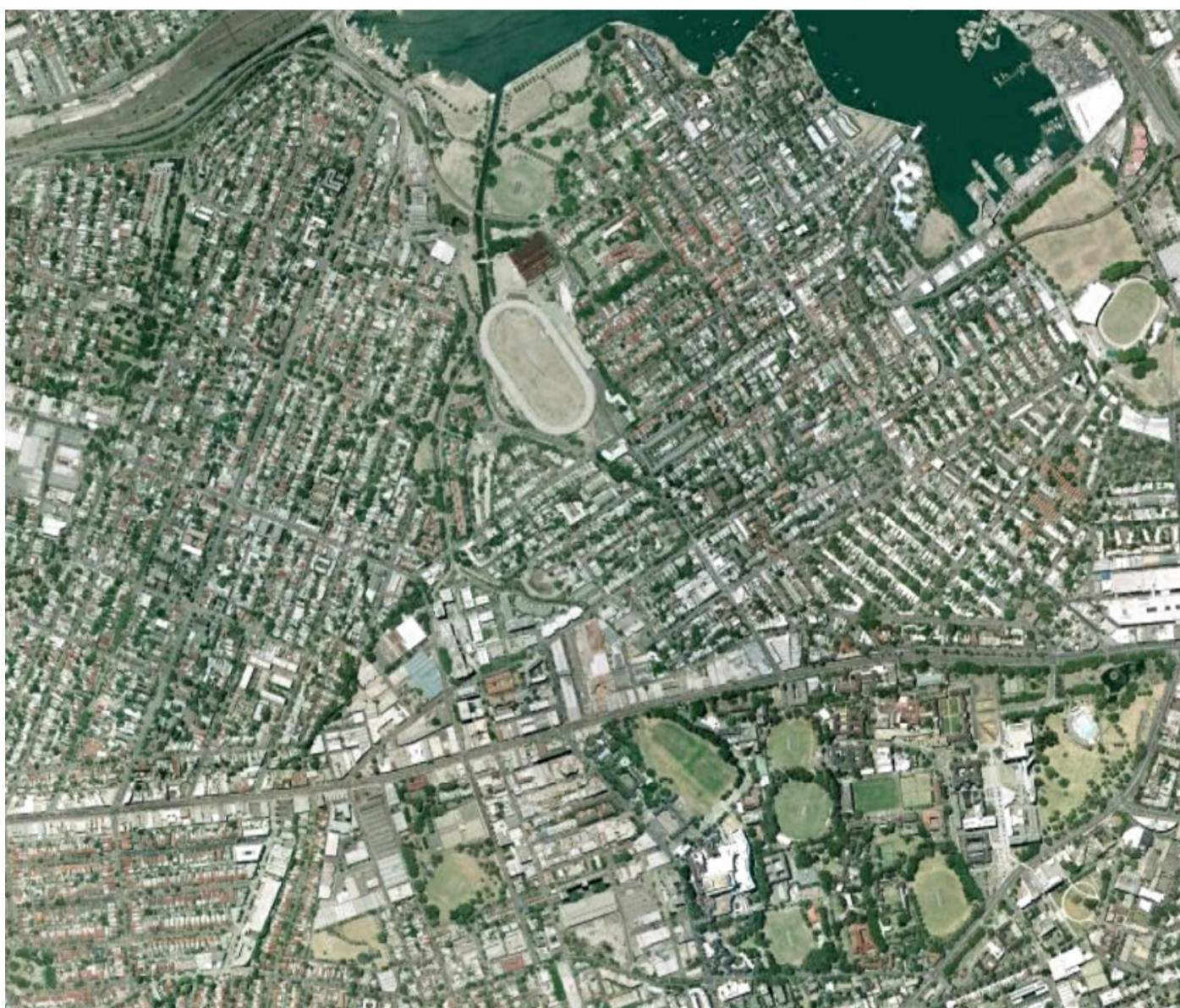


ATTACHMENT G

**JOHNSTONS CREEK CATCHMENT
FLOODPLAIN RISK MANAGEMENT PLAN
(DRAFT REPORT)**

**JOHNSTONS CREEK CATCHMENT
FLOODPLAIN RISK MANAGEMENT
DRAFT PLAN
FINAL DRAFT REPORT**






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JOHNSTONS CREEK CATCHMENT FLOODPLAIN RISK MANAGEMENT DRAFT PLAN

FINAL DRAFT REPORT

MARCH 2015

Project Johnstons Creek Catchment Floodplain Risk Management Draft Plan		Project Number 113046
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JOHNSTONS CREEK CATCHMENT FLOODPLAIN RISK MANAGEMENT DRAFT PLAN

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FOREWORD

The NSW State Government's Flood Prone Land Policy provides a framework to ensure the sustainable use of floodplain environments. The Policy is specifically structured to provide solutions to existing flooding problems in rural and urban areas. In addition, the Policy provides a means of ensuring that any new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Flood Prone Land Policy, the management of flood liable land remains the responsibility of local government. The NSW Government, and administered through the Office of Environment and Heritage (OEH), provides financial assistance and specialist technical advice to assist councils in the discharge of their floodplain management responsibilities. The Australian Government may also provide financial assistance in some circumstances.

The Flood Prone Land Policy provides for specialist technical and financial support to Councils by the NSW Government through the stages set out in the "Floodplain Development Manual – the management of flood liable land, NSW Government, 2005". This Manual is provided to assist Councils to meet their obligations and responsibilities in managing flood liable land. These stages are:

1. **Flood Study**
 - Determine the nature and extent of the flood problem.
2. **Floodplain Risk Management Study**
 - Evaluates management options for the floodplain in respect of both existing and proposed development.
3. **Floodplain Risk Management Draft Plan**
 - Involves formal adoption by Council of a plan of management for the floodplain.
4. **Implementation of the Plan**
 - Construction of flood mitigation works to protect existing development, use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

The Johnstons Creek Catchment Floodplain Risk Management Draft Plan constitutes the third stage of this management process. This plan has been prepared by WMAwater for the City of Sydney (Council) under the guidance of Council's floodplain management committee (Committee). This plan provides the basis for the future management of those parts of the Johnstons Creek catchment which are flood liable and within the City of Sydney local government area.

EXECUTIVE SUMMARY

The recommended Floodplain Risk Management Plan for Johnstons Creek catchment has been prepared in accordance with the NSW Floodplain Development Manual (Reference 1) and:

- Is based on a comprehensive and detailed evaluation of all factors that affect and affected by the use of flood prone land; and
- Provides a long-term path for the future development of the floodplain.

The Johnstons Creeks catchment is located in Sydney's inner-west, in the City of Sydney Local Government Area (LGA). The 460 hectare catchment is fully urbanised, with runoff draining to Rozelle Bay via Johnstons Creek and a pit and pipe stormwater system. There are significant overland flowpaths in the catchment, which are active when the capacity of the pit and pipe network is exceeded. The study area is the part of the catchment within the City of Sydney LGA, which has an area of 224 hectares, around half of the catchment. Flood liability exists across the area, including several locations where overland flow is trapped by unrelieved depressions in the catchment topography.

