

# Flood Risk Assessment Report

## Alexandria Park Community School

7 December 2017 | 16-217

# Contents

Contents .....	2
Document control .....	3
1.0 Introduction .....	4
2.0 Flood management and impacts .....	6
3.0 Flood Evacuation Plan .....	10
4.0 Conclusion .....	12
Appendix A Drawings / Calculations .....	13

# Document control

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# 1.0 Introduction

This Flood Risk Assessment Report has been prepared by Woolacotts Consulting Engineers on behalf of the NSW Department of Education (the 'Applicant'). It accompanies an Environmental Impact Statement (EIS) prepared in support of State Significant Development Application SSD 17\_8373 for the redevelopment of 'Alexandria Park Community School' at 7-11 Park Road, Alexandria (the 'Site'). The EIS seeks development consent for the following works:

The redevelopment of the Alexandria Park Community School ('the School') will address issues of capacity for schools in the inner city areas of Sydney and is also driven by the population growth resulting from the large number of residential developments that are transforming the former industrial precincts of Zetland, Waterloo and Alexandria.

The new school has been briefed to accommodate up to 1,000 primary school students and up to 1,200 secondary school students on one campus in an integrated and fully connected school building.

Specifically, this project includes:

- Demolition of all existing buildings on-site, including the temporary pop-up schools;
- Remediation of specific areas of the site containing contaminated fill;
- Construction of multiple school buildings of up to five stories, arranged along the western and southern parts of the site comprising:
  - Classroom home bases;
  - Collaborative learning spaces;
  - Specialist learning hubs;
  - Learning support spaces;
  - Offices for teachers and administrative staff;
  - Library; and
  - Student canteen.
- Construction of a sports hall and multiple outdoor sports courts;
- An all-weather multipurpose synthetic sports field;
- Informal play spaces and Covered Outdoor Learning Space or COLA;
- A community centre;
- A pre-school for 39 children;
- Site landscaping including green links, community garden and open space;
- Construction of a new on-site car park and associated vehicular access point off Belmont Street; and
- Augmentation and construction of ancillary infrastructure and utilities as required.

Delivery of the project will be undertaken in sequential phases to maintain an operational school on the Park Road Campus and will involve enabling works separate to this application followed by three main construction phases for the new building and external works.

The purpose of this report is to provide an assessment of the proposal as described above and detailed within the EIS.

This report discusses flood related issues associated with the development, as the site is flood affected by both PMF and 1%AEP storm events. Recommendations on all precautions to minimise risk to personal safety of occupants, and the risk of property damage of the total development in the event of a flood will be investigated.



**Figure 1 – Site Location**

## 2.0 Flood management and impacts

### 2.1 Flood information

Flood information relating to the site has been obtained from the Alexandra Canal floodplain risk management plan, risk management study and flood study adopted by City of Sydney in March 2014.

The information within the reports include the following information:

- 1% AEP flood depth
- PMF depth
- Freeboard requirement for flood planning level
- 1% AEP flood extent
- PMF extent
- 1% AEP flood hazard
- PMF hazard
- 1% AEP maximum velocity

The following table outlines flood level information specific to the site:

Flood Level Information	
Design flood level (1% AEP)	13.33m AHD
Freeboard	0.5m
Flood Planning Level (FPL)	13.83m AHD (1% AEP + 0.5m Freeboard)
Probable Maximum Flood (PMF)	13.77

Refer to Figures 2 to 6 for various flood extents, depths and hazards.



