Final Flood Planning Assessment

Bankstown City Centre

NW30274

Prepared for
Canterbury-Bankstown Council

30 March 2022

Cardno

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Stantec

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Abbreviations

1D	One-dimensional
2D	Two-dimensional
ACT	Australian Capital Territory
AEP	Annual Exceedance Probability
AFAC	Australasian Fire and Emergency Service Authorities Council
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BoM	Australian Bureau of Meteorology
CBD	Central Business District
DCP	Development Control Plan
DEM	Digital Elevation Model
DFE	Defined Flood Event
DPE	NSW Department of Planning and Environment
EPA	NSW Environment Protection Authority
FDM	Floodplain Development Manual
FRMS&P	Floodplain Risk Management Study and Plan
FPL	Flood Planning Level
FPA	Flood Planning Area
FRP	Flood Risk Precinct
FSR	Floor Space Ratio
GIS	Geographical Information Systems
IFD	Intensity-Frequency-Duration
LEP	Local Environment Plan
LGA	Local Government Area
LIDAR	Light Detection and Ranging
NSW	New South Wales
PMF	Probable Maximum Flood
SEPP	State Environmental Planning Policy
SES	NSW State Emergency Service
SFC	Special Flood Consideration
SSD	State Significant Development
VPA	Voluntary Planning Agreement
WSU	Western Sydney Uni

Glossary

Annual Exceedance Probability (AEP)	The probability of an event occurring or being exceeded within a year. For example, a 5% AEP flood would have a 5% chance of occurring in any year. An approximate conversion between ARI and AEP is provided.

AEP	ARI
63.2 %	1 year
39.3 %	2 year
18.1 %	5 year
10 %	10 year
5 %	20 year
2 %	50 year
1 %	100 year
0.5 %	200 year
0.2 %	500 year

Australian Height Datum (AHD)	A standard national surface level datum approximately corresponding to mean sea level.
Average Recurrence Interval (ARI)	The long-term average period between occurrences equalling or exceeding a given value. For example, a 20 year ARI flood would occur on average once every 20 years.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events. E.g. some roads may be designed to be overtopped in the 1% AEP flood event.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain which causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood fringe	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood hazard	Potential risk to life and limb caused by flooding.
Flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land. Floodplain Risk Management Plans encompass all flood prone land, rather than being restricted to land subject to designated flood events.

Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Floodplain management measures	The full range of techniques available to floodplain managers.
Floodplain management options	The measures which might be feasible for the management of a particular area.
Flood planning area	The area of land below the flood planning level and thus subject to flood related development controls.
Flood planning levels (FPLs)	Flood levels selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of land use and for different flood plains. The concept of FPLs supersedes the "Standard flood event" of the first edition of the Manual. As FPLs do not necessarily extend to the limits of flood prone land (as defined by the probable maximum flood), floodplain management plans may apply to flood prone land beyond the defined FPLs.
Flood storages	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often, but not always, aligned with naturally defined channels. Floodways are areas which, even if only partially blocked, would cause a significant redistribution of flood flow, or significant increase in flood levels. Floodways are often, but not necessarily, areas of deeper flow or areas where higher velocities occur. As for flood storage areas, the extent and behaviour of floodways may change with flood severity. Areas that are benign for small floods may cater for much greater and more hazardous flows during larger floods. Hence, it is necessary to investigate a range of flood sizes before adopting a design flood event to define floodway areas.
Geographical Information Systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
High hazard	Flood conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Low hazard	Flood conditions such that should it be necessary, people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.
Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.

Mathematical/computer models	The mathematical representation of the physical processes involved in runoff and stream flow. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with rainfall, runoff, pipe and overland stream flow.
Overland Flow	The local runoff, travelling through properties and /or roads, before it discharges into a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions.
Probable maximum precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a more detailed explanation see AEP and Average Recurrence Interval.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Stormwater flooding	Inundation by local runoff. Stormwater flooding can be caused by local runoff exceeding the capacity of an urban stormwater drainage system or by the backwater effects of mainstream flooding causing the urban stormwater drainage system to overflow.
Topography	A surface which defines the ground level of a chosen area.

1 Introduction

Cardno has been engaged by Canterbury-Bankstown Council to prepare a desktop flood planning assessment for Bankstown City Centre.

In 2019, Council completed their Local Strategic Planning Statement (known as Connective City 2036) and the Bankstown Complete Streets CBD Transport and Place Plan. Amongst its many outcomes, the Connective City 2036 recognised Bankstown City Centre as the city's key Strategic Centre.

In line with Connective City 2036, Council has commenced the master planning process for Bankstown. The master plan provides the opportunity to co-locate genuine job-generating development with housing, services, utilities and social infrastructure.

The draft Bankstown City Centre Master Plan was exhibited publicly from 29 March to 14 May 2021, public submissions were subsequently reviewed and the final master plan was adopted by Council on 28 September 2021. The next step is the development of a planning proposal that updates the objectives and controls of Council's Local Environmental Plan (LEP) and Development Control Plan (DCP). The planning proposal shall then be submitted for gateway determination, public exhibition, finalisation and adoption.

In mid-2021, NSW Department of Planning and Environment (DPE) released a new Flood Prone Land Policy Update. Included within this policy is a set of standard flood-related clauses for Local Environment Plans (LEPs) to assist local Councils.

In May 2021, the asset planning stormwater team for Canterbury-Bankstown Council reviewed the proposed master plan for Bankstown and concluded that the plan was developed generally in accordance with the objectives of the new Flood Prone Land Policy Update. However the team requested an industry peer review to provide an independent assessment and verification that the site-specific development and rezoning proposed in the Draft Master Plan is consistent with the relevant planning controls and policies. This is the background for the engagement of Cardno to prepare this desktop review.

A draft version of this report was submitted by Cardno to Council for review on 22 February 2022 with consolidated comments received from Council on 18 March 2022, with this final report incorporating these comments.

1.1 Study Objective

The overarching objective of this review was to determine the consistency of the flooding assessment for the final Bankstown City Centre Master Plan with the NSW Flood Prone Land Policy Update.

The key objectives for this review as outlined by Council were as follows:

- To assess the compliance of the Bankstown City Centre Master Plan with the Ministerial Direction;
- To review the approach to flooding that was adopted in the Bankstown City Centre Master Plan to determine if the resultant-built form is appropriate; and
- To inform Council of any required flood studies, floodplain risk management plan and / or planning interventions required to support a future planning proposal for Bankstown that complies with the Flood Prone Land Policy 2021.

1.2 Study Area

The Bankstown City Centre study area is bounded by Hume Hwy to the north, Stacey St to the east, Dellwood St / Dudley Ave / Chertsey Ave to the south, and Cairds Ave / Winspear Ave / Oxford Ave to the west. The study area for Bankstown City Centre Master Plan is shown in **Figure 1-1**.

The study area is bisected through it centre in an east-west direction by the T3 train line, with the Bankstown Central Business District (CBD) located in the middle of the study area. There are several existing parks and open space areas within the study area including Memorial Park to the south, Griffith Park to the west and Paul Keating Park in the CBD.

The topography of the study area is defined by the ridges to the north along the Hume Highway and Stacey Street. The ground surface elevation at the corner of Hume Highway and Stacey Street is 67.5m AHD, which is the highest point of the catchment. From the highest point, the land generally slopes down south to the railway line where the ground surface elevation is around 22.5m AHD. The raised railway line creates a

break in the northern and southern precincts. From the southern side of the railway line, there is a gentle decline to the south towards the Salt Pan Creek, a tributary of Georges river catchment the banks of which are at 10m AHD south of Macauley Avenue.

Figure 1-1 Bankstown City Centre - Study Area

2 NSW Flood Prone Land Policy Update

2.1 2005 Floodplain Development Manual and Policy

The NSW Government Flood Prone Land Policy is directed towards providing solutions to existing flood problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas. The policy formed part of the New South Wales (NSW) Floodplain Development Manual (FDM) in 2005. The policy provides that councils are primarily responsible for managing flood risk to reduce the risk to life, property damage and other impacts in their local government areas. It also recognises that flood-prone land may be able to support some types of development.

The policy and manual use a broad risk management hierarchy of avoidance, minimisation and mitigation to:

- Reduce the social and financial costs from the risks associated with occupying the floodplain;
- Increase the sustainable benefits of using the floodplain; and,
- Improve or maintain floodplain ecosystems dependent on flood inundation.

The Policy Statement (noted within Section 1.1.1 of the 2005 FDM) promotes a merit-based approach for all development decisions in the floodplain to take into account social, economic and ecological factors, as well as flooding considerations. The statement also notes both mainstream and overland flooding shall be addressed, which is relevant for the study area as it is affected by both types of flooding.

The Policy identifies the following floodplain management 'process' for the identification and management of flood risks:

1. Formation of a Committee – Established by a Local Government Body (Local Council) and includes community group representatives and State agency specialists.
2. Data Collection – The collection of data such as historical flood levels, rainfall records, land use etc.
3. Flood Study – Determines the nature and extent of the flood problem.
4. Floodplain Risk Management Study – Evaluates floodplain management measures for the floodplain in respect of both existing and proposed development.
5. Floodplain Risk Management Plan – Involves formal adoption by Council of a management plan for the floodplain.
6. Implementation of the Plan – Implementation of actions to manage flood risks for existing and new development.

A review of the available studies prepared by Canterbury-Bankstown Council for the study area under the floodplain management process are summarised in **Section 3.2**. These studies provide the basis of understanding of the flood behaviour in the study area.

It is noted that NSW DPE is in the process of updating the 2005 FDM with the 2022 Flood Risk Management Manual. This new manual is still draft and undergoing public comment and updates, and therefore has not yet been gazetted and adopted. Therefore for the purposes of this review the 2005 FDM remains the relevant manual.

2.2 2021 Flood Prone Land Policy

The 2021 Flood Prone Land Package was released in July 2021. The Flood Prone Land package includes the following documents:

- A revised s9.1 local planning direction on flooding (Local Planning Direction, or the Act);
- A new planning circular: Considering flooding in land use planning: guidance and statutory requirements (Planning Circular);
- A new guideline: Considering Flooding in Land Use Planning (Guideline);
- Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021: two local environmental plan (LEP) clauses which introduces flood related development controls;
- An amendment to clause 7A of Schedule 4 to the Environmental Planning and Assessment Regulation 2000 (the Regulation);

- State Environmental Planning Policy Amendment (Flood Planning) 2021; and,
- Revocation of the Guideline on Development Controls on Low Flood Risk Areas (2007).

The revised flood-prone land package allows a more contemporary approach to better manage flood risk beyond the 1% Annual Exceedance Probability (AEP), including building greater resilience. The package reverses the effects of the 2007 Planning Circular and Guideline on Development Controls on Low Flood Risk Areas, Ministerial Direction No. 4.3 which restricted Councils in NSW from applying residential development controls on land between the 1% AEP flood extent and the Probable Maximum Flood (PMF) extent.

The update package addresses the key concerns over the safety of people, the management of potential damage to property and infrastructure, and the management of the cumulative impacts of development, particularly on evacuation capacity. A summary of the key outcomes from the package is summarised in the following sub-sections.

2.3 Updated Standard LEP Clauses

The 2021 package establishes two different categories, and two associated standard Local Environment Plan (LEP) clauses where flood-related development controls may be applied / considered. These are:

- Flood Planning Areas (FPAs): The 'flood planning' LEP clause is mandatory and the LEPs of all Councils in NSW were amended on 14 July 2021;
- Special Flood Considerations (SFCs): The 'special flood consideration' LEP clause is optional, and Councils decide whether to adopt this clause or not. If Councils choose to adopt the optional standard instrument SFC provision, it must be adopted without variation but subject to any relevant direction in the standard instrument (cl 4(2), SI order).

2.3.1 Mandatory LEP Clause - Flood Planning Area

Clause 5.21 outlines the requirements for developments in the FPA which is all land under Flood Planning Level (FPL), which in accordance with the 2005 FDM is typically defined by the 1% AEP (1 in 100 AEP) event with a 0.5 metre freeboard. Councils are permitted to propose alternate FPLs, however they are required to demonstrate and document the merits of any decision based on a risk management approach. The land this clause applies to is essentially unchanged from the previous standard LEP clause.

The main updates to the mandatory standard flood related clause include:

- Several new objectives have been added to the updated text including a reference to cumulative impacts, enabling safe and appropriate uses of land, and enabling safe evacuation from the land;
- The requirements for development consent have been updated with reference to:
  - Compatibility to flood function (floodway, flood storage and flood fringe),
  - No offsite flood impacts and the impact of the development on projected changes to flood behaviour (accounting for climate change);
  - the impact of the development on projected changes to flood behaviour as a result of climate change,
  - There is a reference to safe occupation and efficient evacuation of people and not to exceed the capacity of existing evacuation routes for the surrounding area. Similarly, also stated in the clause is whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood;
  - The intended design and scale of buildings resulting from the development, and the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding.

2.3.2 Optional LEP Clause – Special Flood Considerations

A new optional flood clause 5.22 has been added to the update called the 'Special Flood Considerations' (SFC) clause. The clause applies to all land between FPA and the Probable Maximum Flood (PMF), an area that was not covered within the previous standard LEP clause. The types of development this optional clause would generally relate to include:

- Sensitive uses that require ongoing functionality during and after a flood event such as hospitals with emergency facilities and emergency services facilities;

- Sensitive uses that require high levels of assistance with evacuation, such as seniors housing, group homes, boarding houses, hostels, caravan parks, educational establishments, centre-based childcare facilities and hospitals;
- Hazardous industries or hazardous storage establishments that require containment of materials in the event of a flood;
- Development that requires risk to life or other safety consideration such as (these examples are listed in the guideline Considering Flooding in Land Use Planning):
  - areas of low probability flood events that have the potential for high consequences (for example, where new floodways develop in low probability floods);
  - where development controls are needed to address risk to life or other safety considerations identified in studies under the FRM process or through the emergency management planning process;
  - areas with evacuation limitations;
  - where increases in dwelling densities would have a significant impact on the ability of the existing community to evacuate using existing evacuation routes within the available warning time;
  - where vertical evacuation for short duration flooding is required such as where the rate of rise of floodwater prohibits safe evacuation from the land;
  - behind flood levees which may have warning and/or evacuation limitations;
  - impacted by either high hazard or/and H4 to H6 hazard vulnerability thresholds in the PMF as defined in the manual or its supporting guides, and unable to safely evacuate;
  - areas indirectly affected by flooding where development may have for example outages of utilities; and
  - areas isolated by floodwaters and/or terrain (such as high flood island or trapped perimeter).

The requirements for development consent for this clause are similar but more limited than the mandatory clause considering safe occupation and efficient evacuation of people in the event of a flood, appropriate measures to manage risk to life, and effects on the environment.

2.4 Planning Proposal Requirements

The s9.1 Local Planning Direction applies when an authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land. The key requirements of the local planning direction for planning proposals include:

1. A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, the Considering flooding in land use planning guideline 2021, and any adopted flood study and/or floodplain risk management plan adopted by the relevant council.
2. A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.
3. A planning proposal must not contain provisions that apply to the flood planning area which:
   a. permit development in floodway areas,
   b. permit development that will result in significant flood impacts to other properties,
   c. permit development for the purposes of residential accommodation in high hazard areas,
   d. permit a significant increase in the development and/or dwelling density of that land,
   e. permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,
   f. permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require consent,
   g. are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which

can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or

h. permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.

4. A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which include items a), b), d), e), f) from item 3 above. An additional requirement for this area is if a planning proposal is likely to affect the safe occupation of and efficient evacuation of the lot.

5. For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.

A final section of the direction notes that a planning proposal may be inconsistent with the above terms of the direction only if the planning proposal authority can satisfy the Secretary of the Department of Planning and Environment (or their nominee) that:

(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant Council in accordance with the principles and guidelines of the FDM 2005, or

(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the FDM 2005 or

(c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of FDM 2005 and consistent with the relevant planning authorities' requirements, or

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

It is noted that subsequent to the July 2021 release of the package, the ministerial direction has since been included within the Local Planning Directions set and has been renamed Section 4.1 Flooding. It is included in Focus Area 4 – Resilience and Hazards. The text of the flooding direction is unchanged from that included in Section 9.1 direction of the July 2021 package.

2.5 Relevance to Master Plan

2.5.1 Council Consideration of Optional LEP Clause

In relation to the Special Flood Considerations (SFC) Clause 5.22, as stated within the guideline document:

> *…. this is an optional provision of the Standard Instrument and Councils have the discretion whether to adopt the clause in a LEP in their LGA, provided they have appropriate information and justification to support the flood related development controls. Studies under the FRM process, as well as emergency management planning processes and relevant strategies and plans developed by NSW Government may provide information and support justification for the adoption of the clause.*

In discussions with Canterbury-Bankstown Council's catchment management planning team and stormwater asset planning team it is understood that it is Council's intention not to adopt the optional LEP clause 5.22 for land between the FPA and the PMF. Therefore only the LEP clause 5.21 amended on 14 July 2021 will be considered. However, as discussed in the following sub-section, similar provisions for the SFC are still applicable to planning proposals in accordance with the s9.1 Local Planning Direction.

