LAKES BUSINESS PARK PLANNING PROPOSAL - FLOOD ASSESSMENT

FINAL DRAFT

MAY 2015

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MAY, 2015

Project **Lakes Business Park Planning Proposal – Flood Assessment**	**Project Number** **115008**
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TERMINOLOGY USED IN REPORT

Australian Rainfall and Runoff have produced a set of draft guidelines for appropriate terminology when referring to the probability of floods. In the past, AEP has generally been used for those events with greater than 10% probability of occurring in any one year, and ARI used for events more frequent than this. However, the ARI terminology is to be replaced with a new term, EY.

Annual Exceedance Probability (AEP) is expressed using percentage probability. It expresses the probability that an event of a certain size or larger will occur in any one year, thus a 1% AEP event has a 1% chance of being equalled or exceeded in any one year. For events smaller than the 10% AEP event however, an annualised exceedance probability can be misleading, especially where strong seasonality is experienced. Consequently, events more frequent than the 10% AEP event are expressed as X Exceedances per Year (EY). Statistically a 0.5 EY event is not the same as a 50% AEP event, and likewise an event with a 20% AEP is not the same as a 0.2 EY event. For example an event of 0.5 EY is an event which would, on average, occur every two years. A 2 EY event is equivalent to a design event with a 6 month average recurrence interval where there is no seasonality, or an event that is likely to occur twice in one year.

While AEP has long been used for larger events, the use of EY is to replace the use of ARI, which has previously been used in smaller magnitude events. The use of ARI, the Average Recurrence Interval, which indicates the long term average number of years between events, is now discouraged. It can incorrectly lead people to believe that because a 100-year ARI (1% AEP) event occurred last year it will not happen for another 99 years. For example there are several instances of 1% AEP events occurring within a short period, for example the 1949 and 1950 events at Kempsey.

The PMF is a term also used in describing floods. This is the Probable Maximum Flood that is likely to occur. It is related to the PMP, the Probable Maximum Precipitation.

This report has adopted the approach of the ARR draft terminology guidelines and uses % AEP for all events greater than the 10% AEP and EY for all events smaller and more frequent than this.

FOREWORD

The NSW State Government's Flood 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 Policy, the management of flood liable land remains the responsibility of local government. The State Government provides funding for flood studies, floodplain risk management plans and works to alleviate existing problems, to undertake the necessary technical studies to identify and address the problem and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities. The Federal Government may also provide funding in some circumstances.

The Policy provides for technical and financial support by the Government through four sequential stages:

1. ***Flood Study***
   Determines 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 Draft Mascot, Rosebery and Eastlakes Flood Study constitutes the first stage of the management process for the Botany Wetlands catchment. This study has been prepared by WMAwater for the City of Botany Bay and was undertaken to provide the basis for future management of flood liable lands within the study area.

1. INTRODUCTION

1.1. Overview

DEXUS Property Group property is managing a rezoning submission for mixed use redevelopment of and 11-13 Lord St Botany (the site), which encompasses Lot 2 on DP717692 (see Diagram 1). This assessment relates only to rezoning of the southern precinct of the existing Lakes Business Park, i.e. 11-13 Lord St Botany.

Diagram 1 - Site Location Plan

WMAwater has been engaged to undertake a flood assessment of the site in order to determine flooding behaviour. The flooding behaviour determines what flood-related development controls will need to be applied as outlined in the City of Botany Bay DCP, 2013.

1.2. Scope of Work

The report is solely concerned with determining the Flood Planning Level (minimum floor levels) and identifying whether the development has potential to cause adverse flood impacts on the surrounding areas.

Section 2 of this report contains relevant background information, including a description of the site, available data and relevant studies. Section 3 details existing flooding behaviour at the site, and Section 4 identifies the applicable flood-related development controls. Sections 5 and 6 describe the modelling approach and modelling outcomes, with conclusions in Section 7.

2. BACKGROUND

2.1. Study Area

The site is located in the City of Botany Bay Local Government Area. The site is bordered by Lord Street to the north, Booralee Park to the east, 5-9 Lord Street to the west, and residential properties fronting Daphne Street to the south.

Stormwater from the site drains northwards across the northern precinct of the Lakes Business Park into Mill Pond, which forms part of a chain of swamps and lakes known collectively as the Botany Wetlands.

WMAwater is presently undertaking a catchment-wide Flood Study of the Mascot, Rosebery and Eastlakes areas (MRE Flood Study), which includes the Botany Wetlands (Reference 1). At the time of writing, the MRE Flood Study is at Final Draft stage but has not yet been formally adopted by Council.

2.2. Relevant Documents and Site Plans

WMAwater relied on the following documents for this assessment:

- Mascot, Roseberry and Eastlakes Draft Flood Study (Reference 1);
- Development Control Plan (DCP) City of Botany Bay (Reference 2);
- *Plan of Details and Levels at No 11-13 Lord Street Botany*, Linker Surveying, dated 16/4/2015.
- *Lakes Business Park South Precinct – Planning Proposal Master Plan,* Tony Caro Architecture, Drawing No SK_002, dated 12/5/15; and
- *Lakes Business Park South Precinct – Ground Floor Plan,* Tony Caro Architecture, Drawing No SK_003, dated 12/5/15; and
- Concept Stormwater Layout, Costin Roe Consulting, Drawing No CO9759.01-SKC01, dated 30/4/15.

2.3. Topographic and Stormwater Survey

The topographic datasets used to develop the flood modelling were:

- Digital Elevation Model (DEM) – The basis of the DEM is airborne Light Detection and Ranging (LiDAR) survey of the study area collected by the NSW Department of Lands and Property Information.
- The LiDAR was supplemented by detailed survey of the site and adjacent areas including detention basins, roads, gutters and embankments.
- Pit and pipe stormwater asset data was provided by Linker Surveying with additional information relating to pipe size collected by WMAwater during site inspections

3. FLOOD BEHAVIOUR

The site is affected by flooding from two mechanisms:

- Mainstream flooding through the Botany Wetland system, arising from rain in the Centennial Park, Kensington, Daceyville and Eastlakes areas. Heavy rain over this broad catchment area could cause the level in Mill Pond to rise and cause backwater flooding Lord Street.
- Local overland flooding resulting from very intense rainfall in the immediate vicinity of the site, exceeding the local drainage system capacity, collecting in the sag point in Lord Street, and resulting in overland flow towards Mill Pond.

3.1. Mainstream Flooding

Modelling for the Draft MRE Flood Study has indicated that for a range of flood events up to and including the 1% AEP flood, the level for Mill Pond is not high enough to overflow and produce significant inundation of the Lakes Business Park area (north and south).

3.2. Local overland Flow

Flooding in the Lake Business Park South Precinct up to and including the 1% AEP event will be primarily as a result of local overland flow, when runoff from the local catchment exceeds the capacity of the sub-surface stormwater drainage network. The developments on the southern side of Lord Street from Botany Road to Booralee Park drain to a low point in Lord Street adjacent to the site, as does part of the developments on the north side of Lord Street. Runoff to the Lord Street low point discharges to Mill pond through the underground drainage system. Site inspections indicate that this system is susceptible to blockage. When flow exceeds the capacity of the pipe system to Mill Pond, flooding of the low point will occur and flood levels will rise until they overtop the high point in the northern precinct and drain to Mill Pond.

This flooding mechanism will generally be the primary consideration for development control requirements. Controls relating to the PMF will need to include consideration of overflow from the Mill Pond system (i.e. the mainstream flood mechanism).

4. FLOOD - RELATED DEVELOPMENT CONTROLS

The site is subject to flood-related development controls as specified in:

- The Botany Bay Local Environment Plan 2013 – Sections 6.3, 6.4 & 6.6 (Reference);
- The Botany Bay Development Control Plan 2013 (DCP), Part 3G Stormwater Management; and
- The Stormwater Management Technical Guidelines (SMTG), an attachment to the DCP, in particular Section 8 – Finished Floor Levels, and Section 11 – Flood Study or Overland Flow Path Assessment.

Other sections of the SMTG will apply but are not specifically flood-related, and are not addressed in this assessment.

As part of any development proposal, a detailed Flood Study will be required with future submission of a Development Application (DA). Required aspects of the study may include:

- Flood model of the 1% Annual Exceedance Probability (AEP) design storm events and Probable Maximum Flood (PMF) with the predicated impacts of Climate Change;
- Two-dimensional (2D) flood modelling (such as TUFLOW) to be used for the where the contributing catchment area is greater than 20 Ha.
- Scaled maps, including 0.2 m contour lines showing full upstream catchment area;
- Scaled maps showing the flood extent, flood contour, flood depth and velocity of pre-development and post-development 1% AEP and PMF flood; and
- Detailed scaled plan view showing the pre-development and post-development 1% AEP and PMF flood extent and levels on the subject property.

Modelling and mapping of existing flood behaviour at the site has been completed as part of this assessment (see Section 6).

4.1. Floor Levels

The SMTG specifies different floor level requirements depending on the upstream catchment area of the site, and whether the site is a designated Council flood area or overland flow route. As discussed in Section 2, Council has not yet adopted the Flood Study. WMAwater considers that the minimum Flood Planning Levels (FPLs) that apply to the site would be as follows (from Section 8 of the SMTG):

- Habitable Room Floor Level : FPL of 1% AEP + 0.5 m
- Non-Habitable Floor Level: FPL of 1% AEP + 0.3 m

Note that commercial premised can be considered “habitable rooms” under the definitions provided in Reference 4.

Please note that WMAwater understands Council is planning to review the stormwater-related aspects of the DCP, and introduce a floodplain management policy, which would potentially supersede the current FPL provisions by the time a DA submission is made at the site. It would be prudent to assume that a minimum level of the 1% AEP flood level plus 0.5 m will apply for all finished building levels and basement entry points across the site.

4.2. Filling of Floodplain Storage Areas

Council requires that a development has no adverse impacts on flood levels or flood behaviour in the surrounding areas of the site. The SMTG states that:

- the proposed development must not impede the passage of overland flow to cause a rise (afflux) in the water level upstream and/or increase the downstream velocities of flow;
- No structures and/or fillings are permitted over the 1% AEP flow path unless suitable flood mitigation measures are to be implemented. Such measures would require assessment and approval from Council.

Generally, any net infill of flood affected portions of the site would cause a rise in flood levels elsewhere. This aspect of the proposal is discussed in detail in Section 7.2.

5. MODELLING APPROACH

Hydraulic modelling undertaken by WMAwater for this study was conducted in accordance with methodology recommended in:

- Australian Rainfall and Runoff (AR&R, Reference 5); and
- a guideline document for two-dimensional (2D) modelling of urban and rural floodplains produced as part of the upcoming AR&R revision (Reference 6).

The estimation of flood behaviour in a catchment was undertaken as a two-stage process, consisting of:

1. hydrologic modelling to convert rainfall estimates to overland flow runoff; and
2. hydraulic modelling to estimate overland flow distributions, flood levels and velocities.

The broad approach adopted for this study was to use hydrologic modelling (DRAINS) to create local inflow boundary conditions for input into a two-dimensional unsteady flow hydraulic model (TUFLOW).

5.1. DRAINS Modelling

The total catchment represented by the DRAINS model is 0.279 km^2 (28 ha). This area has been represented by a total of 34 sub-catchments giving an average sub-catchment size of approximately 0.8 ha. The sub-catchment delineation ensures that where hydraulic controls exist that these are accounted for and able to be appropriately incorporated into hydraulic routing. The sub-catchment layout is shown in Figure 2.

