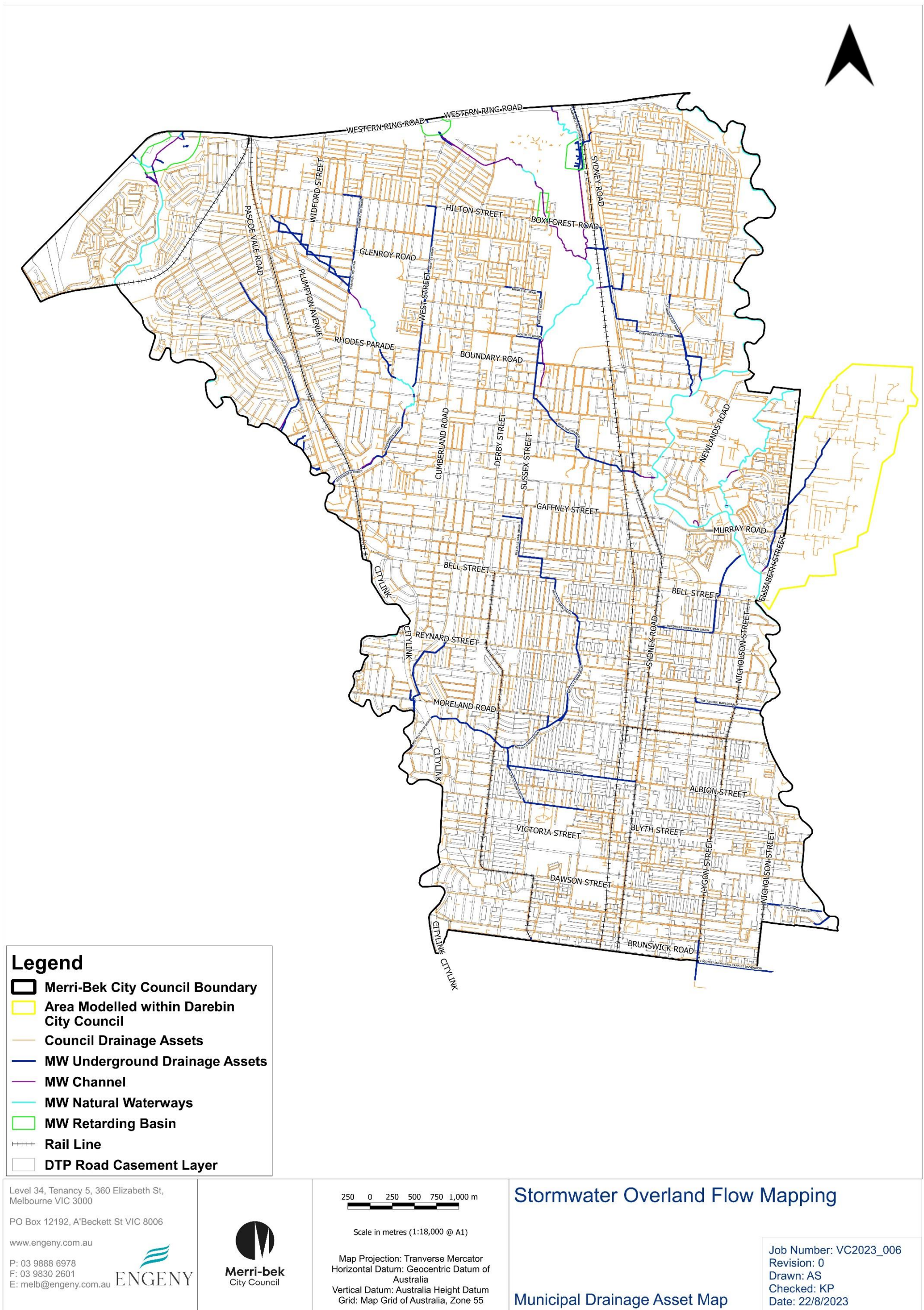


FIGURE 4-3: MUNICIPAL DRAINAGE ASSET MAP

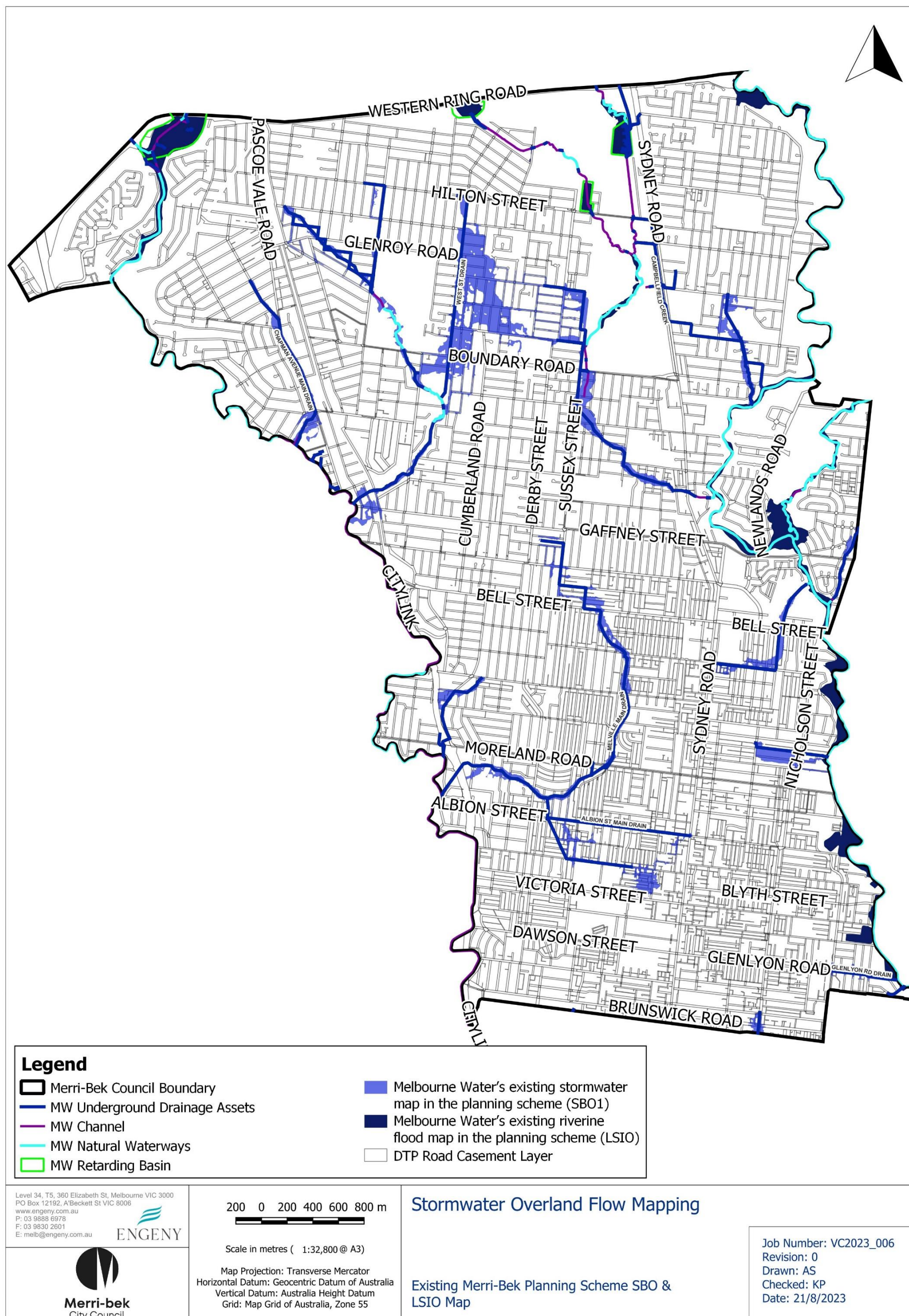


FIGURE 4-4: EXISTING MERRI-BEK PLANNING SCHEME, SBO & LSIO MAP

## 5. CONTEXT

### 5.1 Institutional Arrangements

Melbourne Water and local councils, including Merri-bek City Council, both play a role in managing Melbourne's drainage system.

Melbourne Water is the floodplain management authority and the catchment management authority (CMA) for catchments which drain into Port Phillip and Western Port. Figure 5-1 shows the total area and catchments which Melbourne Water operates.

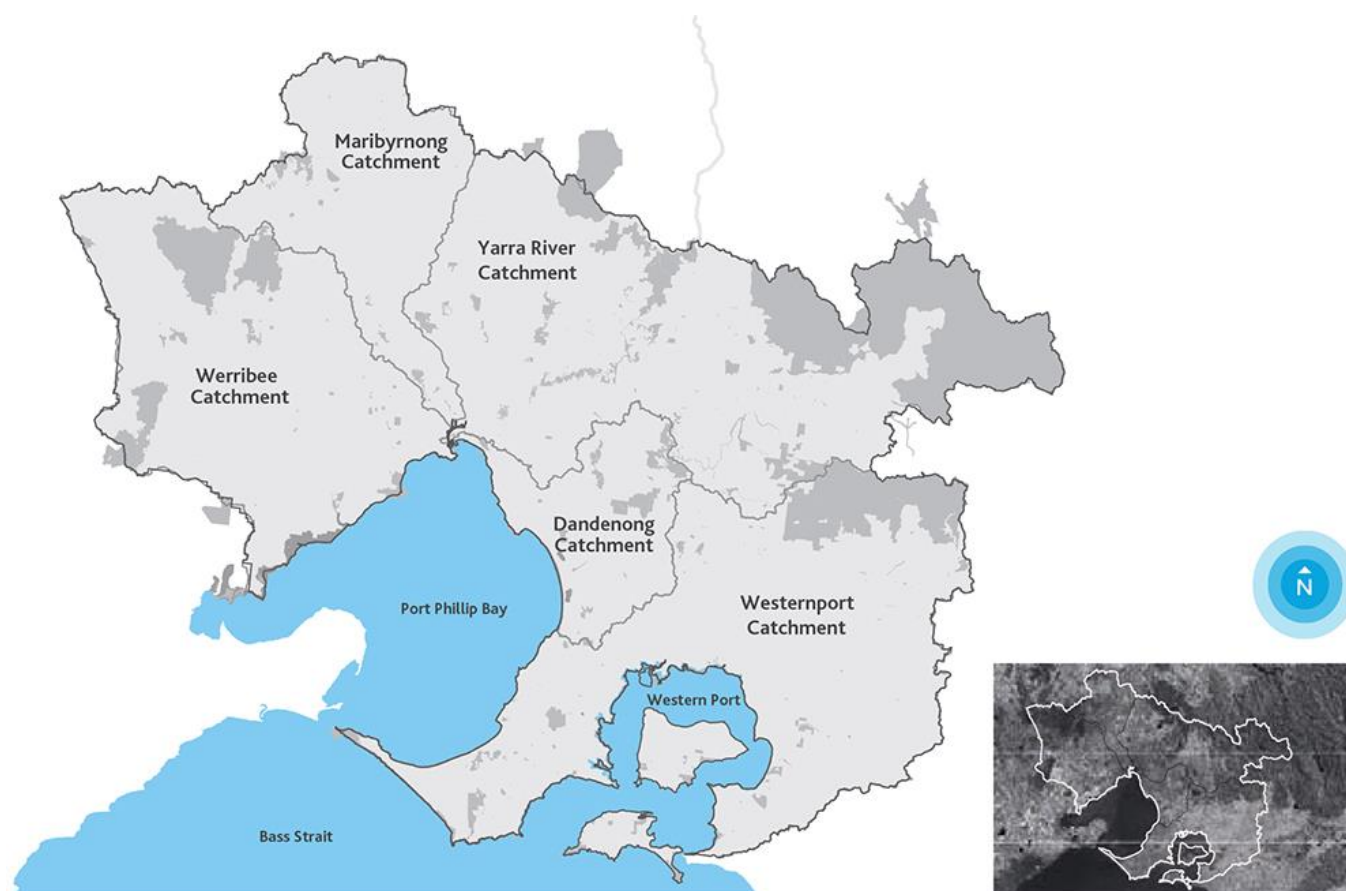


**FIGURE 5-1: MELBOURNE WATER AREA OF RESPONSIBILITY**

(source <https://www.melbournewater.com.au/services/grants/liveable-communities-liveable-waterways-program/program-guidelines>)

Melbourne Water is also the main drainage authority for metropolitan Melbourne, and manages waterways, open drainage channels and underground drains with catchments typically greater than 60 hectares within its area of responsibility. Within the City of Merri-bek this includes Merri Creek, Edgars Creek and Moonee Ponds Creek, which (in parts) form the city's boundaries.

Melbourne Water is also responsible for the ownership and maintenance of wetlands and retarding basins within catchments generally larger than 60 hectares. This includes various assets within Merri-bek.

Melbourne Water's responsibility also extends to managing risk of flooding associated with waterway and drainage assets. Figure 5-2 shows the Melbourne Water managed drainage, channel, and waterway assets within Merri-bek.

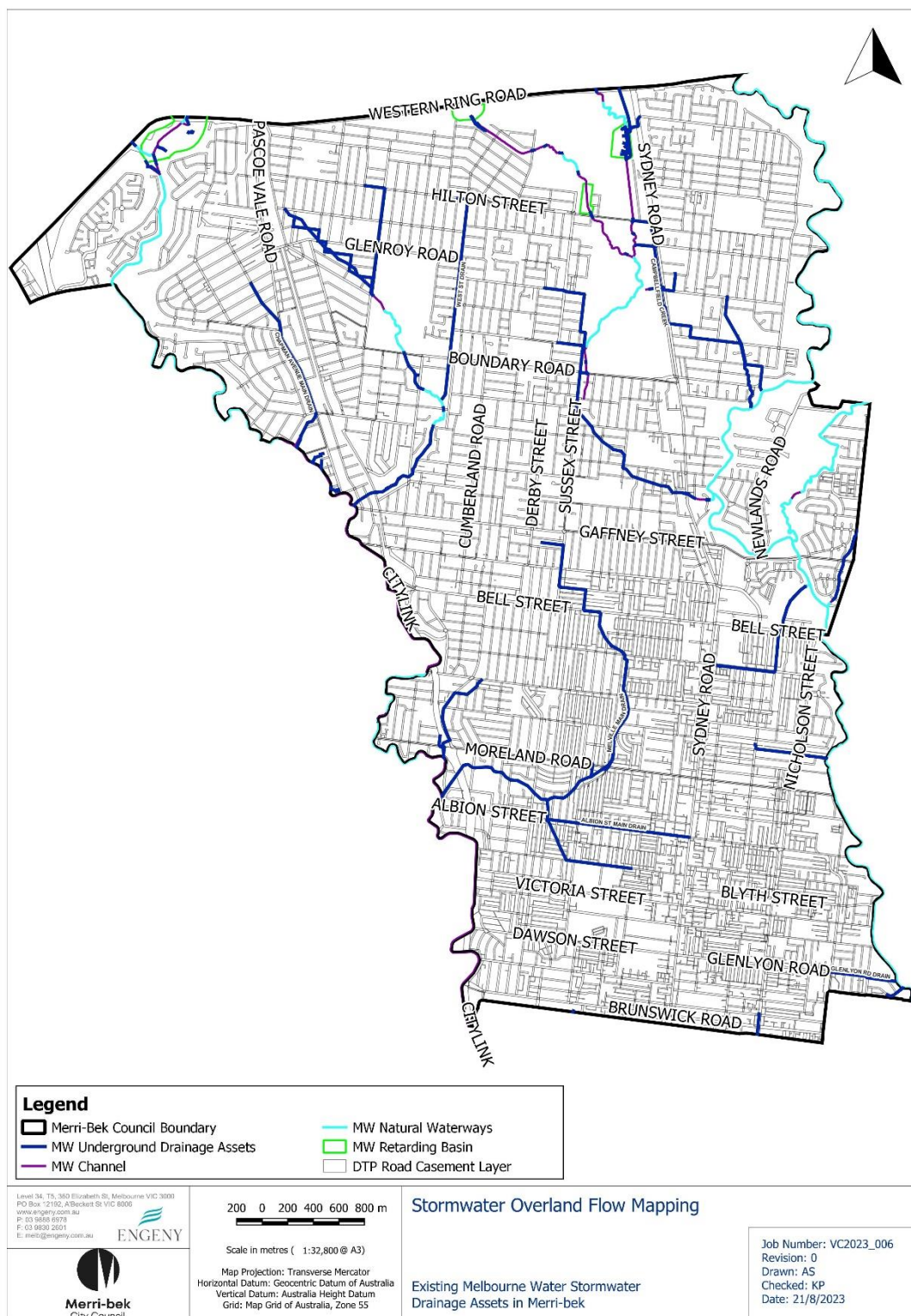


**FIGURE 5-2: MELBOURNE WATER DRAINAGE, CHANNELS AND WATERWAY ASSETS WITHIN MERRI-BEK CITY COUNCIL**

Merri-bek City Council is responsible for local drainage. This drainage network is mostly comprised of underground drains, pits, kerbs and channels and road pavements in catchments typically less than 60 hectares in size. Merri-bek City Council also owns and maintains various Water Sensitive Urban Design (WSUD) assets which serve multiple functions. This includes drainage, as well as urban heat management, urban greening, stormwater quality treatment and landscape design. Council's drainage responsibility includes ownership and maintenance of these assets.

