Lot 1 DP219742 Concord West

Revised Flood Impact and Flood Risk Assessment

Final Report

Prepared For

FTD Holdings C/O Elton Consulting

June 2018

HydroSpatial Pty Ltd

ABN: 23 624 304 070

Suite 2, 472-474 High Street, Penrith NSW 2750

Contact: Tim Morrison

Email: Tim.Morrison@HydroSpatial.com.au

Mobile: 0421 775 175

Proposal Details	Lot 1 DP219742 Concord West – Revised FIA and FRA
Client	Vas Andrews, Elton Consulting
Author	Tim Morrison, David Tetley, Erika Taylor
Job Number	18006
Proposal Number	N/A

Document				
Version	Type	Review	Release	Date
1	Draft	Erika Taylor	Internal	02/05/2018
2	Draft	David Tetley	Vas Andrews	04/05/2018
3	Final	Vas Andrews, Jenny Rudolph	Vas Andrews	17/07/2018

Document Approval	
Tim Morrison Director	Signature

This project has been undertaken in partnership with Catchment Simulation Solutions Pty Ltd.

Catchment Simulation Solutions
ABN: 46 116 032 887
2.01/210 George St Sydney NSW 2000
Contact: David Tetley
Email: dtetley@csse.com.au
Phone: (02) 8355 5500

Disclaimer

The sole purpose of this report and the associated services performed by HydroSpatial Pty Ltd is to provide the information required in accordance with the scope of services set out in the contract between HydroSpatial Pty Ltd and the Client. That scope of services was defined by the requests of the Client and set out in the proposal. The scope is limited by the time and budgetary constraints imposed by the Client, and by the availability of data and other relevant information.

Executive Summary

A flood assessment of the proposed rezoning and development of a parcel of land located at 7 Concord Ave, Concord West has been completed. The assessment has been undertaken using data provided by Canada Bay Council that was developed for the 'Concord West Flood Study' (Jacobs, 2015). The assessment has been undertaken to comply with the Gateway Determination PP_2017_CANAD_005_00 dated 08/01/2018.

The assessment determined that flooding from the railway tracks (to the west of the site) is conveyed along Station Avenue before it splits into two branches; with the first branch continuing along Station Avenue and the second branch flowing into King Street (to the north of Station Avenue). The Station Avenue flow path enters the site from the south-eastern site corner and the King Street flow path enters the site at the mid-point of the eastern site boundary. Both the Station Avenue flow path and the King Street flow path reach the site at approximately the same time.

Overland flooding exiting the site is obstructed by the Homebush Bay Drive roadway embankment located along the western site boundary. This results in flood water stagnating in and around the site until the culverts under the roadway embankment can discharge into the Powells Creek parklands and/or the roadway embankment is overtopped (the latter as is the case in the Probable Maximum Flood (PMF) event).

Under existing conditions, the site is affected by depths of approximately 0.8 m in the 1% Annual Exceedance Probability (AEP) event and 2.4 m in the PMF event; and velocities of approximately 1.4 m/s in the 1% AEP event and 2.0 m/s in the PMF event.

The assessment considered two potential mitigations options to ensure the flood risk due to overland flow across the site could be appropriately managed and also ensure that the flood risk across adjoining properties is not increased as a result of the development. Both Option 1 and Option 2 involved underfloor drainage through the site with storage areas beneath the ground floor. Option 2 was found to be the preferred option and includes the following components:

- Provision of a 14-metre wide by 1 metre high central conveyance area extending beneath the elevated ground floor of the development (the conveyance area is designed to allow water to move from the eastern side of the site to the western side of the site beneath the ground floor).
- A 22-metre wide by 1 m high inlet structure to allow water near the eastern site boundary to enter the conveyance area. A 50% blockage factor was included to reflect that this opening would have a reduced aperture to prevent access into the conveyance areas (a 14-metre wide entrance was originally trialled in line with the IGS proposal, however, the inclusion of blockage required the entrance to be upsized).
- Inclusion of a 14-metre wide opening along the western site boundary to allow water to "escape" from the conveyance area towards Homebush Bay Drive.
- Provision of an additional 10-metre wide by 1 m high conveyance area running from the central conveyance area to the south-western corner of the site.
- Inclusion of a 0.3m diameter low flow pipe to allow flow from the additional conveyance area to discharge into the existing culvert system across Homebush Bay Drive.
- Additional flood storage areas were included to the north and south of the central conveyance area. The following storage volumes were adopted as part of the assessment (the storage volumes incorporate a 5% reduction factor to account for internal stairwells, elevator shafts, piers/supports etc.):
    - Northern storage area = 3,340 m^3
    - Southern storage area = 5,760 m^3

If Option 2 is implemented, there is predicted to be no adverse flood impacts on neighbouring properties and ensures the site is developable.

A qualitative flood risk assessment was undertaken and it was found that due to the flash flood nature of the catchment, there would be negligible opportunity for vehicular escape from the site prior to or during the flood. There are two potential overland escape routes, however these are cut off by high hazard flood waters for approximately 2.3 hours in the PMF and are cut within 30 minutes of rainfall beginning. Even if vehicular evacuation were feasible, the evacuees would be escaping into extreme rainfall that would be too intense to possibly drive through.

Given the short nature of the flooding (less than 4 hours in the PMF) and the lack of warning time, a shelter in place plan is the safest option. Above floor flooding will only occur in floods much rarer than the 1% AEP flood, such as the PMF and the development will include multi-storey buildings so that a publicly available PMF refuge should be easily incorporated in the design of each of the buildings, ideally these will be located on the first floor. The occupants would only need to wait for a maximum of around 4 hours, so no special provisions would need to be provided at the PMF refuge. In order for Shelter in Place to be successful, a robust flood emergency management plan would need to be developed and implemented as part of the development. This should be developed with any future Development Application (DA) for the site.

Based on the flood assessment it can be concluded that:

- If Mitigation Option 2 is incorporated into the design of the development, then there are predicted to be no adverse flood impact on neighbouring properties
- The planning proposal is inconsistent with Clause 6(C) of the Section 9.1 Direction 4.3 Flood Prone Land. However, this inconsistency is considered to of minor significance as:
    - The site has been identified for renewal through master planning processes
    - The site has been subject to several studies which have identified solutions to the flood risk on the site
    - The site is classified as medium flood risk category and development controls and flood emergency management provide effective flood risk management for events up to the PMF to enable change in land use without increase in overall flood risk
    - A further detailed assessment of the flood risk and flood emergency response will be undertaken at the DA stage
    - There are a number of planning proposals with similar flooding conditions and mitigation measures to address flood risk were found to be acceptable significance.
- The recommended flood response on site is Shelter in Place. This is due to the flash flood nature of the flooding. Evacuation of the site is likely to be infeasible and present a greater risk to the occupants than sheltering in place, which will typically require occupants to shelter for less than an hour with a maximum of around 3 hours.

The following recommendations are made for the design of the subject site:

1. Mitigation Option 2 is incorporated into the design of the development.
2. A robust Flood Emergency Response Plan that uses a Shelter in Place strategy is developed for the site.
3. A publicly available PMF refuge is incorporated into the design of each of the buildings
4. The entrance into the basement car parking is set no lower than the PMF level or otherwise flood gates are implemented to ensure that the basement carpark is not flooded during any design flood.
5. The building is designed such that it can withstand the depth and velocity of floodwaters during all floods up to and including the PMF and the building is constructed from flood compatible material at least up to the 1% AEP plus freeboard.

6. The building is in line with the ABCB fire safety requirements for “high rise buildings” regardless of whether it is considered high rise.
7. The design meets all other requirements as outlined by the Canada Bay DCP (2017) and summarised in Table 1.

The proposed solution manages the flooding and overland flow on the site, resulting the site being developable.

Table of Contents

Table of Tables

Table of Plates

Appendices

1 Introduction

1.1 Subject Site

The subject site for this study is Lot 1 DP219742 Concord West (7 Concord Ave, Concord West).

The site is a relatively large lot located at the end of Concord Ave in the north east and Station Ave in the South East and is currently Zoned IN1. The site currently has a large industrial building covering the southern half of the site that is currently used as a recreational centre (Paintball and Go Karting).

The site is subject to overland flooding coming on to the site from the east and then flowing around the building and under Homebush Bay Drive to the west.

1.1.1 Proposed Development

The planning proposal seeks to change the zoning of the site from IN1 (General Industrial) to R3 (Medium Density Residential). The proposed development will comprise two multi storey residential buildings and another building with multi storey townhouses. Buildings will be connected by an elevated ground floor, including roads and open space at the elevated level.

1.1.2 Planning History

The site has a history of planning with respect to flood risk, which is summarised below:

- December 2015: the planning proposal was submitted to Council including a Flood Assessment undertaken by Integrated Group Services (IGS).
- March 2016: Council engaged Jacobs to undertake a review of the IGS Flood Assessment. The review raised a number of concerns that were addressed by IGS and peer reviewed by Dr Brett Phillips from Cardno. Subsequently a meeting was held with Council to discuss.
- June 2016: An additional meeting was held with Council, IGS and Cardno to attempt to resolve flooding issues.
- September 2016: A revised planning proposal was submitted to Council with revised flood impact assessment prepared by IGS.
- September 2016 to January 2017: IGS responded to a number of queries raised by Council and their consultant (Jacobs).
- February 2017: Elton submitted a letter to Council requesting feedback on the planning proposal as well as providing supplementary documentation. Council then held a meeting where the planning proposal was rejected on flooding and traffic issues.
- April 2017: Elton submitted a rezoning review request to the Department of Planning and Environment.
- June 2017: The Sydney Central Planning Panel decided at a meeting that the planning proposal should proceed to Gateway determination stage
- January 2018: The Department of Planning and Environment issued a Gateway Determination.

As part of January 2018 Gateway Determination, the following flood-related requirements are to be addressed in order for the planning proposal to proceed:

- Include the site on Council's LEP Flooding Map to identify the site being within a 'flood planning area' and as result subject of Clause 6.8 Flood Planning

- Outline how the planning proposal complies with the requirements of Section 9.1 Direction 4.3 Flood Prone Land and seek agreement of the Department of Planning and Environment's Secretary where inconsistent (if required)
- Demonstrate consistency with any available findings of the precinct wide flooding study associated with the Burwood Strathfield and Homebush Planned Precinct.

1.2 Project Objectives

Quantify the flood risk and flood impacts associated with the planning proposal and address the requirements of the gateway determination.

1.3 Flood Occurrence

This study primarily presents findings from the 1% Annual Exceedance Probability (AEP) flood event and the Probable Maximum Flood (PMF). The 1% AEP flood is the standard flood for development assessment while the PMF presents the likely worst-case scenario for flooding. In any given year the 1% AEP event has a 1% chance of occurring, or a 55.25% chance of occurring over an 80-year time frame. Therefore, it should be a reasonable expectation that a flood of this magnitude will occur over a lifetime.

The PMF on the other hand typically has a 0.0001% chance of occurring in any given year and a 0.008% chance of occurring over an 80-year time frame. Therefore, it is very unlikely that a flood with the magnitude of a PMF will occur over a lifetime. The PMF is often referred to as an "extreme" flood and areas that are inundated by the PMF usually fall under a "low flood risk category" in flood planning systems, such as the Canada Bay DCP.

2 Available Data

2.1 Development Data

Data for the proposed development on site was provided by Elton Consulting from the Concept Master Plan (dated August 2016) drawing set, specifically the drawings named:

- Basement Plan;
- Flood Storage Void;
- Ground Floor Plan; and
- Sections.

2.2 Model Data

A flood impact assessment was prepared by Integrated Group Services (IGS) to support the proposed rezoning of Lot 1, DP 219742. The first revision of the report was prepared in October 2015. Several revisions of the report were subsequently issued (in addition to an addendum report prepared in April 2017) to address comments raised by Canada Bay Council as well as the outcomes of peer reviews completed by Jacobs and Cardno.

The flood impact assessment was completed using a TUFLOW hydraulic computer model that was originally prepared by Jacobs as part of the 'Concord West Precinct Master Plan Flood Study'. A copy of the TUFLOW model was provided by IGS to use as part of the current assessment. This included the TUFLOW model representation for "existing" topographic and development conditions as well as number of different "post-development" development scenarios. Inputs files were provided to allow each version of the model to be run for the 20% AEP, 1% AEP and Probable Maximum Floods. Additional scenarios were also included to represent potential future climate change.

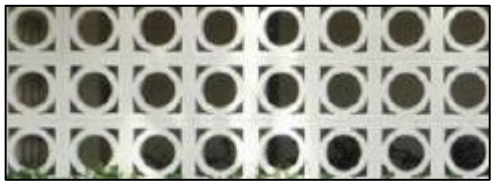
A review of the TUFLOW model was completed as part of the current assessment. This review determined that the model was generally developed in accordance with current best practice. The only major modelling inconsistency that was identified for the "existing" scenario model was the representation of the existing warehouse building located on-site. All significant buildings within the model area were represented as complete flow obstructions. However, the existing warehouse was not represented at all in the model. A review of the IGS and Jacobs reports indicated that this omission was associated with the assumption that the existing building would provide little impediment to flow. However, the warehouse is of brick construction (refer **Error! Reference source not found.**) so it is considered that it would provide a significant flow impediment. Furthermore, inclusion of the obstruction caused by the building is likely to better represent areas of higher flow velocities / flood hazard as water is "squeezed" between buildings in the area. Therefore, it is recommended that the existing conditions model be updated to include the existing warehouse as a complete flow obstruction.