The land use categories and their corresponding impervious surface area is outlined Table 1. The proportion of each land-use category within a sub-catchment was determined based upon 2011 aerial photography provided by CBB

Table 1: Impervious Percentage per Land-use

Land-use Category	Impervious Percentage
Residential property	70% impervious
Commercial property	95% impervious
Vacant land	5% impervious
Vegetation (such as public parks)	5% impervious
Pavement and car parks	100% impervious
Roadway	100% impervious

Methods for modelling the proportion of rainfall that is “lost” to infiltration are outlined in AR&R (Reference 5). The rainfall loss parameters that were adopted for the DRAINS model are outlined in Table 2. Although soils in the catchment are generally sandy, the catchment is highly urbanised, and experience with previous studies suggests real infiltration rates are lower than would be expected for sand in an undeveloped catchment. The soil type was therefore set to have low infiltration capacity.

Table 2: Adopted DRAINS hydrologic model parameters

RAINFALL LOSSES	
Paved Area Depression Storage (Initial Loss)	1.0 mm
Grassed Area Depression Storage (Initial Loss)	5.0 mm
SOIL TYPE	**4**
High Runoff Potential	
ANTECEDENT MOISTURE CONDITONS (AMC)	**3**
Description	Rather wet
Total Rainfall in 5 Days Preceding the Storm	12.5 to 25 mm

5.2. TUFLOW Modelling

A grid cell size of 2 m by 2 m was used, as it provided an appropriate balance between providing sufficient detail for roads and overland flow paths, while still resulting in workable computational run-times. The model grid was established by sampling from a 1 m by 1 m DEM. This DEM was generated from a triangulation of filtered ground points from the LiDAR dataset obtained from LPI. This DEM is shown in

The TUFLOW hydraulic model is bounded by Southern Cross Drive, the Railway line, Myrtle Street and the alignment of the southern boundary of Lakes Business Park. The total area included in the 2D model is 0.35 km^2. The extents of the TUFLOW model are shown in Figure 3.

For local sub-catchments within the TUFLOW model domain, local runoff hydrographs were extracted from the DRAINS model (see Section 5.1). These were applied to the downstream end of the sub-catchments within the 2D domain of the hydraulic model, typically corresponding with the receiving inlet stormwater pit for the sub-catchment.

Tailwater conditions in Mill Pond were set by using inflow and downstream water level boundaries from the Botany Wetlands hydraulic model (Reference 1).

The following inflow boundary conditions were taken from the Botany Wetlands model:

1. Mill Pond beneath the railway line
2. Eastlake Golf Course over a low point in the railway line embankment (only in PMF)
3. Southern Cross Drive east of Botany Road (only in PMF)
4. Southern Cross Drive at intersection with Botany Road (only in PMF)

There are several downstream boundaries in the model. The Mill Pond Boundary is located upstream of Bay Street and the subsequent levels were taken from (Reference 1). Outflow boundary conditions for overland flow were located in Booralee Park and at the southern boundary of the RMS site on Lord Street.

The following hydraulic structures were defined in the model:

- Buildings – were modelled as impermeable obstructions to the floodwaters.
- Bridges – the bridge over Mill Pond at Botany Road was modelled in the 2D domain for the purpose of maintaining continuity in the model.
- Basins – topography and outlet pipes/weirs based on detailed survey of the site
- Subsurface Drainage Network - The major components of the sub-surface drainage network were included in the model based on the detailed survey of the precinct and site inspection. Any pipes less than 300mm in diameter were assumed blocked and not included in the model. The modelled drainage network is shown in Figure 3.

Blockage of the sub-surface drainage network was modelled at 50% in accordance with the City of Botany Bay Council Development Control Plan (Reference 2).

6. DESIGN EVENT MODELLING

6.1. Overview

Design flood levels in the catchment are a combination of flooding from rainfall over the local catchment, as well as elevated tailwater levels in Mill Pond which is part of the Botany Wetlands system. This study determined flooding behaviour in the Lakes Business Park catchment for the 1% AEP event and the PMF.

The site contains a stormwater detention basin. There is a small bund between the basin and the street, however during large events such as the 1% AEP storm, the flood level will be higher than the bund and the basin will become a contiguous part of the Lord Street low point (see Photo 1)

Photo 1: Existing Stormwater Detention Basin

6.2. Critical Duration – Local Overland Flow

To determine the critical storm duration for various parts of the catchment (i.e. produce the highest flood level), modelling of the 1% AEP event was undertaken for a range of design storm durations from 25 minutes to 2 hours, using temporal patterns from AR&R (Reference 5). An envelope of the model results was created, and the storm duration producing the maximum flood level was determined for each grid point within the study area.

It was found that the 2 hour design storm was critical for the Lake Business Park catchment for the 1% AEP and the 1 hour design storm was critical for the PMF event (using the methodology from Reference 7).

6.3. Design Flood Results

The results from this study are presented for combined local catchment and Mill Pond flooding as:

- Peak flood depths and spot levels in; Figure 4 and Figure 5
- Peak flood velocities in; Figure 6 and Figure 7
- Provisional hydraulic hazard in; Figure 8 and Figure 9

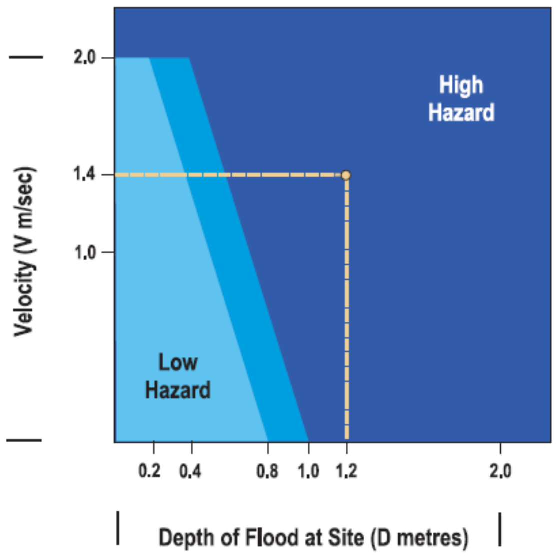
The peak flood levels in the Lord Street low point for the 1% AEP and PMF events are shown in Table 3.

Table 3: Peak Flood Levels

Event	Level
1% AEP	5.4 mAHD
PMF	5.6 mAHD

Provisional hazard categories were determined in accordance with Appendix L of the NSW Floodplain Development Manual (Reference 4), the relevant section of which is shown in Diagram 2. For the purposes of this report, the transition zone presented in Diagram 2 was considered to be high hazard.

Diagram 2: (L2) Provisional Hydraulic Hazard Categories



7. CONCLUSIONS

7.1. Finished Floor Levels

The Flood Planning Level for the site, based on the 1% AEP peak flood level in Lord Street plus 0.5 m freeboard, is **5.9 mAHD**. WMAwater recommends that this level apply to residential and commercial floors, and basement entry points (including ramps, air vents, lift wells, fire stairs, etc.).

7.2. Floodplain Storage

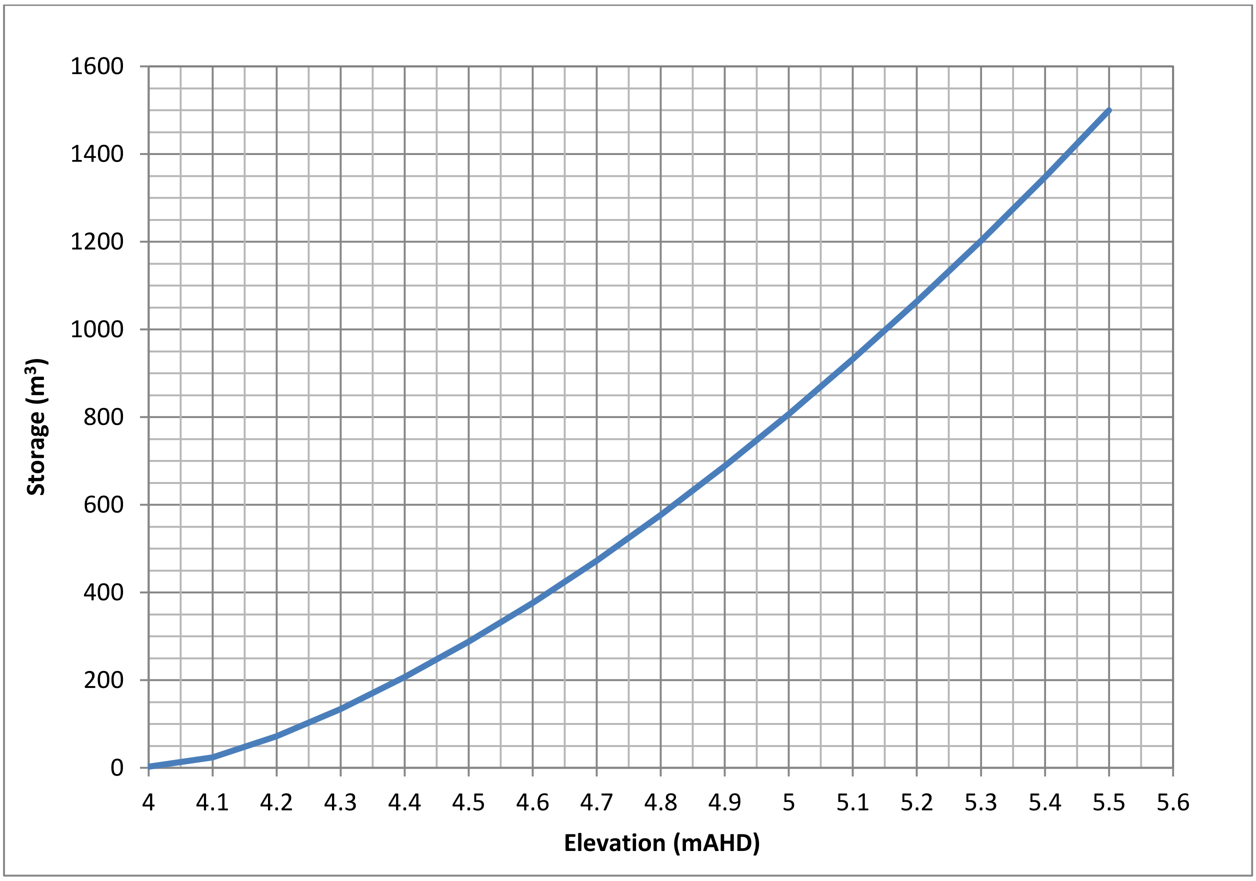
The proposed building and driveway footprint of the proposed development encroaches on existing areas of temporary floodplain storage (such as an existing detention basin and low lying parts of the site frontage. The proposed building footprint will require partial filling of these storage areas. This has the potential to increase flood levels in the Lord St low point (adversely affecting neighbouring development), unless compensatory flood storage is provided to mitigate the filling.

That is, it will be necessary for the proposal to ensure no net filling of the low point to prevent an increase in peak flood levels on existing developments. The detention basins must equal the flood storage of the existing development up to the 1% AEP level, as quantified in the storage/elevation relationship in Table 4 and
Diagram 3. The proposed development must provide equivalent or greater storage at each point on the curve.

Table 4 - Storage Requirements

Elevation (mAHD)	Storage (m^3)
3.9	0
4	3
4.1	24
4.2	72
4.3	134
4.4	207
4.5	289
4.6	377
4.7	473
4.8	577
4.9	689
5	808
5.1	933
5.2	1064
5.3	1202
5.4	1348

Diagram 3 - Elevation v Storage requirements



This could potentially be achieved by:

- Providing open swale or stormwater detention areas along the Lord Street frontage;
- Providing storage tanks (provided the invert of the tank is high enough to drain under gravity through the existing stormwater network, and low enough to accept inflow from the Lord Street sag point); and/or
- Lower portions of the driveway network to be below the 1% AEP flood level.

