Appendix B: Overland Flow Flood Study

Flood Impact Assessment

NSW Forensic Pathology and Coroner's Court

80816199

Prepared for
Health Infrastructure

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Cardno
Shaping the Future

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1 Introduction

Cardno has been commissioned by Health Infrastructure NSW to prepare a flood impact assessment as part of the master planning for the proposed development of the NSW Forensic Pathology and Coroner's Court site and adjoining areas.

The objective of this assessment is to determine the existing extent of flooding on the proposed site and to then assess the potential impacts that the proposed development may have on flooding in the area. A composite hydrologic and hydraulic model was constructed for the purposes of analysing flood behaviour for a range of design flood events in both the existing and post-development scenarios.

This flood impact assessment report should be read in conjunction with Cardno's Civil, Stormwater and Infrastructure Services Report.

2 Background

2.1 Subject Site

The Forensic Pathology Precinct site is bounded by Joseph Street to the west, Main Avenue to the north, Weerona Road to the south, and a residential development to the east. The site is located in the suburb of Lidcombe in the Auburn Council Local Government Area (LGA). Carnarvon Golf Course lies directly to the west of the site.

The total area of the precinct is approximately 7.7 ha which currently houses Forensic and Analytical Science Services, the Office of Environment and Heritage and the Department of Mines offices.

The Forensic Pathology Precinct site is shown in **Figure 2-1**.

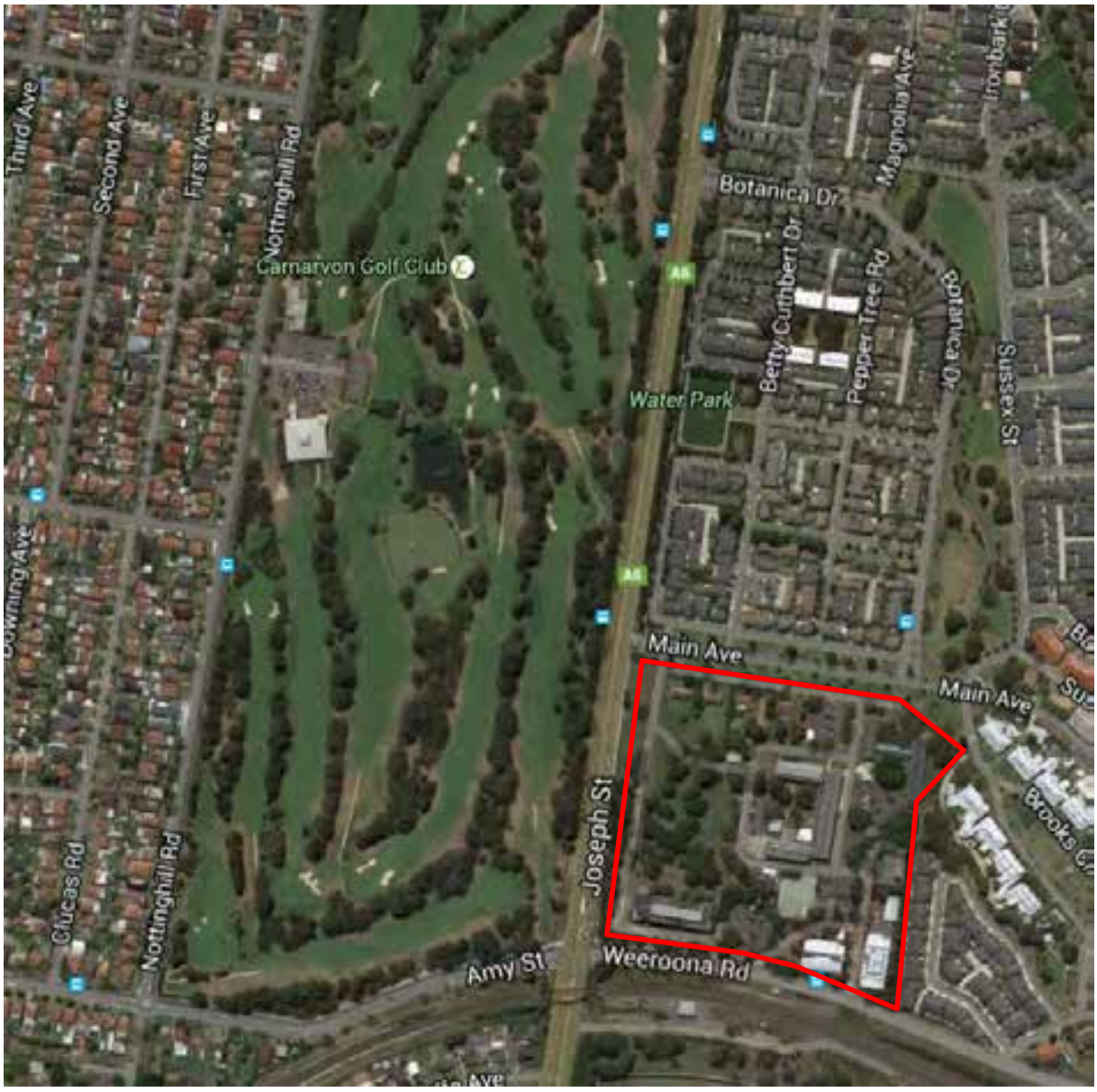

Figure 2-1 Subject Site

2.2 Proposed Development

The proposed development of the site by NSW Health Infrastructure is proposed in three stages;

> Stage 1 will be the development of the Forensic Pathology and Coroners Court (FPCC) building which is to the north-west of the overall precinct;

> Stage 2 is proposed to be the development of the remaining western portion of the precinct including the expansions sites and the Forensic & Analytical Science Services (FASS) building; and,

> Stage 3 is proposed as the development of the eastern portion of the precinct including Site A and Site B.

Stage 2 and Stage 3 of the development has not been examined beyond preliminary master planning level. The potential master plan design of the precinct has been guided by the *Forensic Services Precinct Plan – Draft* (Silver Thomas Hanley (STH), 2015) prepared for NSW Health Infrastructure in November 2015. A summary of the precinct layout incorporating Stage 1, 2, and 3 is shown in **Figure 2-2**.

Figure 2-2 Preliminary Master Plan of Stage 2 Precinct (Source: STH, 2015)

It is noted that the design of the Stage 1 site, the FPCC building, has been further developed since the release of this report in November 2015 and the FPCC site now extends further to the south than shown in **Figure 2-2**, covering part of the expansion site to the south.

The review of the Stage 1 FPCC building design has been guided by civil design drawings prepared by Cardno dated 8 March 2016 (drawing number 80816199-SD-203-Rev1). The drawings include preliminary proposed fill levels for the carpark and site and indicative extent of cut and fill. The FPCC site layout is shown in **Figure 2-3**.