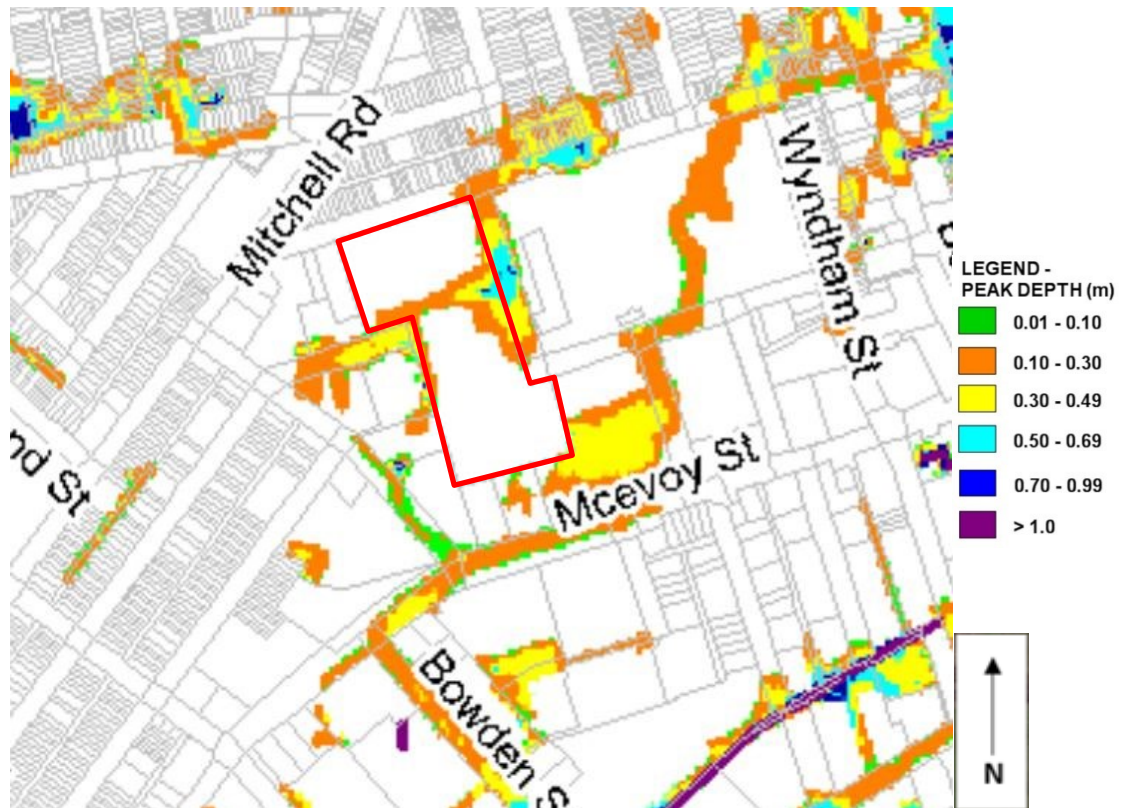


Figure 2 – 1% AEP Flood Depth & Extent

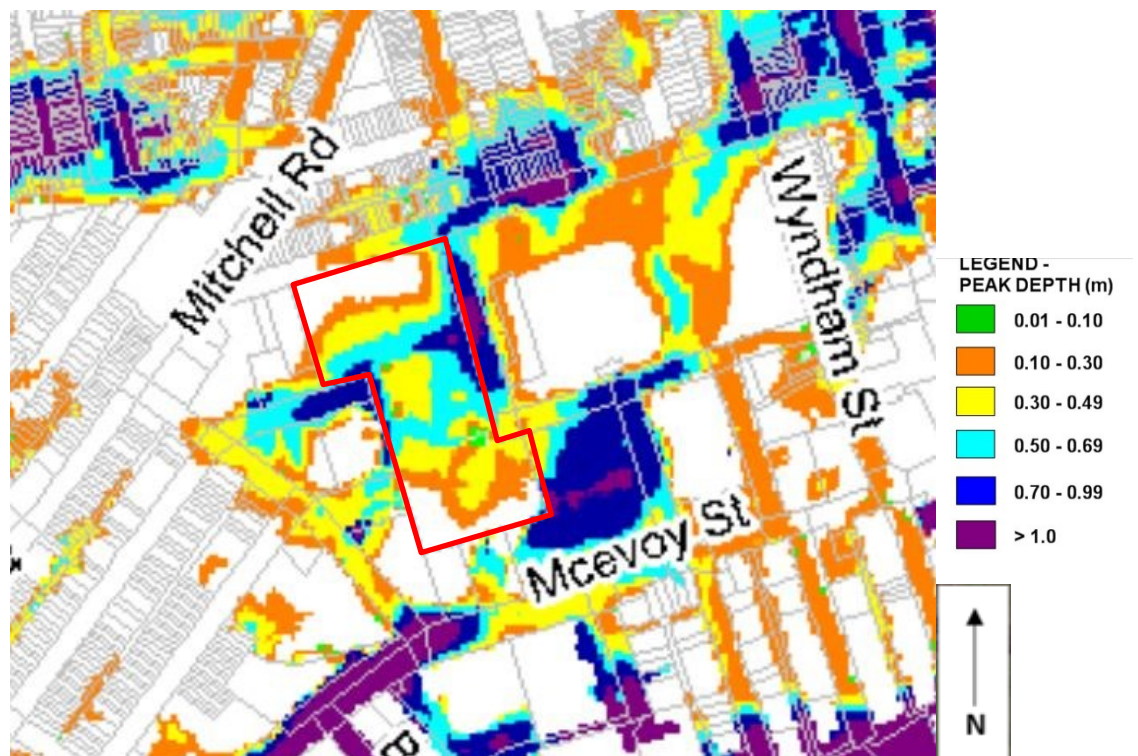


Figure 3 – PMF Flood Depth & Extent

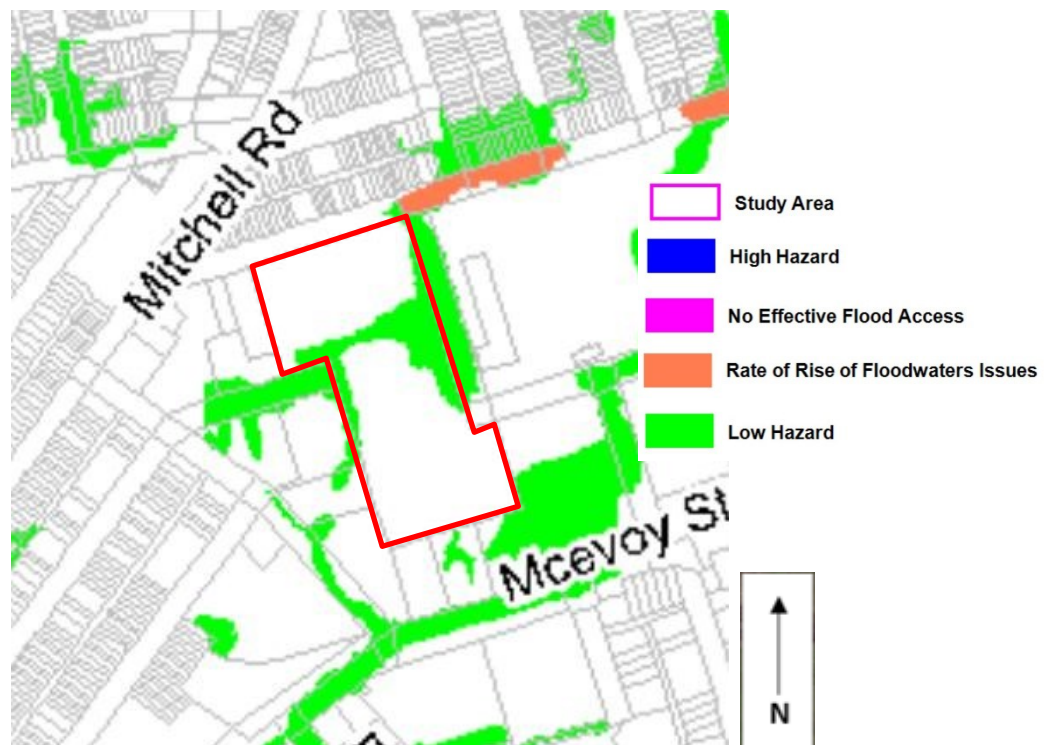


Figure 4 – 1% AEP Flood Hazard

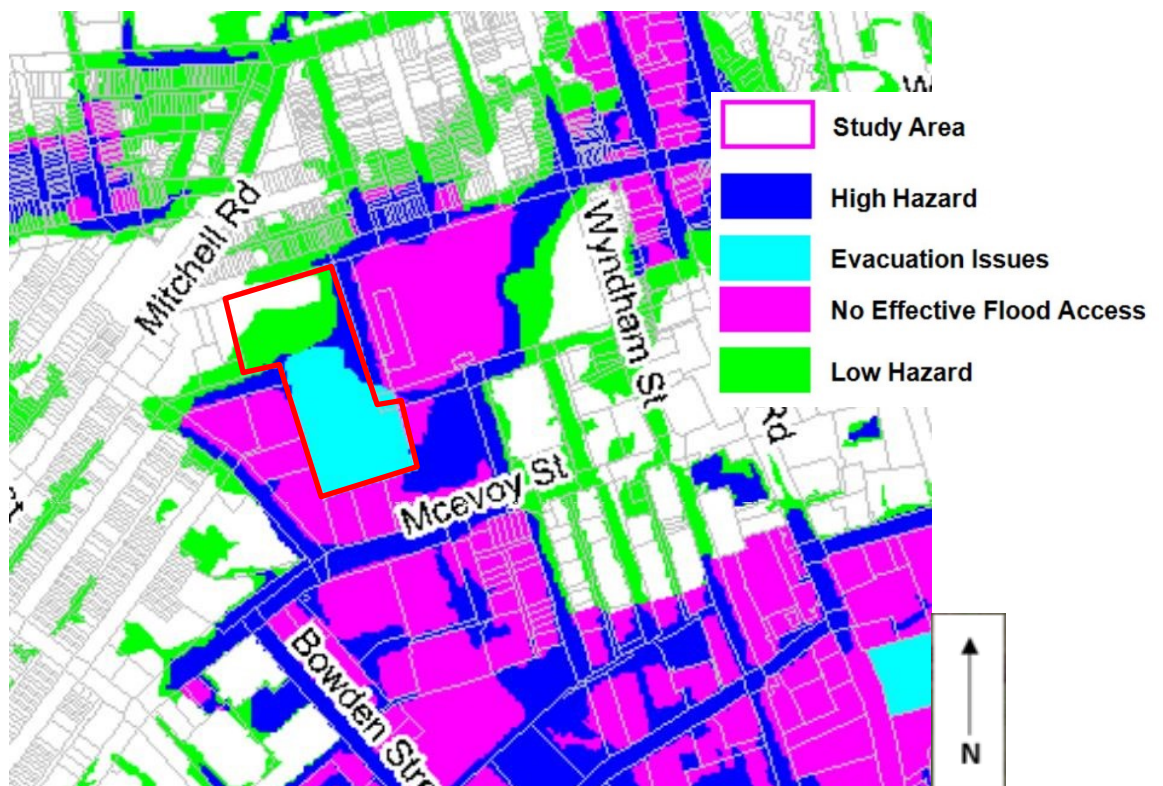


Figure 5 – PMF Hazard





**Figure 6 – 1% AEP Maximum Velocity**

As depicted in the images above, a portion of the site is affected by 1% AEP flood event and a significant portion of the site is affected by PMF event.

Flood planning level was determined by adding 500mm of freeboard to 1% AEP flood level of 13.33 as per Alexandra Canal Floodplain Risk Management Study and Plan. Minimum flood planning level of 13.83 has been adopted for the proposed development.

The site is identified as a low hazard for 1% AEP flood and high hazard for PMF.

The site has a maximum 1% AEP velocity of 1.215 m/s