The civil plan prepared by Costin Roe (see Appendix B) identifies areas for provision of floodplain storage. As part of a future Development Application (DA), the proposed development including the proposed detention basins will need to be modelled in detail using a 2D hydraulic model to confirm the impact on peak flood levels.

8. REFERENCES

1. City of Botany Bay Council
   Mascot, Roseberry and Eastlakes Flood Study (DRAFT)
   WMAwater, 2015

2. City of Botany Bay Council
   Development Control Plan
   2013

3. City of Botany Bay Council
   Local Environment Plan
   2013

4. **Floodplain Development Manual**
   NSW Government, April 2005

5. Pilgrim H (Editor in Chief)
   Australian Rainfall and Runoff – A Guide to Flood Estimation
   Institution of Engineers, Australia, 1987

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

7. Bureau of Meteorology
   The Estimate of Probable Maximum Precipitation in Australia: Generalised Short Duration Method
   June 2003

8. TUFLOW User Manual
   Version 2013-12-AC
   BMT WBM, 2011

Figures

FIGURE 1
STUDY AREA

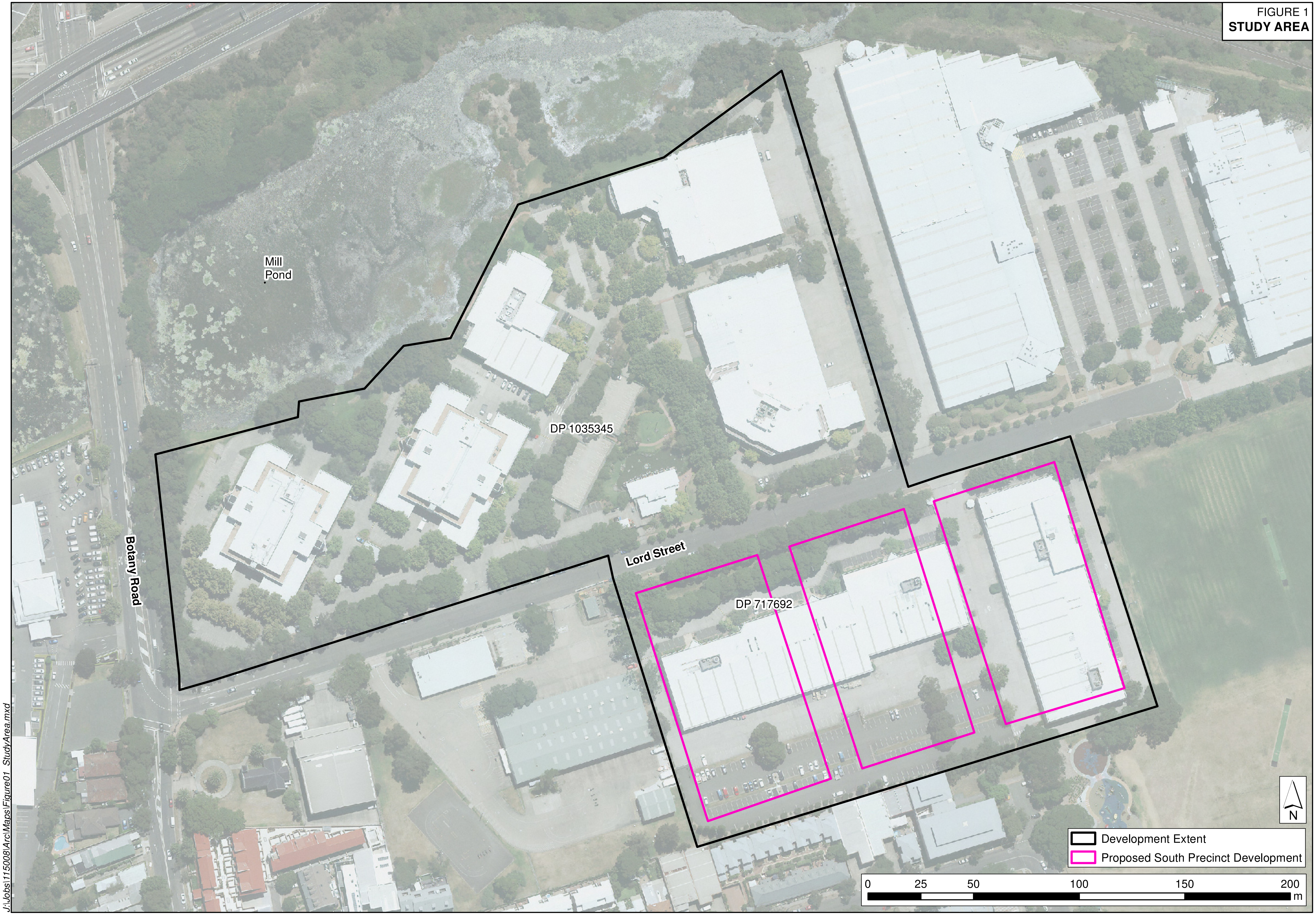


FIGURE 2
HYDROLOGICAL MODEL LAYOUT

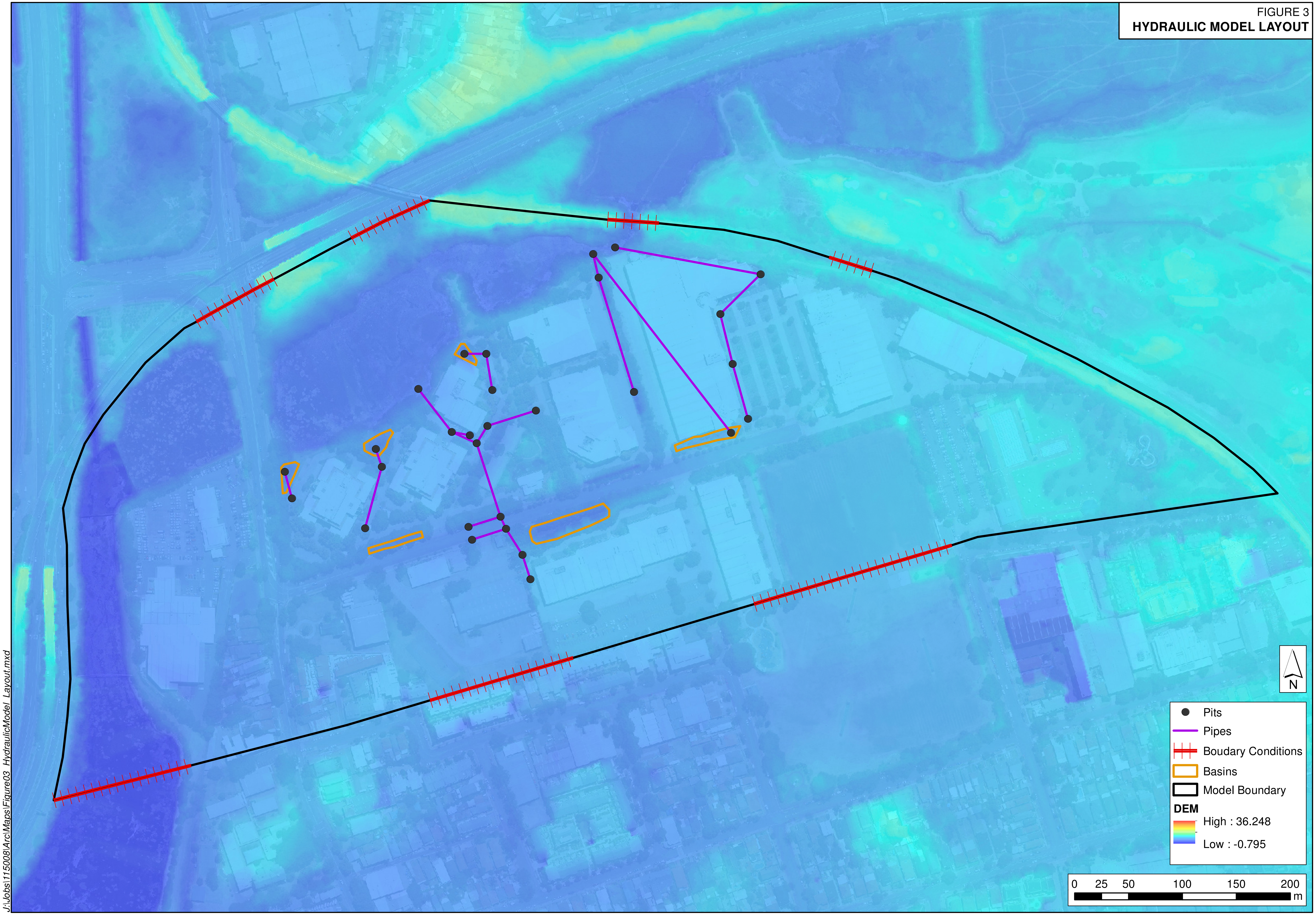


FIGURE 3
HYDRAULIC MODEL LAYOUT

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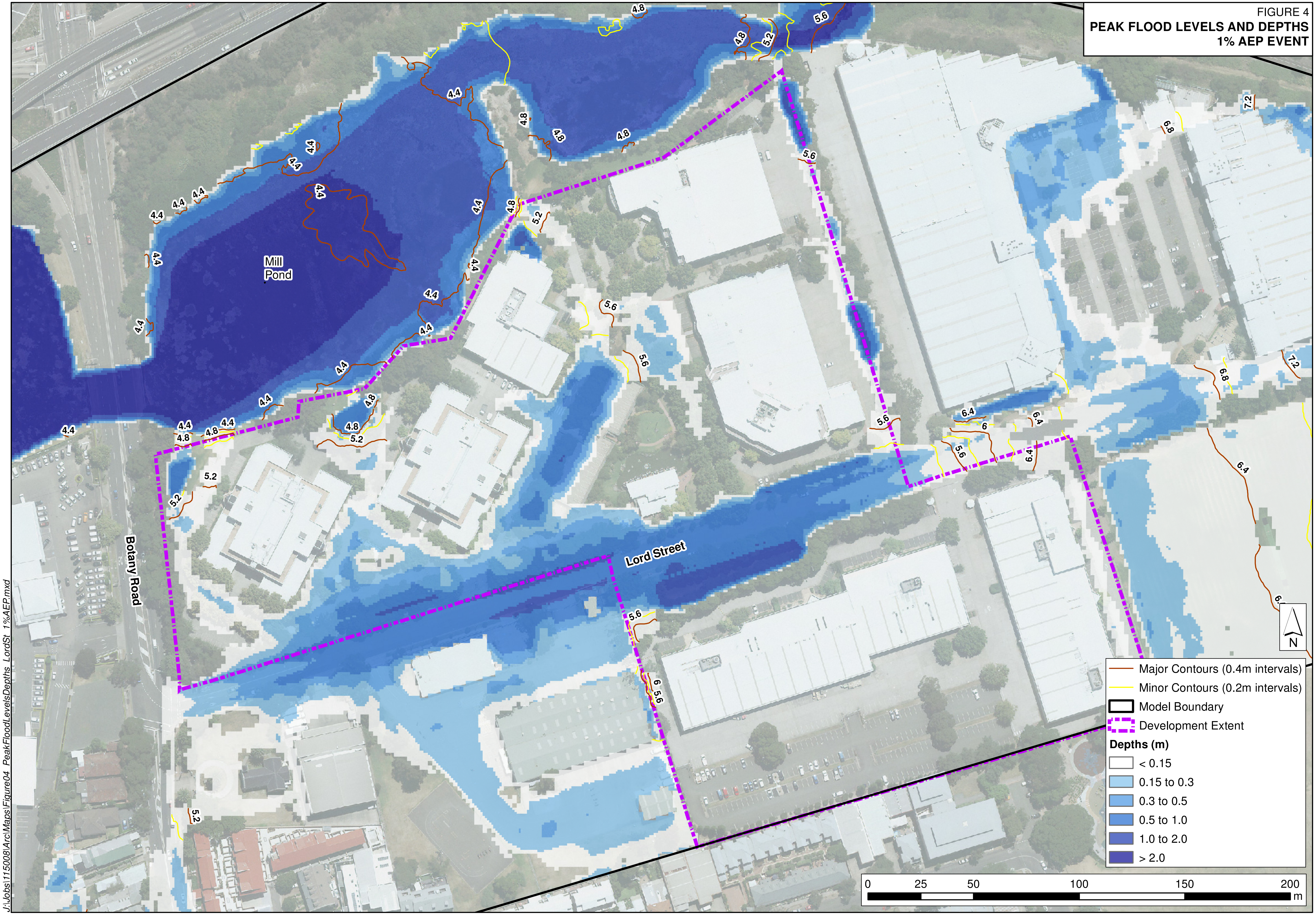
FIGURE 4
PEAK FLOOD LEVELS AND DEPTHS
1% AEP EVENT