VicRoads, VicTrack and some other government agencies also own and maintain public drainage assets in Victoria, including Merri-bek. However, Melbourne Water and Merri-bek City Council manage the majority of the drainage assets within the city.

The final layer of drainage ownership is privately owned drains. Most private properties have drainage assets which connect to either the Council or Melbourne Water drainage network. For individual houses this may include gutters, downpipes and a single underground or above ground connection to a public drain. For larger properties, such as industrial or commercial properties this may include significant pit and pipe infrastructure in addition to roof drainage. These private drainage assets are not managed by Merri-bek Council or Melbourne Water. Industry standards, guidelines and requirements inform the design and construction of privately owned drains.

This report focuses on the role of Council as the local drainage authority.

## 5.2 Engeny's Role

Engeny has been working in Melbourne since 2010, with a focus on stormwater modelling and mapping for local and state government clients. We have done numerous city-wide studies for local governments in metropolitan Melbourne and Regional Victoria, in addition to also doing smaller catchment based studies as well.

Engeny has also been a panel contracted supplier of specialist stormwater modelling service to Melbourne Water since 2015 and is currently one of only four consultancies on Melbourne Water's Specialist services panel providing expert modelling services. We have done numerous studies for Melbourne Water individually and as joint projects between local councils and Melbourne Water. Our staff have also represented Melbourne Water and local councils at planning panels and expert witness hearings, to explain the technical work we have done.

Engeny started working with the City of Merri-bek on a pilot study in 2016 and has continued to work with Council, providing stormwater overland flow modelling and mapping advice for the Council's drainage system. Our studies have been done using RORB and TUFLOW software and have applied the relevant industry standards and guidelines for the development of hydrologic and hydraulic modelling.

Engeny's involvement with Merri-bek City Council and Melbourne Water over the past 7 years has given us a strong understanding of the overland flow dynamics in the city. This includes the issues the Council faces in managing its local catchments, where it is the local drainage authority.

## 5.3 History of Stormwater Studies in Merri-Bek

Engeny was first engaged by Moreland City Council (now Merri-bek City Council) in 2016 to do a pilot study for a local catchment (less than 60ha in size) with known drainage issues. The initial focus was a pilot study to determine whether the modelling software (RORB and TUFLOW) could provide an accurate representation of stormwater overland flows. The modelling of the pilot catchment provided results that matched with Council's understanding of the historic drainage issues and provided a proof of concept that the modelling approach was able to simulate with reasonable accuracy the performance of the drainage network.

Many other Councils that Engeny have worked with across Greater Melbourne have chosen to undertake a pilot catchment study or multiple studies before committing to the larger job of modelling the whole city. This stepped approach is consistent with good engineering industry practice when adopting a new product or study technique to first trial it in a small area and then adopt more widely if it performs well.

Following the pilot study, in 2017 Engeny was engaged to do a city-wide study with a focus on the Council's drainage catchments which was completed in 2020. The local drainage network is made up of mostly smaller pipes and pits. These pipes connect to the downstream Melbourne Water main drainage network. Within Merri-bek Melbourne Water's main drainage network includes large drainage pipes, large open channels, waterways and creeks, drainage retarding basins and large outlet structures into waterways and channels.

After the local drainage study was done, Engeny started a drainage investigation study in 2018. This technical work identified and assessed places at most risk from stormwater overland flows, and proposed concept-design structural mitigation solutions (i.e., design for new drains).

Council is now using this technical work to inform its long-term capital works planning. The final investigations focused on mitigation solution for the 10% AEP (1 in 10 year) event, as the adopted level of service for mitigation pipe upgrades.

Council's current drainage standard for residential areas is a 20% AEP (1 in 5 year) event sized pipe. It is likely that this standard was applied when pipes were originally constructed across the city. By adopting a 10% AEP (1 in 10 year) event, Council is providing extra flow capacity above the minimum design standards.

Arising from Council's progress for its local drainage catchments, Engeny was then engaged by Melbourne Water in 2020 to include the Council's modelling with Melbourne Water's urbanised main drainage catchments in the city (excluding major waterways). This 'whole-of-catchments' modelling approach was then subject to Melbourne Water's external third party peer review process.

Melbourne Water's peer review process is completed on all models developed for Melbourne Water. Melbourne Water has developed a standard template for reviews to ensure consistent quality is maintained in all catchments mapped across Greater Melbourne. The hydrologic (RORB) and hydraulic (TUFLOW) models and the draft and final deliverables are all reviewed at separate hold points with comments provided to Melbourne Water by the third party reviewer. Melbourne Water passes this feedback onto Engeny along with any additional comments from the Melbourne Water team. Engeny responds to all comments made and where appropriate will update the models or deliverables to address the comments. The modelling and mapping deliverables are only finalised by Melbourne Water once all of the review comments have been resolved. The consultancies completing the reviews are typically one of Melbourne Water's approved panel suppliers or have been contracted specifically because of their specialist skills in stormwater flow modelling and mapping.

In 2023 Engeny was engaged by Council to complete a review of new data which had come on-line, to ensure any updated Stormwater Map considered this new information. This gave Engeny an opportunity to also review changes in modelling guidelines, including those given in Australian Rainfall and Runoff 2019. The result of this review found there was sufficient change, associated with the new data and modelling methodology, to warrant further refinements in the overland flow path modelling.

Additional information can be found in the Mapping Data Validation Report which is attached in Appendix C:.

The updated modelling utilising the more recent data and updated methodologies was completed in 2023 modelling and forms the basis for the proposed special building overland amendment maps. The special building overlay represents the non- structural mitigation measure that Merri-bek City Council is enacting to reduce the risk of inundation from stormwater overland flows.

Table 5.1 shows the recent history of the stormwater modelling studies which have been undertaken in the City of Merri-bek.

**TABLE 5.1: HISTORY OF STORMWATER STUDIES IN MERRI-BEK**

| Date       | Study                                                                                 |
|------------|---------------------------------------------------------------------------------------|
| 2016       | Pilot study                                                                           |
| 2017-2020  | Initial Stormwater Map for the city's smaller catchments                              |
| 2018 -2020 | Mitigation assessment and prioritisation of hotspots in the city's smaller catchments |
| 2020-2023  | City-wide study lead by Melbourne Water                                               |
| 2023       | Data validation study for the city's smaller catchments                               |
| 2023       | Updated Stormwater Map for the city's smaller catchments                              |

## 6. METHOD

This section of the report gives more detail the five-step process, which was introduced in Section 4.1.

### 6.1 Step 1 – Initial Models and Maps for Local Catchments (2017-2020)

After doing the pilot study in 2016, Engeny was engaged in 2017 to start doing stormwater overland flow mapping for the Council's local drainage catchments. A copy of the report for this initial mapping is in Appendix A:

#### 6.1.1 Data

The following key base data was supplied for use in the mapping project:

- LiDAR terrain data captured in 2007 and 2008
- Drainage asset (pit and pipe) data in GIS format from Moreland City Council
- Drainage asset (pit and pipe) data in GIS format from Melbourne Water
- Copies of previous stormwater models of some main drainage catchments from Melbourne Water

#### 6.1.2 Hydrology

Hydrological calculations were done using RORB modelling software version 6.32. Seven individual RORB model were setup for the city's local catchments. The modelling adopted methodologies from the newly released Australian Rainfall and Runoff 2016 as much as was practical, subject to software limitations. The modelling adopted the new 2016 IFD data, applied the ten temporal patterns in an ensemble approach and utilised the revised hydrological losses from the Australian Rainfall and Runoff data hub.

The hydrology model was run for the 1, 2, 10 and 20% AEP events under current climate conditions and the 1% AEP under climate change conditions. The 10, 15, 30, 60, 120 and 180 minute storms were modelled for all events. Each duration was also modelled for 10 different temporal patterns as per the ensemble approach set out in Australian Rainfall and Runoff 2016.

The outputs from the RORB models were used as inputs to the hydraulic model. Most outputs from the RORB model were rainfall runoff excess hydrographs with no routing. However, some routed hydrographs were used for the external catchments which form part of the Westbreen Creek and Merlynston Drain catchments which are included in the North East Catchments (NEC) model.

#### 6.1.3 Hydraulics

The hydraulic modelling was done using TUFLOW Classic version 2017-09-AC-IDP-w64. Six TUFLOW model were setup with the following key inputs:

- The Council's drainage network assets
- Melbourne Water (MW) drains which had direct connections to the Council drainage network.
- Topography (ground surface level) data based on DELWP LiDAR data
- Hydraulic "roughness" parameters defined using Mannings "n" values based on planning scheme land usage layers and aerial photography and in line with industry standards
- Inflows generated from RORB hydrologic models as per Section 6.1.2.

The Merlynston Drain and Westbreen Creek models were combined during the model development process due to the degree of cross-catchment flow between the two models. All the models were run for the same events as the hydrologic models.

## 6.1.4 Mapping

The results from the hydraulic mapping were combined to obtain one final output that could be used to create the stormwater overland flow extents. The approach involved running all the 10 different temporal patterns through the hydraulic model for each storm duration. This means that there are 10 similar but different sets of results for each modelled storm duration. To create a single stormwater depth grid, the following steps were taken:

- Determine the median value at each cell from the 10 ensemble pattern results for each storm duration within each AEP.
- Take the maximum value from each of the median grid from each duration (10, 15, 30, 50, 120, 180 minute) to determine the peak stormwater depth for a given AEP event.

The final grids were then converted into extents. The extents were based on a 50 mm depth filter and inclusion/exclusion criteria based on Melbourne Water's Technical Specifications.

## 6.2 Step 2 – Integrated Whole of Catchment Models (2020-2023)

In 2020 Engeny was engaged by Melbourne Water to complete mapping of Melbourne Water's drainage assets in the City of Merri-bek (excluding Moonee Ponds Creek, Merri Creek and Edgar Creek). This work was focused on completing whole of catchment modelling, which included Council's drainage network and Melbourne Water's drainage network.

As part of this Melbourne Water project the previously modelled Merri-bek catchments (Chapman Avenue Drain, Westbreen Creek, Merlynston Drain, Melville Drain, Elizabeth Street Drain, South-East Catchments and Harding Street Drain) were collated and modelled as 4 separate TUFLOW models and were revised to ensure the overland flow models were fully compliant with Australian Rainfall and Runoff 2019 (ARR 2019), Melbourne Water's current Mapping Projects Guidelines and Technical Specifications (July 2020) and incorporated the updated LiDAR data captured in 2017-18. Refer to Engeny's Draft Melbourne Water and Merri-bek City Council Merri-bek Mapping Project Report (November 2022) in Appendix B: for further details.

Step 1 allowed Council to engage with the community about stormwater risk as well as giving an opportunity to prioritize hot spots and high-risk areas across the local catchments. It has also allowed for mitigation assessments to be better quantified and ensure Council can consider stormwater risk to better plan development across the municipality.

During Step 1, all of the stormwater drainage assets for Council and Melbourne Water were modelled in detail but with an emphasis on Council assets. By revising the Melbourne Water drainage and mapping criteria as part of Step 2, the whole of catchment has been more considered and 1% AEP (1 in 100 year) stormwater extents for both Council and Melbourne Water are consistent as they use the same stormwater mapping approach.

The major hydrology updates as part of this Stage 2 work included:

- Application of fraction imperviousness updated to include new land surface type breakdown into Effective Impervious Areas (EIA), and Indirectly Connected Areas (ICA).
- Storm pre-burst losses were revised to 75% pre-burst based on the Benchmarking ARR 2019 for Victoria Technical Report.

The hydraulic TUFLOW modelling development was also revised to account for:

- Revised hydrographs from RORB modelling
- New LiDAR data (captured in 2017-18)
- Upgrades to the Council and Melbourne Water drainage network data with a particular focus of improving the accuracy of data on the Melbourne Water drains
- Changes to land-use and development since the 2018 Council study
- Modelling using the TUFLOW version 2020-01-AB-IDP-w64.

Due to the:

- Significant changes in stormwater mapping methodology and upgrades.
- Development in the city within the two years since the original modelling.

The modelling outputs from Step 2 were taken and compared against the previous mapping results as part of a data validation review. This approach enabled a further review process, to see if there was enough of a difference to warrant any mapping changes.

Refer to Step 3 for the data validation summary which highlights the changes between the hydrologic and hydraulic standard changes between the 2017 Council study and the latest 2020 Melbourne Water study, in particular the differences in LiDAR and differences in stormwater overland flows identified.

## 6.3 Step 3 – Validating for New Information (2023)

Merri-bek City Council has been motivated to achieve a final planning scheme outcome for its Stormwater Map. This motivation prompted Council to engage Engeny to do a data validation exercise before an updated Stormwater Map was produced.

Engeny reviewed the updated data and a report was produced. This report is in Appendix C: A summary of key findings were:

- Updated 2017-18 LiDAR was available and was used for the Melbourne Water updated mapping in Step 2.
- Merri-bek had obtained LiDAR in 2022 for assessing tree canopy coverage. This LiDAR was found to be less accurate than the 2017-18 data set, but suitable for doing geographic sensitivity analysis where land development had occurred. Given the reduced accuracy of this data, compared to the 2017-18 data, the 2022 data was not used in the modelling or mapping.
- Level crossing removal projects were assessed and found to have some beneficial impacts outside of the railway own land corridors.
- Council drainage works were assessed and found to have some beneficial impacts in the 1% AEP event.
- WSUD wetlands and sedimentation basins were designed to provide water quality benefits. There were no negative flow impacts found to be associated with these assets.

Changes in the hydrological approach between 2017 modelling and 2020 modelling (detailed in ARR 2019), which were impacting extents and total volumes of runoff, were also assessed and found to be contributing to differences in the modelled extents.

Based on the overall amount of change in the data and the changes in the hydrology, the decision was made to update the modelling to incorporate all the latest data.

