

Item 3 - Attachment D - Flood Report

# CONCORD WEST PRECINCT

## Flood Report

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# CONCORD WEST PRECINCT

## FLOOD REPORT

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## REVISIONS

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## 1 INTRODUCTION

### 1.1 Project Overview

Arcadis Australia Pacific Pty Ltd (Arcadis) has been engaged to provide flood-related engineering advice for the Concord West Precinct in support of a Planning Proposal (rezoning application).

The proposal seeks to rezone land from R2 Low Density Residential and IN1 General Industrial to R4 High Density Residential with a revised Height of Building and Floor Space Ratio (FSR). The Concord West Precinct (herein referred to as the Study Precinct) which is subject to rezoning and the subject of this report is shown in Figure 1.1.

The rezoning and subsequent redevelopment of the Study Precinct may impact flood behaviour by:

- Increasing the building footprint area;
- Increasing the percentage imperviousness of the area; and/or
- Raising ground levels and floor levels.

These changes may increase the amount of stormwater runoff generated by the Study Precinct, redistribute flows in the area and reduce the available flood storage. Without mitigation these impacts may increase flood levels and flows within the Study Precinct and surrounding areas increasing flood risk.

The following report provides a review of the existing flood behaviour across the Study Precinct based on the current publicly available information. Potential flood impacts of the rezoning and concept flood mitigation options have been identified. Flood related development controls from the City of Canada Bay have been outlined.

Recommendations for further investigations of flood mitigation options also are provided.

### 1.2 Location

The 8.8-hectare Study Precinct is located within the City of Canada Bay (Council) local government area. The Study Precinct is bound by Concord Avenue to the north, the Strathfield to Epping rail line to the east, Rothwell Avenue to the South and Homebush Bay Drive to the west. The Study Precinct is predominately residential properties and Council roadways.

Council has previously identified 7 industrial sites for potential rezoning in the area in Council's 2014 Draft Concord West Precinct Master Plan. Industrial Sites 2 and 3 are located within the Study Precinct. Industrial Site 1 is located immediately to the north and Sites 4 and 5 are located immediately to the south of the Study Precinct, as shown in Figure 1.1.

The Victoria Avenue Community Precinct which includes the Victoria Avenue Public School is located immediately south of the Study Precinct at 64 Victoria Avenue. A Sydney Water asset is also opposite the Community Precinct at 75A Victoria Ave.



Figure 1-1: Study Precinct



## 2 EXISTING FLOOD BEHAVIOUR

### 2.1 Topography and Existing Drainage Network

The topography of the Study Precinct (based on 2013 LiDAR data) and trunk drainage in the area (sourced from Dial Before You Dig) is illustrated in Figure 2-1.

The Study Precinct generally grades from east to west. Typical grades range from 3% along Victoria Avenue in the upstream to less than 0.5% in the low-lying areas at the downstream.

Homebush Bay Drive forms an embankment along the western boundary of the Study Precinct with elevations several meters higher than the surrounding areas.

Stormwater runoff from the local and upstream catchment area drains underground via the pit and pipe drainage network and overland to several crossings beneath Homebush Bay Drive.

Overland flow is typically confined to roadways however based on a review of the topography, flow through low-lying properties may occur along King Street north of Station Avenue. Ponding at the road sag along Victoria Avenue (immediately east of Homebush Bay Drive in front of the Community Precinct) would be expected.

Immediately south of the Study Precinct a sag is also present along George Street where the road bends (between Victoria Avenue and Rothwell Avenue) and ponding at this location would be expected. This location is particularly relevant as it is currently the only vehicle evacuation route for the Study Precinct.

From Homebush Bay Drive the stormwater outlets discharge to open channels and mangroves which convey flow to Powell's Creek. Powell's Creek drains north to Homebush Bay then west to the Parramatta River and ultimately Sydney Harbour. Downstream of Homebush Bay Drive the area is considered environmentally sensitive land in Council's Local Environmental Plan (2013).

### 2.2 Master Plan Flood Study – Jacobs 2015

#### 2.2.1 Study & Model Overview

The most recent flood study encompassing the Study Precinct is the *Concord West Precinct Master Plan Flood Study* (Jacobs, Draft as of 07/08/2015). Jacobs was engaged by Council to undertake the Flood Study and to prepare a concept design for flood mitigation measures based on Council's 2014 Draft Concord West Precinct Master Plan.

The Jacobs Flood Study utilised existing hydrologic and hydraulic models of the area as well as additional information to build a TUFLOW flood model of the Concord West Precinct. The model includes the entire catchment of the Study Precinct and incorporated the pit and pipe drainage network.

The modelling assumed all buildings were solid obstructions to stormwater flows except for Industrial Site 1. Based on advice from Council Industrial Site 1 was assumed not to pose a major flow obstruction and was not included in the flood modelling.

The Jacobs Flood Study provides flood mapping of the Concord West Precinct for a range of flood events from the 50% AEP (1 in 2 year) to the Probable Maximum Flood (PMF) design events.

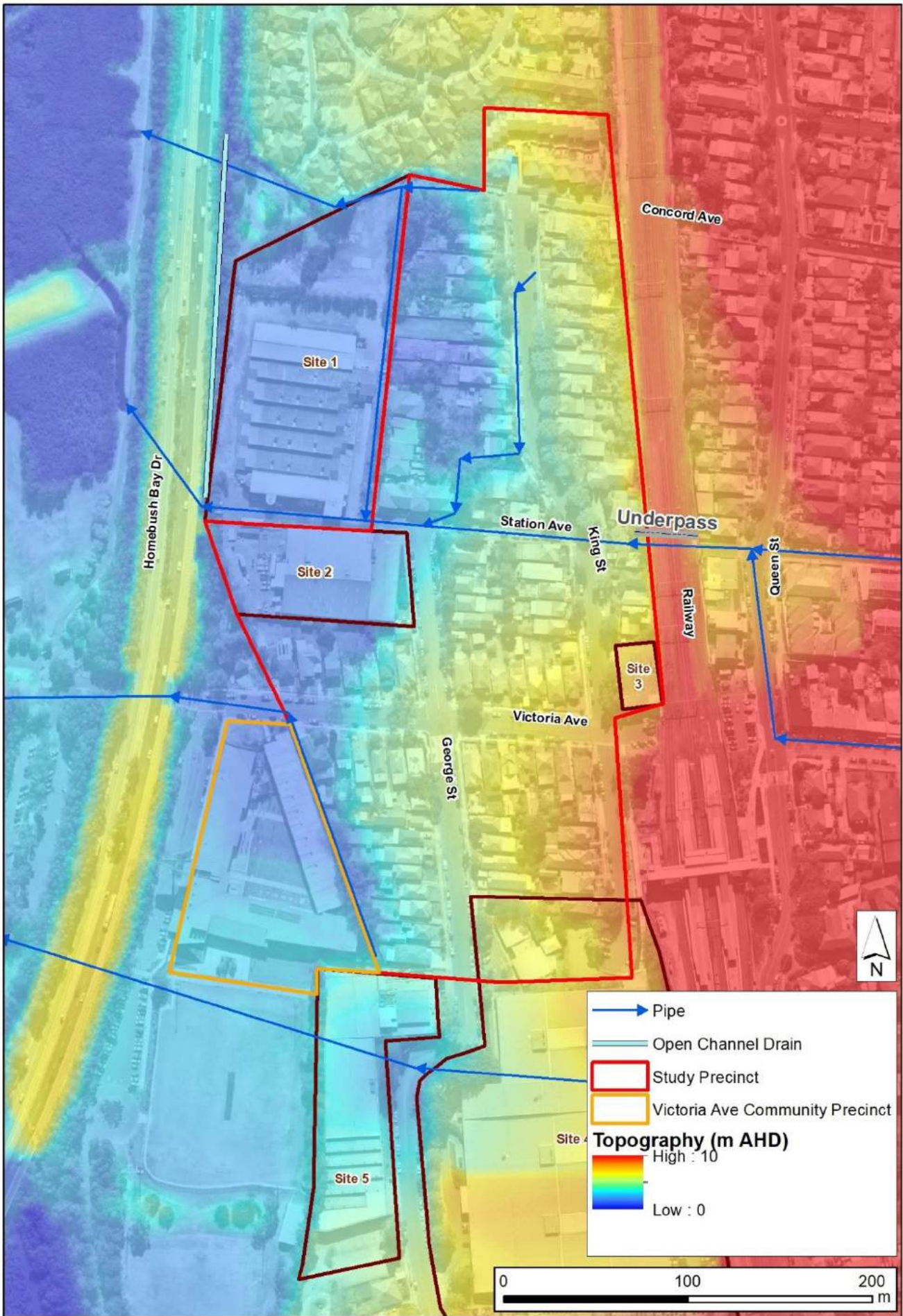


Figure 2-1: Existing Topography and Drainage Network

## 2.2.2 Existing Flood Behaviour

The Study Precinct is mainly subject to overland flow flooding from the local and upstream catchment. The existing flood depth for the 1% AEP (1 in 100 year) based on the Jacobs Flood Study is illustrated in Figure 2-2. A range of flood mapping from the Jacobs Flood Study is provided in Appendix A.

The flood behaviour of the Study Precinct and immediate surrounds is summarised below:

- **Station Avenue/King Street overland flow** – significant stormwater flows drain to the Study Precinct from the area east of the rail line. In addition to an underground trunk drainage line, overland flows drain to the Study Precinct via the Station Avenue pedestrian underpass beneath the rail line. Along with local catchment flows, this overland flow continues to drain west along Station Avenue, whilst also flowing north along King Street and north-west through numerous residential properties. In particular, overland flow pass through the 28A and 30 King Street. This overland flow path through properties is apparent in both the frequent minor events (50% AEP) and the larger rarer storm events. Ultimately the overland flow drains to the low-lying area along Homebush Bay Drive.
- **Low-lying area ponding** – the low-lying area immediately east of Homebush Bay Drive is a trapped depression extending from Victoria Avenue to Concord Avenue. Stormwater runoff ponds in the area given the insufficient capacity of the existing stormwater drainage network and lack of overland flow path to the downstream.

Flood results for the area:

- flood depths of up to 0.5m (typically 0.2m) in the 50% AEP (1 in 2 year) design event.
  - flood depths of up to 0.5m to 1.0m (typically 0.2m-0.5m) in the 1% AEP (1 in 100 year) design event, generally with a low provisional flood hazard.
  - flood depths greater than 2.0m (typically 1.0m to 2.0m) in the PMF design event with flood levels greater than 3.0m AHD, generally with a high provisional flood hazard.
- **George Street sag** – ponding occurs at the sag point along George Street between Victoria Avenue and Rothwell Avenue. An existing industrial building at 174-184 George Street (Industrial Site 5) prevents overland flows draining west to the Community Precinct's oval. Vehicle access to and evacuation from the Study Precinct is blocked by this ponding during frequent storm events.

Flood results for the sag:

- flood depths of over 1.0m in the 50% AEP (1 in 2 year) design event.
- flood depths up to 1.5m in the 1% AEP (1 in 100 year) design event, with a high provisional flood hazard.
- flood depths greater than 2.0m in the PMF design event with flood levels greater than 4.0m AHD, with a high provisional flood hazard.



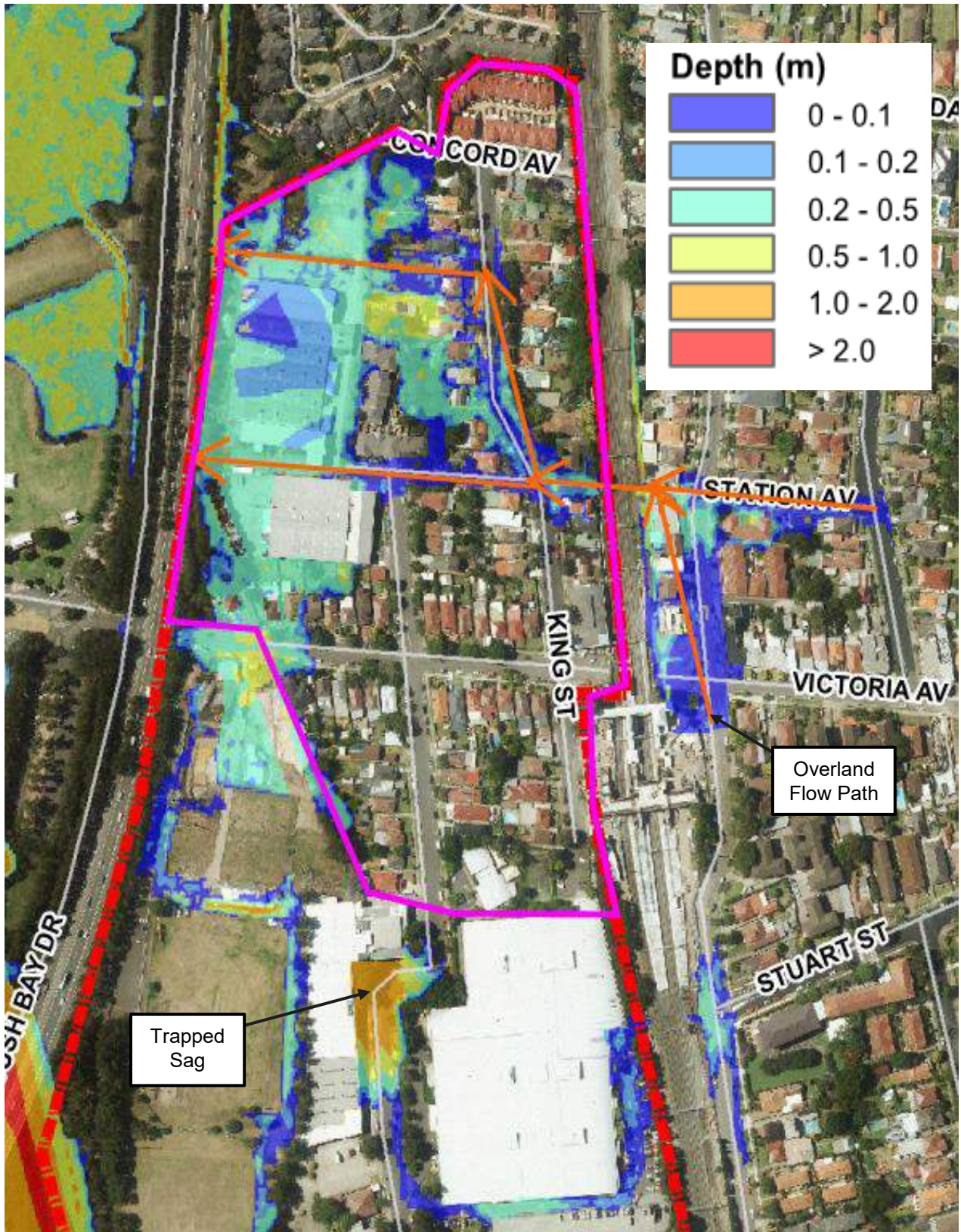


Figure 2-2: Existing Flood Behaviour for the 1% AEP (1 in 100 year) Event\*

\*base flood mapping sourced from Concord West Precinct Master Plan Flood Study (Jacobs, 2015).



### 2.2.3 Assessment of Proposed Industrial Sites

The Jacobs Flood Study assessed the potential flood impacts of developing the 7 Industrial Sites included in the *Concord West Precinct Master Plan* by JBA & GTA Consultants (2014). The assessment assumed the masterplan building footprints of the 7 Industrial Sites were fully blocked in the TUFLOW model, in line with the existing case modelling approach. These building footprints are illustrated in Figure 2-3.

It does not appear that the hydrology of the TUFLOW model was updated to reflect the change in the imperviousness of the catchment due to the proposed development. It may have been assumed that the resulting increase in stormwater runoff would be mitigated by on-site detention at each building/site.

The assessment considered the 5%, 1% AEP and PMF flood events. Flood mapping from the assessment is provided as Appendix B. The results of the assessment are summarised below:

- **Station Avenue/King Street overland flow** – the overland flows in the upstream of the Study Precinct were not impacted by the proposed development given the distance from the industrial sites.
- **Low-lying area ponding** – the low-lying areas were adversely impacted by flooding in both the 5% and 1% AEP design events due to the loss of floodplain storage from the increase in building footprint area in Industrial Sites 1 and 2. For the 1% AEP (1 in 100 year) design event:
  - flood level increases of 0.02-0.05m were typical across Industrial Sites 1 and 2, with the provisional flood hazard generally remaining low.
  - flood level increases of 0.06-0.10m occurred on neighbouring properties along King Street. Increases at the rear of King Street properties resulted from a partial obstruction of the overland flow path by a proposed building in Industrial Site 1.

For the PMF event flood levels reduced by 0.02-0.03m. This was attributed to the additional overland flow path through Industrial Site 5 redistributing a portion of the flows to the south as discussed below.

- **George Street sag** – ponding depths at the sag decreased in the 5%, 1% AEP and PMF events due to the location of the buildings within Industrial Site 5. By removing the single industrial building at 174-184 George Street an overland flow path is created between the proposed building footprints. For the 1% AEP (1 in 100 year) design event:
  - flood levels reduce by up to 0.5m at the sag (whilst the sag remains a high provisional flood hazard for the 5% AEP).
  - flood levels increase at the rear of the Victoria Avenue Community Precinct by up to 0.1m as a portion of the flows from the new overland flow path through Industrial Site 5 drains to this area.
  - flood levels increase at the rear of properties along Rothwell Avenue as a portion of the flows from the new overland flow path through Industrial Site 5 drains to this area.

For the PMF event flood levels reduced at the George Street sag and increased at the rear of the Victoria Avenue Community Precinct by up to 0.07m due to the additional overland flow path created through Industrial Site 5. The overland flows path results in more flow draining to the south to Powell's Creek. This results in an increase in PMF flood levels for properties along Rothwell Avenue.



Figure 2-3: Masterplan Building Footprints (Concord West Precinct Master Plan, 2014)

## 3 FLOOD MITIGATION OPTIONS

### 3.1 Overview

The rezoning and subsequent redevelopment of the Study Precinct may impact flood behaviour by:

- Increasing the building footprint area;
- Increasing the percentage imperviousness of the area; and/or
- Raising ground levels and floor levels.

These changes may increase the amount of stormwater runoff generated by the Study Precinct, redistribute flows in the area and reduce the available flood storage. Without mitigation these impacts may increase flood levels and flows within the Study Precinct and surrounding areas.

Several concept flood mitigation options are provided in the following to address the anticipated flood impacts of rezoning the Study Precinct, aiming to:

- Prevent flood level increases on neighbouring properties; and/or
- Reduce flood risk within the Study Precinct or surrounding areas.

Typically flood mitigation options involve one or a combination of the following:

- Providing additional flood storage
- Increasing the capacity of the drainage network (underground or overland)
- Raising ground levels or floor levels
- Redirecting flows.

It has been assumed that properties and roadways throughout the Study Precinct and surrounds may be modified. Flood mitigation options can be further investigated and assessed using the Jacobs Flood Study TUFLOW model.

### 3.2 Previous Options Assessment

The Jacobs Flood Study provides a preliminary assessment of flood impacts from the Concord West Precinct Master Plan which considered the development of 7 Industrial Sites as discussed in Section 2.2.3.

The focus of this report is the potential flood impacts of the proposed rezoning within the Study Precinct. The scope of the flood mitigation options is therefore beyond the 7 Industrial Sites which were the focus of the Jacobs Flood Study (2015). The following concept flood mitigation options build upon the options assessed in the Jacobs Flood Study. The options presented in the Jacobs Flood Study and their modelled impact on flood levels is provided in Appendix C.

The Jacobs Flood Study found that upgrading or amplifying the existing pipe network upstream of Homebush Bay Drive was ineffective in improving flood conditions for the proposed masterplan development. Surface treatments (regarding) was found to be more efficient given the site constraints of low site elevations, minimal grades and depths of cover. As such the flood mitigation options presented here do not rely heavily on pipe network upgrades.

Increasing the capacity of the underground drainage network and overland flow paths across Homebush Bay Drive have also not been considered given stakeholder approvals that would be expected potentially from the RMS, Sydney Olympic Park Authority, Council and Sydney Water.

### 3.3 Station Avenue/King Street Overland Flow

Overland flow from Station Avenue currently drains through numerous properties along King Street to the low-lying area. This results from an insufficient capacity of the underground drainage network and the roadways which act as overland flow paths.

Options to reduce this flooding include:

- **Option 1A – House Raising**

The existing properties (or future properties) impacted could be raised above the DCP floor level requirement. For existing properties, the floor levels would be initially surveyed to assess the number of properties impacted.

- **Option 1B – Pit and Pipe Upgrade**

Increasing the capacity of the existing drainage network (number of inlets and pipe diameters) along King Street and Station Avenue. As the existing pipeline along King Street runs through several properties, and grade in the area is low, a significant reduction in flood levels would not be expected.

Increasing the capacity of the Station Avenue drainage line to minimise overland flows reaching King Street may prove more beneficial.

- **Option 1C – Overland Flow Path Modification**

The capacity of the overland flow paths along Station Avenue and King Street could be increased by raising the surrounding flood impacted properties. A formalised overland flow path to the west could be provided by acquiring a residential property along the western side of King Street. By demolishing the existing building and regrading the lot (and potentially the surrounding properties and roadway) flow could be directed and conveyed to the low-lying area. The lot may also provide additional flood storage volume.