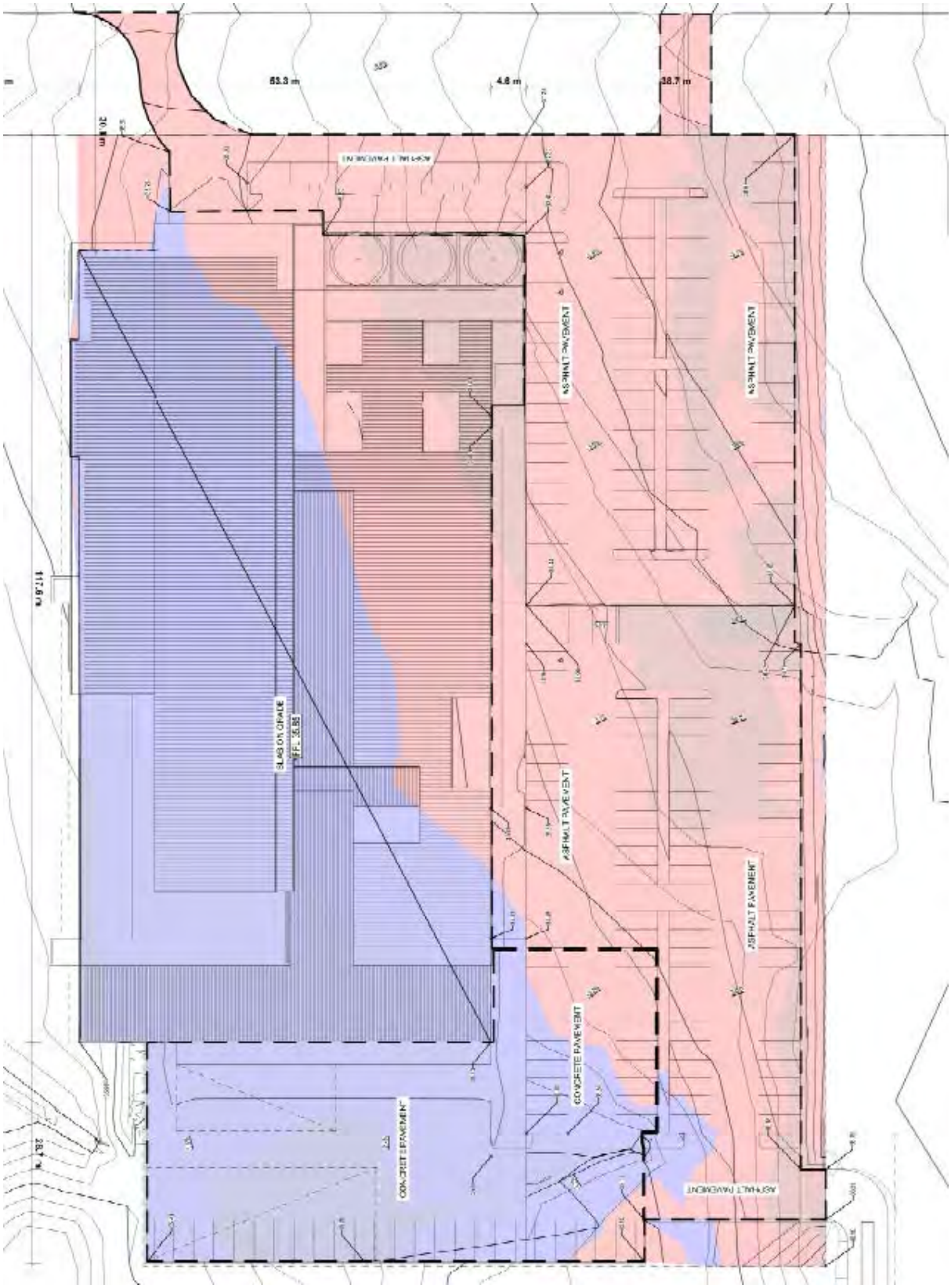

Figure 2-3 Stage 1 - FPCC Site Proposed Layout (Source: Cardno, 2016)

The FPCC site incorporates a building to the north-west of the precinct with open air car parking surrounding the building to the east and the south.

2.3 Available Data

2.3.1 Flood Studies

The Forensic Services Precinct lies on the upstream side of the Haslams Creek catchment area. The latest publically available study for this catchment is the *Haslams Creek Floodplain Risk Management Study and Plan* (Bewsher Consulting, 2003) prepared for Auburn Council. The FRMS&P was developed following the completion of the *Haslams Creek Flood Study* (Bewsher Consulting, 1999).

Hydrology modelling was conducted for this study by modifying an XP-RAFTS model that was developed for the study area as part of the Flood Study (Bewsher Consulting, 1999). Hydraulic modelling for the FRMS&P was conducted using a 1D HEC-RAS model modified from the 1999 Flood Study model.

The location of the Forensic Services Precinct in the context of the wider Haslams Creek catchment is shown in **Figure 2-4**. As can be seen in **Figure 2-4** the site is located upper reaches of the catchment, as a result the FRMS&P hydraulic modelling did not include the site and its surrounds and therefore flood mapping has not been prepared for the site and its surrounds.