Part B12 of the Bankstown Development Control Plan (DCP) 2015 outlines flood controls for the former Bankstown LGA. Schedule 3 of Part B12 for the Georges River Floodplain (which includes the Salt Pan Creek floodplain and the study area) sets out development controls that are applied in the low flood risk precinct (area between 100 year extent and PMF extent) for 'sensitive uses and facilities' and for flood risk and evacuation for all other development types. These controls would have been compatible with the optional LEP clause, and generally address the same development types and flood risk profiles outlined in the optional clause.

Therefore, although the optional SFC clause is unlikely to be adopted by Council, it is still considered relevant as it is generally in accordance with relevant DCP controls, and similar provisions for the SFC are applicable to planning proposals in accordance with the s9.1 Local Planning Direction.

2.5.2 Bankstown City Centre Planning Proposal Requirements

As the next stage for the Bankstown City Centre Master Plan is the preparation of a planning proposal submission, the planning proposal requirements outlined within s9.1 Local Planning Direction (listed in **Section 2.4**) are particularly relevant to this review. The list of requirements provides clear guidance on what must be considered for a planning proposal as it relates to flood risk.

This list forms the basis for the review of the Master Plan included in **Section 4**. Furthermore, the requirements generally address the same objectives as those in the LEP amended clause 5.21.

3 Available Data

3.1 Master Plan

The final Bankstown City Centre Master Plan was adopted by Council on 28 September 2021. It is a growth strategy that focusses on 10 key directions that balances opportunities for development to meet the demands of growing numbers of workers, residents and students and their changing needs. It provides a framework for the funding and delivery of new and enhanced community facilities, open spaces and the essential services that will help the city thrive. The proposed framework layout is shown in **Figure 3-1**.

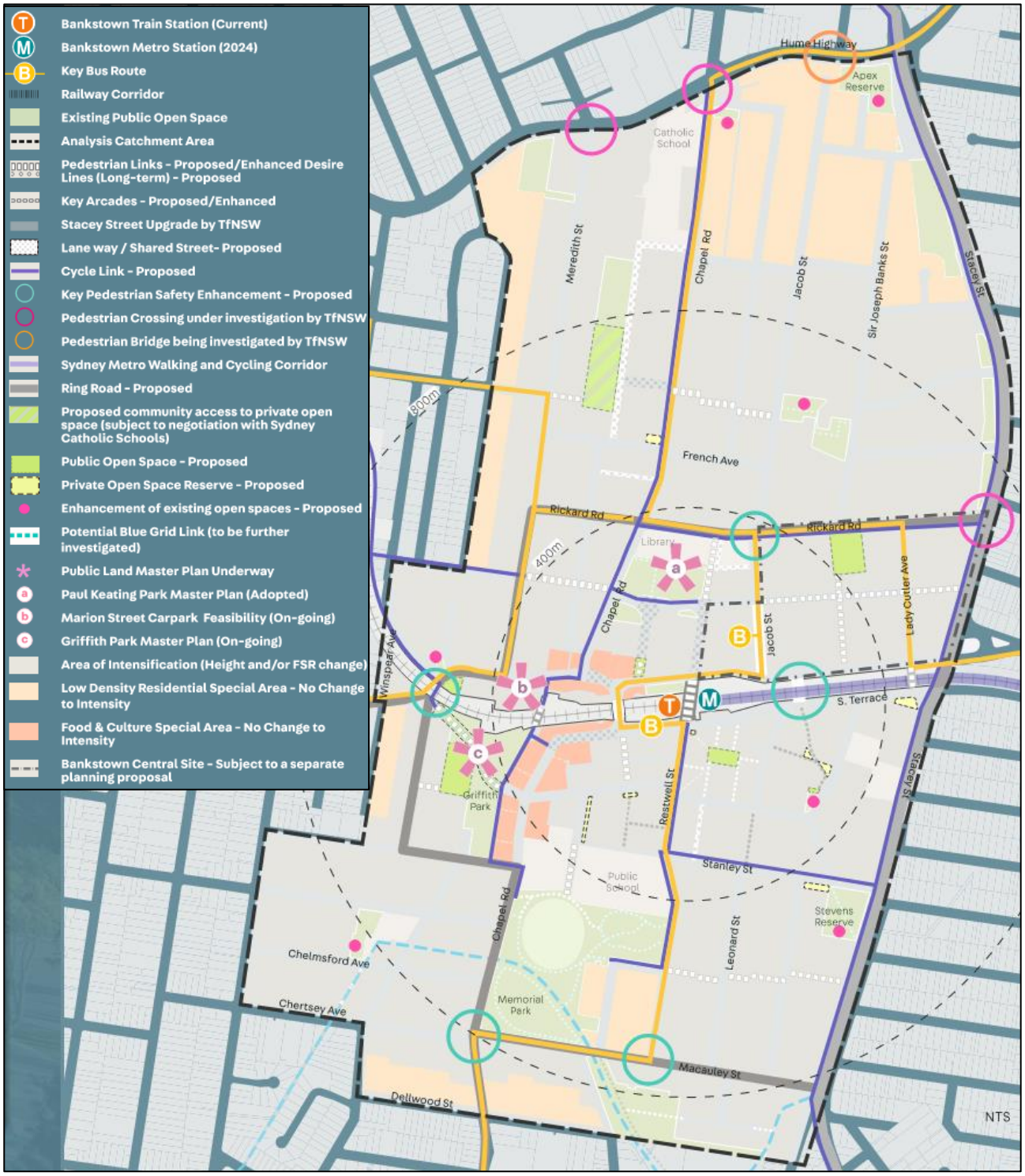

Figure 3-1 **Bankstown City Centre Master Plan – Framework Map Showing the Proposed Future City Layout**

One of the key drivers for Bankstown City Centre will be growth over the next 20 years (to the year 2036), in population (additional 29,500 residents), housing (additional 12,500 homes), and employment (additional 15,300 jobs). This growth has been addressed through opportunities for additional height and density (Floor Space Ratio, or FSR), ensuring more people are living and working near sustainable transport, jobs and services. The majority of the city centre is proposed for intensification the only areas with no change in intensity is the central food and culture district and some lower density residential at the edges of the city.

Generally the height and density are proposed to be highest in the heart of the city centre and decrease further away from this central location. As most of the city is developed already (brownfield), the intensification will most likely be vertical aside from some infill development opportunities.

The proposed land use zoning is shown in **Figure 3-2**.

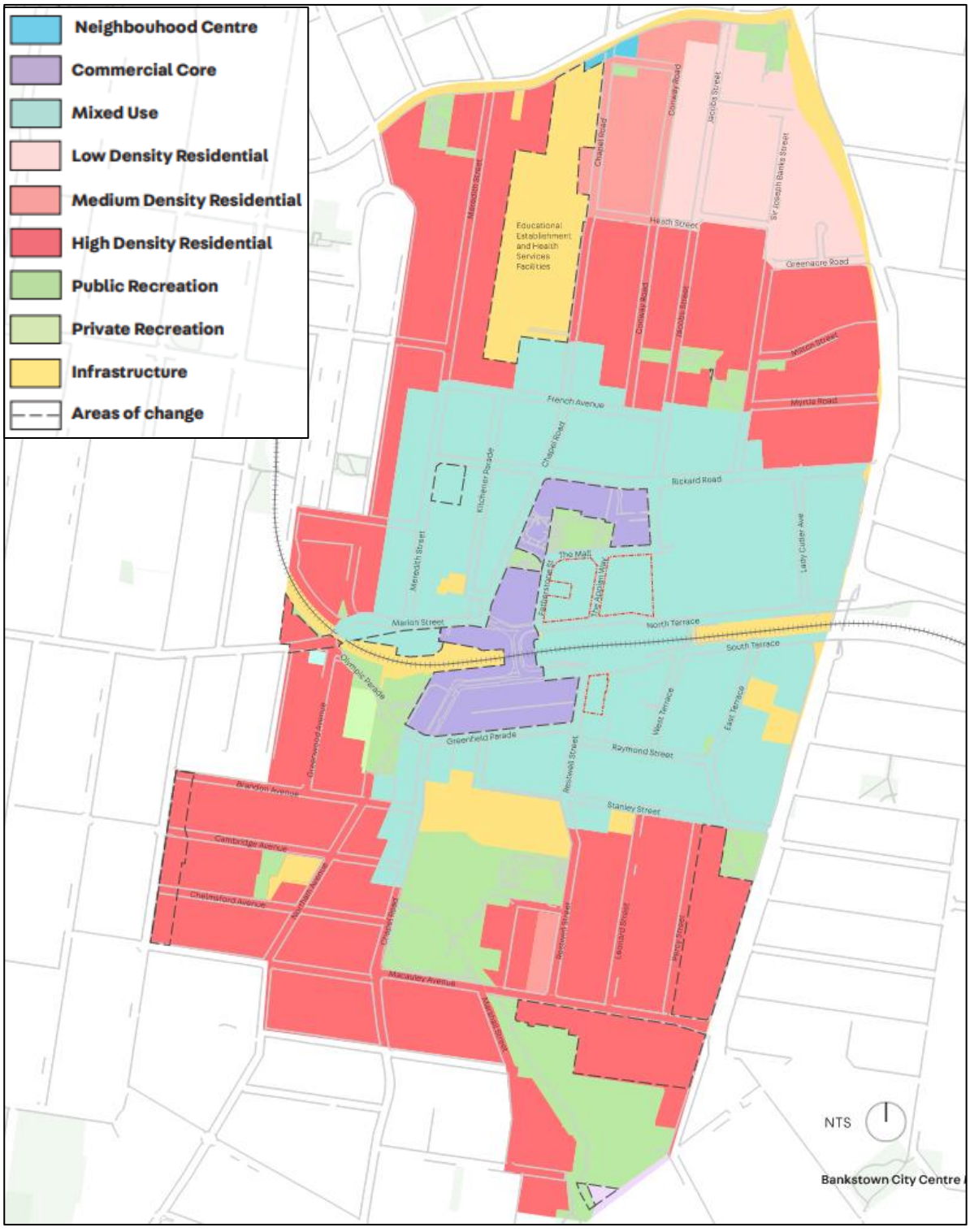

Figure 3-2 Bankstown City Centre Master Plan – Proposed Land Use Mapping

As can be seen in **Figure 3-2** the centre is mostly mixed use or commercial core, with the surrounding areas predominantly high density residential. The land use for most of the area has remained unchanged. The areas of change are dash-lined areas such as the town centre 'commercial core', 'infrastructure' zoning for the hospital and TAFE to the north, and some high density residential in the south-east corner.

The study area has also been divided into 8 character areas to represent the predominant proposed future development types that are shown in **Figure 3-3**.

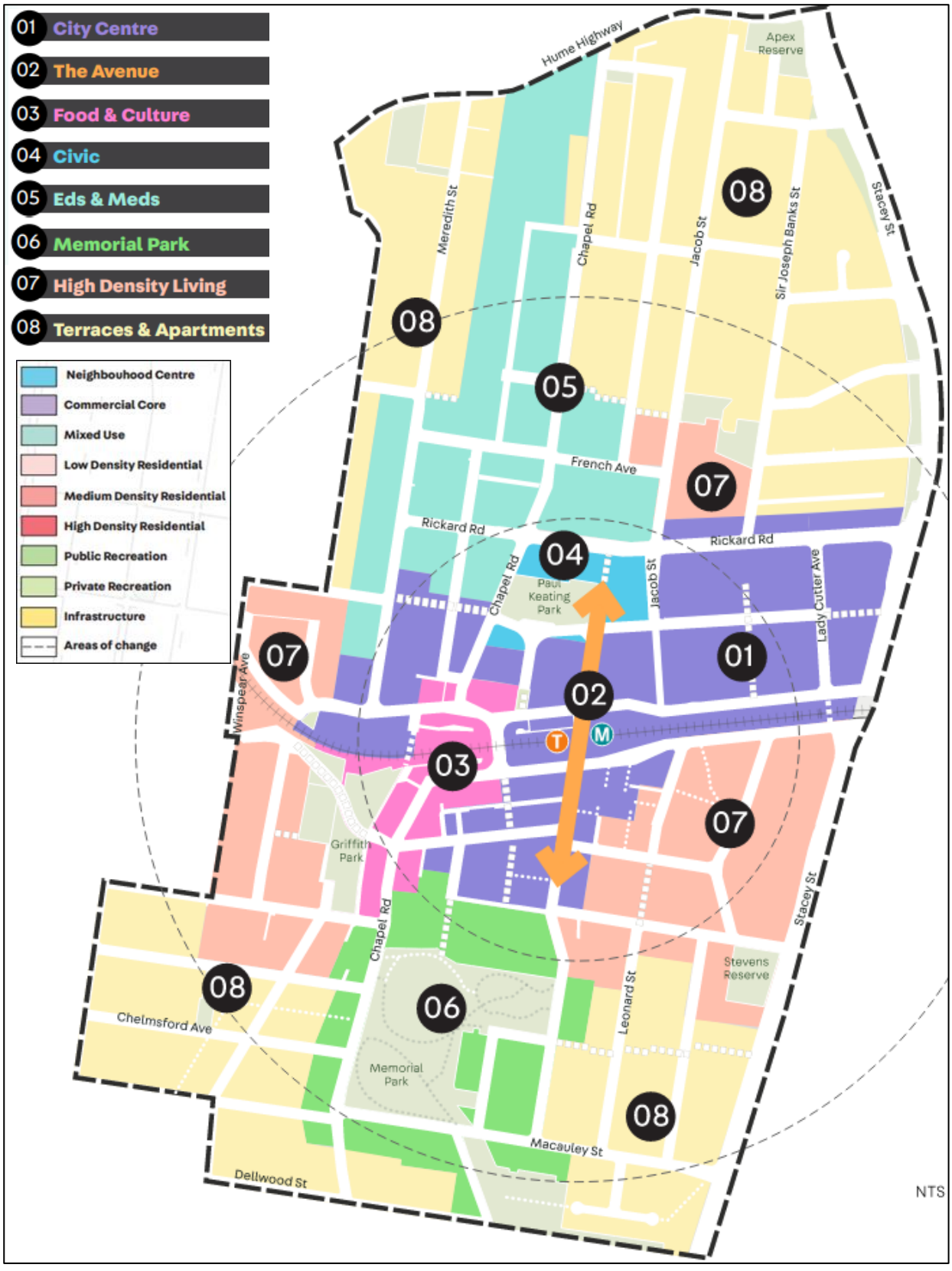

Figure 3-3 **Bankstown City Centre Master Plan – Proposed Character Areas**

The key future infrastructure projects that have guided the layout of the character areas include:

- A new Western Sydney University Bankstown City Campus to be located in a central Civic area (in Area 04 shown in **Figure 3-3**). Associated with this is the Appian Way upgrade (Area 02) that will provide connection from the campus through the CBD and train stations and south to Restwell Street. A Development Application (DA) has been received for the Appian Way upgrade associated with this campus (further discussion in **Section 3.5.1**).
- The opening of Sydney Metro City and Southwest services through the existing Bankstown station in the centre of the city and the existing above ground rail line that bisects the area in an east-west direction;
- A new public hospital for Bankstown will be the centre of the proposed educational and medical centre (Area 05) which will also be surrounded by the existing TAFE and a network of supporting and related organisations and industries; and,
- The Memorial Park area (Area 06) will be lined by streets and bordered by well-designed medium to high density apartment developments. New pedestrian links are proposed along existing creek lines in property setbacks. Segments of the stormwater infrastructure will progressively be landscaped and naturalised to promote a water-sensitive urban environment.

3.2 Flood Studies, Floodplain Risk Management Studies and Plans

The following regional flood studies have been prepared for the Bankstown study area:

- Salt Pan Creek Stormwater Catchment Study (Bewsher/BMT, 2009)
- Salt Pan Creek Catchments Floodplain Risk Management Study and Plan (Bewsher, 2013)

3.2.1 2009 Salt Pan Creek Stormwater Catchment Study

The study prepared by Bewsher and BMT-WBM on behalf of Canterbury-Bankstown Council (then Bankstown City Council) investigates flood behaviour throughout the Salt Pan Creek catchment. The report and modelling completed in 2007 was amended in 2009 for more up-to-date modelling techniques. Salt Pan Creek is a tributary of the Georges River and has a catchment area of some 26 km^2 and includes the entirety of the Bankstown City Centre study area which is in the centre of the catchment.

The study provides information on flood conditions throughout the catchment for a range of design floods, including the 1 year, 2 year, 5 year, 10 year, 20 year, 50 year, and 100 year Average Recurrence Intervals (ARI's) and the PMF. Information on the extent of flood inundation, depth of flooding, and velocity of floodwater has been provided. As it defines existing flood conditions, this study is the equivalent of a Flood Study in accordance with the Floodplain Management Process discussed in **Section 2.1**. These results form the technical basis for a subsequent floodplain management study (refer to next sub-section).

This study included the analysis of surface runoff across the catchment, flooding within the underground stormwater drainage network, and flood behaviour through the drains and other watercourses towards the lower end of the catchment. A 1D/2D hydraulic TUFLOW hydraulic model was established with a 2m grid cell size based on available LIDAR data from 2003. Variable hydraulic roughness was applied with buildings digitised in the 2D but not blocked from the model, instead a higher surface roughness value was applied. The downstream boundary water levels are significantly lower than the minimum level of the Bankstown City Centre study area, therefore the study area is not affected by Georges River tailwater flooding in any way.