### 3.4 Low-lying Area Ponding

The low-lying area immediately east of Homebush Bay Drive is a trapped depression extending from Victoria Avenue to Concord Avenue. Stormwater runoff ponds in the area given the insufficient capacity of the existing stormwater drainage network and lack of overland flow path to the downstream.

Options to reduce the potential flood impacts of the proposed rezoning include:

- **Option 2A – Site 1 & 2 Floodplain Storage**

With the aim of maintaining existing flood conditions, any loss in floodplain storage due to future building footprints needs to be offset by balancing the cut and fill volumes across the Study Precinct. The Jacobs Flood Study developed a regarding and filling strategy for the Industrial Sites 1 and 2 as illustrated in Appendix C.

The floodplain storage was defined as the volume below the 1% AEP (1 in 100 year) flood event. Note Council's DCP requires filling of land up to the PMF level be demonstrated not to have adverse flood impacts.

The strategy incorporated a floodway through Industrial Site 1 as mentioned below. Levels between the proposed building footprints and Homebush Bay Drive were reduced by 0.3 - 0.5m to 1.5 - 1.7m AHD (keeping above the 1.5m AHD 1% AEP high tide). Internal roads and parking were kept at a minimum of 2.1m AHD.

The Jacobs Flood Study notes that the effectiveness of the flood storage is diminished if the storage contains water at the start of a storm event. Whilst maintaining flood storage, the minimum ground elevations should therefore remain above the high tide with a sufficient drainage network.

As an extension to the Jacobs Flood Study option, additional properties surrounding Industrial Sites 1 and 2 could be purchased to provide additional conveyance of flows and flood storage as outlined in Option 2C below.

- **Option 2B – Site 1 & 2 Floodway**

As featured in the Jacobs Flood Study options, providing a floodway through Industrial Site 1 would assist in conveying flows through the low-lying area to the downstream open channel along Homebush Bay Drive. A vehicle bridge across the floodway would be required.

The Jacobs Flood Study option incorporated a 10m wide channel as illustrated in Appendix C. Culverts were not considered practical given the flat grade and minimum cover. The Jacobs Flood Study also highlighted the need for the buildings along the eastern side of the Industrial Site 1 to be spaced to allow for a clear passage of flow from the upstream overland flow path. Open drains were also provided along the eastern side of Industrial Site 1 to intercept and convey flows to the floodway.

- **Option 2C – Additional Overland Flow Paths**

As an extension to the Jacobs Flood Study option, additional properties surrounding Industrial Sites 1 and 2 could be purchased to provide additional conveyance of flows and flood storage as outlined below:

- a) King Street lot – as mentioned in Section 3.3, a property could be purchased and converted to an overland flow path to convey flows from King Street to the low-lying area.
- b) King Street partial lots – typically the houses along King Street are positioned close to the road frontage of the lots. The rear portion of the residential lots could be purchased and used for flood mitigation.
- c) Victoria Avenue North – a residential property, Council, the RMS or Sydney Water land along the northern side of Victoria Ave near the sag location could be purchased and converted to an overland flow path to convey flows from Victoria Avenue to the existing open channel.
- d) Victoria Avenue West – regarding works could be undertaken to drain the Victoria Avenue sag overland to the west through the existing entrance to Sydney Olympic Park, through Sydney Olympic Park land to Powell's Creek. Permission would need to be sought from the Sydney Olympic Park Authority and potentially Sydney Water and the RMS. Downstream of Homebush Bay Drive the area is considered environmentally sensitive land in Council's Local Environmental Plan (2013), as such additional constraints may apply.
- e) Existing Open Channel – the existing open channel running parallel to Homebush Bay Drive could potentially be extended further upstream and widened to convey additional flows. Permission would need to be sought from the land over (potentially the RMS).

### 3.5 George Street Sag

Ponding occurs at the sag point along George Street given the insufficient capacity of the drainage network and lack of overland flow path. The existing industrial building at 174-184 George Street (Industrial Site 5) prevents overland flows draining west to the Community Precinct's oval. Vehicle access to and evacuation from the Study Precinct is blocked by this ponding during frequent storm events.

Options to reduce this flooding include:

- **Option 3A – Additional Overland Flow Path**

The Jacobs Flood Study developed a strategy for the Industrial Sites 5 and the downstream area as illustrated in Appendix C. A new overland flow path could be provided between the proposed buildings in Industrial Site 5.

By raising the sag in the road by 1m (to 3.4m AHD) additional culverts could be placed below the roadway to collect and discharge flows to a floodway downstream of Industrial Site 5 along the Victoria Avenue Community Precinct's oval. Stormwater flows could then drain overland to Powell's Creek.

This option would require:

- Relocation of the amenities block and irrigation tank next to the oval.
- Permission from Council and the Department of Education to construct the overland flow path through their property.
- Permission from Sydney Water to drain to Powell's Creek.

It is unclear from the Jacobs Flood Study if this option would still utilise the existing pit and pipe network at the location which has an upstream catchment and drains beneath Homebush Bay Drive.

- **Option 3B – Pit and Pipe Upgrade**

Increasing the capacity of the existing drainage network (number of inlets and pipe diameters) along George Street surrounding the sag location. As the downstream pipe runs beneath the Victoria Avenue Community Precinct's oval and Homebush Bay Drive, permission from the Department of Education, the RMS and Sydney Olympic Park Authority. This option is not expected to be as efficient as Option 3A but may be used in conjunction with Option 3A.



## 4 FLOOD DEVELOPMENT CONTROLS

### 4.1 Overview

Flood development controls for the Study Precinct are outlined in Council's 2017 Development Control Plan (DCP), Section C7 as provided in Appendix D. Flood development controls apply to land within the Flood Planning Area based on the flood risk precinct and the Flood Planning Matrix.

### 4.2 Flood Planning Area

The Flood Planning Area (FPA) for the existing Study Precinct and surrounds have been sourced from the Jacobs Flood Study (2015) as provided in Figure 4-1. The Jacobs FPA has been based on the 1% AEP flood levels, excluding shallow overland flooding with depths up to 0.15m.

The FPA for the Study Precinct and surrounds, with adopted freeboard, includes:

- Station Avenue/King Street overland flow
  - Freeboard 0.3m
- Low-lying area
  - Extends from Victoria Avenue to Concord Avenue
  - Includes Industrial Sites 1 & 2
  - Freeboard 0.5m
- George Street sag
  - Borders Industrial Sites 4 & 5
  - Freeboard 0.3m

### 4.3 Flood Risk Precinct

The flood hazard categories for the existing Study Precinct and surrounds have been sourced from the Jacobs Flood Study (2015) as provided in Figure 4-2. The majority of the existing Study Precinct is considered a low flood hazard for the 1% AEP event. South of the Study Precinct the George Street sag has a high flood hazard. The Jacobs Flood Study assessment of the 2014 masterplan without any flood mitigation had little impact on the existing flood hazard across the Study Precinct and surrounds.

The DCP defines the following flood risk precincts:

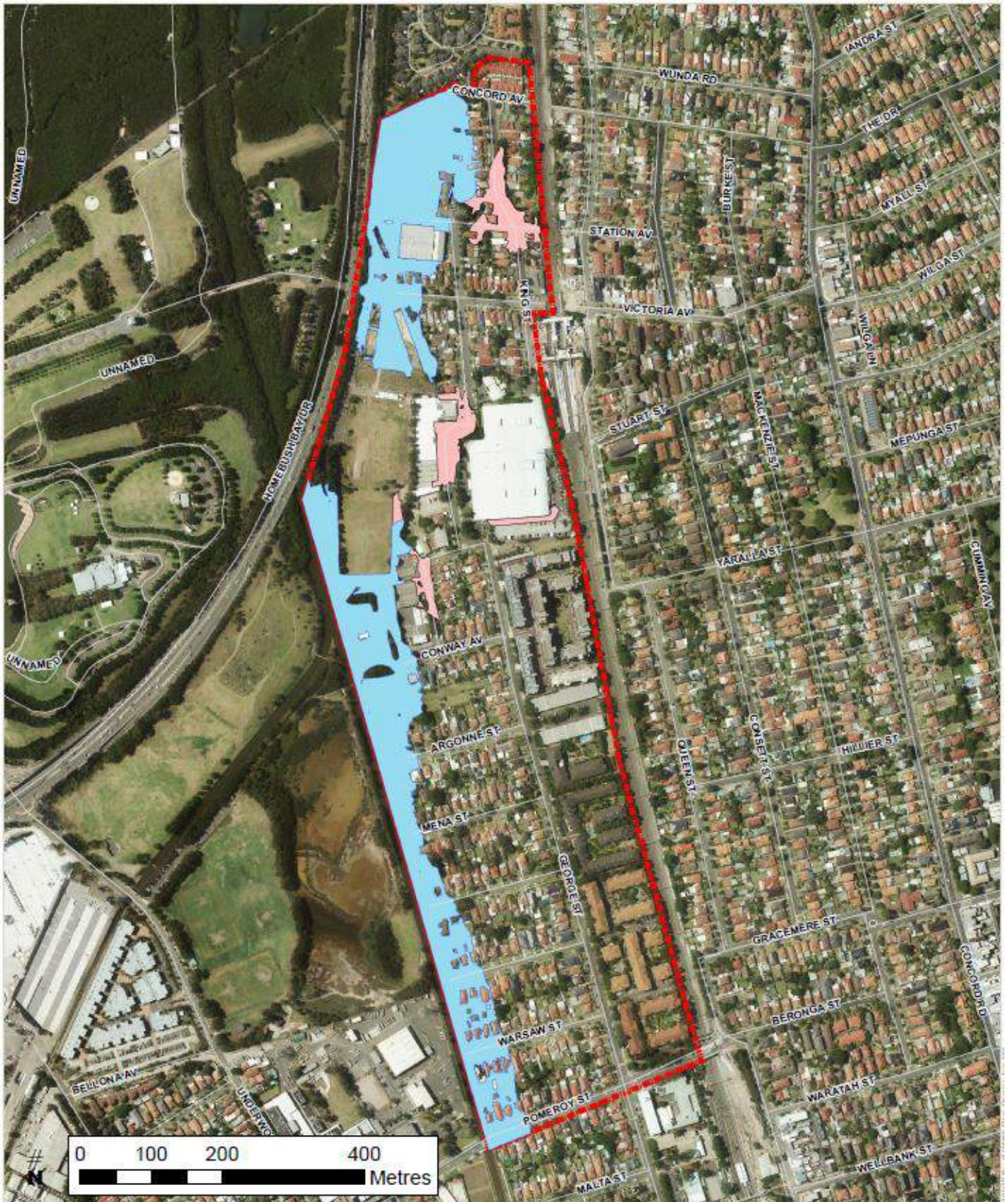
- High Flood Risk Precinct – land under the 1% AEP (1 in 100 year) flood level that is either subject to a high flood hazard or presents significant evacuation difficulties.
- Medium Flood Risk Precinct – land under the 1% AEP (1 in 100 year) flood level that is not subject to high flood hazard and presents less significant evacuation difficulties
- Low Flood Risk Precinct – land above the 1% AEP (1 in 100 year) flood level and includes all area up to and including the PMF.

Based on the 1% AEP flood extent and flood hazard, the existing flood risk precincts across the Study Precinct and immediate surrounds are typically:

- Station Avenue/King Street overland – Medium Flood Risk
- Low-lying area – Medium Flood Risk
- George Street sag – High Flood Risk

Given the extent of inundation and flood depths in the 1% AEP, selected properties within the low-lying area and Station Avenue/King Street area may be considered high flood risk as evacuation may be difficult. Areas outside of the 1% AEP flood extent, but within the PMF extent are classed as low flood risk.





**Legend**

Flood Planning Area (1% AEP Flood Level plus Freeboard)

- 0.3m Freeboard
- 0.5m Freeboard

Figure 4-1: Existing Flood Planning Area (Concord West Precinct Master Plan Flood Study, 2015)



Concord West Precinct



Legend

Flood Hazard Categories

- Low Hazard
- High Hazard

Figure 4-2: Existing 1% AEP Flood Hazard (Concord West Precinct Master Plan Flood Study, 2015)



## 4.4 Flood Development Controls

Flood planning controls apply to land within the Flood Planning Area (FPA) based on the flood risk precinct and the Flood Planning Matrix. The Flood Planning Matrix is provided in Figure 4-3. The planning matrix highlights the need to minimise flood risk to enable development as residential, commercial and industrial land use is not permitted within high flood risk precincts.

Within the Study Precinct FPA, properties are typically within the medium flood risk precinct. Properties with high flood hazard or significant evacuation difficulties should implement flood mitigation measures to reduce the flood risk to enable development to occur.

Flood planning controls that apply to the medium flood risk precinct for residential, commercial and industrial development are provided in Table 4-1. The complete list of flood development controls is provided in Appendix D. Any proposed development must adequately address Council's planning controls in the development approval process.

Flood Level	
C2	Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard.
C5	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed.
C6	Because of the particular catchment characteristics of the Concord West Precinct, additional requirement is for habitable floor levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the CWFS.
Building Component	
C1	All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard.
Structural Soundness	
C1	An Engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard.
Flood Affection	
C1	An Engineer's report is required to demonstrate how and certify that the development will not increase flood affection elsewhere, having regard to: <ul style="list-style-type: none"> <li>a) loss of flood storage;</li> <li>b) changes in flood levels, flows and velocities caused by alterations to flood flows; and</li> <li>c) the cumulate impact of multiple potential developments in the vicinity.</li> </ul>
Car Parking and Driveway Access	
C1	The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.
C3	Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by

## Concord West Precinct

	floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level.
C5	The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level.
C6	Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.
C7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood.
C8*	<p>Enclosed underground car parks shall have all potential water entry points protected from the PMF. The intent of this requirement is to mitigate the creation of life threatening circumstances and very high economic loss such as may occur with the complete inundation of an underground car park. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of inundation is less than 300mm.</p> <p>Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable floor levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the CWFS.</p>

### Evacuation

C3	Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site.
C4	Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan.
C6	Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.

### Management & Design

C2	Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI flood level (except for single dwelling-houses).
C3	Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard.
C4	No storage of materials below the 100 year ARI flood level.

*Table 4-1: City of Canada Bay - DPC Flood Development Controls – Residential, Commercial & Industrial Properties (2017)*

(\*) - applicable to residential development only

Table C-K Flood Planning Matrix

Planning & Development Controls	Flood Risk Precincts									
	Low Flood Risk			Medium Flood Risk				High Flood Risk		
Planning Consideration (the numbers below identify the controls which are applicable, as contained in section C7.5)										
Floor Level	3	3	2, 5	2, 5	2, 5	2, 5	2, 5	2, 5	1, 5	4, 5
Building Component	2	2							1	1
Structural Soundness	2	2							1	1
Flood Affection	2	2	2	2	2	1	1	1	1	1
Car Parking & Driveway Access	1, 3, 5, 6, 8	1, 3, 5, 6, 8	1, 3, 5, 6, 8	1, 3, 5, 6, 8	1, 3, 5, 6, 7, 8	1, 3, 5, 6, 7	1, 3, 5, 6, 7	1, 3, 5, 6, 7	2, 4, 6, 7	1, 5
Evacuation	2, 4	2, 4, 6	3, 4	4	3, 4, 6	5	3, 4, 6	3, 4, 6	1, 4	3, 4, 6
Management & Design	2, 3, 4	2, 3, 4			1				2, 3, 4	2, 3, 4

**Colour Key**  Not Relevant  Unsuitable Land Use \* For redevelopment refer also to 'Concessional Development' provisions

- Notes**
- i Canada Bay Local Environmental Plan 2013 identifies development permissible with consent in various zones. Notwithstanding, constraints to individual sites may preclude the granting of consent for certain forms of development on all or part of a site. The above matrix identifies where flood risks are likely to determine where certain development types will be considered "unsuitable" due to flood related risks.
  - ii Filling of site, where acceptable to Council, may change the FRP used to determine the controls applied in the circumstances of individual applications.
  - iii Any fencing that forms a part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category. Fences may need to be of open design to address this cause.
  - iv Development within the floodplain may be subject to Clause 6.4 Limited Development On Foreshore Area and Foreshore building line provisions in the Canada Bay Local Environmental Plan 2013.

Note that the land above the PMF level is not captured by the above matrix.

Figure 4-3: City of Canada Bay - DCP Flood Planning Matrix (2017)

## 5 SUMMARY

This report has been prepared based on the current publicly available information of the Study Precinct, being:

- *Concord West Precinct Master Plan*, Draft Report dated 27<sup>th</sup> May 2014 by JBA & GTA Consultants.
- *Concord West Precinct Master Plan Flood Study*, Final Draft Report dated 7<sup>th</sup> August 2015 by Jacobs Group Australia Pty Ltd.
- *City of Canada Bay Development Control Plan – C7 Flooding Control*, adopted 21<sup>st</sup> February 2017, last amended 27<sup>th</sup> April 2018.

The existing Study Precinct and surrounds is impacted by flooding during frequent storm events at three main locations, being

- King Street – north of Station Avenue.
- Low-lying area – immediately east of Homebush Bay Drive from Victoria Avenue to Concord Avenue.
- George Street sag – at the road bend between Victoria Avenue and Rothwell Avenue.

Flooding results from the insufficient capacity of the underground and overland drainage network.

The rezoning and subsequent redevelopment of the Study Precinct may impact flood behaviour by:

- Increasing the building footprint area;
- Increasing the percentage imperviousness of the area; and/or
- Raising ground levels and floor levels.

These changes may increase the amount of stormwater runoff generated by the Study Precinct, redistribute flows in the area and reduce the available flood storage. Without mitigation these impacts may increase flood levels and flows within the Study Precinct and surrounding areas.

Several flood mitigation options have been provided for each of the flooding locations mentioned above. The options aim to reduce existing flood risk or mitigate potential flood impacts from rezoning within the Study Precinct by:

- Providing additional flood storage
- Increasing the capacity of the drainage network (underground or overland)
- Raising ground levels and floor levels or
- Redirecting flows.

The flood mitigation options build upon the Jacobs Flood Study (2015) undertaken for the seven industrial sites of the Concord West Precinct master plan (2014). It is anticipated that a combination of these approaches will be adopted.

Flood development controls have been provided based on Council's Development Control Plan for properties located within the Medium Flood Risk Precinct based on the flood hazard and flood planning area identified in the Jacobs Flood Study. Any proposed development must adequately address Council's planning controls in the development approval process.

## 6 RECOMMENDATIONS

Any development within the Study Precinct and surrounds must not adversely impact flood affectation or flood risk to other properties. Any site filling within the floodplain storage (below the PMF) must be balanced but cut. The proposed development must demonstrate no adverse impact on flood behaviour through appropriate modelling.

It is recommended that Council's TUFLOW model from the Jacobs Concord West Precinct Master Plan Flood Study (2015) be used as a base for subsequent investigation and assessment of flood mitigation options. On review the TUFLOW model may need to be updated and or refined to represent existing conditions.

Further investigation of flood mitigation options is to consider:

- Capacity and potential capacity of the stormwater drainage network
- The potential increase in flood levels due to sea level rise and increasing rainfall intensities resulting from climate change
- Groundwater impacts
- Impact on acid sulfate soils and ground contamination
- Public amenity, health and safety factors.

Stakeholder consultation is recommended with Council, Sydney Olympic Park Authority, Sydney Water, the RMS, NSW Office of Environment and Heritage, NSW Department of Education and Sydney Local Health District.

Council's DCP (specifically Appendix 2 – Engineering Specifications) should be referred to for additional stormwater management development controls including stormwater drainage design, on-site detention systems, rainwater re-use systems and water sensitive urban design.