## 6.4 Step 4 – Updated Models and Maps for Local Catchments (2023)

The 2023 modelling builds upon the 2020 modelling done for Melbourne Water. The models were developed and reviewed as part of the Melbourne Water modelling (Step 2), have been used and updated with the new information assessed under Step 3. Engeny's Draft Melbourne Water and Merri-bek City Council Merri-bek Mapping Project Report (November 2022) provides details on the development of the model for Melbourne Water. The following sections detail what has been updated from the Melbourne Water model, because of this step of the process.

### 6.4.1 Data

The following data has been added to the modelling:

- Updated pipe data, including all drainage upgrade projects completed from 2017 to the start of 2023.
- Updated pipe and topography data associated with the Bell to Moreland level crossing removal project. This data was sourced from the modelling undertaken by the level crossing removal project team.
- Updated pipe and topography data associated with the Glenroy level crossing removal project. The pipe and topography data were obtained from design plans and entered into the model.

### 6.4.2 Hydrology

No changes have been made to the Melbourne Water adopted hydrology models and outputs, with the hydrology modelling using the same RORB model and outputs as were used in Step 2. The objective of the hydrological modelling was generally to produce rainfall excess hydrographs for each subarea delineated within the study area. These are then used as inputs into the TUFLOW hydraulic model to undertake flow routing and to estimate stormwater flow dynamics within the modelled catchment. The flows from two large external catchments of

Merlynston Creek and Campbellfield Creek were applied to the North-East Catchments TUFLOW model as routed flows from the external catchment RORB models.

The rainfall-excess hydrographs were produced for all subareas within the study catchment for the 1 %, AEP climate change conditions for all required storm durations and selected temporal patterns. Council and Melbourne Water have decided to adopt 1 % AEP climate change modelling results to inform a future update of the planning scheme and therefore only this AEP has been considered for the updated municipal modelling.

The models have all been run using the same critical temporal patterns and durations as the previous modelling in Step 2. The models have only been run using an Areal Reduction Factor (ARF) of 1. This has been adopted as all the catchments being mapped under this stage of the works are less than one square kilometre and so this is the appropriate ARF to apply.

While there were no changes made to the hydrology between the Melbourne Water study (Step 2) and the Step 4 modelling, notable changes were made between the original Council modelling and the Melbourne Water modelling. This includes incorporation of the updated advice contained in the Benchmarking ARR 2019 for Victoria study commissioned by the Department of Environment, Land Water and Planning (DELWP). This study recommended changes to the treatment of the pre-burst in particular which results in a greater volume of runoff being generated in the storm events.

### 6.4.3 Hydraulics

The TUFLOW models developed as part of Step 2 for Melbourne Water were updated to include the data listed in Section 6.4.1. Table 6.1 shows the breakdown of the pipe diameters for the new pipes added to the hydraulic model as part of the 2023 Step 4 updates.

**TABLE 6.1: NEWLY CONSTRUCTED PIPE SUMMARY**

| Diameter     | Number of pipes | Diameter | Number of pipes |
|--------------|-----------------|----------|-----------------|
| 100          | 20              | 525      | 54              |
| 150          | 118             | 600      | 40              |
| 200          | 1               | 675      | 7               |
| 225          | 159             | 750      | 29              |
| 300          | 802             | 825      | 23              |
| 330          | 1               | 900      | 14              |
| 375          | 205             | 1050     | 3               |
| 450          | 136             | 1200     | 4               |
| <b>Total</b> |                 |          | 1638            |

The TUFLOW models were run for the 1% AEP event including climate change. Climate change was accounted for assuming an 18.5% increase in rainfall intensity, which is in line with the recommendations in Melbourne Water's Technical Specifications for Mapping and *Australian Rainfall and Runoff 2019*.

### 6.4.4 Results Processing

The results processing is described in Section 7.2.3.

## 6.5 Step 5 – Map Extent Review and Amended Stormwater Map (2023)

To ensure the robustness and consistency of the updated stormwater overland flow extent a detailed assessment of the extent was completed by Council and Engeny to visually check for any anomalies or inconsistencies in the mapping extent. Separate to the visual extent checks, review requests of the stormwater overland flow extent were also undertaken based on responses from residents.

In collaboration with Council, Figure 7-17 below shows a simple schematic flow chart which details the methodology adopted for map-checking for anomalies. The same process was adopted for the visual map review and priority requests from residents.

Section 7.3 of this report provides additional detail on the map extent review process and outcomes.

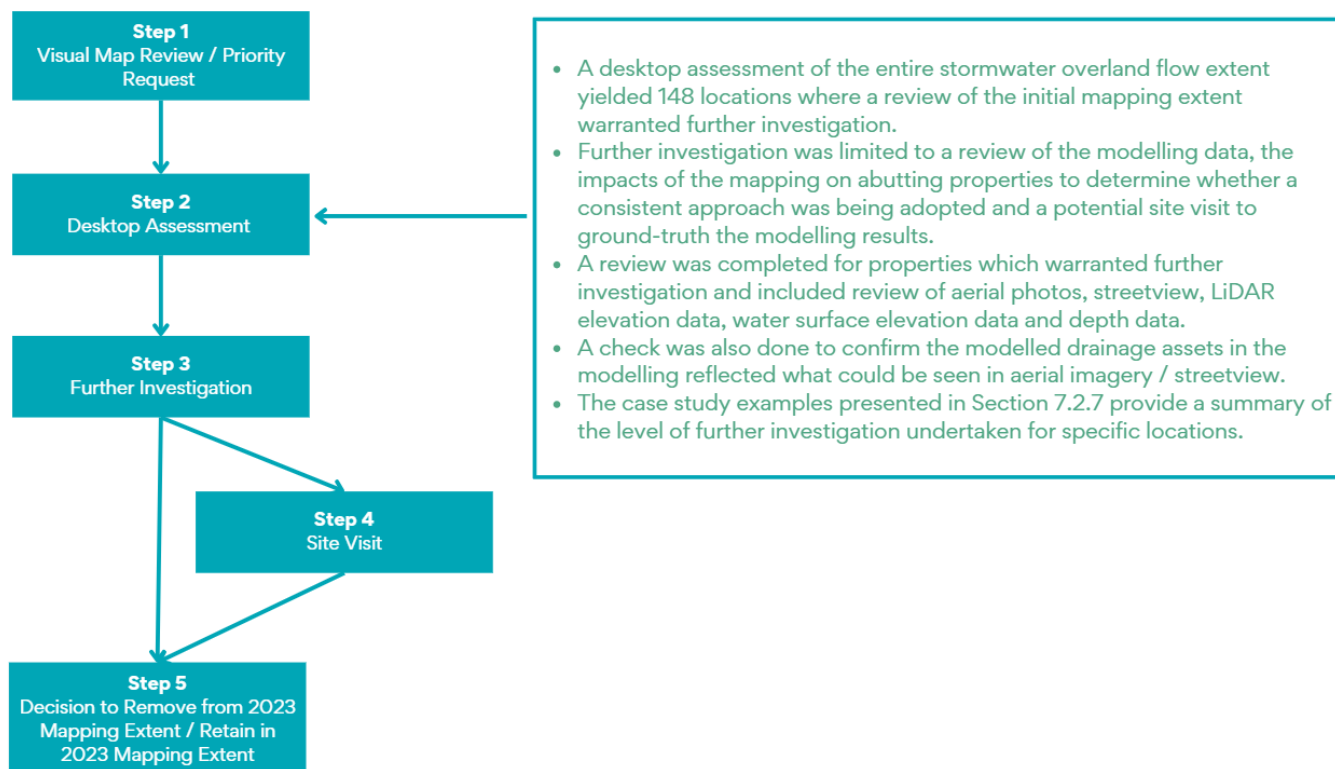


**FIGURE 6-1: MAP CHECKING METHODOLOGY**

## 7. RESULTS

### 7.1 Part A - Stormwater Overland Flow Maps

This section of the report describes the outputs and references the maps in the Appendices.

#### 7.1.1 Raw Model Outputs

For the 1% AEP climate change scenario, the TUFLOW results for the range of storm durations modelled have been combined to identify the maximum result at each modelled cell. Note the original *ARR 2016* modelling for Council identified the median temporal patterns for each duration for the municipality, for the updated modelling in 2023 the same temporal patterns were applied.

Provided alongside this report are the following raster grids:

- Maximum Stormwater Depth (max\_d)
- Maximum Stormwater Level in mAHD (max\_h)
- Maximum Stormwater Velocity m/s (max\_V)
- Maximum Hazard Velocity x Depth (max\_Z0)
- Maximum Hazard (ARR 2019 Hazard Criteria H1-6) (max\_ZAEM1)

Refer to Appendix E: for the mapped maximum stormwater overland flow depths, and maximum hazard for each modelled catchment.

#### 7.1.2 Extents

Melbourne Water's filtering guidelines have been applied to the maximum depth grids to create stormwater overland flow extents.

Points are included in the development of the stormwater overland flow extent if the following conditions are satisfied:

- Depth  $\geq 0.05$  metres
- Isolated areas of stormwater overland flow  $< 100$  square metres excluded from the stormwater overland flow extent.
- Surrounded dry islands (or high points)  $\leq 100$  square metres and considered to be overland flow and are included in the stormwater overland flow extent.

Melbourne Water's method for stormwater extent creation using Feature Manipulation Engine (FME) to create a smoothed stormwater overland flow extent has also been adopted.

Stormwater overland flow extents for each AEP and scenario have been delineated only for Council drainage catchments.

In some areas, the stormwater overland flow extents produced by applying the filtering criteria and using the FME process were discontinuous. Interrogation of the raw modelling outputs showed that in some of these areas, the discontinuous sections of the extent were connected by wet cells, which may have been filtered from the extent due to low depths of flow.

The extents have subsequently been manually adjusted and refined to:

- Connect some of the discontinuous areas of the extent, where the model identifies that the disconnected areas are connected by wet cells with a depth of less than 50 mm. An example of where this can occur is if ponded water is dropping off a ledge, flowing down a very steep embankment or overtopping a road the depth can reduce to less than 50 mm, but the flow path is still continuous.
- Remove some areas where the extent was being included due to the modelling approach of applying flows directly to the 2D domain, but the extent did not represent part of the major flow path but was rather a minor lateral inflow.
- Starting stormwater overland flow extents in roads or council reserves rather than having flow paths beginning in private or commercial properties.
- Starting stormwater overland flow extents where 100 mm stormwater depth occurs rather than 50 mm to ensure flow paths are continuous and not caused by modelling limitations (such as model grid size and kerb definition limitations).

In addition to the above, Engeny developed a secondary filtering criteria. Refer to Section 7.2.3 for further details.

Maps showing the 2023 amended final extents at a wider municipal scale are in Appendix F. Maps showing the amended final extents at a closer scale are in Appendix G. The maps presented in Appendix F and Appendix G have been prepared after community consultation and a visual mapping review which is discussed in Section 7.3.

### 7.1.3 Properties Affected

There are 80,180 land parcels in Merri-bek. This is informed by GIS data provided by the Department of Transport and Planning (DTP). Until recently this information was held by the Department of Environment, Land Water and Planning (DEWLP).

7,159 land parcels are impacted by the 1% AEP Climate Change produced Council stormwater overland flow paths in the local drainage catchments where Council is the local drainage authority. This is about 9% of all land parcels.

### 7.1.4 Hazard

For each AEP event and scenario, the TUFLOW results for the range of modelled storm durations have been combined to identify the maximum hazard result at each modelled cell. The hazard outputs are categorised from H1-H6 with H6 being classified as unsafe for vehicles and people with all building types considered vulnerable to failure. Refer to Figure 7-1 below for the hazard curves and descriptions taken from the ARR 2019 Guide to Flood Estimation.

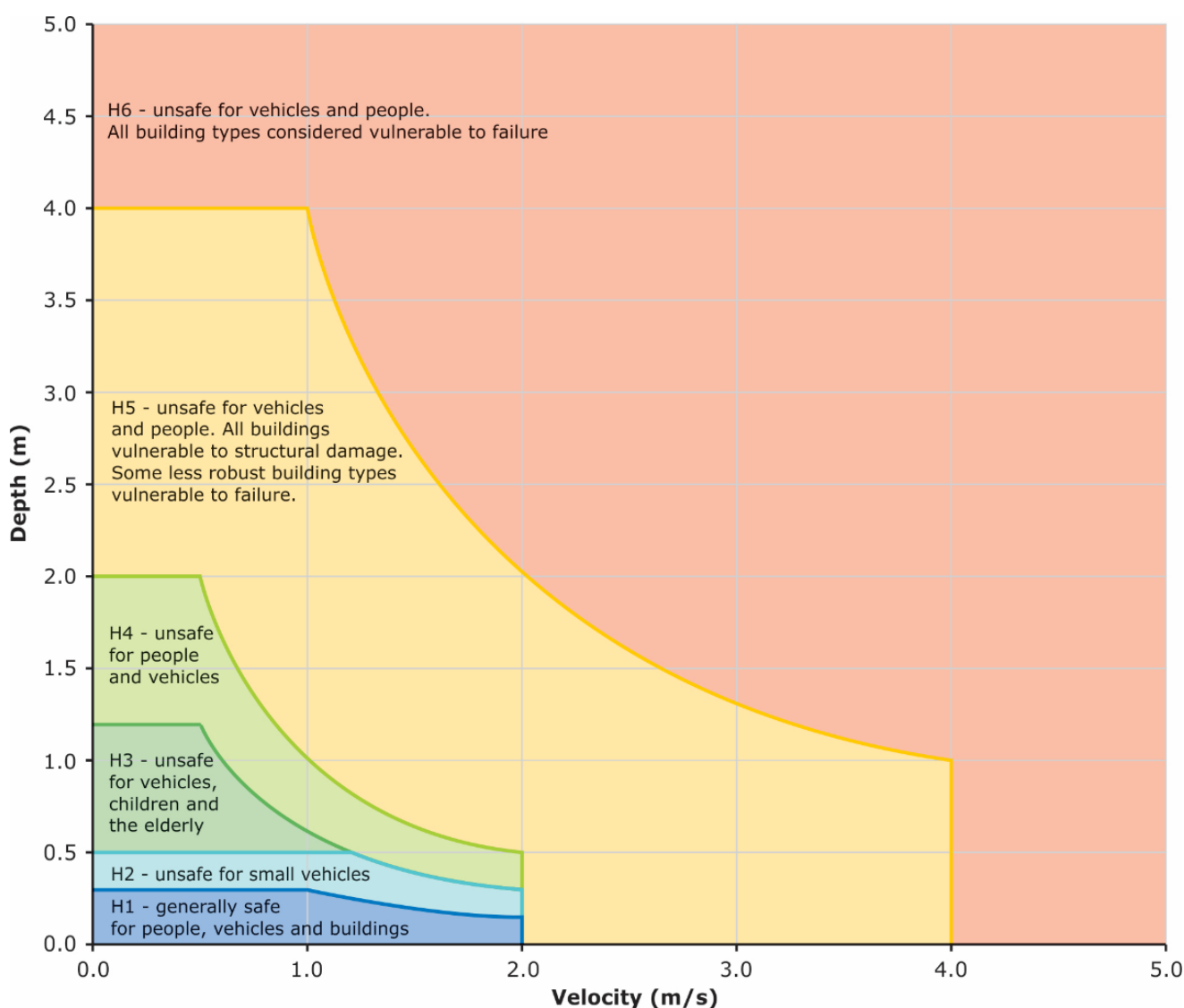


FIGURE 7-1: COMBINED HAZARD CURVES, (SMITH ET AL, 2014)

Stormwater hazard is influenced by:

- Velocity
- Stormwater Overland Flow Depth
- Isolation
- Warning Time, and
- Rate of rising stormwater

The hazard rating criteria in ARR 2019 is calculated based on Depth (D), Velocity (V) and combined  $D \times V$  as per the table below:

**TABLE 7.1: COMBINED HAZARD CURVES - VULNERABILITY THRESHOLDS CLASSIFICATION LIMITS (SMITH ET AL., 2014)**

| Hazard Classification | Vulnerability Classification Limit (D and V in combination) | Limiting Still Water Depth (D) | Limiting Velocity (V) |
|-----------------------|-------------------------------------------------------------|--------------------------------|-----------------------|
| H1                    | $D \times V \leq 0.3$                                       | 0.3                            | 2.0                   |
| H2                    | $D \times V \leq 0.6$                                       | 0.5                            | 2.0                   |
| H3                    | $D \times V \leq 0.6$                                       | 1.2                            | 2.0                   |
| H4                    | $D \times V \leq 1.0$                                       | 2.0                            | 2.0                   |
| H5                    | $D \times V \leq 4.0$                                       | 4.0                            | 4.0                   |
| H6                    | $D \times V > 4.0$                                          | -                              | -                     |

The H1 category is regarded as generally safe inundation, except for vulnerable groups such as children and the elderly for which there is no safe level of inundation. However, any category H2 or above is considered hazardous.

