

CENTENNIAL PARK FLOODPLAIN RISK MANAGEMENT PLAN

FINAL







Level 2, 160 Clarence Street
Sydney, NSW, 2000

Tel: 9299 2855
Fax: 9262 6208
Email: wma@wmawater.com.au
Web: www.wmawater.com.au

CENTENNIAL PARK CATCHMENT FLOODPLAIN RISK MANAGEMENT PLAN

FINAL REPORT

APRIL 2016

Project Centennial Park Catchment Floodplain Risk Management Plan		Project Number 114014	
Client City of Sydney		Client's Representative Shah Alam	
Authors Felix Taaffe Steve Gray		Prepared by 	
Date 21 April 2016		Verified by 	
Revision	Description	Distribution	Date
4	Final	Shah Alam	Apr 2016
3	Draft Final		Dec 2015
2	Draft Plan - Revised		Apr 2015
1	Draft Plan		Feb 2015

CENTENNIAL PARK CATCHMENT FLOODPLAIN RISK MANAGEMENT PLAN

TABLE OF CONTENTS

	PAGE
FOREWORD	i
EXECUTIVE SUMMARY	ii
1. FINDINGS OF FLOODPLAIN RISK MANAGEMENT STUDY	1
1.1. Background	1
1.2. Flood Hazard Classification	1
1.3. Economic Impact of Flooding.....	3
2. RECOMMENDED MANAGEMENT MEASURES	4
2.1. Timeframe for Implementation	4
2.2. Flood Modification Measures	4
2.2.1. Trunk Drainage Upgrade – Stewart and Leinster Street (FM - CP02)	5
2.2.2. Trunk Drainage Upgrade – Lang Road North (FM - CP03)	5
2.2.3. Trunk Drainage Upgrade – Lang Road (FM – CP05).....	5
2.3. Response Modification Measures	6
2.3.1. Variable Message Display (RM-CP01).....	6
2.3.2. Evacuation Planning (RM – CP02)	6
2.3.3. Public Information and Raising Flood Awareness (RM – CP03).....	6
2.3.4. Local Flood Plan and DISPLAN (RM – CP04)	7
2.4. Property Modification Measures.....	7
2.4.1. Flood Planning Levels (PM – CP01)	7
2.4.2. Investigate Flood Proofing (PM – CP02).....	8
2.4.3. Voluntary Purchase (PM – CP03).....	8
2.4.4. Development Control Planning (PM – CP04).....	8
2.5. Recommended Management Measures – Table	9
3. ACKNOWLEDGEMENTS	12
4. REFERENCES	13

LIST OF TABLES

Table 1: Hazard Classification.....	2
Table 2: Estimated Combined Flood Damages for Centennial Park Catchment.....	3
Table 3: Recommended Management Measures.....	10

LIST OF FIGURES

Figure 1: Study Area	
Figure 2: Peak Flood Depth - 1% AEP Design Flood Event	
Figure 3: Peak Flood Depth - PMF Event	
Figure 4: Hazard Categories - 1% AEP Design Flood Event	
Figure 5: Hazard Categories - PMF Event	
Figure 6: Short Term Flood Risk Mitigation Options	
Figure 7: Long Term Flood Risk Mitigation Options	

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 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 Centennial Park Catchment Floodplain Risk Management 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 Centennial Park catchment which are flood liable and within the City of Sydney local government area.

EXECUTIVE SUMMARY

The recommended Floodplain Risk Management Plan for Centennial Park 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 are affected by the use of flood prone land; and
- Provides a long-term path for the future development of the floodplain.

The Centennial Park catchment is located 3 km south-east of the Sydney Central Business District (CBD), in the City of Sydney Local Government Area (LGA). The 150 hectare catchment is fully urbanised, with runoff in the catchment draining to Centennial Park and south along Anzac Parade. There are significant overland flowpaths in the catchment, which are active when the capacity of the pit and pipe network is exceeded. Flood liability exists across the area, including several locations where overland flow is trapped by unrelieved depressions in the catchment topography.

The Centennial Park 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 regraded roads, 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, 11 were recommended for implementation, with a priority and time frame assigned to each.

1. FINDINGS OF FLOODPLAIN RISK MANAGEMENT STUDY

1.1. Background

The Centennial Park catchment is located south-east of the Sydney CBD and lies within the City of Sydney LGA. The catchment has an area of approximately 150 hectares and includes parts of Moore Park, Centennial Park and Paddington (refer Figure 1). The area has been extensively developed for urban usage, with a mix of land uses, including recreational areas (Moore Park, Sydney Cricket Ground and Sydney Football Stadium), medium to high density residential in the area's north and north-west, and commercial and industrial areas in Fox Studios and the Entertainment Quarter. Moore Park is the area's main open recreational space, taking up a large portion of the catchment.

The catchment's runoff drains to Sydney Water Corporation's (SWC) major trunk drainage systems (known as SWC 58, 59 and 89) to route flows from the upper regions of the catchment. The trunk drainage system is linked to Council's local drainage system consisting of covered channels, in-ground pipes, culverts and kerb inlet pits. When these systems reach capacity, flow cannot enter the subsurface network and passes overland along streets and other open space. There is no open channel or other watercourse in the area.

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. Urbanisation throughout the catchment occurred prior to the installation of road drainage systems in the 1900s and some 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 is exacerbated by the relatively flat terrain in the lower section of the catchment (broadly, the area south of Moore Park Road and west of Cook Road), which results in a lack of flood gradient in this area. This lack of gradient, as well as insufficient pipe drainage causes localised flooding in several areas in the catchment.

The Centennial Park Catchment Flood Study (2013) was carried out to define existing flood behaviour for the Centennial Park 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 unrelieved depressions in Driver Avenue, Stewart Street, Leinster Street and Poate Road. 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 aforementioned unrelieved depressions, as well as at Lang Road near Driver Avenue.