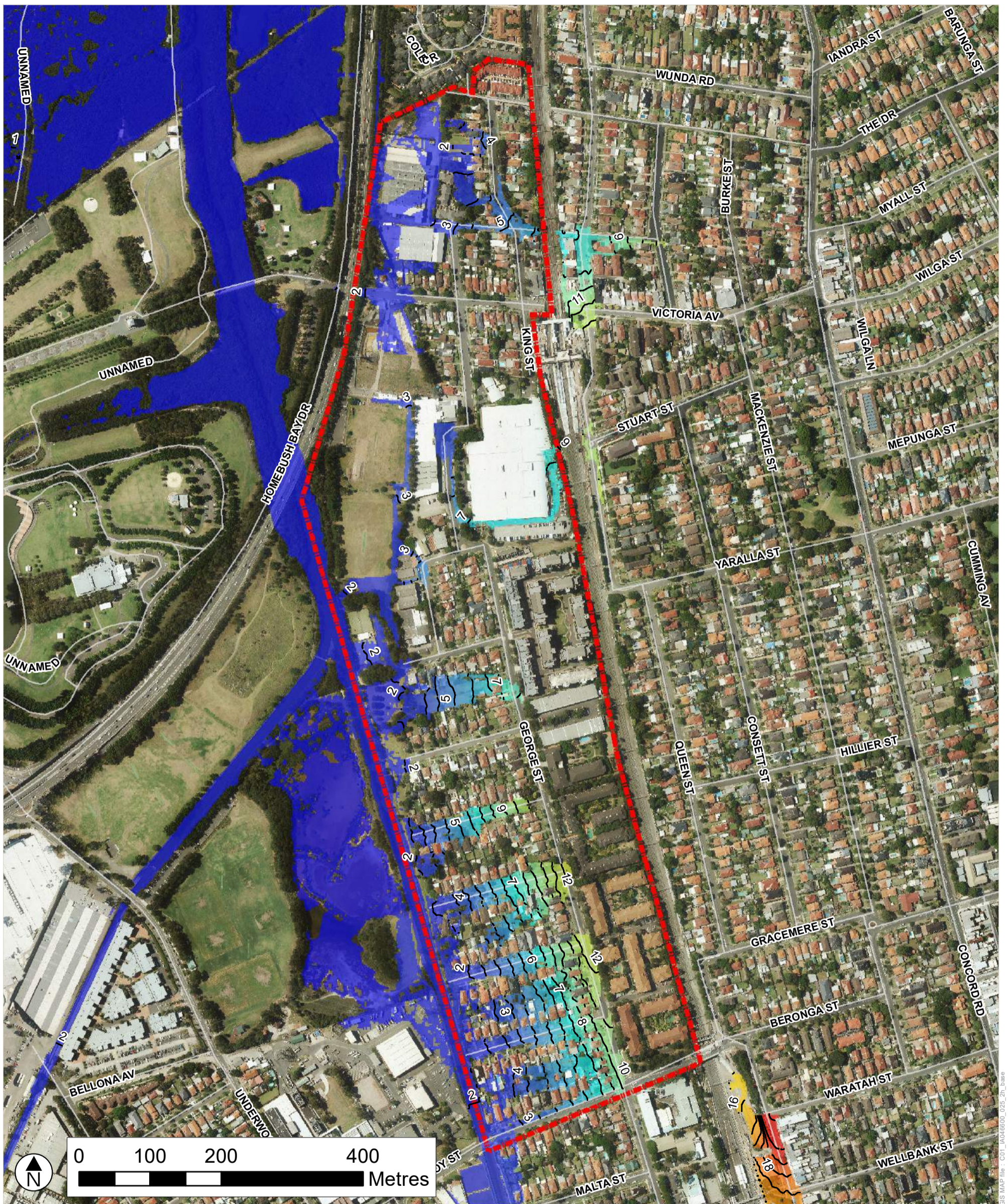
## **APPENDIX A**

### **Flood Mapping – Existing Conditions**

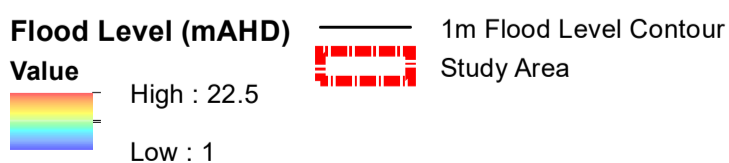
Extracted from the *Draft Concord West Precinct Master Plan Flood Study* (Jacobs, 2015)







**Legend**

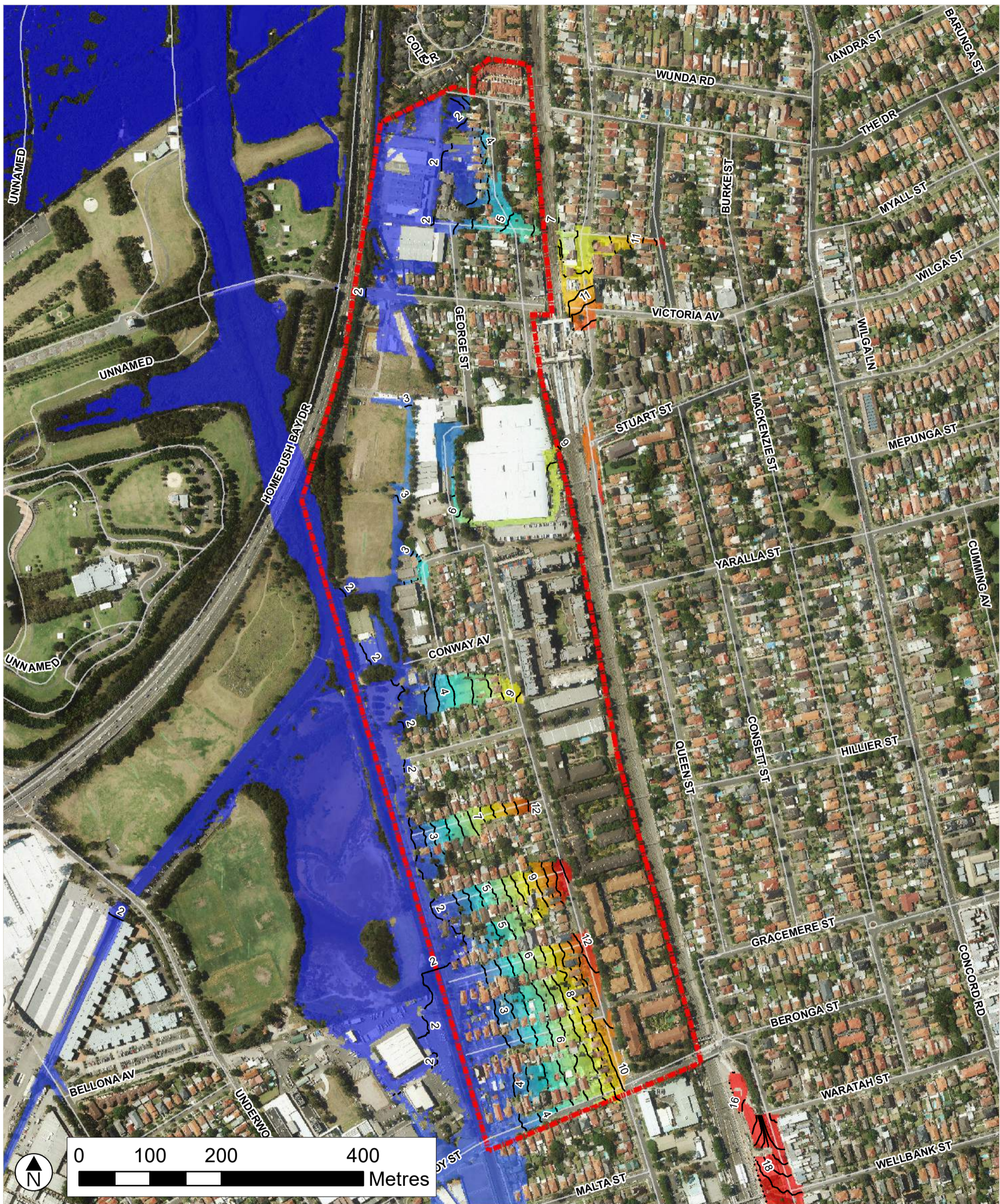


Data Sources: LPI, Council.

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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	50% AEP Flood Level - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-1	1 1
CHECK	DATE		
LC	8/05/2015		





**Legend**

**Flood Level (mAHD)**  
 Value  
 High : 22.5  
 Low : 1

— 1m Flood Level Contour  
 Study Area

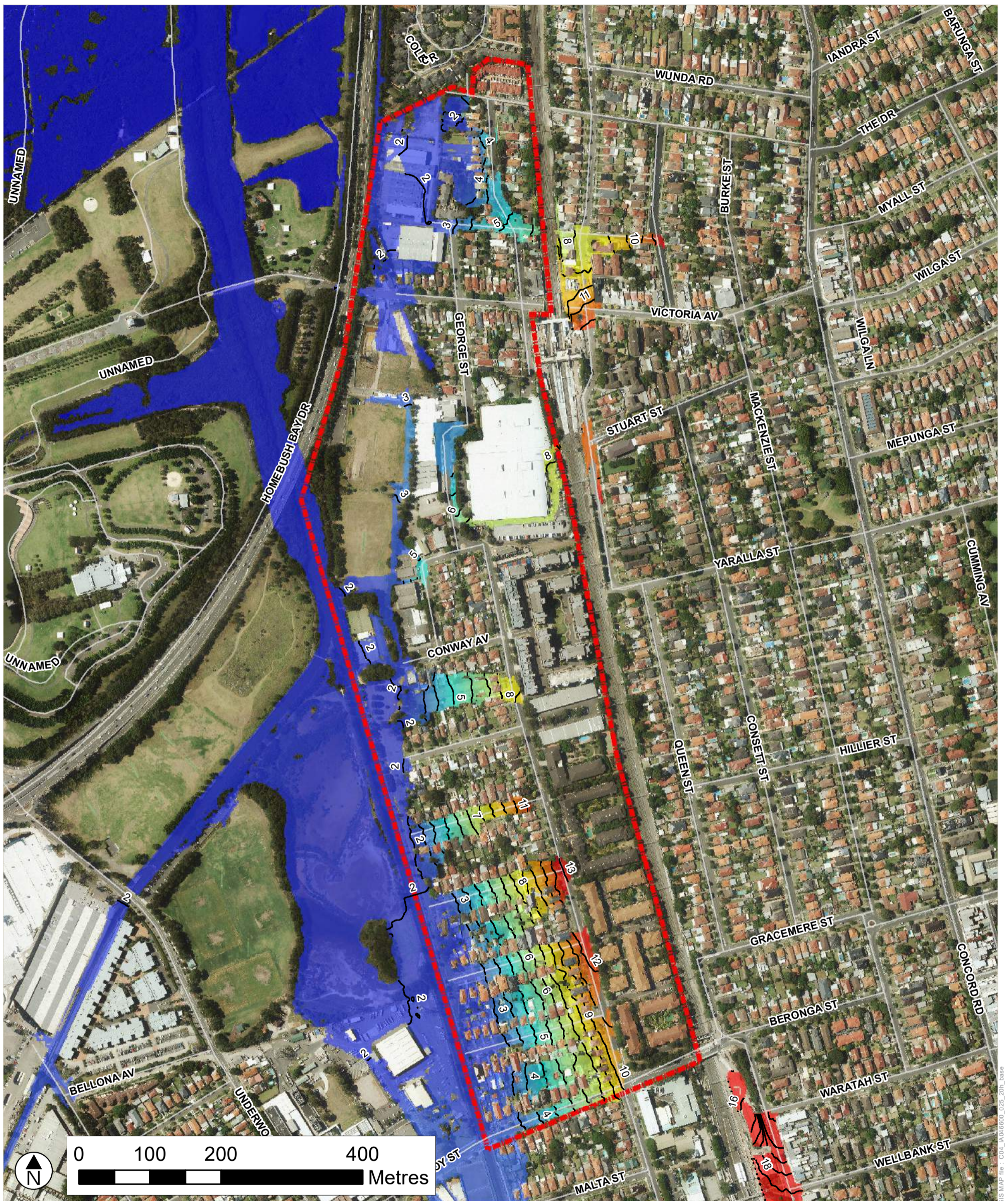


Data Sources: LPI, Council.

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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	10% AEP Flood Level - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-3	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**

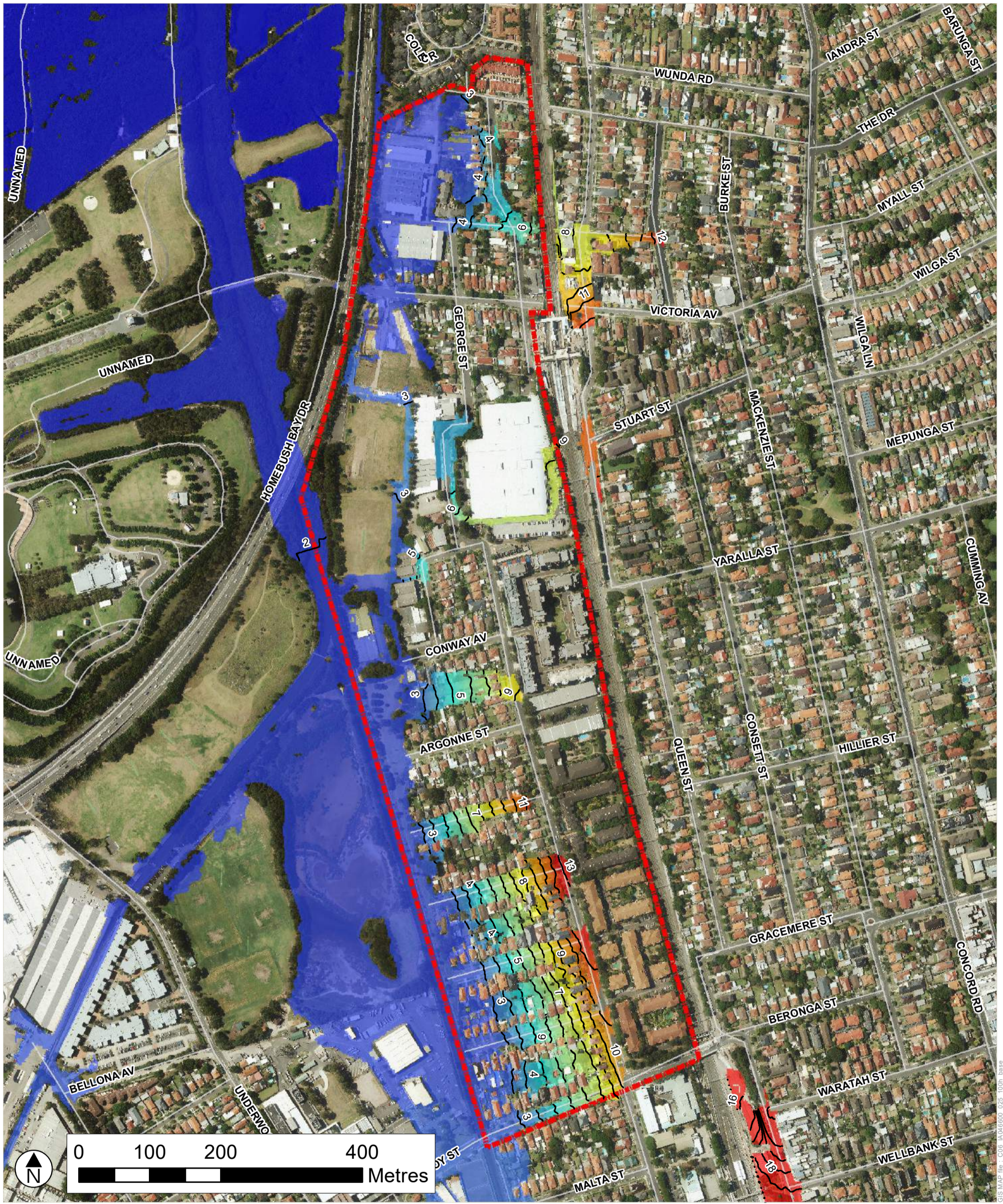
- Flood Level (mAHD)**
- Value**
- High : 22.5
- Low : 1
- 1m Flood Level Contour
- Study Area



Data Sources: LPI, Council.  
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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	5% AEP Flood Level - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-4	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**

**Flood Level (mAHD)**  
 Value  
 High : 22.5  
 Low : 1

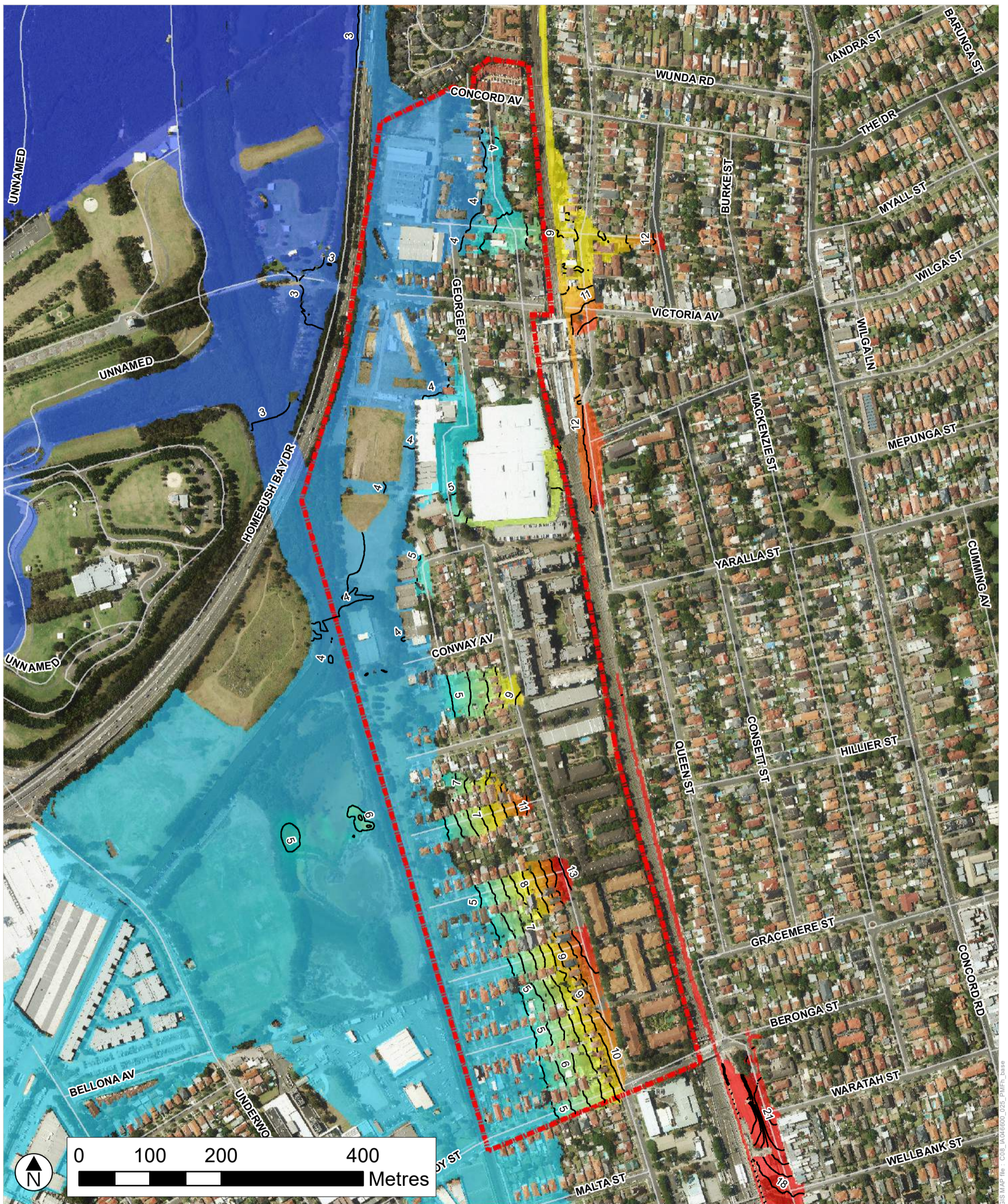
— 1m Flood Level Contour  
 [Red dashed box] Study Area



Data Sources: LPI, Council.  
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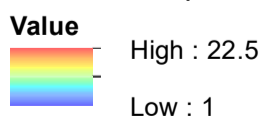
A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	1% AEP Flood Level - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-6	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**

**Flood Level (mAHD)**



Study Area



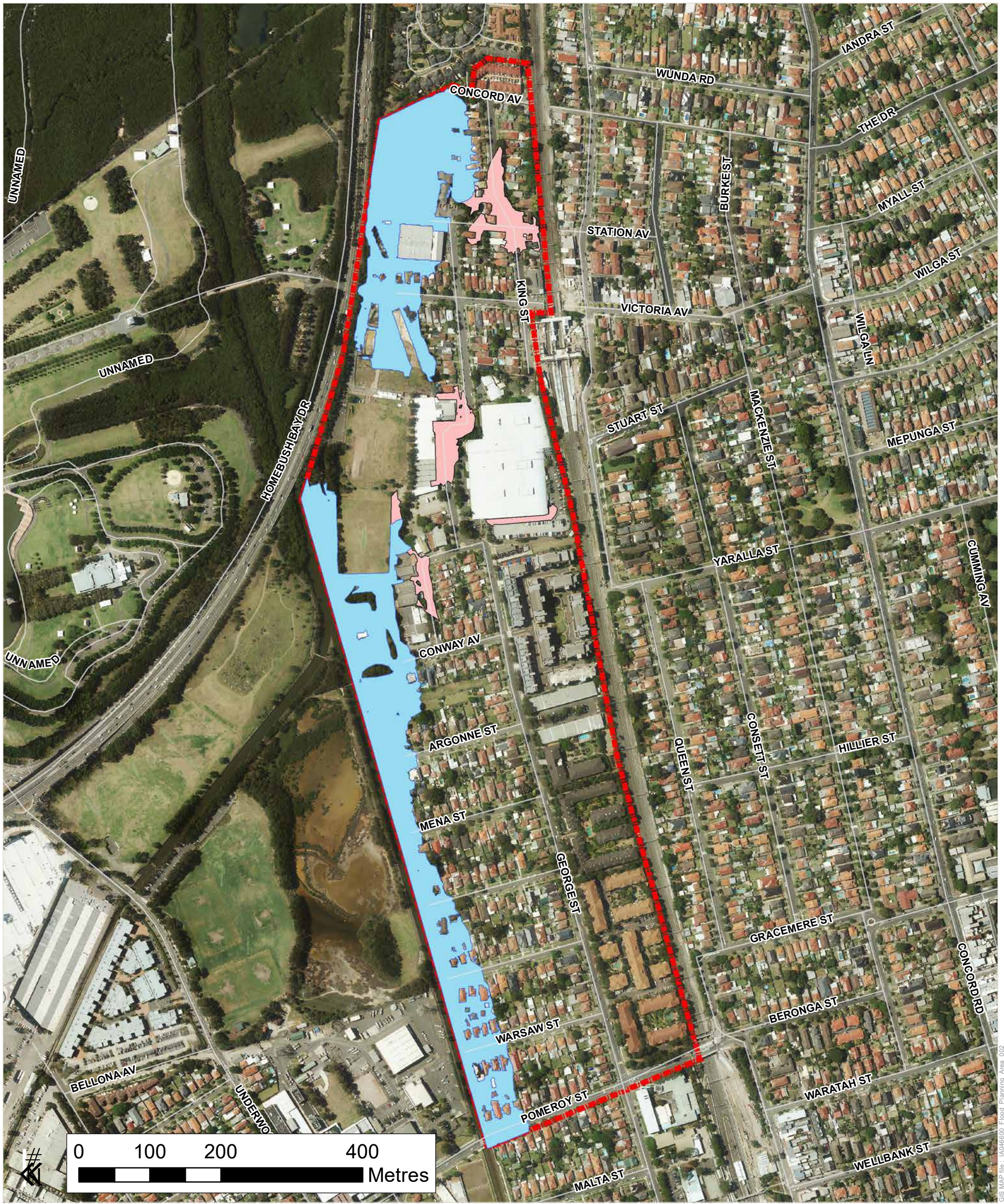
Data Sources: LPI, Council.