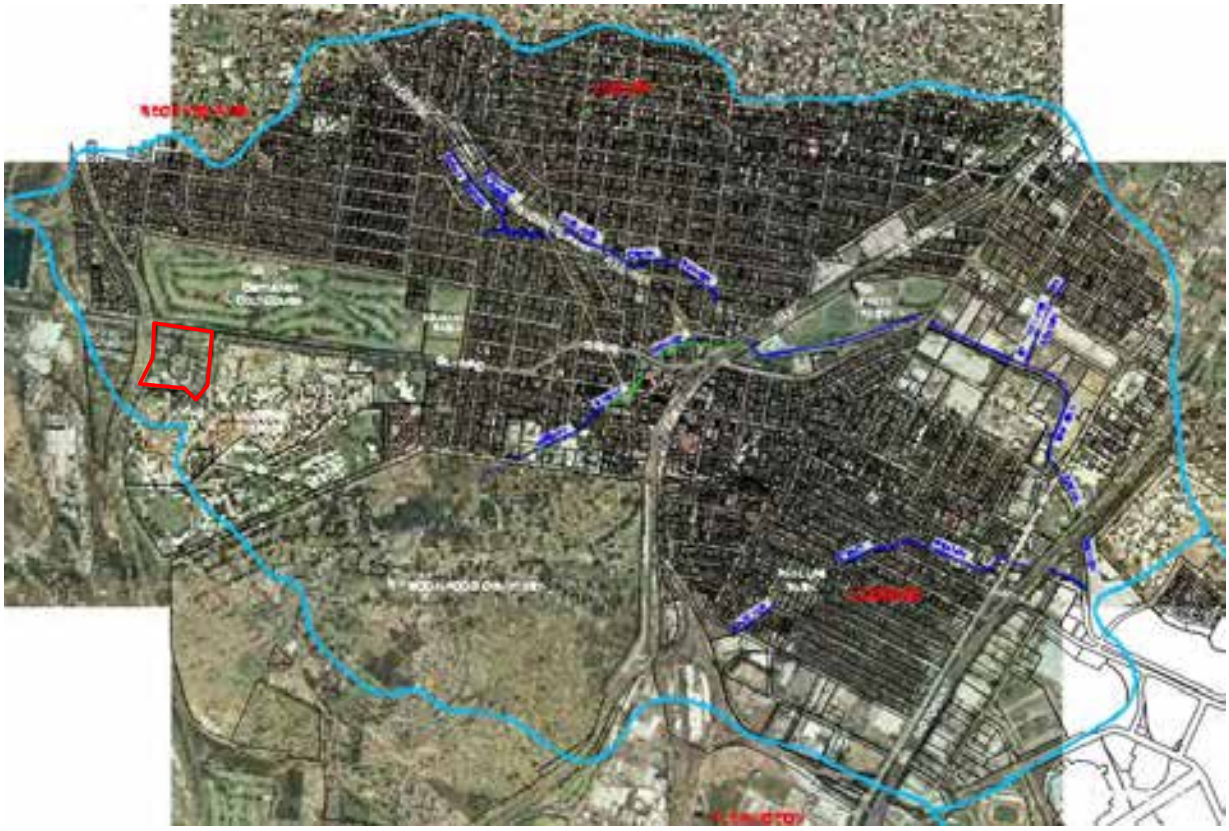

Figure 2-4 Location of Subject Site (shown in red) in Haslams Creek Floodplain (Source: Bewsher, 2003)

It is noted that Auburn Council has commissioned the preparation of an updated *Haslams Creek Flood Study* (Royal Haskoning DHV, ongoing) however a draft report for the Flood Study is not currently available to the public. In lieu of this data Cardno has contacted Royal Haskoning DHV, the consultants preparing the Study on behalf of Auburn Council, and they have provided comment to assist our modelling as required.

2.3.2 Survey Data

The following survey information was used within this Flood Impact Assessment:

> Ground survey data of the eastern portion of the Forensic Services Precinct site including existing surface elevations, survey of the Joseph Street culvert downstream of the site, and survey of the concrete open channel through the site. The ground survey was recorded by Cardno as part of this project (Cardno drawing set 117680500 Rev 3, 11/12/15);

> LiDAR data for the local area was acquired from the NSW Department of Land and Property Information to inform this study; and,

> Pit and pipe data for the local area was supplied by Royal Haskoning DHV to Cardno using the 1D elements that have been included in the hydraulic model for the *Haslams Creek Flood Study* (Royal Haskoning DHV, ongoing). Included within the data was the location of stormwater assets, pit and pipe sizes, and invert levels where available. The data included the existing culvert crossing of Joseph Street on the downstream edge of the site, as well as culverts under Weeroma Road and the rail line upstream of the site to the south.

2.4 Council Requirements

This study is part of a State Significant Development planning proposal for submission to NSW Department of Planning and Infrastructure (DP&I) and it is expected will be referred to Auburn Council as the most relevant authority for assessing the flood risk of the proposed development.

Therefore consideration has been given to Auburn Councils flood related development controls outlined within the *Auburn Development Control Plan 2010*. There is a Part of the DCP that focusses on all aspects of Stormwater Drainage, including flooding, on site detention and stormwater design and treatment.

As discussed in **Section 2.3**, the site lies outside mainstream flooding of Haslams Creek, meaning that the provisions of Section 6 of the DCP relating to mainstream flooding are only partially applicable. The provisions in Section 9.3 of the DCP outlines requirements for any submissions for "*overland stormwater inundation*" which are:

> *A hydrological analysis of the upstream catchment and a hydraulic analysis of the relevant section of the piped drainage system, to determine overland flow rates through the site. Where known, these values will be supplied by Council.*

> *Plans and calculations of the pre-developed and post-developed position, depth and velocity of the floodway through the site, and adjoining properties where relevant, prepared by a suitably experienced, qualified civil/hydraulic engineer.*

Using this information it will be possible to show that the proposed development does not result in any increased risk to human life, and does not detrimentally increase the potential flood affectation on other development or properties.

3 Modelling Methodology

In order to assess the flood behaviour of the site, a local TUFLOW 1D/2D floodplain model of the development site and surrounds was assembled and run using the "rainfall on grid" approach to estimate runoff and flood extents.

The set-up of the hydrology and hydraulic components of the model are outlined in the following sections.

Three scenarios have been considered in this impact assessment:

> Existing scenario – the modelling methodology for the existing scenario model is summarised in **Section 3.1** and **Section 3.2**;

> Post-development Stage 1 Scenario – Involves the development of the FPCC site with the remainder of the precinct remaining as existing, with modelling of this scenario summarised in **Section 3.3**;

> Post-development Stage 3 Scenario – Involves the development of the entire Forensic Services Precinct, with the modelling of this scenario summarised in **Section 3.4**.

3.1 Hydrology Model

3.1.1 Rainfall-on-Grid

As the site lies near the top of the catchment the runoff was estimated using the "rainfall on grid" approach where rainfall is applied to the 2D domain and runoff responds to the local terrain. Rainfall-on-grid modelling enables overland flow to find its way to the discharge point of either the receiving water or drainage inlet pit according to ground contours or land form in its way.

3.1.2 Model Topography

The model terrain grid was developed from primarily by LiDAR data for the wider area, with the terrain informed by the ground survey for the western portion of the site. The civil and surveying package 12D was used to generate a detailed 3D surface (digital terrain model) of the study area.

A grid size of 2m x 2m was adopted for the study area. The base terrain is shown in **Figure 3-1**.

The catchment of the site originates to the south of the site near the rail line and to the east from the surrounding residential area. The model has been extended 250 metres downstream of Joseph Street into the Carnarvon Golf Course. A secondary catchment has been included in the model that collects from south of the rail line and flows through the Joseph Street underpass and onto Carnarvon Golf Course. This flowpath is excluded from the site through a minor levee along the south-west edge of the precinct.

There is an existing concrete lined open channel that runs through the precinct in a north-westerly direction and it can be seen that is the low point of the precinct.