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	High	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	Medium	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	Medium	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	Low	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.

⁽¹⁾ Relative weighting in assessing the hazard for the Centennial Park catchment

Detailed description of the flood hazard classification is given in Section 3.2 of the Centennial Park Catchment Floodplain Risk Management Study.

1.3. Economic Impact of Flooding

The economic impact of flooding in Centennial Park 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 28 properties within the catchment are liable to over floor inundation in the 1% AEP event, while 13 properties are liable in the 20% AEP event. The assessment estimated the average annual damage to be approximately \$0.7 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 Centennial Park 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
PMF	90	57	\$ 3,540,500	\$ 39,300
0.2%	86	37	\$ 2,427,900	\$ 28,200
1%	84	28	\$ 1,850,100	\$ 22,000
2%	80	25	\$ 1,668,600	\$ 20,900
5%	77	23	\$ 1,511,100	\$ 19,600
10%	71	19	\$ 1,287,300	\$ 18,100
20%	64	13	\$ 914,700	\$ 14,300
50%	55	9	\$ 612,900	\$ 11,100
Average Annual Damages (AAD)			\$ 650,800	\$ 7,800

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

2. RECOMMENDED MANAGEMENT MEASURES

The Centennial Park 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 9.5 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. Timeframe for Implementation

Floodplain management measures recommended by this Plan have been assigned a timeframe for implementation, in order to form short term, medium term and long term strategies for the area's floodplain management. Use of different timeframes ensures that priority is given to those measures which can be undertaken in the near future, while also retaining less feasible options for long term implementation.

Short term measures are those that are able to be implemented in the next 1-10 years, and are comprised of response modification and property modification measures, while medium term refers to a 10-20 year timeframe. Long term measures are those that have greater constraints (usually financial or logistical) and are therefore planned to be implemented in the next 20-50 years. As discussed in the floodplain risk management study, the structural options for the Centennial Park catchment have numerous technical constraints and do not have favourable benefit-cost ratios. For this reason, the options should be undertaken in conjunction with other infrastructure works (for example, road upgrades) that mitigate their constraints.

The following section includes both a priority and a designated timeframe for each recommended management measure. Short term measures are shown on Figure 6, while Figure 7 shows the long term measures.

2.2. Flood Modification Measures

The following sections detail the flood modification measures recommended for implementation in the catchment. Figure 7 shows the location of the options in the catchment.

2.2.1. Trunk Drainage Upgrade – Stewart and Leinster Street (FM - CP02)

Option FM – CP02 entails an upgrade of the trunk drainage system that drains the low points on Stewart Street and Leinster Street, in order to address the property affectation at these locations. The option, which involves upgrading the capacity of the pit and pipe system, has been shown to reduce the flood level by up to 1.2 m on Leinster Street and 0.9 m on Stewart Street in the 5% AEP event. This reduction corresponds to 11 properties being no longer flooded above floor level in the 5% AEP event.

Although the measure significantly benefits the area's flood risk, it is prohibitively expensive and involves very large capacity pipes. The benefit-cost ratio of the option is 0.5.

The measure has been given a low priority in the Floodplain Risk Management Plan, based on its financial feasibility, benefit cost ratio and associated technical issues. The measure is recommended to be implemented by City of Sydney in the long term.

2.2.2. Trunk Drainage Upgrade – Lang Road North (FM - CP03)

Option FM – CP03 consists of upgrading the drainage on Lang Road near Darvall Street, in order to reduce the hazardous ponding that cuts off Lang Road, and the nuisance flooding of the nearby property. The option, which involves upgrading the existing 450 mm diameter pipe to a 900 mm diameter, largely removes the flood issue in the 10% AEP event, by draining the runoff into Centennial Park. Although the option benefits the area, the existing flood issue is quite modest relative to others in the catchment,

The measure has been given a low priority in the Floodplain Risk Management Plan, based on its limited benefit to the catchment overall, and its economic feasibility. The measure is recommended to be implemented by City of Sydney in the long term.

2.2.3. Trunk Drainage Upgrade – Lang Road (FM – CP05)

Option FM – CP05 entails a large-scale trunk drainage upgrade between Lang Road and Kensington Ponds in Centennial Park, and is aimed at alleviating the widely flooded section of Lang Road near Driver Avenue. The option, which involves very large upgrades to the pit and pipe system that drains the area, largely removes the flood issue in the 10% AEP event. However, the flat grade of the southern section of the catchment, where the upgrade is located, means that exceptionally large capacity drainage would be required under Robertson Road Sport Fields as part of the upgrade.

The measure has been given a low priority in the Floodplain Risk Management Plan, based on its economic and technical feasibility, and its environmental impact. The measure is recommended to be implemented by City of Sydney in the medium to long term.

2.3. Response Modification Measures

2.3.1. Variable Message Display (RM-CP01)

Variable message displays can be used on main roads to warn motorists and pedestrians of a flood that is occurring. The hazardous nature of flooding on a main road can be underestimated in an urban area, where ponding of floodwaters may appear innocuous. When depths of flooding are greater than 0.3 m and it becomes dangerous for vehicles to cross them, it will be necessary to provide a detour around the flooded area. The variable message displays are aimed at reducing the number of people who enter floodwaters by warning of the conditions and recommending an alternative route.

The measure has been given a high priority in the Floodplain Risk Management Plan, based on its benefit to the SES and its relative ease of application. The measure is recommended to be implemented by City of Sydney and Roads and Maritime Services (RMS) in the short term.