## 2.2 Floodplain Risk Management Plan

Alexandra Canal Floodplain Risk Management Study and Plan outlines various measures for floodplain risk management options. It includes flood modification measures, property modification measures as well as emergency response measures. Appropriate measures that are applicable to the proposed development are outlined below:

- Flood Planning Level

Floor levels of the proposed development to be set at a minimum of the PMF or FPL, whichever is greater. For the proposed development, the flood planning level is 13.83.

- Flood Proofing Guidelines

All structural elements below the flood planning level shall be constructed from flood compatible materials.

All structures must be designed and constructed to ensure structural integrity for immersion and impact of debris up to the 1% AEP flood event. If the structure is to be relied upon for shelter-in-place evacuation then structural integrity must be ensured up to the level of the PMF.

All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the flood planning level.

- Evacuation

Flood free access to the evacuation centres.

- Flood Warning Signs

Appropriate flood warning signs are to be posted.

- Flood Awareness and Education

School needs to maintain an adequate level of flood awareness during the extended periods when flooding does not occur. Flood awareness extends to the students, staff and parents.

## 3.0 Flood Evacuation Plan

The site has been identified as being flood affected by both 1% AEP and PMF storm events. Warnings of an upcoming flood may occur through numerous avenues. The Bureau of Meteorology issue thunderstorm and severe weather warnings when such events are expected to develop or move into the area under threat. The NSW State Emergency Service (SES) receive updated weather information and notify the general public through numerous forms. The SES commonly distributes flood bulletins to the media who will broadcast information regarding what is expected to happen during a flood.