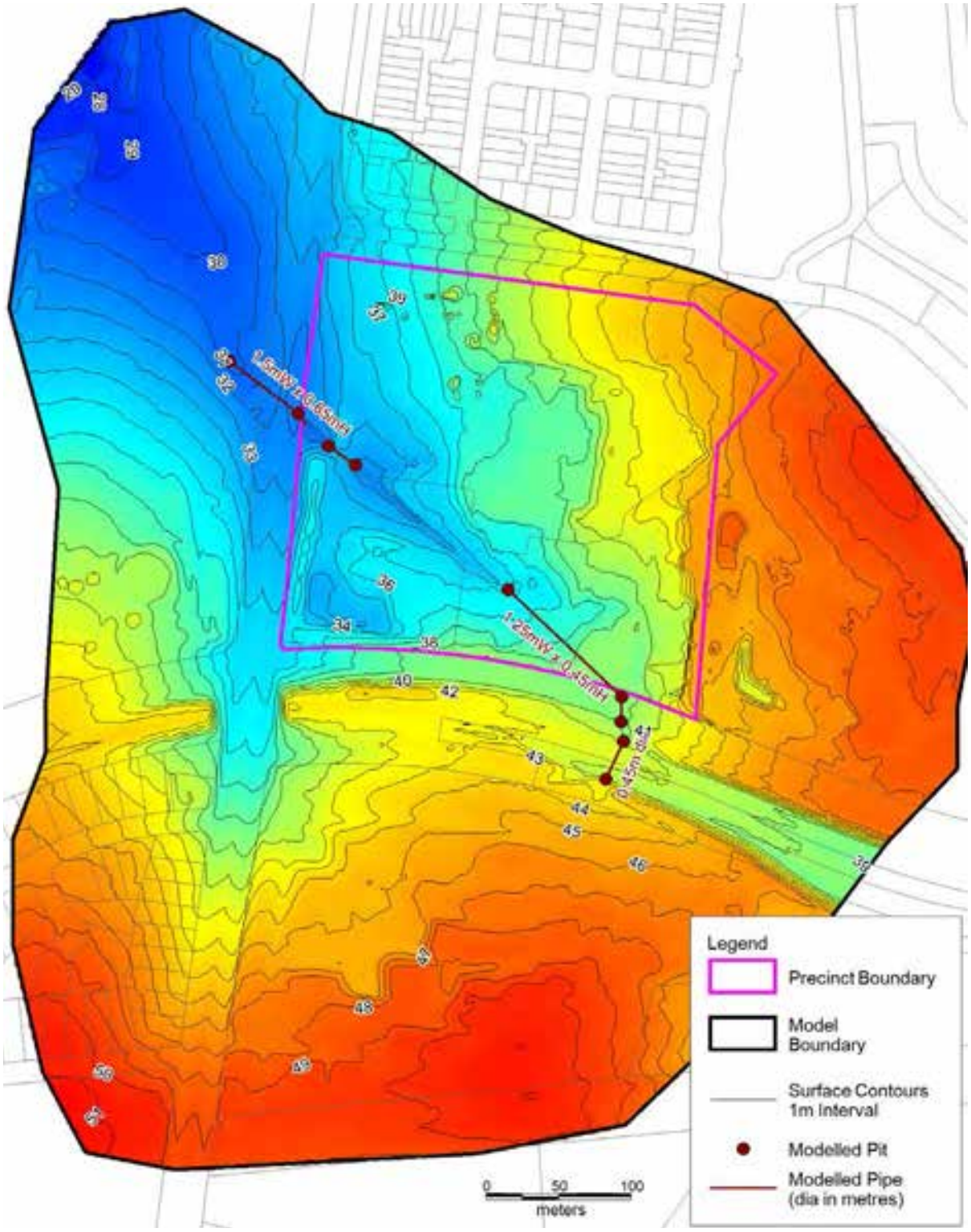

Figure 3-1 Topography and 1D Components of the Forensic Services Precinct

3.1.3 Rainfall

Rainfall events for the area were modelled using design temporal patterns obtained from Australian Rainfall and Runoff (AR&R1988). Modelled rainfall intensities match those identified by Auburn Council in a report issued 18 February 1988 (file reference GN 2530) which was forwarded to Cardno by Auburn Council for the purposes of this study.

Two design rainfall events were analysed for the purposes of this impact assessment. The two rainfall events are 100 year and 20 year Annual Recurrence Interval (ARI) storms. The critical storm burst duration for the overall site catchment was 2 hour. In the model, the 100yr ARI and 20yr ARI rainfall intensities were 49.5 mm/hr, and 37.9 mm/hr respectively.

In addition a Probable Maximum Flood (PMF) event was modelled for the area, with rainfall intensities for the PMF event match those adopted within the *Haslams Creek Flood Study* (Royal Haskoning DHV, ongoing). These PMF rainfall intensities were supplied to Cardno by Royal Haskoning DHV on 13 April 2016 to inform this impact assessment. The critical duration of PMF events for the catchment was the 15 minute duration with a rainfall intensity of 680 mm/hr.

3.1.4 Rainfall Losses

Infiltration and other runoff losses have been accounted for within the model using the initial and continuing loss approach with variable losses modelled across the hydrological catchment based on land use. The existing land use mapping for the model and the associated initial (IL) and continuing (CL) rainfall losses are shown in **Figure 3-2**.

Rainfall losses for the PMF event were assumed to be 0 which is considered a conservative assumption.

Figure 3-2 Land Use Breakdown for the Model Area

3.2 Hydraulic Model

3.2.1 Surface Roughness

Hydraulic surface roughness have been modelled in the 2D TUFLOW model using spatially distributed roughness ("n") values based on land uses similar to rainfall losses in the hydrology model.

The roughness values (n) for the land uses of the study area are shown in **Figure 3-2**.

3.2.2 1D Hydraulics

The stormwater pit and pipe network was modelled as 1D elements in the TUFLOW model. The layout of drainage system is shown in **Figure 3-1**, with the pipe diameters shown in metres within the figure. The culverts included the hydraulic model are:

> 0.45 metre diameter culvert under the rail line on the upstream side of the catchment;

> 1.25m W x 0.45m H box culvert crossing Weeroona Street immediately upstream of the precinct;

> A 110 metre long section of 1.25m W x 0.45m H box culvert conveys flow through the south-eastern portion of the precinct which discharges into the concrete-lined open channel which has been accounted for in the 2D hydraulic model domain;

> The open channel flows for a distance of 135 metres through the site before entering a 23 metre long 1.5m W x 0.65m H box culvert under the local road on the western side of the site. This culvert crosses under the local road in the precinct before discharging back into open channel for a further 29 metres; and,

> The overland flowpath discharges from the site through a 60 metre long 1.5m W x 0.65m H box culvert under Joseph Street which discharges to the Carnarvon Golf Course site.

A mannings roughness ("n") of 0.015 has been adopted for all culverts with entry losses between 0.3 and 0.5 and exit losses between 0.2 and 1.0 depending on the geometry of each culvert.

In accordance with provisions of the *Auburn DCP 2010*, Council recommends a design blockage of 50% for all culverts be considered in modelling. In accordance with this recommendation all culverts in the model have adopted a 50% blockage.

3.2.3 Downstream Boundary

As discussed in **Section 2.3** review of the previous *Haslams Creek Floodplain Risk Management Study and Plan* (Bewsher Consulting, 2003) shows that the precinct is in the upper reaches of the Haslams Creek catchment. Review of the design flood levels of this Study compared to the surface levels surveyed on site show that the site lies well above the mainstream flood levels downstream.

Therefore it has been assumed that there are negligible tailwater influences that therefore the hydraulic model for the precinct has adopted a free outfall at the downstream boundary of the model.

3.3 Post-development Model - Stage 1 FPCC Site

Two changes are proposed within the Stage 1 post-development scenario:

> The development of the FPCC site including construction of a new building and surrounding carpark area on the north-west portion of the precinct;

> The replacement of the existing concrete lined open channel through the precinct with a new culvert system.