The Johnstons Creek Catchment Floodplain Risk Management Study (Reference 2) undertook a detailed assessment of flood risk in the catchment. The assessment included a description of flood hazard in the catchment, as well as an estimate of the economic impact of flooding. The study gave a description of the flood emergency response arrangements in the area, as well as a review of the flood planning level and flood planning area.

The floodplain risk management study also included an investigation of possible options for the management of flood risk in the area. These included structural works, such as drainage upgrades and detention basins, as well as planning measures and SES-related actions. The measures were assessed for their ability to reduce flood risk while also considering their economic, social and environmental impact. A multi-criteria matrix assessment was used to directly compare the options. Of the options investigated, thirteen were recommended for implementation, with a priority and time frame assigned to each.

1. FINDINGS OF FLOODPLAIN RISK MANAGEMENT STUDY

1.1. Background

The Johnstons Creek catchment is located immediately west of the Sydney CBD and lies within the City of Sydney and Leichhardt Council Local Government Areas (LGA). The catchment has a total area of 460 ha, though the study area is limited to the City of Sydney LGA. This study area (224 ha) is approximately half of that of the total catchment area and is located in the inner city suburbs of Annandale, Camperdown, Forest Lodge, Glebe and Newtown (refer Figure 1). This region has been extensively developed for urban usage. Land use is predominantly medium to high-density housing with commercial zoned regions concentrated along Parramatta Road and King Street (Newtown) and industrial land largely situated between Pyrmont Bridge Road and Parramatta Road. Regions of open space are also positioned throughout the catchment particularly in the vicinity of the University of Sydney and in recreational parks such as Camperdown Park, Harold Park, Jubilee Park, Federal Park and Bicentennial Park.

The entire study area (with the exception of the immediate Sydney Harbour foreshore) drains to Sydney Water's major trunk drainage system (known as SWC55). SWC55 is composed of various branches, the main one being Johnstons Creek, which route flow from a number of distinctly separate sub-catchments in the upper regions of the catchment. Flow is discharged into Rozelle Bay via Johnstons Creek which is a large concrete lined channel. The trunk drainage system is linked to Council's feeder drainage system consisting of covered channels, in-ground pipes, culverts and kerb inlet pits.

A number of locations within the catchment are flood liable. This flood liability mainly relates to the nature of the topography within the study area as well as the capacity of service provided by drainage assets. The topography of the catchment is steep in the upper areas, steep and undulating in the middle sections, and then flat particularly in the lower regions close to Rozelle Bay. The upper regions of the catchment experience the greatest relief with a maximum elevation of approximately 45 m AHD occurring in the vicinity of Kings Street (Newtown). Urbanisation throughout the catchment occurred prior to the installation of road drainage systems in the 1900s and many buildings have been constructed on overland flow paths or in unrelieved sags. Due to these drainage restrictions, topographic depressions can cause localised flooding as excess flows have no opportunity to escape via overland flow paths. This creates a significant drainage/flooding problem in many areas throughout the catchment.

The Johnstons Creek Catchment Flood Study (2012) was carried out to define existing flood behaviour for the Johnstons Creek catchment in terms of flood levels, depth, velocities, flows, hydraulic categories and provisional hazard. The 1% AEP peak flood depth is shown on Figure 2, while Figure 3 shows the Probable Maximum Flood (PMF). As can be seen on Figure 2, there is significant overland flow in large flood events, with over 1 m of water in several areas, including the natural depression north of Harold Park, in parts of Sydney University, and immediately upstream of Bridge Road, where an unrelieved depression causes water to pond to a depth of over 3 m. Figure 4 and Figure 5 show the hazard categories for the 1% AEP and

PMF events respectively. Areas of high hazard in the catchment generally correspond to the major overland flowpaths, including north of Harold Park in Glebe, upstream of Bridge Road, and in the Johnstons Creek open channel.

1.2. Flood Hazard Classification

Classification of flood hazard in the catchment was based on a combination of the provisional flood hazard categories and a range of other factors that are not captured by the provisional categories. These factors include, but are not limited to: rate of rise of floodwater, duration of flooding, community awareness and effective warning time. A qualitative assessment of these factors was undertaken, the results of which are summarised in Table 1. The provisional hazard categories complement this assessment, as they delineate areas of the floodplain where the depth or velocity of floodwaters is considered hazardous.

Table 1: Hazard Classification

Criteria	Weight ⁽¹⁾	Comment
Size of the Flood	Medium	Relatively low flood hazard is associated with more frequent minor floods while the less frequent major floods are more likely to present a high hazard situation.
Depth & Velocity of Floodwaters	Medium	The provisional hazard is the product of depths and velocity of flood waters. These can be influenced by the magnitude of the flood event.
Rate of Rise of Floodwaters	Medium	Rate of rise of floodwaters is relative to catchment size, soil type, slope and land use cover. It is also influenced by the spatial and temporal pattern of rainfall during events.
Duration of Flooding	Low	The greater the duration of flooding the more disruption to the community and potential flood damages. Permanent inundation due to sea level rise is of indefinite duration.
Flood Awareness and Readiness of the Community	High	General community awareness tends to reduce as the time between flood events lengthens and people become less prepared for the next flood event. Even a flood aware community is unlikely to be wise to the impacts of a larger, less frequent, event.
Effective Warning & Evacuation Time	Medium	This is dependent on rate at which waters rise, an effective flood warning system and the awareness and readiness of the community to act.
Effective Flood Access	High	Access is affected by the depths and velocities of flood waters, the distance to higher ground, the number of people using and the capacity of evacuation routes and good communication.
Evacuation Problems	Medium	The number of people to be evacuated and limited resources of the SES and other rescue services can make evacuation difficult. Mobility of people, such as the elderly, children or disabled, who are less likely to be able to move through floodwaters and ongoing bad weather conditions is a consideration.
Provision of Services	Low	In a large flood it is likely that services will be cut (sewer and possibly others). There is also the likelihood that the storm may affect power and telephones. Permanent inundation from sea level rise may lead to permanent loss of services.
Additional Concerns	Low	Floating debris, vehicles or other items can increase hazard. Sewerage overflows can occur when river levels are high preventing effective discharge of the sewerage system.

Detailed description of the flood hazard classification is given in Section 3.4 of the Johnstons Creek Catchment Floodplain Risk Management Study.

1.3. Economic Impact of Flooding

The economic impact of flooding in Johnstons Creek catchment was assessed as part of the floodplain risk management study. Damages were calculated for residential and commercial/industrial properties, based on a floor level survey of properties inundated in the 1% AEP event. The flood damages estimate does not include the cost of restoring or maintaining public services and infrastructure. It should be noted that damages calculations do not take into account flood damages to any basements or cellars, hence where properties have basements damages can be under estimated.