School staff are encouraged to seek out updated information regarding current weather status and severity in the event of heavy rain. Common forms of communicating flooding information include door knocks from emergency services, TV/ radio and other media, word of mouth, and the SES emergency alert.

It is critical that staff are able to identify when to follow the evacuation plan. Evacuation routes require flood free access to evacuation centres, however at both 1% AEP flood and PMF events, access to the external road and street are inundated. Thus when flood depths exceed 0.4m, all staff and students need to go inside any of the building which all have a ground floor level higher than PMF level. Staff then need to contact to authorities, such as the Police or SES, for further instructions.

DO NOT attempt to access the site if flood waters are rising rapidly or if flood waters are approaching the building. Move immediately to higher ground and leave the area, as per the evacuation plan.

DO NOT walk through flood waters to access the building.

Follow any instructions given by the police or SES.

Ensure all staff and students gather at a known location to confirm all have been accounted for and safely out of the flood area.

### **4.3 Emergency contacts**

Police	000
SES	132 500

## 4.0 Conclusion

The objectives set out in Alexandra Canal Floodplain Risk Management Study and Plan have been investigated/ satisfied with the following design measures:

- Proposed structure FFL is 13.83m AHD minimum. This is 500mm higher than 1% AEP flood level and higher than PMF flood level of 13.77.
- All structural elements below the flood planning level (13.83) shall be constructed from flood compatible materials.
- All building are to be relied upon for shelter-in-place evacuation, thus structural integrity must be ensured up to the level of the PMF.
- All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the flood planning level.
- The Flood Evacuation Plan outlines shelter-in-place during the 1% AEP and PMF event. Refer to Section 3.0 for further detail.
- Appropriate flood warning signs are to be posted.



## **Appendix A**

### **Drawings / Calculations**

### 10.11 Culvert Blockage

Stormwater pits can potentially block through a number of factors, including the build-up of leaf litter, parked cars and garbage bins. Blockages to culverts and bridges within the study area can occur by the accumulation of debris washed down from upstream. This debris, from historical observations in other similar catchments, can include vegetation and trees, cars and garbage bins.

Culvert blockages were assessed as part of the Flood Study (Cardno, 2013) for two cases, 100% blockage and 50% blockage. The impact of pit and culvert blockages results in some significant localised increases in peak water levels.

For the 50% blockage, the main areas impacted are Bowden Street, with an approximate 0.7 metre increase, Euston Road, with an approximate 0.35 metre increase and Ralph Street, with an approximate increase of 0.3 metres. These locations are impacted by the culvert blockage together with the lower pit capacities.

The impact of the 100% blockage case results in more widespread impacts. Key areas impacted are the low lying trapped depression locations, such as Coulson Street, areas along Botany Road, the area to the north of Copeland Street and Erskineville Oval and the trapped low points in the vicinity of Danks Street. In these locations, the primary outflow points are via the pit and pipe system. If this system is to become blocked, then there are limited opportunities for outflow of water from these locations.

Whilst it can be seen that the flood levels some areas are sensitive to culvert blockage, the average increase in flood levels as a result of culvert blockage is only 0.02m for the 100% blockage scenario (with a standard deviation of 0.07m). Therefore, it is recommended that the effects of culvert blockages continue to be assessed when undertaking flooding investigations as they can significantly impact some properties. However, with respect to freeboard, the blockage rates have minimal flood level impacts on the majority of properties within the catchment and should not affect the selection of flood planning levels.

### 10.12 Freeboard Selection

As outlined in **Section 10.1**, a freeboard ranging from 0.3 – 0.5 metres is commonly adopted in determining the FPL. The freeboard accounts for uncertainties in deriving the design flood levels and as such should be used as a safety margin for the adopted FPL. The freeboard may account for factors such as:

- Changes in the catchment;
- Changes in the creek / channel vegetation;
- Accuracy of the model inputs (e.g. ground survey, design rainfall inputs for the area);
- Model sensitivity:
  - Local flood behaviour (due to local obstructions);
  - Wave action (e.g. wind induced waves or was from vehicles);
  - Culvert blockage; and
  - Climate change (affecting both rainfall and ocean levels).