2.3.2. Evacuation Planning (RM – CP02)

Significant property inundation in a rare flood may force residents to evacuate their homes. Residents will either leave of their own accord, as they feel their property is uninhabitable, or they will be issued an evacuation order. The SES has responsibility for evacuating people due to flooding. The sudden nature of flooding in the catchment means little to no warning is available for a flood event, and so the evacuation would almost certainly take place during or after the storm event.

There are a number of issues associated with evacuating, mostly relating to the additional hazards arising from leaving one's home, and the risk to the rescuers, that mean evacuation should generally not be undertaken in the Centennial Park catchment. However, the process should be planned for (likely in a DISPLAN prepared for the area) in case evacuation is required.

The measure has been given a medium priority in the Floodplain Risk Management Plan, based on its positive effect on SES operations. The measure is recommended to be implemented by City of Sydney and the SES in the short term, likely as part of other emergency response arrangements.

2.3.3. Public Information and Raising Flood Awareness (RM – CP03)

High flood awareness in a community reduces the damage and disruption during and after a flood event. Flood awareness includes knowledge of the range of floods that can occur and with what frequency, and what should be done during and after a event to minimise the flood risk and its disruption. When there is a transient population of residents and commercial operators, for example in inner Sydney, awareness can be promoted through a public information programme. There are a number of tools available to disseminate information on flooding, including letters from Council, historical flood markers and articles in local newspapers.

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. The measure is recommended to be implemented by City of Sydney in the short term.

2.3.4. Local Flood Plan and DISPLAN (RM – CP04)

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 DISPLAN and a Local Flood 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 these plans for vulnerable communities.

The measure has been given a high priority in the Floodplain Risk Management Plan, based on its positive effect on SES operation in the catchment and the resultant reduction in flood risk. The DISPLAN is recommended to be prepared by the SES in the short term, while the Local Flood Plan is recommended to be prepared in the same time frame by the SES, with City of Sydney responsible for supplying the required data.

2.4. Property Modification Measures

2.4.1. Flood Planning Levels (PM – CP01)

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 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.

2.4.2. Investigate Flood Proofing (PM – CP02)

Flood Proofing involves the sealing of entrances, windows, vents, etc., to prevent or limit the ingress of floodwaters. It is only suitable for brick buildings with concrete floors and can prevent ingress for outside depths of approximately one metre. Greater depths may cause collapse of the structure unless water is allowed to enter.

Preliminary assessment has indicated that flood proofing is a good solution to reducing flood risk to commercial and industrial properties. Based on previous experience, the option can be cost-effective relative to drainage upgrades or other structural works, and easier to implement. Further assessment should be undertaken to ascertain the depth of ponding that flood proofing can protect against, what types of properties can be flood-proofed, the variation in cost for different cases, where responsibility lies for carrying out and funding the works, and any associated risks with the approach.

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. Investigation is recommended to be undertaken by City of Sydney in the short term.

2.4.3. Voluntary Purchase (PM – CP03)

Voluntary purchase involves the acquisition of flood affected residential properties (particularly those frequently inundated in high hazard areas). Although it conventionally involves demolishing the house to remove it from the high hazard flow, there is also an opportunity for the existing structure to be flood-proofed and kept on. This conventional approach of removing the house is not considered necessary for the Centennial Park catchment. However, it may be possible to modify the approach and purchase properties situated on high hazard overland flowpaths, carry out floodproofing works on them, and then re-sell them. It is recommended that the feasibility of such an approach be investigated to determine its cost, associated benefits and possible risks.

The measure has been given medium priority in the Floodplain Risk Management Plan, based on its potential to aid flood-affected properties. Investigation is recommended to be undertaken by City of Sydney in the short term.

2.4.4. Development Control Planning (PM – CP04)

The catchment's location in inner Sydney means 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 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 short term.

2.5. 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 Centennial Park catchment.

Table 3: Recommended Management Measures

REF ¹	MEASURE	PURPOSE	PRIORITY	RESPONSIBILITY	TIME FRAME	COST
RM-CP04	Local Flood Plan and DISPLAN for the Sydney East Emergency Management District	Formalise emergency response arrangements for the area, including evacuation procedures.	High Priority	SES (Plans) and City of Sydney (Data)	Short term	Internally within SES and Council
PM-CP02	Investigate flood proofing for its feasibility across varied buildings types and flooding behaviour.	Reduce the damages of flood affected properties by preventing ingress of floodwaters.	High Priority	City of Sydney	Short term	Internally within Council
RM-CP01	Use of Variable Message Displays on affected roads as part of emergency response arrangements	Improve public awareness during a flood event, reduce number of vehicles entering hazardous ponding.	High Priority	City of Sydney and RMS	Short term	Internally within Council and RMS
PM-CP04	Update Sydney DCP 2012 and LEP 2012 based on FRMS&P outcomes and to inform of Council's Interim Floodplain Management Policy	Prevent development occurring in high hazard areas or impacting existing flood behaviour	High Priority	City of Sydney	Short term	Internally within Council
PM-CP01	Review FPLs following completion of FRMS&P for Centennial Park catchment.	Reduce the damages of flood affected properties by having elevated floor level	High Priority	City of Sydney	Short term	Internally within Council
RM-CP03	Develop ongoing flood awareness and public information programmes for the area	Increase community's awareness during and after a flood event to reduce damages and risk to life	Medium Priority	City of Sydney	Short term	Internally within Council
RM-CP02	Evacuation planning (may be included in the area's DISPLAN and Local Flood Plan.)	Minimise the risk associated with evacuations, determine when evacuation is required	Medium Priority	City of Sydney and SES	Short term	Internally within Council
PM-CP03	Investigate the feasibility of a voluntary purchase scheme that includes flood proofing affected properties	Reduce the damages of flood affected properties via flood proofing	Medium Priority	City of Sydney	Short term	Internally within Council
FM-CP02	Trunk Drainage Upgrade - Stewart and Leinster Street to Moore Park Road	Reduce property affectation in the area	Low Priority	City of Sydney	Long term	Approx. \$5,277,200 capital,