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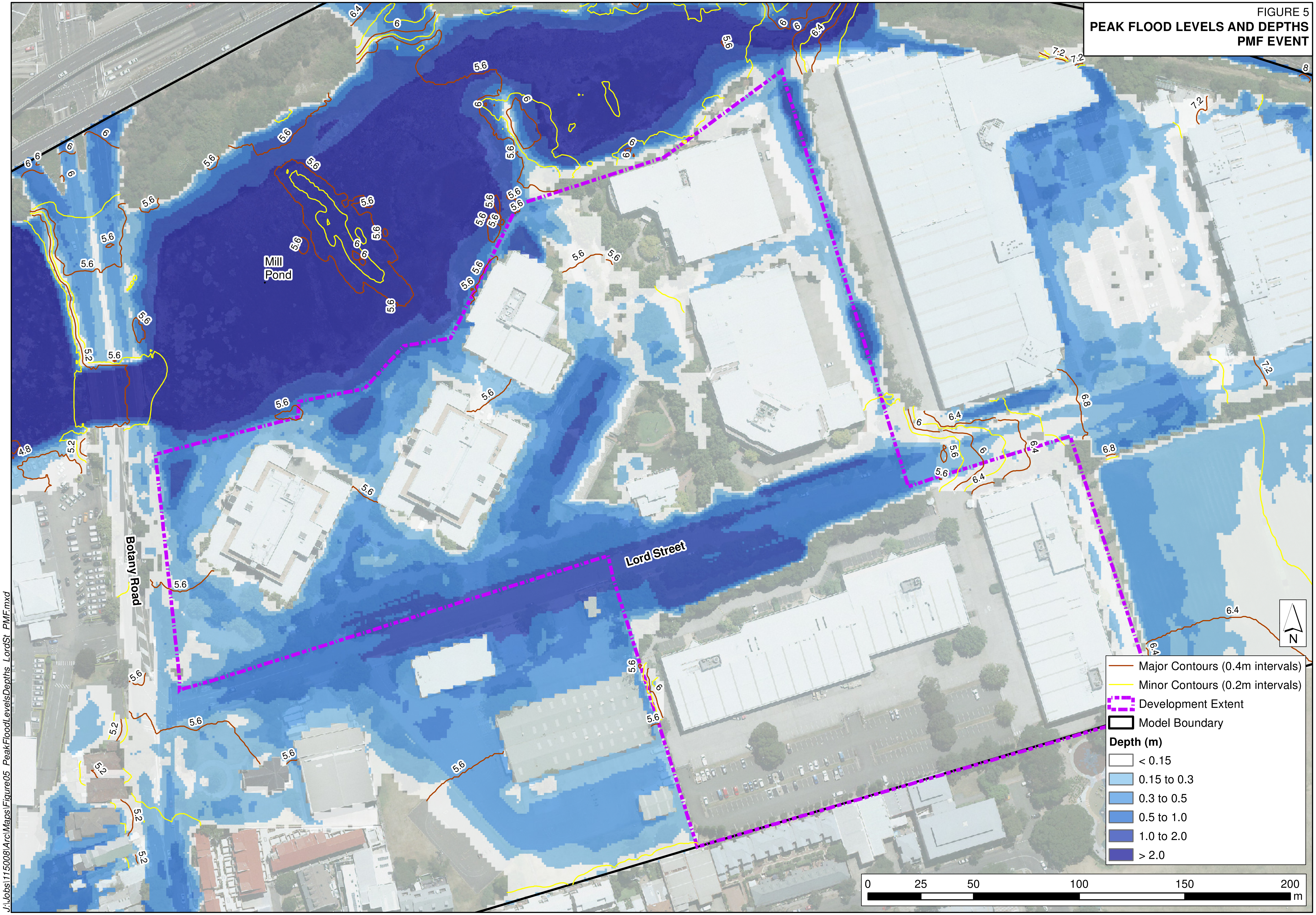

FIGURE 5
PEAK FLOOD LEVELS AND DEPTHS
PMF EVENT
Mill Pond
Lord Street
Botany Road
Major Contours (0.4m intervals)
Minor Contours (0.2m intervals)
Development Extent
Model Boundary
Depth (m)
< 0.15
0.15 to 0.3
0.3 to 0.5
0.5 to 1.0
1.0 to 2.0
> 2.0
0 25 50 100 150 200 m
N
J:\Jobs\115008\ArcMaps\Figure05_PeakFloodLevelsDepths_LordSt_PMF.mxd

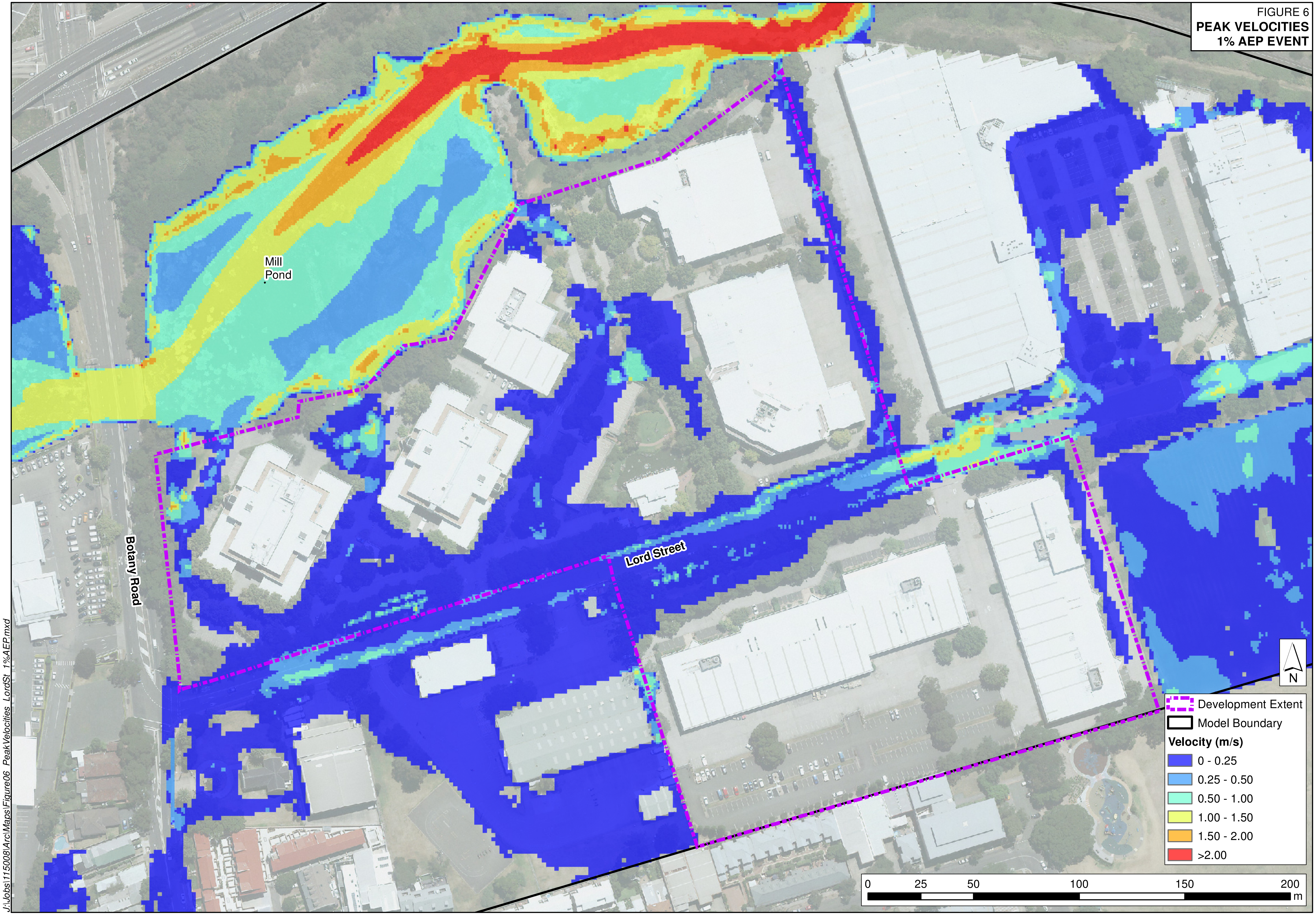
FIGURE 6
PEAK VELOCITIES
1% AEP EVENT
Mill
Pond
Botany Road
Lord Street
N
Development Extent
Model Boundary
Velocity (m/s)
0 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.50
1.50 - 2.00
>2.00
0
25
50
100
150
200
m
J:Jobs\115008\ArcMaps\Figure06_PeakVelocities_LordSt_1%AEP.mxd