The various elements factored into a freeboard can be summarised as follows:

- Afflux (local increase in flood levels due to small local obstructions not accounted for in the modelling) (+0.1m) (Gillespie, 2005).
- Local wave action (trucks and other vehicles) (allowances of +0.1m are typical).

- Accuracy of ground / aerial survey (+/- 0.15m).
- Climate change impacts on rainfall and sea level rise (+0.03m).
- Sensitivity of the model +/-0.05m.

Based on this analysis, the total sum of the likely variations is in the order of 400mm, excluding climate change. This would suggest that a freeboard allowance of 500mm would be appropriate for the Alexandra Canal Catchment.

When applied to design events less than the PMF, the freeboard may still result in the FPL being higher than the PMF in certain cases.

It should also be noted that flooding within the Alexandra Canal Catchment in many locations could be categorised as overland flow. A shallow overland flowpath may not be significantly impacted with respect to several of the factors listed above thus a freeboard may be adopted only where flood depths are significant. Other municipal councils have adopted a threshold depth of 0.3m for these purposes.

### 10.13 Flood Planning Level Recommendations

Based on the previous assessments, it is recommended that Council adopt a FPL of 100 Year ARI and a 0.5m freeboard for habitable residential development.

Commercial and industrial properties have often adopted high frequency flood events such as the 20 year ARI event. This is based on the perception of risk. Occupiers of these properties can make informed commercial decisions on their ability to bear the burden of economic loss through flood damage, while residential lots do not generally provide an income to offset the losses. Additionally, inventory, machinery and other assets can be stored above flood levels to lessen the economic loss as a result of a flood event.

There is only an average difference of 0.1m between the 20 year ARI and 100 year ARI event. Considering this relatively small difference between the events and the large number of industrial and commercial properties within the floodplain, it is recommended that the 100 year ARI plus 0.5m be adopted for commercial and industrial properties, as well as residential properties.

Underground car park entrances in addition to vents and openings are also to be set at the 100 year ARI + 0.5m, or PMF, whichever is the higher. These locations are a particularly high risk to life.

For critical infrastructure, such as hospitals, police stations and aged care, the PMF should be adopted as the FPL. It is important that these facilities, which are either difficult to evacuate or are essential during an emergency, remain flood free.

Due to the nature of flooding in the catchment and the large areas affected by shallow overland flow paths, a reduction to the freeboard may be appropriate in some cases. Where the depth of flow from local drainage overland flow paths is less than 0.25m for the 100 year ARI, the FPL could be set at two times the depth of flow with a minimum of 0.3 m above the surrounding surface.

A summary of the proposed flood planning levels for development are shown below in **Table 10-5**. These LGA-wide flood planning level recommendations outlined in the Draft Floodplain Management Policy (**Section 9.4.1**) are consistent with the requirements of the flood behaviour within the Alexandra Canal floodplain.

**Table 10-5 Recommended FPLs for Alexandra Canal Catchment**

Development		Type of flooding	Flood Planning Level
Residential	Habitable rooms	Inundated by mainstream flooding	100 year flood level + 0.5 m
		Inundated by local drainage flooding	100 year 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 100 year flood is less than 0.25 m
		All other	0.3 m above surrounding ground
	Non-habitable rooms such as a laundry or garage (excluding below-ground car parks)	Inundated by mainstream or local drainage flooding	100 year flood level
Industrial or Commercial	Business	Inundated by mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of 100 year flood level
	Schools and child care facilities	Inundated by mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of 100 year flood level
	Residential floors within tourist establishments	Inundated by mainstream or local drainage flooding	100 year floor level + 0.5 m
	Housing for older people or people with disabilities	Inundated by mainstream or local drainage flooding	100 year flood level + 0.5 m or a the PMF, whichever is the higher
	On-site sewer management (sewer mining)	Inundated by mainstream or local drainage flooding	100 year floor level + 0.5 m
	Storage of hazardous substances	Inundated by mainstream or local drainage flooding	100 year flood level + 0.5 m
	Below-ground garage or car park (For this purpose a below-ground garage or car park is where the floor of the car park is more than 1 m below the surrounding natural ground.)		
	Single property owner with not more than 2 car spaces.	Inundated by mainstream or local drainage flooding	100 year flood level + 0.5 m
	All other below-ground car parks	Inundated by mainstream or local drainage flooding	100 year flood level + 0.5 m or the PMF (whichever is the higher) See Note 1
	Below-ground car park outside floodplain		0.3 m above the surrounding surface
Above ground car park	All car parks	Inundated by mainstream or local drainage flooding	100 year flood level