The damages assessment found that 94 properties within the catchment are liable to over floor inundation in the 1% AEP event, while 38 properties are liable in the 5 year ARI event. The assessment estimated the average annual damage to be approximately \$2.3 million for the catchment. Table 2 gives the estimated tangible damages for the catchment (both residential and commercial/industrial properties)

Table 2: Estimated Combined Flood Damages for Johnstons Creek Catchment

Event	Number of Properties Flood Affected	No. of Properties Flooded Above Floor Level	Total Tangible Flood Damages	Average Tangible Damages Per Flood Affected Property
5 year ARI	111	38	\$ 3,281,700	\$ 29,600
10% AEP	127	61	\$ 4,311,900	\$ 34,000
5% AEP	138	75	\$ 5,358,000	\$ 38,900
2% AEP	148	82	\$ 6,080,100	\$ 41,100
1% AEP	159	94	\$ 7,027,200	\$ 44,200
PMF	180	139	\$ 14,320,800	\$ 79,600
Average Annual Damages (AAD)			\$ 2,277,900	\$ 12,700

Detailed description and results of the damages assessment is given in Section 5 of the Johnstons Creek Catchment Floodplain Risk Management Study.

2. RECOMMENDED MANAGEMENT MEASURES

The Johnstons Creek Catchment Floodplain Risk Management Study made a full assessment of the existing flood risk in the catchment. Based on this assessment of flood risk, the study investigated a range of management measures for the area, which can be categorised as Response Modification Measures, Property Modification Measures and Flood Modification measures, as per the NSW Floodplain Development Manual (Reference 1). Measures were assessed for their efficacy across a range of criteria, which allowed them to be compared against one another and their overall effectiveness ranked. Measures which improved the management of flood risk in the catchment were selected and form the primary content of this Plan.

The measures have been categorised by their type (Response, Flood or Property) and given a priority ranking. The ranking is based upon a combination of reduction in flood risk, ease of implementation, cost/funding implications and outcomes based on the multi-criteria matrix assessment (refer Section 10.4 of the Study). More information on each measure is available in the Floodplain Risk Management Study, including discussion of its implementation and its effect on the existing flood behaviour.

2.1. Flood Modification Measures

The following sections detail the flood modification measures recommended for implementation in the catchment. Figure 6 shows the location of the options in the catchment.

2.1.1. Detention Basin – St Johns Oval (FM - JC01)

Option FM – JC01 is proposed to mitigate flooding in the vicinity of the Parramatta Road/Larkin Street intersection as well as reducing the volume of floodwaters which will get trapped eventually at the trapped low point upstream of Pyrmont Bridge Road. The purpose of this mitigation option is two fold: to reduce the likelihood of flooding on Parramatta Road which is a major access road and to reduce the flood liability for the residential properties located on the Larkin Street low point. This option comprises provision of detention storage with 14,400 m³ capacity (area approximately 7,000 m² with depth up to 2 m) in St Johns Oval by excavating existing ground to the indicated invert level.

The measure has been given a medium priority in the Floodplain Risk Management Plan, based on its benefit cost ratio, and its positive effect on the flood behaviour downstream. The measure is recommended to be implemented by City of Sydney in the medium to long term. Consultation with the University of Sydney is required to further assess the option's feasibility.

2.1.2. Drainage Upgrade – Sparkes Street to Johnstons Creek (FM – JC02)

Option FM – JC02 is proposed to alleviate flood risk at the unrelieved depression upstream of Pyrmont Bridge Road. The severity of flooding for some properties in this area can be reduced

with the upgrade of the Sydney Water-owned trunk drainage system to the 5% AEP capacity all the way to the confluence with Johnstons Creek. Works have to be undertaken to enhance the capacity of the surrounding pits to facilitate the transfer of floodwaters from above surface to the sub-surface drainage system.

The measure has been given a medium priority in the Floodplain Risk Management Plan, based on its good benefit cost ratio, and its positive effect on the flood behaviour in the area upstream of Bridge Road. The measure is recommended to be implemented by City of Sydney in the medium to long term, for example when other drainage works are being undertaken in the area.

2.1.3. Drainage Upgrade – Hereford Street and Detention Basins – John Street and Arthur (Paddy) Gray Reserves (FM – JC03)

The premise of Option FM – JC03 is to reduce flooding on Bridge Road, Hereford Street and their surrounds. This involves upgrading the Sydney Water-owned trunk drainage starting from Reuss Street all the way to Wigram Lane, downstream of Glebe Gardens to the 5% AEP capacity. To provide additional flood storage, two detention basins are proposed utilising existing parklands, i.e. John Street and Arthur (Paddy) Gray Reserves. The excavation volume required for these basins is about 4,200 m³ (area approximately 1,700 m² with depth up to 3 m) and 11,700 m³ (area approximately 3,700 m² with depth up to 4 m) respectively. Also, works have to be undertaken to enhance the capacity of the surrounding pits to facilitate the transfer of floodwaters from above surface to the sub-surface drainage system.

The measure has been given a low priority in the Floodplain Risk Management Plan, based on its relatively poor benefit cost ratio, its lack of support in the community and issues relating to its technical feasibility. The measure is recommended to be implemented by City of Sydney in the long term, for example when other drainage works are being undertaken in the area.

2.1.4. Lowering of Hogan Park and Widening of Walkway - The Crescent (FM – JC04)

Option FM – JC04 is proposed to provide additional flood storage area in order to alleviate to some extent the flood risk presented by mainstream Johnstons Creek flooding as well as reduce over floor flood liability for properties on Coneill Place and The Crescent. The 2012 Flood Study has shown that floodwaters overtop the channel bank for events less than the 5 year ARI and lowering Hogan Park would provide an additional 16,200 m³ of storage (area approximately 17,500 m² with depth up to 2 m) that would reduce the peak flood levels of Johnstons Creek and its surrounds. As floodwaters are discharged downstream through The Crescent bridge for in-bank flows and through the pedestrian walkway underneath the bridge for over-bank flows, widening the walkway would create additional conveyance capacity for this “secondary outlet” for major event flows coming from upstream.

The measure has been given a low priority in the Floodplain Risk Management Plan, based on its relatively poor benefit cost ratio and issues relating to its political feasibility. The measure is recommended to be implemented by City of Sydney in the long term, for example when other

major works are being undertaken in the park.

2.1.5. Bridge Raising – Johnstons Creek (FM – JC05)

As part of Option FM – JC05, bridges along Johnstons Creek which have soffit levels below the 1% AEP channel peak flood level are raised to a new designated design level, preferably above the 1% AEP peak flood level plus freeboard. In addition, a few bridges would be reconstructed to eliminate the need for piers which would effectively improve conveyance within the concrete lined channel. The increased discharge to Rozelle Bay would reduce peak flood levels for the over-bank areas stretching from Wigram Road to Bicentennial Park. Here, the cumulative impacts are determined for this option together with Option FM – JC04.