Plate 1 *Existing warehouse located on-site (brick construction so would afford a significant impediment to flow) (Google, 2018)*

As discussed, a range of different "post-development" scenarios were also included in the TUFLOW model. These scenarios included representation of the impediment to flow that would be afforded by the future buildings across the site as well as three different mitigation options that could be potentially incorporated in the future development of the site to offset any predicted flood impacts. The development "scenario 3" was nominated in the report as the preferred post-development option. This option included provision for a flood storage / conveyance area above the basement car park but below the elevated ground floor level as a means of allowing water to pass through and be "stored" on the site (refer Plate 2). This scenario was reviewed and determined to be generally suitable. However, the following limitations were identified:

- The flood storage / conveyance area was represented in the TUFLOW model in the 2-dimensional domain as a "flow constriction" layer. This is considered to be reasonable in smaller events where the flow is contained below the ground floor level. However, during larger events (e.g., PMF), when flow exceeds the capacity of the storage area and begins to spill across the ground floor, it provides a less reliable description of the spatial variation in flow impediments. Furthermore, the results from this representation do not provide a reliable representation of the likely flood hazard across habitable areas of the proposed development as the depths and velocities are representative of the conveyance/storage areas only. Therefore, it is suggested that the storage/conveyance area would be better represented as a 1-dimensional culvert or storage area with flow across the ground floor level represented in the 2-dimensional domain (with a suitable representation of flow impediments across the ground floor).

- A low flow pipe culvert was nominated in the concept design to drain flows from the south-western corner of the conveyance/storage area into the pipe system beneath Homebush Bay Drive. However, a pipe/culvert size is not provided in the plans and the pipe/culvert is not included in the TUFLOW model. Although this structure is intended to drain the area after the flood and is therefore unlikely to have a large impact on the performance of the proposed system at the peak of the flood, it is considered important to include a full representation of the design concept in the model to ensure the potential flood impacts are fully understood. IGS have suggested that "Breezeway Blocks" (refer to image below for an example) could be provided to prevent future residents from accessing the conveyance/storage area but still allow for water to enter/exit the area. These blocks have a relatively small aperture (smaller than most debris likely to be mobilised in an urban catchment) and no allowance for blockage of the entrance has been included in the TUFLOW modelling. It is suggested that a minimum blockage allowance of 50% be included to reflect the potential for blockage of the entrance.



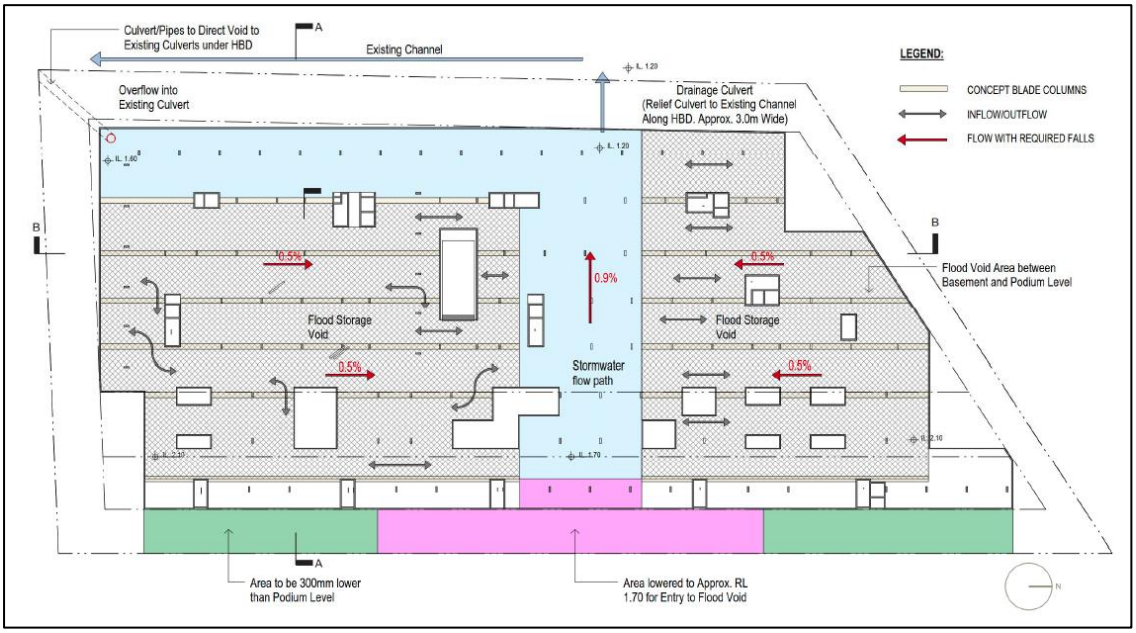


Plate 2 Preferred flood mitigation option nominated by IGS (IGS, 2017)

Some issues were also identified with the design flood levels that were presented in the report. Specifically, the tabulated flood levels were reported as being identical during the 20% AEP, 1% AEP and PMF events at multiple locations, which is highly unlikely. A review of the TUFLOW modelling results indicated that this is most likely a reporting problem, rather than a problem with the underlying model (i.e., the peak flood level results have been transposed incorrectly from the modelling results to the report table).

Overall, it is considered that the flood impact assessment and the associated TUFLOW model prepared by IGS provides a suitable starting point for understanding the flood constraints that confront the site. It also outlines mitigation measures can likely be implemented to offset any adverse flood impacts associated with the future development of the site. Notwithstanding, it

is recommended that some updates are completed to the TUFLOW model to ensure it provides the best possible representation of existing as well as potential future flood behaviour. Further discussion on the updates that were completed to the model as well as the results of the revised flood simulations are provided in Chapter 4.

3 Planning Control Review

3.1 Local Environment Plan

As per the Gateway Determination the site is to be identified as being within a 'flood planning area' in Council's LEP Flooding Map and be subject of Clause 6.8 Flood Planning.

The published LEP map does not currently show the site as being flood affected as part of the planning proposal, a revised flood prone land map will be included (as per the gateway condition 1b).

6.8 Flood planning

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to:

(a) land identified as "Flood planning area" on the Flood Planning Map, and

(b) other land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005, unless it is otherwise defined in this clause.

(5) In this clause:

flood planning level means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard, or other freeboard specified in a development control plan applying to the land.

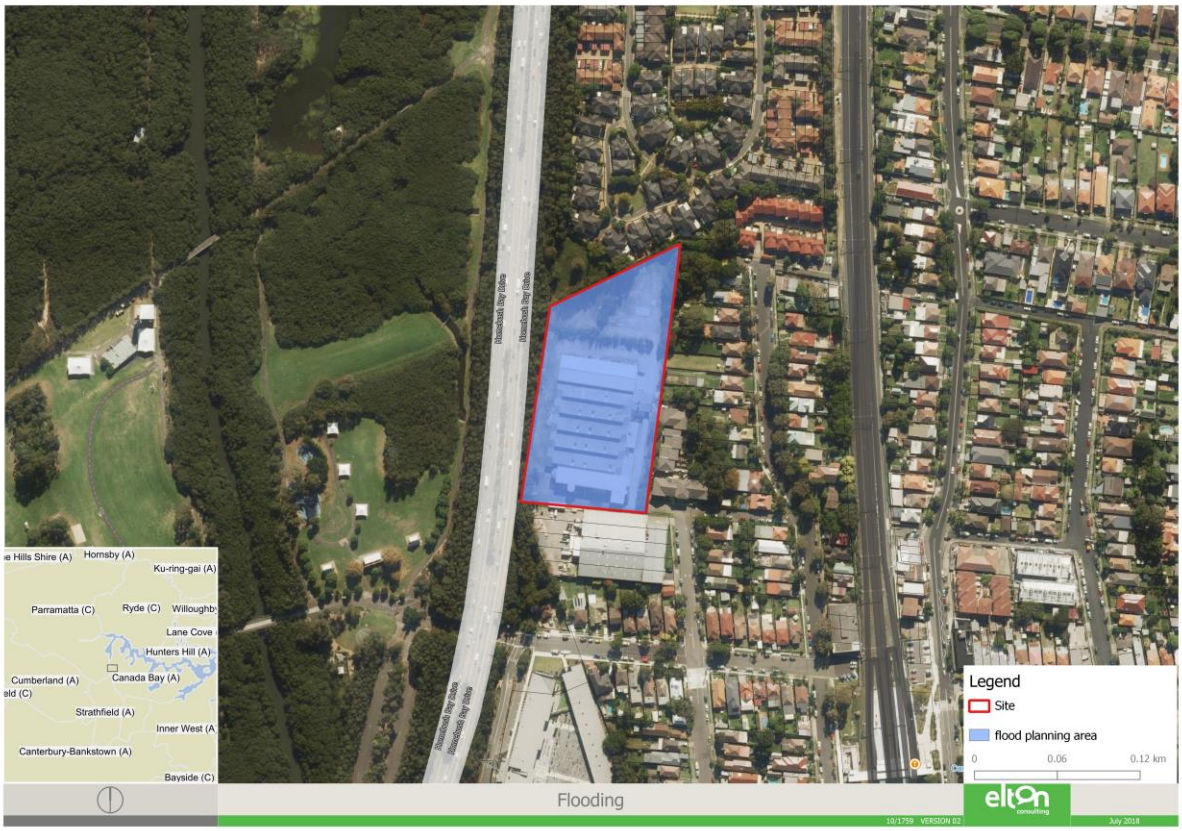


Plate 3 Subject Site on the Proposed LEP Maps

3.2 Development Control Plan

A review of the Canada Bay Development Control Plan (2017) (DCP) has been undertaken with respect to the site. In particular the C7 Flooding Control section has been reviewed.

3.2.1 Land Use

The planning proposal seeks to change the zone of the site to R3, which is a residential only zone. Therefore, the proposed land use of the site is "Residential" under the Table C-J of the DCP.

3.2.2 Flood Risk Categories

The Jacobs Flood Study does not define the flood risk category for the site (or any part of their study area). Therefore, the flood risk category has been determined based upon the flood model results (refer Section 5.1).

The DCP defines flood risk categories as:

- High in areas where the flood hazard in the 1% AEP event is high.
- Medium in areas where the flood hazard in the 1% AEP event is low.
- Low in areas where the flood category is not medium or high but are inundated within the PMF.

Figure A6 shows that the majority of the site is inundated by the 1% AEP event; however, the flood hazard is Low. Therefore, the site would fall within the medium flood risk category, as shown in Figure A9.

3.2.3 Flood Controls

The flood controls applicable to the site have been extracted from Table C-K and Section C7.5 of the DCP for "Residential" Land Use for the "Medium" flood risk category. These are presented in Table 1. Commentary is also provided on how development within the study area would address these controls. In many cases more detailed information is provided in subsequent sections of this report.

Table 1 DCP Flood Controls

Planning Consideration	Planning Control	Comment
Floor Level	Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. A restriction is to be place 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.	These are achieved through elevating the ground floor of the development to above the flood planning level (outlined in Section 5.4).
Building Component	All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard.	This will be achieved during detailed design phase.
Structural Soundness	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.	This will be achieved during detailed design phase as the detailed design has not been undertaken for the structures.

Planning Consideration	Planning Control	Comment
Flood Affection	An Engineer's report is required to demonstrate how and certify that the development will not increase flood affectation elsewhere, having regard to: a) loss of flood storage; b) changes in flood levels, flows and velocities caused by alterations to flood flows; and c) the cumulate impact of multiple potential developments in the vicinity.	This report shows that if Mitigation Option 2 is adopted under the current design, there are no adverse flood impact or affectation on adjacent lands.
Car Parking & Driveway Access	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. 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 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. 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. 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. Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood. 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 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.	The entrance to the basement car parking area will need to be set at the PMF level, this and driveway requirements will need to be addressed as part of detailed design.
Evacuation	Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site. Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan. Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.	The proposal encourages multi-storey development which will include refuges above the level of the PMF. Given the flash-flood nature, there is no time available for evacuation therefore a shelter in place plan is more appropriate (discussed in Section 7)

Planning Consideration	Planning Control	Comment
Management and Design	Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard. No storage of materials below the 100 year ARI flood level.	The development is elevated above the 100 year flood level plus freeboard, basement car parking would be protected to the PMF. Therefore, no goods or material will be stored below the 100 year level plus freeboard.

4 Section 9.1 Direction 4.3 Flood Prone Land

Section 9.11(2) of the EP&A Act permits the Minister for Planning to issue a direction in relation to the making of local environmental plans. Several of these have been issued including Direction 4.3 which relates to flood prone land. The direction is outlined below and commentary has been provided on how the planning proposal attempts to meet those requirements.

Objectives

(1) The objectives of this direction are:

(a) to ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and

Consistent: The proposal has undergone a flood impact and flood risk assessment that is consistent with the approaches outlined in the Flood Prone Land Policy and Principles of the Floodplain Development Plan

(b) to ensure that the provisions of an LEP on flood prone land is commensurate with flood hazard and includes consideration of the potential flood impacts both on and off the subject land.

Consistent: The proposed changes of the LEP reflect the flood risk associated with the land and the potential for impacts has been mitigated through proposed on site mitigation measures.