The updates to the existing modelling methodology are summarised in the sections below.

3.3.1 Hydrology Model

The stormwater drainage design for the FPCC site has been assessed within Cardno's *Civil, Stormwater and Infrastructure Services Report* that accompanies this flood impact assessment. From this report it has been assumed that for the FPCC building the stormwater drainage network will be sufficiently sized to convey all rain water. The conclusion is that in the flood model runoff from the post-development FPCC building

footprint can be discharged directly to the stormwater network and does not need to be modelled using the "rainfall on grid" approach.

Instead the hydrology of the FPCC building has been modelled using a local XP-RAFTS hydrology model. The remainder of the FPCC site including the proposed carpark areas were modelled using the rainfall-on-grid methodology similar to the existing scenario model. The following model inputs for the building footprint XP-RAFTS model were adopted:

> The catchment area for the FPCC building footprint was estimated to be 0.62 ha;

> The rainfall data adopted within the model is identical to that used in the existing model (**Section 3.1.3**);

> Rainfall losses were applied within the XP-RAFTS hydrology model;

> Conservatively the entire FPCC site including building and carpark has been assumed 100% impervious in the XP-RAFTS model;

Flow hydrographs for all design events were extracted from this local XP-RAFTS model and input to the TUFLOW hydraulic model directly to the inlet pit closest to the FPCC site. If the capacity of the 1D network is exceeded at this location than this flow would enter the 2D domain of the TUFLOW model as surcharge from the inlet pit.

It is noted that no On-Site Drainage or detention was applied to the flow hydrographs and flows were allowed to discharge straight to the stormwater network.

Aside from the FPCC site, hydrology has remained as per existing throughout the remainder of the Forensic Services Precinct in the Stage 1 model.

3.3.2 Hydraulic Model

The FPCC site was modelled as follows within the hydraulic model:

> The FPCC building polygon was excluded from the hydraulic model as it has been assumed it will represent a 100% blockage to flood storage;

> The carpark area has been modelled using the preliminary finished surface levels provided in the civil design drawings (see **Section 2.2**). The southern portion of the carpark closest to the precinct low point has proposed surface levels between 35.1 – 36.0m AHD representing depths of fill of up to 3 metres above existing surface levels. The raising of the FPCC carpark areas represents a significant flow obstruction for overland flows leaving the site.

> In terms of hydraulic roughness, a mannings "n" of 0.014 was applied to the carpark, equivalent to concrete surfaces.

The other change to the hydraulic model for the Stage 1 precinct is the filling of the existing concrete lined channel and replacement with a culvert. The open channel is proposed to be replaced with a 1.5m W x 0.45m H box culvert for the majority of its length. The small portion of channel between the local road and Joseph Street has been replaced with a 1.5m W x 0.65m H box culvert, identical to the size of culvert under Joseph Street.

The model terrain has been updated to cover over the concrete channel and the proposed culverts have been modelled as 1D elements with inverts the same as the existing channel. The terrain over the culvert has been left as a local low point to allow for any remnant overland flows.

A summary of the Stage 1 hydraulic model is included in **Figure 3-3**.

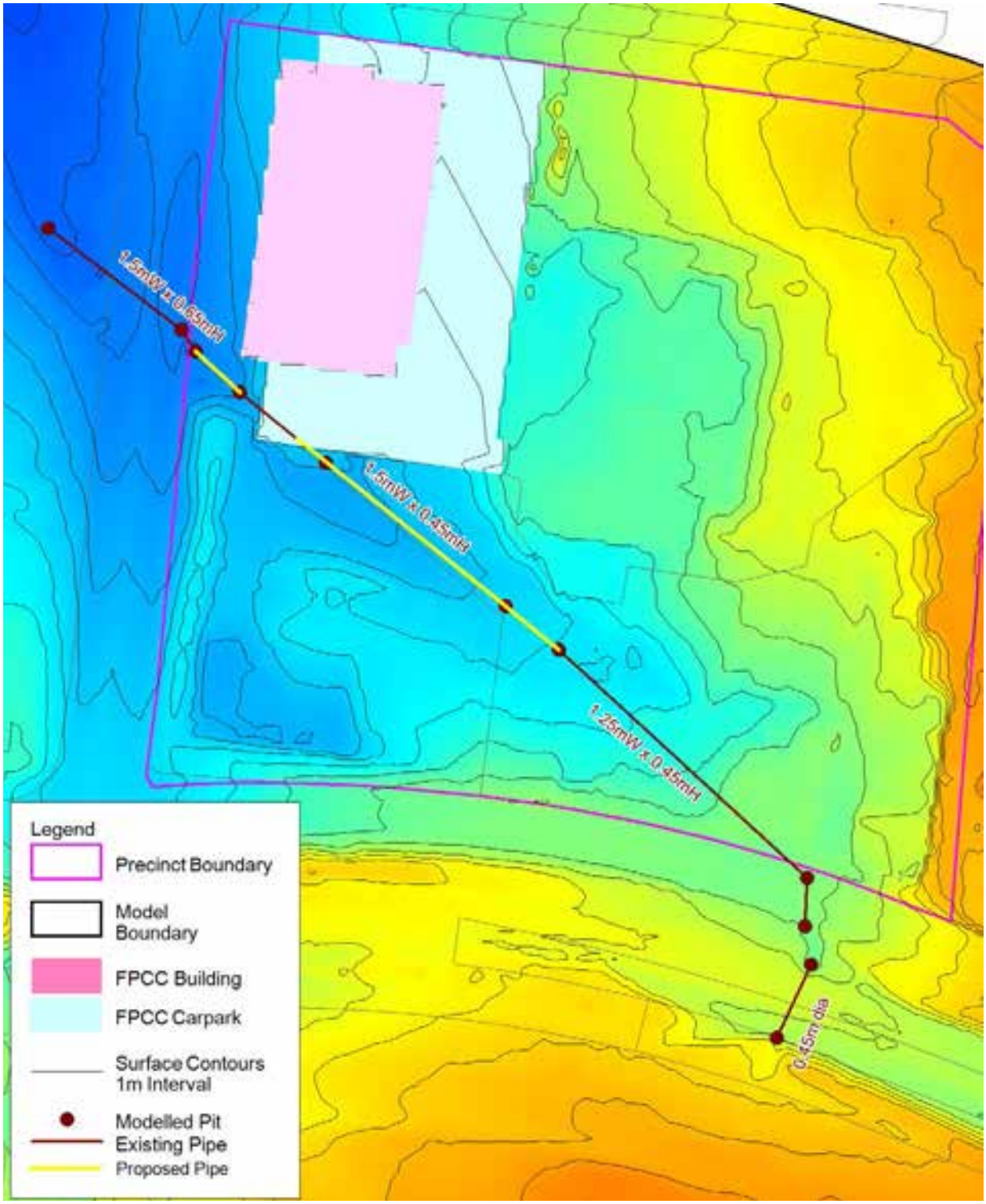

Figure 3-3 Post-development Stage 1 FPCC Site – Model Set-up

3.4 Post-development Model - Stage 3 Forensic Precinct

The Stage 3 post-development scenario, which involves the development of the remainder of the precinct is the same as the Stage 1 post-development model (**Section 3.3**4.2) with the development of the remainder of the precinct accounted for in updated hydrology modelling.