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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		PMF Flood Level - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-8	1	1	
CHECK	DATE				
LC	7/05/2015				

GIS MAP file: C08\_IA046600\_025\_PMFh\_base





**Legend**

- Flood Planning Area (1% AEP Flood Level plus Freeboard)**
- 0.3m Freeboard
  - 0.5m Freeboard

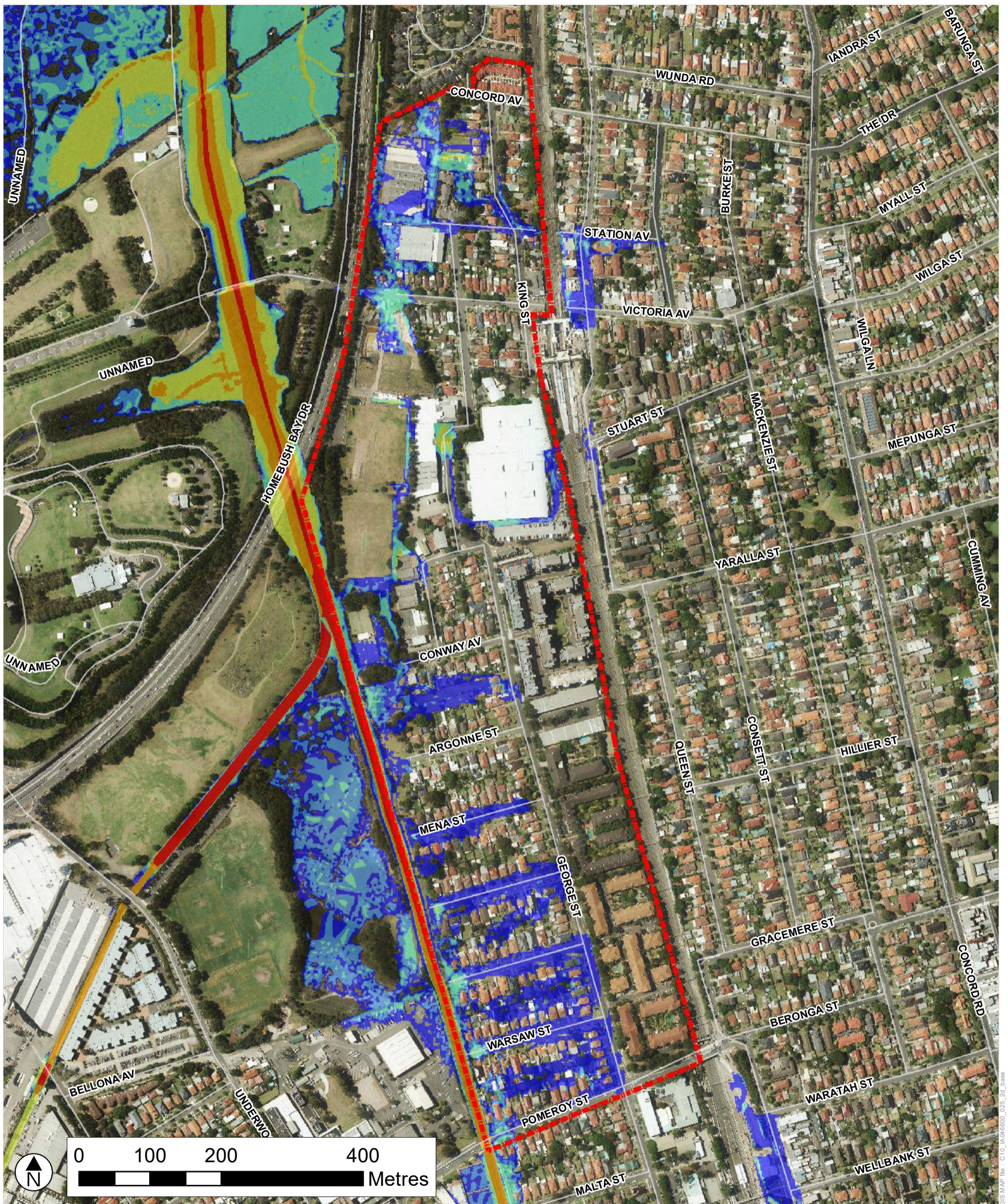


Data Sources: LPI, Council.

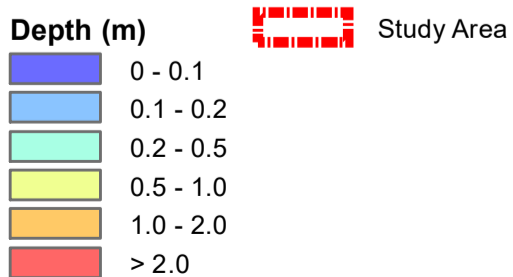
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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		Flood Planning Area			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	FIGURE C-9	1	1	
CHECK	DATE				
AH	7/08/2015				





**Legend**

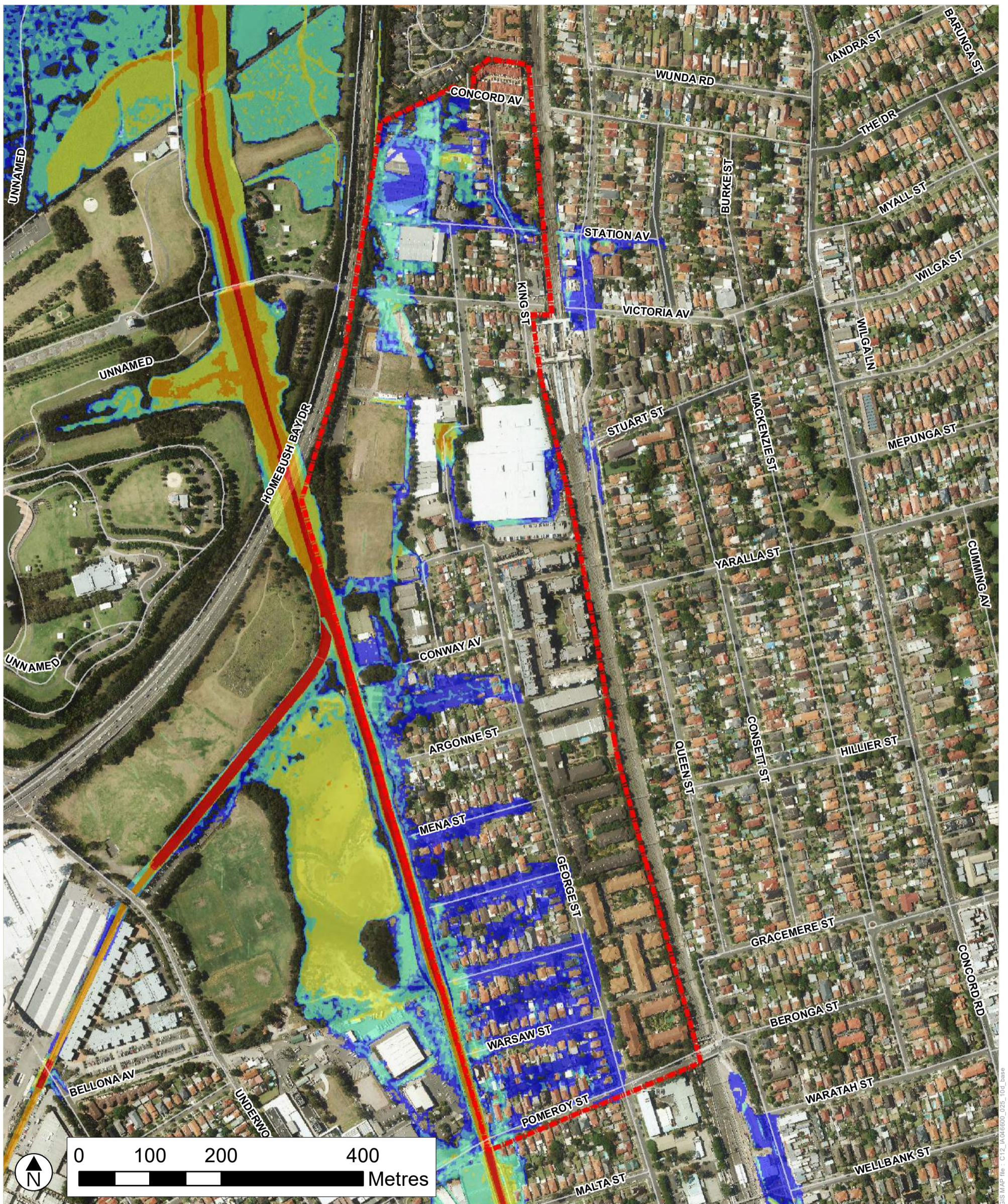


Data Sources: LPI, Council.

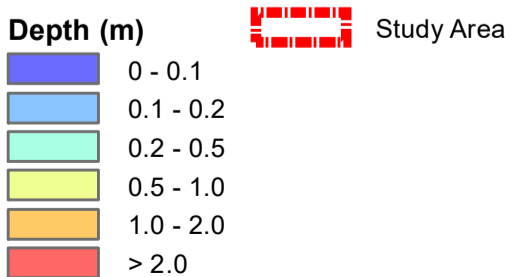
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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		50% AEP Flood Depth - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-10	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

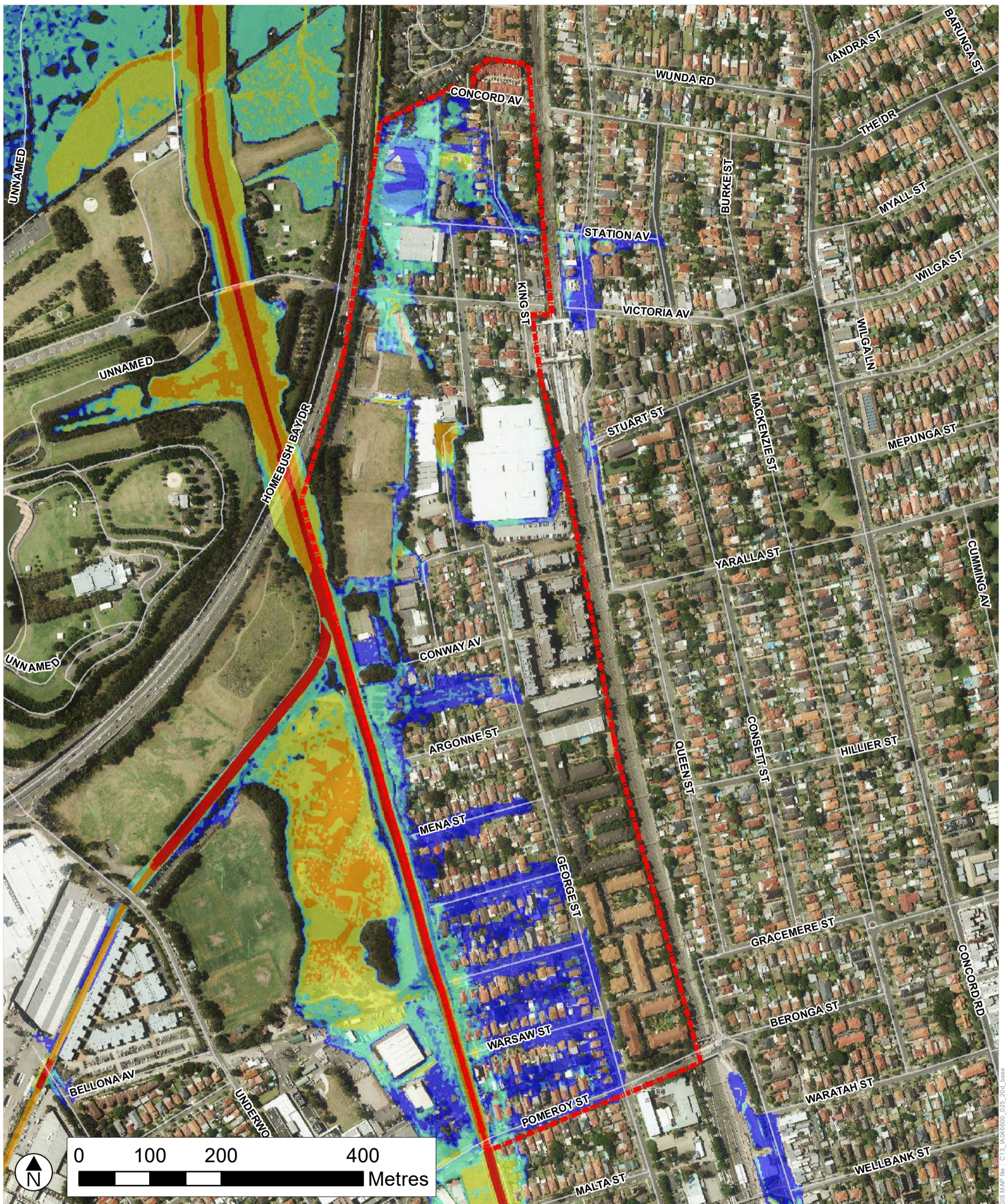


Data Sources: LPI, Council.

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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	10% AEP Flood Depth - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-12	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**

- Depth (m)**
- 0 - 0.1
  - 0.1 - 0.2
  - 0.2 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - > 2.0
- Study Area

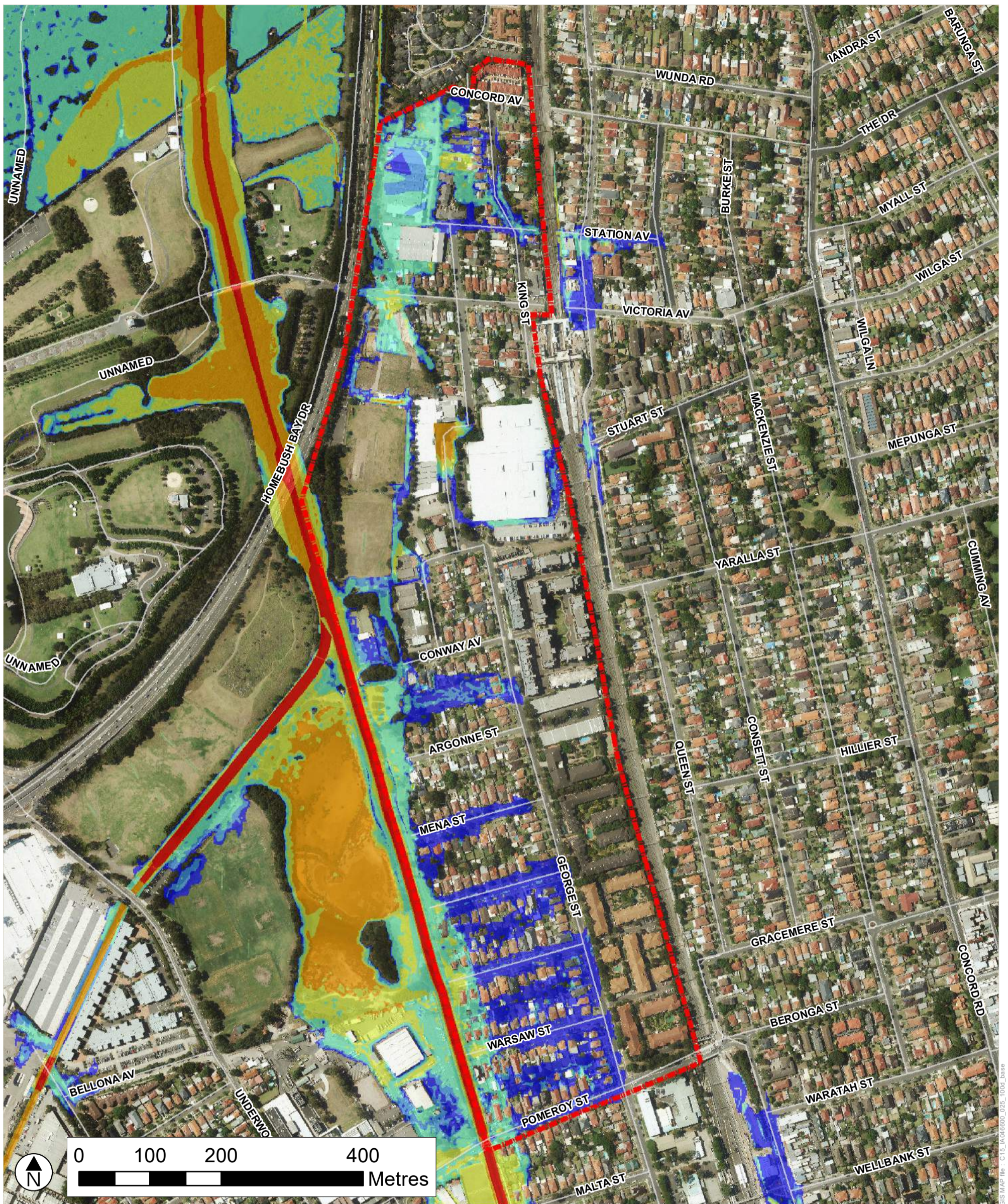


Data Sources: LPI, Council.

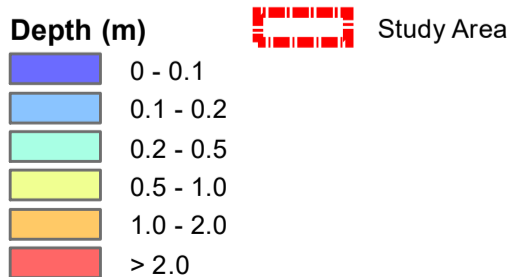
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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	5% AEP Flood Depth - Baseline Case		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP C-13	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**



Data Sources: LPI, Council.

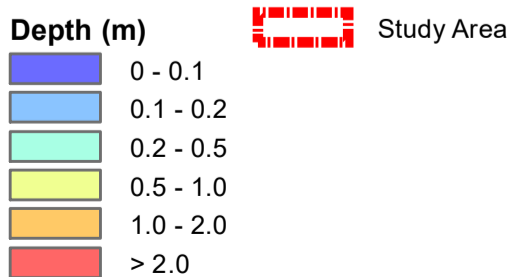
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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		1% AEP Flood Depth - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-15	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**



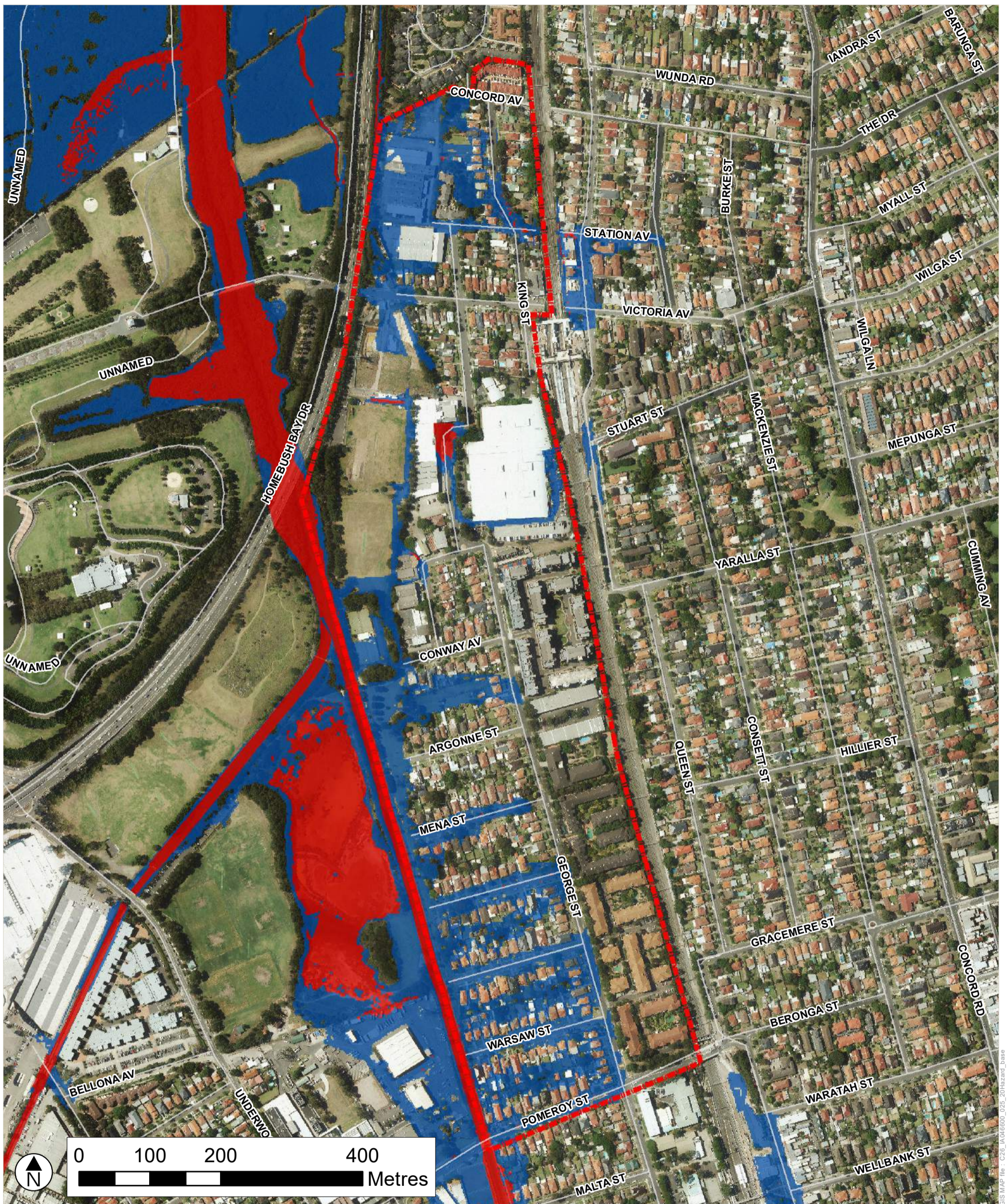
Data Sources: LPI, Council.