Structures are generally considered safe for H2 to H4, but in circumstances which produce H5 and H6 conditions structures are also at risk of failure. These conditions would typically be seen on floodplains or major flow paths, often associated with large river systems.

Maps shows the hazard are shown in Appendix E:.

### 7.1.5 Hot Spots

Starting in 2018, Engeny did assessment of areas most at risk of inundation and proposed a series of concept designs to address the stormwater overland flows in these locations. A prioritised list of mitigation projects was developed. These were based on the cost to benefit ratio of reducing the risk of stormwater flows at each location.

Council has used this work to inform capital works planning for structural mitigation projects. The updated modelling done in 2023 does not invalidate the previous work as the areas which were previously identified as at high risk of inundation, still have that some risk - unless the mitigation works have been completed, in which case the benefits of the works has been captured in the updated modelling.

## 7.2 Part B – Comparison of 2017 and 2023 Stormwater Overland Flow Maps

Between the beginning of the original modelling for Council in 2017 and January 2023 there have been various changes to available data, as well as changes to guidelines and standards for doing overland flow modelling. These changes are discussed in the Data Validation report in Appendix C:.

The key changes are:

- Updated LiDAR data
- Updated drainage data
- Completed major infrastructure projects in the city, such as level crossing removal projects
- Updated technical guidelines, in particular Australian Rainfall and Runoff 2019 and Melbourne Water's Technical Specifications for Flood Mapping.
- Updated modelling software.

This section of the report discusses these key changes and their impact on the modelling and mapping results.

### 7.2.1 Impacts of Changing National Standards

Australian Rainfall and Runoff is the key national hydrology guideline. It was first released in 1958 and has been periodically updated since. A major release in 1987 was the industry standard for nearly 30 years until an updated draft version was released in November 2016 (*ARR 2016*). This release occurred just before the start of the Step 1 modelling for Merri-bek City Council. The Step 1 modelling adopted, as much as was reasonably and practically possible in accordance with the direction and advice provided in *ARR 2016*. A finished version of the 2016 draft was released in 2019, and while largely like the 2016 draft it also included additional guidance on modelling in urban catchments.

Following the release of *Australian Rainfall and Runoff 2019* (*ARR 2019*) Melbourne Water and the then Department of Environment, Land, Water and Planning (DELWP) commissioned a study to provide further information specific to Victoria. This advice was commissioned based on concerns that some of the updated advice in *ARR 2019* was resulting in flows being calculated which were below expected outcomes based on historical data. The *Benchmarking ARR 2019 for Victoria* report was released in October 2020 and contained additional advice on how to best adopt *ARR 2019* for Victorian conditions specifically.

The most significant changes between *ARR 2016* and *ARR 2019* including the additional Victorian information, relate to the method of selection of loss parameters for hydrologic modelling and the treatment of pre-burst in hydrologic modelling. The treatment of pre-burst can have a significant impact on the level of inundation experienced in areas where the extent of inundation is being drive by volumetric factors more so than the peak flow rates. Volumetric factors are likely to be important in areas with hydraulically constrained outfalls, for example a localised depression / retarding basin which is only drained by a pipe, whereas peak flow factors are more likely to drive maximum inundation extents where flows are not limited by downstream factors, such as flow along a road or within a channel or waterway.

The changes in Australian Rainfall and Runoff have also required changes to the hydrology software that provides inflows to the hydraulic models. There was a lag period between when the updated Australian Rainfall and Runoff guidelines were released and when the updated hydrologic modelling software (RORB) could also be released. The updated to the hydrologic modelling software were also staged with some major updates being provided initially followed by a series of smaller updates. These changes to the hydrologic software have led to some changes between the 2017 and 2023 modelling results.

Version 6.32 of RORB was used for the 2017 modelling, which was released in September 2017. Version 6.45 of RORB was used for the 2023 modelling and was released in March 2019. Version 6.45 provided additional functionality and improvements for modelling which enabled the hydrology modelling to better align with the guidance provided by *ARR 2019*.

### 7.2.2 Implications for Applying Melbourne Water's Technical Specifications for Flood Mapping

The 2017 Merri-bek modelling and mapping adopted, where applicable, Melbourne Water's *Flood Mapping Guidelines and Technical Specifications* (November 2016). As *ARR 2016* had only recently been released Melbourne Water's Technical Specifications at that time did not provide comprehensive advice on how to incorporate the new guidelines.

The main deviations from the Melbourne Water Technical Specification 2016, which were done as part of the 2017 modelling, included:

1. Adopted the new 2016 IFD data
2. Applied the ten temporal patterns in an ensemble approach,
3. Used the revised the losses parameters provided by the Australian Rainfall and Runoff data hub

The 2023 modelling has referenced the updated July 2020 Melbourne Water Technical Specifications which did respond to ARR 2019 with several changes from the 2016 Technical Specifications, mostly due to the updated ARR guidelines.

Below is a summary of the key changes between the 2016 and 2020 MW Technical Specifications:

1. RORB software was previously compared against the Rational Method for catchments where no calibration data is available – this validation approach was not supported under ARR 2016.
2. The 2016 Technical Specifications state to use *Australian Rainfall and Runoff 1987* Intensity Frequency Duration (IFD) data and compare against 2013 IFD, whereas the 2020 Specifications require adoption of the new 2016 IFD design rainfalls.
3. Climate Change was applied using a 1.16 multiplier to IFD parameters in 2016, rather than an 18.5% increase as is recommended in the 2020 Technical Specifications.
4. Initial and continuing losses were 10 mm for urban catchments and 10-25 mm for rural catchments in 2016, whereas the 2020 Specifications adopt ARR Data Hub losses, and apply different losses for EIA, ICA, and Pervious Areas (lower total loss values in 2020 than 2016, resulting in more runoff).
5. Multiple temporal patterns were considered in the 2020 Specifications as they weren't available prior to the 2016 Technical Specifications.

### 7.2.3 Refined Approach for Establishing Extents

The 2017 modelling work was done in line with the Melbourne Water Technical Specifications for Mapping (November 2016). The updated 2023 mapping is based on the July 2020 version of the same document. Each of these documents provide detailed guidance on how Melbourne Water converts the raw hydraulic model outputs into a stormwater flow path extent. The processes used between the two versions are broadly similar, but more detail is provided on what “clean up” is required once the automated processes have been completed.

The goal of the methodologies described for converting raw hydraulic model results into stormwater flow path extents for use in the planning scheme, is to ensure Melbourne Water takes a consistent approach between catchments and also to ensure that different consultancies, who do the studies for Melbourne Water, are able to produce consistent results.

In agreement with Council, the 2017 study utilised the methodology of stormwater extent creation as detailed in the Melbourne Water Technical Specifications for the creation of the Merri-bek extents. For the 2023 extent creation very similar methodologies have been applied and agreed with Council. However, there is some variance from exactly what Melbourne Water proposes for its main drainage stormwater mapping.

A key issue for creating planning scheme ready overlay maps, from raw mapping results is to answer - what to do with those properties at the perimeter of the raw mapping result?

The process in Melbourne Water's Technical Specification, leads to any property where greater than 2 % of the property area is covered by the stormwater extent being included in the final map. These specifications also lead to properties being included, where the raw mapping result has less than 2 % area coverage, but where greater than 25 % of the total road frontage of the property is included in the raw extent.

An area of 2 % property area has been chosen by Melbourne Water as a risk threshold at which it will accept properties which may be at some risk of stormwater flows not being included in the final map. A different test is applied to road frontages with a much lower threshold due to the risk posed by basements, in particular basement carparks.

A basement carpark in a new development can ramp straight down from the edge of the property into the basement to maximise the basement carpark area. If the property is at risk of inundation, Melbourne Water will require the basement entry ramp's apex to be constructed at a level either 300 mm (Special Building Overlay areas) or 600 mm (Land Subject to Inundation Overlay areas) above the stormwater level. Without this apex, a carpark basement which has a driveway which ramps down from the property boundary, even where only a very small fraction of the property is inundated, could result in a large amount of stormwater entering a basement.

For the development of the 2023 overland flow extents for Merri-bek City Council, Engeny has adopted Melbourne Water's Technical Specifications inclusion criteria for all land use zonings except for the General Residential Zone and Neighbourhood Residential Zone. This captures all of the properties likely to be built with large basement carparks, including commercial property along main roads, industrial property and residential growth zoned areas.

For properties which are in a General Residential Zone or a Neighbourhood Residential Zone, the road frontage criteria have been removed and the total area impacted has been raised to 5 % from 2 %.

This change has been made for the following reasons:

- There are many overland flow paths along roads throughout the city's local catchments. The resolution and placement of the model grid and resolution of the LiDAR can mean that one or two properties along a road are included in the overland flow extent while the rest are not. In most cases the road cross sections are homogenous and continuous within a single block and so the inclusion of one or two properties is driven not by physical overland flow characteristics but more by modelling resolution factors. By removing the road frontage and increasing the total percentage of coverage required to 5 %, a more consistent outcome for overland flows along a road is achieved.
- 5 % of total property area is still a relatively low total threshold for property inclusion and is considered appropriate for managing local catchment risk of inundation for residential properties in the General Residential Zone and Neighbourhood Residential Zone.
- The Council flow paths are generally occurring across relatively flat terrain, where there is nominal overland flow velocity. In this setting, when flows are predominantly contained within road reservations, any hazard impacting upon abutting properties will be minimal.
- Many properties in a General Residential Zone or Neighbourhood Residential Zone are likely to have front, side, or rear property setbacks. This is also the case for residential redevelopment in these zones. This reduces the risk of buildings being built at property boundaries, where there may be a nominal stormwater impact.
- Council flow paths are of smaller magnitude to flow paths managed by Melbourne Water. This is largely due to the Council catchments being smaller and upstream of Melbourne Water's larger catchments. Therefore, the risks associated with smaller, upstream catchment overland flows are typically less than for the larger, downstream Melbourne Water flow paths.
- Adopting this criterion removes various properties from the raw mapped areas where there is nominal risk. This will reduce the administrative load on Council and give more certainty for land developers. This outcome makes for a more effective application of the Special Building Overlay in local drainage catchments.
- Properties in a General Residential Zone or a Neighbourhood Residential Zone are unlikely to construct underground car parks, due to the cost associated with construction and the planning constraints enabled by the zone.
- Council informs that having the final Special Building Overlay map extend up to a property's frontage, still gives Council the opportunity to discuss 'frontage design issues' with land developers. In this way Council can address concerns, if any changes are proposed at a property boundary that defines the extent of the map.
- If any underground car parking is proposed, it is likely to be for a smaller development (i.e., single dwelling or smaller multiple dwelling development), because the property size and zoning restrictions will limit the opportunity for a large basement carpark that services a multistorey apartment. Therefore, any risks in the General Residential Zone and the Neighbourhood Residential Zone will be limited.

Where properties have been removed from the stormwater overland flow extent there may be hard or sharp edges that have been created by the removal process as it occurs after all other smoothing processes. Figure 7-2 shows an example of a flow path along a road where two properties have been removed. At this scale the extent appears to be smooth and logical with a few straight edges. At the property-level scale, the smoothing of the Stormwater Map's edges is visible, refer to Figure 7-3, and shows how the location of a property boundary informs the mapping limit. The presence of a mapping edge at property boundaries is helpful because it goes to show that changes to front boundary conditions (enabled by property development that lowers land levels) can still be highlighted via the SBO map. A small gap is deliberately left between the property boundary and the stormwater flow extent boundary. This gap is left as different geographic information systems (GIS) which are used by government organisations can result in very small movements to the locations of the lines depending on the file format used. If the lines are perfectly on top of one another and the files are converted to a different GIS platform it can result in overlaps between the extent and the property boundary which are not intended. Given that property overlaps are a key method of identifying if a property is affected by an overlay, leaving a very small gap prevents this issue from occurring.