Hydrology for the model was applied as direct rainfall or rainfall-on-grid in the TUFLOW model. Design rainfall was assessed using AR&R87 design rainfall depths and patterns, with 2 hour duration assumed critical for all design events including the PMF event. Initial and continuing losses were variable based on pervious (10mm and 2.5mm/hr) and impervious (0mm and 0mm/hr) surfaces.

With regards to the 1D drainage network, a blocked and unblocked condition were simulated for combined flood mapping results. A 50% blockage factor was applied to all bridges, box culverts, or pipe culverts where the clear opening is less than 6m. Blockage factors of 20% and 50% were also applied to all lintel pit openings and grated pits respectively. Open channels and creeks were modelled using 1D elements.

The Flood Risk Precincts (FRPs) developed as part of the Flood Study are as follows:

- High Flood Risk precinct: 1% AEP high hazard areas;
- Medium Flood Risk precinct: 1% AEP flood extents (0.05 m depth and 250 m^2 area filter applied) excluding the High Flood Risk Precinct; and,
- Low Flood Risk precinct: PMF extent excluding High & Medium FRPs (0.05m depth filter applied).

3.2.2 2013 Salt Pan Creek Catchments Floodplain Risk Management Study and Plan

This Floodplain Risk Management Study and Plan (FRMS&P) constitutes the second and third stages of the floodplain management process for the Salt Pan Creek catchments and was prepared for Council by Bewsher. The Floodplain Risk Management Study investigated what can be done to minimise the effects of stormwater flooding in the Salt Pan Creek catchment and recommended a strategy in the form of a draft Floodplain Risk Management Plan. The study area not only included the Salt Pan Creek catchment from the Flood Study described in the previous section, but three additional catchments to the south. The document was adopted by Council on 17 December 2013.

The study updated the flood risk precincts established in the Flood Study (refer to previous section), with the following minor amendments:

- Overland flowpaths were defined for the upper catchment where maximum 1% AEP depths across the flowpath were less than 0.25 m. Under this definition, the majority of the study area remained mainstream flooding, with only the northern upper catchment areas defined as overland flow; and
- A High Flood Risk precinct was identified based on the extents of 1% AEP high hazard similar to the Flood Study, however areas with severe evacuation issues was also included in this precinct, which does not appear to have applied to any areas in the Bankstown City Centre area,

The resultant flood risk precincts from the FRMS&P are shown in **Figure 3-4**.

Floor level survey for flood affected buildings was recorded, and from this survey compared to peak flood levels, the number of properties with overfloor flooding was able to be determined. The location of existing (as of 2013) overfloor flooded properties for the 1% AEP event are shown in **Figure 3-5**. As can be seen in the figure in the study area there are a significant number of flood affected properties with varying depths of overfloor flooding. For the CBD area (Area 4 in **Figure 3-5**) alone, the FRMS&P reports there are 163 flood affected commercial / industrial properties and 11 residential properties. The combined flood damages for just this CBD area across four design flood events (20%, 5%, 1% AEP and PMF) was calculated to be $1.93 million in 2013.

Aside from this central CBD area, as shown in **Figure 3-5** the study area of this review also includes a significant number of flood affected properties to the south-west near Northam Ave and Greenwood Ave, and to the south-east near Macauley Avenue.

Floodplain risk management options were developed within the FRMS&P for both site-specific, physical solutions to flood risk, as well as general catchment-wide options. The catchment-wide options included planning and development controls (that have subsequently been applied by Council for this catchment), improved public awareness, emergency management options, and stormwater maintenance.

Site-specific options for Bankstown CBD area were discussed in Section 7.14 of the FRMS&P report and included the following:

- Adopt flood mapping based on completed works;
- As redevelopment occurs, ensure existing overland flowpath capacities are maintained or enhanced;
- As building entrances along Appian Way are redeveloped, ensure their redesign provides for flood immunity by internal ramping and/or raising of floor levels;
- Provide additional inlet capacity along the SWC conduits on the northern side of Rickard Road and at the French Ave low point (southern side); and,
- Investigate opportunities to improve the aesthetics of the existing formal overland flow path south of the railway line. Remove part of existing concrete wall in the centre of the flowpath on the southern side of South Terrace.

The layout of the floodplain risk management options for the Bankstown City Centre proposed within the FRMS&P have been presented in **Figure 3-6**.

3.3 GIS Information

To assist this review, Canterbury-Bankstown Council provided GIS information including an updated cadastral layer, existing and proposed land use zoning layers, and combined flood extent mapping for the 1% AEP and PMF events for the entire Local Government Area (LGA).

Existing vulnerable developments within the study area were mapped through publicly available information, such as GoogleMaps searches.

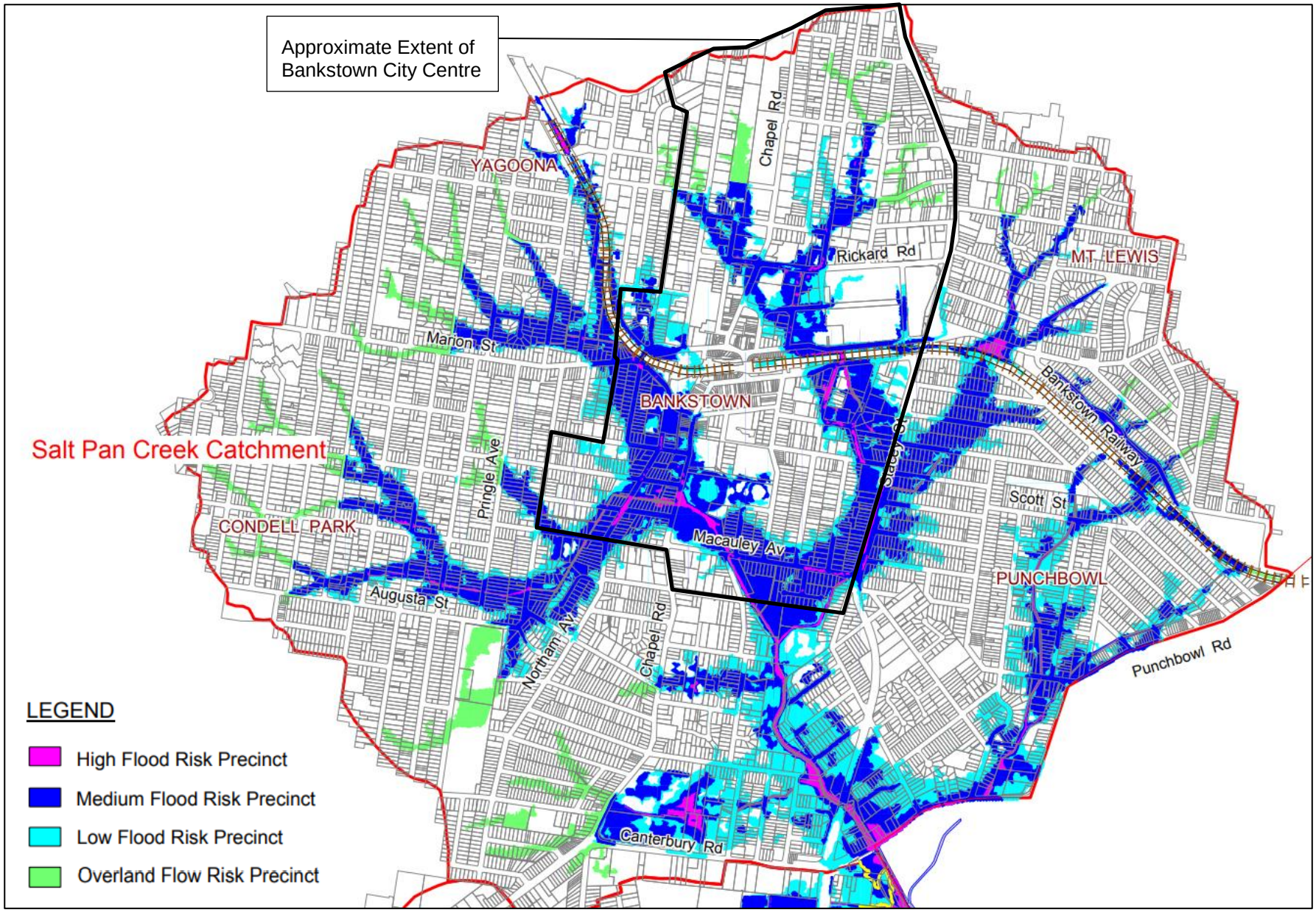

Figure 3-4 Provisional Flood Risk Precinct Map – Salt Pan Creek FRMS&P (2013) with Mark-up of Approximate Bankstown City Centre Study Area

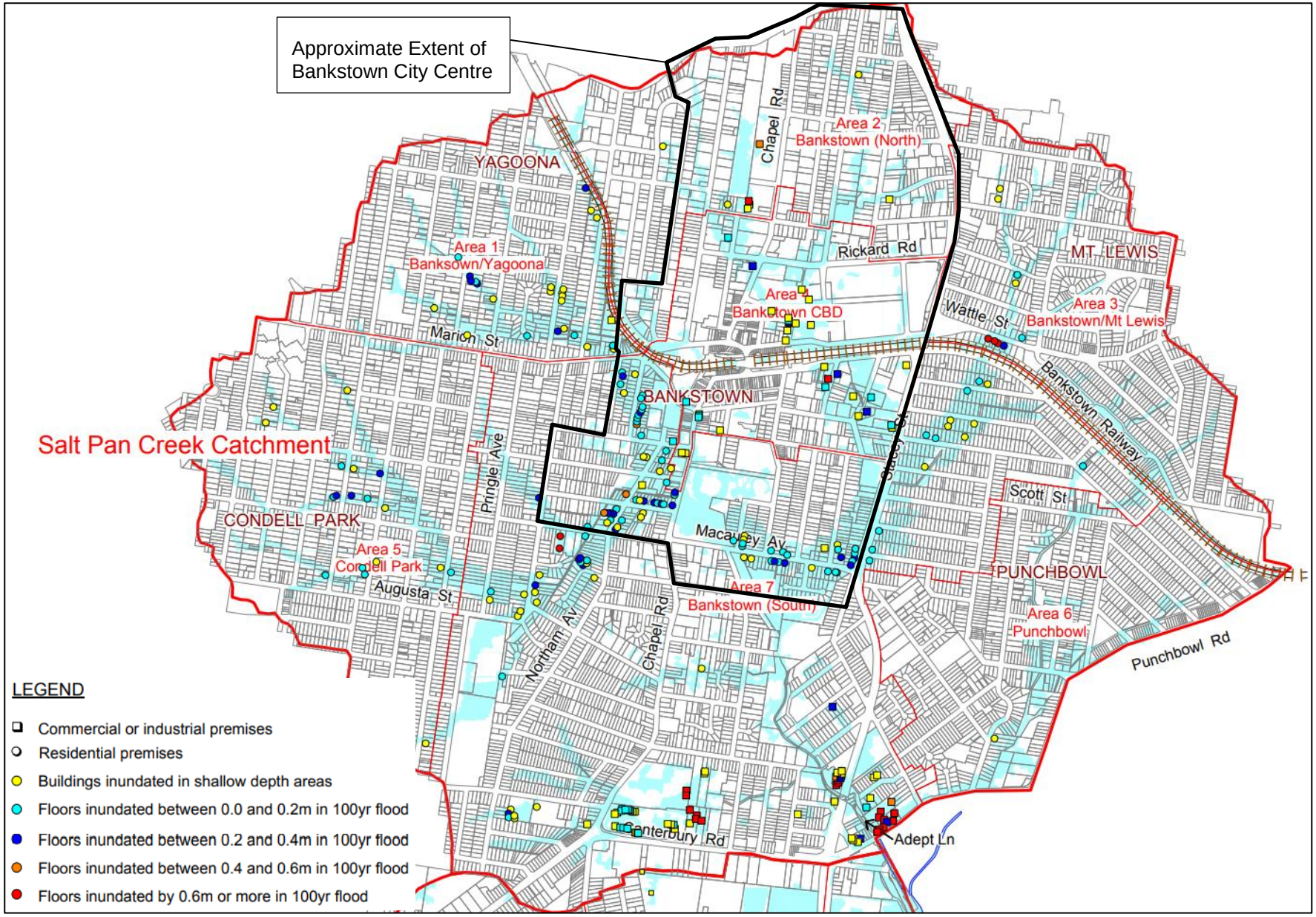

Figure 3-5 **Existing Buildings Inundated in the 100 year ARI – Salt Pan Creek FRMS&P (2013) with Mark-up of Approximate Bankstown City Centre Study Area**

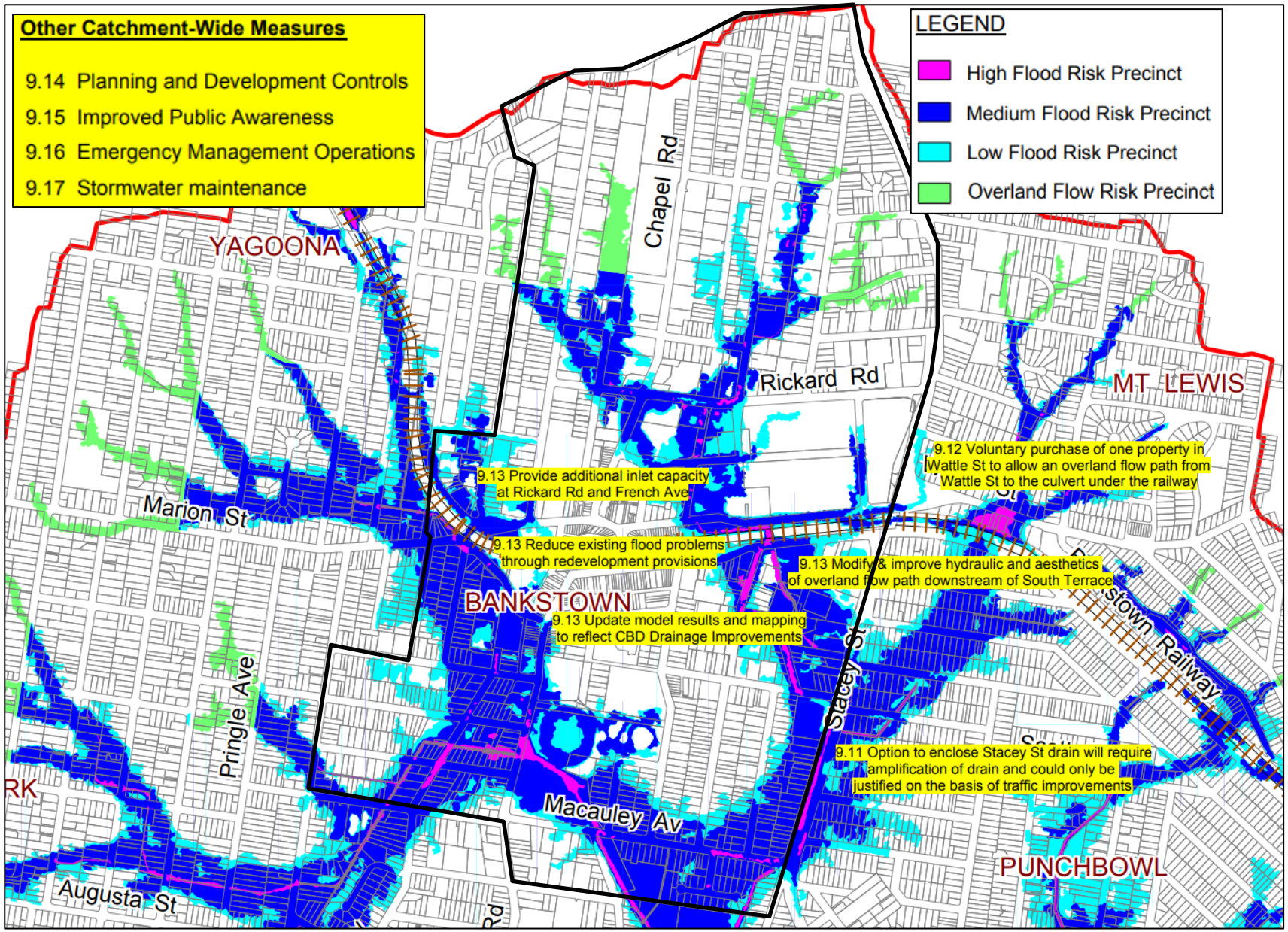

Figure 3-6 **Floodplain Risk Management Options – Salt Pan Creek FRMS&P (2013) with Mark-up of Approximate Bankstown City Centre Study Area**

3.4 Flood Modelling Results

3.4.1 Available Results

The following flood modelling results were made available from the *Salt Pan Creek Stormwater Catchment Study* (Bewsher/BMT, 2009):

- Flood risk mapping from this study including Low (PMF extents), Medium (1% AEP extents) and High flood risk precincts (1% AEP high provisional hazard);
- Model DEM and LiDAR data from this Flood Study;
- Peak depth, velocity and water level grid results for the 5%, 2%, and 1% AEP floods as well as the PMF event.
- Provisional hazard mapping for the 1% AEP flood only.