REF ¹	MEASURE	PURPOSE	PRIORITY	RESPONSIBILITY	TIME FRAME	COST
						\$3,600 ongoing (annual)
FM-CP03	Drainage Upgrade - Lang Road near Darvall Street into Centennial Park	Reduce depth and duration of flooding major roads, reduce property affectation	Low Priority	City of Sydney	Long term	Approx. \$108,500 capital, \$200 ongoing (annual)
FM-CP05	Trunk Drainage Upgrade - Lang Road	Reduce depth and duration of flooding major roads	Low Priority	City of Sydney	Long term	Approx. \$22,769,400 capital, \$8,700 ongoing (annual)

¹Reference of measure in the Centennial Park Catchment Floodplain Risk Management Study

3. ACKNOWLEDGEMENTS

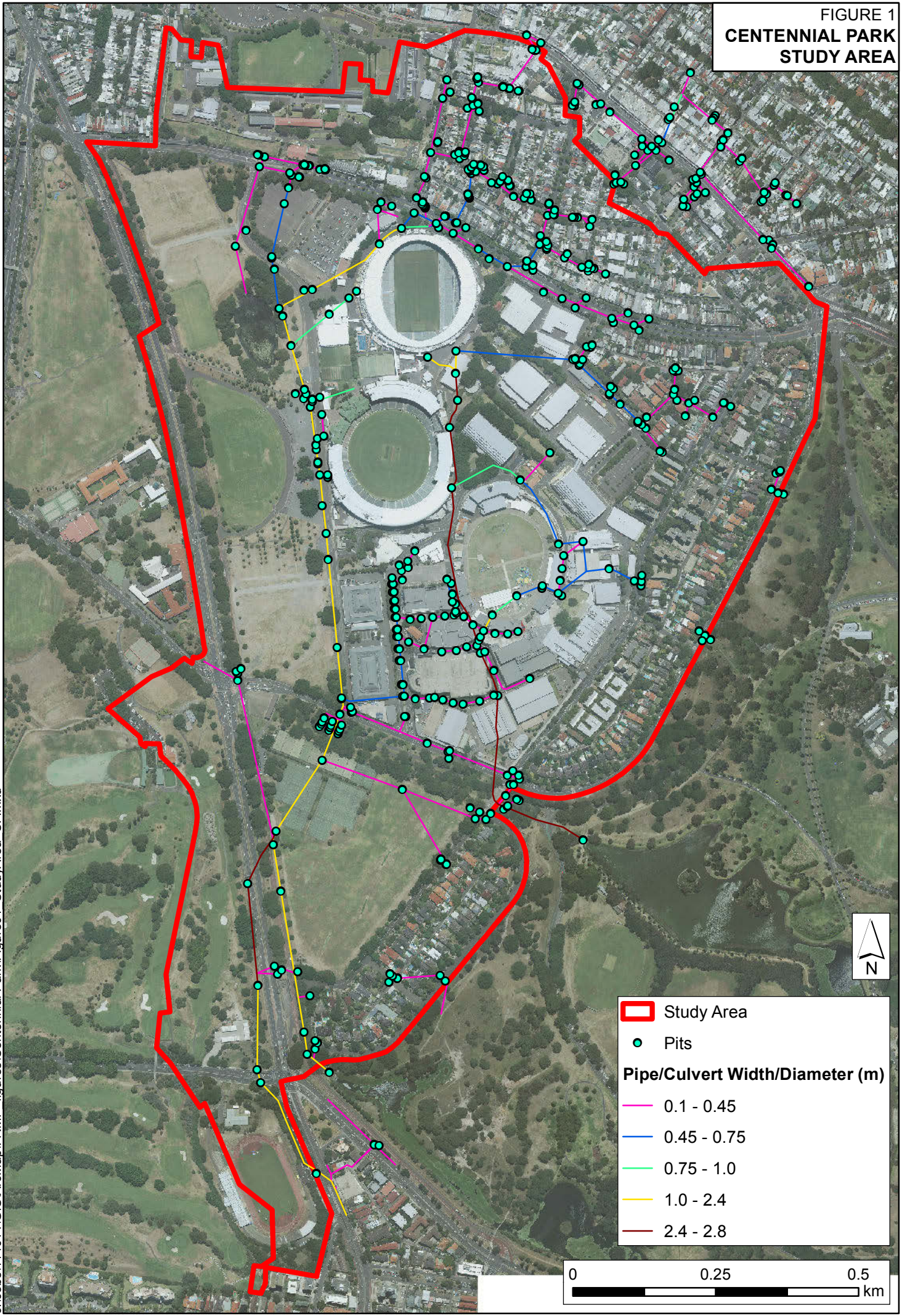
WMAwater wish to acknowledge the assistance of the City of Sydney Council staff and the Floodplain Management Committee in carrying out this study as well as the NSW Government (Office of Environment and Heritage) and the residents of the Centennial Park catchment. This study was jointly funded by the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

4. REFERENCES

1. NSW Government (2005) Floodplain Development Manual – the Management of Flood Liable Land, Department of Infrastructure, Planning and Natural Resources
2. WMAwater (2015), Centennial Park Catchment Floodplain Risk Management Study, Draft Report
3. WMAwater (2013), Centennial Park Catchment Flood Study, Draft Report
4. City of Sydney (2014), Interim Floodplain Management Policy