3.4.1 Hydrology Model

Hydrology for the Stage 1 component of the precinct, the FPCC site has remained as modelled in the Stage 1 model (**Section 3.3.1**). The hydrology of the remainder of the Forensic Services Precinct has also been modelled within XP-RAFTS to account for the addition of developed area to the existing site.

As the design of the remainder of the Forensic Services Precinct has not progressed beyond the master planning phase assumptions have been made regarding the hydrology of the developed precinct:

> In accordance with Auburn Council recommendations a 75% impervious percentage has been applied for the entire post-development precinct area;

> Rainfall losses were applied within the XP-RAFTS hydrology model;

> The rainfall data adopted within the XP-RAFTS model is identical to that used in the existing model (**Section 3.1.3**);

Flow hydrographs for all design events were extracted from this XP-RAFTS model and inserted into the hydraulic model based on the following assumptions:

> The future stormwater network for the Forensic Services Precinct is proposed to be designed to a minimum to the 20yr ARI. Conservatively it has been assumed in the hydrology model that the capacity of the future road network will be the 5yr ARI event. Therefore the 5yr ARI component of flows was applied to the TUFLOW hydraulic model directly to the inlet pit within the 1D component of the model.

> All flows in excess of this 5yr ARI capacity for the design flood events was applied to the 2D terrain of the hydraulic model using the "rainfall on grid" method. The 20yr and 100yr ARI and PMF hydrographs from the XP-RAFTS modelled had the equivalent 5yr ARI flows removed with the resulting rainfall volumes summed and re-applied to the rainfall temporal patterns provided within AR&R 1987.

3.4.2 Hydraulic Model

The hydraulic model is the same as the Stage 1 post-development scenario model, with the existing channel replaced by a culvert network and the development of the FPCC site. See **Section 3.3.2** for further details.

As the design of the remainder of the Forensic Services Precinct has not progressed beyond the master planning phase it has not been possible to determine areas of changes terrain. Therefore it has been assumed that the terrain in the precinct is the same as existing.

In terms of hydraulic roughness, the likely land uses across the precinct have been considered and a composite mannings "n" roughness value of 0.026 has been modelled throughout the precinct. This roughness value is considered slightly conservative as it represents a high proportion of concrete surface equivalent to the 75% assumed imperviousness in the hydrology.

4 Hydraulic Model Results

Flood model result mapping has been included in **Appendix A**.

4.1 Existing Scenario

4.1.1 Peak Depths and Velocities

20yr ARI, 100yr ARI and PMF peak depth profiles under existing conditions are included in **Figure A1, Figure A2** and **Figure A3** respectively.

20yr ARI, 100yr ARI and PMF peak velocity profiles under existing conditions are included in **Figure A4, Figure A5** and **Figure A6** respectively.

The depth results show that the existing concrete lined channel for the majority of its length contains the 20yr ARI and 100yr ARI flood with limited overtopping. Flood depths in the 100yr ARI in the channel exceed 1 metre with peak velocities in the channel in the 100yr ARI event up to 1.5 m/s.

The only location where the capacity of the channel is exceeded in the 100yr ARI is immediately upstream of the local road near the western edge of the precinct upstream of the Joseph Street culvert. Upstream of this culvert there is a minor extent of ponding in the low lying open space area adjacent to the concrete channel with ponding depths less than 0.5 metres and 1.0 metres in the 20yr ARI and 100yr ARI respectively.

The PMF event is also contained within the concrete lined channel on the upstream side however as the flow approaches the downstream culverts significant ponding occurs with depths of nearly 2 metres adjacent to the channel in the PMF event.

This concrete channel and associated culverts upstream and downstream are the major form of overland flow within the site, however there are other minor forms of flooding on the site:

> In the south-west corner of the precinct there is minor ponding (depths of 0.7 metres in the 100yr ARI event) which is more or less stagnant (velocities less than 0.3 m/s for all design events). This ponding is sourced by the local catchment in the south-west corner of the precinct and is unable to discharge from the site due to the existing levee that surrounds the south-west corner of the site.

> Throughout the remainder of the precinct there are small areas of ponding (depths less than 0.5 metres in the 100yr ARI event), with velocities less than 0.3m/s. In all instances this ponding is assumed to be generated by the local catchment within the precinct.

In these instances the ponding would not be classed as either mainstream or overland flow flooding and it is assumed it can be suitably addressed through stormwater drainage within the precinct and as a result is not discussed further within this flood impact assessment.

4.1.2 Provisional Hazard

It is possible to assess the hydraulic hazard for the area using the provisional hazard categories nominated within Figure L2 of the *Floodplain Development Manual* (NSW Government, 2005) included as **Figure 4-1**.

If the product of depth and velocity exceeds a critical value, the flood flow will create a high hazard to life, meaning there will likely be danger to persons caught in the floodwaters. By contrast, in low hazard areas people and their possessions can generally be evacuated safely by vehicles. Between the two categories there is a transition zone, which for the purposes of this study to ensure a conservative approach, has been defined as high hazard.

20yr ARI, 100yr ARI and PMF hydraulic hazard profiles under existing conditions are included in **Figure A7, Figure A8** and **Figure A9** respectively.

The existing scenario hazard maps show that the high hazard extents are contained within the concrete channel for both the 20yr and 100yr ARI events. The PMF high hazard area is more extensive, covering a significant portion of the low-lying open space area adjoining the channel.

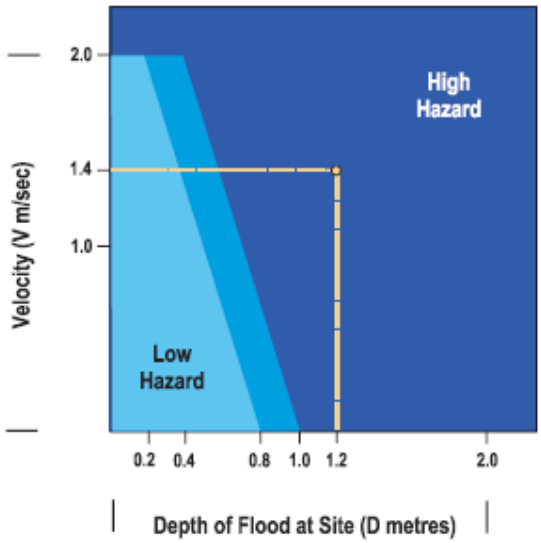

Figure 4-1 Provisional Hazard Categories (Figure L2 of the Floodplain Development Manual)

4.1.3 Peak Flows

An assessment of 1D results has shown that the peak capacity of the outlet from the precinct, the 1.5m W x 0.65m H box culvert under Joseph Street, has an approximate capacity of 0.8 m^3/s and 2.2 m^3/s for the 50% blockage and 0% blockage scenarios respectively.