The flood extent mapping for the revised Flood Risk Precincts from the *Salt Pan Creek Catchments Floodplain Risk Management Study and Plan* (Bewsher, 2013) was also provided. The flood risk mapping included mapping of overland flows, Low, Medium and High flood risk precincts.

Of the available design storm events, the 1% AEP and PMF events are the most relevant to the review of the Master Plan. There are several flood mapping types that are relevant to this review as they are either directly or indirectly referenced within the NSW Flood Prone Land planning proposal requirements (see **Section 2.4**):

- Provisional hazard: Low, transitional and high hazard conditions outlined within the 2005 FDM;
- H1-H6 Hazard: A more recent set of flood hazard curves that is not directly referenced in the NSW Flood Prone Land requirements, however are relevant to flood emergency response provisions; and,
- Hydraulic categories which include floodway, flood storage and flood fringe. In particular floodway is relevant within this review.

None of these three flood mapping types were included in the results provided by Council (with the exception of the 1% AEP provisional hazard). However, using the provided peak depth and velocity results from the 2009 Flood Study it was possible to use a post-processing tool to map these categories for the 1% AEP and PMF events for this review. The definition of these three flood map types is outlined in the following sub-sections. The mapping of these three flood map types for the Bankstown City Centre study area is included in **Appendix A**.

The reasons the following result mapping prepared for this desktop review is considered approximate is:

- This approach adopts combined peak depth and velocity grids, where normal mapping of this type uses depth and velocity combinations in time steps. If peak depths and velocities do not occur at the same time in the model simulation then the adopted approach will overestimate Velocity x Depth products.
- The definition of depth and velocity thresholds for floodway and flood storage vary between Councils. Definitions for hydraulic categories for the purpose of this desktop review have been assumed, however Council may adopt different definitions to these in past or future Flood Studies or FRMS&Ps.

For the purposes of discussion within this review, these assumptions are considered appropriate, however these limitations should be considered before adopting these maps for other purposes.

3.4.2 Provisional Hazard

Provisional flood hazard is determined through a relationship developed between the depth and velocity of floodwaters and is based strictly on hydraulic considerations.

Historically, the criteria for these relationships has been taken from the NSW FDM (Appendix L; NSW Government, 2005). The Manual defines two major categories for provisional hazard – high and low. A third minor transitional category is also included that requires further investigation of the site in question to define the hazard category. The provisional hazard curves are shown in **Figure 3-7**.

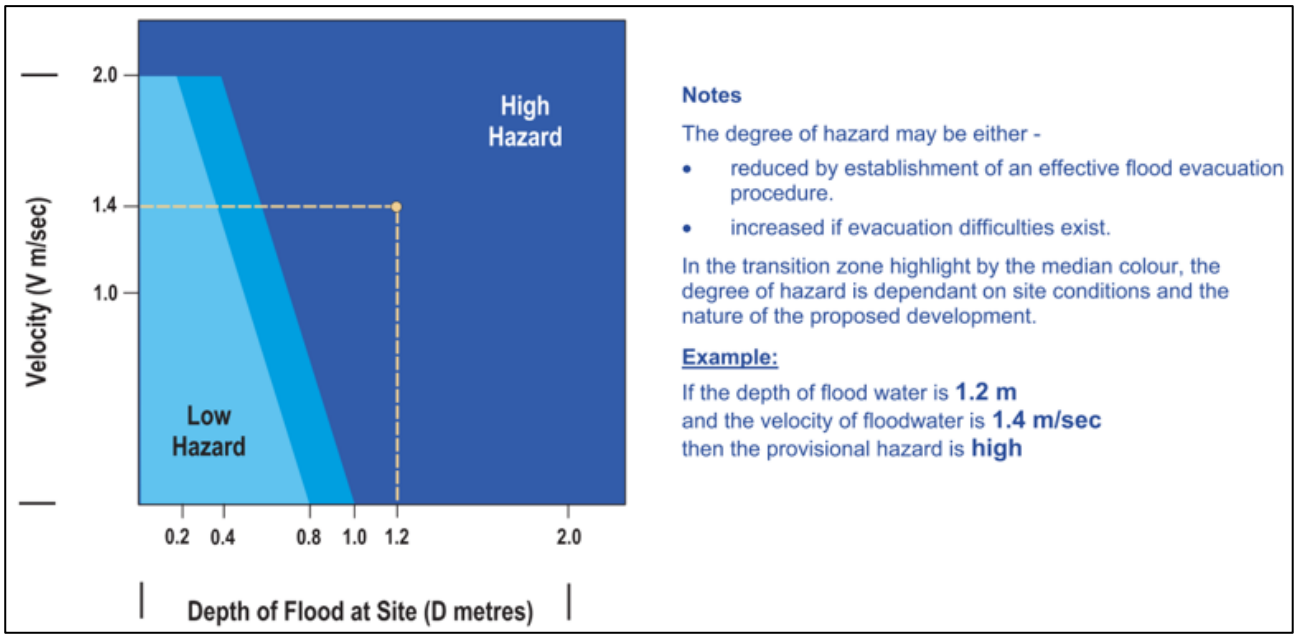

Figure 3-7 Provisional Hazard Curves from Appendix L of the Floodplain Development Manual

3.4.3 H1-H6 Hazard Category

A new method of hazard categorisation has been developed and is included in the 2019 edition of Australian Rainfall & Runoff (Book 6: Flood Hydraulics, Section 7.2.7). The classification is still based on depth and velocity, but utilises six categories based on the stability of children, adults, the elderly and vehicles in floodwaters. The ARR hazard category curves are shown in **Figure 3-8**.

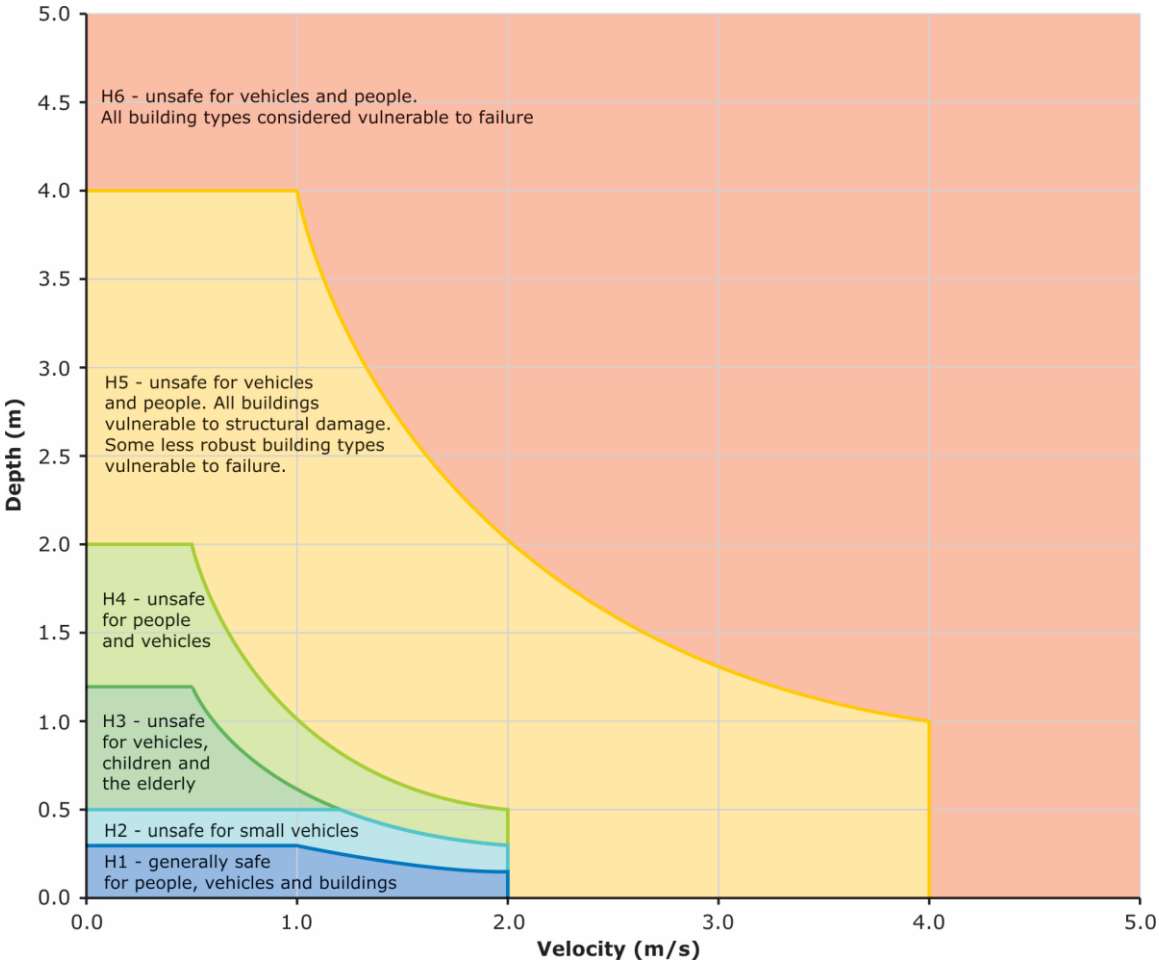

Figure 3-8 H1-H6 Hazard Categories Source: Section 7.2.7, Book 6, ARR, 2019)

3.4.4 Hydraulic Categories

The 2005 FDM defines flood prone land to be one of the following three hydraulic categories:

- Floodway - Areas that convey a significant portion of the flow. These are areas that, even if partially blocked, would cause a significant increase in flood levels or a significant redistribution of flood flows, which may adversely affect other areas. The following criteria was used to define the floodways for the purposes of this desktop review:
  - Velocity x Depth product greater than 0.25 m^2/s and Velocity greater than 0.25 m/s; or;
  - Velocity is greater than 1 m/s.
- Flood Storage - Areas that are important in the temporary storage of the floodwater during the passage of the flood. If the area is substantially removed by levees or fill it will result in elevated water levels and/or elevated discharges. Flood Storage areas, if completely blocked would cause peak flood levels to increase by 0.1m and/or would cause the peak discharge to increase by more than 10%. The criteria used to define the flood storage for the purposes of this desktop review was areas with Depths greater than 0.2 metres.
- Flood Fringe - Remaining area of flood prone land, after Floodway and Flood Storage areas have been defined. Blockage or filling of this area will not have any significant effect on the flood pattern or levels.

3.5 Current Development Proposals

3.5.1 Western Sydney University and Appian Way Upgrade

The Western Sydney University (WSU) Bankstown Campus was approved as a State Significant Development (SSD) in early 2021. As part of the approval, the applicant and Canterbury-Bankstown Council entered into a Voluntary Planning Agreement (VPA) to provide contributions for a public purpose. One of the contributions to be provided under the VPA included the upgrade of the Appian Way public domain. The site is just north of the Bankstown CBD, in the “04 Civic character area” in the Master Plan, and Appian Way upgrade is a key focus of the “02 Avenue character area” in the Master Plan (see Figure 3-3).

Review of the DA documents for the Appian Way upgrade provided an indication of the planned road upgrade. The overall works of the WSU and Appian Way combined project involve:

- A high-rise WSU campus building currently under construction (identified and discussed within the Master Plan document);
- Appian Way public domain upgrades; and
- Drainage upgrades for existing culverts under the corridor.

The layout of the proposed drainage upgrades are shown in **Figure 3-9**.

The Flood Impact Assessment report (GRC Hydro, April 2021) included in the DA package, estimated that these proposed works would result in water level reductions in the 1% AEP flood of up to 0.3 m within the Appian Way corridor. This results in a reduction of 1% AEP flood hazard in the Appian Way corridor from H2 with areas of H4-H5 hazard categories under the pre-developed condition to H1 hazard under the post-development conditions.

These reductions in flooding in the area are a direct result of the drainage upgrades on Appian Way. This development proposal directly addresses flood risk management option 9.13 from the Salt Pan Creek FRMS&P (shown in **Figure 3-6**). The site-specific recommendations for Bankstown CBD area discussed in Section 7.14 of the FRMS&P report, in particular:

> *…. As building entrances along Appian Way are redeveloped, ensure their redesign provides for flood immunity by internal ramping and/or raising of floor levels*

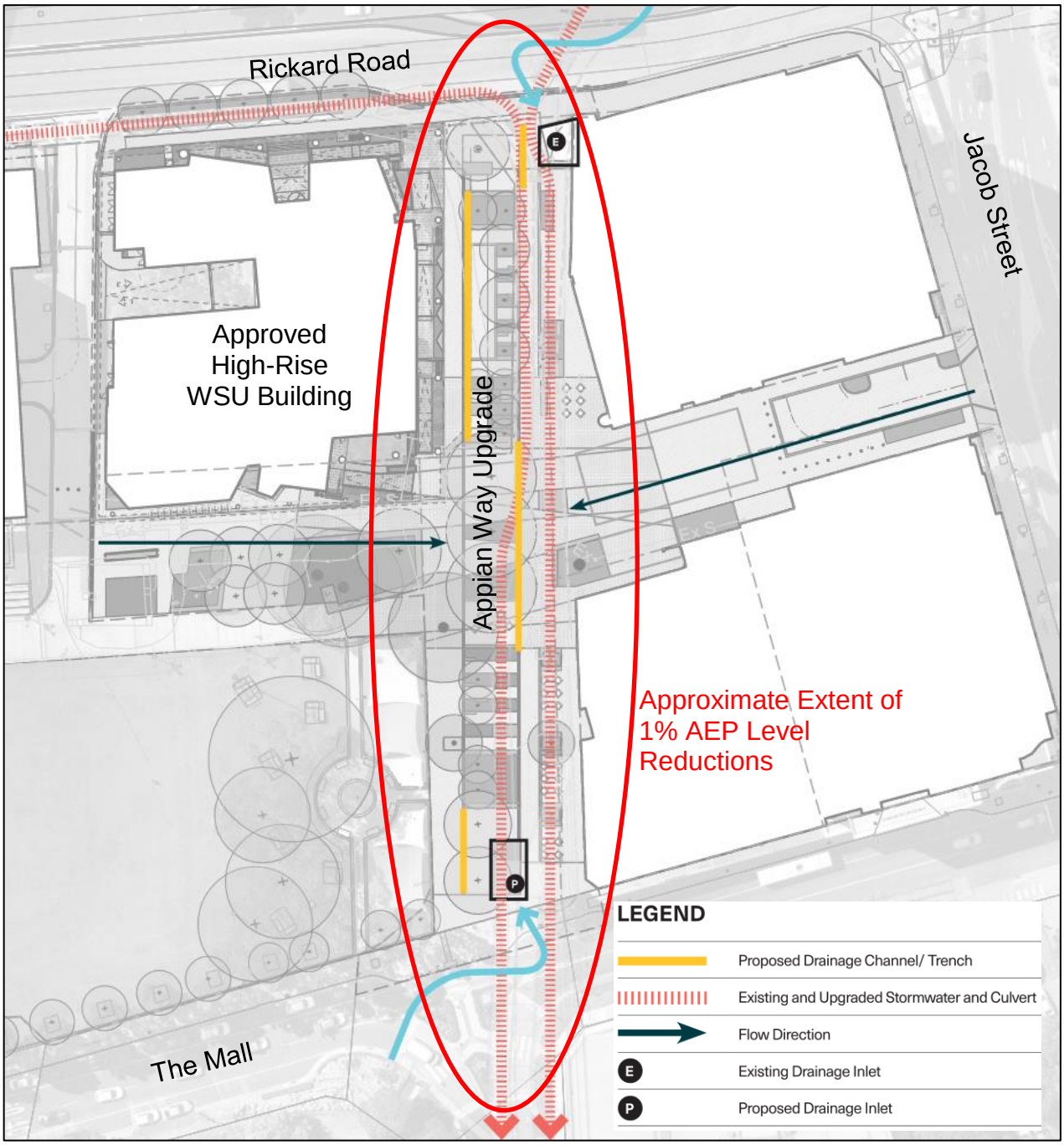

Figure 3-9 Proposed Drainage Upgrades for Appian Way Upgrade (Source: Walker Corporation, November 2020)

3.5.2 Bankstown Central Development

It is understood that a planning proposal has been submitted for the rezoning of the Bankstown Central site that is located north of the Bankstown CBD directly to the east of the Appian Way upgrade. Council has provided the planning proposal documents for context as part of this review.

The proposed development involves intensification through construction of high-rise buildings with residential dwellings above ground flood commercial space, with a child care centre, hotel and student housing proposed as part of the development.

The proposal is still undergoing review at the time of this review, however it provides insight into the type of developments and rezoning that is being proposed within the study area outside of the scope of, but generally in keeping with the City Centre Master Plan.

4 Flood Risk Review

In accordance with the NSW Flood Prone Land Policy package, in particular the s9.1 Local Planning Direction, planning proposals (which is the next stage for the Master Plan) should consider the following issues (requirements listed in further detail in **Section 2.4**):

- Precluding development within high flood risk areas such as floodways or high hazard areas;
- Rezoning and intensification of residential development within the FPA;
- Flood emergency response, in particular evacuation;
- Special flood considerations and additional flood risk for vulnerable developments; and
- Conformance with any relevant floodplain risk management mitigation measures.