FIGURE 7
PEAK VELOCITIES
PMF EVENT

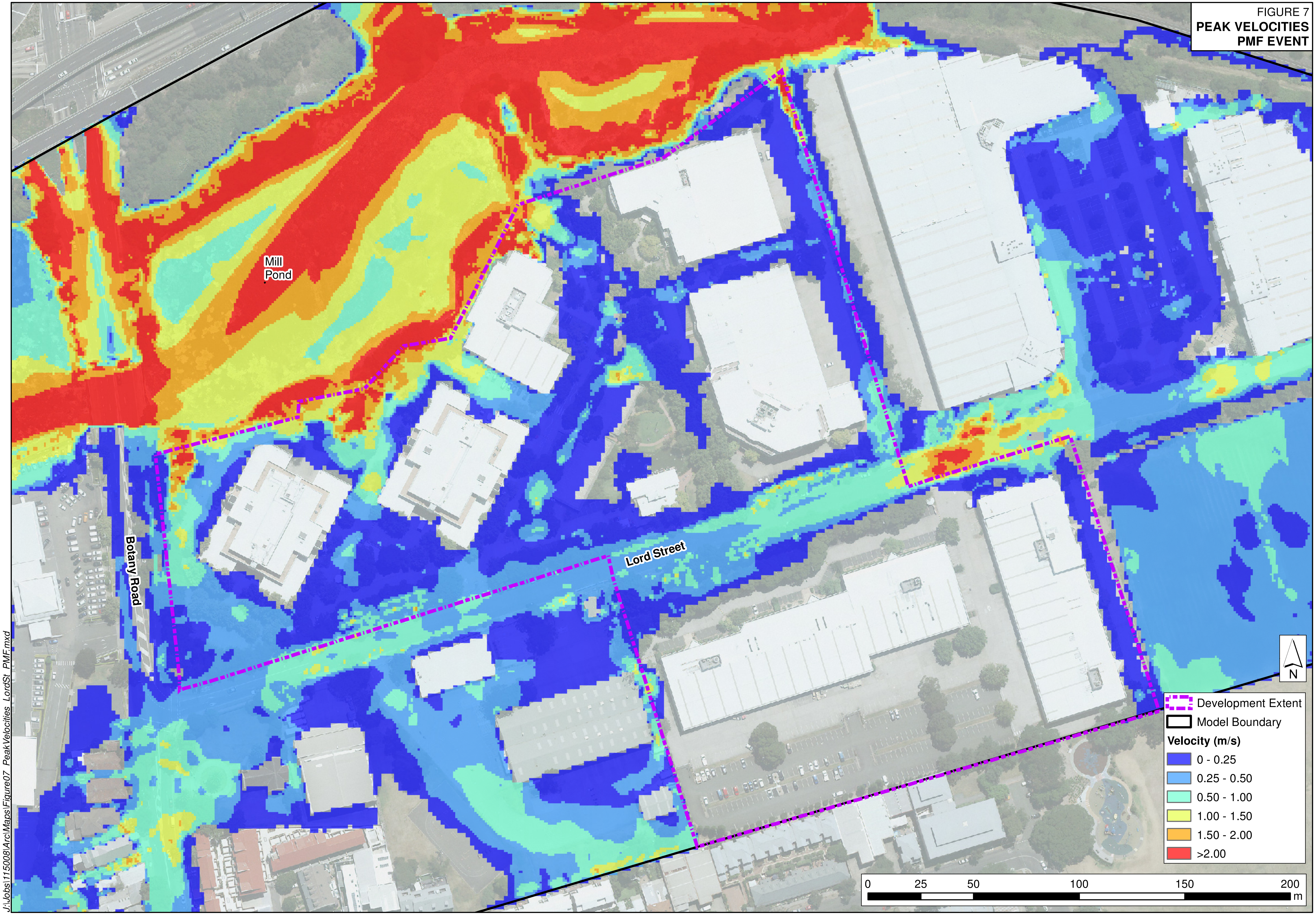

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FIGURE 8
PROVISIONAL HYDRAULIC HAZARD
1% AEP EVENT

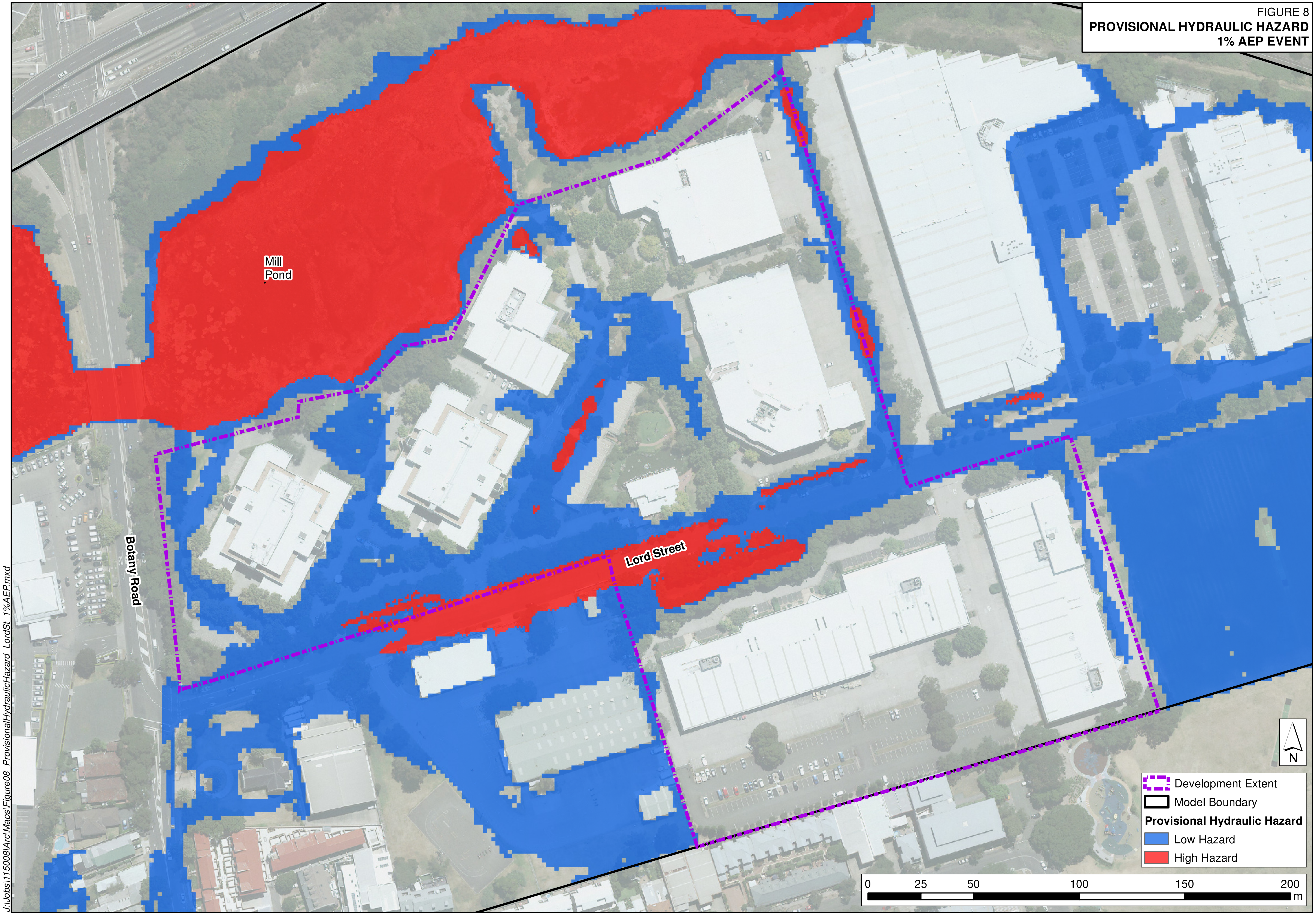
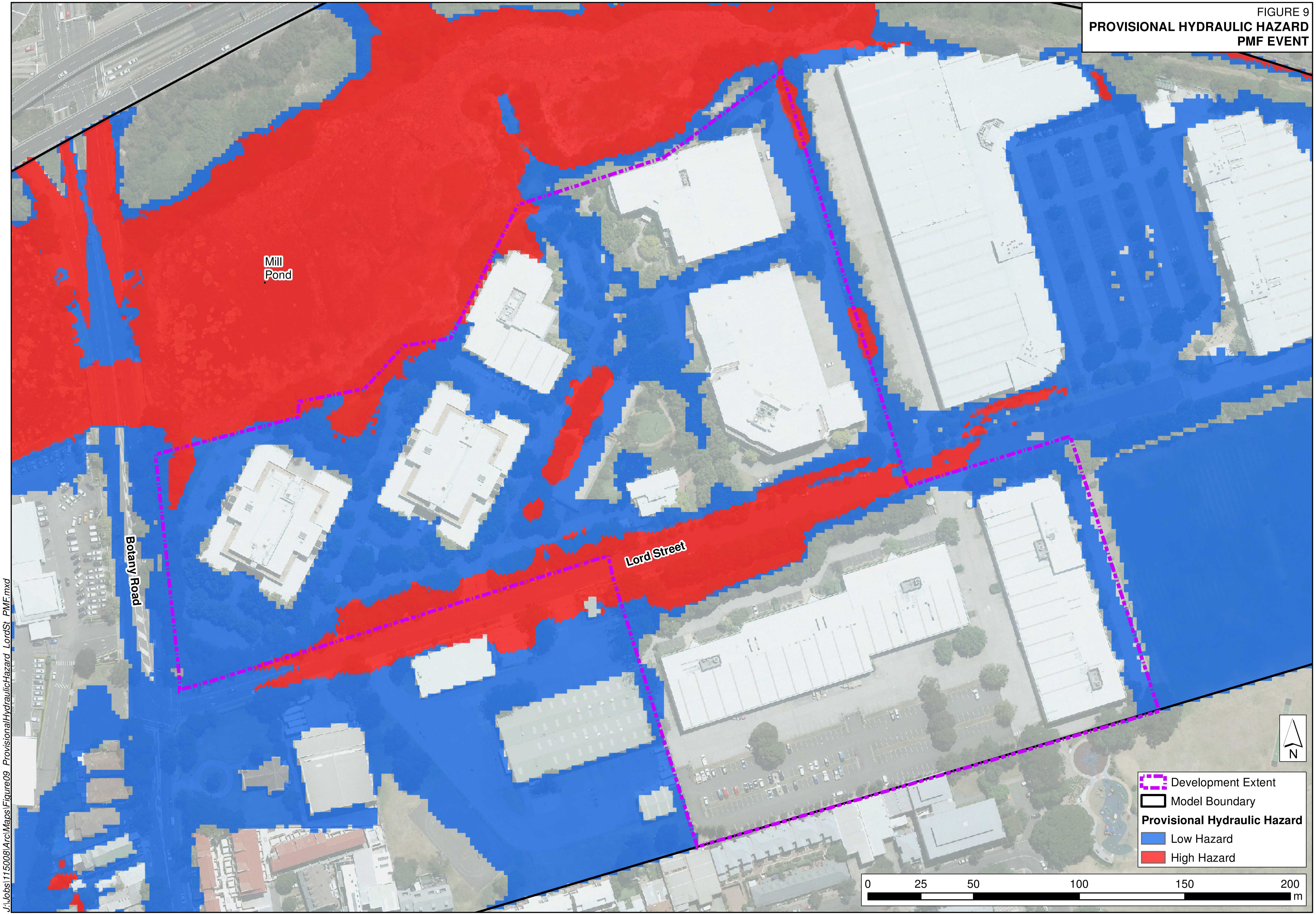


FIGURE 9
PROVISIONAL HYDRAULIC HAZARD
PMF EVENT



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Appendix A

APPENDIX A: GLOSSARY of TERMS

Taken from the Floodplain Development Manual (April 2005 edition)

acid sulfate soils	Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger event occurring in any one year (see ARI).
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Annual Damage (AAD)	Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
Average Recurrence Interval (ARI)	The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
caravan and moveable home parks	Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.
catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	The Council, Government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of DIPNR, as having the function to determine an application.
development	Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act). **infill development:** refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. **new development:** refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power. **redevelopment:** refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of