FIGURE 1
CENTENNIAL PARK
STUDY AREA

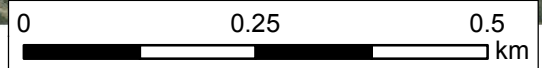


Study Area

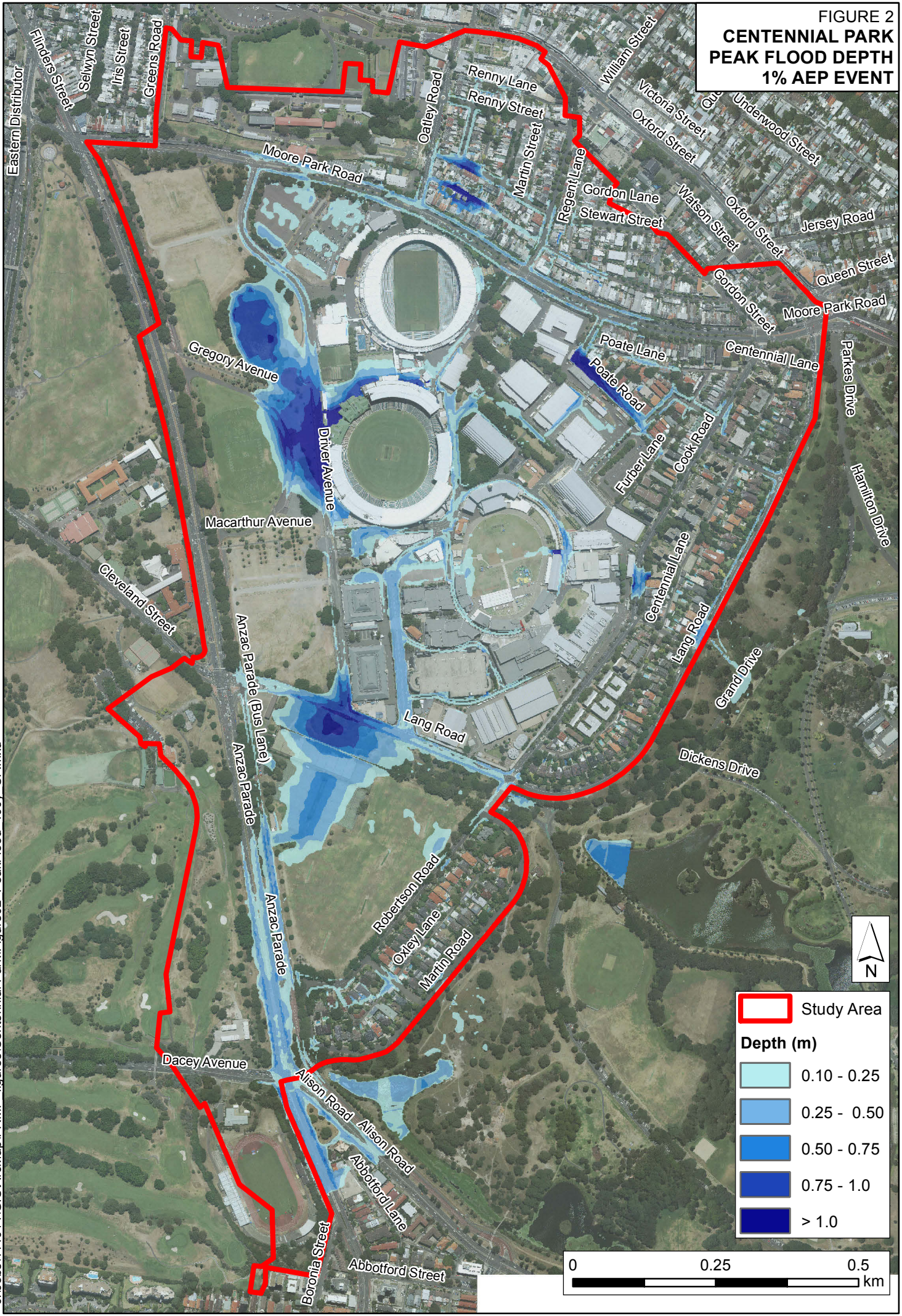
Pits

Pipe/Culvert Width/Diameter (m)