The calculated flow discharging from the precinct in the existing scenario was calculated to be approximately 1.8 m^3/s for the 20yr ARI event. Therefore it is concluded that the Joseph Street culvert has a capacity of less than 20yr ARI event when design blockage of 50% is assumed as in modelling for this assessment.

4.2 Post-development Scenario – Stage 1 FPCC Site

4.2.1 Peak Depths

20yr ARI, 100yr ARI and PMF peak depth profiles under Stage 1 post-development conditions are included in **Figure A10, Figure A11** and **Figure A12** respectively.

The peak depth results for the Stage 1 post-development scenario have been included to show the extent of flooding within this future scenario. The results show that the replacement of the concrete lined channel with a culvert network is an effective way to reduce the extent of flooding for the post-development precinct.

However the raising of the FPCC carpark restricts the overland flow that can discharge from the site to the west that leads to an area of flood detention to the south of the FPCC carpark. Peak depths for this detention area are up to 0.9 metres and 1.0 metres for the 20yr and 100yr ARI respectively.

As expected the capacity of the network is exceeded significantly in the PMF event leading to flooding depths of up to 1.8 metres in this low lying area to the south of the FPCC carpark.

4.2.2 Provisional Hazard

20yr ARI, 100yr ARI and PMF hydraulic hazard profiles under Stage 1 post-development conditions are included in **Figure A13, Figure A14** and **Figure A15** respectively.

The results show that in the Stage 1 post-development scenario the replacement of the concrete lined channel with the culvert removes high hazard overland flow from the low lying area for the 20yr ARI and 100yr ARI. The only area of significant high hazard affectation for these events is a portion of the detention flooding area south of the FPCC carapark.

4.2.3 Water Level Differences

20yr ARI, and 100yr ARI water level difference profiles for the Stage 1 post-development scenario compared to existing conditions are included in **Figure A16** and **Figure A17** respectively.

Results show that for the 20yr ARI event all water level impacts (greater than 0.02 metres) caused by the Stage 1 development of the FPCC site is almost entirely contained with the Forensic Services Precinct with a negligible area of minor increases within the Joseph Street road reserve. For the 100yr ARI there are minor locations of water level increases (peak of 0.05 metres) within the Joseph Street road reserve.

For both design events there are minor impacts modelled at the downstream model boundary in the Carnarvon Golf Course (minor decreases in the 20yr ARI and increases in the 100yr ARI). As these impacts are disconnected from the development impacts further upstream and they are located on the model boundary it is assumed that they are caused by minor model matters and are not representative of real flood impacts resulting from the Stage 1 development.

There are more significant water level increases within the precinct south of the FPCC carpark with increases of up to 0.7 – 0.8 metres for both the 20yr and 100yr ARI events. These water level increases reflect the terrain changes within the site resulting from the filling of the existing open channel and as they are contained within the site are assumed to be acceptable.

4.3 Post-development Scenario – Stage 3 Forensic Services Precinct

4.3.1 Peak Depths

20yr ARI, 100yr ARI and PMF peak depth profiles under existing conditions are included in **Figure A18, Figure A19** and **Figure A20** respectively.

The peak depth results for the Stage 3 post-development scenario have been included to show the extent of flooding within this future scenario. The results show that:

> Due to the assumption in the Stage 3 modelling that the 5yr ARI for the entire precinct will be conveyed by future stormwater drainage the areas of minor ponding through the site have been reduced from the existing scenario in both the 20yr and 100yr ARI events.

> The depth of ponding in the area of detention to the south of the FPCC Carpark is comparable to the Stage 1 development scenario. Peak depths at this location are approximately 0.9 metres, 1.0 metres, and 1.8 metres for the 20yr ARI, 100yr ARI and PMF events respectively, the same as Stage 1. Therefore the proposed development of the remainder of the precinct does not significantly affect the detention volumes required for the site.

4.3.2 Provisional Hazard

20yr ARI, 100yr ARI and PMF hydraulic hazard profiles under Stage 3 post-development conditions are included in **Figure A21, Figure A22** and **Figure A23** respectively.

Similar to Stage 1 results the extent of high hazard in the 20yr ARI and 100yr ARI events is restricted to a portion of the flood detention area to the south of the FPCC Carpark.

4.3.3 Water Level Differences

20yr ARI, and 100yr ARI water level difference profiles for the Stage 3 post-development scenario compared to existing conditions are included in **Figure A24** and **Figure A25** respectively.

Water level difference results for Stage 3 modelling show there is a minor area of water level increase resulting from the development within a portion of the Joseph Street road reserve immediately downstream of the precinct. The water level increases within the road reserve are 0.05 metre and 0.08 metres for the 20yr and 100yr ARI respectively. There is a more widespread area of minor increases (0.03 metres) for the 100yr ARI within the Carnarvon Golf Course.

These flood impacts are considered insignificant as the increases are relatively minor and as the impacts are contained localized areas within either public road reserve or the golf course downstream and do not affect any neighbouring development.

As noted in **Section 4.3.1**, the assumption within the modelling relating to the 5yr ARI capacity of the stormwater drainage network leads to reductions in minor surface flooding throughout the precinct and minor increases in stormwater surcharge from the proposed culvert system at the precinct low point.

5 Discussion

The following section summarises the suitability of the proposed development based on Council's flood-related development controls as provided within the *Auburn DCP 2010*. Relevant flooding requirements have been assessed for the Haslams Creek catchment as per Table 5 and Table 6 of the DCP.

5.1 Floor Level Requirements

The FPCC site has been defined as commercial / industrial development in accordance with Table 6 as the development does not fall under the categories of either essential community facilities or critical utilities. Therefore the floor level requirements for this type of development are equal to or greater than the 100yr ARI plus a freeboard. In this instance as the site lies outside of the Haslams Creek FRMP study area a 500mm freeboard has been assumed.

The post-development scenarios for Stage 1 and Stage 3 development have almost identical flood levels for the 100yr ARI event in the vicinity of the FPCC site. The peak water level results for the detention area to the south of the FPCC site for the Stage 1 scenario are shown in **Figure 5-1**.