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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		PMF Flood Depth - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-17	1	1	
CHECK	DATE				
LC	7/05/2015				

GIS MAP file: C:\Z\AC046600\_025\_PMF04\_base





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area

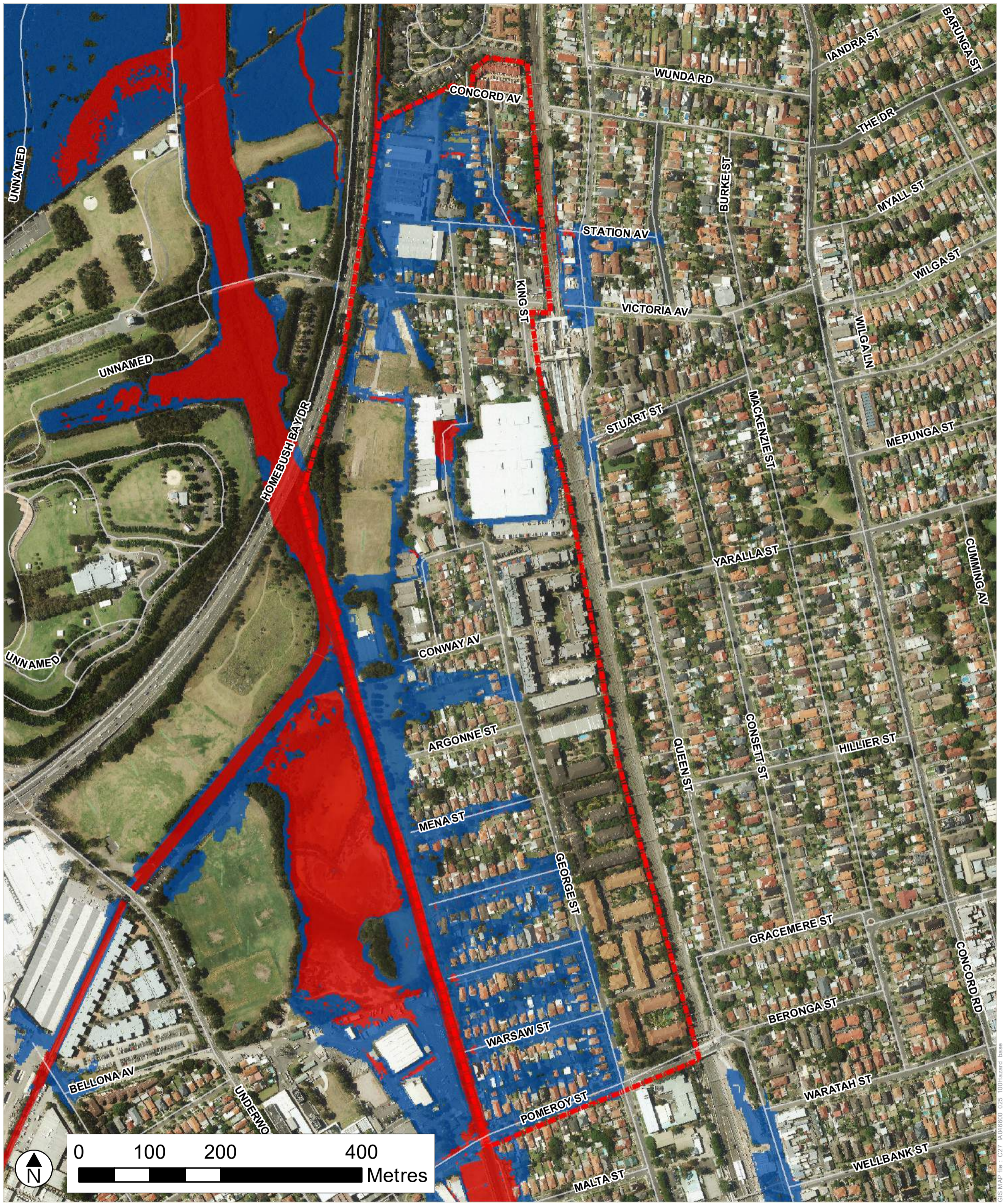


Data Sources: LPI, Council.

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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		5% AEP Flood Hazard - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-26	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area



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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		1% AEP Flood Hazard - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-27	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area



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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		PMF Flood Hazard - Baseline Case			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP C-28	1	1	
CHECK	DATE				
LC	7/05/2015				



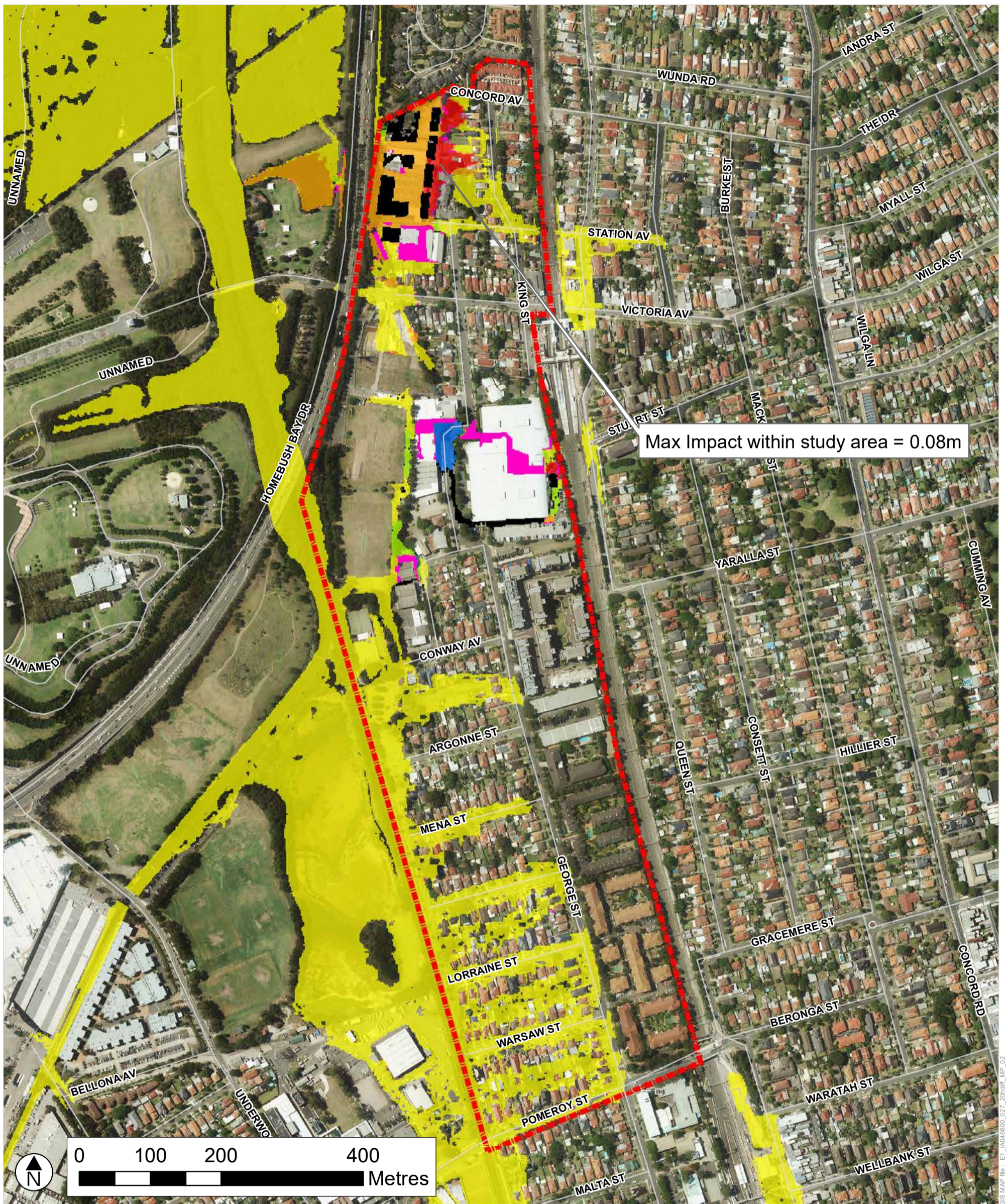
## **APPENDIX B**

### **Flood Mapping – 2014 Masterplan Conditions**

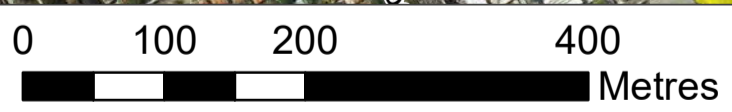
Extracted from the *Draft Concord West Precinct Master Plan Flood Study* (Jacobs, 2015)

















Max Impact within study area = 0.08m



**Legend**

	< -0.1		Previously Flooded
	-0.1 - -0.06		Newly Flooded
	-0.05 - -0.02		Study Area
	-0.01 - 0.01		
	0.02 - 0.05		
	0.06 - 0.1		
	> 0.1		

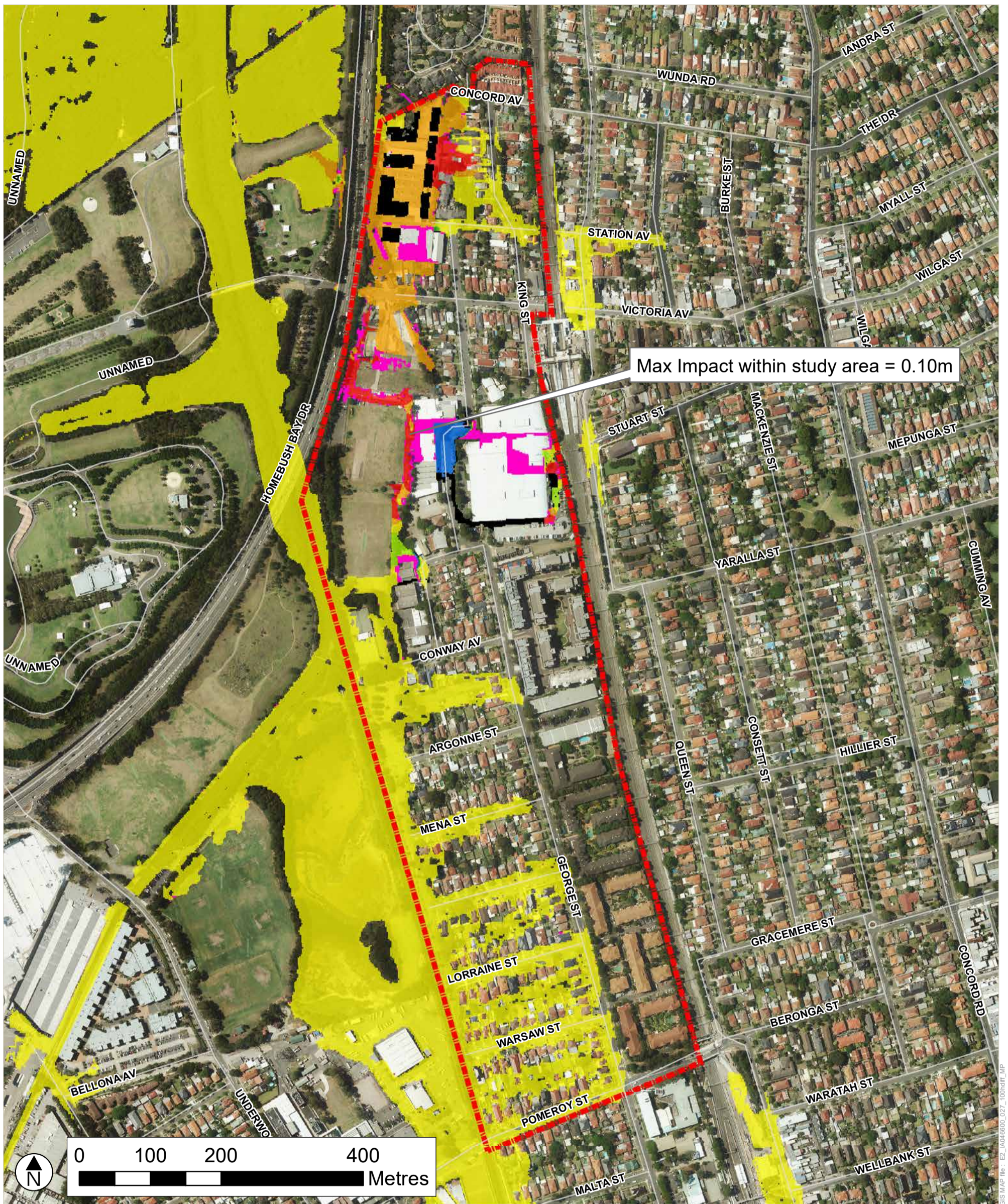


Data Sources: LPI, Council.

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SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	Change in 5% AEP Flood Level - Masterplan		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP E-1	1 1
CHECK	DATE		
LC	15/07/2015		





**Legend**

	< -0.1		Previously Flooded
	-0.1 - -0.06		Newly Flooded
	-0.05 - -0.02		Study Area
	-0.01 - 0.01		
	0.02 - 0.05		
	0.06 - 0.1		
	> 0.1		

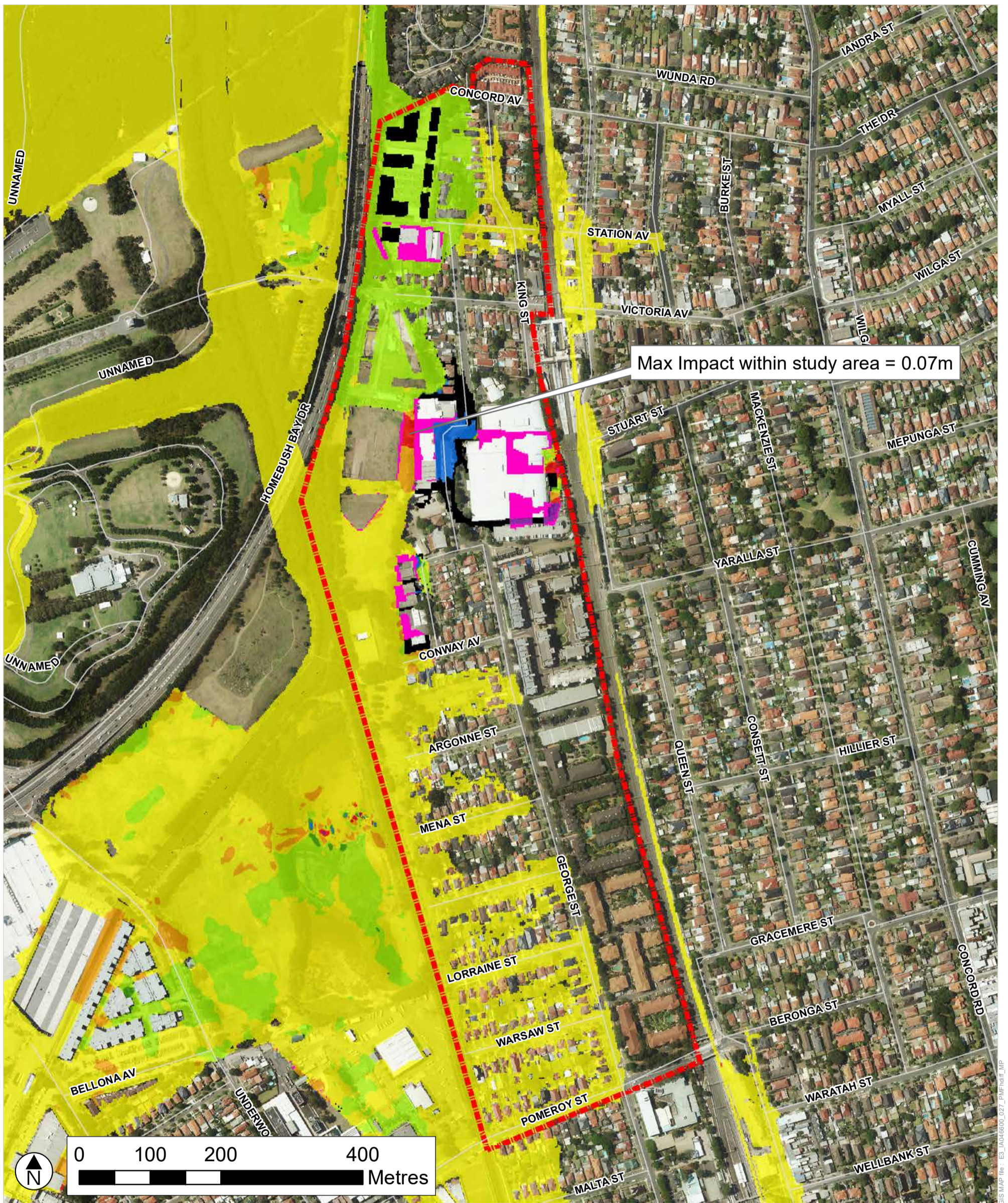


Data Sources: LPI, Council.











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DRAWN	PROJECT #	MAP #	REV	VER
LC	IA046600	MAP E-2	1	1
CHECK	DATE			
LC	15/07/2015			





**Legend**

	< -0.1		Previously Flooded
	-0.1 - -0.06		Newly Flooded
	-0.05 - -0.02		Study Area
	-0.01 - 0.01		
	0.02 - 0.05		
	0.06 - 0.1		
	> 0.1		

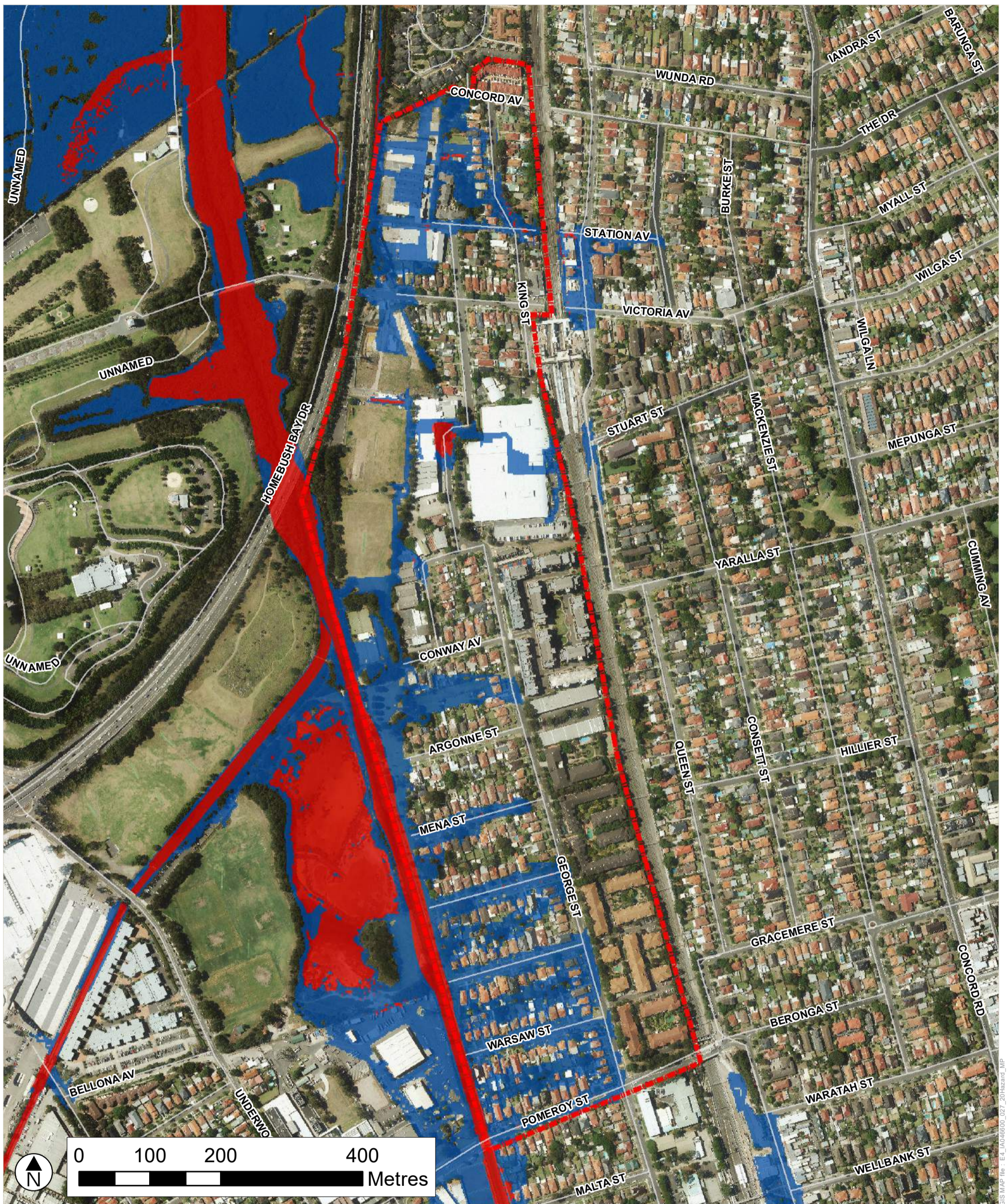


Data Sources: LPI, Council.

