

Reference: DC15109-FSR-L01-RevA1

23 September 2015

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Mr Mino Howard
Toga Group
PO Box 1745
STRAWBERRY HILLS NSW 2012

Dear Mino,

SURRY HILLS SHOPPING VILLAGE PRELIMINARY FLOOD STUDY

We refer to your email on 9th September 2015 and request for a preliminary Flood Study and advice for the proposed development at Surry Hills Shopping Village. As such we provide you this Flood Study as requested.

1 INTRODUCTION

Diversi Consulting have been engaged to prepare the analysis of the existing 1% AEP flood level at the south east corner of the proposed development site located off Cleveland Street between Marriott and Baptist Street as shown on the Locality Plan in **Attachment A**.

A preliminary analysis was undertaken in order to provide an estimate on the required finished floor level for the terraces and garage crest level based on the maximum flow depth located at the corner of Cooper and Marriott Street.

The following methodology has been adopted to produce the 1% AEP peak flow calculations:

1. Hydrological Analysis;
 - Catchment Analysis based on orthrophoto map and site inspection.
 - 1% AEP Peak Flow Calculations based on rational method.
2. Hydraulic Analysis;
 - 1% AEP and Manning's Calculations located at the crest, north of Marriott Street Reserve. Refer to **Attachment B** for location.
 - Peak Flow Depth.
 - Peak Flow Velocity.
 - Estimated flood levels.

2 STORMWATER ANALYSIS

2.1 Hydrological Analysis

A simplified Rational Method analysis was undertaken in order to determine maximum flow depth for the 1% AEP flow located at the crest north of Marriott Street Reserve.

2.1.1 Rainfall

Rainfall data was obtained from Intensity Frequency Duration (IFD) data provided by the Bureau of Meteorology for the Surry Hills area.

2.1.2 Catchment Area

In order to determine the catchment area for the analysis, a review of available cadastral, imagery and topographic data was undertaken. The following sources were utilised to undertake the catchment analysis;

- NSW Department of Finance and Services (LPI) "Six Maps" online mapping tool (10m existing contours, cadastral data, aerial photography).
- Detailed ground survey undertaken by RPS Australia East Pty Ltd (dated 24/07/2015).
- Site inspection on 17 September 2015. Refer to **Attachment C** for photos.

Based on site inspection, detailed survey and 10m contours, we estimate that the catchment is about **17.13 hectares**. The catchment extends to the north and west of the sit as shown in **Attachment D**.

The site is bounded by commercial property surrounding the north, Sydney Mounted Police Stables along the east, Marriott Street Reserve at the south east corner and residential property along majority of the west and south.

The catchment characteristics are made up of medium density residential housing, commercial property and road reserves. The analysis assumes the catchment to be 80% impervious.

2.1.3 Peak flows

Based on the Rational Method Calculation, the catchment generates a 1% AEP flow rate of **7.09 m³/s**, as detailed in **Attachment D**.

2.2 Hydraulic Model Characteristics

Based on site inspection, detailed survey and 10m contours, the 1% AEP flows will converge at the corner of Marriott and Cooper Street before overtopping the kerb into Marriott Street Reserve. The converged flow that overtops the kerb will split into 2 channels by a large planter box and the existing southern carpark. Once the southern carpark overflows, the flow will continue to travel south through Marriott Street Reserve.

Therefore, the critical section of interest for 1% AEP flood level is along the crest at the north of Marriot Street Reserve as shown in **Attachment B**.

Based on the Manning's Calculation, the 1% AEP flow will generate a depth of approximately **250mm** at the crest and **450mm** (includes 150mm height of gutter plus 50m fall/rise in footpath) from invert of gutter at the corner of Cooper and Marriot Street.

The Manning's Calculation for the 1% AEP flow can be seen in **Attachment E**.

Based on AR&R (Australian Rainfall and Runoff) and Council standards, the recommended minimum free board of 500mm is to be provided between the 1% AEP flood level and habitable floor levels and 300mm free board to garages and carparks.

As such we estimate as a guide that the minimum finished floor level for proposed building of **RL.30.93** (crest RL 30.18) and a minimum crest level for the proposed carpark driveway of **RL.30.73** (crest RL 30.18).

Given the complex overland flow routes, channels and patterns occurring at the intersection of Cooper Street and Marriott Street, we note that this analysis is an estimate only and should not be used as accurate flood levels. Due to the complex flow patterns occurring, Council will likely require an accurate pre-developed to post-developed flood study using TULFOW or HECRAS modelling to determine the flood level at the critical section and surrounding road reserves.