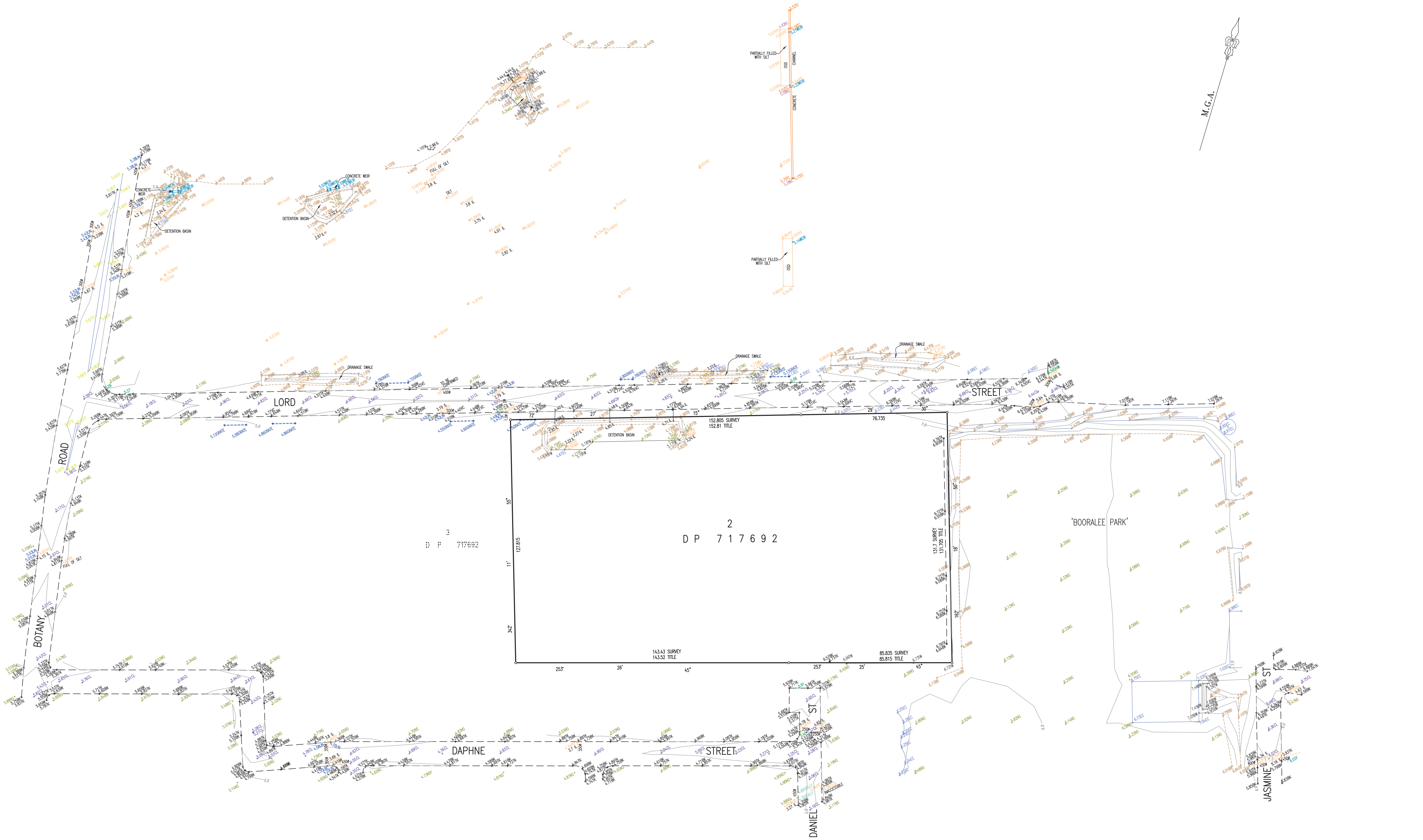
	connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves an their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).
flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.

flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Manual.
Flood Planning Levels (FPLs)	FPL's are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "standard flood event" in the 1986 manual.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood readiness	Flood readiness is an ability to react within the effective warning time.
flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. **existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain. **future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain. **continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.
freeboard	Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.
habitable room	**in a residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. **in an industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
hazard	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the

	Manual.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: • the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or • water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or • major overland flow paths through developed areas outside of defined drainage reserves; and/or • the potential to affect a number of buildings along the major flow path.
mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.
minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: **minor flooding:** causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. **moderate flooding:** low-lying areas are inundated requiring removal of stock

	and/or evacuation of some houses. Main traffic routes may be covered. **major flooding:** appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 with further discussion in the Manual.
peak discharge	The maximum discharge occurring during a flood event.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	A statistical measure of the expected chance of flooding (see AEP).
risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	Equivalent to “water level”. Both are measured with reference to a specified datum.
stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	A plan prepared by a registered surveyor.
water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	The horizontal distance in the direction of wind over which wind waves are generated.

Appendix B



NOTE: UNDERGROUND DETENTION TANKS INACCESSIBLE

ISSUE	DATE	AMENDMENT	BY

TYPICAL NOTES:

1. ORIGIN OF LEVELS PSM 29.591, R.L.4.416 (A.H.D.)
2. BEARINGS ARE ON MGA NORTH
3. RELATIONSHIP OF IMPROVEMENTS AND DETAIL TO BOUNDARIES IS DIAGRAMMATIC ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
4. SERVICES SHOWN ARE BASED ON VISIBLE SURFACE INDICATORS EVIDENT AT THE DATE OF SURVEY AND THE RELEVANT SERVICE DIAGRAMS OF THE VARIOUS AUTHORITIES. ALL SERVICE MUST BE VERIFIED ON SITE PRIOR TO ANY WORK BEING UNDERTAKEN. LINKER SURVEYING PTY LTD BEAR NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE SERVICES SHOWN HEREON.
5. RIDGE, EAVE & GUTTER HEIGHTS HAVE BEEN OBTAINED BY AN INDIRECT METHOD AND ARE ACCURATE FOR PLANNING PURPOSES ONLY.
6. ADJOINING BUILDINGS AND DWELLINGS HAVE BEEN PLOTTED FOR DIAGRAMMATIC PURPOSES ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
7. THE DIAMETER (ø), SPREAD (S) & HEIGHT (H) OF EACH TREE IS INDICATIVE ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
8. CONTOURS ARE AN INDICATION OF THE TOPOGRAPHY ONLY. SPOT LEVELS SHOULD BE USED IF DETAILED DESIGN IS TO BE UNDERTAKEN.
9. CONTOUR INTERVAL 0.5 METRE.

LEGEND OF TYPICAL CODES

AE	ARCHITECTURAL EMBELLISHMENT	NS	NATURAL SURFACE
AP	ALIGNMENT PIN	OPT	OPTUS
AWN	AWNING	PC	PRAM CROSSING
BLD	BUILDING	PED	PEDESTRIAN CROSSING
BALC	BALCONY	PERG	PERGOLA
BB	BOTTOM OF BANK	PM	PERMANENT MARK
BDY	BOUNDARY	PP	POWER POLE
BC	BOTTOM OF CHANNEL	RLWY	RAILWAY
BIT	BITUMEN	RCK	ROCK
BK	BOTTOM OF KERB	RM	REFERENCE MARK
BM	BENCH MARK	RR	ROOF RIDGE
BOL	BOLLARD	RSN	CONCRETE NAIL
BOR	BOTTOM OF ROCK	SEW	SEWER
BRK	BRICK	SLH	SEWER LAMP HOLE
BRW	BOTTOM OF RETAINING WALL	SHR	SHRUB
BS	BOTTOM OF STEPS	SMH	SEWER MANHOLE
BW	BOTTOM OF WALL	SP	SIGN POST
BWIN	BOTTOM OF WINDOW	SSM	STATE SURVEY MARK
CL	CENTRELINE	SV	STOP VALVE
CLID	CONCRETE LID	SW	STORM WATER
COL	COLUMN	TB	TOP OF BANK
CONC	CONCRETE	TC	TOP OF CHANNEL
CPORT	CARPORT	TEL	TELSTRA
D	DOOR	TELP	TELSTRA PILLAR
DD	DISH DRAIN	TF	TOP OF FENCE
DH	DRILL HOLE	TG	TOP OF GUTTER
DHW	DRILL HOLE & WINGS	TI	TRAFFIC TIAND
DWY	DRIVEWAY	TK	TOP OF KERB
EB	EDGE OF BITUMEN	TL	TRAFFIC LIGHT
EBOX	ELECTRICITY BOX	TP	TOP OF PARAPET
EC	EDGE OF CONCRETE	TR	TREE
EG	EDGE OF GARDEN	TRF	TOP OF ROOF
EP	EDGE OF PATH	TRK	TOP OF ROCK
ER	EDGE OF ROAD	TRW	TOP OF RETAINING WALL
ELEC	ELECTRICITY PIT	TS	TOP OF STEPS
FCE	FENCE	TW	TOP OF WALL
FL	FLOOR LEVEL	TWIN	TOP OF WINDOW
GD	GLASS DOOR	US	UNDERSIDE
GM	GAS METER	USE	UNDERSIDE OF EAVE
HPG	HIGH POWERED GAS	USG	UNDERSIDE OF GUTTER
HR	HANDRAIL	USA	UNDERSIDE OF AWNING
HYD	HYDRANT	USB	UNDERSIDE OF BEAM
IL	INVERT LEVEL	USC	UNDERSIDE OF CEILING
IP	INSPECTION PIT	V	VENT
K	KERB	VC	VEHICLE CROSSING
LP	LAMP POST	W	WINDOW
MH	MANHOLE	WM	WATER METER
MLID	METAL LID		

LEGEND OF TYPICAL SERVICES

CSWP	CERAMIC STORMWATER PIPE	RW	RECYCLED WATER
E	UNDERGROUND ELECTRICITY CABLES	RM	RISING MAIN
AE AO	UNDERGROUND ELECTRICITY & OPTUS CABLES	RTA	ROADS & MARITIME PIT
FS	FIRE SERVICE	S	SEWER
G	GAS LINE	SO	SEWER OUTFALL
GE	GAS LINE & ELECTRICITY CABLES	ST	SHARED TRENCH
NG	NATURAL GAS LINE	SW	STORM WATER
OH	OVERHEAD CABLES	SW CK	STORMWATER CREEK
OPT	OPTUS CABLE	T	TELSTRA CABLES
PE	PRIVATE ELECTRICITY	TG	TELSTRA & GAS CABLES
PS	PRIVATE SEWER	U	UNKNOWN SERVICE
PW	PRIVATE WATER	V	VERIZON CABLES
		W	WATER SUPPLY
		WM	WATER MAIN

1. ALL UNDERGROUND SERVICE INFORMATION INCLUSIVE OF GENERAL POSITION AND SURFACE COVER DEPTHS NOTED ON THE PLAN ARE APPROXIMATELY ONLY.
2. ALL UNDERGROUND SERVICE INFORMATION HAS BEEN COMPILED FROM SERVICE AUTHORITY PLANS PROVIDED BY THE AUTHORITIES.
3. THE LOCATION OF SERVICES BETWEEN SURVEYED POINTS (AS INDICATED) HAVE BEEN SHOWN DIAGRAMATICALLY ONLY USING THE SERVICE DIAGRAMS AS PROVIDED. THE EXACT LOCATION OF THESE SERVICES BETWEEN THE SURVEYED POINTS MUST BE VERIFIED PRIOR TO ANY EXCAVATION OR PILING. NO WARRANTY IS GIVEN AGAINST THE POSSIBILITY OF THE EXISTANCE OF FURTHER UNCHARTED SERVICES.
4. ALL CONTRACTORS, TRADESMEN, BUILDING & PROJECT CONSULTANTS MUST CONTAC THE VARIOUS AUTHORITIES, IN ACCORDANCE WITH STANDARD "DIAL BEFORE YOU DIG" PROCEDURES PRIOR TO UNDERTAKING ANY WORKS WITHIN THE VICINITY OF THE SERVICE LINES TO VERIFY THE POSITION OF THE SERVICE LINES.