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DRAWN	PROJECT #	MAP #	REV	VER
LC	IA046600	MAP E-3	1	1
CHECK	DATE			
LC	15/07/2015			





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area

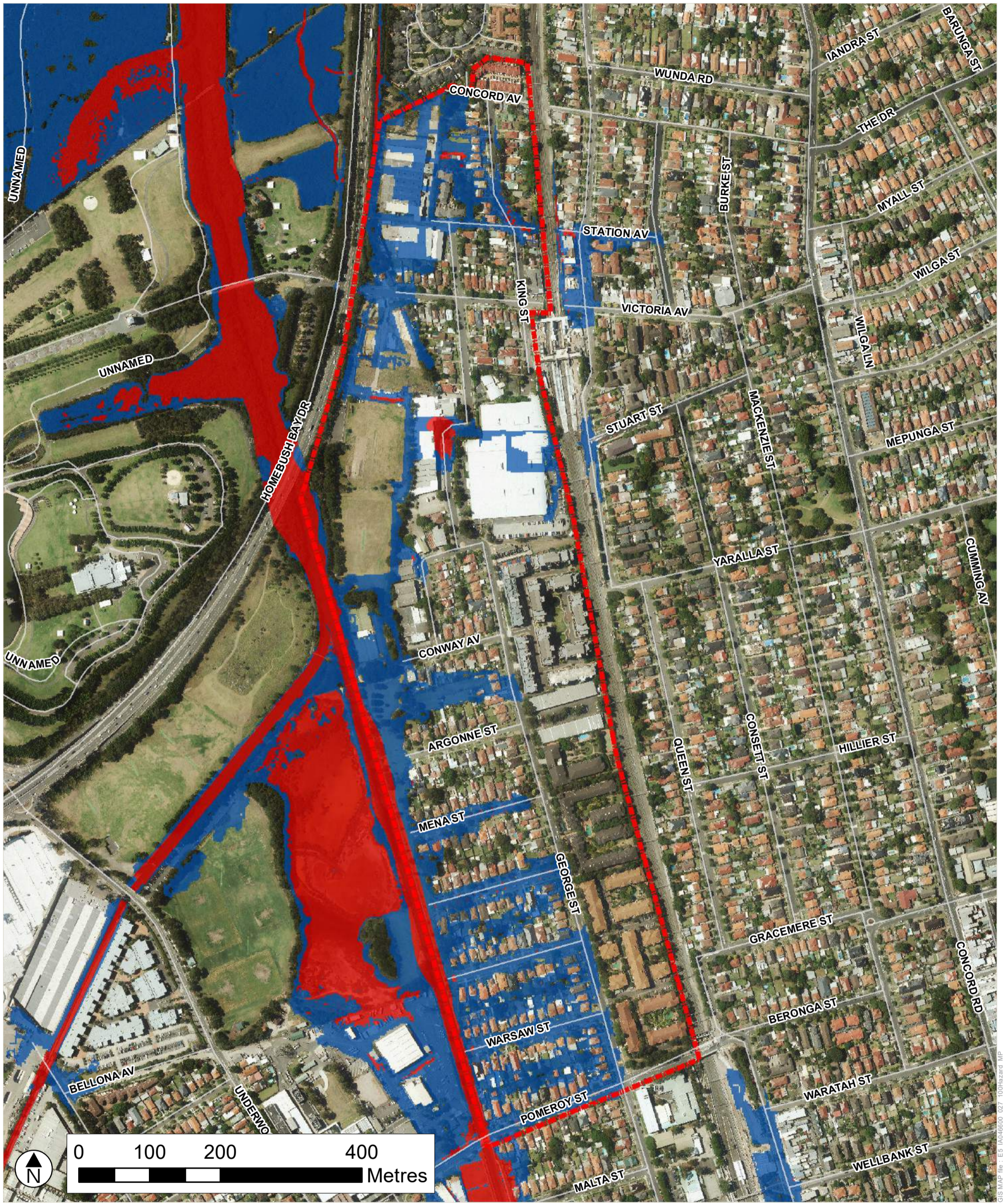


Data Sources: LPI, Council.

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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		5% AEP Flood Hazard - Masterplan			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP E-4	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

**Flood Hazard Categories**

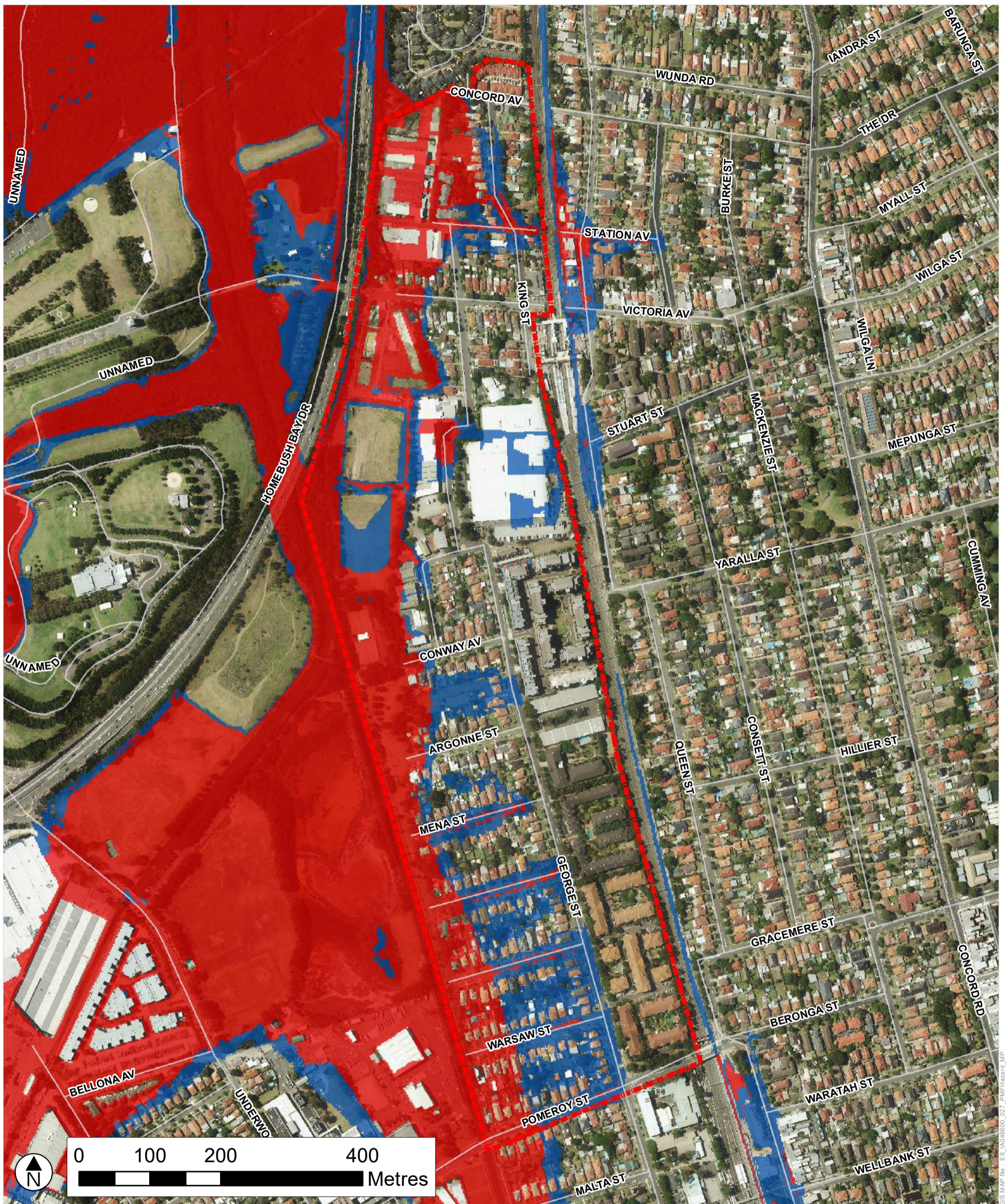
- Low Hazard
- High Hazard
- Study Area



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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		1% AEP Flood Hazard - Masterplan			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP E-5	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area



Data Sources: LPI, Council.

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SHEET		1 of 1		A3	
				GDA 1994 MGA Zone 56	
TITLE		PMF Flood Hazard - Masterplan			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP E-6	1	1	
CHECK	DATE				
LC	7/05/2015				



Concord West Precinct

## **APPENDIX C**

### **Concord West Precinct – Masterplan Flood Mitigation Options (Jacobs, 2015)**

Extracted from the *Draft Concord West Precinct Master Plan Flood Study* (Jacobs, 2015)







Further, that approval will be required from the City of Canada Bay for the proposed floodway on public land to the west of site 5, and that consultation would also likely be required with the Department of Education and Communities in terms of the option for culverts under the school oval.

Figure 8-1 Site 1 and Site 2 Flood Mitigation Option

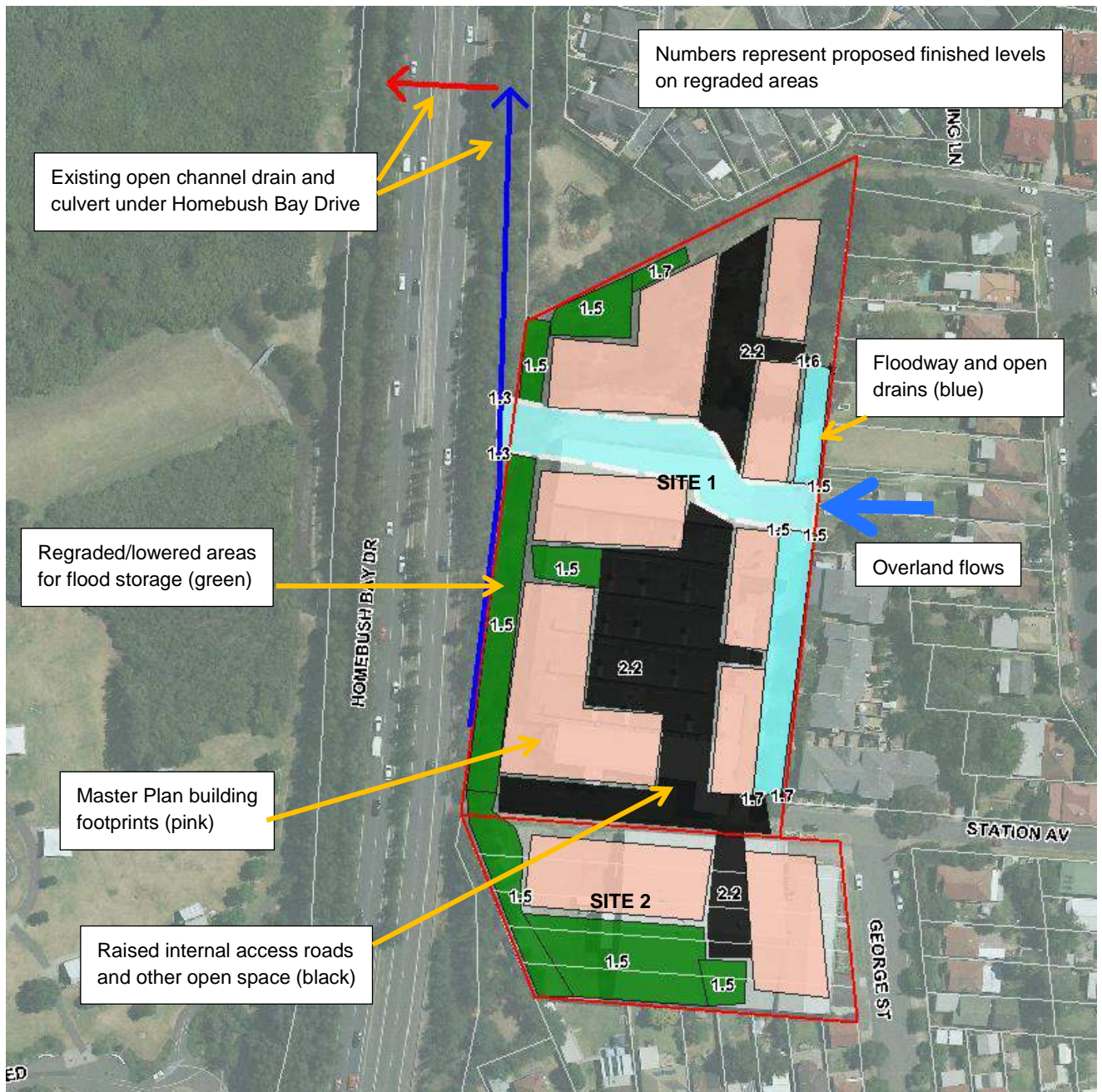
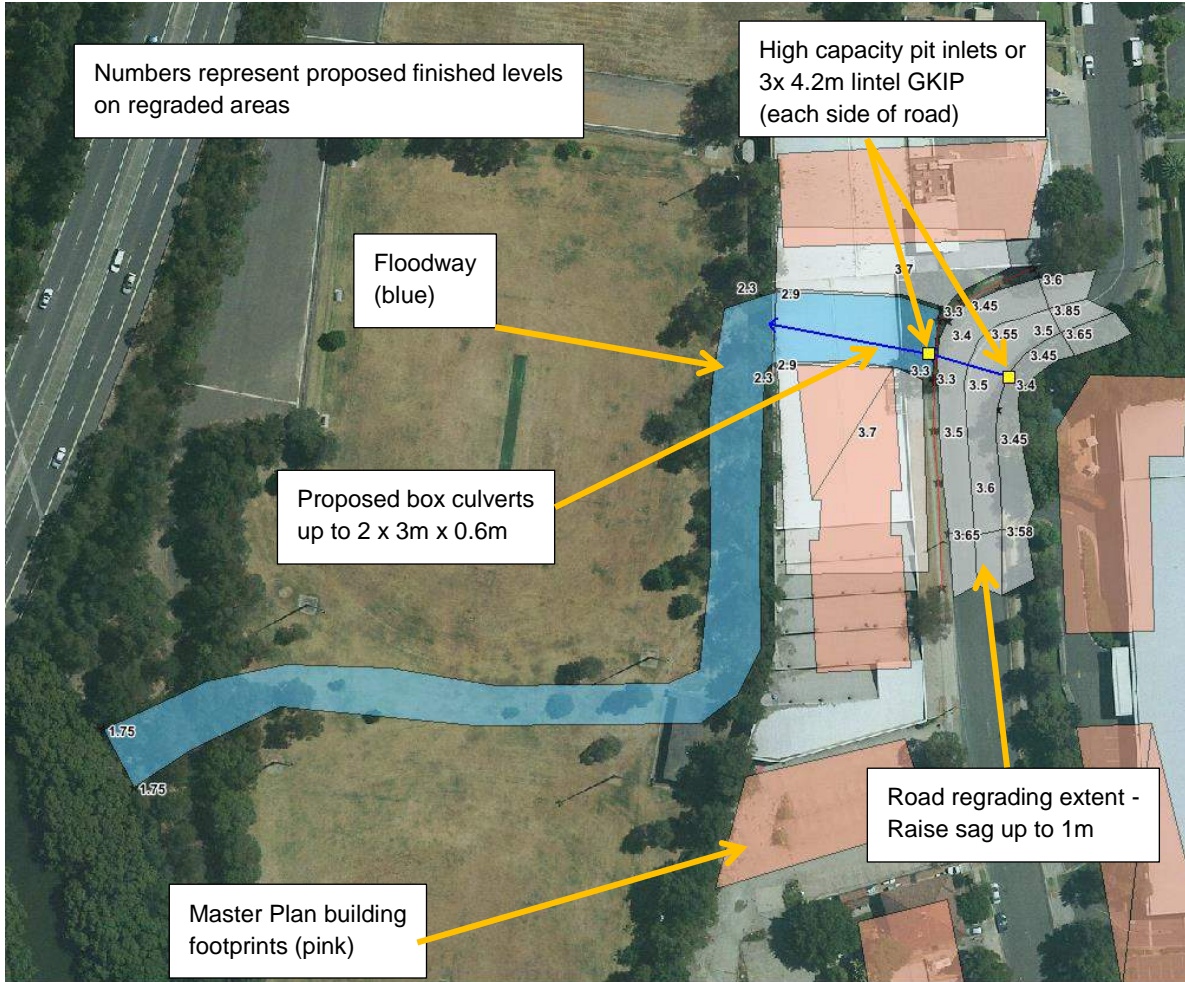




Figure 8-2 George Street Sag Point Flood Mitigation Option







GIS MAP file: F01\_IA046600\_Site1\_2\_Finished\_con

**Legend**

- Concept Design ground levels 0.2m contour
- - - Existing ground levels 0.2m contour
- ▭ Proposed buildings (Concept Design)



Data Sources: LPI, Council.

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A3

SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	Site 1 and 2 Existing and Proposed Ground Levels		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-1	1 1
CHECK	DATE		
LC	8/05/2015		





GIS MAP file : F:\2a\_1A046600\_GeorgeSt\_Finished\_con\_part11

**Legend**

- Concept Design ground levels 0.2m contour
- - - Existing ground levels 0.2m contour
- ▭ Proposed buildings (Concept Design)



Data Sources: LPI, Council.

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A3

SHEET	1 of 2	GDA 1994 MGA Zone 56	
TITLE	Site 5 and George Street Existing and Proposed Ground Levels		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-2a	1 1
CHECK	DATE		
LC	7/05/2015		





GIS MAP file : F:\2b\_1A046600\_GeorgeST\_Finished\_con\_part2

**Legend**

- Concept Design ground levels 0.2m contour
- Existing ground levels 0.2m contour
- Proposed buildings (Concept Design)

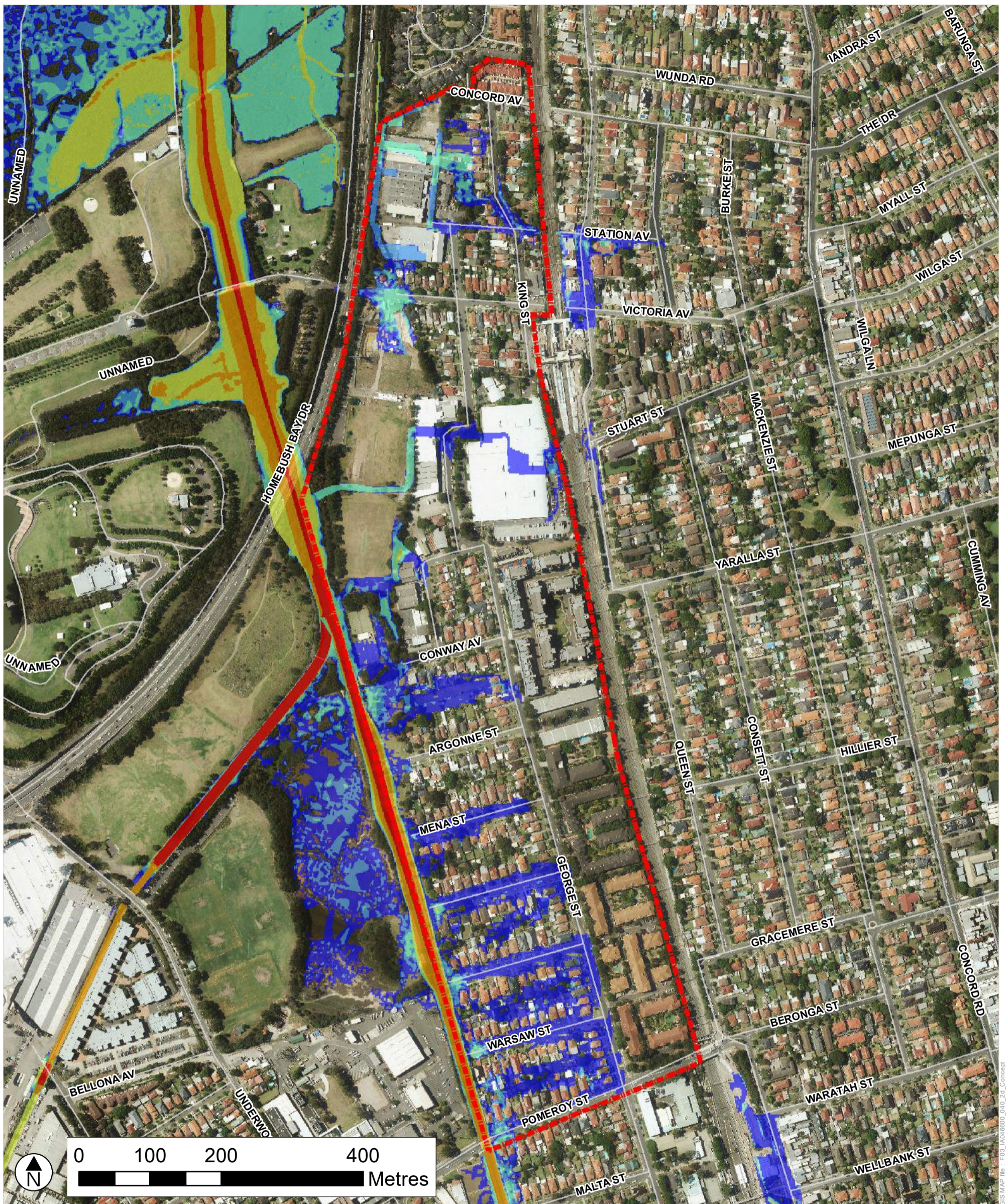


Data Sources: LPI, Council.