The measure has been given a high priority in the Floodplain Risk Management Plan, as there are existing plans to upgrade some of the pedestrian bridges, and the option would be relatively straightforward to incorporate into structural upgrades. The measure is recommended to be implemented by City of Sydney in the next 24 months as part of the planned upgrades.

2.2. Property Modification Measures

2.2.1. Flood Planning Levels (PM – JC01)

The flood planning level (FPL) is used to define land subject to flood related development controls and is generally adopted as the minimum level to which floor levels in the flood affected areas must be built. The FPL includes a freeboard above the design flood level. It is common practice to set minimum floor levels for residential buildings, garages, driveways and even commercial floors as this reduces the frequency and extent of flood damages. Freeboards provide reasonable certainty that the reduced level of risk exposure selected (by deciding upon a particular event to provide flood protection for) is actually provided.

The measure has been given a high priority in the Floodplain Risk Management Plan, based on its positive effect on long term floodplain risk management in the catchment, and its community acceptance and economic merits. A review of the FPLs put forward by Council in their *Interim Floodplain Management Policy* (Reference 4) was carried out as part of the Floodplain Risk Management Study and it was recommended that case studies be provided to illustrate how these levels could be applied to individual developments to assist in development applications.

2.2.2. Development Control Planning (PM – JC02)

Within the Johnstons Creek catchment there is continuing pressures for both redevelopments of existing buildings as well as for new developments. The strategic assessment of flood risk can prevent development occurring in areas with a high hazard and/or with the potential to have significant impacts upon flood behaviour in other areas. It can also reduce the potential damage to new or redeveloped properties likely to be affected by flooding to acceptable levels.

The measure has been given a high priority in the Floodplain Risk Management Plan, based on

its positive effect on long term floodplain risk management in the catchment, and its community acceptance and financial feasibility. Recommendation for an update of the planning documents (i.e. Sydney DCP 2012 and Sydney LEP 2012) has been discussed in the Floodplain Risk Management Study in order to inform of the development controls as published in the Interim Floodplain Management Policy (Reference 4). Inclusion of these provisions would ensure that the controls can be enforced which also take into consideration the potential impact of climate change. The update is recommended to be implemented within City of Sydney in the next 12 months.

2.2.3. Flood Proofing (PM – JC03)

An alternative to house raising for buildings that are not compatible or not economically viable, is flood proofing or sealing off the entry points to the building. This measure has the advantage that it is generally less expensive than house raising and causes less social disruption. Flood proofing requires sealing of doors and possibly windows (new frame, seal and door); sealing and re-routing of ventilation gaps in brick work; sealing of all underfloor entrances and checking of brickwork to ensure there are no gaps or weaknesses in mortar. It is generally only suitable for brick buildings with concrete floors and it can prevent ingress from outside depths of up to one meter. Greater depths may cause structural problems (buoyancy) unless water is allowed to enter. Generally an existing house can be sealed for approximately \$10,000. New development and extensions allow the inclusions of flood appropriate materials and designs meaning the actual cost of flood proofing can be significantly less when compared to buildings requiring retro-fitting of flood proofing measures.

The measure has been given medium priority in the Floodplain Risk Management Plan, based on the number of properties it can benefit and its economic merits. The measure is recommended to be implemented by local business owners in the short term.

2.2.4. Minor Property Adjustments (PM – JC04)

In overland flow areas minor property adjustments can be made to manage overland flow passing through private property. Such adjustments can include amendments to fences, construction of fences which act as deflector levees, modifying gardens, changing easements etc all of which can affect the local continuity of overland flow paths.

The measure has been given low priority in the Floodplain Risk Management Plan, based on its limited benefit and the difficulty in administering the measure. The measure is recommended to be implemented in the short term by local residents with overland flow on their property.

2.3. Response Modification Measures

2.3.1. Flood Warning and Evacuation (RM – JC01)

Flood warning can significantly reduce damages and risk to life and studies have shown that flood warning systems generally have high benefit/cost ration if sufficient warning time is

provided.

Flood warning and the implementation of evacuation procedures by the SES are widely used throughout NSW to reduce flood damages and protect lives. The Bureau of Meteorology (BoM) is responsible for flood warnings on major river systems and the SES is disseminating these warning to the local community. Adequate warning gives residents time to move goods and cars above the reach of floodwaters and to evacuate from the immediate area to designated evacuation points or flood free ground. The effectiveness of a flood warning scheme, known as the effective flood warning time, depends on;

- The maximum potential warning time before the onset of flooding;
- The actual warning time provided before the onset of flooding. This depends on the adequacy of the information gathering network and the skill and knowledge of the operators; and
- The flood awareness of the community responding to a warning.

The measure has been given a medium priority in the Floodplain Risk Management Plan, based on its positive effect on SES operations and risk to life, as well as its relatively strong community acceptance. The measure is recommended to be implemented within the catchment in the next 12 months.

2.3.2. Flood Emergency Management (RM – JC02 and RM – JC03)

As mentioned previously, it may be necessary for some residents to evacuate their homes in a major flood. This would usually be undertaken under the direction of the lead agency under the DISPLAN, the SES. Some residents may choose to leave on their own accord based on flood information from the radio or other warnings, and may be assisted by local residents. The main problems with all flood evacuations are;

- They must be carried out quickly and efficiently;
- There can be confusion about 'ordering' evacuations, with rumours and well-meaning advice taking precedence over official directions which can only come from the lead agency, the SES;
- They are hazardous for both rescuers and the evacuees;
- Residents are generally reluctant to leave their homes, causing delays and placing more stress on the rescuers, and
- People (residents and visitors) do not appreciate the dangers of crossing floodwaters.

For this reason, the preparation of a flood emergency response plan helps to minimise the risk associated with evacuations by providing information regarding evacuation routes, refuge areas, what to do/not to do during floods etc. It is the role of the SES to develop this plan for vulnerable communities.

The measures have been given a high priority in the Floodplain Risk Management Plan, based on their positive effect on SES operation in the catchment and the resultant reduction in flood

risk. The measures also have relatively high community acceptance. The DISPLAN (RM - JC02) is recommended to be prepared by the SES in the next 12 months, while the Local Flood Plan (RM - JC03) is recommended to be prepared in the same time frame by City of Sydney and the SES.

2.3.3. Community Awareness Programme (RM – JC04)

The success of any flood warning system and the evacuation process in reducing flood losses and damages depends on:

- *Flood Awareness*: How aware is the community of the flood threat? Has it been adequately informed and educated?
- *Flood Preparedness*: How prepared is the community to react to the threat of flooding? Do they (or the SES) have damage minimisation strategies (such as sand bags, raising possessions) which can be implemented?
- *Flood Evacuation*: How prepared are the authorities and the residents to evacuate households to minimise damages and the potential risk to life during a flood? How will the evacuation be done, where will the evacuees be moved to?

Public information and the level of public awareness are keys in reducing flood damages and losses. A more aware community will suffer less losses and damage than an unprepared community.