A high-level review of the Master Plan is outlined in the following sections, in order to determine if the Master Plan is in accordance with the Policy. These requirements for Bankstown City Centre should be reviewed in further detail during the planning proposal development stage. As discussed in **Section 2.4**, these planning proposal requirements mirror those presented in the standard LEP clauses (both mandatory and the optional clause which has not been adopted by Council) so this review essentially encompasses all aspects of the 2021 NSW Flood Prone Land package.

4.1 Development in High Flood Risk Areas

4.1.1 Floodway and Impacts

The NSW Flood Prone Land 2021 package notes planning proposals should not propose development in floodway areas, interpreted to mean the floodway areas in a 1% AEP flood.

The second requirement is that development not result in significant flood impacts on other properties. The second point cannot be assessed at a Master Plan level as it would rely on site-specific detailed flood modelling to assess flood impacts of development proposals.

The 1% AEP floodway is mapped against the land use zoning of the Master Plan in Figure 3 in **Appendix A**. It shows that the floodway is generally confined to Salt Pan Creek channel and public road reserve in most locations. However, it does cover some portions of developable land, particularly high density residential zoned land in the southern portion of the study area adjacent to Salt Pan Creek.

In accordance with these provisions, these floodway areas should not be considered developable. However due to the narrow floodway extents, it is probable that in most instances the floodway does not cover an entire development site. Partially floodway affected properties still have development potential as follows:

- Non-floodway portions of sites should be eligible for development; and
- For floodway portions of sites, consideration could be given to re-aligning the floodway to consolidate the developable portion of a site or consideration could be given to elevating structures one level above the floodway to maintain the flood conveyance up to the PMF and to allow for maintenance.

4.1.2 High Hazard

The NSW Flood Prone Land 2021 package notes planning proposals should not propose development for the purposes of residential accommodation in high hazard areas, which is interpreted as high hazards in a 1% AEP flood. This would likely relate to flood risk to buildings and occupants.

The 1% AEP high hazard is mapped against the land use zoning of the Master Plan in Figure 5 of **Appendix A**. It shows that the high hazard is generally confined to Salt Pan Creek channel and public road reserves in most locations. However, it does cover some portions of areas zoned for residential land use, particularly high density residential in the southern portion of the study area adjacent to Salt Pan Creek.

In accordance with these provisions, these high hazard areas should not be developed for residential uses. However similar to the floodway issue discussed above, as the high hazard extents are mostly quite narrow it is assumed that most sites will be only partially affected by high hazard floodwaters.

Consideration could be given to re-aligning the high hazard flowpaths to consolidate the developable portion of a site or consideration could be given to elevating structures one level above the high hazard flowpath to maintain the flood conveyance up to the PMF and to allow for maintenance.

4.1.3 Outcome

The NSW Flood Prone Land 2021 package notes planning proposals should not propose any development within floodway areas, or residential developments for high hazard areas (which is interpreted as under 1% AEP flooding). The maps in **Appendix A** show that the Master Plan zoning does propose developable land uses within areas affected by both of these high risk areas. However due to the isolated and narrow extents of these flood areas and through potential site-specific design opportunities, there may be development potential for most affected sites. Therefore, the proposed zoning of the Master Plan may need to be qualified in some areas to align with these provisions of the NSW Flood Prone Land 2021 package.

4.2 Intensification of Development on the Floodplain

4.2.1 Land Use Zoning Changes

The NSW Flood Prone Land 2021 package notes a planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones. These land use changes represent an intensification in zoning which could potentially increase flood risk.

In the absence of the mapping on the extents of the Flood Planning Area (FPA) (1% AEP flood level plus 0.5 m freeboard) and in the absence of mapping of the 0.5% or 0.2% flood extents, the 1% AEP flood extents were adopted as an approximation of the FPA for this high-level review. The 1% AEP flood extents and the proposed land use zoning of the Master Plan are shown in Figure 1 of **Appendix A**. The land use zoning map shows proposed change in zoning areas as dashed outline areas. As can be seen in Figure 1 the 1% AEP flood extent covers several of these proposed areas of land use change.

A summary of the land use change areas proposed in the Master Plan with location numbering is shown in **Figure 4-1**. The land use changes for the numbered areas, and whether or not they are flood affected and therefore not in accordance with this provision of the Policy is summarised in **Table 4-1**.

Table 4-1 Review of Proposed Land Use Change Areas

Location	Existing Land Use	Proposed Land Use	Flood Affected	In Study Area	Consistent with Policy Provision
1	Infrastructure	Infrastructure (Education)	Yes	Yes	Yes – Eligible Change
2	Infrastructure (Emergency)	Mixed Use	No	Yes	Yes – Ineligible Change but Outside Flood Extents
3	Mixed Use	Commercial Core	Yes	Yes	Yes – Eligible Change
4	Mixed Use	Mixed Use	Yes	Yes	Yes – Eligible Change
5	Medium Density Residential	High Density Residential	Yes	Yes	Yes – Eligible Change
6	Medium Density Residential	High Density Residential	Yes	Yes	Yes – Eligible Change
7	Medium Density Residential	High Density Residential	Yes	Yes	Yes – Eligible Change
8	Low Density Residential	High Density Residential	Yes	Yes	Yes – Eligible Change
9	Public Recreation	Light Industrial	Yes	No – but part of the proposed planning proposal	No – However a potentially allowable inconsistency

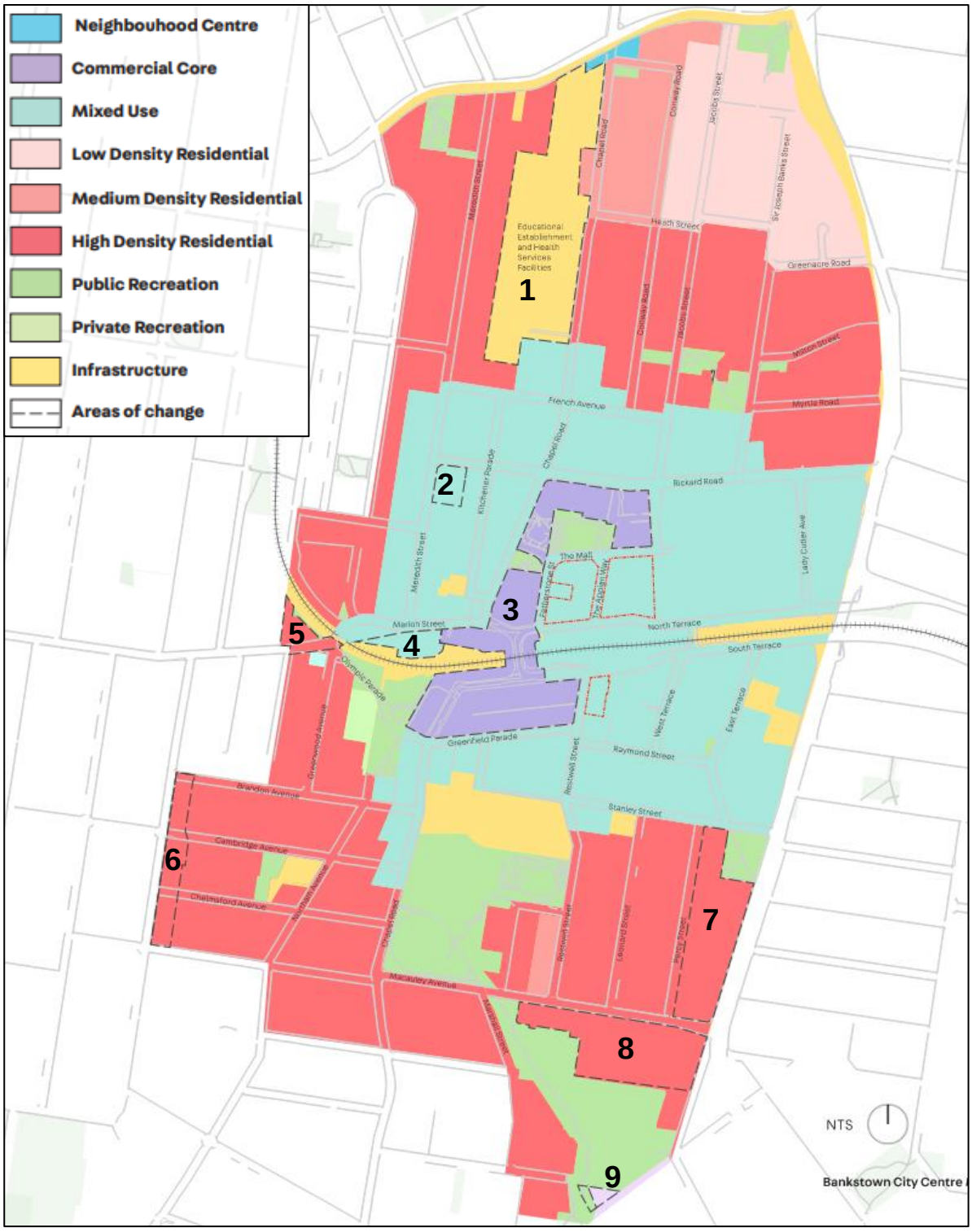

Figure 4-1 Numbered Locations of Land Use Changes from the 2021 Master Plan

Most land use changes are not in the categories listed in the NSW Flood Prone Land 2021 package, therefore are eligible changes even if they are flood affected. Two sites fall within the list of ineligible land use changes. The first is not flood affected (Location 2), and the second is flood affected (Location 9) therefore is inconsistent with the criteria. However, as noted within **Section 2.4**, the direction does allow for inconsistencies if the planning proposal meets one of four possible criteria as assessed by the Secretary of DPE (or their nominee). The fourth criteria for acceptable inconsistencies is:

> *"…the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority"*

In the specific instance of this inconsistency at Location 9 (address 53 De Witt Street, Bankstown), it could be reasonably considered of minor significance. The main reason for this is that though the current zoning is RE1 Public Recreation for the site, in fact the current use is already an industrial use. Evidence of this is shown in the aerial imagery of the site from 2018 shown in **Figure 4-2**.

Therefore, the proposed rezoning to IN2 Light Industrial would not represent a change in the current use of the lot, and does not represent an intensification of development. As a result, the flood risk of the site would not be expected to increase as a result of the planning proposal, particularly as any potential redevelopment for the site would need to adhere to Council's flood related development controls which should suitably address future flood risk. Consequently, this specific inconsistency is expected to qualify as of "minor significance" as the flood risk of the site will not change from the current site, and therefore is likely to be considered an acceptable inconsistency. The ministerial direction notes that the determination of minor significance needs to be made by the relevant planning authority.

Figure 4-2 Existing Industrial Use for Location 9 (53 De Witt St, Bankstown) (Source: GoogleEarth, Recorded March 2018)

4.2.2 Intensification of Development and Cumulative Development

The NSW Flood Prone Land 2021 package notes a planning proposal must not permit a significant increase in the development and/or dwelling density within the FPA. Similarly, the standard LEP clause notes that Councils should consider the impacts of cumulative development on the floodplain.

This is particularly relevant for the Master Plan as can be seen in **Figure 3-1**, the vast majority of the study area is proposed for intensified development (the grey areas in the figure). The proposed intensification is required to accommodate the additional residents in the City Centre over the next 20 years.

In most instances, the proposed intensification will be in the form of vertical development with maximum height and FSR increases to accommodate the growing population. As discussed in the previous section, for

the proposed change of land use areas, most involve an intensification of land use as well (for example locations 5, 6 and 7 all involve change from medium to high density residential zones).

Using the 1% AEP flood extents shown in Figure 2 of **Appendix A** as an approximation for the FPA, there is a significant portion of this floodplain that is proposed for intensification in the Master Plan.

However, it is considered that this be assessed on its merit as is encouraged in the 2005 FDM. The reason for the merit-based approach is that in this instance it is possible that person at direct risk could be reduced and that the residual flood risk could be also reduced through consideration of the following:

- Much of the intensification in the Master Plan will occur vertically and with most of the sites brownfield, the expected number of persons located and the ground floors could be limited to current occupation or increased if the raised ground floor level reduces the risk to future occupants such that the no. of occupants x flood risk does not increase. Similarly, through FPL requirements and other development controls similar to those currently in Council's DCP the risk of property damage in new development may be also addressed feasibly. Given the flood behaviour of the area is overland flow flooding rather than riverine flooding, it is expected that all storeys above the ground floor would be above the PMF level in most instances. It is fully expected that new multi-storey buildings will be stable during flooding up to the PMF and that all non-ground floor residents in multi-storey residential development would be only exposed to an indirect flood risk.
- Implementation of flood emergency response plans for new multi-storey development can address the flood risk faced directly and indirectly by future residents in contrast to the flood risks faced by existing residents in flood affected neighbourhoods, particularly those to the south near Salt Pan Creek where a significant portion of existing residential sites appear to be single storey houses. It is likely most of these properties have no established site-based flood emergency response plan. Co-ordinated emergency response in such areas can be time-consuming and a challenge as there is no vertical evacuation opportunity that multi-storey buildings can offer for shelter-in-place. Therefore it is conceivable that a high-rise residential development with an effective flood emergency response plan and vertical evacuation opportunities may have a lower residual flood risk than existing single storey housing without any opportunity for vertical evacuation.

4.2.3 Outcome

Regarding land use changes in the floodplain, it appears that the Master Plan is consistent with the provisions with the possible exception of Location 9, 53 De Witt St, Bankstown which appears to be inconsistent with permissible land use zoning changes. Nevertheless this inconsistency is likely allowable as the current use of the site is already industrial meaning no intensification or increase in flood risk is anticipated. This would qualify this inconsistency as of minor significance and therefore allowable. As noted in the direction, this determination needs to be made by the relevant planning authority

Regarding intensification in the FPA, on initial review it appears that the Master Plan may not adhere to the requirements of the Policy. However, when adopting a merit-based approach and considering the potential flood risk implications of potential development compared to existing flood risk at a high level, it is possible that intensification could occur and not increase direct site flood risk. The residual flood risk to life is influenced by many factors, perhaps most importantly flood emergency response planning. Flood risk can be addressed effectively through customising the Flood Planning Level and flood proofing requirements similar to those currently in Council's DCP.

Therefore on a merit-based approach it is possible that the intensification proposed in the 2021 Master Plan could respond to the flooding regime. The number of considerations that factor into flood risk mean that directly equating intensification to increased direct flood risk at a Master Plan scale is a simplification. At the Master Planning stage consideration should be given as to how best to manage the flood risk to future residents. This conclusion is in keeping with the 2005 FDM that notes that one of its objectives is not to preclude all development from the floodplain.

No alterations to the Master Plan are recommended in response to this Policy provision, however it is recommended that this interpretation and conclusion be confirmed by Council in discussions with DPE post Gateway determination.

4.3 Flood Emergency Response

When determining the flood risk to life, the flood hazard in an area does not directly equate to the danger posed to persons on the floodplain. This is due to the capacity for people to respond and react to flooding and to avoid entering floodwaters. This concept is referred to as flood emergency response.

To help minimise the flood risk to future occupants, it is important that developments consider flood emergency response. There are two main forms of evacuation that may be adopted:

- Evacuation: The horizontal evacuation of occupants from the floodplain before the properties and/or evacuation routes becomes flooded;
- Shelter-in-place: The vertical evacuation of occupants in a building to a level higher than the PMF level who then shelter from the flood until it is safe to return to the ground floor and external areas.

Within the NSW Flood Prone Land 2021 package, flood emergency response requirements are included in both the standard LEP clauses (both mandatory and optional) and the planning proposal requirements. It is also discussed in the guideline and other documents in the package. Its significance is that if a suitable flood emergency response is implemented that removes occupants from any flooding, then the residual flood risk of a site can be addressed, even potentially for intensified development on the floodplain.

Effective flood emergency response is developed on a site-by-site basis; therefore, it is difficult to assess its feasibility for a high-level Master Plan review such as this. However general commentary on the Master Plans and the opportunities for flood evacuation or shelter-in-place are discussed as follows.

4.3.1 Flood Behaviour

The PMF event is typically adopted as the design event for flood emergency response as it represents the estimated upper limit of flooding albeit extremely rare flooding. The typical AEP of the PMF in urban areas like the study area is 1 in 1 million AEP to 1 in 10 million AEP.

This discussion of flood emergency response focusses on the PMF. The PMF H1-H6 hazard category mapping overlaid the proposed land use zoning is shown in Figure 8 of **Appendix A**.

Based on NSW SES advice, horizontal evacuation is typically the primary recommended flood emergency response for all new developments on flood prone land. However if horizontal evacuation is not feasible due to flash flooding and the very short warning times then shelter-in-place is a feasible alternative. Particularly if the period of isolation is several hours only.

The Australasian Fire and Emergency Service Authorities Council (AFAC) defines flash flooding as:

> *Flash flooding may be defined as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment. Flash flood environments are characterized by the rapid onset of flooding from when rainfall begins (often within tens of minutes to a few hours) and by rapid rates of rise and by high flow velocity. …..*

The critical duration for the Salt Pan Creek catchment is 2 hours. The study area, which drains to the Georges River, is not exposed to the far longer duration flooding in the Georges River. Consequently the study area is classified as a flash flooding environment. The implications of flash flooding for evacuation are discussed as follows.