REDUCTION RATIO 1 : 750
0 10 20 30 40 50
LENGTHS ARE IN METRES

CLIENT: DEXUS PROPERTY GROUP

TITLE No: 2/717692	REF: 150336
DATUM: A.H.D.	ISSUE: 1
DATE OF SURVEY: 7.04.15	ISSUE DATE: 16.04.15
SURVEYOR: MA	SHEET SIZE: A1
DRAFTER: PH	SHEET 1 OF 1 SHEETS

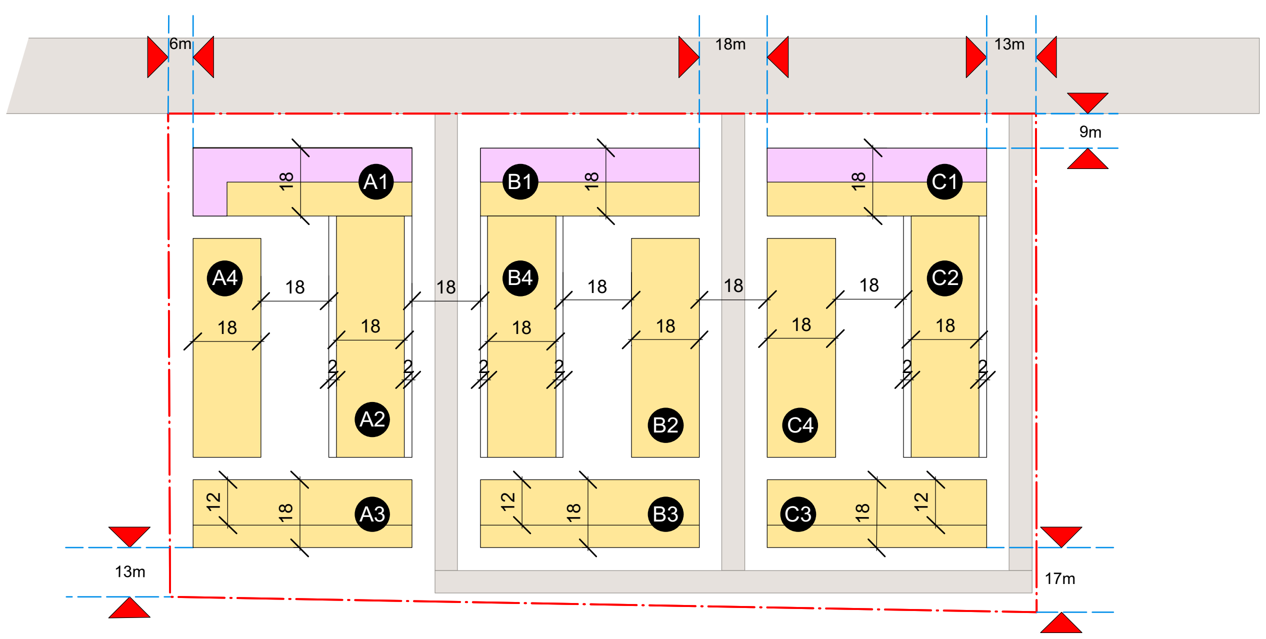
PLAN OF DETAIOL & LEVELS AT No 11-13 LORD STREET BOTANY

LINKER SURVEYING
Suite 301, Level 3, 55 Holt Street
Surry Hills NSW 2012
PO Box 1807
Strawberry Hills NSW 2012
t: (02) 9212 4655
f: (02) 9212 5254
email: linker@linkersurveying.com.au
web site: www.linkersurveying.com.au

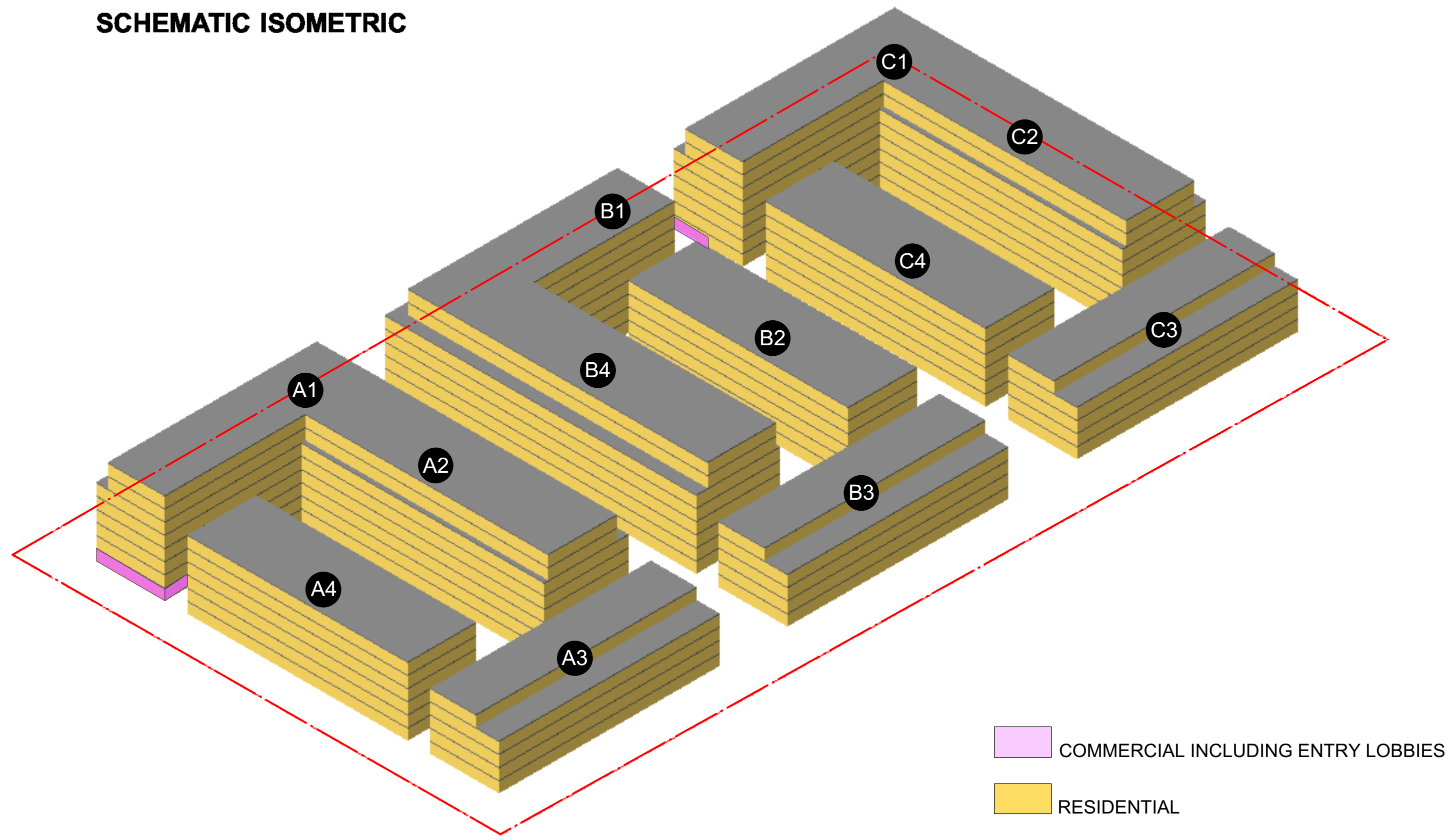
X:\15JOBS\150336 11-13 LORD ST BOTANY\150336_DETAIL.DWG

PLANNING PROPOSAL MASTERPLAN (12/05/2015)

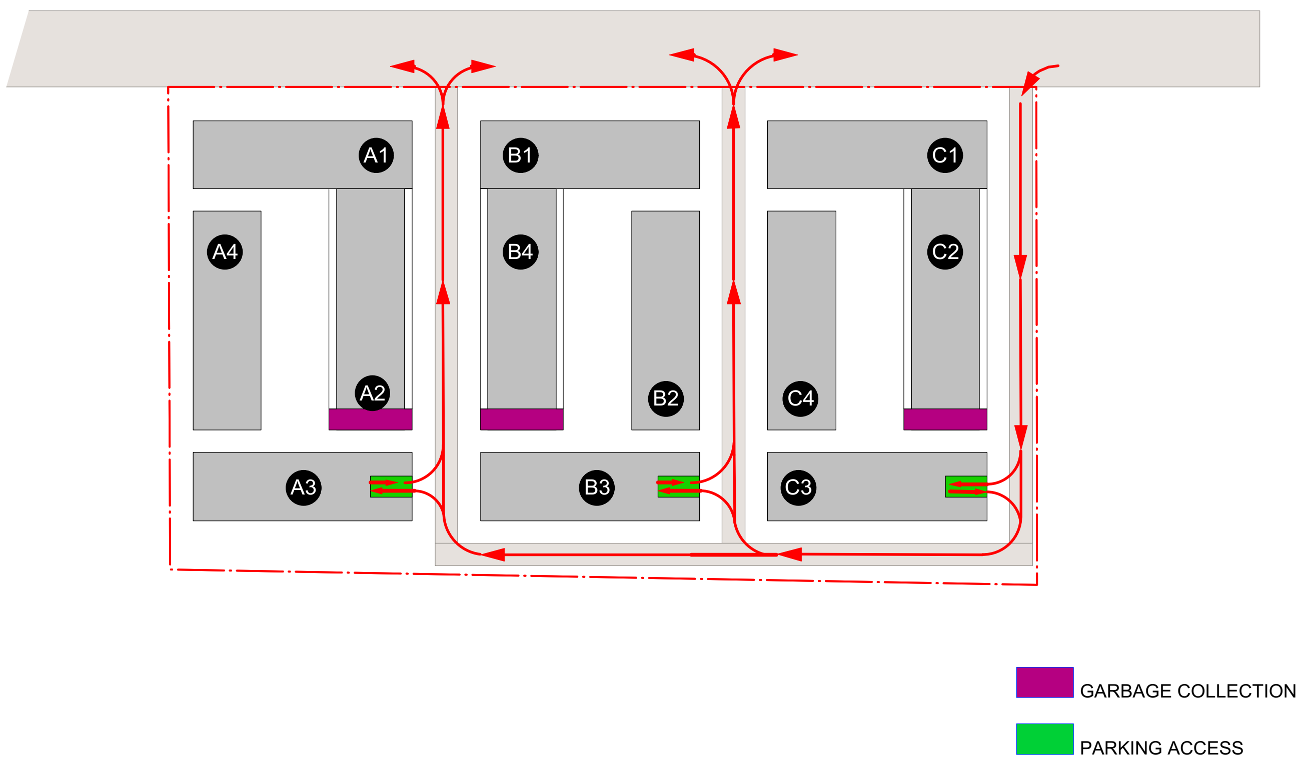
SCHEMATIC CONCEPT PLAN



SCHEMATIC ISOMETRIC



VEHICULAR CIRCULATION DIAGRAM



MASTERPLAN DETAILS

TOTAL GFA: 62,912 m^2

SITE AREA: 29,770 m^2

FSR: 2.11:1

NOTES

- MIXED USE
- CASA HEIGHT COMPLIANT
- BUILDING HEIGHTS COMPLY WITH MAX RL=AHD 33.00

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NSW 2061 SYDNEY AUSTRALIA
T 99649100 F 99649133
WWW.TONYCAROARCHITECTURE.COM.AU