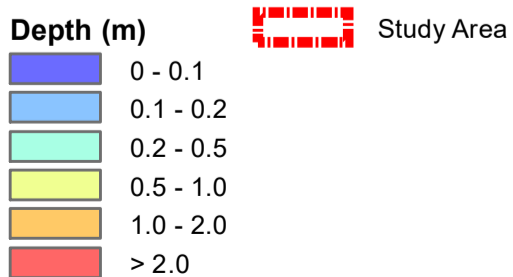
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A3	
SHEET	1 of 2
GDA 1994 MGA Zone 56	
TITLE	Site 5 and George Street Existing and Proposed Ground Levels
PROJECT	Concord West Precinct Masterplan Flood Study
CLIENT	City of Canada Bay
DRAWN	PROJECT #
LC	IA046600
CHECK	MAP #
LC	DATE
	7/05/2015
	REV VER
	1 1





**Legend**



Data Sources: LPI, Council.

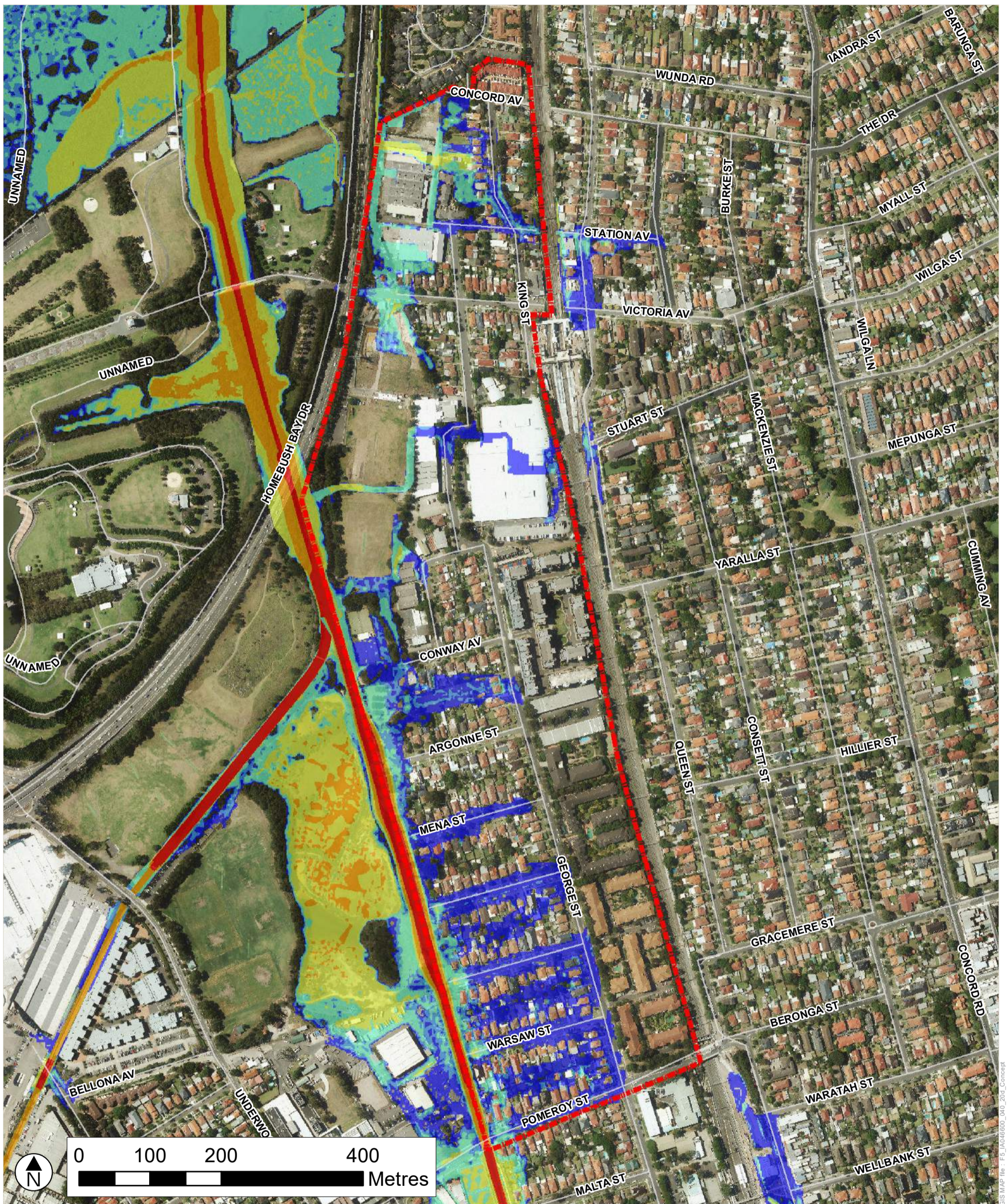
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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		50% AEP Flood Depth - Concept Design			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP F-3	1	1	
CHECK	DATE				
LC	7/05/2015				

A3

GIS MAP file: F03\_IA046600\_040\_20\_Concept





**Legend**

- Depth (m)**
- 0 - 0.1
  - 0.1 - 0.2
  - 0.2 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - > 2.0
- Study Area



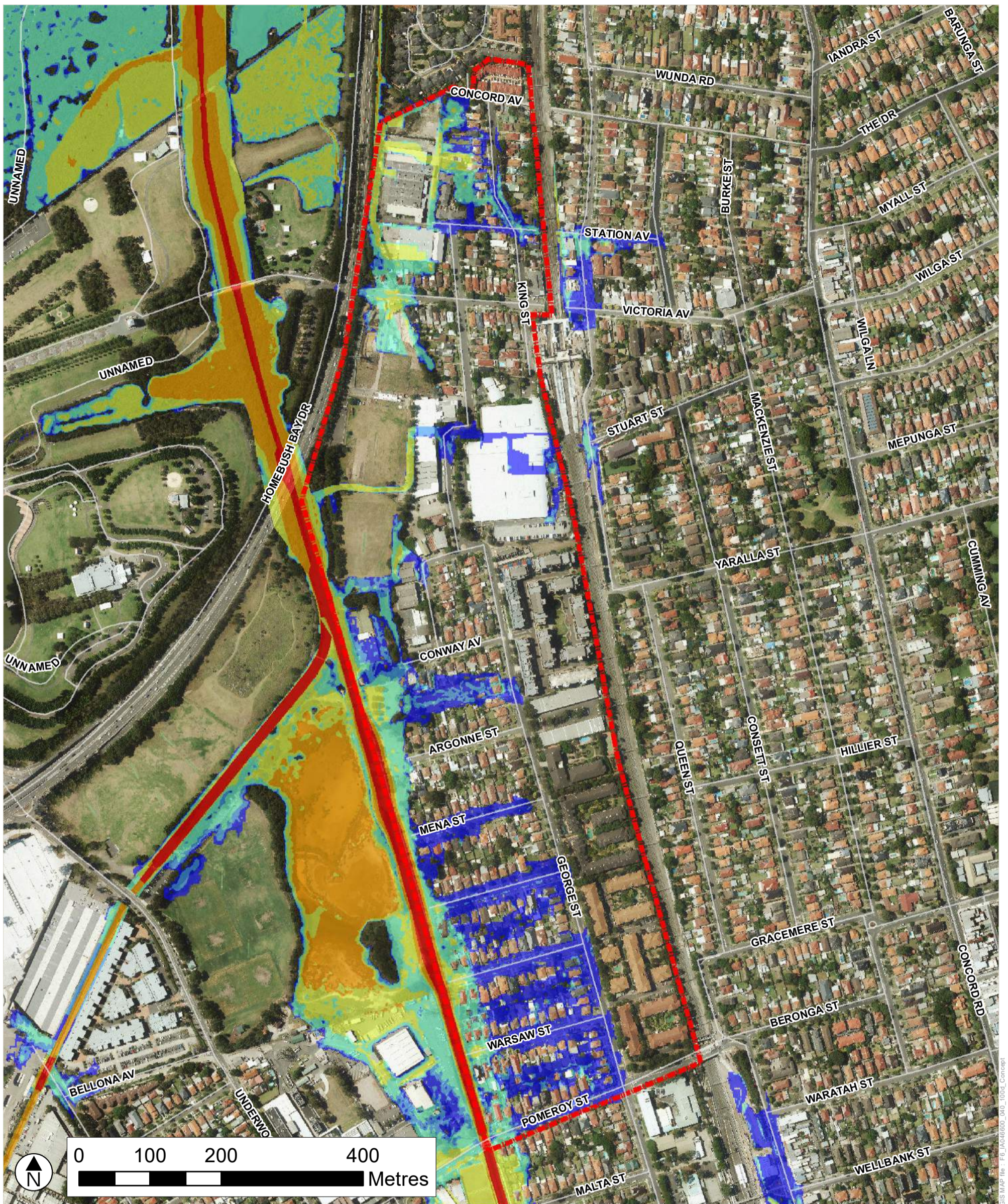
Data Sources: LPI, Council.

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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		5% AEP Flood Depth - Concept Design			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP F-5	1	1	
CHECK	DATE				
LC	7/05/2015				

GIS MAP file: F5\_IA046600\_040\_2014\_Concept





**Legend**

- Depth (m)**
- 0 - 0.1
  - 0.1 - 0.2
  - 0.2 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - > 2.0
- Study Area

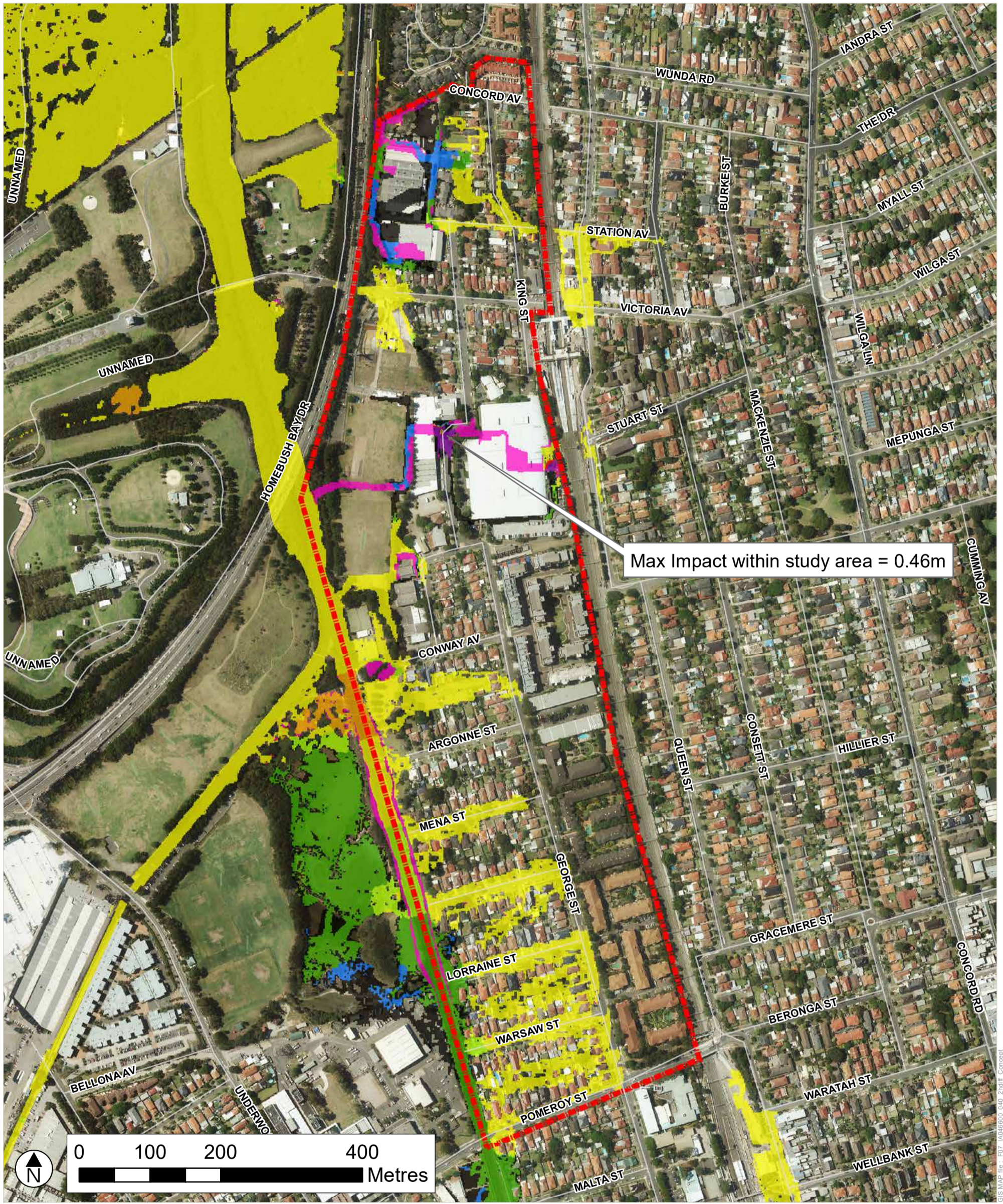


Data Sources: LPI, Council.

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SHEET		1 of 1		GDA 1994 MGA Zone 56	
TITLE		1% AEP Flood Depth - Concept Design			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP F-6	1	1	
CHECK	DATE				
LC	7/05/2015				





Max Impact within study area = 0.46m

**Legend**

- < -0.1
- 0.1 - -0.06
- 0.05 - -0.02
- 0.01 - 0.01
- 0.02 - 0.05
- 0.06 - 0.1
- > 0.1
- Previously Flooded
- Newly Flooded
- Study Area



Data Sources: LPI, Council.  
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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	Change in 50% AEP Flood Level - Concept Design		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-7	1 1
CHECK	DATE		
LC	15/07/2015		





Max Impact within study area = 0.04m



**Legend**

	< -0.1		Previously Flooded
	-0.1 - -0.06		Newly Flooded
	-0.05 - -0.02		Study Area
	-0.01 - 0.01		
	0.02 - 0.05		
	0.06 - 0.1		
	> 0.1		



Data Sources: LPI, Council.










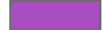
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A3			
SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	Change in 5% AEP Flood Level - Concept Design		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-9	1 1
CHECK	DATE		
LC	15/07/2015		





**Legend**

	< -0.1		Previously Flooded
	-0.1 - -0.06		Newly Flooded
	-0.05 - -0.02		Study Area
	-0.01 - 0.01		
	0.02 - 0.05		
	0.06 - 0.1		
	> 0.1		

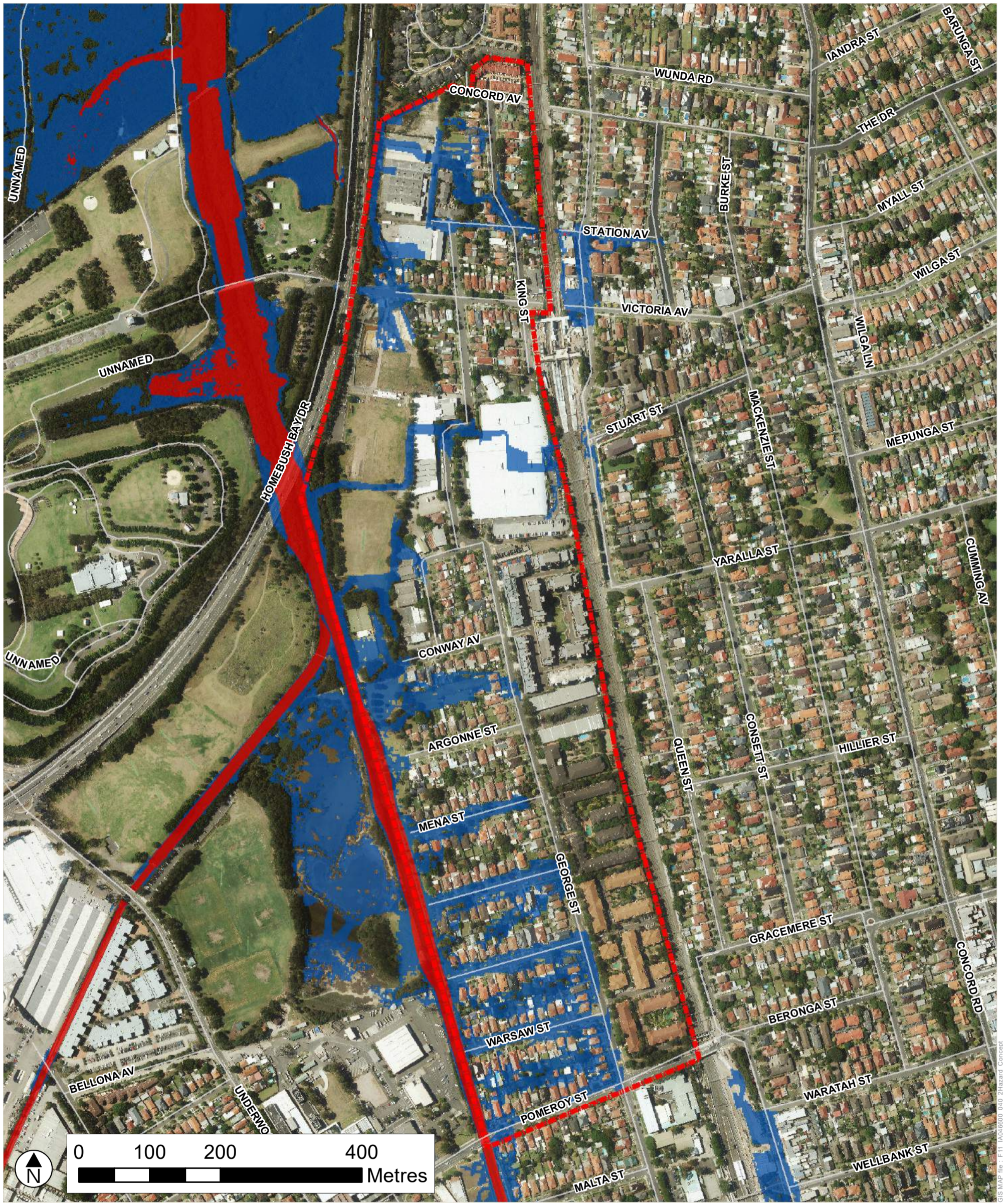


Data Sources: LPI, Council.