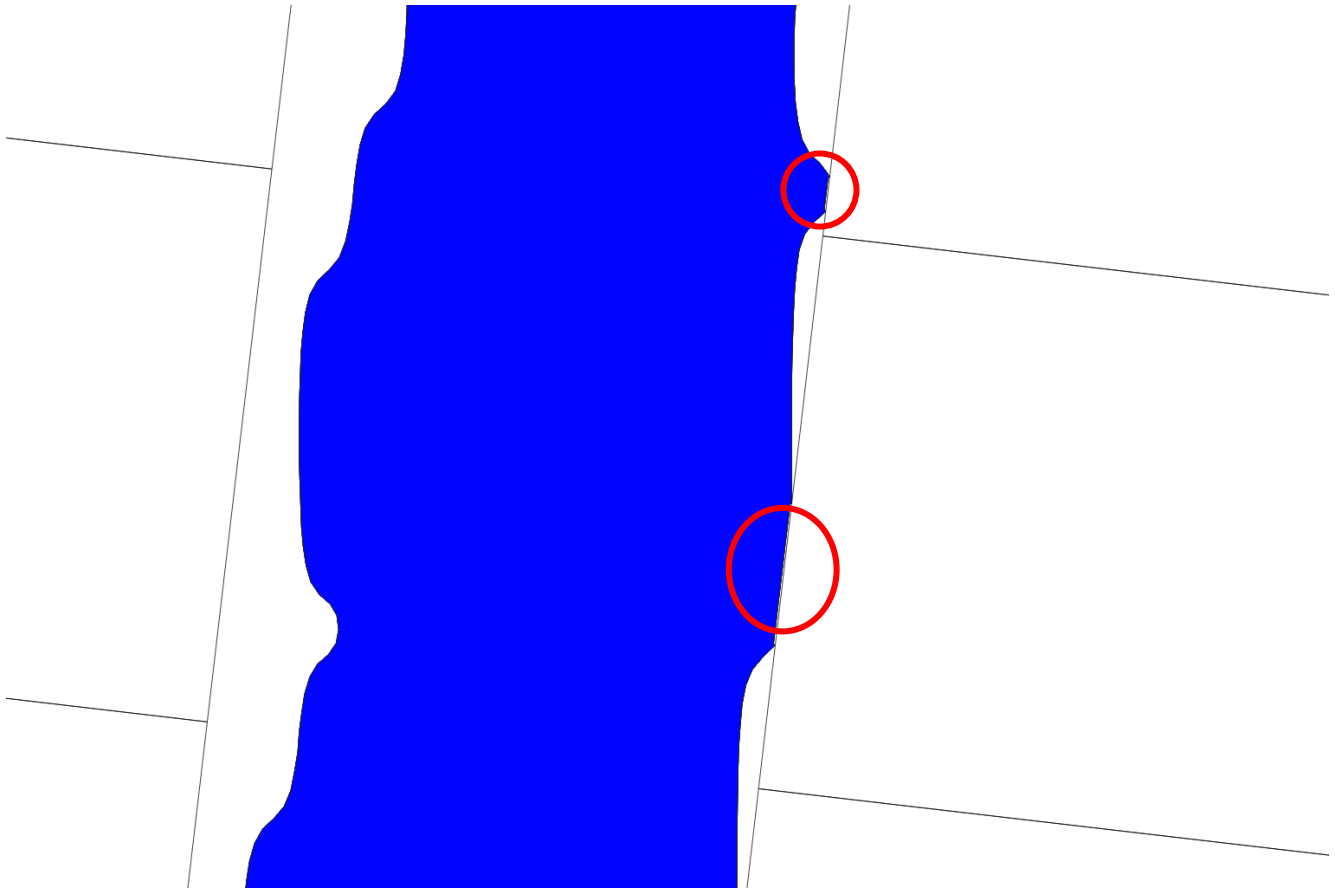


**FIGURE 7-2: EXAMPLE OF FLOW PATH ALONG A ROAD WITH PROPERTIES REMOVED**

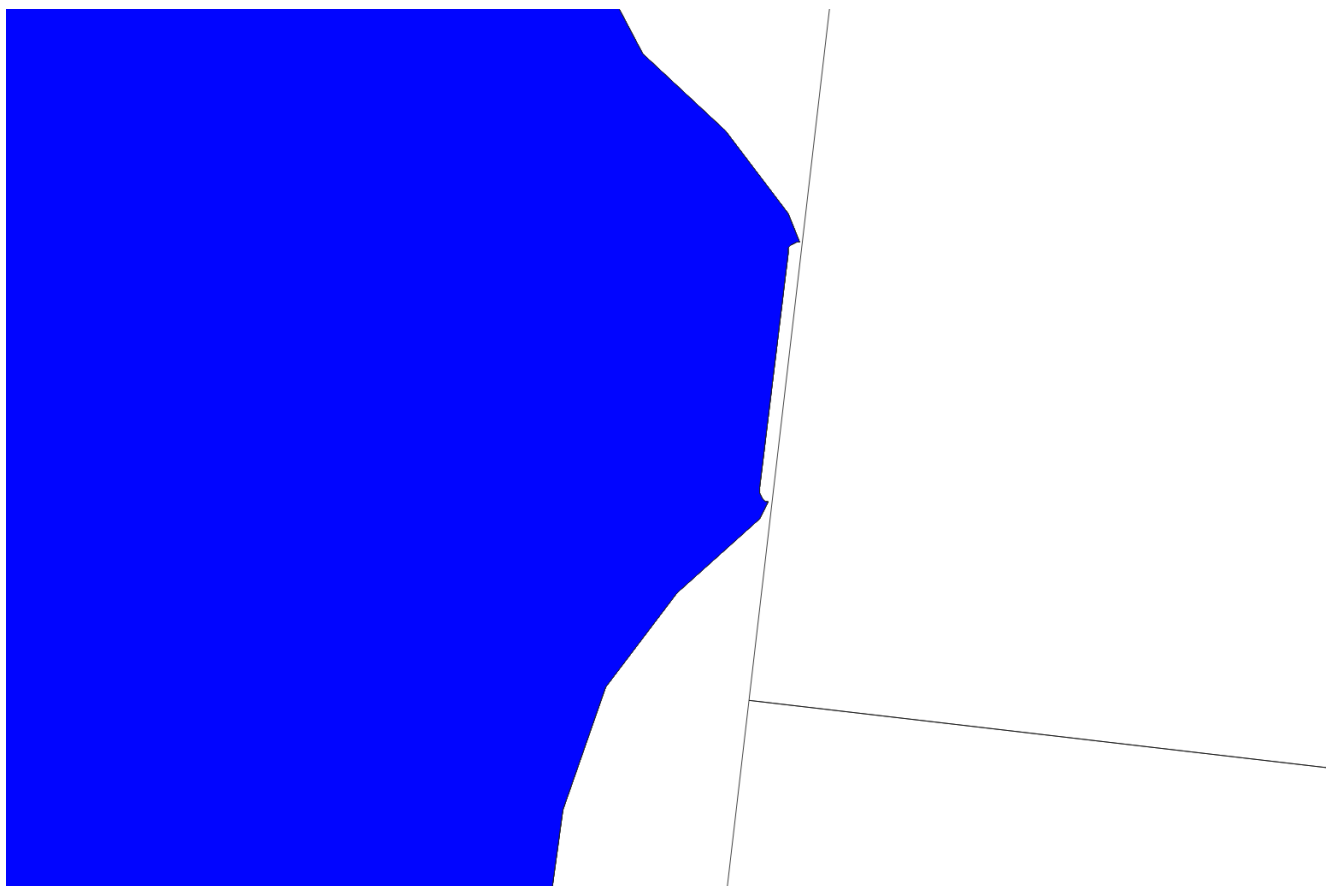


**FIGURE 7-3: CLOSER INSPECTION OF PROPERTY REMOVED FROM EXTENT**

Figure 7-4 to Figure 7-6 are examples of some sharp edges which are an artefact of the filtering process. The sharp edges do not represent an error in the stormwater overland flow modelling but are a result of the filtering parameters and process. Additional automated smoothing after completing the filtering process can adjust the extents too much and bring in properties which have already been removed from the extent by the filtering process, and thus has not been implemented. In some instances where these angles look particularly stark or potentially misleading / erroneous they have been manually smoothed in the GIS software.

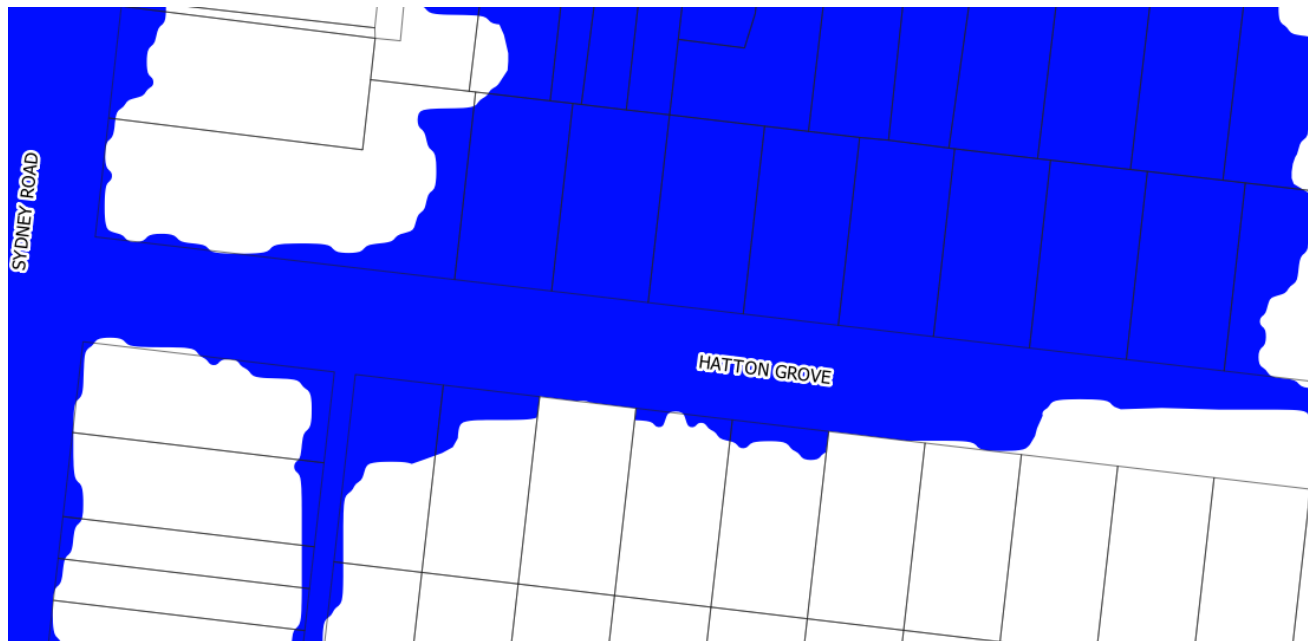


**FIGURE 7-4: EXAMPLE 1 OF FLOW PATH ALONG A ROAD WITH SOME SHARP EDGES**

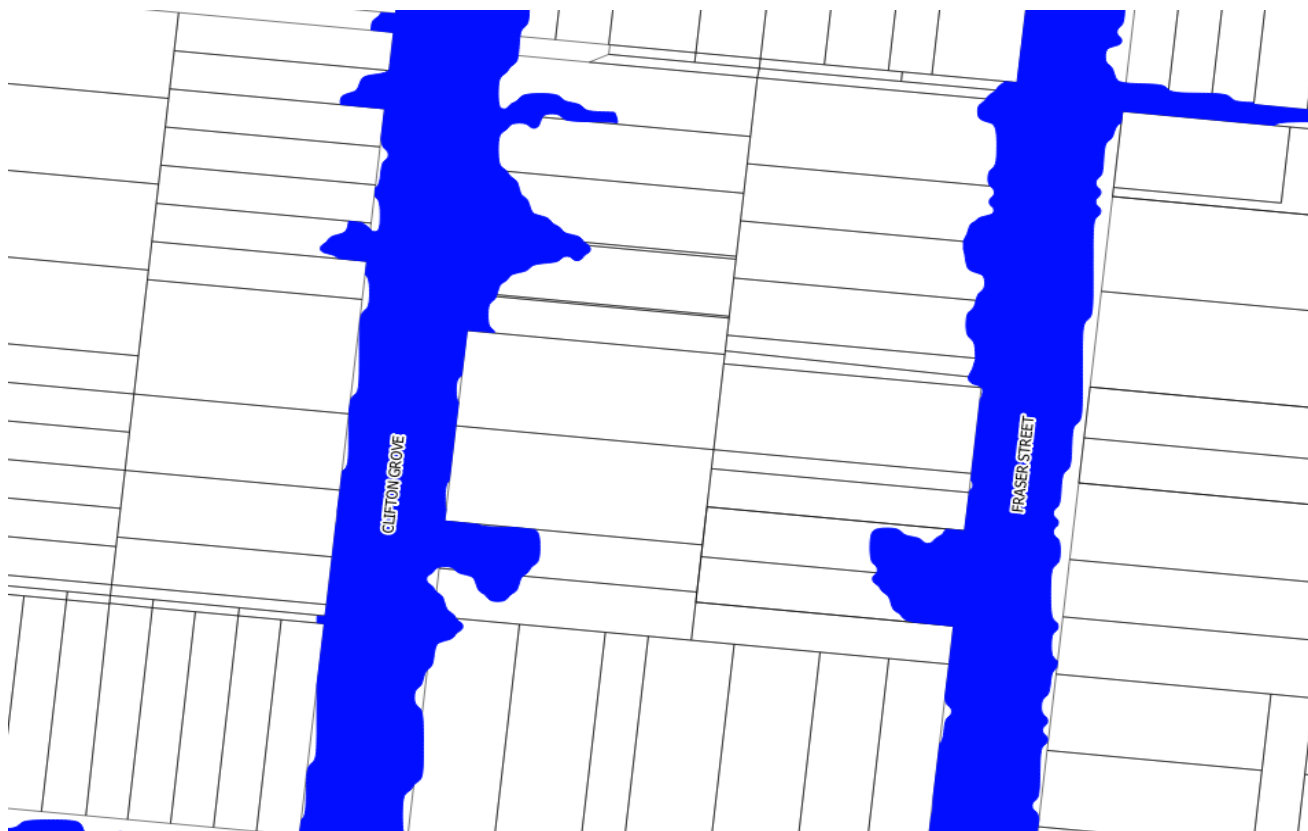


**FIGURE 7-5: EXAMPLE 2 OF FLOW PATH ALONG A ROAD WITH SOME SHARP EDGES**



FIGURE 7-6: EXAMPLE 3 OF FLOW PATH ALONG A ROAD WITH SOME SHARP EDGES

## 7.2.4 Climate Change

The consideration of climate change has remained consistent between the work done in 2017 and 2023. The modelling is assuming Representative Concentration Pathway (RCP) pathway 8.5, which assumes 3.5 degrees of warming by 2100. The modelling is simulating the assumed climatic conditions in 2100. The hydrologic modelling has assumed a 18.5% increase in rainfall intensity because of the 3.5 degree warming in 2100. A 18.5% increase in rainfall intensity can translate to a greater increase in peak flow rates as rainfall intensity and the resulting overland flow peak flow rates are not linearly linked.

## 7.2.5 Hydraulic Modelling Software

TUFLOW has been used for all model simulations undertaken. All modelling of Merri-bek has used a version of TUFLOW known as TUFLOW Classic. The 2018 modelling used version 2017-09-AC-iDP-w64. The 2023 modelling (and the modelling completed for Melbourne Water in 2021) used version 2020-01-AB-iDP-w64. While there are differences between the two versions used the impacts on the outputs from the different model version is insignificant.

## 7.2.6 Example locations where the initial 2023 map extent has changed

There are several locations where the initial 2021 map extents have significantly changed which is largely driven by the whole of catchment modelling (Step 2) and mapping validation study (Step 3). This has resulted in areas being completely removed from the initial 2021 map or re-designated as Melbourne Water mapped extents. Melbourne Water and Council have conducted a series of workshops to determine the flow location splits and determine which extents are assigned to which organisation, generally based on the origination point of the overland flow being from either a Council or Melbourne Water asset. Eight specific locations have been identified below with a brief summary provided as to why the initial 2023 mapping extent has altered in these areas.

### 7.2.6.1 Location 1 – West of Sydney Road

This area has been re-classified as Melbourne Water stormwater overland flow (based on Step 2 as mentioned above) and as a result mapped extents have been reallocated to Melbourne Water.



FIGURE 7-7: LOCATION 1 - WEST OF SYDNEY ROAD

### 7.2.6.2 Location 2 – Glenlyon Road / Alister Street

This area has been re-classified as Melbourne Water stormwater overland flow (based on Step 2 as mentioned above) and as a result mapped extents have been reallocated to Melbourne Water.



FIGURE 7-8: LOCATION 2 – GLENLYON ROAD / ALISTER STREET

### 7.2.6.3 Location 3 – North of Dawson Street / Near Halpin Street

The depth of stormwater overland flow in Halpin Street and Dawson Street does not trigger the threshold to be included in the 2023 mapping extent. This is a function of the updated 2023 mapping and from our review is most likely due to differences in the underlying terrain data adopted between the 2021 and 2023 overland flow mapping projects.