4.3.2 Evacuation Timeline

The NSW SES evacuation timeline assesses the suitability of evacuation based on two considerations:

- Available time: For flood evacuation to be effective, a warning system and procedure needs to be prepared that ensures all occupants can be evacuated prior to flooding occurring. For flash flooding environments such as the Salt Pan Creek catchment the amount of time from the onset of rainfall to flooding occurring is typically sub-hourly, which does not provide a sufficient time for horizontal flood evacuation except on the fringes of the floodplain. Also for flash flooding there are not typically stream gauges installed within trunk drainage systems, unlike in large riverine catchments where streamflow gauges can detect flooding in the upper catchment and provide an additional warning time. The only opportunity for advanced warning times would be to implement a system like FloodSmart Parramatta which relies on continuous real-time modelling of forecast rainfall to provide flood warnings. Even then horizontal evacuation within the study area may be vulnerable to any incidents on evacuation routes which trap drivers and passengers on flooded roads.
- Required time: The time needed to evacuate all occupants considering time for acceptance of occupants of the need to evacuate, travel time, and traffic and other delays. In this instance, as shown in Figure 1 of Appendix A, the Salt Pan Creek floodplain, even in the PMF event is relatively narrow. This is advantageous for evacuation as it means that the distance to land higher than the PMF is short and travel time is also likely to

be short, even if pedestrian evacuation is required instead of vehicular evacuation. Review of flood extent mapping suggests most flooded areas can access land above the PMF within several hundred metres of the site along public roads. This is in contrast to large riverine floodplains where land higher than the PMF may be several kilometres away and along heavily used regional evacuation routes which would significantly increase the required time.

For shelter-in-place, the same flash flooding conditions apply as discussed above for horizontal evacuation. However under shelter-in-place the time required to evacuate vertically within a building to a level higher than the PMF could be several minutes only.

4.3.3 Evacuation Routes

As discussed above a review of PMF extents shows that in most instances land higher than the PMF is typically within several hundred metres of most development sites. Furthermore it appears that for most of the floodplain, the evacuation routes would be defined as rising road access meaning that evacuation would be along a route where the flood depth progressively decreases as one travels along the evacuation route. This is viewed as a lower flood risk than flood islands where evacuation routes are cut before flooding of the site occurs. In these instances, horizontal flood evacuation is much more difficult.

One of the requirements for planning proposals within the NSW Flood Prone Land 2021 package is that:

> *… not result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities.*

Evacuation for most sites is a short distance away, with limited sites able to access any one of the evacuation routes. However a consideration is whether it is safer for occupants on levels higher than the PMF to remain safely within a building than to add to the number of persons attempting to evacuate by road. It is possible that the number of vehicles queued on multi-storey basement driveways waiting to exit on to possibly crowded local roads exposes the occupants to greater flood risk than if they remained in place.

Another advantage of multi-storey residential buildings is that a flood emergency response plan is routinely developed for such developments and that the bodies corporate provides a means to implement and maintain the plans.

Under these circumstances, it is expected that the Master Plan would not cause a significant additional strain on emergency services.

4.3.4 Shelter-in-Place

Shelter-in-Place is a feasible emergency response, particularly for multi-storey residential developments with ground floor commercial space such as those commonly proposed within the Master Plan. This type of development can elevate the higher risk residential use above the PMF level and can make allowance for shelter-in-place refuge and vertical evacuation from commercial areas. In this way, intensified development offers more shelter-in-place opportunities as it will likely provide more floor space for refuge above the PMF level compared to an existing single storey residential dwelling.

Aside from the timeline considerations discussed above, there are two other key concerns for shelter-in-place - period of isolation and structural stability of the building.

The period of isolation is the amount of time a site would be flooded, stopping occupants in refuge from leaving the property and accessing emergency services in the event of a medical emergency. As the Salt Pan Creek is a flash flooding catchment (with a 2-hour critical duration), the duration of flooding can often subside as quickly as it occurs, so flooding would not be expected to exceed 3 - 6 hours. Relative to the isolation period for riverine floodplains that can often exceed multiple days, the risks associated with a sub-daily isolation period are far less.

The H1-H6 hazard category curves presented in **Figure 3-8**, include two hazards that relate to potential structural instability; H5 and H6. Any flood hazard areas less than H5 or H6 should be structurally stable under normal construction. The H1-H6 hazard for the PMF event is included in Figure 8 of Appendix A. It shows that even in the PMF event H5 - H6 areas are mostly confined to Salt Pan Creek channel and the public road reserves, though some developable areas do fall within these categories. Any proposed development in these areas that proposes shelter-in-place should consider special structural design for flood forces in the PMF. Otherwise, the flooding conditions for the study area suggest that structural stability should be readily achieved through appropriate structural engineering design and that shelter-in-place is a feasible flood emergency response.

4.3.5 Outcome

This high-level review of flood emergency response considerations suggests that both horizontal flood evacuation and shelter-in-place (vertical evacuation) should be feasible for the majority of the development areas proposed under 2021 Master Plan. The flash flooding regime means that site-specific FERPs should be feasible without a need to increase the burden on emergency services or any regional evacuation routes. Therefore, the Master Plan is compatible with the flood emergency response guidance provided in the NSW Flood Prone Land 2021 package. This is a broadscale review of potential for the study area. The identification of appropriate flood emergency responses needs to be undertaken on a site-by-site basis and should be applied through Council's role as a consent authority.

4.4 Special Flood Consideration and Vulnerable Developments

The NSW Flood Prone Land 2021 package notes planning proposals should contain provisions that apply to areas between the flood planning area and PMF extent to which Special Flood Considerations apply. These SFCs are also outlined within the optional LEP clause that Council has not adopted.

In accordance with the package, planning proposals should not permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate.

The existing vulnerable developments in the study area have been mapped and are compared to the 1% AEP and PMF flood extents in Figure 9 of **Appendix A**. With respect to proposed vulnerable developments, the character map from the Master Plan has been included in Figure 9. It identifies the "05 'Eds and Meds' character area" that will likely contain the majority of future vulnerable developments.

4.4.1 Existing Vulnerable Developments

As shown in Figure 9 of **Appendix A,** there are a number of existing vulnerable developments within the study area that are on the fringe of the floodplain or marginally affected by flooding. However, most existing vulnerable sites appear to be on land higher than the PMF level. The potential redevelopment of any flood affected vulnerable development sites in accordance with the Master Plan offers an opportunity to apply flood-related development controls to reduce the existing flood risk for these sensitive-use sites.

4.4.2 Proposed Vulnerable Developments

Within the Master Plan, the "05 'Eds and Meds' character area" located north of the Bankstown CBD will likely contain the majority of future vulnerable developments. This area will contain the proposed TAFE campus, WSU campus (currently under construction), and Bankstown Hospital as well as associated medical clinics and facilities surrounding the hospital.

Figure 9 of **Appendix A** shows that this area does experience inundation in both the 1% AEP flood and the PMF, including partially on the TAFE / Hospital rezoned site. However, this area is in the upper catchment and is generally only affected by overland flows unlike the Salt Pan Creek floodplain further south. Consequently, the Master Plan has identified a suitable location for most vulnerable developments in the less flood affected portion of the study area. Though the entire "Eds and Meds area" is not flood free, the overland flow flooding in the area means that drainage upgrades and appropriate site design could feasibly reduce flood risk for these sites up to an including in the PMF.

4.4.3 Outcome

The NSW Flood Prone Land 2021 package notes that planning proposals should not propose any vulnerable development where the occupants of the development cannot effectively evacuate. As discussed in the above a high-level review of flood emergency response suggests that evacuation should be feasible for most of the Master Plan study area. This is especially true of the upper portions of the catchment such as the proposed "05 Eds and Meds character area" where the majority of future vulnerable developments are proposed. The Master Plan has therefore proposed a layout for the study area that attempts to minimise flood risk experienced by future vulnerable developments.

Regarding existing flood affected vulnerable developments, the Master Plan offers an opportunity for redevelopment of any flood affected sites to potentially reduce the flood risk. Therefore the proposed zoning of the Master Plan is considered to be in accordance with the intent of the SFC and vulnerable development provisions of the NSW Flood Prone Land 2021.

4.5 Relevant Floodplain Risk Management Provisions

The NSW Flood Prone Land 2021 package notes that a planning proposal must be consistent with the principles of any Floodplain Risk Management Study or Plan adopted by Council. As discussed in **Section 3.2.2**, the Salt Pan Creek FRMS&P (Bewsher, 2013) outlines the following floodplain management options for the study area:

1. Adopt flood mapping based on completed works;
2. As redevelopment occurs, ensure existing overland flowpath capacities are maintained or enhanced;
3. As building entrances along Appian Way are redeveloped, ensure their redesign provides for flood immunity by internal ramping and/or raising of floor levels;
4. Provide additional inlet capacity along the SWC conduits on the northern side of Rickard Road and at the French Ave low point (southern side); and,
5. Investigate opportunities to improve the aesthetics of the existing formal overland flow path south of the railway line. Remove part of existing concrete wall in the centre of the flowpath on the southern side of South Terrace.

The Master Plan proposed layout has the potential to satisfy all of these recommendations, as the proposed intensification of development allows for VPA's for drainage upgrades and other floodplain improvement measures.

A good example of this is the current proposal for the Appian Way upgrade discussed in **Section 3.5**. The WSU building which is currently under construction that is discussed in the Master Plan has a VPA associated with it for the upgrade of Appian Way, which is a floodplain option specifically identified in the third and fourth bullet points above. The Master Plan allows for initiatives such as this to further deliver the floodplain management options identified within the Salt Pan Creek FRMS&P (Bewsher, 2013).

Specific recommendations of the FRMS&P that should be accounted for in future planning proposals and developments (assuming Appian Way upgrade is already addressed) would be items 2, 4 and 5 listed above.

5 Conclusions

Cardno has been engaged by Canterbury-Bankstown Council to conduct a desktop flood planning review of compliance of the 2021 Bankstown City Centre Master Plan with the NSW Flood Prone Land Policy Update. The key objectives and outcomes are summarised as follows.

To assess compliance of the Bankstown City Centre Master Plan with the Ministerial Direction

The Bankstown City Master Plan has been reviewed against the planning proposal requirements of the NSW Flood Prone Land 2021 package as discussed in **Section 4**. A summary of each of the planning proposal requirements is included in **Table 5-1** below.

Table 5-1 Review of Master Plan Compared to Ministerial Direction Planning Proposal Requirements

Direction Provision	Consistent with Direction Provision
A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, the Considering flooding in land use planning guideline 2021, and any adopted flood study and/or floodplain risk management plan adopted by the relevant council	Yes, upon review it appears that the Master Plan adheres to the principles of all of these documents.
A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones	Yes, all but one location is consistent with these land use changes. The one inconsistency, at 53 De Witt St Bankstown is likely to be acceptable as it the current use of the land matches the proposed rezoned industrial use. Therefore the intensification and flood risk of the proposal for this site are expected to be of “minor significance” in accordance with the ministerial direction.
A planning proposal must not contain provisions that apply to the flood planning area which: a) permit development in floodway areas, b) permit development that will result in significant flood impacts to other properties, c) permit development for the purposes of residential accommodation in high hazard areas, d) permit a significant increase in the development and/or dwelling density of that land, e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require consent, g) are likely to result in a significantly increased requirement for	All of these conditions are considered satisfied as follows: a) Some development sites are floodway affected, however the narrow nature of the floodway suggests most sites should be only partially floodway affected, meaning they should still have some development potential, b) It is not possible to assess flood impacts at this early Master Plan stage. There is no evidence that any site could be developed without ensuring no offsite flood impacts, c) The Master Plan zoning proposes developable land uses within high hazard areas. However due to the isolated and narrow extents of these flooded areas and through potential site-specific design measures, it is assessed that there is still development potential d) On initial review it appears that the Master Plan does not adhere to the requirements of the Policy. However when adopting a merit-based approach and considering the flood risk implications of potential development compared to existing flood risk it is possible that intensification could occur and not adversely increase the site flood risk. The residual flood risk to life can be affected by many factors including most importantly flood emergency response planning. Flood risk to property could also be addressed effectively through FPL and flood proofing requirements. Therefore on a merit-based approach it is possible that the intensification proposed in the Master Plan could be responsive to the flooding experienced in the study area, e) A high-level review of flood emergency response suggests that evacuation should be feasible for most of the Master Plan study area. This is especially true of the upper portions of the catchment such as the proposed “05 Eds and Meds character area” where the majority of future vulnerable developments are proposed. The Master Plan has therefore proposed a layout for the study area that attempts to minimise flood risk experienced by future vulnerable developments.

Direction Provision	Consistent with Direction Provision
government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	f) It is not possible to assess this at this early Master Plan stage. g) A high-level review of flood emergency response suggests that evacuation should be feasible for most of the Master Plan study area. This should be possible through site specific emergency response plans that do not increase the burden on emergency services or require significant road upgrades to enable evacuation. h) It is not possible to assess this at this early Master Plan stage, the current DCP has specific requirements that do not permit hazardous material storage below a certain level which should address this concern for future development associated with the Master Plan.
A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which include items a), b), d), e), f) from item 3 above. An additional requirement for this area is if a planning proposal is likely to affect the safe occupation of and efficient evacuation of the lot	The same responses as noted in the relevant items above apply to Special Flood Considerations.
For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council	In accordance with this provision, the 1% AEP plus 500mm freeboard should be used when assessing the planning proposal associated with the Master Plan. This requirement is also in accordance with Part 2.2 of the draft Consolidated Canterbury Bankstown DCP.

To review the approach to flooding that was taken in the Bankstown City Centre Master Plan to determine if the resultant-built form is appropriate

Review of flood emergency response considerations suggests that both horizontal flood evacuation and vertical evacuation (shelter-in-place) should be feasible for the majority of developable areas proposed in the Master Plan. The flash flooding nature of the study area means that site-specific planning should be feasible without a need to increase the burden on emergency services or any regional evacuation routes.

Therefore, the Master Plan is compatible with the flood emergency response guidance provided in the NSW Flood Prone Land 2021 package. This is an overview of the potential of the study area, the assessment of proper emergency response on a site-by-site basis should be applied through Council's role as a consent authority.

Much of the intensification in the Master Plan will occur vertically. A common built form for the Master Plan is high-rise residential developments with ground floor commercial space. This type of development can elevate the higher risk residential use above the PMF level and can make allowance for shelter-in-place refuge and vertical evacuation for commercial occupants. In this way, the proposed built form offers greater opportunities for flood emergency response compared to existing single storey residential dwellings.

A key area for the Master Plan layout is the "05 Eds and Meds character area" located north of the Bankstown CBD in the upper portions of the catchment. This is where the majority of future vulnerable developments are proposed including the TAFE campus, WSU campus, and Bankstown Hospital as well as associated medical clinics and facilities surrounding the hospital. The proposed location of this precinct minimises but does not eliminate flood risks for future vulnerable developments.

To inform Council of any required flood studies, floodplain risk management plan and / or planning interventions required to support a future planning proposal for Bankstown to comply with the NSW Flood Prone Land 2021 Package

The Salt Pan Creek FRMS&P (Bewsher, 2013) outlines the following floodplain management options for the study area:

1. Adopt flood mapping based on completed works;
2. As redevelopment occurs, ensure existing overland flowpath capacities are maintained or enhanced;
3. As building entrances along Appian Way are redeveloped, ensure their redesign provides for flood immunity by internal ramping and/or raising of floor levels (currently being addressed by the Appian Way upgrade DA)
4. Provide additional inlet capacity along the SWC conduits on the northern side of Rickard Road and at the French Ave low point (southern side); and,
5. Investigate opportunities to improve the aesthetics of the existing formal overland flow path south of the railway line. Remove part of existing concrete wall in the centre of the flowpath on the southern side of South Terrace.

These specific recommendations of the FRMS&P should be accounted for in future planning proposals and developments.

Overall, this flood planning review concludes that generally the 2021 Master Plan is considered to be in accordance with the provisions of the NSW Flood Prone Land 2021.

It is noted that this is a high-level review of the 2021 Master Plan. These requirements should be reviewed for Bankstown City Centre in further detail and more formally during the planning proposal development stage.