The measure has been given a medium priority in the Floodplain Risk Management Plan, based on its positive effect on SES operations and risk to life, as well as its relatively strong community acceptance. The measure is recommended to be implemented within City of Sydney in the next 12 months.

2.4. Recommended Management Measures – Table

The recommended measures described in the previous sections are summarised in Table 3 in order of priority. The table provides a reference point for the Plan's recommendations, and represents one of the main outcomes of the floodplain risk management process for the Johnstons Creek catchment.

Table 3: Recommended Management Measures

REF ¹	MEASURE	PURPOSE	PRIORITY	RESPONSIBILITY	TIME FRAME	COST
FM-JC05	Raise footbridges along Johnstons Creek to above the 1% AEP level (Section 9.4.4)	Reduce risk associated with high hazard flows in the area and reduce risk to nearby affected properties.	High Priority	City of Sydney	24 months	Approx. \$1,000,000 capital, \$10,000 ongoing (annual)
RM-JC02	Prepare DISPLAN for the Sydney West Emergency Management District (SES) (Section 9.6.2)	Minimise the risk associated with evacuations	High Priority	SES	12 months	Internally within SES
RM-JC03	Prepare Local Flood Plan to inform evacuation centres, identify vulnerable facilities and evacuation routes (Section 9.6.2)	Inform evacuation centres, identify vulnerable facilities and evacuation routes	High Priority	City of Sydney and SES	12 months	Internally within Council
PM-JC02	Update Sydney DCP 2012 and LEP 2012 based on FRMS&P outcomes and to inform of Council's Interim Floodplain Management Policy (Section 9.5.2)	Prevent development occurring in high hazard areas or impacting existing flood behaviour	High Priority	City of Sydney	12 months	Internally within Council
PM-JC01	Review FPLs following completion of FRMS&P for Johnstons Creek catchment. Provide case studies to assist DA (Section 9.5.1)	Reduce the damages of flood affected properties by having elevated floor level	High Priority	City of Sydney	2-3 years	Internally within Council
RM-JC01	Make available flood warnings on Council's website or social media, investigate feasibility of installing flood warning systems at key locations (Section 9.6.1)	Increase community's awareness during and after a flood event to reduce damages and risk to life	Medium Priority	City of Sydney	12 months	Internally within Council
RM-JC04	Develop ongoing flood awareness programmes for the community (Section 9.6.3)	Increase community's general awareness to reduce damages and risk to life	Medium Priority	City of Sydney	12 months	Internally within Council
PM-JC03	Investigate flood proofing techniques for flood affected commercial/industrial properties (Section 9.5.4)	Reduce the damages of flood affected properties by preventing ingress of floodwaters.	Medium Priority	Local Business Owners	Short term	Low to investigate
FM-JC01	Detention basin in part of St Johns Oval, University of Sydney (Section 9.4.1)	Improve duration of flooding on major road and reduce risk to nearby affected properties	Medium Priority	City of Sydney	Medium to long term	Approx. \$3,000,000 capital, \$10,000 ongoing (annual)

FM-JC02	Drainage upgrade between Sparkes Street to Johnstons Creek and downstream channel works (Section 9.4.2)	Reduce risk to affected properties in the area and risk due to high hazard flood storage in the area.	Medium Priority	City of Sydney	Medium to long term	Approx. \$11,000,000 capital, \$28,000 ongoing (annual)
PM-JC04	Investigate potential for property adjustments to manage overland flow at flooding hot spots (Section 9.5.5)	Manage overland flows through private property by directing away from dwellings	Low Priority	Local Residents	Short term	Low to investigate
FM-JC04	Regrade Hogan Park and widen walkway under The Crescent (Section 9.4.4)	Reduce risk associated with high hazard flows in the area	Low Priority	City of Sydney	Long term	Approx. \$5,000,000 capital
FM-JC03	Drainage upgrade near Hereford Street and detention basins in John Street and Arthur Gray Reserves (Section 9.4.3)	Reduce risk to affected properties in the area	Low Priority	City of Sydney	Long term	Approx. \$9,000,000 capital, \$16,000 ongoing (annual)

¹Reference of measure in the Johnstons Creek Floodplain Risk Management Study

3. ACKNOWLEDGEMENTS

WMAwater wish to acknowledge the assistance of the City of Sydney Council staff and the Floodplain Management Committee in carrying out this study as well as the NSW Government (Office of Environment and Heritage) and the residents of the Johnstons Creek catchment. This study was jointly funded by the City of Sydney Council and the NSW Government.

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4. REFERENCES

1. NSW Government (2005) Floodplain Development Manual – the Management of Flood Liable Land, Department of Infrastructure, Planning and Natural Resources
2. WMAwater (2014), Johnstons Creek Catchment Floodplain Risk Management Study, Draft Report
3. WMAwater (2012), Johnstons Creek Catchment Flood Study, Draft Report
4. City of Sydney (2014), Interim Floodplain Management Policy

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FIGURE 1
STUDY AREA
JOHNSTONS CREEK CATCHMENT



Study Area
● Pits
Pipe/Culvert Diameter (m)
 0.1 - 0.45
 0.45 - 0.75
 0.75 - 1.0
 1.0 - 2.4
 2.4 - 3.8
 Open Channel