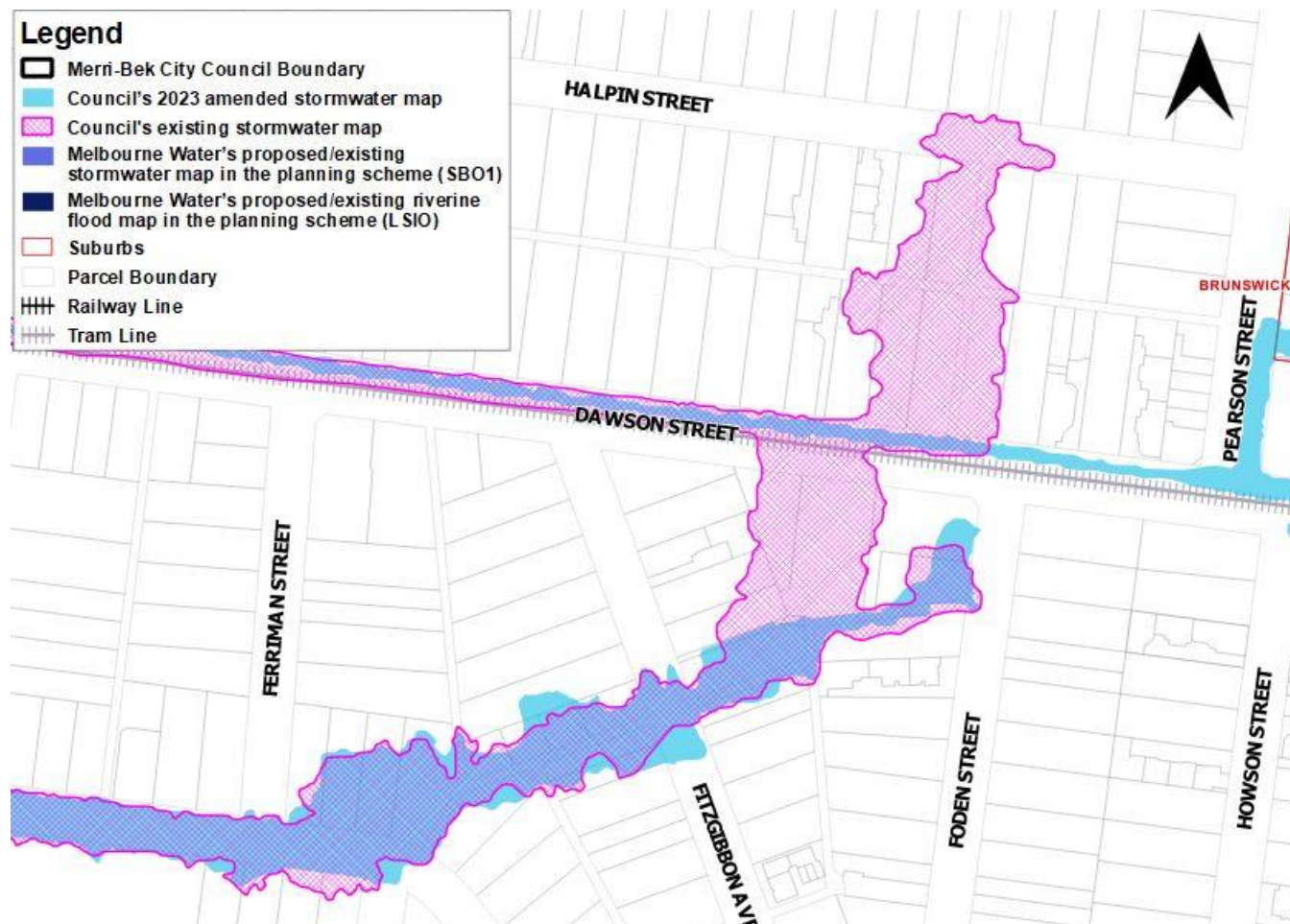


FIGURE 7-9: LOCATION 3 – NORTH OF DAWSON STREET / NEAR HALPIN STREET

#### 7.2.6.4 Location 4 – Near Brunswick Road / Coronation Street

The depth of stormwater overland flow in Brunswick Road does not trigger the threshold to be included in the 2023 mapping extent. This is a function of the updated 2023 mapping as the terrain data adopted has better kerb definition and limits the amount of water that can spill over the southern kerb of Brunswick Road and be modelled as impacting properties.



FIGURE 7-10: LOCATION 4 – NEAR BRUNSWICK ROAD / CORONATION STREET

### 7.2.6.5 Location 5 – East of Tullamarine Fwy / Citylink

This area has been re-classified as Melbourne Water stormwater overland flow (based on Step 2 as mentioned above) and as a result mapped extents have been reallocated to Melbourne Water.

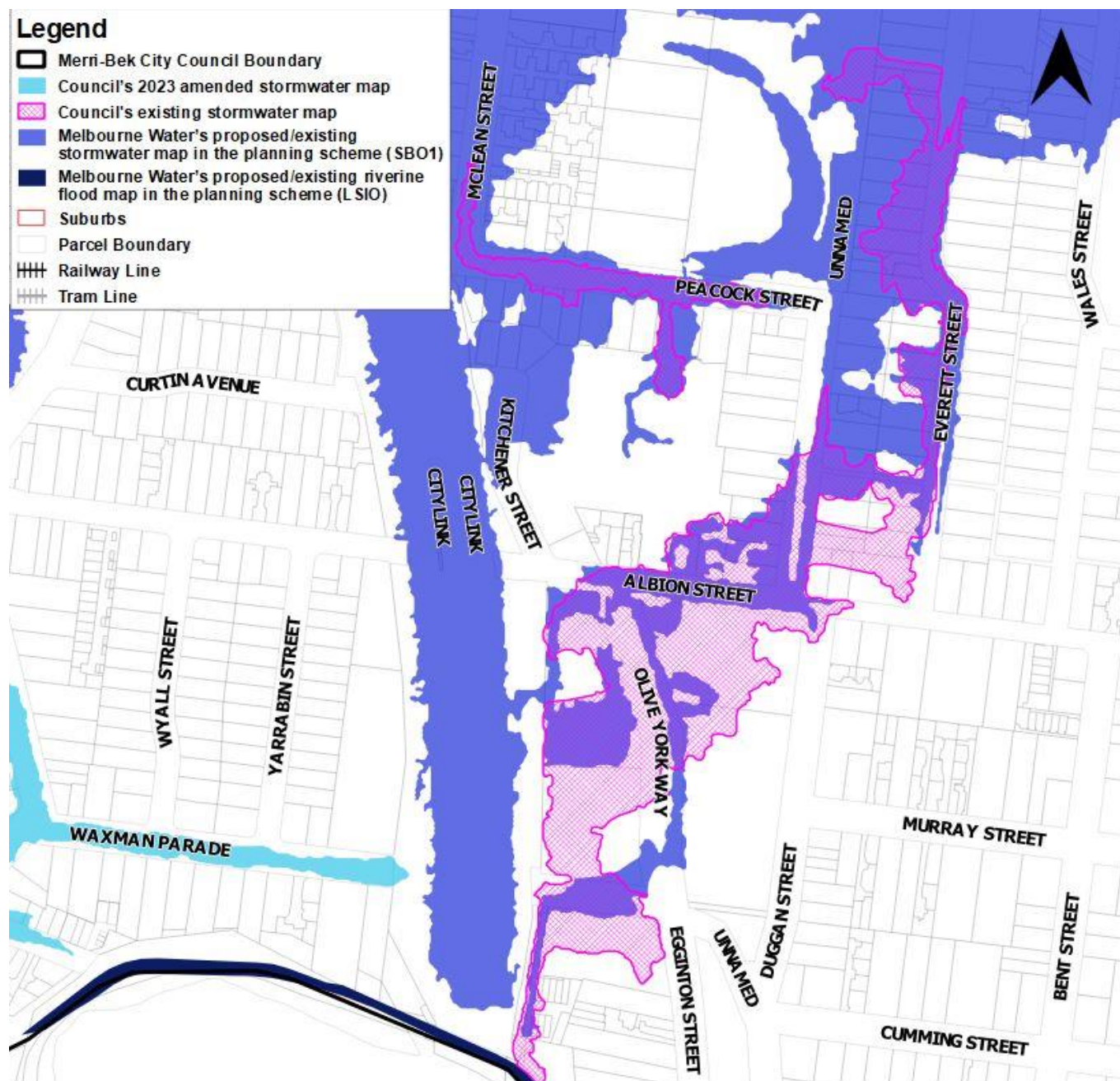


FIGURE 7-11: LOCATION 5 – EAST OF TULLAMARINE FWY / CITYLINK

### 7.2.6.6 Location 6 – Melville Road / Reynard Street

The depth of stormwater overland flow in Melville Road does not trigger the threshold to be included in the 2023 mapping extent. This is a function of the updated 2023 mapping and from our review is most likely due to differences in the underlying terrain data adopted between the 2021 and 2023 overland flow mapping projects. Furthermore, under Stage 3, updates have been made to Council's drainage system north of the Melville Road low point (additional Council assets constructed post 2018 which are included in the 2023 mapping but weren't included in 2021) which reduces the amount of water that can flow overland to the low point in Melville Road.

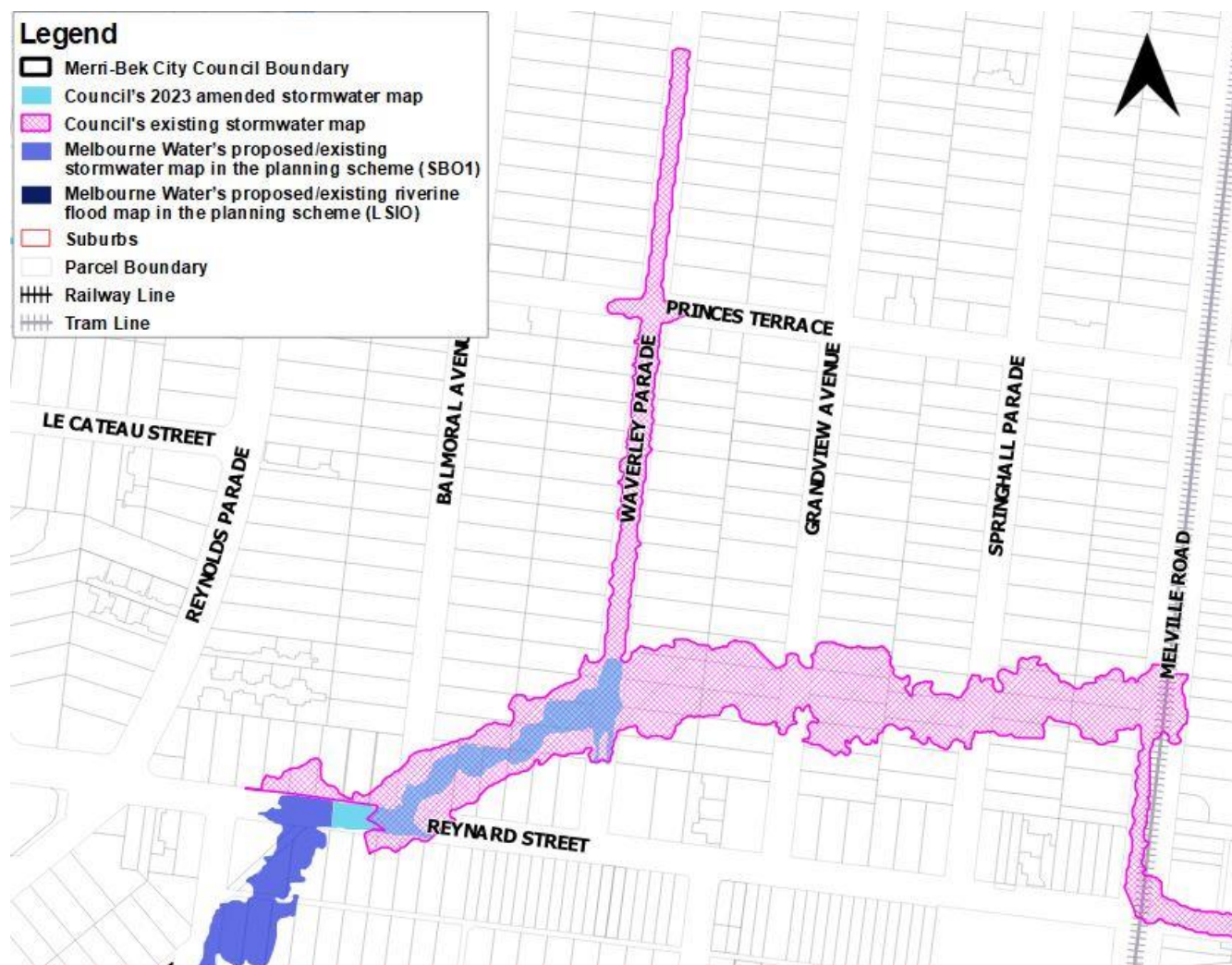


FIGURE 7-12: LOCATION 6 – MELVILLE ROAD / REYNARD STREET

### 7.2.6.7 Location 7 – Various Locations in Hadfield

This area has been re-classified as Melbourne Water stormwater overland flow (based on Step 2 as mentioned above) and as a result mapped extents have been reallocated to Melbourne Water.

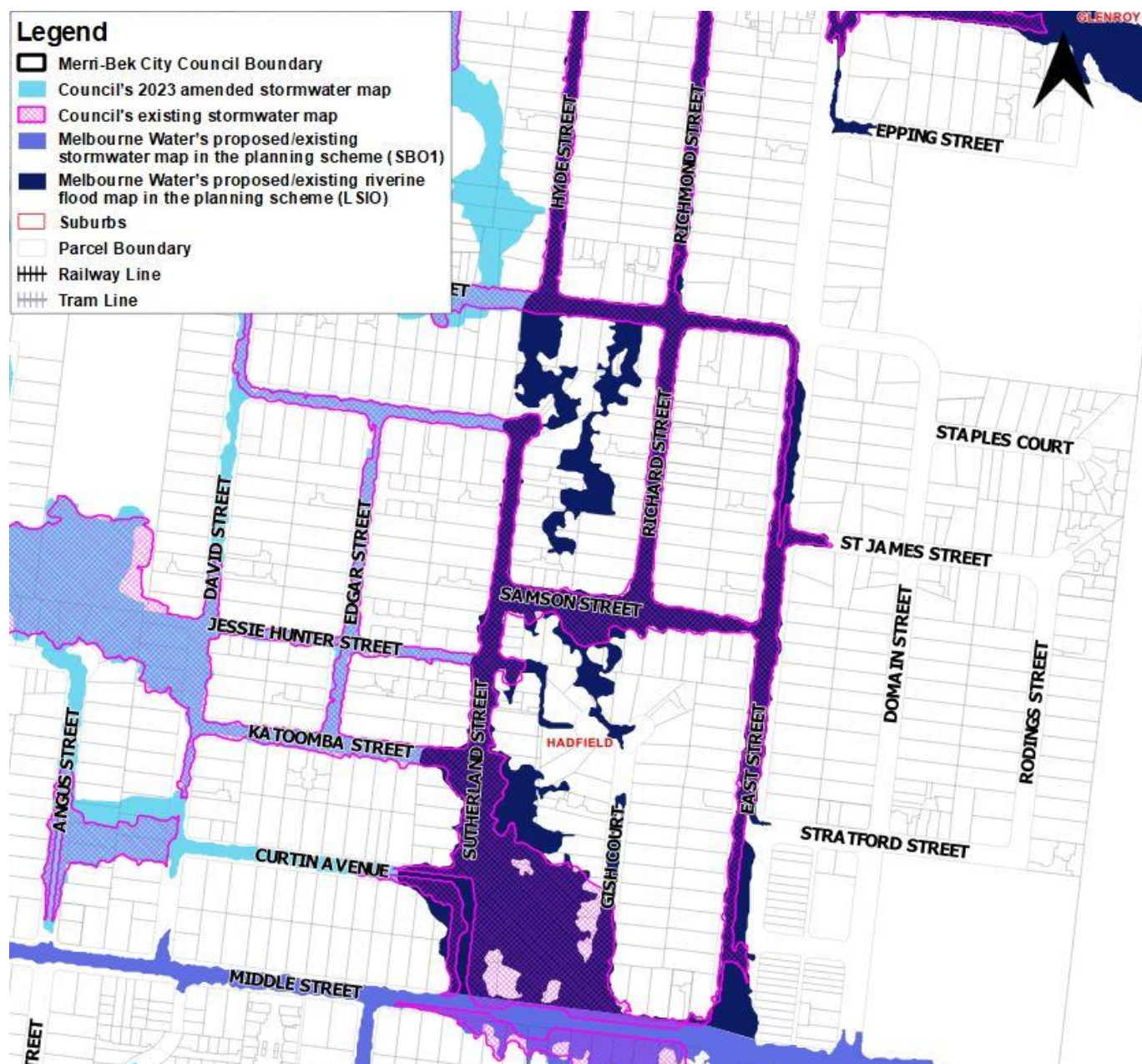


FIGURE 7-13: LOCATION 7 – VARIOUS LOCATIONS IN HADFIELD

### 7.2.6.8 Location 8 – Various Locations East of Hume Fwy

This area has been re-classified as Melbourne Water stormwater overland flow (based on Step 2 as mentioned above) and as a result mapped extents have been reallocated to Melbourne Water.