Development	Type of flooding	Flood Planning Level
Critical Facilities (include hospitals and ancillary service; communication centres; police, fire and SES stations; major transport facilities, sewerage and electricity plants; any installations containing infrastructure control equipment, any operational centres for use in a flood.)	Floor level  Access to and from critical facility within development site	100 year flood level + 0.5m or the PMF (whichever is the higher) 100 year flood level

#### 10.14 Flood Planning Maps

Flood planning maps provide a mapping based tool to identify areas relevant to floodplain management. The floodplain is defined by the PMF extent; however, it is common practice to also consider the flood planning level extent for planning purposes. This is usually defined as the extent of the adopted FPL (e.g. 100 year ARI + 0.5m). Development within this extent would need to consider the adopted FPL for setting of floor levels and other flood protection design aspects.

The development of flood planning maps depends on the content of planning instruments. When considering updates to planning instruments, consideration should also be given to developing appropriate flood planning maps to support the planning instruments.

#### 4.2.6 **PM9 – Prepare Flood Proofing Guidelines**

Flood proofing involves undertaking structural changes and other procedures in order to reduce or eliminate the risk to life and property, and thus the damage caused by flooding. Flood proofing of buildings can be undertaken through a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding.

These include modifications or adjustments to building design, site location or placement of contents. Measures range from elevating or relocating, to the intentional flooding of parts of the building during a flood in order to equalise pressure on walls and prevent them from collapsing.

Examples of proofing measures include:

- All structural elements below the flood planning level shall be constructed from flood compatible materials.
- All structures must be designed and constructed to ensure structural integrity for immersion and impact of debris up to the 1% AEP flood event. If the structure is to be relied upon for shelter-in-place evacuation then structural integrity must be ensured up to the level of the PMF.
- All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the flood planning level.

In addition to flood proofing measures that are implemented to protect a building, temporary / emergency flood proofing measures may be undertaken prior to or during a flood to protect the contents of the building. These measures are generally best applied to commercial properties.

These measures should be carried out according to a pre-arranged plan. These measures may include:

- Raising belongings by stacking them on shelves or taking them to a second storey of the building.
- Secure objects that are likely to float and cause damage.
- Re-locate waste containers, chemical and poisons well above floor level.
- Install any available flood proofing devices, such as temporary levees and emergency water sealing of openings.

The SES business Flash Flood Tool Kit (SES, 2012) provides businesses with a template to create a flood-safe plan and to be prepared to implement flood proofing measures. It is recommended that this tool kit is distributed to the flood affected businesses within the Alexandra Canal floodplain.

### 4.3 **Emergency Response Measures Recommended for Implementation**

#### 4.3.1 **EM 1 – Information Transfer to SES**

The findings of the Flood Study and the Flood Risk Management Study and Plan provide a useful data source for the State Emergency Service. This should specifically include the transfer of information to the City of Sydney Security and Emergency Management Centre located at Town Hall.

#### 4.3.2 **EM 2 – Prepare a District DISPLAN**

The DISPLAN states that:

“Each District and Local Emergency Management Committee is to develop and maintain its own District / Local Disaster Plan, with appropriate Supporting Plans and Sub Plans, as required by Functional Area Coordinators and Combat Agency Controllers at the appropriate level. Supporting plans are to be the exception at local level and their development must be approved by District Functional Area Coordinators.”

It is recommended that a DISPLAN be prepared for the *Sydney East Emergency Management District* to outline emergency response arrangement specific to the district. In particular the purpose of a District DISPLAN is to:

- Identify responsibilities at a District and Local level in regards to the prevention, preparation, response and recovery for each type of emergency situation likely to affect the district.



- Detail arrangements for coordinating resource support during emergency operations at both a District and Local level.
- Outline the tasks to be performed in the event of an emergency at a District and Local level.
- Specifies the responsibilities of the South West Metropolitan District Emergency Operations Controller and Local Emergency Operations Controllers within the South West Metro EM District.
- Detail the responsibilities for the identification, development and implementation of prevention and mitigation strategies.
- Detail the responsibilities of the District & Local Emergency Management Committees within the District
- Detail agreed Agency and Functional Area roles and responsibilities in preparation for, response to and recovery from, emergencies.
- Outline the control, coordination and liaison arrangements at District and Local levels
- Detail arrangements for the acquisition and coordination of resources.
- Detail public warning systems and responsibility for implementation.
- Detail public information arrangements and public education responsibilities.
- Specifies arrangements for reporting before, during and after an operation.
- Detail the arrangements for the review, testing, evaluation and maintenance of the Plan.