Please note however that this study and report has not considered flow capacity and characteristics in Marriott Street (north of Cooper Street) which may affect entry/egress and doorways, etc. along the western side of the development. Similarly this study has not considered flows, capacity and characteristics along Baptist Lane which will need to be considered for estimation of floor levels for the proposed terraces.

We therefore recommend that future flooding modelling include these areas and other areas around the site where large overland flows may require consideration which impact on the development and surrounding areas.

Additionally we propose a pre and post flood map and determination of flow characteristics around the development to guide the design of the development and confirm that the future impacts from the development are not worse than the pre-development.

3 CONCLUSION

Based on the Rational Method Analysis described above, we note the following:

- There is an estimated catchment of about **17.13 ha** and an estimated 1% AEP catchment flow of **7.09 m³/s** draining to the south west corner of the site.
- Minimum finished floor level for proposed building of **RL.30.93** and a minimum crest level for the proposed carpark driveway of **RL.30.73** to satisfy AR&R and Council requirements.
- Detailed pre-developed to post-developed flood analysis to model the complexity of the multiple channels and road reserves adjacent to the proposed redevelopment. Council will likely require an accurate flood level which will require TUFLOW or HECRAS modelling.

Should you require further information please call me on (02) 8883 1113.

Yours faithfully
Diversi Consulting



pPhil Diversi
Director

Encl.

ATTACHMENT A – LOCALITY PLAN



Figure A : Locality Plan (Source: Google Maps)

ATTACHMENT B – CRITICAL SECTION

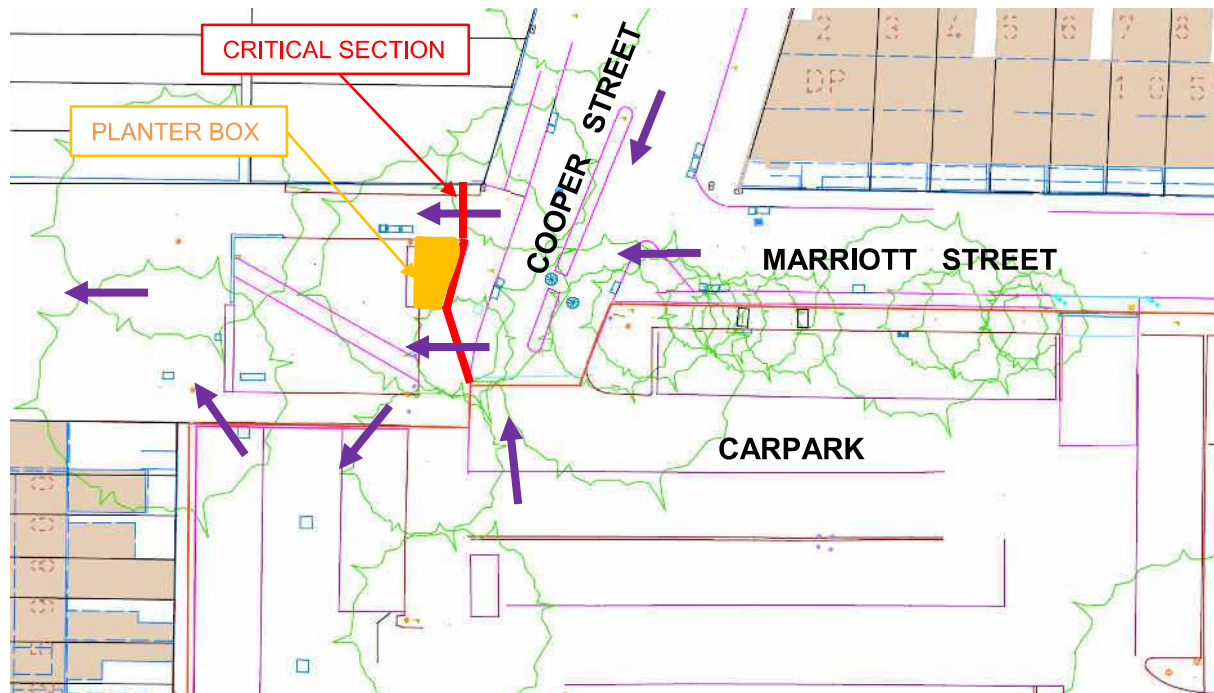


Figure B : Critical Section (Survey by RPS Australia East Pty Ltd 24/07/2015)

ATTACHMENT C – SITE PHOTOS



Photo C.1 : Marriot Street (viewed from corner of Marriot and Cooper Street)