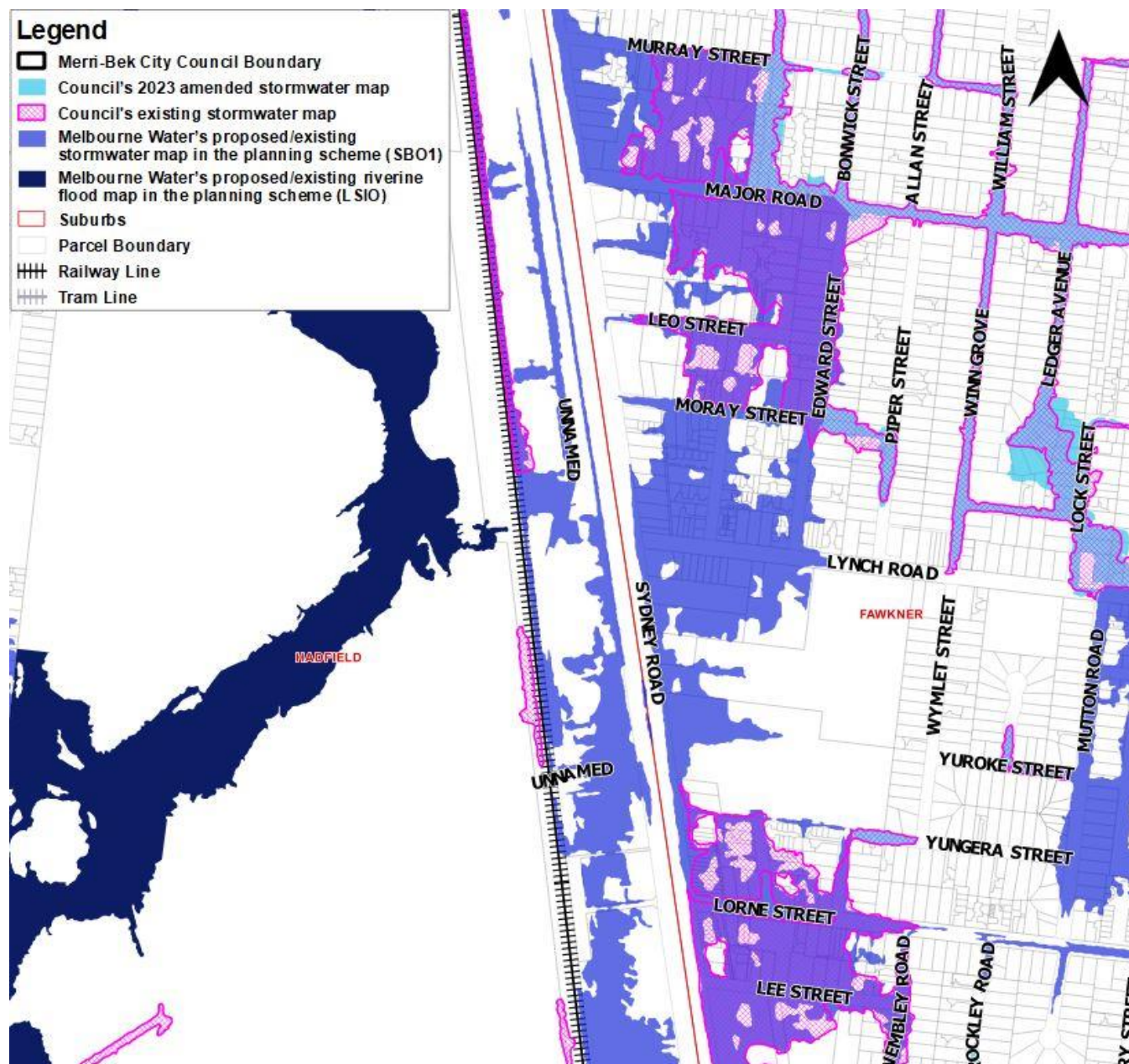


FIGURE 7-14: LOCATION 8 – VARIOUS LOCATIONS EAST OF HUME FWY

## 7.2.7 Case Studies

Several locations, separate to the example locations in Section 7.2.6, were also reviewed where the 2021 and 2023 mapping extents differ because of the factors detailed in previous sections (Section 7.2.1 to 7.2.5). The following locations have been identified as case study locations because they show an example of the following:

- A property that was not impacted by stormwater runoff under the 2021 mapping extent (current SBO2) but is predicted to be under the 2023 mapping extent (future SBO2)
- A property that was impacted by stormwater runoff under the 2021 mapping extent (current SBO2) and is predicted to remain in the 2023 mapping extent however with a slightly larger extent impacting the property.

Both case study locations are examples of where the 2021 mapping extent differs compared to the updated 2023 mapping extent.

### Case Study Example 1 – 293 O’Hea Street Pascoe Vale

293 O’Hea Street (hereafter referred to as ‘the site’) was reviewed in detail due to the notable changes in extent of stormwater runoff between the 2021 and 2023 mapping extents which saw the site included in the Updated Stormwater Map Extent (2023) noting the site is not included in the current 2021 extent. Figure 7-15 below provides an overview of 2021 mapping extent compared to the 2023 mapping extent (future SBO2) for this specific location. The following can be noted with respect to the site:

- The site is subject to impact from stormwater runoff due to build-up of water in Dace Court which overtops the kerb and flows through the property in question, nearby sites (1-4 Dace Court & 295 O’Hea Street) and the existing drainage easement which runs along the western boundary of the property. Stormwater runoff is predicted to pond up to a depth of 350 mm in a 1 % AEP CC event in Dace Court. The depth of water impacting the 293 O’Hea Street is expected to reach up to 150 mm at the rear of the property.
- A review of the LiDAR terrain information suggests the following:
  - The grade of the drainage easement (south to north) is relatively flat and therefore is unlikely to provide a sufficient overland flow conveyance for the runoff which is not captured by the piped system.
  - The subject site is also at a relatively similar level to the drainage easement and therefore flows in the drainage easement have the potential to break out of the easement and flow east into the property based on observations during a site visit.
- The modelled drainage infrastructure in the hydraulic model reflects the drainage assets which can be viewed through Google Streetview and as seen on the site visit. The extent of the updated stormwater map impacts the property where the 2021 extent did not due to changes in the adopted methodology in the 2023 modelling. Specifically, the impacts of ARR2019 methodologies and use of 75th percentile pre-burst contributes to greater depths of stormwater runoff in roadways across the whole municipality. A review of the hydraulic grade line (HGL) in the direction of flow from the upstream catchment and through the site also noted the following:
  - Stormwater runoff can travel from the upstream catchment, into Dace Court and through the existing drainage easement / western boundary of the subject site before flowing into O’Hea Street. Overland flows from the upstream catchment enter into Eunice Court and Dace Court (immediately upstream of the subject site) from Eastgate Street. The underground piped drainage in Dace Court area is unable to convey flows from the 1 % AEP climate change storm event and the modelling shows runoff will build up and flow north through the subject site (and surrounding properties also impacted by the Updated Stormwater Map).

The review findings detailed above concluded that the site should remain in the updated mapping extent.

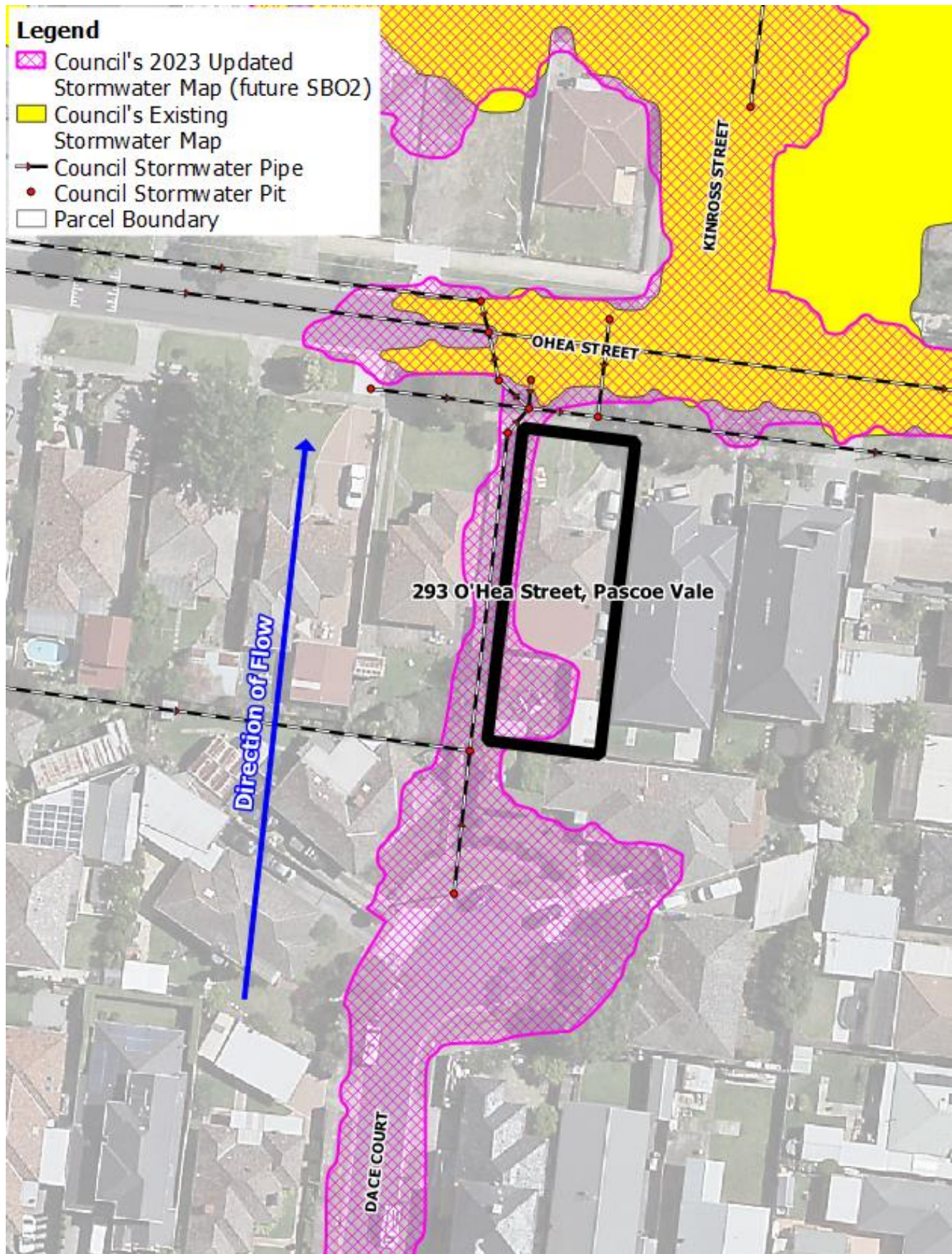


FIGURE 7-15: CASE STUDY EXAMPLE LOCATION 1

## Case Study Example 2 - 13 Darlington Grove, Coburg

13 Darlington Grove, Coburg (hereafter referred to as 'the site') was reviewed in detail due to the change in extent of stormwater runoff between the 2021 and 2023 mapping extents which saw an expansion of the mapping extent impacting the site under the 2023 mapping extent scenario. Figure 7-16 below provides an overview of 2021 mapping extent compared to the 2023 mapping extent (future SBO2) for this specific location. The following can be noted with respect to the site: The site is subject to impact from stormwater runoff due to build-up of water in Hardwick Street. Stormwater runoff is predicted by the model to pond up to a depth of 250 mm in a 1 % AEP climate change event in Hardwick Street immediately at the rear of the subject property. The depth of water impacting the property is expected to reach up to ~150-200 mm at the rear of the property. Only the rear of the property is predicted to be subject to impact from stormwater runoff. There is a brick garage located at the rear of the property also. The dwelling footprint is not shown to be impacted by stormwater runoff in the model. The following can be noted with respect to the site:

- A review of the LiDAR terrain information suggests the following:
  - The grade and levels of the laneway and Hardwick Street near the vicinity of the brick garage at the rear of the property (as shown in the site photos) appear to be captured in the LiDAR.
  - The site photos and Google Streetview (snip below) suggest the level of the garage / rear access gate are higher than the low point in Hardwick Street and this is confirmed in the LiDAR.
  - Water that builds up in the low point at the rear of the subject property / within Hardwick Street flows north through the laneway (following Council's drainage alignment).
- The modelled drainage infrastructure in the hydraulic model reflects the drainage assets which can be viewed through Google Streetview and which were observed onsite. This includes the grated pit in Hardwick Street at the rear of the site.
- The updated stormwater map impacts the property slightly more than the initial map due to changes in the adopted methodology in the latest modelling. Specifically, the impacts of ARR2019 methodologies and use of 75<sup>th</sup> percentile pre-burst contributes to greater depths of stormwater runoff in roadways. The modelling also adopted a 3 m grid size which is consistent with municipal wide urban mapping as per Melbourne Water's latest flood mapping projects specifications.
- Structures have been modelled with a higher manning roughness to simulate the effect of water slowing down as it passes through these areas. Focusing on this property, the entire brick garage may not be considered as a full blockout to flow as water has the ability to pass through / under the laneway access door and roller door.
- A review of the Hydraulic Grade Line (HGL) in the direction of flow suggests stormwater runoff can build up and tip into the rear of the property

The review findings detailed above concluded that the site should remain in the updated mapping extent. A site visit was also undertaken at the site to ground-truth the modelling results.