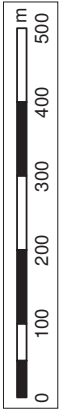
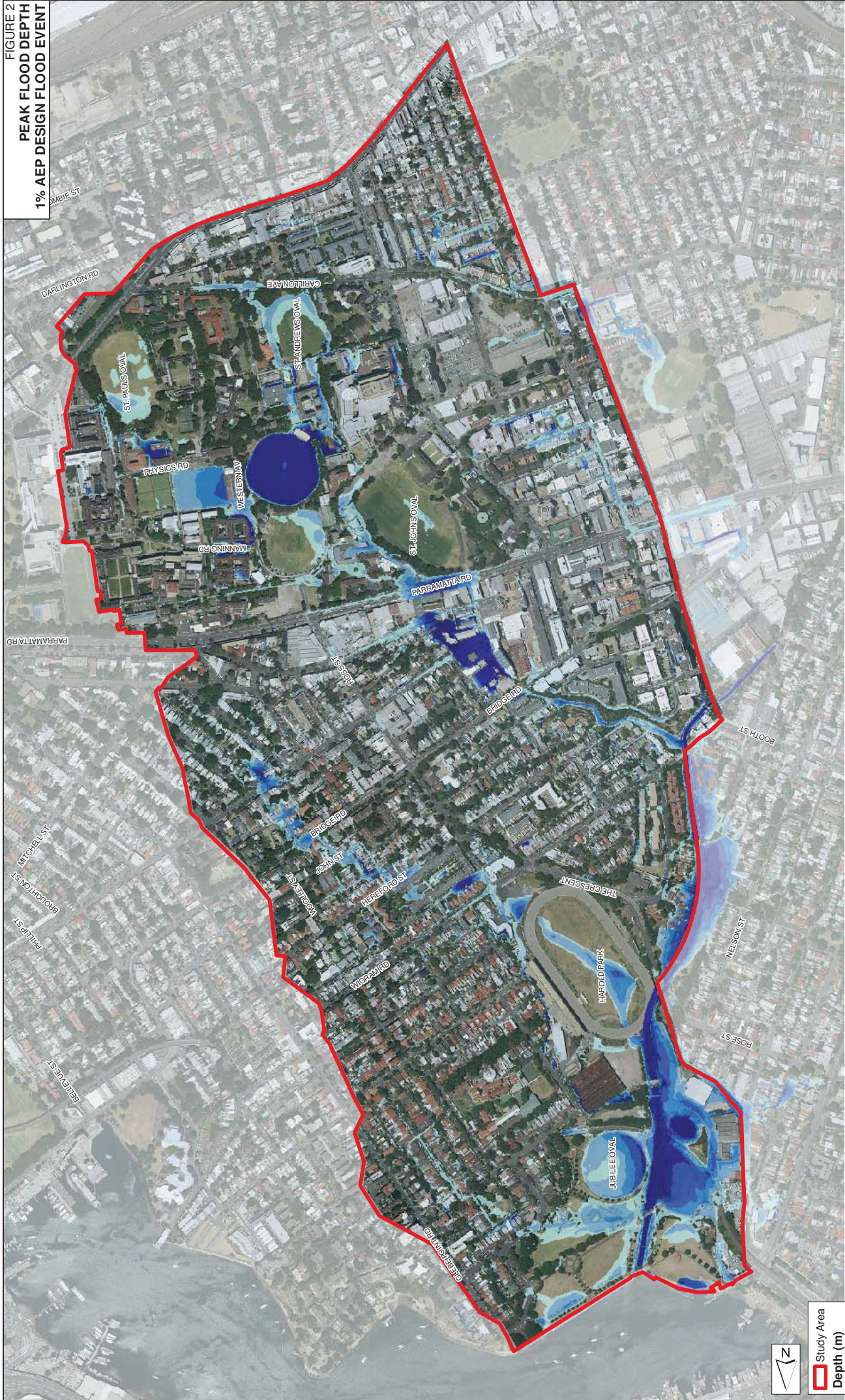


FIGURE 2
PEAK FLOOD DEPTH
1% AEP DESIGN FLOOD EVENT

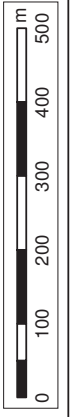


Disclaimer:
Inundation patterns and/or peak flood levels shown for design events are based on best available estimates of flood behaviour within the Catchment. Inundation from local overland flow may vary slightly to the displayed design rainfall inundation patterns. Council should be consulted to confirm flood affectation at individual allotments.

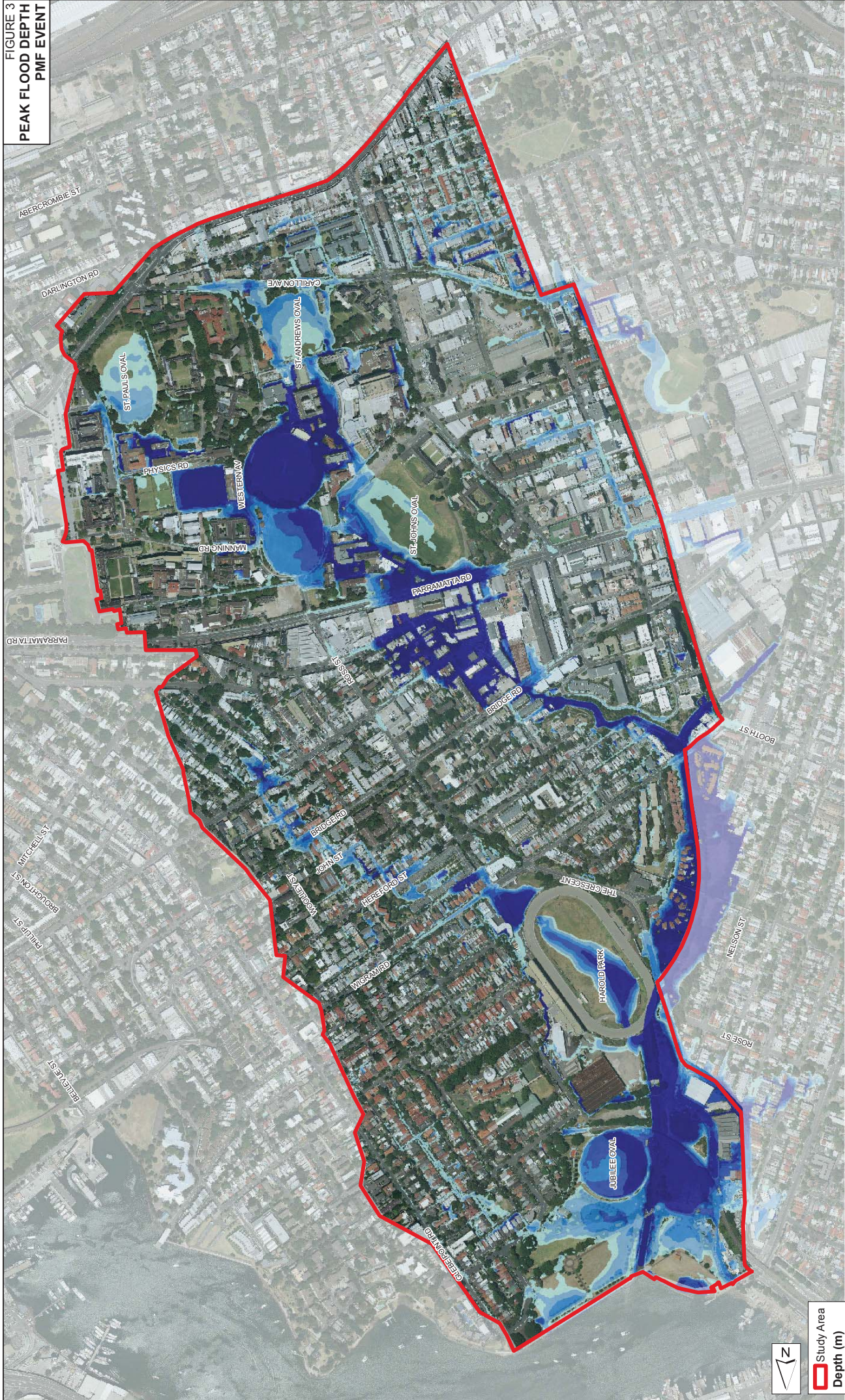
Note: Flood depths modelled as less than 0.1m are not displayed



Study Area	Depth (m)
[Light Blue Box]	0.1 - 0.25
[Medium Blue Box]	0.25 - 0.5
[Dark Blue Box]	0.5 - 0.75
[Very Dark Blue Box]	0.75 - 1
[Black Box]	> 1