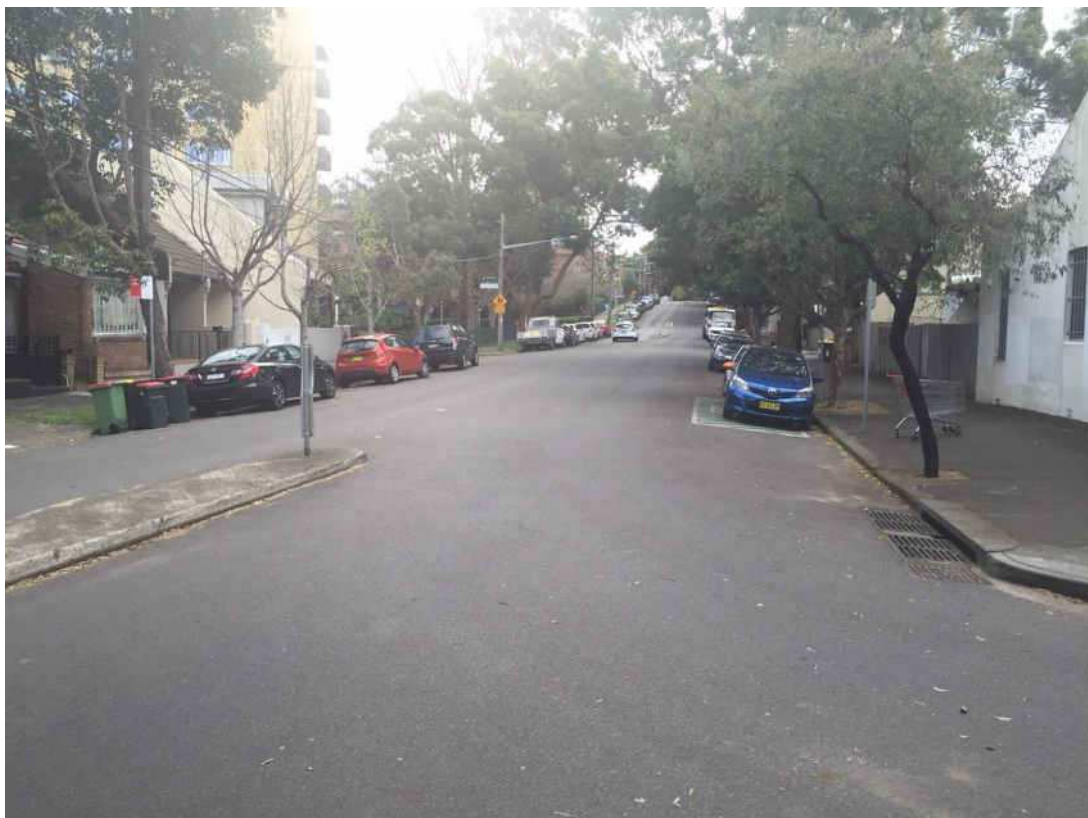


Photo C.2 : Cooper Street (viewed from corner of Marriot and Cooper Street)



Photo C.3 : *Corner of Marriot and Cooper Street (viewed from Cooper Street)*



Photo C.4 : *Right side of Marriott Street Reserve (viewed from corner of Marriot and Cooper Street)*



Photo C.5 : *Left side of Marriott Street Reserve (viewed from corner of Marriot and Cooper Street)*



Photo C.6 : *Existing shopping village carpark (viewed from corner of Marriot and Cooper Street)*



Photo C.7 : Existing shopping village south carpark (viewed from Marriott Street Reserve)



Photo C.8 : Existing shopping village eastern boundary and Baptist Street (viewed from Sydney Mounted Police Stables)