Where this direction applies

(2) This direction applies to all relevant planning authorities that are responsible for flood prone land within their LGA.

Applies: The planning proposal is within Canada Bay LGA.

When this direction applies

(3) This direction applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.

Applies: The planning proposal includes land that is flood prone.

What a relevant planning authority must do if this direction applies

(4) A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas).

Consistent: The planning proposal has undergone a thorough risk assessment process and complies with the flood controls outlined Canada Bay LEP (2013) and DCP (2017) which has been developed in line with the NSW Flood Prone Land Policy and Floodplain Development Manual 2005. The Planning Proposal will not alter land provisions within the DCP.

(5) A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.

Consistent: The planning proposal rezones land from IN1 (industrial) to R3 (residential).

(6) A planning proposal must not contain provisions that apply to the flood planning areas which:

(a) permit development in floodway areas,

Consistent: The planning proposal area does not contain a floodway for either the baseline or developed case as shown Figure A8 and D10.

(b) permit development that will result in significant flood impacts to other properties,

Consistent: The planning proposal will have no flood impacts (under mitigation scenario 2) to other properties as shown in Section 5.

(c) permit a significant increase in the development of that land,

Inconsistent: The rezoning from IN1 to R3 provides the opportunity for increased development at the site. Refer 9(b) of this Clause for justification and Section 4.1 of this report.

(d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services, or

Consistent: The proposed flood emergency response plan for the site will not require additional assistance from the emergency services and no external flood mitigation measures or infrastructure are required.

(e) permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.

Consistent: A development application will be lodged seeking consent for the proposed development following the approval of the planning proposal. Development controls would require consideration of potential adverse flood impact in the development assessment process.

(7) A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).

Consistent: The planning proposal will not impose flood related development controls above the residential flood planning level.

(8) For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the

proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).

Consistent: The proposed flood planning level is the 1% AEP flood plus 500 mm freeboard, which is consistent with the Floodplain Development Manual 2005.

Consistency

(9) A planning proposal may be inconsistent with this direction only if the relevant planning authority can satisfy the Director-General (or an officer of the Department nominated by the Director-General) that:

(a) the planning proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005,

Not applicable – See Section 6.

(b) the provisions of the planning proposal that are inconsistent are of minor significance.

As identified in Point 6(C) the planning proposal is increasing the development of the land. The existing development is located near natural surface and any development arising as a result of this planning proposal will need to comply with the DCP. Given this, while the development would increase the population at risk, it would reduce the risk presented to the population and therefore the development will not result in an increase to the overall flood risk. This is due to the application of flood controls and implementation of a flood emergency response plan. Refer Section 4.1 below for justification as to why this inconsistency is minor.

4.1 Clause 6(c) Significance

As discussed, we believe that the inconsistency with Clause 6(c) of Direction 4.3 should be considered “minor significance”. This is due to:

- The site has been identified for renewal through master planning processes
- The site has been subject to several studies which have identified solutions to the flood risk on the site
- The site is classified as medium flood risk category and development controls and flood emergency management provide effective flood risk management for events up to the PMF to enable change in land use without increase in overall flood risk
- A further detailed assessment of the flood risk and flood emergency response will be undertaken at the DA stage
- There are a number of planning proposals with similar flooding conditions and mitigation measures to address flood risk were found to be acceptable significance.

A review of similar planning proposals was undertaken to ensure that this interpretation was consistent for similar proposals. The findings of this review are outlined below.

4.1.1 2, 2A and 4 Rothwell Avenue, Concord West Planning Proposal

A planning proposal was submitted to Canada Bay Council to rezone 2, 2A and 4 Rothwell Avenue Concord West from IN1 General Industrial to R3 Medium Residential. This is a very similar planning proposal to the subject site. The planning proposal was supported by Council and approved by the Minister on the 14 January 2016

Review of the documentation (http://www.canadabay.nsw.gov.au/link.aspx?id=15700) for the Rothwell Avenue planning proposal shows that the Department's flood planning model clause for the Canada Bay LEP 2013 (now Clause 6.8 Flood Planning in the LEP) was proposed as part of this planning proposal in accordance with the findings of the draft Concord West Precinct Flood Study. A map was also included in the LEP that identifies the subject area as 'flood planning area' and be read in conjunction with the draft flood planning controls above.

A separate site specific flood assessment was also submitted with the planning proposal, concluding that the proposed development will not have any negative impact with respect to flooding on neighbouring properties. The assessment report recommended minimum flood planning levels, freeboards and retention of an existing overland flow path, along with further investigations when detailed development designs are prepared for the subject site.

Council considered that the planning proposal is consistent with the findings of the draft Concord West Flood Study, and that it can be progressed in parallel with the draft Flood Study.

The Department considered that the proposed new clause regarding flood planning will appropriately address any flood hazards, flood behaviour and potential detrimental impacts of flooding on other development at the development application stage.

4.1.2 2-32 Junction Street Forest Lodge

A planning proposal was submitted by City of Sydney Council to increase allowable building heights at 2-32 Junction St Forest Lodge from 12 metres to 35.5 metres and associated floor space ratio increases.

This site is significantly flood affected, with depths of up to 3.5 metres in a 5% AEP event and evacuation is not possible for the majority duration of the flood. The flood strategy suggests early evacuation, however due to the flash flood nature of the catchment, this is unlikely to be successful. (See: https://www.sydneyyoursay.com.au/28897/documents/60465 and http://leptracking.planning.nsw.gov.au/proposaldetails.php?rid=2715)

The Planning Proposal and site specific amendment to Sydney DCP 2012 requires various flood risk mitigation measures. This includes suspending the car park floor slab, elevating it to the 5% annual AEP, using permeable screening for its face, locating the vehicle access to the high point, requiring three evacuation points and requiring permanent signage. The planning proposal also identified that detailed flood assessment would be undertaken.

The proposal was considered to be inconsistent with Ministerial Direction 4.3 as it would significantly increase the development of the land in flood prone area.

A Department of Planning's assessment team recommended that the Secretary can be satisfied that the inconsistency was of minor significance based on the mitigation measures proposed to be implemented.

In the Gateway Determination, the Department of Planning and Environment stated that "I have also agreed, as delegate of the Secretary, the planning proposal's inconsistency with

S117 Direction 4.3 Flood Prone Land is of minor significance". (See: https://www.sydneyyoursay.com.au/28897/documents/60464)

4.1.3 Updated Parramatta CBD Floodplain Risk Management Plan

As part of Parramatta Council's plan to increase development within the Parramatta CBD, they engaged consultants Molino Stewart to undertake an update of the Parramatta CBD Floodplain Risk Management Plans (FRMP). This would allow Council to proceed with their planning proposal despite inconsistency with Section 6(C) of Direction 4.3.

see: https://www.cityofparramatta.nsw.gov.au/sites/council/files/inline-files/Appendix_10_Draft_Updated_Parramatta_Flood_Risk_Management_Plans.pdf

As part of the updated FRMP, Parramatta CBD was categorised according to the risk to life and recommendations for flood risk mitigation were made for each of the categories. If the same categorisation was applied to the subject site, it would be considered a Category 2 (inundated during the 1% AEP, Inundated for less than 8 hours during the PMF with a depth greater than 0.6 m). The requirements in the updated Parramatta FRMP for a Category 2 building with respect to flood risk to life are:

- A shelter for all building occupants above the PMF
- Fire Safety is rated to ABCB requirements for high rise whether high rise building or not
- Flood Emergency Response Plan for the building maintained by the building owner or body corporate
- Residents able to exit the building in a 1% AEP.

The planning proposal and proposed development for this subject site 7 Concord Avenue, Concord West would meet all of the above requirements and the site would likely to be consistent with any Floodplain Risk Management Plan.

Further, many planning proposals for individual sites in the Parramatta CBD that are flood affected have been able to proceed in advance of the planning proposal for the CBD which is still yet to receive a gateway determination to proceed to exhibition for example:

4.1.4 2-10 Phillip Street, Parramatta

The proposal seeks to increase the maximum FSR to 10:1 (plus design excellence bonus) and increase the maximum building height to 192m for land at 2-10 Phillip Street, Parramatta. In addition, a site specific provision is included that allows an additional 5.5:1 of floorspace where it is provided as a hotel.

Portions of the site are affected by 1:20 and 1:100 year flood event and the entire site is would be inundated in the event of a probably maximum flood.

The Gateway Determination report prepared by the Department of Planning and Environment stated that:

The inconsistency was considered justified on the basis of minor significance. The applicant will be required to submit details of appropriate design features and evacuation measures a part of design excellence and development application processes. It was recommended that delegate agree to any inconsistency being of minor significance

The Secretary agreed that the planning proposal's inconsistency with section 4.3 was of minor significance and it was approved by the Minister on the 15 June 2018.

5 Flood Impact Assessment

5.1 Existing Flood Assessment

To understand the potential impact that rezoning and development may have on existing flood behaviour, it is first necessary to define flood behaviour for 'existing' conditions. 'Existing' flood behaviour in the vicinity of the site was originally defined using a TUFLOW hydraulic model that was developed as part of the "Concord West Precinct Master Plan Flood Study" (Jacobs, 2015). This TUFLOW model was also used by IGS as part of the "Low 1 DP 219742, Concord West - Flood Impact Assessment" (IGS, 2016) to represent existing flood conditions across the site.

As discussed, in Section 2.2, a review of the TUFLOW model was completed as it was generally considered to be fit-for-purpose. However, it was recommended that the impediment to flow afforded by the warehouse located on the existing site be better represented in the model. Therefore, the 'existing' conditions model was updated to represent the existing warehouse as a complete flow impediment (in-line with the way in which buildings are represented in the original TUFLOW model). The updated TUFLOW model layout is presented in Figure A1 in Appendix A.

The updated model was used to simulate flood behaviour for existing topographic and development conditions for the 20% AEP (25-minute and 120-minute storm durations) and 1% AEP (25-minute and 120-minute storm durations) floods as well as the Probable Maximum Flood (PMF) (120-minute duration).

The results from each design flood simulation were subsequently combined to form a final design envelope for each flood frequency. Peak flood levels were extracted at various locations in the vicinity of the site and are tabulated in Table 2.

Table 2 Peak Design Flood Levels for Existing Conditions

Location (refer Plate 4)	Peak Flood Level (mAHD)		
	20% AEP	1% AEP	PMF
Concord Ave	2.02	2.16	3.76
Station Ave	2.02	2.16	3.77
George St Sag	3.40	4.12	4.81
NW Corner of Site	1.97	2.11	3.76
SW Corner of Site	1.90	2.12	3.76
King Street	2.02	2.17	3.76
SE Corner of Site	2.02	2.16	3.77
NE Corner of Site	2.02	2.16	3.76

The flood levels in Table 2 shows that there is minimal variation in peak water level across the site during the PMF. This indicates that the floodwaters are effectively forming a level "pool" of water behind the Homebush Bay Drive roadway embankment. During the 20% AEP and 1% AEP floods, a more significant variation in peak flood levels across the site is predicted.

However, the flood level variations across the site are predicted to be less than 0.15 metres. The relatively "flat" flood gradient across the site indicates that the site is subject to low flow velocities.

Plate 4 Flood Level Comparison Locations

Peak floodwater depths were also extracted from the TUFLOW model results and are presented in Figures A2 to A4, which are enclosed in Appendix A.

Figures A2 to A4 show that peak floodwater depths across the existing site are generally less than 0.2 metres during the 20% AEP event and less than 0.5 metres during the 1% AEP event. During the PMF, more significant depths of inundation are predicted (i.e. in the order to 2 metres).

The water depth mapping also indicates that the majority of floodwater enters the existing site via three main flow paths:

- The majority of water enters part way along the eastern site boundary via a sag point located in King Street
- Overland flow also enters near the south-eastern corner of the site via floodwater travelling in a westerly direction down Station Ave
- An additional flow path enters the site near the south-western corner. This flow path originates south of the site and travels through the Victoria Avenue Public School.

Flood hazard maps were also prepared using the TUFLOW model outputs based upon flood hazard vulnerability curves presented in the Australian Government's *"Technical Flood Risk Management Guideline: Flood Hazard"* (2014). The hazard curves are reproduced in Plate 5. As shown in Plate 5, the hazard curves assess the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters at a particular location. The flood hazard maps are provided in Figures A5 to A7.