Further details regarding the existing DISPLAN and the purpose and function of a DISPLAN are provided in Section 8 (of Cardno 2013a).

#### **4.3.3 EM 3 – Prepare a Local Flood Plan**

It is recommended that the City of Sydney to prepare a local flood plan in conjunction with the SES to outline the following details:

- Evacuation centres in close proximity to the floodplain which allow flood free access to the centres and are flood free sites.
- Inclusion of a description of local flooding conditions.
- Identification of potentially flood affected vulnerable facilities.
- Identification of key access road subject to flooding.

Further details of evacuation centres, access road flooding and recommended inclusions for the flood plan are provided in Section 8 (of Cardno 2013a).

#### **4.3.4 EM 5 – Public Awareness and Education**

Flood awareness is an essential component of flood risk management for people residing in the floodplain. The affected community must be made aware, and remain aware, of their role in the overall floodplain management strategy for the area. This includes the defence of their property and their evacuation, if required, during the flood event.

Flood awareness campaigns should be an ongoing process and requires the continuous effort of related organisations (e.g. Council and SES). The major factor determining the degree of awareness within the community is the frequency of moderate to large floods in the recent history of the area.

For effective flood emergency planning, it is important to maintain an adequate level of flood awareness during the extended periods when flooding does not occur. A continuous awareness program needs to be undertaken to ensure new residents are informed, the level of awareness of long-term residents is maintained, and to cater for changing circumstances of flood behaviour and new developments. An effective awareness program requires ongoing commitment.

It is recommended that the following awareness campaigns be considered for the floodplain. These should be prepared together with the SES, as they have a responsibility for community awareness under the DISPLAN.

- Preparation of a FloodSafe brochure. Such a brochure with a fridge magnet may prove to be a more effective means of ensuring people retain information. Once prepared, the FloodSafe brochure can then be uploaded to the Council and SES websites in a suitable format, where it would be made available under the flood information sections of the website. The brochures could also be made available at Council offices and community halls.
- Development of a Schools Package from existing material developed by the SES and distribution to schools accordingly. Education is not only useful in educating the students, but can be useful in dissemination of information to the wider community.
- A regular (annual) meeting of local community groups to arrange flood awareness programs on a regular basis.
- Information dissemination is recommended to be included in Council rates notices for all affected properties on a regular basis.

#### **4.3.5 EM 6 – Flood Warning Signs at Critical Locations**

A number of public places in the catchment experience high hazard flooding in the 1% AEP event. It is therefore important that appropriate flood warning signs are posted at these locations. These signs may contain information on flooding issues or be depth gauges to inform residents of the flooding depth over roads and paths.

It is recommended that depth gauges be installed at road crossings which are subject to inundation in frequent events.

#### **4.3.6 EM 4 – Flood Warning System and Short-Term Refuges**

The critical duration and response times for the Alexandra Canal floodplain limit the implementation of a flood warning system. The short duration flooding experienced in local systems is not well suited to flood warning systems. Severe weather warnings are likely to be the only assistance for these areas.

There may be some opportunity to connect in with the City of Sydney Emergency Response Centre. This may provide some limited warning, as well as a more coordinated response to a flood event.

A number of open, public areas are located within the Alexandra Canal Catchment. The provision of temporary refuges which can be accessed in a few minutes, even a small warning time may provide the public with sufficient time to seek refuge. The provision of rapid flood warnings within the Alexandra Canal Catchment may be delivered through an automated process that triggers a warning (e.g. with the installation of water level sensors placed in trapped depression areas). The warning itself can be delivered through the use of suitably located electronic information boards at key locations.

Another option is to have a public address system, which can relay a recorded message. The system could be similar to what the City of Sydney has already installed to manage emergencies in the busy streets of the City. An example of this system can be found near the main entrance of the Council building at Town Hall Square where the public address speakers are installed on a traffic light pole.