ATTACHMENT D – HYDROLOGICAL ANALYSIS

STORMWATER CALCULATIONS

PROJECT: **397-399 Clewend Street Surry Hills**

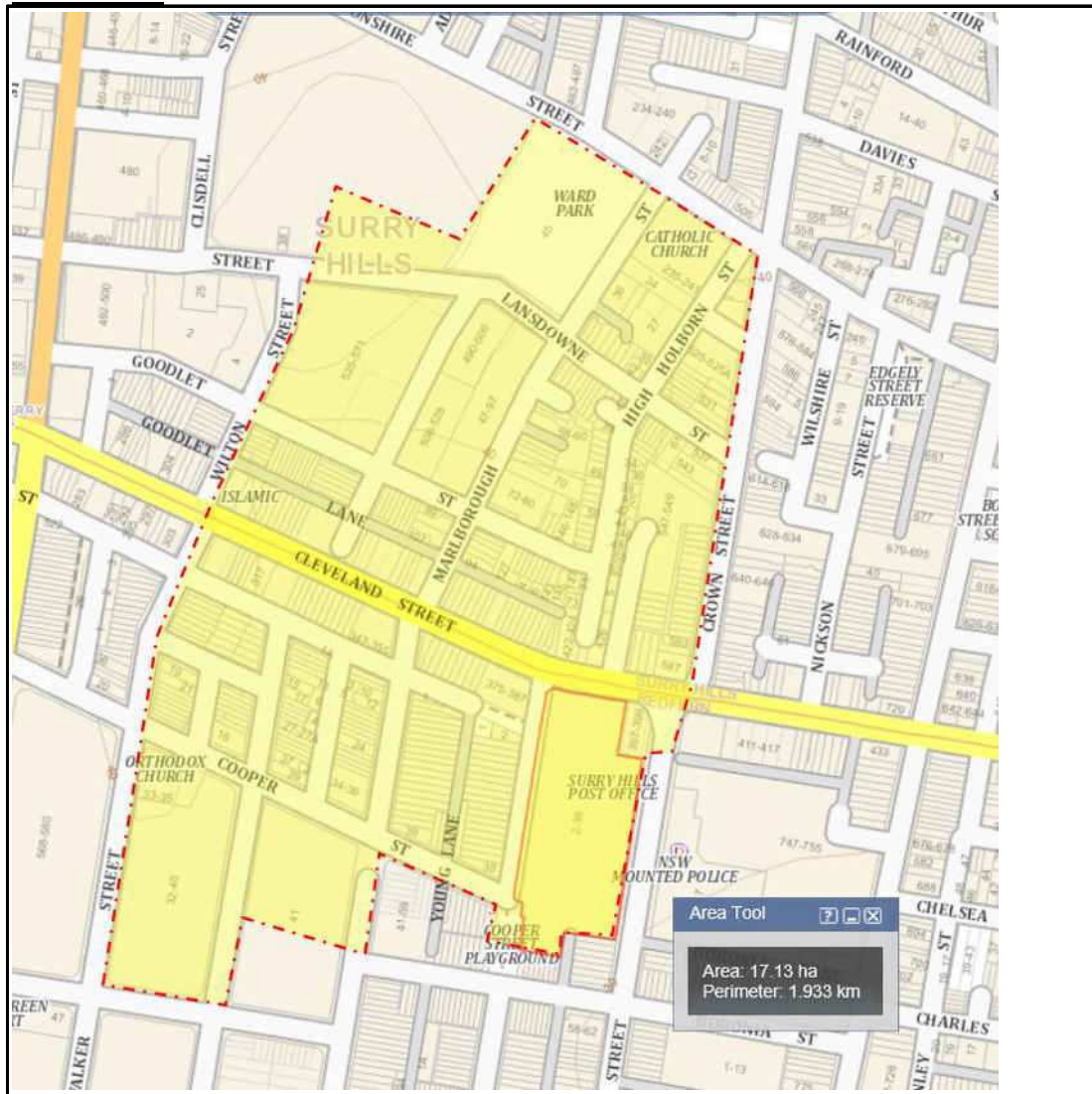
Proj. No.: 15109

Date: 22/09/2015



Preliminary Stormwater Flood Assessment

Catchment:



Hydrology:

A = 17.13 ha

L = 1140 m

t_c = 24.0 min

f = 0.8

C = 1.0

t_{100} = 149

Q_{100} = 7.088 m³/s

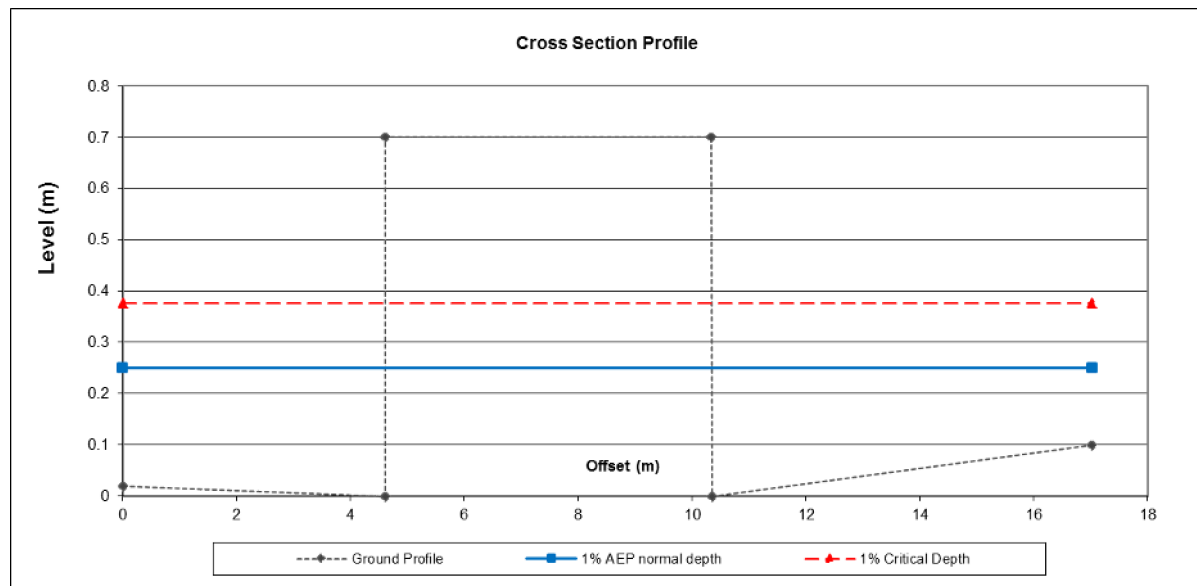
ATTACHMENT C – HYDRAULIC ANALYSIS

Natural Channel Capacity Calculations Mannings Formula

Section Details:

Section Flow (m3/s)	7.09
Channel Slope (%)	1
Manning's Roughness	0.012
Elevation datum (m)	0
Velocity head coefficient	1

	Normal	Critical
Depth (from datum)	0.249	0.376
Depth elevation (m)	0.249	0.376
Area of Flow (m2)	2.435	3.868
Wetted Perimeter (m)	11.780	11.780
Hydraulic Radius (m)	0.207	0.328
Top Width (m)	8.859	11.291
Velocity (m/s)	2.91	1.83
Velocity*Depth (m2/s)	0.73	0.69
Fr	1.77	1.00
Flow Type	Supercritical	





Appendix K1: Flood Level Summary

Our Ref 59916077_010

Contact Joshua Coates



13 May 2016

Surry Hills Project Pty Ltd
Level 5, 15 Jones St
Ultimo, NSW 2007

Attention Mino Howard

Via email: Mino Howard<mhoward@toga.com.au>

Dear Mino,

SURRY HILLS SHOPPING VILLAGE, 2-38 BAPTIST ST REDFERM – FLOOD LEVEL SUMMARY

Cardno (NSW/ACT) Pty Ltd
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The Alexandra Canal Catchment Flood Study & Alexandra Canal Floodplain Risk Management Study were prepared by Cardno and adopted by the City of Sydney on 17 March 2014. The studies utilise a combined 1D/2D hydraulic flood model, SOBEK, to define flood behaviour in the catchment which includes the subject site (Surry Hills Shopping Village, 2-38 Baptist Street, Redfern).

Indicative flood levels can be estimated from the model results, but it is noted that the modelling is designed to estimate flood behaviour in the catchment generally and may not include specific localised flow controls such as internal site drainage.

Modelling indicates that in a 1% Annual Exceedance Probability (AEP) event runoff is conveyed overland from Marriott Street (West of the development site) towards Boronia Street. Increased flood levels are observed low point at the intersection of Marriott and Boronia Street. This ponding produces increased flood levels at the southern end of the development site.

This flood level summary is prepared for the site as modelled with site conditions at the time of the Flood Studies. Peak 1% AEP and Probable Maximum Flood (PMF) water levels for the site are listed in Table 1. Extracts from the flood model showing inundation (where depths are greater than 0.10 m) are included as Figure 1 for the 1% AEP event and as Figure 2 for the PMF event.

Peak flood levels presented in Table 1 are extracted from the Alexandra Canal Flood Studies models which are determined based on the existing layout of buildings and roads. Changes to the landform may influence the peak flood levels, thus it is recommended that peak flood levels are reviewed when building footprints and road alignments are confirmed.

Table 1 – Peak Water Levels

Reference Label on Figure 1 and 2	1% AEP Peak Water Level (m AHD)	1% AEP Peak Depth (m)	PMF Peak Water Level (m AHD)
A	-	-	31.40
B	30.63	0.15	31.23
C	31.27	0.15	31.50
D	32.21	< 0.15	32.43
E	30.65	0.36	31.23
F	32.82	0.15	33.09
G	33.20	< 0.15	33.44
H	-	-	35.29
I	31.91	0.15	32.16
J	-	-	35.89
K	34.01	0.15	34.38
L	30.65	0.50	31.23
M	30.65	0.60	31.23
N	30.65	0.52	31.23

Flood Planning Requirements

Proposed development on the site will need to comply with Council's flood planning requirements. Council's Interim Floodplain Management Policy (May 2014) lists performance criteria for development, including that it '*will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties*'. The Policy also states specific flood planning level (FPL) requirements for development of the property. Table 2 is an extract of relevant FPL criteria from the Policy (Section 5 attached).