Table 3 Flood hazard vulnerability table (Australian Government, 2014)

Hazard Vulnerability Classification	Classification Limit (D and V)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

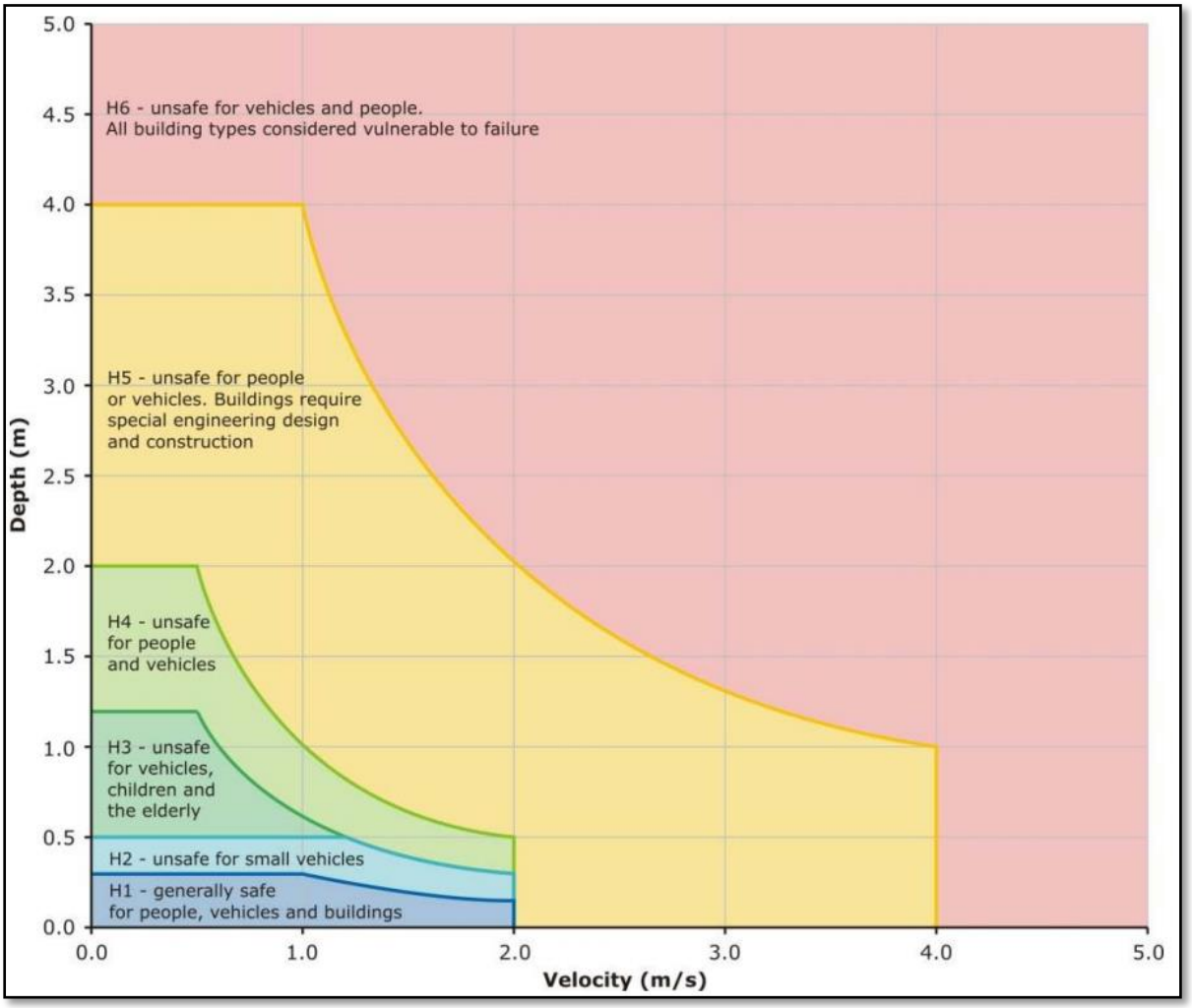


Plate 5 Flood hazard vulnerability curves (Australian Government, 2014)

Figure A5 shows that during the 20% AEP flood, most of the site would be categorised as "H1". This classification indicates that the site would be safe for people, buildings and vehicles at the peak of the 20% AEP flood.

Figure A6 shows that a greater proportion of the existing site would be classified as "H2" at the peak of the 1% AEP flood. This classification indicates that it would still be safe for buildings and people but may be unsafe for small vehicles.

During the PMF, most of the site would be classified as H4 or above (refer Figure A7). This classification indicates that the existing site is unlikely to be safe for vehicles and people and, for those areas subject to a H5 classification, the structural integrity of any buildings may be compromised if they are not specifically designed to withstand the depth and velocity of water during the PMF.

Overall, the existing site is subject to inundation in events as frequent as the 20% AEP flood. However, the peak floodwater depths and flow velocities during events up to and including the 1% AEP flood would not be sufficient to expose people or buildings to a significant flood hazard. A notable increase in flood hazard is predicted during the PMF.

5.2 Post-Development Flood Assessment

5.2.1 No Mitigation Options

As discussed in Section 1.1.1, the development proposal will involve rezoning of the site for residential purposes and construction of three medium density residential buildings with basement car parking and areas of open space surrounding the buildings. In order to comply with minimum floor level requires (discussed in more detail in Section 5.4), it will be necessary to elevate habitable areas above the peak level of the 1% AEP flood (this will also serve to reduce inundation depths across the site during the PMF, which will assist in reducing the existing flood hazard). However, these works may displace floodwaters that currently traverse the site which may adversely impact on flood behaviour across neighbouring properties.

To quantify the potential impact that the proposed development may have on existing flood behaviour, the TUFLOW model that was used to simulate existing flood behaviour was updated to include a representation of the proposed development. The model was initially setup to include the development with no associated mitigation options to confirm if mitigation measures were required in the first instance. The following updates were completed to the TUFLOW model to reflect the proposed development:

- The existing warehouse was removed;
- The ground floor of the proposed development was elevated to an elevation of 3.2 m AHD. It was assumed that this would extend all the way to the northern and southern site boundaries to ensure a conservative assessment of potential flood impacts was provided;
- The three proposed buildings were represented as complete flow obstructions;
- The lower lying area that was proposed by IGS adjacent to the eastern site boundary to direct water into the flow conveyance/storage area was retained. However, the flow conveyance/storage area was not included.

All existing drainage information was retained in the model and no additional drainage infrastructure was included. The final representation of the proposed development in the TUFLOW model is shown in Figure B1, which is enclosed in Appendix B.

The updated TUFLOW model was used to re-simulate the 1%AEP flood and PMF for “post-development” conditions. Peak floodwater depths and levels were extracted from the results of the modelling and are presented in Figures B2 and B3. Peak 1% AEP flood and PMF levels were extracted from the results of the modelling at multiple locations in the vicinity of the site and are summarised in Table 4. Flood levels for existing conditions are also included in Table 4 for comparison.

The floodwater depths presented in Figure B2 shows that elevating the ground floor of the proposed development to 3.2 m AHD will prevent inundation of the elevated ground floor and the adjoining ground floor level of the residential buildings during the 1% AEP flood. However, Figure B2 shows that inundation of the elevated ground floor is predicted at the peak of the PMF.

Flood hazard mapping was also prepared based on the results of the post-development with no mitigation options scenario. The hazard maps are presented in Figures B4 and B5 for the 1% AEP and PMF events respectively.

Table 4 Peak Design Flood Levels for Post-Development Conditions

Location (refer Plate 4)	Peak Flood Level (m AHD)							
	1% AEP				PMF			
	Existing	Post-Development			Existing	Post-Development		
		No Mitigation	Mitigation Option 1	Mitigation Option 2		No Mitigation	Mitigation Option 1	Mitigation Option 2
Concord Ave	2.16	2.69	2.28	2.17	3.76	3.83	3.81	3.79
Station Ave	2.16	2.69	2.28	2.18	3.77	3.84	3.82	3.79
George St Sag	4.12	4.12	4.12	4.12	4.81	4.81	4.81	4.81
NW Corner of Site	2.11	-	-	-	3.76	3.78	3.78	3.77
SW Corner of Site	2.12	-	-	-	3.76	3.76	3.76	3.76
King Street	2.17	2.69	2.27	2.16	3.76	3.84	3.82	3.79
SE Corner of Site	2.16	2.69	2.28	2.18	3.77	3.84	3.82	3.79
NE Corner of Site	2.16	2.69	2.28	2.18	3.76	3.83	3.81	3.79

The hazard maps confirm that no flood hazard is predicted across habitable sections of the site at the peak of the 1% AEP flood. During the PMF, where floodwaters are predicted to inundate the ground floor level, the flood hazard is classified as "H3". This classification indicates that adults could likely wade through water on the ground floor levels and the buildings themselves would not likely suffer structural damage. However, small cars parked on the ground floor may be mobilised and children and the elderly may not be able to wade through the floodwaters. Accordingly, although the elevated ground floor is predicted to significantly reduce the existing flood hazard at the peak of the PMF, it will not eliminate it completely.

5.2.1.1 Flood Impact Assessment

Although the proposed development is not predicted to expose future occupants of the site to a significant flood risk, there is potential for filling to adversely impact on flood behaviour across areas located outside of the site. This may increase the flood risk across adjoining properties.

To quality the potential for the proposed development of the site (with no mitigation options) to impact on existing flood levels, flood level difference mapping was prepared. Flood level difference mapping is prepared by subtracting peak "post-development" flood levels from "existing" flood levels. This creates a contours map of predicted changes in flood levels and enables the impact of the development on existing flood levels and extents to be readily quantified. The flood level difference mapping for this scenario is presented in Figures B6 and B7.

The difference mapping indicates that the proposed development (with no mitigation options) is predicted to produce some significant changes in flood levels during the 1% AEP. More specifically, flood level increases of over 0.5 metres are predicted across neighbouring residential properties to the east of the site. Accordingly, if the development was implemented without mitigation measures it would increase the flood exposure of existing properties located outside of the site. This is considered undesirable and indicates that mitigation measures will need to be implemented to ensure that the existing flood risk is not increased.

During the PMF, the flood level impacts are less significant (increases are typically about 0.07 metres). This reduced impact is associated with the following factors:

- The elevated Homebush Bay Drive embankment serves as the main hydraulic control in the area. Therefore, although the development does serve to impede flow, the roadway serves as a more significant impediment during the PMF and largely dictates peak flood levels across neighbouring properties.
- The elevated flood levels during the PMF allow flow to travel across the ground floor. Therefore, floodwaters are not completely obstructed during the PMF like they are during the 1% AEP which serves to lessen the flood impacts.

Therefore, although the flood impacts are relatively minor during the PMF, the more significant impacts during the 1% AEP flood will need to be reduced through the implementation of appropriate flood mitigation measures. Further discussion of the mitigation options that were investigated are provided in the following sections.

5.2.2 Mitigation Option 1

As outlined in Section 2.2, the preferred mitigation concept prepared by IGS as part of the original flood assessment for the site involved provision of a flow conveyance and flood storage area located below the ground floor (but above the car parking area) (refer Plate 2). This mitigation option was used as a starting point for the current study as well.

However, the flood storage area was removed from the first round of modelling to determine if provision of a flow conveyance area in isolation would be sufficient to offset the predicted flood level impacts (this is subsequently referred to as "mitigation option 1"). The modifications that were completed to the TUFLOW model to reflect this option are documented in Figure C1 in Appendix C and include:

- Provision of a 14-metre wide by 1 metre high central conveyance area extending beneath the elevated ground floor (the conveyance area is designed to allow water to move from the eastern side of the site to the western side of the site beneath the ground floor).
- A 22-metre wide by 1 m high inlet structure to allow water near the eastern site boundary to enter the conveyance area. A 50% blockage factor was included to reflect that this opening would have a reduced aperture to prevent access into the conveyance areas (a 14-metre wide entrance was originally trialled in line with the IGS proposal, however, the inclusion of blockage required the entrance to be upsized).
- Inclusion of a 14-metre wide opening along the western site boundary to allow water to "escape" from the conveyance area towards Homebush Bay Drive.
- Provision of an additional 10-metre wide by 1 m high conveyance area running from the central conveyance area to the south-western corner of the site.
- Inclusion of a 0.3m diameter low flow pipe to allow flow from the additional conveyance area to discharge into the existing culvert system across Homebush Bay Drive.

Each of the conveyance areas was represented in the TUFLOW model as a 1-dimensional structure. This enables the flow conveyance beneath the ground floor to be represented while still allowing for representation of flow across the top of the ground floor in 2-dimensions during large events, such as the PMF.

The updated model was used to re-simulate flood behaviour for post-development conditions with mitigation option 1. Peak 1% AEP flood and PMF levels were extracted from the results of the modelling at multiple locations near the site and are summarised in Table 4.

Peak floodwater depths and levels were also extracted from the results of the modelling and are presented in Figures C2 and C3. A review of Figure C2 relative to Figure B2 shows that the inclusion of the conveyance area is predicted to reduce peak 1% AEP floodwater depths immediately east of the development site. Accordingly, the inclusion of the conveyance area appears to be offsetting some of the adverse flood impacts that were observed as part of the no mitigation assessment. Figure C2 also indicates that the ground floor would remain above the peak level of the 1% AEP flood. However, Figure C3 shows that the ground floor would continue to be inundated to a depth of about 0.5 metres during the PMF.

Flood hazard mapping was prepared based upon the results of the mitigation option 1 modelling and is presented in in Figures C4 and C5.

The hazard mapping confirms that the elevated ground level would not be exposed to a flood hazard during the 1% AEP flood. However, during the PMF the ground level would be exposed to a H3 classification. The outcome is essentially unchanged from the no mitigation assessment and indicates that mitigation option 1 is not predicted to have a significant impact on flood behaviour across the site itself.

5.2.2.1 Flood Impact Assessment

To confirm the magnitude and extent of changes in peak flood levels and extents associated with implementation of mitigation option 1 in areas outside of the site, flood level difference was prepared for mitigation option 1. This was prepared by subtracting peak flood levels from

the mitigation option 1 simulation results from "existing" flood levels. The difference mapping is provided in Figures C6 and C7.