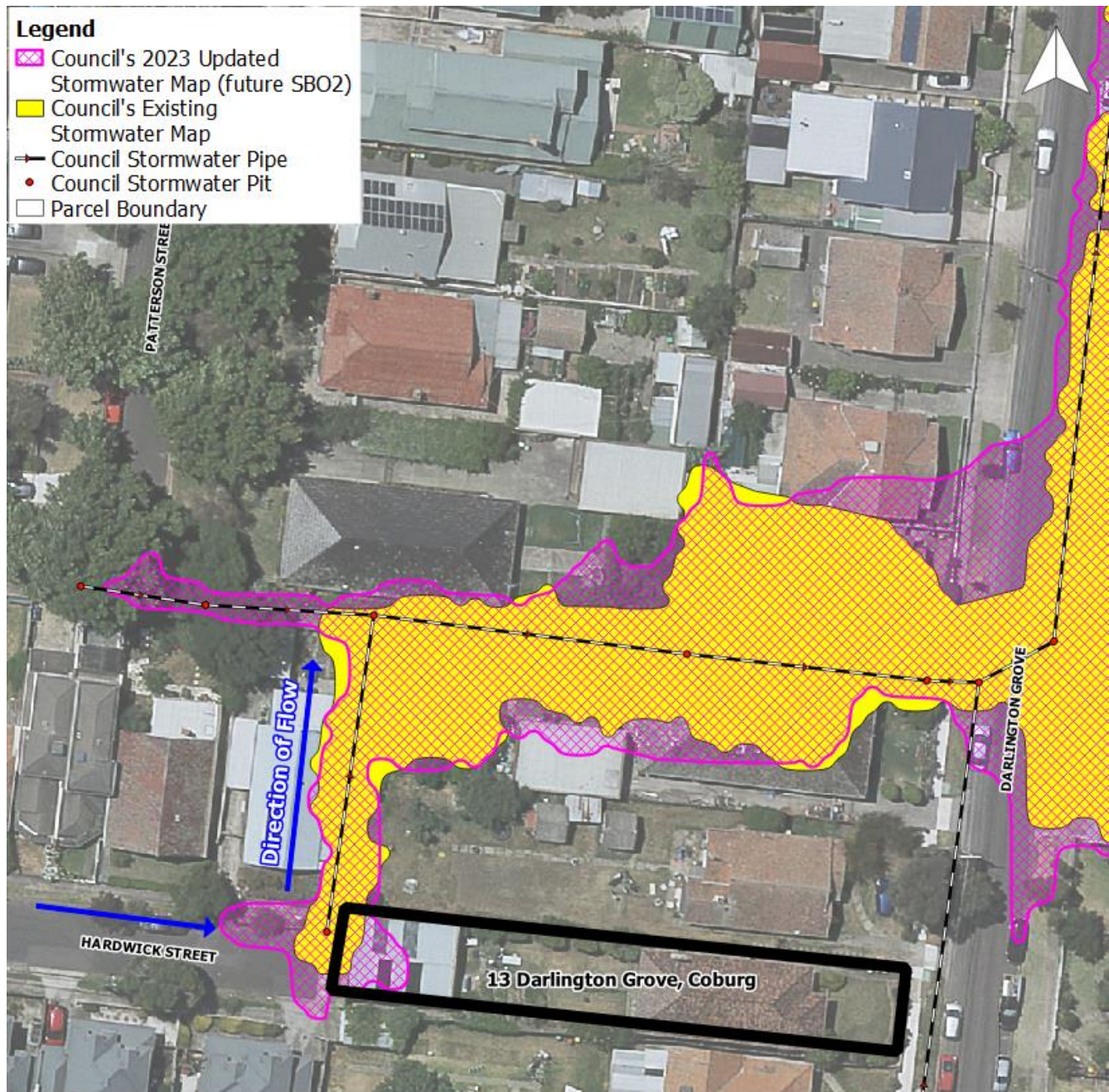


FIGURE 7-16: CASE STUDY EXAMPLE LOCATION 2

## 7.3 2023 Mapping Extent Review

The initial 2023 stormwater overland flow extent was created largely by automated GIS processes which implemented the inclusion / exclusion criteria detailed in section 7.2.3. To ensure the robustness and consistency of the updated stormwater overland flow extent a detailed assess of the extent was completed by Council and Engeny to check for any anomalies or inconsistencies in the mapping extent across the entire municipal area.

An anomaly in this instance refers to a location where the 2023 mapping extent provides a potentially unrealistic or inconsistent result and therefore warrants further review and investigation. An example of an anomaly is a location where a visual check of the extent indicated that one property is in due to minor intrusion of the extent into the property but neighbouring properties are not included in the extent. If the anomaly location warranted a site visit this was undertaken to determine on-site observations and ensuring on-the-ground checking was completed before a decision was made to update the stormwater mapping extent for that respective location.

For properties in a General Residential Zone or Neighbourhood Residential Zone, the mapping extent includes a property where the total percentage of property impacted is more than 5% based on the adopted criteria mentioned in Section 7.2.3. For properties not in a General Residential Zone or Neighbourhood Residential Zone, the mapping extent may include a property where the total percentage of property impacted is more than 2% and if greater than 25% of the property frontage is covered by the stormwater overland flow extent.

Separate to the visual extent checks, review requests of the stormwater overland flow extent were also undertaken based on responses from residents.

In collaboration with Council, Figure 7-17 below shows a simple schematic flow chart which details the methodology adopted for map-checking for anomalies. The same process was adopted for the visual map review and priority requests from residents.

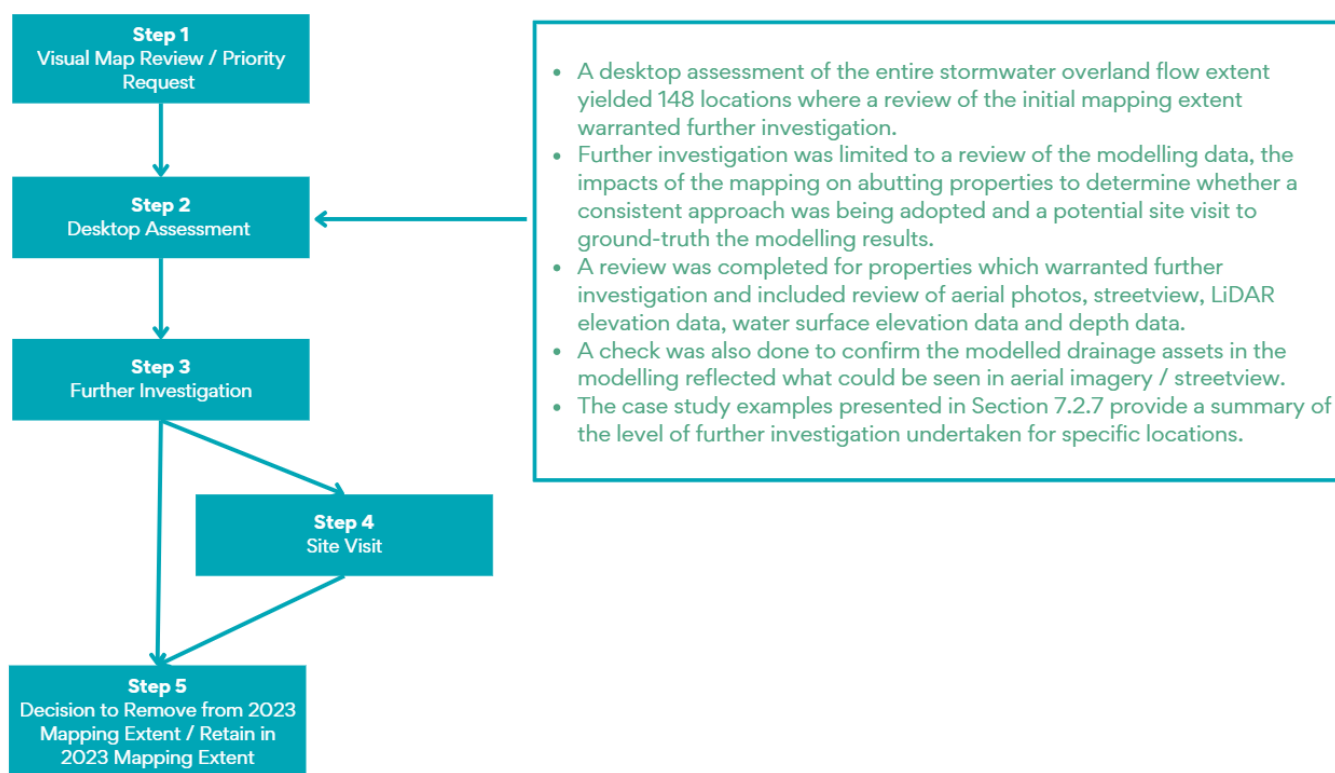


**FIGURE 7-17: MAP CHECKING METHODOLOGY**

The results of the map-checking, as detailed in the methodology shown in Figure 7-17 above, are provided in Appendix H in a table format. All properties identified in the visual scan or through resident requests have been included.

The 2023 amended stormwater overland flow extent maps, prepared after community consultation and the map checking process detailed above, can be found in Appendix G.

A comparison between the 2021 mapping extent (current SBO2) and 2023 amended mapping extent can be found in Appendix I. This map shows the difference between the 2021 mapping extent and 2023 amended mapping extent by identifying areas which have been added to the 2021 mapping extent and removed from the 2021 mapping extent.

## 8. CONCLUSION

Merri-bek City Council has uncovered the impact of the 1% AEP (1 in 100 year) storm event in its local drainage catchments. This was achieved through a thorough, stepped process, where sequential reviews and ongoing refinements have achieved an updated Stormwater Map that is now suitable for statutory implementation. This work has focused on the city's local drainage catchments, because this is where Council has its drainage assets and is the local drainage authority. It has also imbedded consideration of climate change.

The process started with a pilot study in 2016, when a proof of concept demonstrated modelling software and available information could effectively represent overland flow paths, informed by past storm events.

This triggered a study for the city's local catchments, to initially uncover flow paths in these catchments (Step 1). A mitigation study was also done so Council had well informed structural mitigation options, to reduce stormwater overland flow risks in 'hot spots' where more frequent storm impacts are expected.

Giving local catchment models and maps to Melbourne Water, then enabled a review of the Council's initial 2020 Stormwater Map. The Floodplain Management Authority facilitated a whole-of-catchments approach, for both local and main drainage areas across the city's urbanised catchments. This technical work included an independent peer review and application of updated technical standards. Arising from this, Council had access to improved models (Step 2).

Motivated by the need to 'capture the best available information', the Council then did a validation exercise for its local catchments, to ensure final models and technical standards informed an updated Stormwater Map (Step 3).

Then, to bring all past work together, further modelling and mapping has been done to produce the updated Stormwater Map (Step 4).

The updated stormwater map was used to consult affected landowners and a review of resident responses was completed in collaboration with municipal-wide field observations and a visual check of the mapping extent to produce an amended Stormwater Map (Step 5).

The 5-step process is shown in Figure 8-1 and demonstrates a sequential process to continually review and refine technical information, and apply technical methods for an updated Stormwater Map, which can now be considered for statutory implementation.

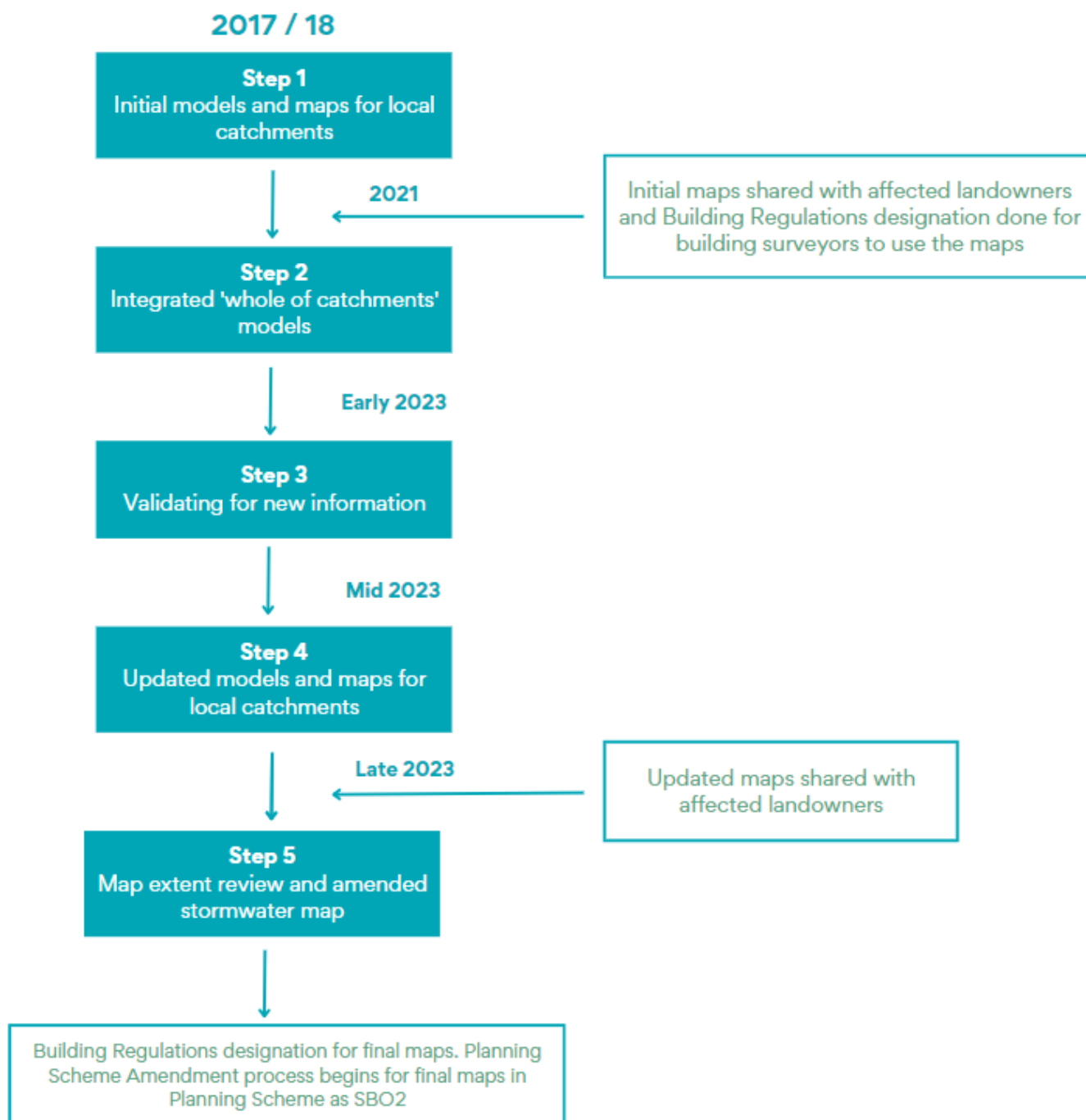


FIGURE 8-1: FIVE STEP MODELLING AND MAPPING PROCESS

## 9. QUALIFICATIONS

- (a) In preparing this document, including all relevant calculation, and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- (b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
- (c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:
  - (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or
  - (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.
- (d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents, and representatives of Engeny to the same extent that they apply for the benefit of Engeny.
- (e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.
- (f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.
- (g) This Report does not provide legal advice.

---

# APPENDIX A: 2017 MERRI-BEK STORMWATER OVERLAND FLOW MAPPING REPORT



---

# APPENDIX B: MELBOURNE WATER AND MERRI-BEK CITY COUNCIL MAPPING PROJECT REPORT (NOVEMBER 2022)



---

# APPENDIX C: DATA VALIDATION REPORT



---

# APPENDIX D: TUFLOW MODEL LAYOUTS



---

# APPENDIX E: 1% AEP DEPTH AND HAZARD MAPS



---

# APPENDIX F: 2023 AMENDED STORMWATER OVERLAND FLOW EXTENT MAPS (WIDER SCALE)



---

# APPENDIX G: 2023 AMENDED STORMWATER OVERLAND FLOW EXTENT MAPS (LOCAL SCALE)



---

## APPENDIX H: 2023 MAPPING EXTENT REVIEW OUTCOMES



---

# APPENDIX I: 2023 AMENDED MAP COMPARED TO 2021 MAP