The term "Below-Ground Garage/Car park" is defined in the Policy as "where the floor of the parking and/or access surface is more than 1 m below the surrounding natural ground".

The term "floodplain" is defined in the Policy as "the area of land which is subject to inundation by floods up to and including the PMF event".

The Sydney Local Environmental Plan 2011 also includes flood related clauses, such as Clause 7.17 (which may apply). This states that development consent will not be approved unless it is shown that (among other conditions): the development is compatible with the flood hazard of the land, and it will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties.

Table 2 – Flood Planning Levels (extract)

Development	Type of Flooding	Flood Planning Level (FPL)	Note
Residential – habitable rooms	Inundated by mainstream / overland flooding	1% AEP flood level + 0.5m	
	Local drainage flooding	1% AEP flood level + 0.5 m or Two times the depth of flow with a minimum of 0.3 m above the surrounding surface if the depth of flow in the 1% AEP flood is less than 0.25 m	
	Outside floodplain	0.3m above surrounding ground	
Residential – non-habitable rooms	Inundated by mainstream / overland or local drainage flooding	1% AEP flood level	For areas such as a laundry, garage, lobby or stairwell.
Commercial – Retail floor levels	Inundated by mainstream / overland or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.	
Commercial - Business rooms	Inundated by mainstream / overland or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood.	
Above ground car park	Enclosed car park	1% AEP flood level	
Below ground car park	Inundated by mainstream / overland or local drainage flooding	1% AEP flood level + 0.5 m or PMF (whichever is higher)	FPL applies to all openings - eg vehicular entrances, vents, lifts, stairwells.

We recommended that the relevant Council policies be further reviewed or to contact Council to determine the implications of these results for proposed alterations and additions to the site, particularly with respect to required freeboards for the modelled peak flow depth. Further analysis and flood modelling would likely be required to confirm flood planning levels and potential affectation for development of the site.

Please contact me on 9496 7874 if you would like to clarify details of this letter.

Yours faithfully



Joshua Coates
for **Cardno (NSW/ACT) Pty Ltd**

Attachments - Figures showing modelled 100y ARI and PMF extents (2 pages); and Council's Flood Planning Level Requirements (2 pages).

GLOSSARY

Annual Exceedance Probability (AEP)

The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year. For example, a 1% Annual Exceedance Probability (AEP) flood extent has a one in a hundred chance of being exceeded in any year. The term 1 in 100 year Average Recurrence Interval (ARI) is used interchangeably with 1% AEP.

Probable Maximum Flood (PMF)

The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation (PMP). PMP is the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.