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DRAWN	PROJECT #	MAP #	REV	VER
LC	IA046600	MAP F-10	1	1
CHECK	DATE			
LC	15/07/2015			





**Legend**

**Flood Hazard Categories**

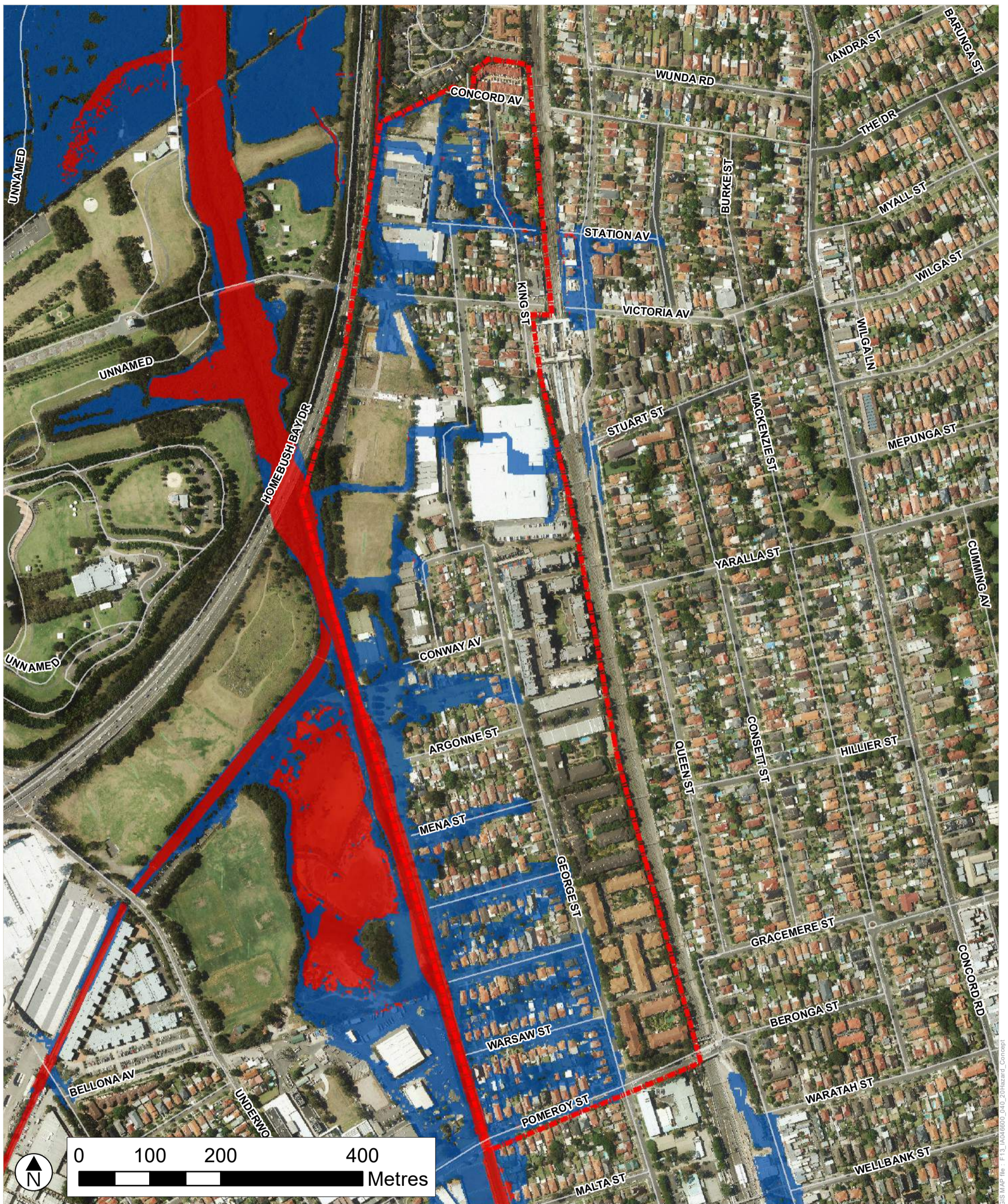
- Low Hazard
- High Hazard
- Study Area



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SHEET		1 of 1		A3	
		GDA 1994 MGA Zone 56			
TITLE		50% AEP Flood Hazard - Concept Design			
PROJECT		Concord West Precinct Masterplan Flood Study			
CLIENT		City of Canada Bay			
DRAWN	PROJECT #	MAP #	REV	VER	
LC	IA046600	MAP F-11	1	1	
CHECK	DATE				
LC	7/05/2015				





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area

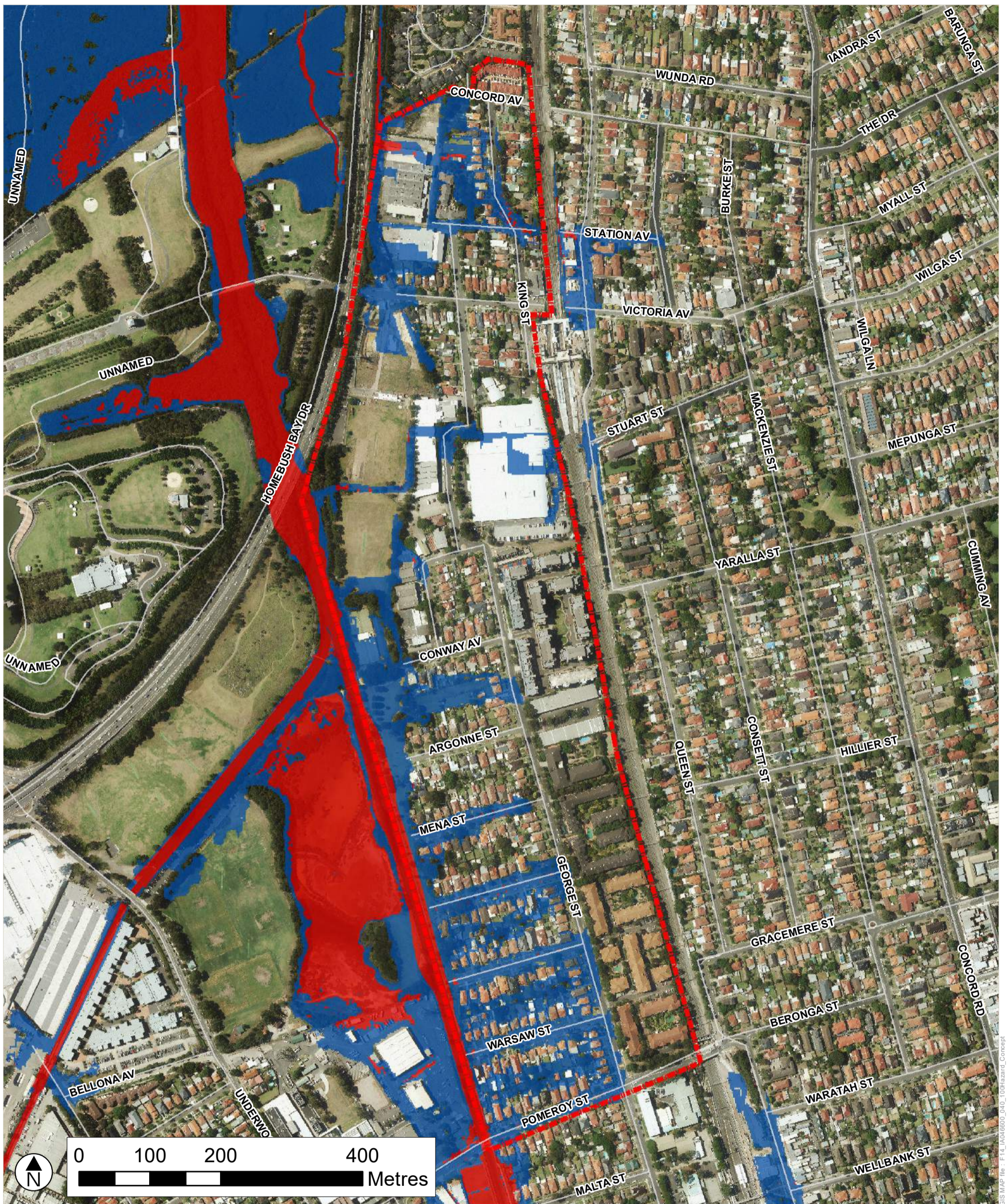


Data Sources: LPI, Council.

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SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	5% AEP Flood Hazard - Concept Design		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-13	1 1
CHECK	DATE		
LC	7/05/2015		





**Legend**

**Flood Hazard Categories**

- Low Hazard
- High Hazard
- Study Area



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A3

SHEET	1 of 1	GDA 1994 MGA Zone 56	
TITLE	1% AEP Flood Hazard - Concept Design		
PROJECT	Concord West Precinct Masterplan Flood Study		
CLIENT	City of Canada Bay		
DRAWN	PROJECT #	MAP #	REV VER
LC	IA046600	MAP F-14	1 1
CHECK	DATE		
LC	7/05/2015		



## **APPENDIX D**

### **City of Canada Bay DCP – Part C7 Flooding Control**

Extracted from the City of Canada Bay Development Control Plan, adopted 21<sup>st</sup> February 2017, last amended 27<sup>th</sup> April 2018.







## C7 Flooding Control

### C7.1 Introduction

Flooding can be a significant issue that affects people and development in some areas of the City of Canada Bay. The hazard can vary through a wide range over short distances and should be assessed on a location by location basis.

This Section establishes Council's approach to flood related development control for the whole LGA. Council's approach to flood is based on the requirements of the New South Wales Government's Flood Prone Land Policy and Floodplain Development Manual as amended (FDM 2005).

Different controls are applicable depending on the land use, level of potential inundation and hazard category.

### C7.2 Relationship to other documents

In areas where Council has adopted a Flood Study or Floodplain Risk Management Study or Floodplain Risk Management Plan that sets a flood planning area and freeboards, these will take precedence over the following DCP controls where there is any inconsistency.

### C7.3 Land to which this Flood Control clause applies

This section applies to:

- Land which is shown as 'Flood Planning Area' in a Flood Planning Map in the Canada Bay Local Environmental Plan.
- Land which is recommended to be shown as a Flood Planning Area in the Canada Bay Local Environmental plan by a publicly exhibited and/or adopted Flood Study prepared in accordance with the FDM (2005).

Where Council is of the understanding that land subject of an application is or may potentially be affected by flood, Council may require the applicant to prepare a flood study.

Words and phrases in this section have the meanings assigned in the LEP and FDM(2005).

A 'High Flood Risk' Precinct is an area of land that under 1%AEP conditions is either subject to a high hydraulic hazard or presents a high evacuation risk.

A 'Medium Flood Risk' Precinct is an area of land that under 1%AEP conditions is not subject to a high hydraulic hazard and presents less than a high evacuation risk.

A 'Low Flood Risk' Precinct is the area above the 100 year flood and includes all area up to and including the 'Probable Maximum Flood (PMF)'.

Freeboard represents a nominated additional height above a flood level to provide a safety factor against inundation. It is used to set minimum freeboard levels.

#### Abbreviations:

AEP: Annual Exceedance Probability

FDM 2005: Floodplain Development Manual

FRMP: Flood Risk Management Plan

FRMS: Flood Risk Management Study



## Objectives

- O1. To ensure the proponents of development and the community in general are aware of the potential hazard over the whole range of AEP and of the consequent risk and liability associated with the development and use of liable land.
- O2. To manage liable land in manner that is economically and environmentally sustainable and socially responsible.
- O3. To establish whether or not a proposed development or activity is appropriate to be carried out having regard to the economic, property, environmental and human impacts of
- O4. To protect community by ensuring that developments with high sensitivity to risk (eg. critical public utilities) are sited and designed to provide reliable access, continued operability during emergencies, quick recovery and to generally minimise risk from
- O5. To allow development with a lower sensitivity to the hazard to be located within the subject to appropriate design and siting controls and provided that the potential consequences that could still arise from remain acceptable.
- O6. To prevent of inappropriate development.
- O7. To control the use of 'High Hazard' areas and Floodways, and wherever appropriate and feasible, allow for their conversion to natural waterway corridors.
- O8. To ensure that proposed development does not expose existing development to increased risks associated with
- O9. To ensure building design and location address hazard.
- O10. To ensure that development does not result in unreasonable impacts upon the amenity or ecology of an area.
- O11. To incorporate the principles of Ecologically Sustainable Development (ESD).
- O12. To minimise the risk to life and property arising from
- O13. To ensure the provision of appropriate access to and egress from areas affected by including for extreme events.
- O14. To provide controls to ensure that development is carried out in accordance with this Policy.
- O15. To implement the principles of risk management as by the NSW Government's Flood Prone Land Policy and the FDM 2005.

## Design Principles

- D1. Development should not result in any increased risk to human life.
- D2. The additional economic and social costs which may arise from damage to property from should not be greater than that which can reasonably be managed by the property owner, property occupants and general community.
- D3. Development should only be permitted where effective warning time is available for the evacuation of an area potentially affected by to an area free of risk from
- D4. Development should only be permitted where reliable egress is available for the evacuation of an area potentially affected by to an area free of risk from
- D5. Evacuation should be consistent with any relevant evacuation strategy or risk management plan where in existence.
- D6. Development should not adversely increase the potential affectation on other development or properties, either individually or in combination with similar developments(s) that are likely to occur within the same catchment.
- D7. Developments must make allowances for motor vehicles to be relocated to an area with substantially less risk from within an effective warning time.
- D8. Developments must provide an evacuation plan detailing procedures that would be in place for an emergency (such as warning systems, signage or evacuation drills).



- D9. Flood mitigation measures associated with new developments should not result in impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (eg. by unsympathetic house raising), alienation of otherwise usable open space or by being incompatible with the streetscape or character of the locality (including heritage).
- D10. Raised structures shall be designed to cater for the forces of                      An Engineer's                      will be required for the structural design.
- D11. Development is to be compatible with any relevant Floodplain Risk Management Study, Floodplain Risk Management Plan, Flood Studies, or Sub-Catchment Management Plan.
- D12. Development must not divert                      waters, nor interfere with                      storage or the natural function of waterways.
- D13. Filling of land up to the Probable Maximum Flood (PMF) must not adversely impact upon                      behaviour. This must be demonstrated by appropriate modelling.
- D14. Development must consider the impact of                      resulting from local overland                      whether it is a result of Local Drainage or Major Drainage.
- D15. Where hydraulic                      modelling is required,                      hazard categories should be                      and adequately addressed in the design of the development.
- D16. Council strongly discourages basement car parks on properties within the                      Where site conditions require a basement car park on a property within the                      development applications must provide a detailed hydraulic                      study and design demonstrating that the proposed basement car park has been protected from all                      up to and including the PMF event. An adequate emergency response and evacuation plan must also be provided where basement car parks are proposed in the

## C7.4 Development Controls

All proposals are to have regard to the planning matrix at Table C-K. The procedure to determine which design standards apply to proposed development involves:

**Step 1:** identify the land use category of the development from Table C-K; and

**Step 2:** determine which                      risk category applies to the land (in some areas Council may have undertaken a formal                      study and published                      risk mapping or made the data available on application. Where Council is of the understanding that land subject of an application is or may potentially be affected by                      Council may require the applicant to prepare a                      study.); and

**Step 3:** apply the objectives and design principles as outlined in this section and then the design standards in the planning matrix at Table C-K as applicable to the                      and land use category, the numbers in Table C-K identify the controls which are applicable as detailed in C7.5 Details of Flood Controls (Flood Planning Matrix).

NOTE: An evacuation plan does not negate requirements for compliance with planning and building regulations.







Open Space or Non-urban Uses	Recreation facilities (outdoor); Recreation areas and minor ancillary structures (e.g. Amenities blocks or kiosks) Boat launching ramps; Boat repair facilities; Boat sheds; Jetty; Animal boarding and training establishments; Environmental facilities; Helipad.
Concessional Development	<p>Concessional development is any development or redevelopment that would normally not be permitted under this Plan, but may be permitted as a concession provided it:-</p> <ol style="list-style-type: none"> <li>1. is kept clear of any                      and</li> <li>2. involves an acceptably small (see below for limits) addition or alteration to an existing development that will not cause a                      increase in potential losses or risks or have an adverse impact on adjoining properties; or</li> <li>3. redevelopment that achieves a substantial reduction of the extent of affectation relative to the existing situation provided that such redevelopments incorporate, to the fullest extent practical, design features and measures to reduce the existing potential for                      losses and personal risks and avoid any adverse impacts on adjoining properties – especially obstruction or diversion of                      and loss of                      storage.</li> </ol> <p><b>Limits for residential development. The maximum size of a concessional development is:</b></p> <ol style="list-style-type: none"> <li>1. a once-only addition or alteration to an existing dwelling of no more than 10% or 30m<sup>2</sup> (whichever is the lesser) of the habitable                      area which existed at the date of commencement of this Policy or Plan; or</li> <li>2. the construction of an outbuilding with a maximum                      area of 20m<sup>2</sup>.</li> </ol> <p><b>Limits for other (non-residential) development</b></p> <p>In the case of other development categories, the maximum size of a concessional development is a once-only addition to existing premises of no more than 10% of the                      area which existed at the date of commencement of this Policy or Plan.</p>



Table C-K Flood Planning Matrix

Planning & Development Controls	Flood Risk Precincts																				
	Low Flood Risk				Medium Flood Risk				High Flood Risk												
	Concessional Development	Open Space & Non-Urban	Tourist Related Development	Commercial & Industrial	Residential*	Filling	Subdivision	Critical Uses & Facilities	Sensitive Uses & Facilities	Concessional Development	Open Space & Non-Urban	Tourist Related Development	Commercial & Industrial	Residential*	Filling	Subdivision	Critical Uses & Facilities	Sensitive Uses & Facilities			
	3	3	2	2	2	2	2	2	2	2, 5	2, 5	2, 5	2, 5	2, 5	2, 5	2, 5	2, 5	2, 5			
<b>Planning Consideration</b> (the numbers below identify the controls which are applicable, as contained in section C7.5)	Floor Level																		1, 5 4, 5		
	Building Component	2	2																1	1	
	Structural Soundness	2	2																1	1	
	Flood Affection	2	2	1	2	2	2	2	2										1	1	
	Car Parking & Driveway Access	1, 3, 5, 6, 8	1, 3, 5, 6, 8																	2, 4 6, 7	1, 5
	Evacuation	2, 4	2, 4	5	3, 4	4	4	4	4											1, 4	3, 4, 6
	Management & Design	2, 3	2, 3	4	1															2, 3, 4	2, 3, 4

**Colour Key**  Not Relevant  Unsuitable Land Use  \* For redevelopment refer also to 'Concessional Development' provisions

- Notes**
- i Canada Bay Local Environmental Plan 2013 development permissible with consent in various zones. Notwithstanding, constraints to individual sites may preclude the granting of consent for certain forms of development on all or part of a site. The above matrix where risks are likely to determine where certain development types will be considered "unsuitable" due to related risks.
  - ii Filling of site, where acceptable to Council, may change the FRP used to determine the controls applied in the circumstances of individual applications.
  - iii Any fencing that forms a part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category. Fences may need to be of open design to address this cause.
  - iv Development within the may be subject to Clause 6.4 Limited Development On Foreshore Area and Foreshore building line provisions in the Canada Bay Local Environmental Plan 2013.
- Note that the land above the PMF level is not captured by the above matrix.



## C7.5 Details of the Flood Controls

(Flood Planning Matrix see Table C-K)

### Floor Level

Controls	
C1.	Floor levels to be equal to or greater than the 20 year Average Recurrence Interval (ARI) level plus freeboard.
C2.	Habitable levels to be equal to or greater than the 100 year ARI level plus freeboard.
C3.	All levels to be equal to or greater than the Probable Maximum Flood (PMF) level.
C4.	Floor levels to be equal to or greater than the 100 year ARI level plus freeboard. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the level of existing buildings, or the need for access for persons with disabilities, a lower level may be considered. In these circumstances, the level is to be as high as practical, and, when undertaking alternations or additions, no lower than the existing level.
C5.	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable area is elevated more than 1.5m above ground level, that the space is not to be enclosed.
C6.	Because of the particular catchment characteristics of the Concord West Precinct, additional requirement is for habitable levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the CWFS.

### Building Components and Method

Controls	
C1.	All structures to have compatible building components below the 100 year ARI level plus freeboard.
C2.	All structures to have compatible building components below the PMF.

### Structural Soundness

Controls	
C1.	An Engineer's report is required to certify that the structure can withstand the forces of , debris and buoyancy up to and including a 100 year ARI level plus freeboard.
C2.	An Engineer's report is required to certify that the structure can withstand the forces of , debris and buoyancy up to and including a PMF level.

### Flood Affection

Controls	
C1.	An Engineer's report is required to demonstrate how and certify that the development will not increase affection elsewhere, having regard to: <ol style="list-style-type: none"> <li>loss of storage;</li> <li>changes in levels, and velocities caused by alterations to and</li> <li>the cumulate impact of multiple potential developments in the vicinity.</li> </ol>
C2.	The impact of the development on elsewhere to be considered having regard to the three factors listed in C11 above.

### Car Parking and Driveway Access

Controls	
C1.	The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI level.



C2.	The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.3m above the 20 year ARI level.
C3.	Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by equal to or greater than the 100 year ARI Ramp levels to be no lower than 0.5m above the 100 year ARI level.
C4.	The driveway providing access between the road and parking spaces shall be as high as practical and generally rising in the egress direction.
C5.	The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI level.
C6.	Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a below the 100 year ARI level, shall have adequate warning systems, signage, exits and evacuation routes.
C7.	Restraints or vehicle barriers to be provided to prevent vehicles leaving a site during a 100 year ARI
C8.	Enclosed underground car parks shall have all potential water entry points protected from the PMF. The intent of this requirement is to mitigate the creation of life threatening circumstances and very high economic loss such as may occur with the complete inundation of an underground car park. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of inundation is less than 300mm. Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the CWFS.

## Evacuation

Controls	
C1.	Reliable access for pedestrians required during a 20 year ARI peak
C2.	Reliable access for pedestrians and vehicles required to a publicly accessible location during the PMF peak
C3.	Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site.
C4.	Applicant is to demonstrate the development is consistent with any relevant evacuation strategy or similar plan.
C5.	Applicant is to demonstrate that evacuation in accordance with the requirements of this DCP is available for the potential development resulting from the subdivision.
C6.	Adequate warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.

## Management and Design

Controls	
C1.	Applicant is to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this clause, and any applicable study, FRMS and FRMP.
C2.	Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI level (except for single dwelling-houses).
C3.	Applicant is to demonstrate that area is available to store goods above the 100 year level plus freeboard.
C4.	No storage of materials below the 100 year ARI level.