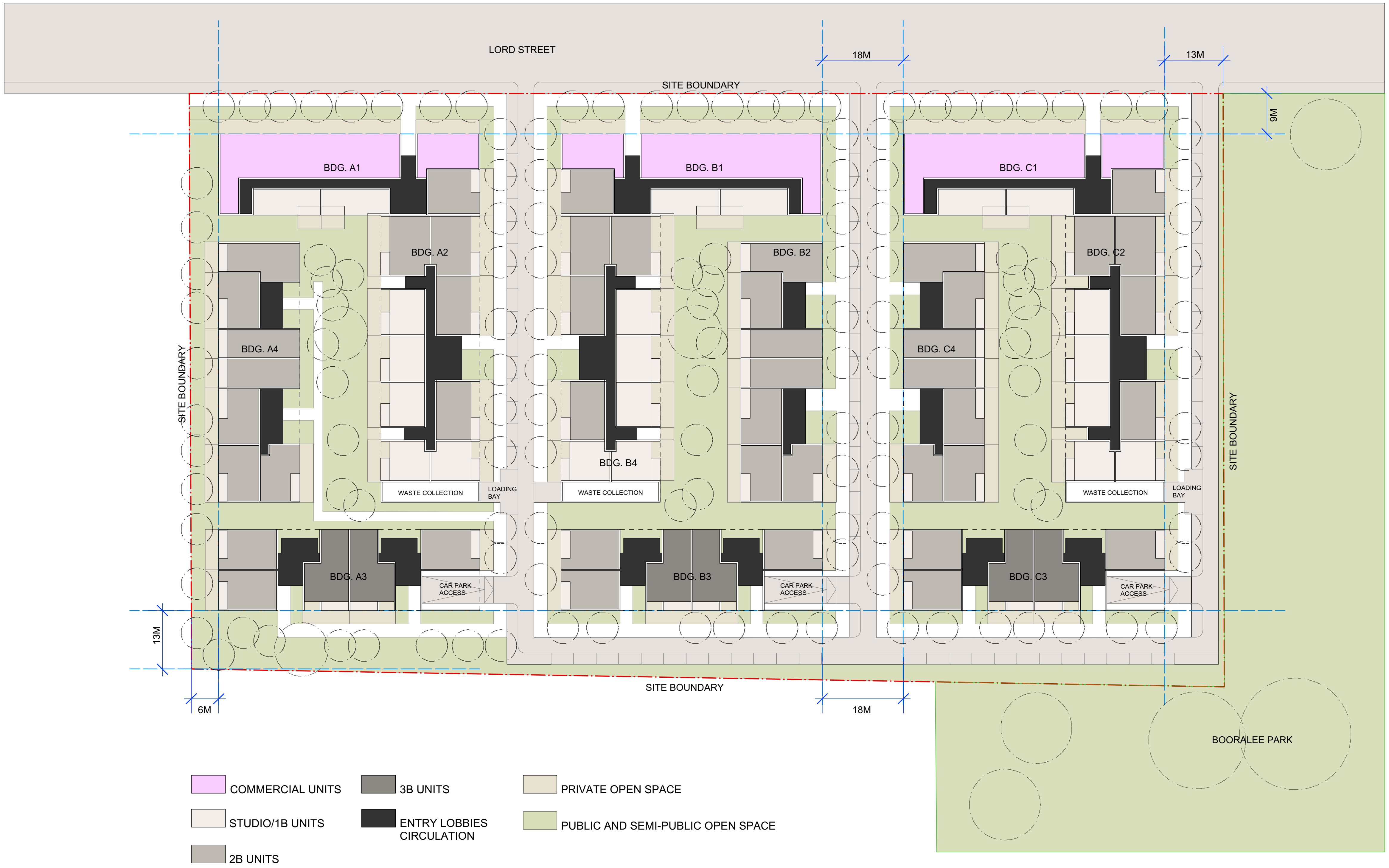
LAKES BUSINESS PARK SOUTH PRECINCT

DEXUS

PLANNING PROPOSAL MASTERPLAN

DWG NO.	SK_002
PROJECT No.	1503
PLOT DATE	12/5/15
SCALE	1:2000 @ A3

PLANNING PROPOSAL MASTERPLAN (12/05/2015)



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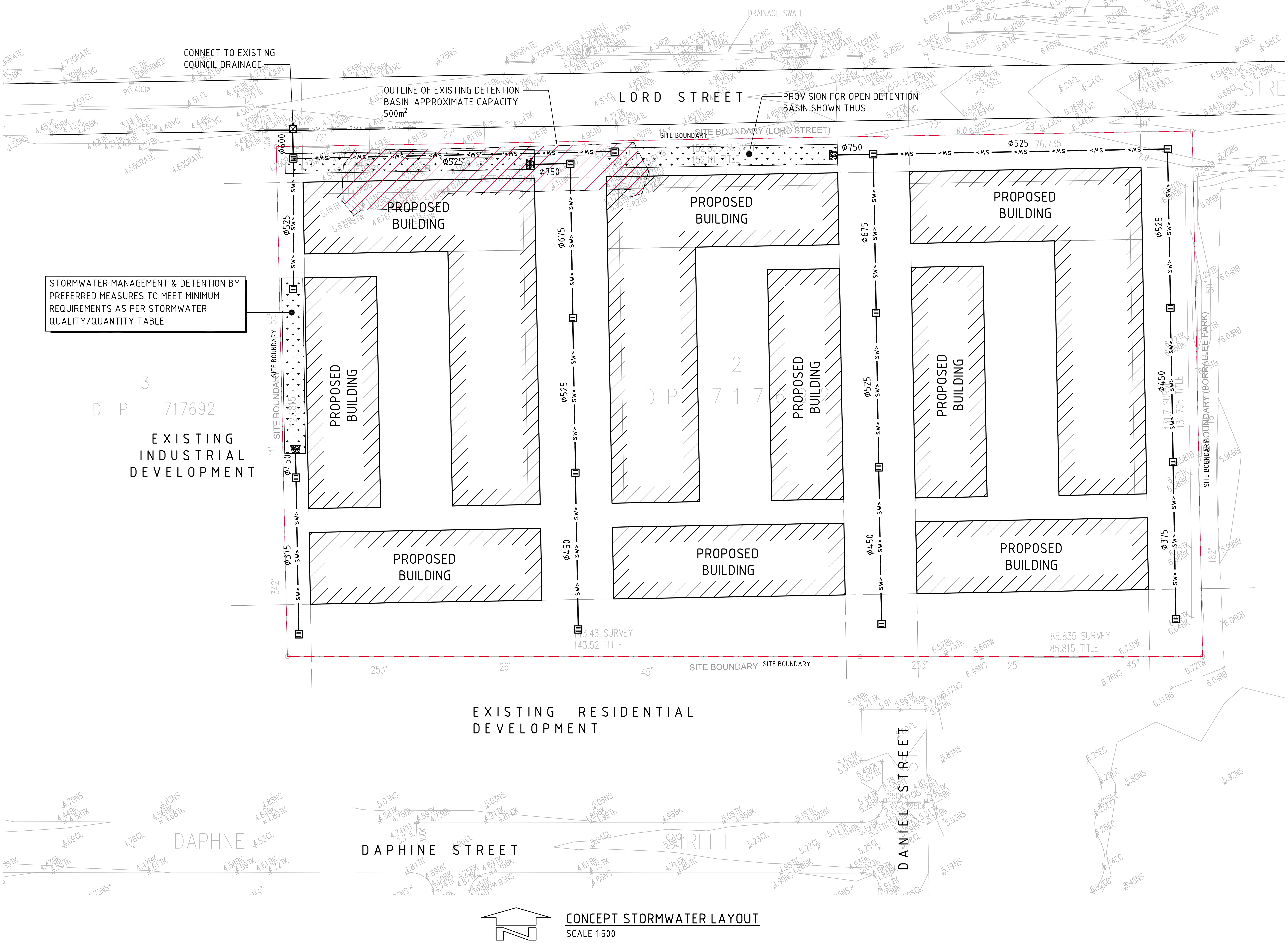
LAKES BUSINESS PARK SOUTH PRECINCT

DEXUS

GROUND FLOOR PLAN

DWG NO.	SK_003
PROJECT No.	1503
PLOT DATE	12/5/15
SCALE	1:1000



CONCEPT STORMWATER LAYOUT
SCALE 1:500

LEGEND:

LEVELS DATUM IS AHD.

EXISTING SITE LEVELS AND DETAILS BASED ON SURVEY INFORMATION PROVIDED BY LINKER SURVEYING DATED 16.04.15

- SGGP, SINGLE GRATED GULLY PIT
- SJP, SEALED JUNCTION PIT
- DRAINAGE LINE
- DENOTES STORMWATER MANAGEMENT BASIN AREA

STORMWATER MANAGEMENT REQUIREMENTS

STORMWATER QUALITY

GROSS POLLUTANTS	90%
TOTAL SUSPENDED SOLIDS (TSS)	80%
TOTAL PHOSPHOROUS (TP)	55%
TOTAL NITROGEN (TN)	40%

REDUCTIONS ARE PRESENTED IN TERMS OF ANNUAL PERCENTAGE POLLUTANT REDUCTIONS ON THE DEVELOPED CATCHMENT.

STORMWATER QUANTITY

STORMWATER RUNOFF GENERATED FOR ALL STORM DURATIONS UP TO AND INCLUDING THE 100 YEAR ARI WILL BE DETAINED TO THE PRE-DEVELOPED 5 YEAR ARI STORM FLOW.
CAPACITY OF EXISTING DETENTION BASIN & LANDSCAPE STORAGE TO BE PROVIDED IN NEW OPEN DETENTION BASIN TO ENSURE NO CHANGE IN THE OVERLAND FLOW OR FLOODING FOLLOWING DEVELOPMENT AS PER THE BELOW STORAGE TABLE.

STORAGE TABLE

ELEVATION (m AHD)	STORAGE (m^3)
3.9	0
4.0	3
4.1	24
4.2	72
4.3	134
4.4	207
4.5	289
4.6	377
4.7	473
4.8	577
4.9	689
5.0	808
5.1	933
5.2	1064
5.3	1202
5.4	1348

NOTE:

DRAWINGS TO BE READ IN CONJUCTION WITH REPORT C09759.01-03.rpt BY COSTIN ROE CONSULTING.
THESE DRAWINGS ARE CONCEPTUAL IN NATURE & PREPARED FOR THE SOLE PURPOSE OF DEMONSTRATING THAT STORMWATER MANAGEMENT FOR A PROPOSED MIXED USE DEVELOPMENT IS ACHIEVABLE.

5m 0 10 20 30 40 50m
SCALE 1:500 AT A1 SHEET SIZE

FOR INFORMATION

AMENDMENTS	DATE	ISSUE
ISSUED FOR INFORMATION	11.05.15	D
DRAWING REVISED AS CLOUDED	30.04.15	C
DRAWING REVISED AS CLOUDED	24.04.15	B
ISSUED FOR REVIEW	22.04.15	A

ARCHITECT
TONY CARO ARCHITECTURE
LEVEL 1, 2 GLEN STREET
MILSONS POINT, NSW 2061

CLIENT
DEXUS PROPERTY GROUP

PROJECT
LAKES BUSINESS PARK - SOUTH PRECINCT
LORD STREET
BOTANY, NSW 2019

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	RB	21.04.15		A1	AS SHOWN	C09759.01 - SKC01

Costin Roe Consulting Pty Ltd.
Consulting Engineers
Level 1, 8 Windmill Street
Walsh Bay, Sydney NSW 2000
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email: mail@costinroe.com.au ©

CostinRoe Consulting
Value in Engineering and Management

DRAWING TITLE
CONCEPT STORMWATER LAYOUT

DRAWING No C09759.01 - SKC01
ISSUE D