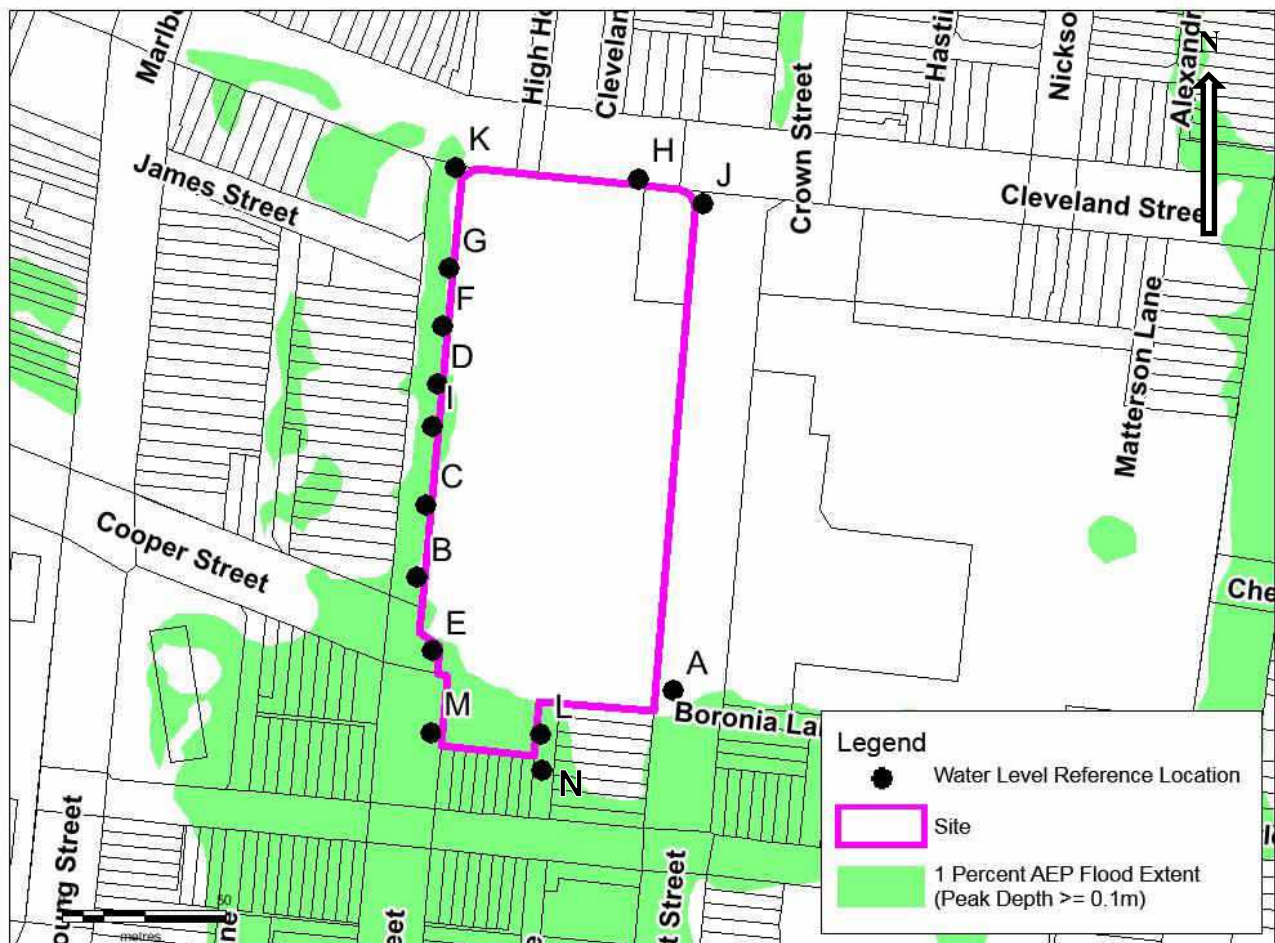


Figure 1 – Results Extract from 1% AEP Event Flood Model

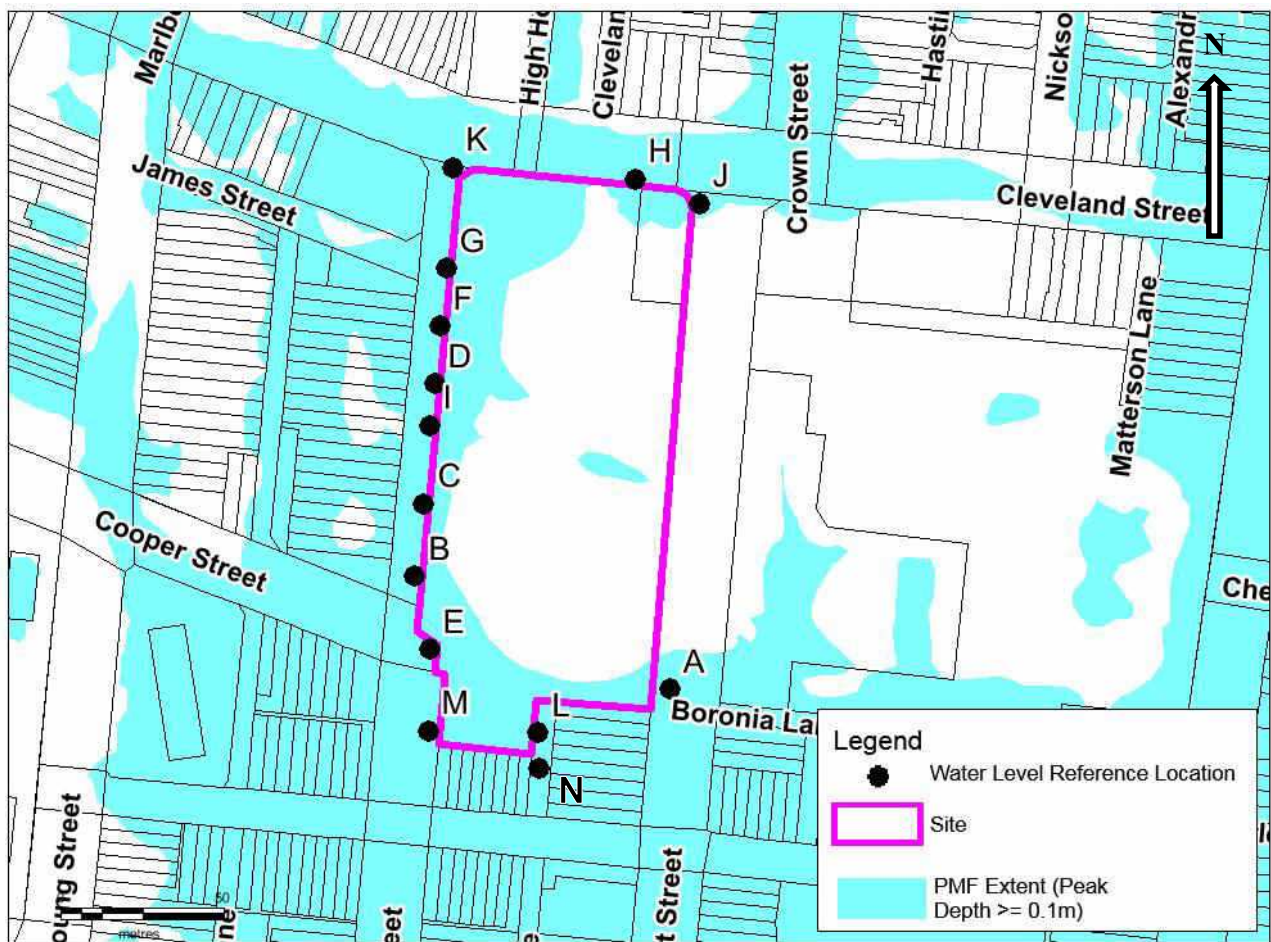


Figure 2 – Results Extract from PMF Event Flood Model

5 Flood Planning Levels

A Flood Planning Level refers to the permissible minimum building floor levels. For below-ground parking or other forms of below-ground development, the Flood Planning Level refers to the minimum level at each access point. Where more than one flood planning level is applicable the higher of the applicable Flood Planning Levels shall prevail.

Development		Type of flooding	Flood Planning Level
Residential	Habitable rooms	Mainstream flooding	1% AEP flood level + 0.5 m
		Local drainage flooding (Refer to Note 2)	1% AEP flood level + 0.5 m or Two times the depth of flow with a minimum of 0.3 m above the surrounding surface if the depth of flow in the 1% AEP flood is less than 0.25 m
		Outside floodplain	0.3 m above surrounding ground
	Non-habitable rooms such as a laundry or garage (excluding below-ground car parks)	Mainstream or local drainage flooding	1% AEP flood level
Industrial or Commercial	Business	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level
	Schools and child care facilities	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level + 0.5m
	Residential floors within tourist establishments	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m
	Housing for older people or people with disabilities	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m or a the PMF, whichever is the higher
	On-site sewer management (sewer mining)	Mainstream or local drainage flooding	1% AEP flood level
	Retail Floor Levels	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Below-ground garage/ car park	Single property owner with not more than 2 car spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m