Figure C6 shows that inclusion of mitigation option 1 has reduced the magnitude and extent of flood level increases during the 1% AEP flood to the east of the site. More specifically, flood level increases across properties to the east of the site are predicted to reduce from >0.5 metres during the no mitigation option assessment to around 0.1 metres under the mitigation option 1 assessment. Therefore, although mitigation option 1 has reduced the flood level impacts, it has not eliminated them. Therefore, additional mitigation measures are considered necessary to further reduce the potential for flood level increases across neighbouring properties to the east of the site during the 1% AEP event.

Figure C5 shows that mitigation option 1 has also reduced the adverse flood impacts during the PMF (although the differences are less obvious relative to the 1% AEP event). More specifically, flood level increases across the properties east of the site are predicted to reduce from 0.07 metres during the no mitigation option assessment down to about 0.05 metres during the mitigation option 1 assessment.

Overall, implementation of mitigation option 1 has produced a notable reduction in flood level impacts during the 1% AEP event. However, it is considered necessary to supplement thus mitigation options with additional mitigation features to try and eliminate adverse flood level impacts during the 1% AEP event. Further discussion on the additional mitigation assessment is provided below.

5.2.3 Mitigation Option 2

Mitigation option 2 builds upon the mitigation option 1 but is expanded to include provision of additional flood storage areas adjacent to the flood conveyance areas explored as part of mitigation option 1. This is very similar to the preferred mitigation options recommended by IGS as part of the original flood assessment for the site. However, as noted in the mitigation option 1 discussion, some modifications to the flow conveyance arrangement proposed by IGS were completed. In addition to the mitigation options already included for mitigation option 1, the following additional modifications were completed to the TUFLOW model to reflect the final mitigation option 2 (also refer to Figure D1 in Appendix D):

- Additional flood storage areas were included to the north and south of the central conveyance area. The storage areas were represented in the TUFLOW model as 1-dimensional storage nodes. The following storage volumes were incorporated in each node (the storage volumes incorporate a 5% reduction factor to account for internal stairwells, elevator shafts, piers/supports etc):
  - Northern storage area = 3,340 m^3
  - Southern storage area = 5,760 m^3
- 1-dimensional "connectors" were also included to allow water to move between the conveyance areas and the storage areas

The updated model was used to re-simulate the 1% AEP and PMF floods with mitigation option 2 in place. Peak 1% AEP flood and PMF levels were extracted from the results of the modelling at multiple locations near the site and are summarised in Table 4.

Peak floodwater depths and levels were extracted from the results of the modelling and are presented in Figures D2 and D3. Flood hazard mapping was also prepared and is presented in Figure D4 and Figure D5.

Figures D2 to D5 show similar inundation and flood hazard characteristics across the site relative to the other post-development scenarios (i.e., no inundation/hazard across the ground

floor during the 1% AEP, 0.5 m depth of water and H3 hazard across the ground floor during the PMF).

The flood level comparison within Table 4 also shows that peak design flood levels for the mitigation option 2 are very similar to existing levels. The extent of flood level changes outside the site was assessed using difference mapping, which is discussed in more detail below.

Mitigation Option 2 is the proposed flood solution by HydroSpatial and Catchment Simulation Solutions.

5.2.3.1 Flood Impact Assessment

To confirm the magnitude and extent of changes in peak flood levels and extents associated with implementation of mitigation Option 2, flood level difference was prepared. The difference mapping is provided in Figures D6 and D7.

Figure D6 shows that if the development was implemented with mitigation Option 2, flood level increases are largely eliminated. The only flood level increase is predicted to occur near the south-west corner of the site and is predicted to be less than 0.02 metres. This is considered to be a negligible increase and is contained to a small localised area.

Figure D6 also shows that peak 1% AEP flood levels are predicted to reduce across a number of locations if the development is implemented with mitigation Option 2. This includes an area of mangroves between Homebush Bay Drive and Powell Creek as well as the Victoria Avenue Public School. This is considered to be a beneficial outcome given that school children are more vulnerable during flooding. The flood hazard mapping provided in Figure D4 confirms the majority of the school would be classified as either H1 or H2. This indicates that children would not be exposed to a significant flood risk. Notwithstanding, a small area of H3 extends across the Victoria Avenue frontage of the school where it may not be safe for children at the peak of the 1% AEP flood (although the extent of this H3 area is reduced relative to existing conditions).

Figure D7 shows that implementation of mitigation Option 2 will not eliminate all flood level increases during the PMF. However, the increases are not predicted to exceed 0.03 metres at any location. Given the minor nature of the flood level increases and the rarity of the PMF, this flood level impact is considered acceptable when considered in combination with the benefits afforded during the 1% AEP flood across other properties.

5.3 Recommended Options

It is recommended that the development is implemented with mitigation Option 2. This option incorporates the following major features:

- Flood conveyance areas running centrally beneath the ground level (but above the basement car parking area) and along the western edge of the elevated ground level
- Flood storage areas located to the north and south.

There are concerns that the flow conveyance and storage areas may be difficult to access for maintenance purposes and sediment will accumulate in the area. However, if the flow conveyance areas are implemented with a minimum grade (1% suggested) this will assist in providing a “self-cleansing” velocities ensuring sediment is not deposited in the area (velocities of about 0.8 m/s are predicted through the area at the peak of the 1% AEP flood). It is also noted that flow velocities immediately upstream (i.e., east) of the conveyance area are typically low (i.e., less than 0.5 m/s at the peak of the 1% AEP flood). Therefore, it is likely that much of the sediment will drop out of suspension before entering the conveyance area. It is recommended that a sediment deposition area (essentially a flat, grassed area that is located

slightly below the invert of the inlet) be provided near the entrance to the conveyance area that can serve to capture sediment that falls out of suspension (as well as gross pollutants that cannot fit through the entrance structure) before entering the conveyance area. This area can be maintained/cleaned following rainfall events without requiring access into the conveyance/storage area. Cleaning of the conveyance/storage area will still be required, but this will only need to be completed very periodically (noting that the size of the conveyance/storage area is quite substantial relative to the likely thickness of a layer of sediment).

The responsibility for maintenance should rest with the strata/body corporate for the proposed development however access should be provided to Council for inspection if required.

5.3.1 Developed Examples Similar to Mitigation Option 2

Previous reporting by IGS provided some examples of developments where similar mitigation options were implemented. Council subsequently raised concerns that these examples were not actually implemented and that “most importantly they are not subject to the speed of rise experienced by the subject site”.

We have undertaken a brief review of areas that have similar flooding conditions and examples of similar flood mitigation solutions. The most similar example that we can find is along the Clay Cliff Creek area of Parramatta.

Clay Cliff Creek runs from the suburban area of Parramatta in the south west, through the CBD and into the Parramatta River. The area of interest is along the southern side of Parramatta CBD, primarily along Parkes St between the Great Western Highway and Harris Street. At this location, the Creek is effectively filled in and the flooding is primarily overland flow. This area is subject to very frequently flooding, with widespread flooding occurring in the 5% AEP event. Similarly, to Concord West, Clay Cliff Creek is considered a “flash flood” catchment with no effective warning time available and very fast rates of rise.

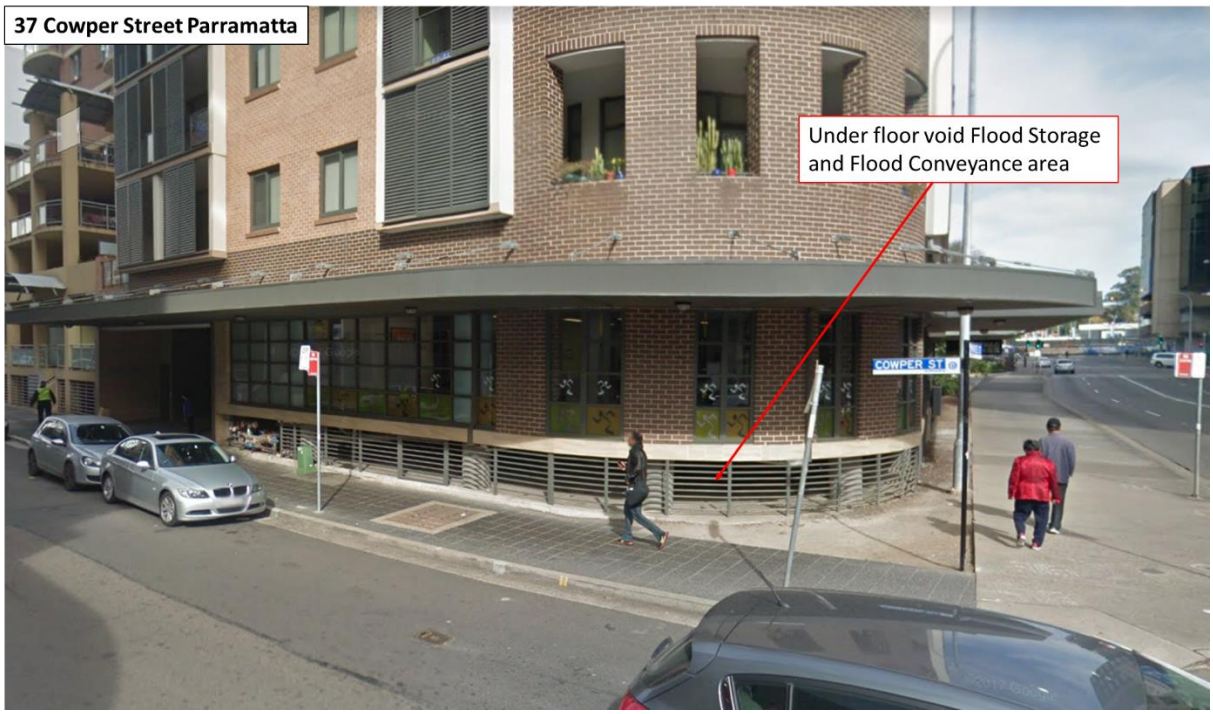


Plate 6 Example of under floor void flood storage and conveyance (37 Cowper St Parramatta)

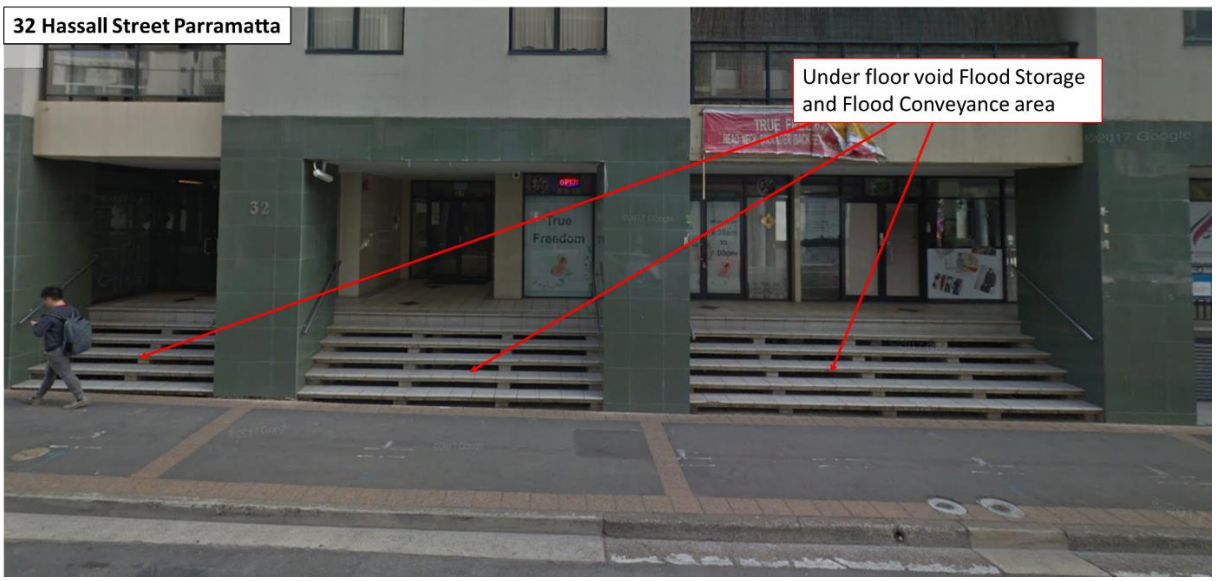


Plate 7 Example of under floor void flood storage and conveyance (32 Hassall St Parramatta)

Plate 8 Example of under floor void flood storage and conveyance (31 - 37 Hassall St Parramatta)

Plate 9 Example of under floor void flood storage and conveyance (2 Kendall St Parramatta)

5.3.2 Impacts on Mangroves

As noted in the preceding sections, the proposed development of the site is predicted to produce small flood level impacts across areas to the west of Homebush Bay Drive. This includes reductions in flood levels during the 1% AEP flood and small increases in flood levels during the PMF. The area to the west of Homebush Bay Drive includes sections of the Badu Mangroves that provide an important habitat for birdlife.

In recognition of the potential for any changes in flood behaviour to impact on these mangroves and the associated habitat, further detailed interrogation of the model results was completed. This aimed to verify:

- The magnitude of any increases in flow velocity across the mangroves
- The magnitude of any increases in freshwater (i.e., flood) inundation time across the mangroves

5.3.2.1 Velocity Impacts

The review of the velocity outputs determined that the proposed development is predicted to cause small increases in flow velocity during the 1% AEP flood and PMF across part sections of the mangroves located between Homebush Bay Drive and Powells Creek. However, the increases in flow velocity are not predicted to exceed 0.1 m/s during the 1% AEP flood and 0.15 m/s during the PMF.