6 References

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APPENDIX A

FLOOD MAPPING FIGURES

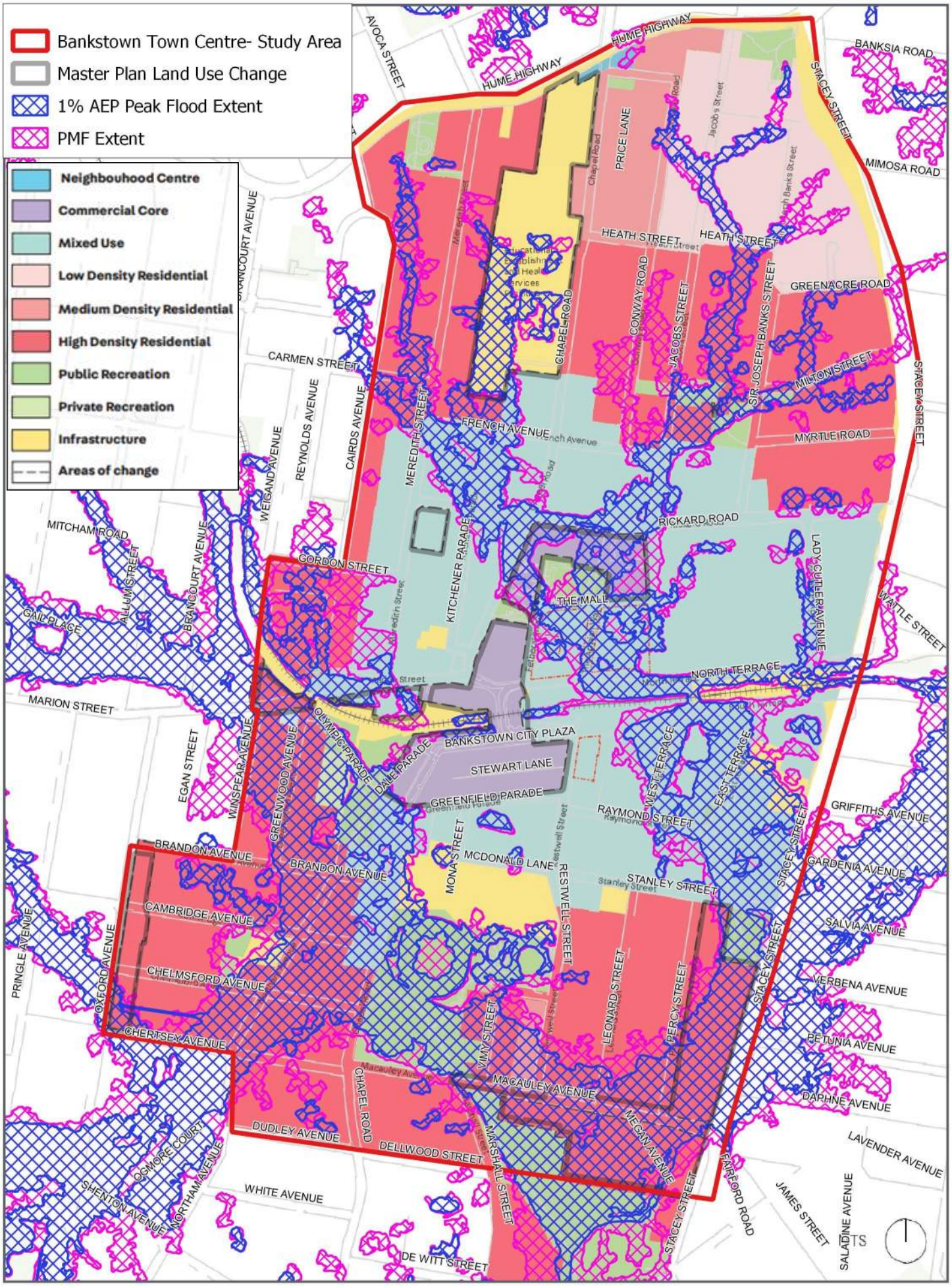

Figure 1: Flood Extents and Proposed Zoning

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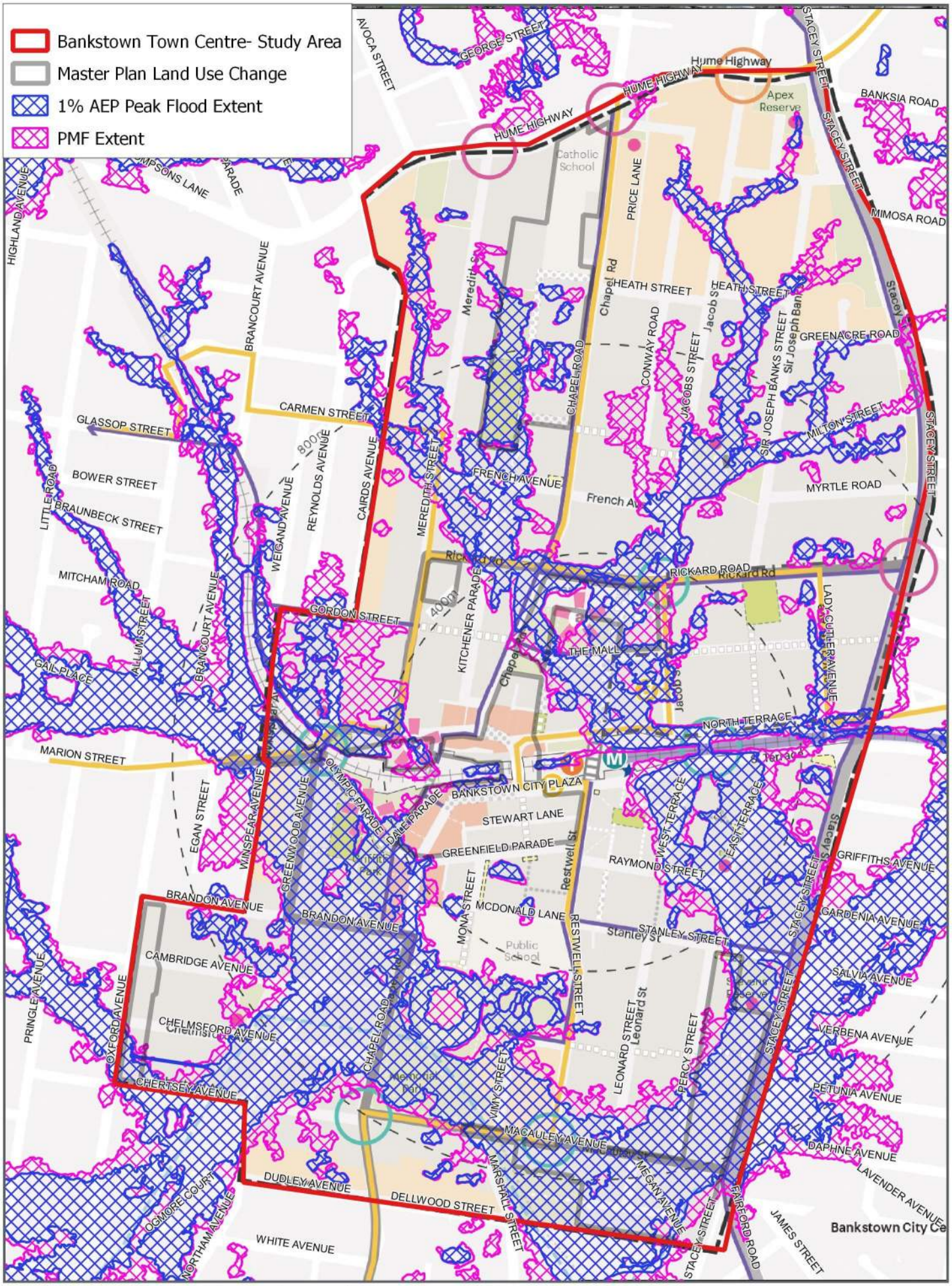

Figure 2: Flood Extents and Proposed Framework

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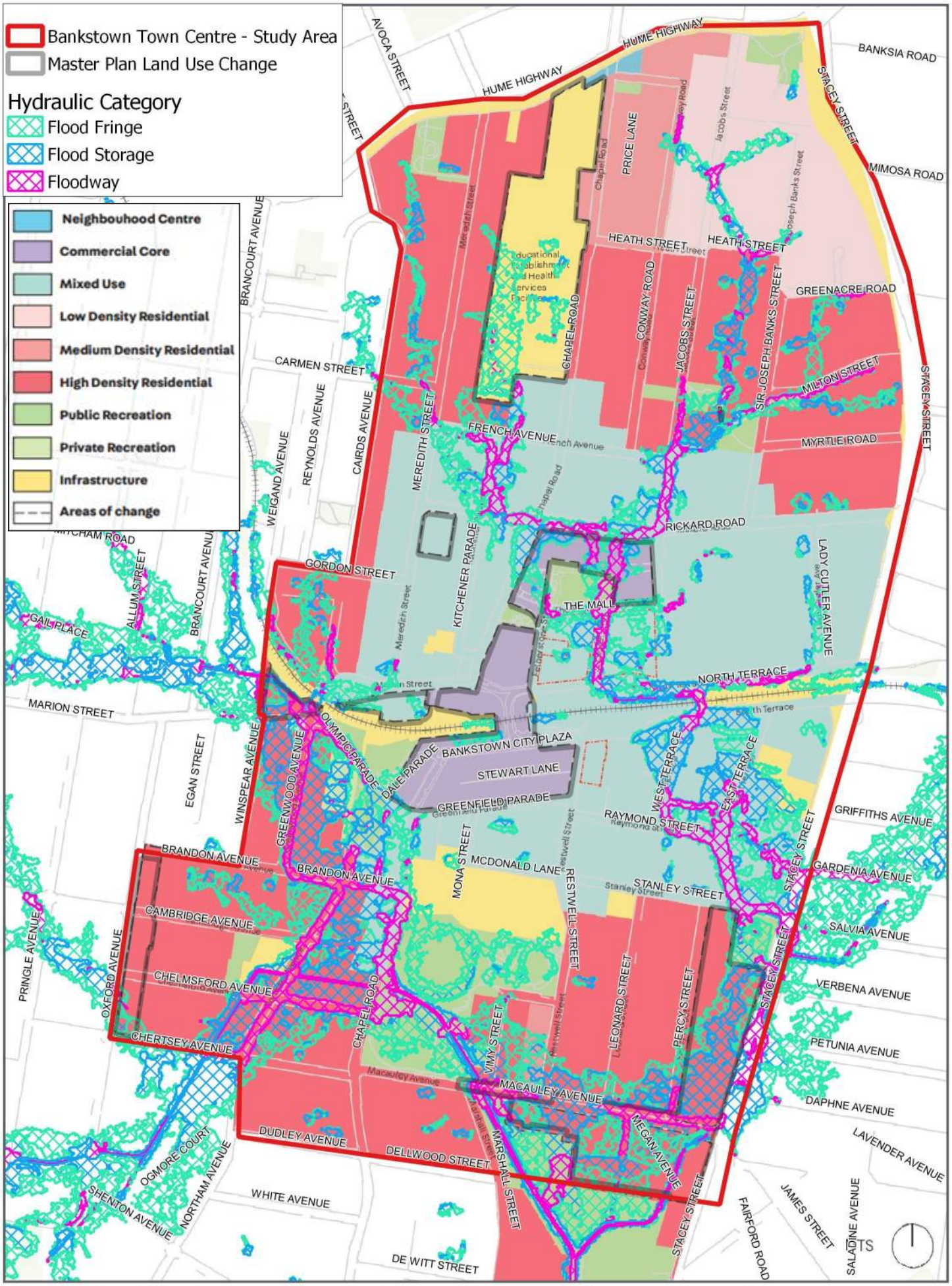

Figure 3: 1% AEP Hydraulic Categories and Proposed Zoning

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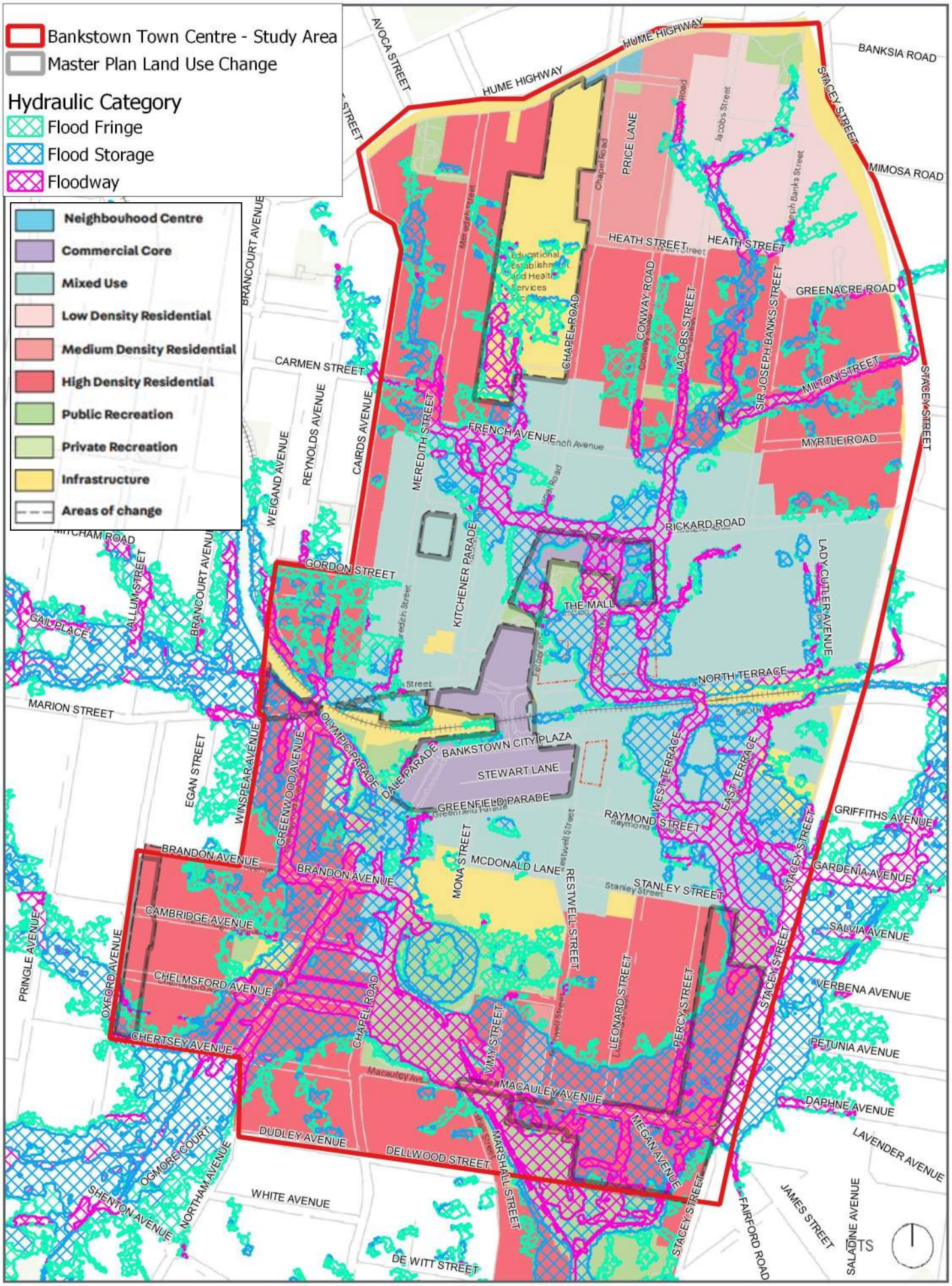

Figure 4: PMF Hydraulic Categories and Proposed Zoning

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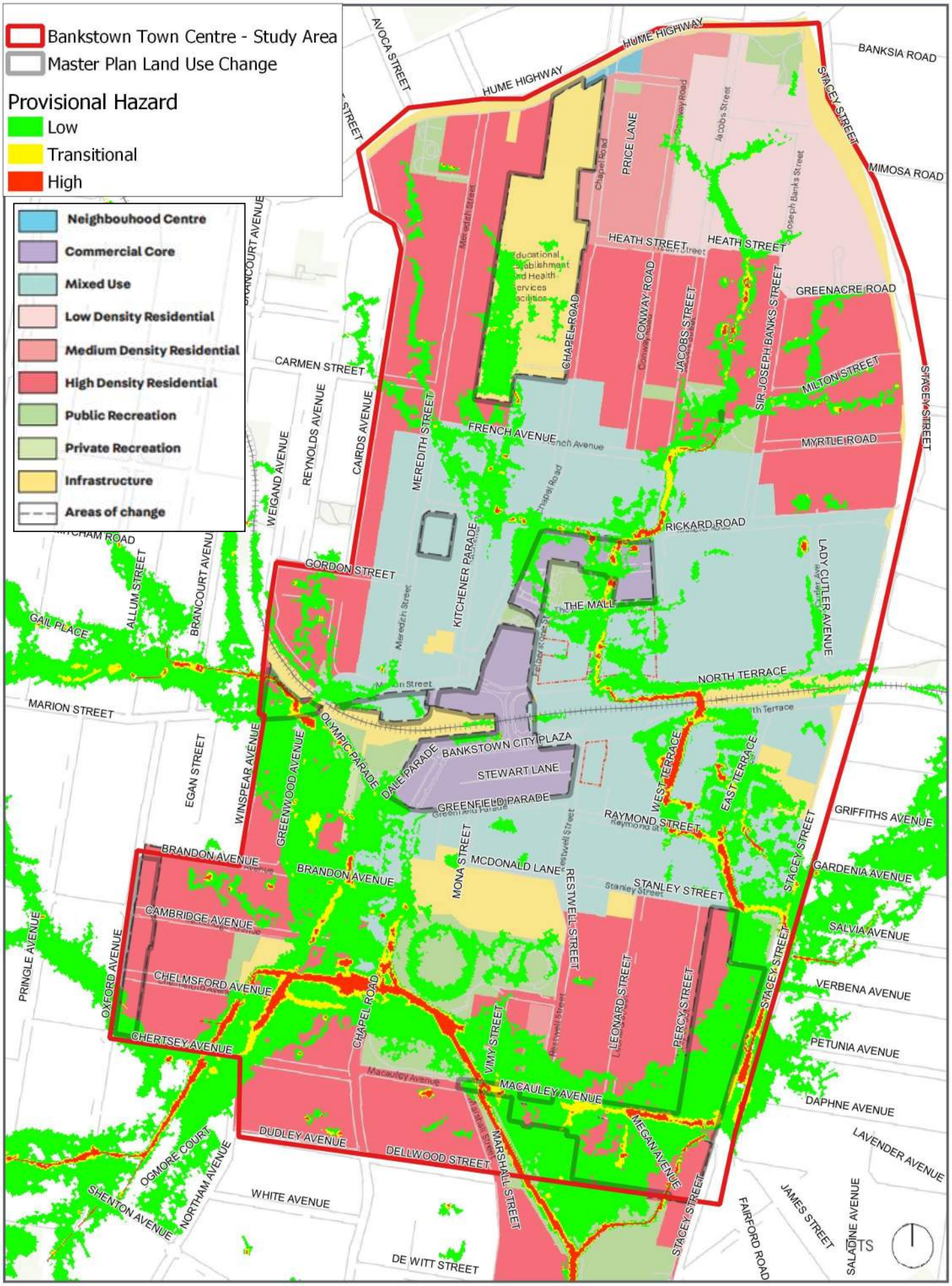