Development	Type of flooding	Flood Planning Level
Below-ground car park	All other below-ground car parks	Mainstream or local drainage flooding
	Below-ground car park outside floodplain	1% AEP flood level + 0.5 m or the PMF (whichever is the higher) See Note 1
Above ground car park	Enclosed car parks	0.3 m above the surrounding surface
	Open car parks	1% AEP flood level
Critical Facilities	Enclosed car parks	Mainstream or local drainage flooding
	Open car parks	5% AEP flood level
Critical Facilities	Floor level	Mainstream or local drainage flooding
	Access to and from critical facility within development site	1% AEP flood level + 0.5m or the PMF (whichever is higher)
		1% AEP flood level

Notes

- 1) The below ground garage/car park level applies to all possible ingress points to the car park such as vehicle entrances and exits, ventilation ducts, windows, light wells, lift shaft openings, risers and stairwells.
- 2) Local drainage flooding occurs where:
 - The maximum cross sectional depth of flooding in the local overland flow path through and upstream of the site is less than 0.25m for the 1% AEP flood; and
 - The development is at least 0.5m above the 1% AEP flood level at the nearest downstream trapped low point; and
 - The development does not adjoin the nearest upstream trapped low point; and
 - Blockage of an upstream trapped low point is unlikely to increase the depth of flow past the property to greater than 0.25m in the 1% AEP flood.
- 3) Mainstream flooding occurs where the local drainage flooding criteria cannot be satisfied.
- 4) A property is considered to be outside the floodplain where it is above the mainstream and local drainage flood planning levels including freeboard.