The maximum flow velocities across the mangroves during the 1% AEP are predicted to vary from about 0.2 m/s to more than 1 m/s near Powells Creek. Significant vegetation such as mangroves can withstand this magnitude of flow velocity. Accordingly, the mangroves are not likely to be damaged by flow velocities during the 1% AEP event.

During the PMF, the maximum flow velocities are predicted to vary from 0.5 m/s up to 4.5 m/s approaching Powells Creek. The significant flow velocities approaching Powells Creek do increase the likelihood of damage to mangroves in this area during this major flood. However, the velocity increases associated with the development at this location are predicted to be around 0.1 m/s. Accordingly, the development is not predicted to increase the susceptibility of the mangroves to damage during the PMF as the existing velocities are already high.

5.3.2.2 Duration of Inundation Impacts

To gain an understanding of the potential for the development to alter the amount of time the mangroves are subject to inundation, floodwater depth hydrographs were extracted from the modelling results. The location where the depth hydrograph was extracted is shown in Plate 10 and the hydrographs are shown in Plate 11 and Plate 12.

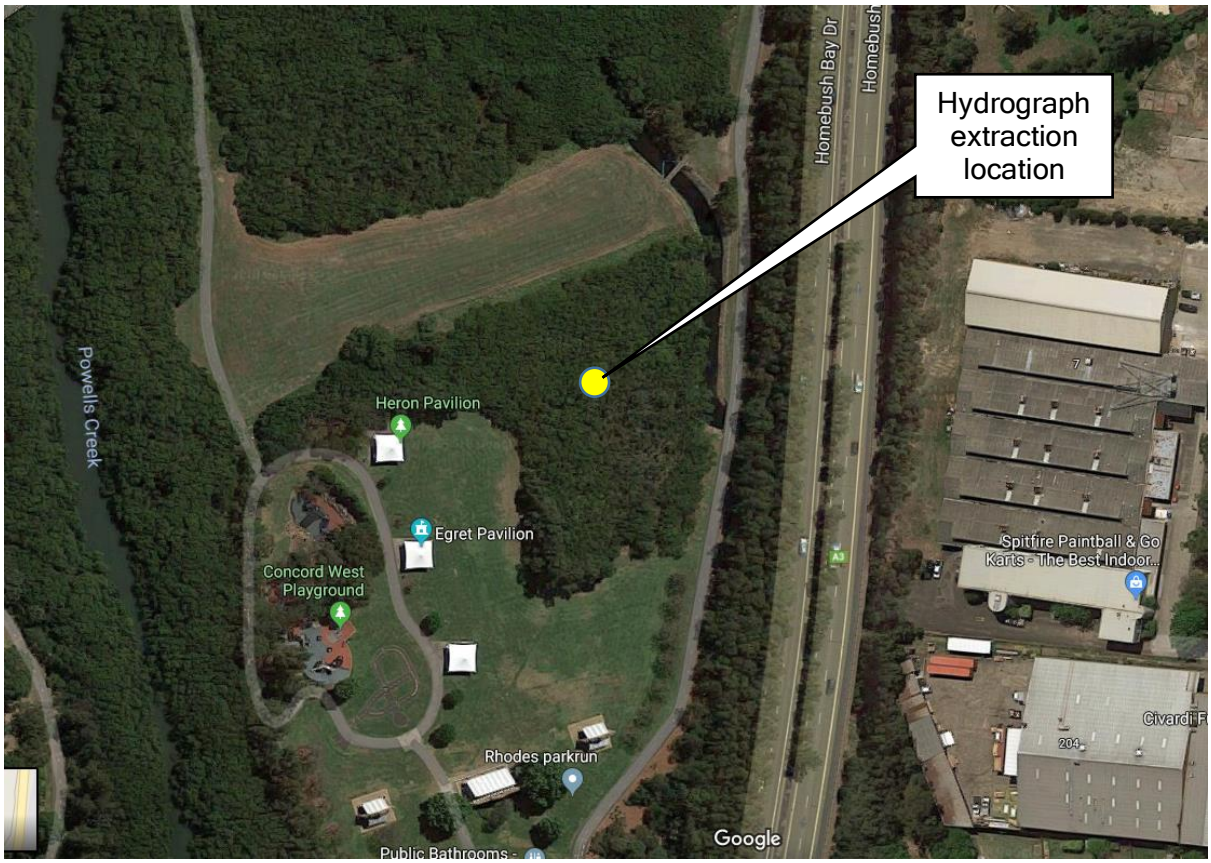


Plate 10 Location where water depth hydrographs were extracted (Google, 2018)

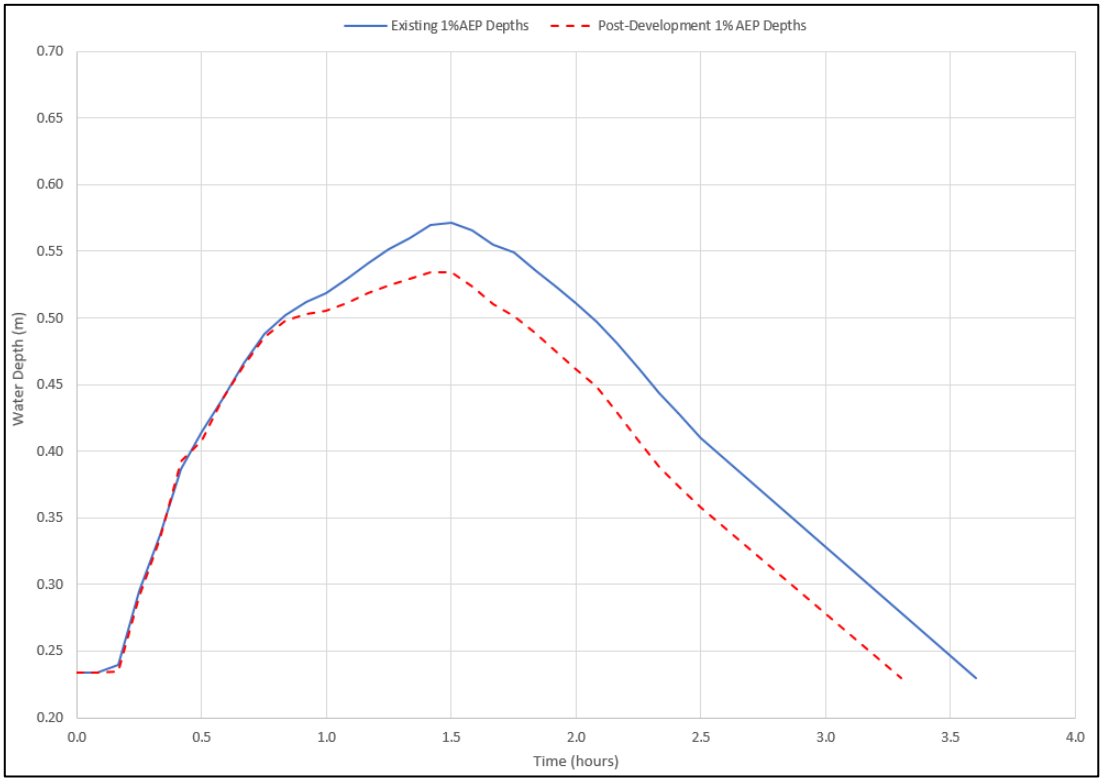


Plate 11 1% AEP water depth hydrograph

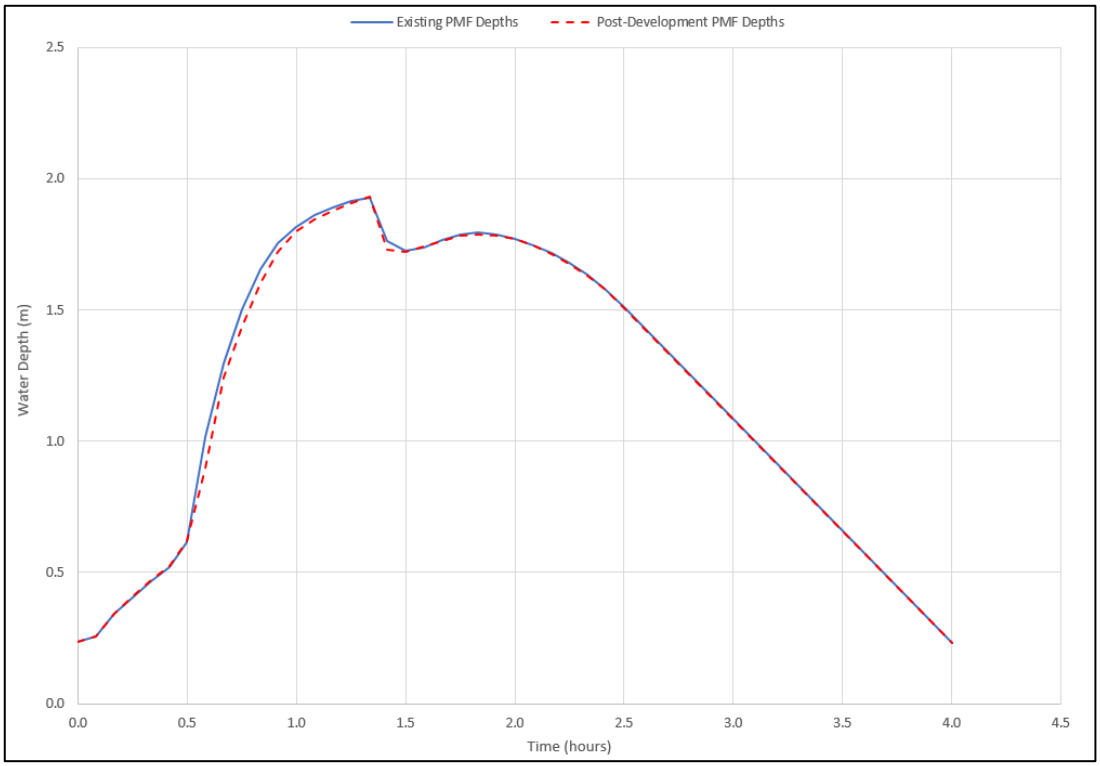


Plate 12 PMF water depth hydrograph

The PMF hydrographs in Plate 12 show that the development is predicted to produce any significant changes in inundation depths/durations. In particular, the initial rising limb and receding limb of the hydrographs are identical indicating identical times of inundation.

Plate 11 shows that during the 1% AEP flood, the rising limb of the hydrograph is predicted to remain essentially unchanged. However, the post-development peak depth is predicted to be lower than existing and is predicted to "drain" more rapidly. As a result, the development is predicted to reduce the total duration of inundation across this area by approximately 20 minutes during this particular design event.

Accordingly, the results of the design simulations indicate that the proposed development is not predicted to increase the total amount of time that the mangroves would be exposed to freshwater inundation during future floods.

5.3.3 Climate Change Impacts

To assess the potential impacts that climate change induced rainfall intensity and ocean level increases may have on the proposed development, additional 1% AEP simulations were completed with an allowance for climate change (incorporating the preferred mitigation option). This included:

- 1% AEP catchment runoff event with 0.9 metre increase in sea level
- 1% AEP catchment runoff event with a 30% increase in rainfall

Peak floodwater depths and levels were extracted from the results of the modelling and are presented in Figures D8 and D9. Peak flood levels at various locations near the site were also extracted and are presented in Table 5.

Table 5 Peak 1% AEP Flood Levels for Post-Development Conditions with Climate Change

Location (refer Plate 4)	Peak 1% AEP Flood Level (m AHD)		
	Existing Climate Conditions	30% Increase in Rainfall	0.9 metre Increase in Ocean Level
Concord Ave	2.17	2.29	2.33
Station Ave	2.18	2.30	2.33
George St Sag	4.12	4.48	4.25
NW Corner of Site	2.16	2.28	2.33
SW Corner of Site	2.18	2.30	2.33
King Street	2.18	2.29	2.33
SE Corner of Site	2.17	2.29	2.33
NE Corner of Site	2.18	2.30	2.33

The depth and flood level information show that rainfall intensity and ocean level increases are predicted to increase 1% AEP flood depths, levels in and around the site. The 30% increase in rainfall scenario is predicted to increase peak flood levels/depths by around 0.12 metres while the 0.9m increase in ocean level scenario is predicted to increase 1% AEP levels/depths by around 0.15 metres.

Although climate change is predicted to increase flood level across the site, the ground floor of the development will be located at an elevation of 3.2 m AHD. This is roughly 1 metre higher than current 1% AEP flood level estimates and will also be well elevated above potential future elevated flood levels. Therefore, the development is considered to be relatively robust with regard to potential climate change impacts.

5.4 Proposed Development Flood Planning Level

The City of Canada Bay Council requires the habitable floor level of residential buildings to be located at the flood planning level in their Development Control Plan. For areas subject to "major" overland flooding, Appendix E of the DCP defines the flood planning level is defined as the 1% AEP flood level + 0.5 metres freeboard. Therefore, the flood planning level for the site is 2.18 + 0.5 = 2.68 m AHD.

As discussed in the preceding sections, the ground floor for the development will be located at 3.2 m AHD. Accordingly, the ground floor levels of the residential buildings will be located well above the flood planning level.