- 0.1 - 0.45
- 0.45 - 0.75
- 0.75 - 1.0
- 1.0 - 2.4
- 2.4 - 2.8



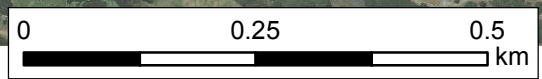
**FIGURE 2
CENTENNIAL PARK
PEAK FLOOD DEPTH
1% AEP EVENT**



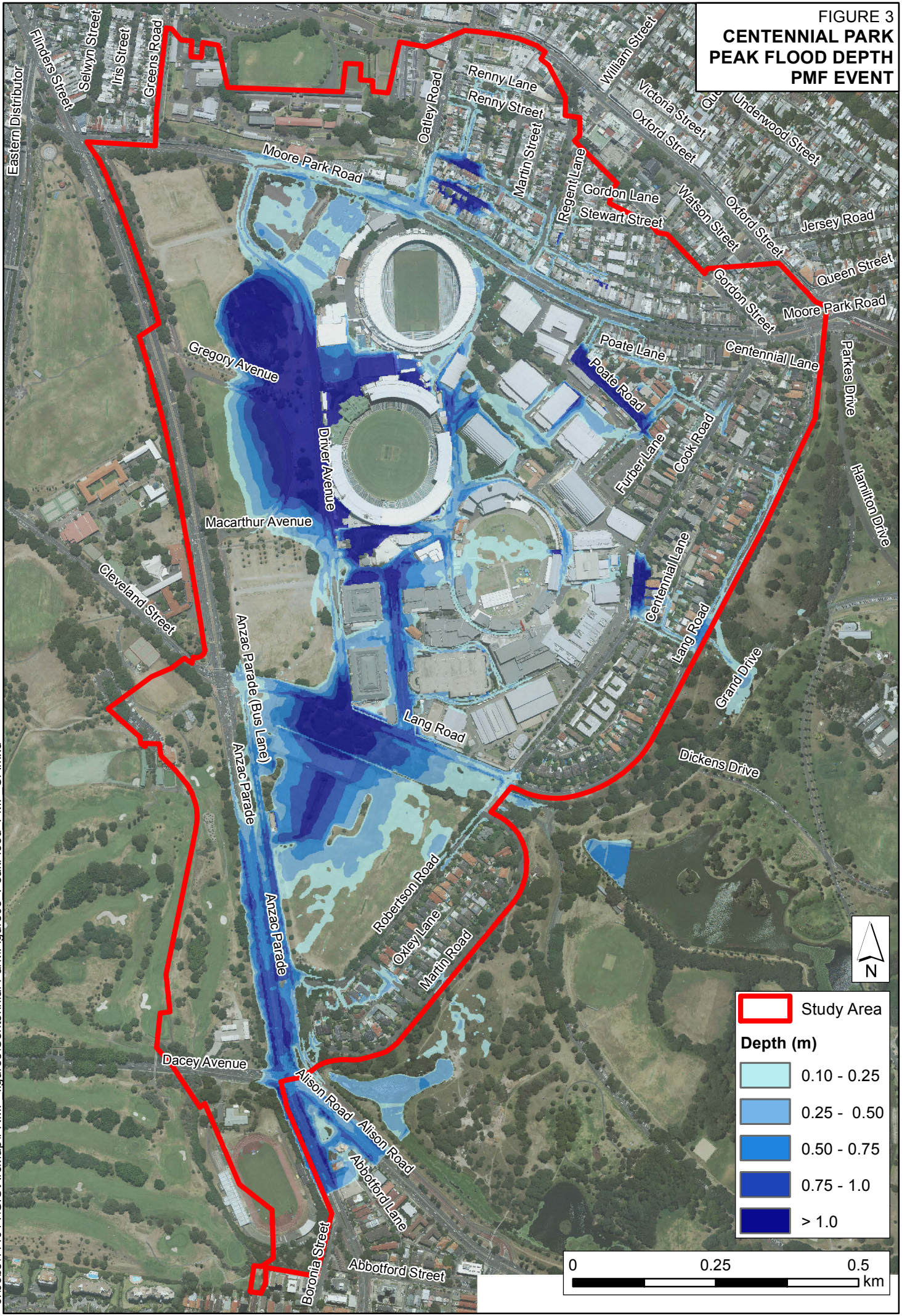
Study Area

Depth (m)

- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.0
- > 1.0



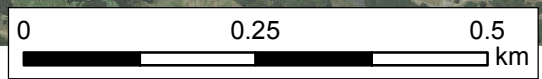
**FIGURE 3
CENTENNIAL PARK
PEAK FLOOD DEPTH
PMF EVENT**



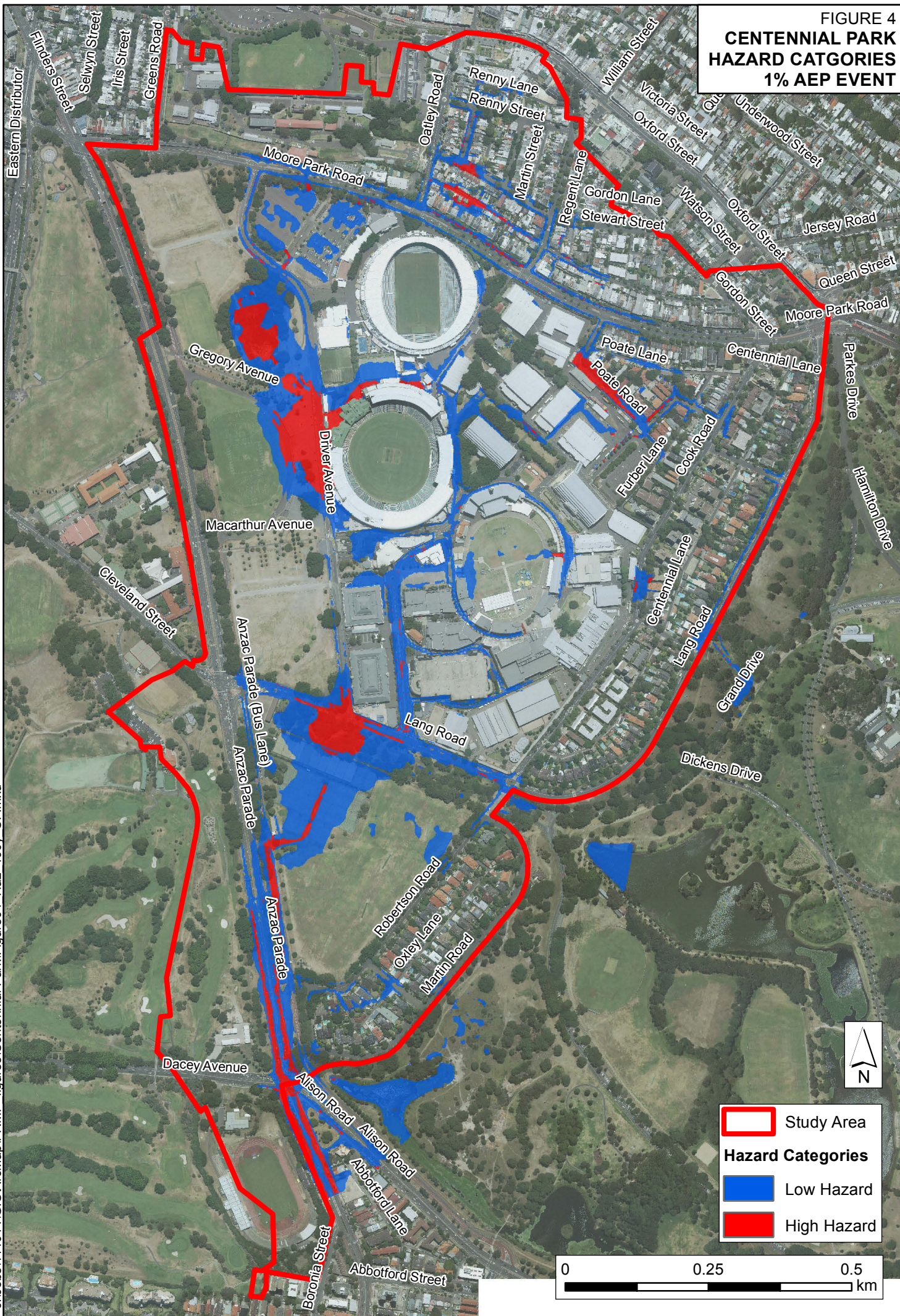
Study Area




Depth (m)

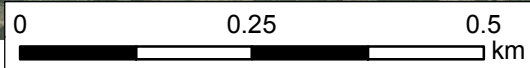
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.0
- > 1.0