**FIGURE 3
PEAK FLOOD DEPTH
PMF EVENT**



Disclaimer:
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Note: Flood depths modelled as less than 0.1m are not displayed

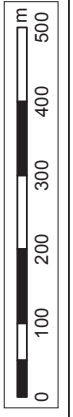
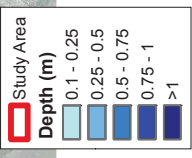
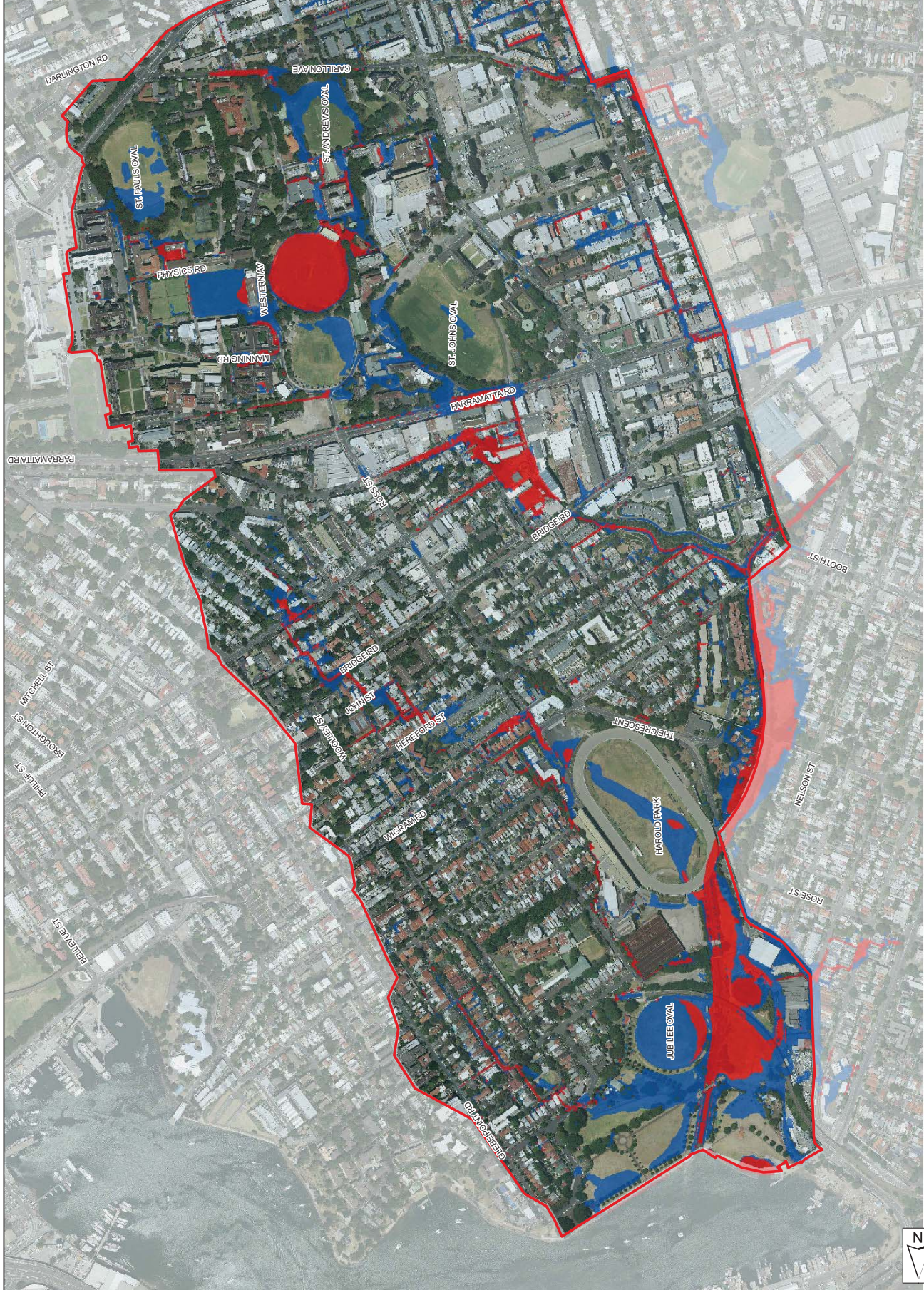