The DCP also requires that the entrance to basement areas must be located at the PMF level. Access to the basement car park will be provided via the elevated ground floor. However, the ground floor is not elevated above the peak level of the PMF. It may not be feasible to elevate the entire ground floor by an extra 0.5 metres to meet this requirement. If so there may be opportunities to install an automatic flood gate system at the car park entry point that would be activated when inundation of the ground floor occurs and provide the additional 0.5m of protection.

6 Consistency with Precinct Wide Studies

Council has prepared a Masterplan for the Concord West Precinct, in line with the Parramatta Urban Transformation, that envisages rezoning of the subject site, as well other sites within the local area, to medium density residential (R3). As part of the master planning process, Council engaged Jacobs to undertake a flood study which had a particular emphasis on areas proposed for rezoning, including this site (identified as Site 1 in the Jacobs study). As part of the study, Jacobs did not rule out the rezoning of the site due to flood risk and made a number of recommendations for a flood mitigation strategy for the site.

The flood mitigation strategy for the site (outlined in Section 8.2.1 of the Jacobs study) is consistent with the flood mitigation options outlined and recommended in this study. However, as the proposed design of the site has changed, the mitigation options have changed.

We have sought out any additional precinct wide flood studies and plans while undertaking this study. It is our understanding that Council is now proceeding to undertake a Floodplain Risk Management Study and Plan for the Concord West Precinct and at the time of writing, no consultant had been engaged. In our experience, it will take around two years to go through the process of engaging a consultant, undertake the study and have the resulting plan adopted by Council. This does not fit with the Gateway Determination process timeframe and therefore cannot be considered. Regardless of the precinct wide study, a similar process such as the one undertaken here would need to be completed for any site within the floodplain.

Like other planning proposals in the area, this planning proposal will adopt relevant Council flood clauses for development assessment and any development application would need to consider the Council floodplain risk management study and plan currently in preparation.

7 Flood Risk Assessment

7.1 Flood Behaviour

Flooding from the railway tracks (to the west of the site) is conveyed along Station Avenue before it splits into two branches; with the first branch continuing along Station Avenue and the second branch flowing into King Street (to the north of Station Avenue). The Station Avenue flow path enters the site from the south-eastern site corner and the King Street flow path enters the site at the mid-point of the eastern site boundary. Both the Station Avenue flow path and the King Street flow path reach the site at approximately the same time.

Overland flooding exiting the site is obstructed by the Homebush Bay Drive roadway embankment located along the western site boundary. This results in flood water "ponding" in and around the site until the culverts under the embankment can discharge into the Powells Creek parklands and/or the roadway embankment is overtopped (the latter as is the case in the PMF event).

As outlined in Section 5.1, the existing site is affected by depths of approximately 0.8 m in the 1% AEP event and 2.4 m in the PMF event. Velocities of up to 1.4 m/s are predicted during 1% AEP event and velocities of up to 2.0 m/s are anticipated in the PMF event.

7.2 Vehicular Evacuation Potential

Due to the flash flood nature of the local catchment, evacuation from the site from overland flooding is unlikely to be feasible. More specifically, there is insufficient warning time for the NSW SES and other emergency services to mobilise and warn the community.

Evacuees would likely be evacuating into flooding conditions that would be far worse than if they elected to safely shelter in place. A storm that would produce flooding in the order of a 1% AEP event or greater is likely to have rainfall intensities such that clear vision ahead of the car while driving is impossible.

As a result, vehicular evacuation from the site is not considered feasible.

7.3 Overland Escape Route

Potential overland escape routes were investigated for the site from the two access roads (Concord Ave and Station Ave then George St). The distance to flood free land is 69 m along Concord Ave and 91 m on Station and George Streets. These potential overland escape routes are shown in Plate 13.

The flood level on the two access roads to the site was found to be a uniform 3.8 m AHD in the PMF event. However, the ground level adjacent to the site on Concord Avenue was higher than Station Avenue, resulting in lower flood depths on Concord Avenue. The peak PMF flood depth on Concord Avenue was 1.4 m and on Station Avenue was 2.0 m.

The flood hazard classifications (criteria shown in Plate 5 and Table 3) describe the thresholds at which flooding conditions become hazardous to certain people and property. Table 6 shows the duration that the flood hazard classification thresholds were exceeded in the PMF event (i.e. how long the access was "cut" for). Table 7 shows the amount time for the flood hazard classification to rise to critical thresholds to be in the PMF event. All times are measured relative to when rainfall first begins to fall).

Flood hazard classifications of H3 or above are described as the conditions in which flood characteristics become unsafe for the elderly children people. In the PMF event, the site is

affected by H3 flood hazard conditions for a duration of 2.5 hours, with only 0.5 hours warning time from the time of rainfall commencing to the time this threshold is exceeded.

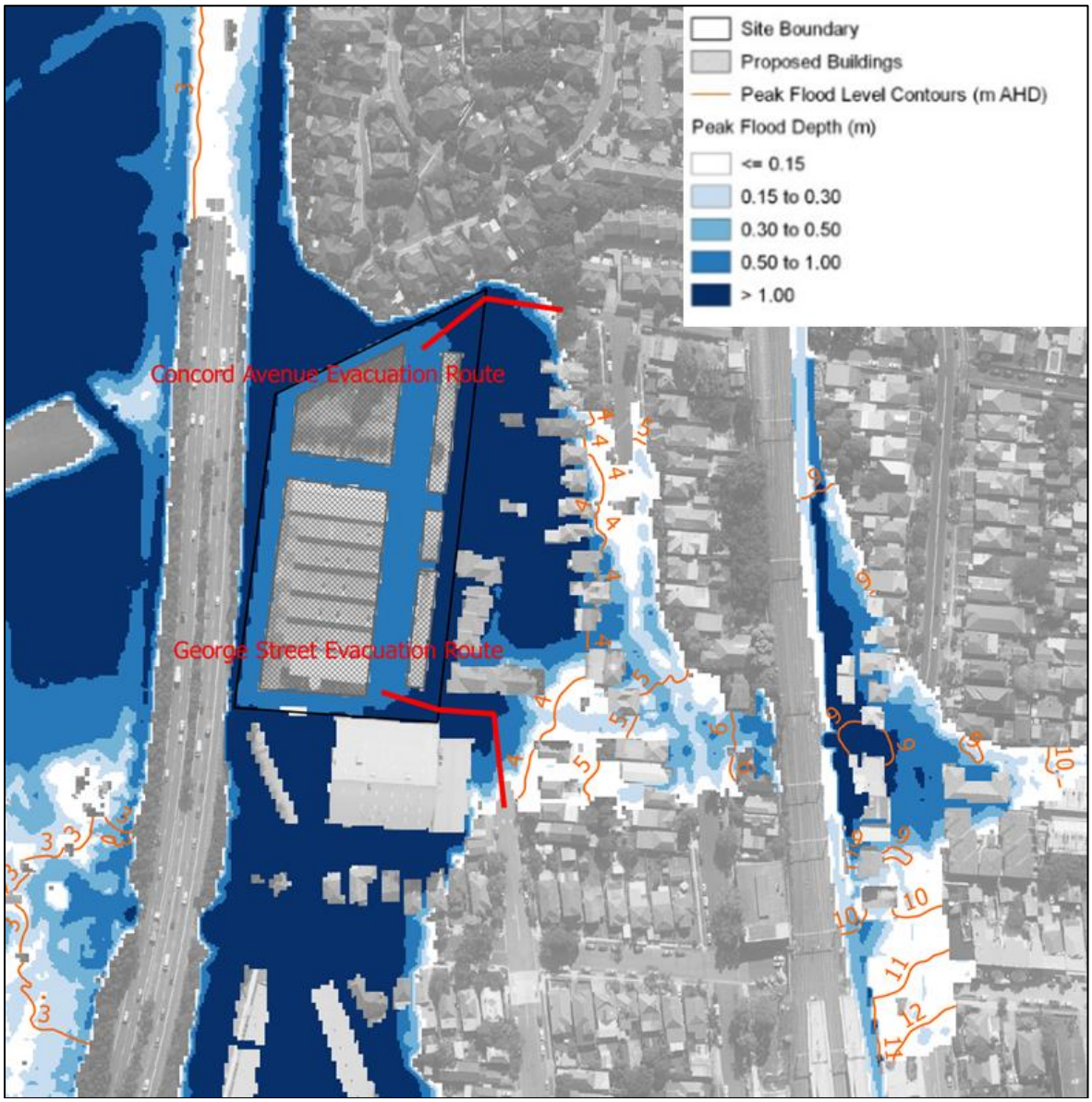


Plate 13 Potential Overland Escape Routes with Peak PMF Depth

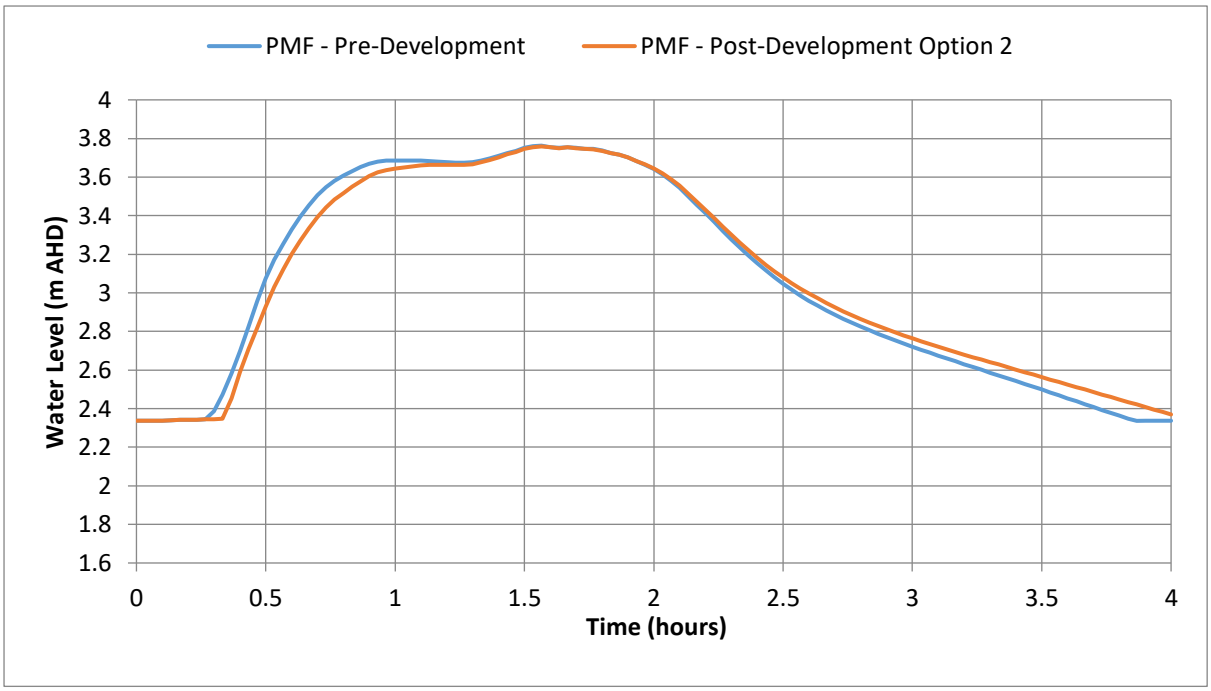


Plate 14 PMF water level hydrograph - Concord Avenue

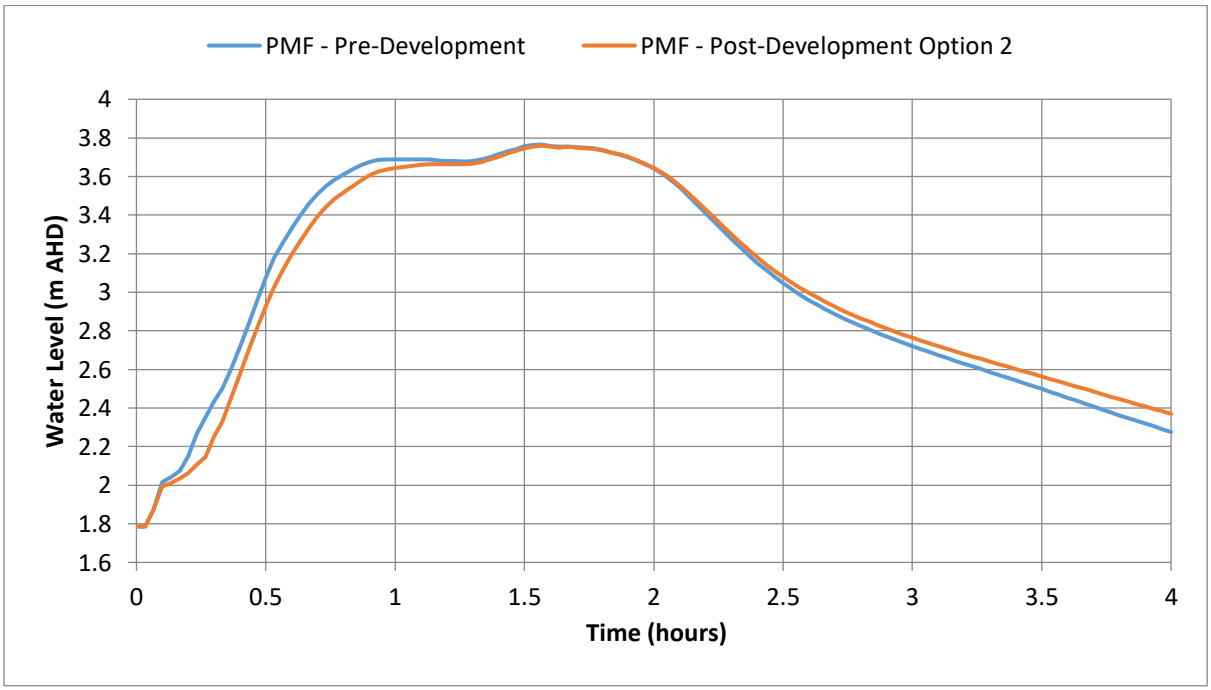


Plate 15 PMF water level hydrograph - Station Avenue

Table 6 Duration of inundation (in hours) that the flood hazard classification thresholds were exceeded in the PMF event

Hazard Vulnerability Classification	Elevated Ground Floor	Ground Floor to Concord Avenue (North of Site)	Ground Floor to George Street (South of Site)
H1	3.9	3.8	3.9
H2	3.8	3.7	3.7
H3	2.5	2.3	2.3
H4	1.2	0.5	0.6
H5	0.0	0.0	0.0
H6	0.0	0.0	0.0

Table 7 Time to rise (in hours) for the flood hazard classification thresholds to be exceeded in the PMF event

Hazard Vulnerability Classification	Elevated Ground Floor	Ground Floor to Concord Avenue (North of Site)	Ground Floor to George Street (South of Site)
H1	0.1	0.2	0.1
H2	0.2	0.3	0.1
H3	0.5	0.5	0.1
H4	0.9	1.4	0.1
H5	0.0	0.0	0.0
H6	0.0	0.0	0.0

Given the above, we can conclude that Concord Ave is the safer overland escape route as it is a shorter distance to flood free land, has a shorter duration of hazardous flooding (2.3 hours) and there is more time from when the rain begins to when the flooding becomes hazardous (0.5 hours).