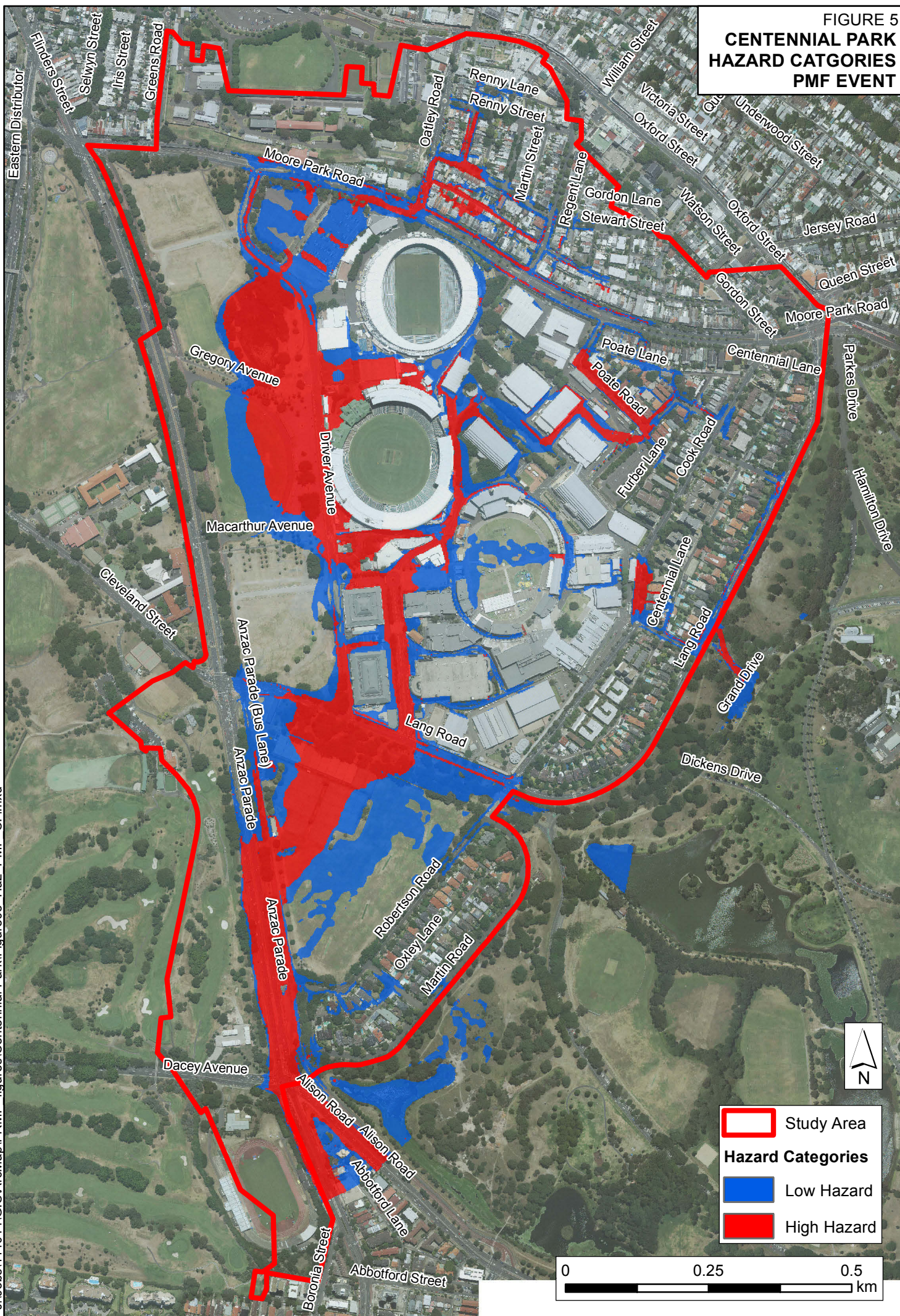
**FIGURE 4
CENTENNIAL PARK
HAZARD CATEGORIES
1% AEP EVENT**



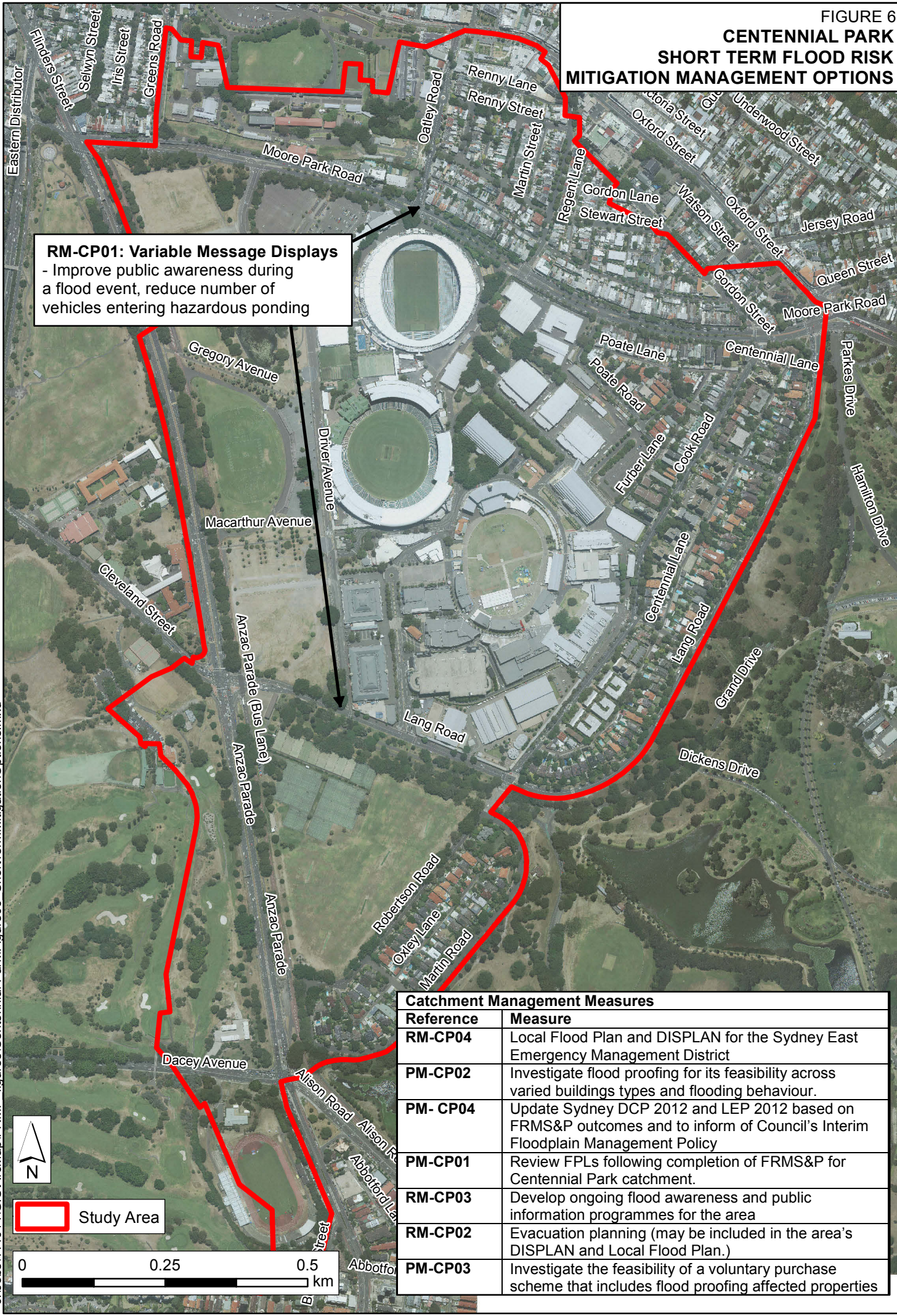
	Study Area
Hazard Categories	
	Low Hazard
	High Hazard



**FIGURE 5
CENTENNIAL PARK
HAZARD CATEGORIES
PMF EVENT**



**FIGURE 6
CENTENNIAL PARK
SHORT TERM FLOOD RISK
MITIGATION MANAGEMENT OPTIONS**



RM-CP01: Variable Message Displays
- Improve public awareness during a flood event, reduce number of vehicles entering hazardous ponding

Catchment Management Measures	
Reference	Measure
RM-CP04	Local Flood Plan and DISPLAN for the Sydney East Emergency Management District
PM-CP02	Investigate flood proofing for its feasibility across varied buildings types and flooding behaviour.
PM-CP04	Update Sydney DCP 2012 and LEP 2012 based on FRMS&P outcomes and to inform of Council's Interim Floodplain Management Policy
PM-CP01	Review FPLs following completion of FRMS&P for Centennial Park catchment.
RM-CP03	Develop ongoing flood awareness and public information programmes for the area
RM-CP02	Evacuation planning (may be included in the area's DISPLAN and Local Flood Plan.)
PM-CP03	Investigate the feasibility of a voluntary purchase scheme that includes flood proofing affected properties



Study Area

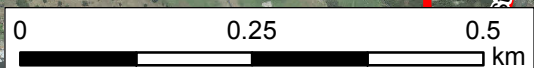


FIGURE 7

CENTENNIAL PARK LONG TERM FLOOD RISK MITIGATION MANAGEMENT OPTIONS


FM-CP02: Drainage Upgrade
- Upgrade capacity of drainage pipes on Stewart Street, Leinster Street, Moore Park Road and Oatley Road


FM-CP01: Drainage Upgrade
- Upgrade capacity of drainage pipe from Poate Road to Sydney Cricket Ground


FM-CP04: Regraded Road
- Re-grade grading of Driver Avenue to relieve trapped low point

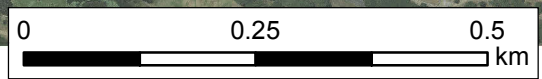
FM-CP03: Drainage Upgrade
- Upgrade capacity of drainage pipe on Lang Road

FM-CP05: Trunk Drainage Upgrade
- Upgrade capacity of trunk drainage between Lang Road and outlet at Centennial Park

 Study Area

 Upgraded Pipes

 Regraded Road



J:\Jobs\114014\GIS\ArcMap\FRMP_figures\Centennial_Park\Figure07_LongTermMitigationOptions.mxd