FIGURE 4
HAZARD CATEGORIES
1% AEP DESIGN FLOOD EVENT

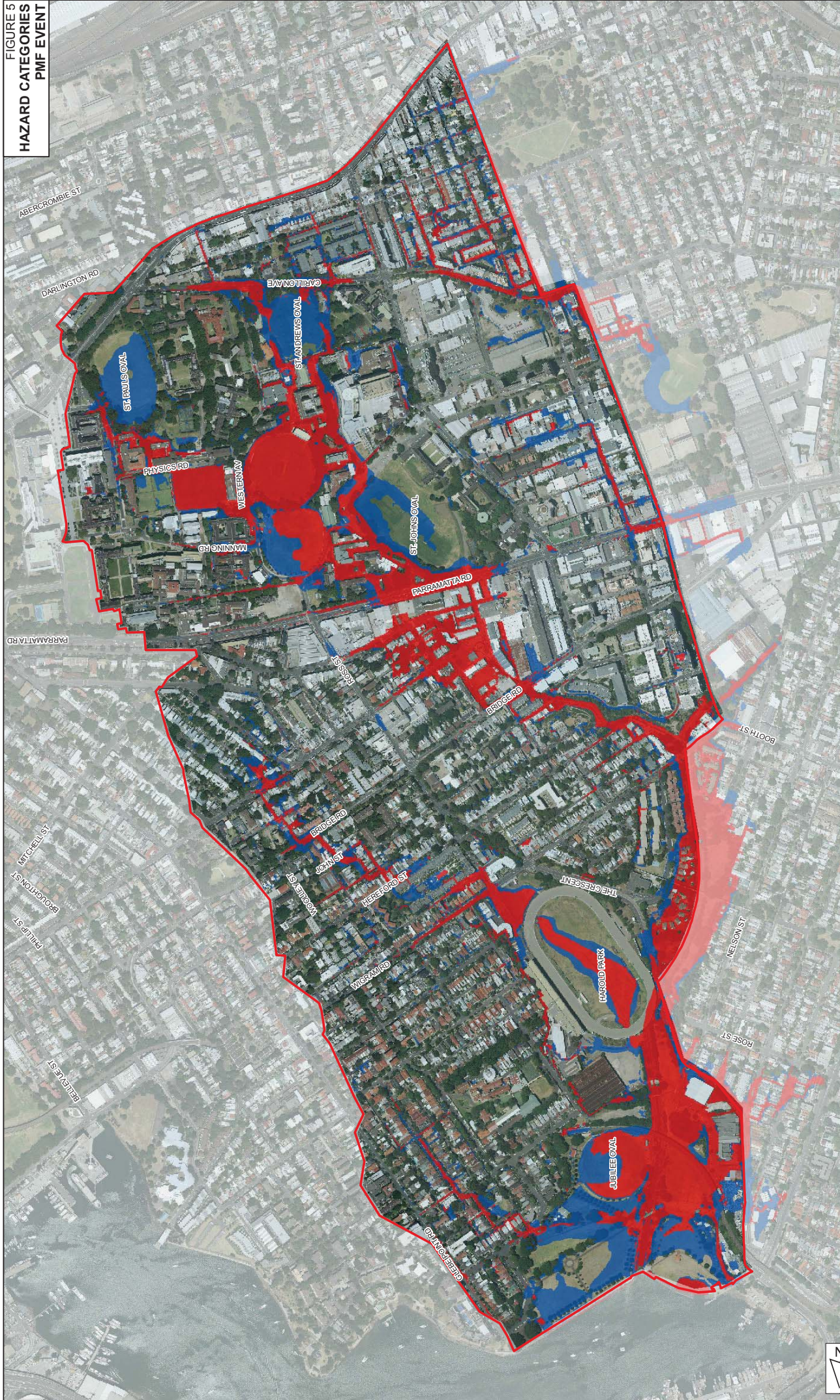


- Study Area
- Hydraulic Hazard
- Low Hazard
- High Hazard

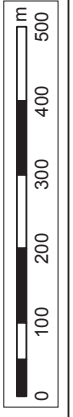


Disclaimer:
Inundation patterns and/or peak flood levels shown for design events are based on best available estimates of flood behaviour within the Catchment. Inundation from local overland flow may vary slightly to the displayed design rainfall inundation patterns. Council should be consulted to confirm flood affectation at individual allotments.

**FIGURE 5
HAZARD CATEGORIES
PMF EVENT**

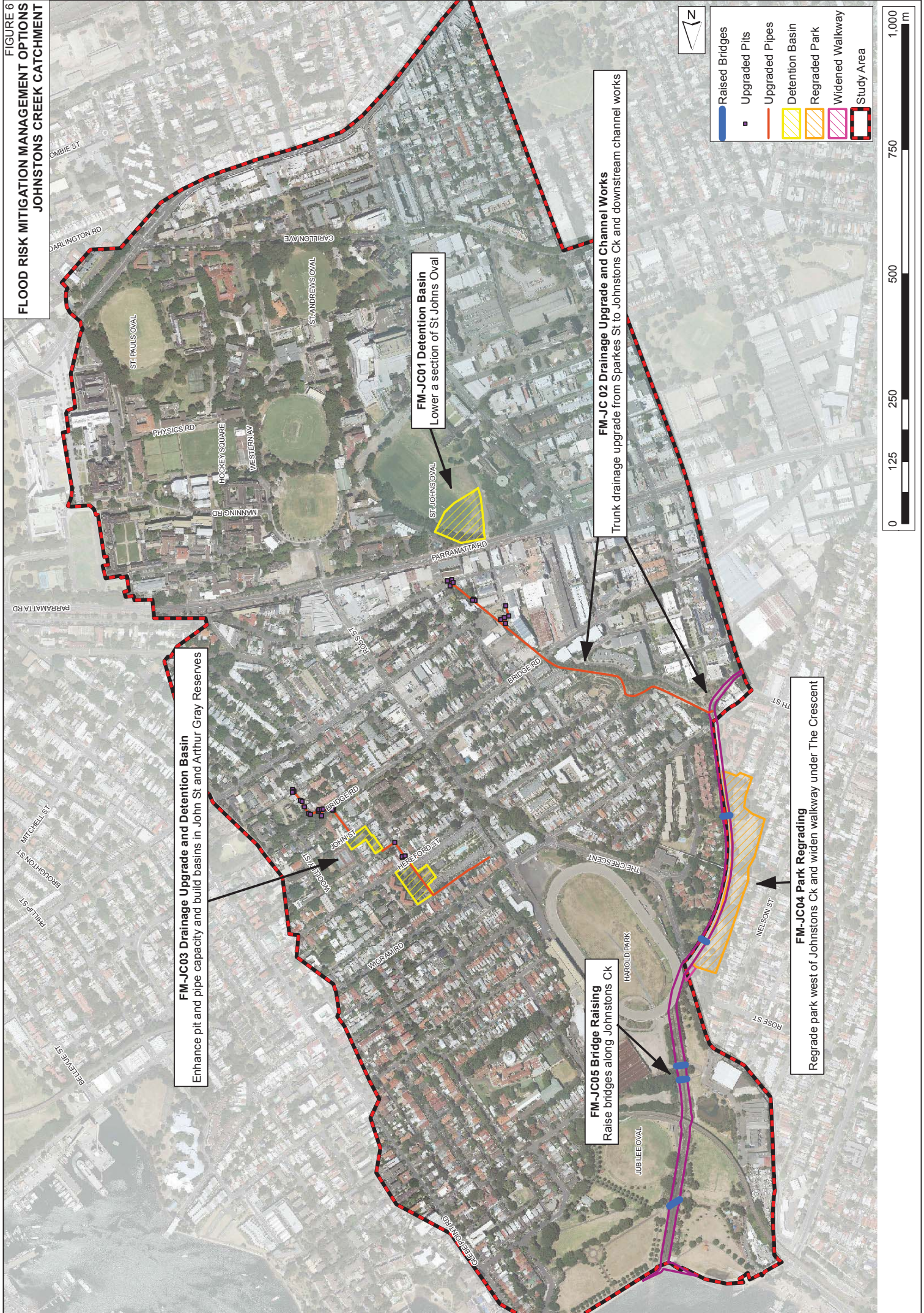


 Study Area
 Hydraulic Hazard
 Low Hazard
 High Hazard



Disclaimer: Inundation patterns and/or peak flood levels shown for design events are based on best available estimates of flood behaviour within the Catchment. Inundation from local overland flow may vary slightly to the displayed design rainfall inundation patterns. Council should be consulted to confirm flood affectation at individual allotments.

**FIGURE 6
FLOOD RISK MITIGATION MANAGEMENT OPTIONS
JOHNSTONS CREEK CATCHMENT**



- Raised Bridges
- Upgraded Pits
- Upgraded Pipes
- Detention Basin
- Regrading Park
- Widened Walkway
- Study Area

0 125 250 500 750 1,000 m

FM-JC03 Drainage Upgrade and Detention Basin
Enhance pit and pipe capacity and build basins in John St and Arthur Gray Reserves

FM-JC01 Detention Basin
Lower a section of St Johns Oval

FM-JC02 Drainage Upgrade and Channel Works
Trunk drainage upgrade from Sparkes St to Johnstons Ck and downstream channel works

FM-JC05 Bridge Raising
Raise bridges along Johnstons Ck

FM-JC04 Park Regrading
Regrade park west of Johnstons Ck and widen walkway under The Crescent