Figure 5. 1% AEP Provisional Hazard and Proposed Zoning

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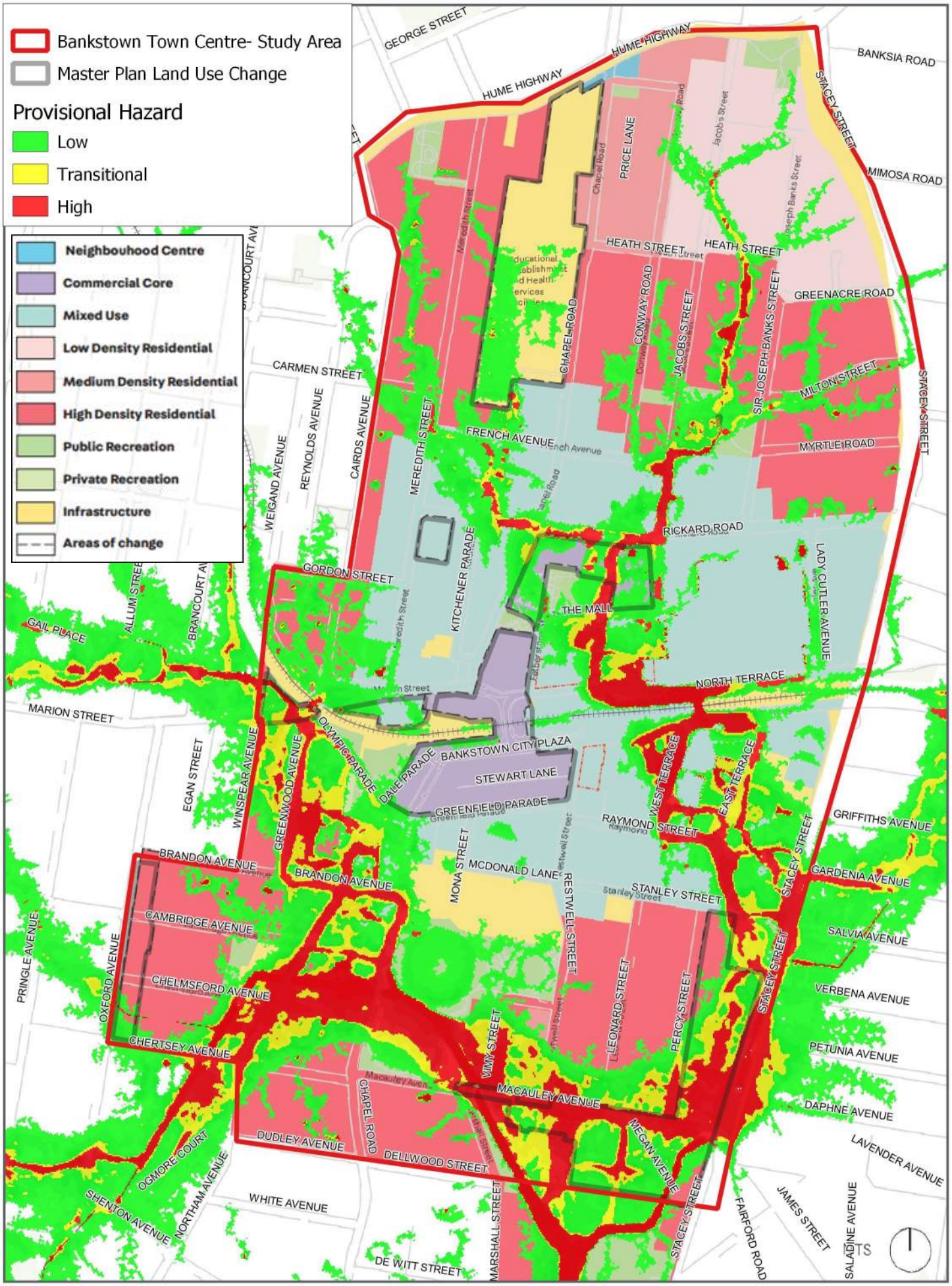

Figure 6: PMF Provisional Hazard and Proposed Zoning

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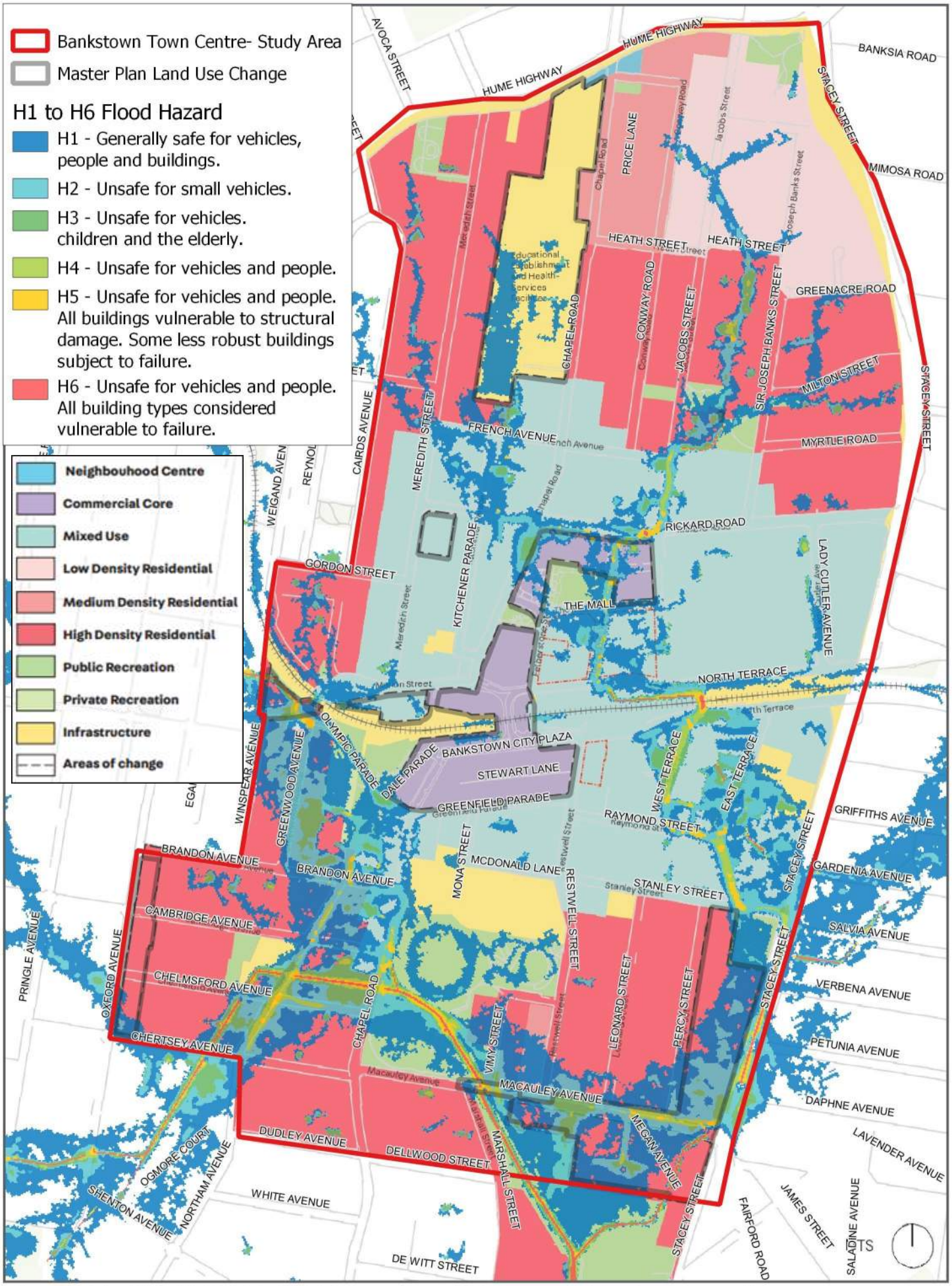

Figure 7: 1% AEP H1-H6 Hazard and Proposed Zoning - Bankstown

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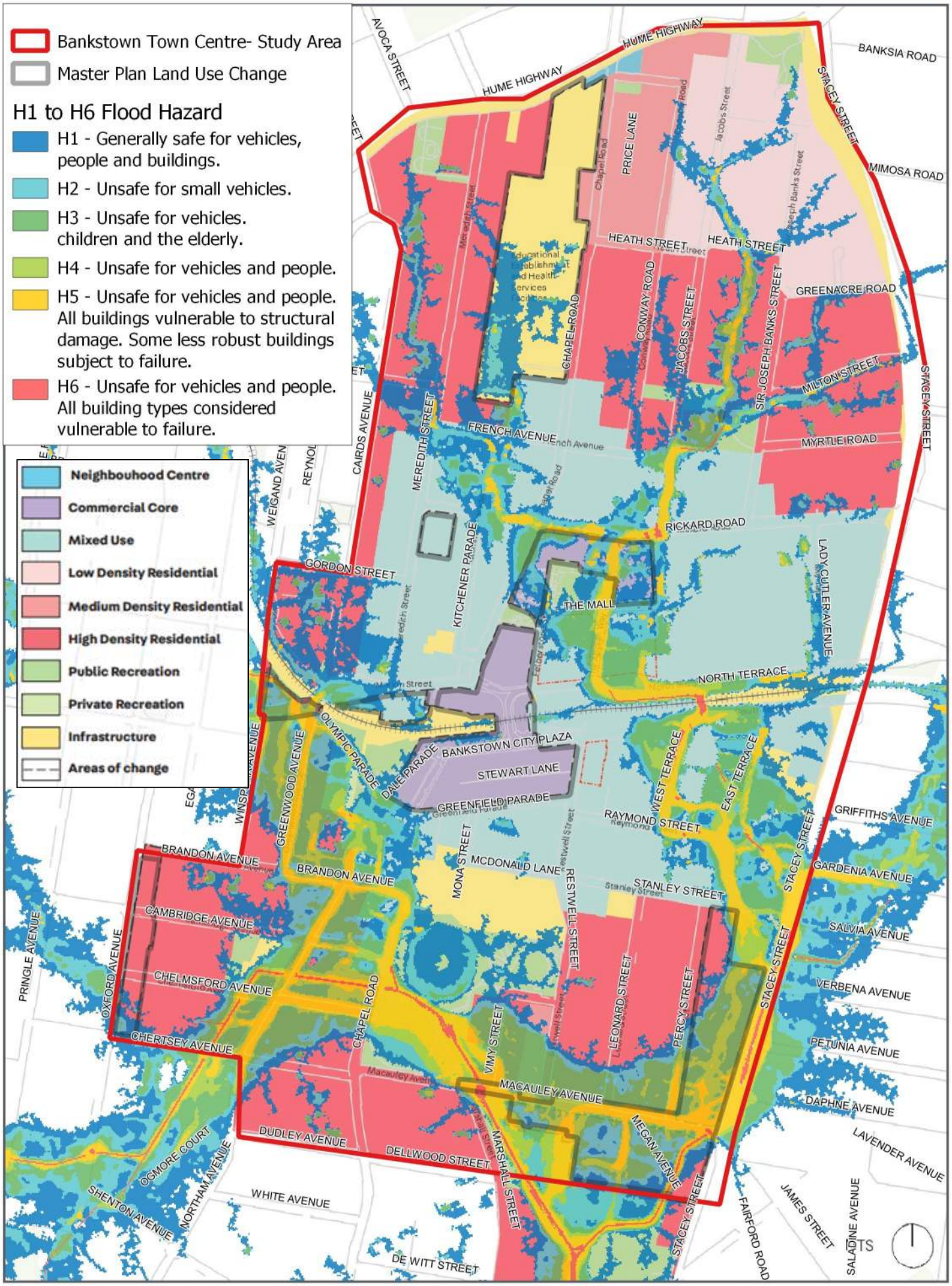

Figure 8: PMF H1-H6 Hazard and Proposed Zoning - Bankstown

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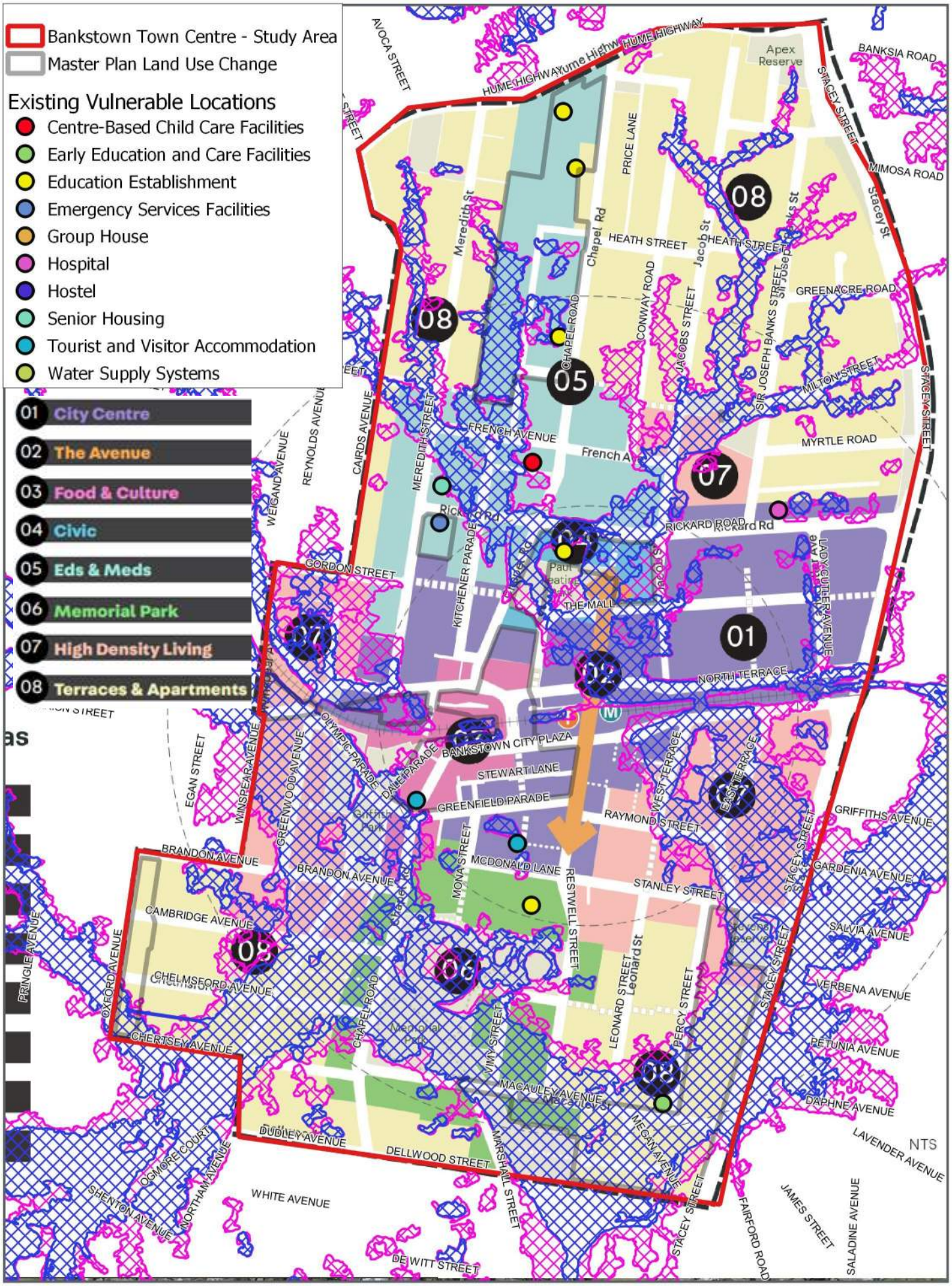

Figure 9: Special Flood Considerations

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