Any potential overland escape (e.g. due to secondary emergency) would need to wait around 2.3 hours for hazardous conditions to recede and around 4 hours for the flood to fully recede.

It should be noted that the duration of inundation and time to rise is dependent on the storm burst duration (with the PMF 120 minute storm burst duration being the critical duration for the catchment; i.e. the storm duration that produced the highest peak flood levels across the catchment). It is possible that other storms will produce a longer duration or shorter time to rise, however these storms will have lower flood depths and flood hazard.

7.4 Shelter in Place

The recommended emergency management strategy for the site is to shelter in place. The site presents minimal danger to its occupants should they elect to shelter in place and represents the safest possible strategy for this site.

While the adopted position of the NSW SES is to oppose Shelter in Place in all circumstances, there are several reasons why this proposed development is a good example of where shelter in place is appropriate. These are:

- The site is only inundated for a short duration (approximately 4 hours with relatively high hazard for only around 2.5 hours). Therefore, there is minimal risk of secondary emergencies such as fire or medical emergencies and minimal risk of occupants attempting to leave, or attempting to enter the site.
- The ground floor will be well above the 1% AEP level and only in a PMF will flood levels exceed the ground floor. The first floor of all buildings will be above the level of the PMF and therefore a safe PMF refuge is available.
- The site will have on site management. This allows for the effective implementation of a Flood Emergency Response Plan (FERP).
- Evacuation is likely to create a situation where occupants are exposed to a greater risk than if they were to shelter in place. Note that Opper (2011) presented this as a defensible reason for opting to shelter in place.

A number of other documents with respect to floodplain management acknowledge the appropriateness of Shelter in Place for flash flood environments. The Flood Preparedness Manual (Australian Emergency Manual Series, prepared by the Attorney-General's Department 1999) states that evacuation is a suitable strategy only when, by evacuating, people are not exposed to greater risks than they would by remaining where they are.

7.4.1 Comparison of Risk to Non-Flood Prone Land

Shelter in Place planning is often opposed by Councils and the NSW SES. Typically, their concerns are regarding the risk of secondary emergencies and the increase resources required to rescue people that either attempt to leave or enter a premise that cannot be evacuated.

While these concerns are legitimate, if development is restricted to areas that have a feasible evacuation route, then no development would take place within Concord West or in that case, most of Sydney. A PMF in Concord West would likely cause significant flooding over other surrounding catchments, so a site may be evacuated but the evacuees would only get a short distance before encountering flood waters. Realistically, the NSW SES would not be able to perform any actions in the Concord West Precinct during a flood due to the flash flood nature of the catchment.

Developments that are above the PMF would also be isolated from emergency services (i.e. high flood islands), therefore if a secondary emergency occurs during a flood, then they would likely need to wait as long as a flood prone site to be attended to or being able to reach a hospital.

Research shows that the vast majority (86%) of flood fatalities occur when people attempt to traverse or perform an activity (e.g. boating or swimming) around flood waters (Haynes et al, 2017). An effective flood emergency response plan, such as what is proposed by the site, will encourage residents to avoid traversing or undertaking any activities around flood waters.

Given the above, it is arguable that a development that is within flood prone land with a PMF refuge presents a smaller risk in overland flood catchments than those located just outside the PMF. While residents within the site will be advised to shelter in place, developments above the PMF will have no flood controls and no flood emergency response plan and therefore be uninformed of the flood risk around their property and are more likely to increase the burden on the NSW SES by attempting to traverse flood waters.

7.5 Recommended Risk Reduction Measures

The following measures are recommended to reduce the flood risk to life on site.

7.5.1 Emergency Response Plan

The risks of Shelter in Place can be mitigated by incorporating a robust Flood Emergency Response Plan. Most of the key features of the Flood Emergency Response Plan will need to be determined at the Development Application stage. However, some key aspects have been outlined in Table 8.

Given the relatively short nature of the flooding, it is not expected that the site will require maintaining food and water supplies and residents are likely to have access to medications that last beyond a day. Similarly, if the electrical system fails during the flood, the duration (less than 3 hours) is short enough that the residents would be largely unaffected.

Table 8 Typical FEMP Requirements

FEMP Requirement	Comment
A description of the flood behaviour	As per Section 7.1
A description of the development, including the number of persons at risk and their conditions	This will be finalised during the DA stage of the project.
Emergency services contact details	Details of the NSW SES and 000 (ambulance, police services) should be displayed prominently in the plan.
Nominated “flood warden” who is responsible for maintaining and activating the plan. Note: There should be multiple wardens if possible.	This will be nominated by the Strata committee. It is recommended that the flood warden is either the on site manager or lives on site. A strata manager who does not live on site is not appropriate as they may not be available during a flood.
A heads up warning to ensure the site is prepared for flooding, usually a severe weather warning or flood watch or flood warning issued by the Bureau of Meteorology	The flood warden will need to sign up to the BoM RSS feed which will automatically inform the flood warden (via email) of any BoM Warnings. Alternatively, the Warden will need to review the BoM website on a regular basis. Once a warning is received, the Warden will then need to notify all residents and the warning should include a reminder to all residents of the applicable action (either shelter in place if a flood occurs or do not attempt to enter the building if a flood occurs while away from the site).
A clear “trigger” for action, such as a depth of rainfall over a designated time period, or the presence of flood water on site	The most likely appropriate trigger will be presence of water on site at the northern and southern ends of the ground floor. This is a clear indication that flooding is occurring. Other potential triggers, such as rainfall will be too slow to be enacted in flash flood catchment

A clear list of actions, roles and responsibilities, including the flood warden and residents (for before, during and after a flood)	Prior to the flood, all building occupants should be aware of the flood risks and the FEMP (through some form of induction or training). The Flood Warden should regularly check accessibility to the PMF refuge. Contact details of building occupants should also be kept. During a flood, the building warden should advise all occupants that the FEMP trigger has been activated and that all occupants should be aware not to attempt to leave or enter the site. Those on the ground floor should be advised to go to the PMF refuge. The building warden should actively encourage compliance by restricting access to the basement parking. After the flood, the building warden should ensure that all occupants are accounted for. Occupants should also not enter flood waters. Any flood electrical systems should be checked by a qualified electrician prior to use.
Systems to ensure that the plan is regularly exercised (at least annually) and that a review is undertaken by an appropriately qualified person following a flood event	A FEMP that is not regularly exercised by the flood wardens will likely be of little use during a flood. Similarly, if occupants are not aware of the FEMP and the flood risk, then they are likely to attempt to leave (or enter) the site during a flood. Therefore, the occupants should be regularly reminded by way of a sign in the foyer, newsletters or in the agenda of the strata committee meeting. Following a flood, a full debrief and review of the plan should be undertaken by an appropriately qualified flood engineer or emergency management professional.

7.5.2 PMF Refuge

It is recommended that all areas of the site have access to a “PMF refuge” which would be a publicly accessible space above the ground floor. The FERP will include details on how to access the PMF refuges and how long to wait there. Given the relatively short length of time that refuge is likely to be required, there only needs to be minimal provisions, such as water and first aid supplies.

Each building will require its own PMF refuge (so occupants are not moving between buildings). The private terraces (Building 3) will not require a publicly accessible space as long as each residence can retreat to the level above.

As part of this project, a review of the concept design which includes PMF refuges has been undertaken.

7.5.3 Basement Car Parking

Basement car parks present a significant risk to life during a flood event. The level of the basement car parking entry should be set at the level of the PMF. This will prevent overland flow from affecting the basement car park. It is recommended that the FERP include procedures to ensure that the basement car parks are evacuated and subsequently remain inaccessible until after the flood has receded.

Alternatively, the use of flood gates or flood barriers could be investigated to prevent flooding of the basement car park.

7.5.4 Building Construction

In addition to the Flood Emergency Response Plan and PMF Refuge, it is important that the buildings be designed with flood aware principles in mind, in particularly this should include:

- Construction using flood compatible materials up to and including the level of the PMF; and
- Assurance that the buildings can withstand the forces applied by the flooding.

8 Conclusion and Recommendations

8.1 Conclusions

A flood assessment of the proposed development has been undertaken using data provided by Council developed for the Concord West Precinct Flood Study, the study has been undertaken using the approaches outlined in the Floodplain Development Manual (2005). Based on the flood assessment it can be concluded that:

- If Mitigation Option 2 is incorporated into the design of the development, then there are predicted to be no adverse flood impact on neighbouring properties
- The planning proposal is inconsistent with Clause 6(C) of the S117 Direction 4.3 Flood Prone Land. The inconsistency is of minor significance as:
    - The site has been identified for renewal through master planning processes
    - The site has been subject to several studies which have identified solutions to the flood risk on the site
    - The site is classified as medium flood risk category and development controls and flood emergency management provide effective flood risk management for events up to the PMF to enable change in land use without increase in overall flood risk
    - A further detailed assessment of the flood risk and flood emergency response will be undertaken at the DA stage
    - There are a number of planning proposals with similar flooding conditions and mitigation measures to address flood risk were found to be acceptable significance.
- The recommended flood response on site is Shelter in Place. This is due to the flash flood nature of the flooding. Evacuation of the site is likely to be infeasible and present a greater risk to the occupants than sheltering in place, which will typically require occupants to shelter for less than an hour with a maximum of around 3 hours

This report satisfies the gateway conditions:

1b. include the site on Council's LEP Flood Planning Map to identify the site as being within the 'flood planning area' (in accordance with the standard technical requirements for spatial datasets and maps.

1d. Demonstrate consistency with any available findings of the precinct wide flooding study associated with the Burwood, Strathfield and Homebush Planned Precinct.

As part of this project we have sought consultation with the NSW State Emergency Services, and Office of Environment and Heritage who did not provide any feedback

8.2 Recommendations

The following recommendations are made for the design of the subject site:

1. Mitigation Option 2 is incorporated into the design of the development.

2. A robust Flood Emergency Response Plan that uses a Shelter in Place strategy is developed for the site.
3. A publicly available PMF refuge is incorporated into the design. Note this is been reviewed and incorporated into the master plan.
4. The entrance into the basement car parking is set no lower than the PMF level or otherwise flood gates are implemented to ensure that the basement carpark is not flooded during any design flood.
5. The building is designed such that it can withstand the depth and velocity of floodwaters during all floods up to and including the PMF and the building is constructed from flood compatible material at least up to the 1% AEP plus freeboard.
6. The building is in line with the ABCB fire safety requirements for “high rise buildings” regardless of whether it is considered high rise.
7. The design meets all other requirements as outlined by the Canada Bay DCP (2017) and summarised in Table 1.

9 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

Department of Infrastructure, Planning and Natural Resources (DIPNR), 2005, *NSW Floodplain Development Manual*

Haynes, K. Coates, L. Honert, R. Gissing, A. Bird, D. de Oliveira, F. D'Arcy, R. Smith, C. Radford, D (2017) Exploring the circumstances surrounding flood fatalities in Australia 1900-2015 and the implications for policy and practice. *Environmental Science and Policy***76** 168 - 176

Institute of Engineers Australia, 2012, Australian Rainfall and Runoff Revision Project 15 – Two Dimensional Modelling in Urban and Rural Floodplains.

Opper, S. Gissing, A. Davies, B. Bouvet, M. Opper, S. (2011) Community Safety Decision Making in Flash Flood Environments. *Floodplain Management Association (2011) Tamworth NSW.*