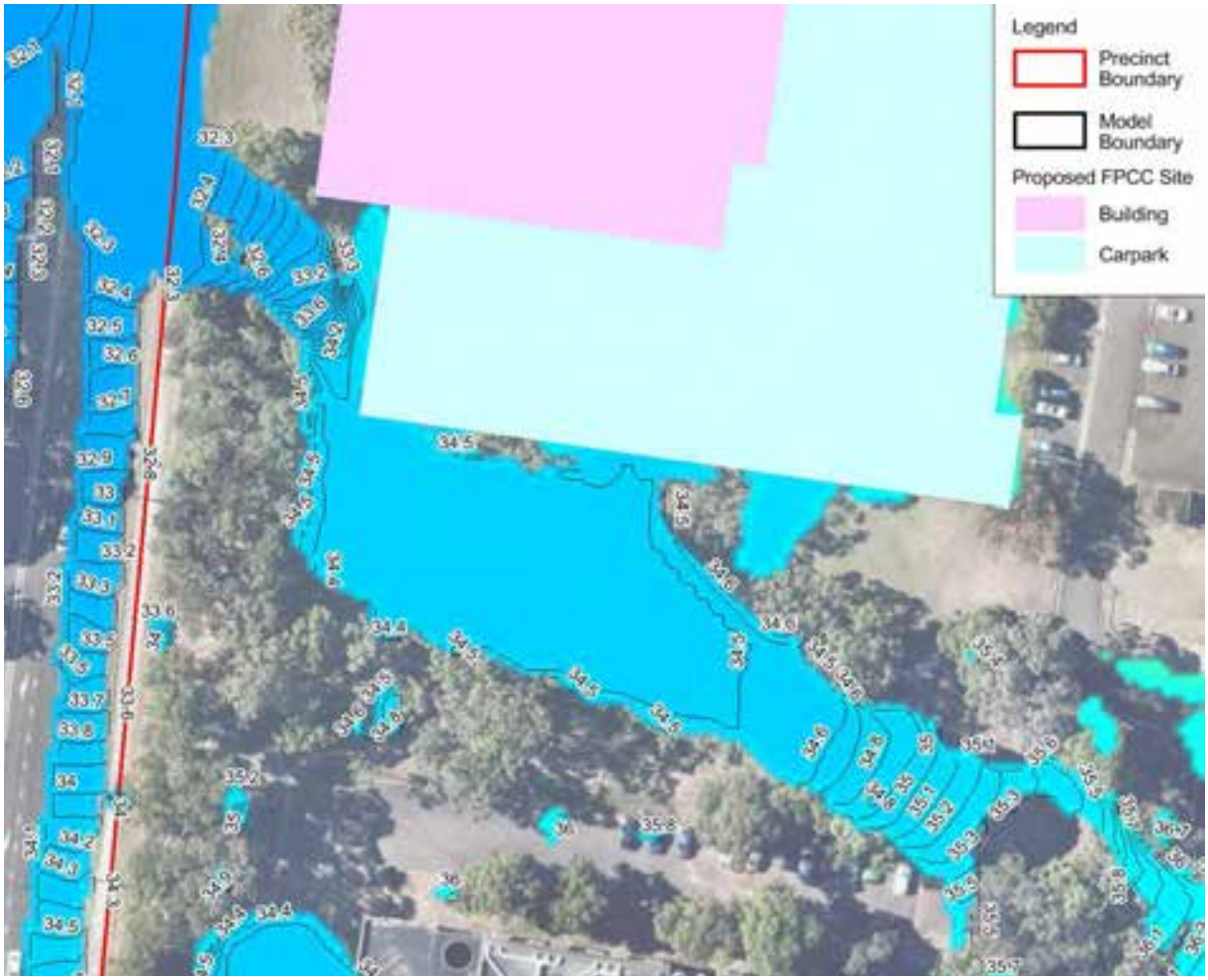

Figure 5-1 100yr ARI Peak Water Levels for Stage 1 Scenario – FPCC Site

The peak 100yr ARI water level in the area is approximately 34.5m AHD to the south of the carpark area. With a 500mm freeboard the minimum floor level requirement for the FPCC building is approximately 35.0m AHD. As shown in preliminary civil design drawings for the site (refer to **Section 2.2**) the proposed floor level is 35.85m AHD therefore Councils floor level requirements for the FPCC site are satisfied.

This floor level also achieves important management and design requirements relating to storing any materials that may cause pollution or be potentially hazardous are stored above the 100yr ARI plus 500mm freeboard.

Note that floor levels for the remainder of the site have not been assigned at this early stage of planning but flood model results from this study can be used in the future to ensure Councils minimum floor level requirements are achieved for the remainder of the precinct.

5.2 Roadways and Carparks

The *Auburn DCP 2010* also has requirements for carparks for commercial developments within the Haslams Creek floodplain that they be located above the 20 year ARI plus 500mm freeboard. The minimum finished level proposed for the FPCC carpark is 35.1m AHD. As discussed in **Section 5.1**, the 100yr ARI plus 500mm freeboard is equal to 35.0m AHD, meaning the carpark lies not only above the 20yr ARI but also the 100yr ARI plus 500mm freeboard. Therefore the current carpark design for the FPCC site satisfies Councils flooding requirements.

In addition there is a proposed roadway to the south-west of the FPCC site, with the location of the road shown in **Figure 5-2**. As can be seen in the figure the proposed roadway is affected by flood depths of less than 0.2 metres for a small stretch of road for the 100yr ARI event. This minor affectation is considered to be a result of minor surface run-off from the local catchment and considered insignificant. Therefore it is concluded that the proposed local road is flood free.

5.3 On Site Detention and Flood Storage

As discussed in **Section 3.4**, it has been assumed within the hydrology model for this study that On Site Detention (OSD) has not been applied to the post-development precinct, in either Stage 1 or Stage 3 of development. This means that in the hydraulic model the stormwater of the precinct discharges to the sites stormwater network undetained, with post-development flows from the precinct higher due to the 75% imperviousness assumed for the precinct.

However the model results summarised in **Section 4.2.3** and **Section 4.3.3** show that the increased run-off from the post-development site does not result in significant flood impacts downstream. The reason that there are negligible water level increases downstream of the precinct is due to the existing culvert under Joseph Street acting as a significant constriction of flow.

As discussed in **Section 4.1.3**, the capacity of the Joseph Street culvert was calculated to be equivalent to less than a 20yr ARI event for the external catchment upstream. The limited capacity of this culvert downstream of the precinct results in flood storage occurring upstream of Joseph Street in all scenarios:

> In the existing scenario the ponding occurs upstream of the internal road within the precinct as summarised in the depth results discussion in **Section 4.1.1**.

> In the Stage 1 and Stage 3 post-development scenarios the flood storage is restricted to an area just south of the FPCC carpark as discussed in **Section 4.2.3** and **Section 4.3.3**.

The overland flow conveyed in the concrete-lined open channel in the existing scenario is proposed to be conveyed through the site through a culvert in the post-development reducing the flood affectation for the site. However the model results show that additional flood storage needs to be provided due to the limited capacity of the Joseph Street culvert.

Based on model results the required volume of flood storage required for the 1% AEP design event with 50% blockage would be approximately 3,500 m^3. Sensitivity analysis modelling of the 0% blockage scenario shows that if this design event was adopted then a reduced volume of 2,700 m^3.

In order for the Stage 3 precinct to be flood free in the 1% AEP event for development areas it is recommended that a regional detention basin be allowed for to the south of the FPCC carpark with design storage volumes similar to the above. The recommended location of the future regional basin is shown in **Figure 5-2**. The design of this regional basin is proposed to be addressed in future stages of the development process.

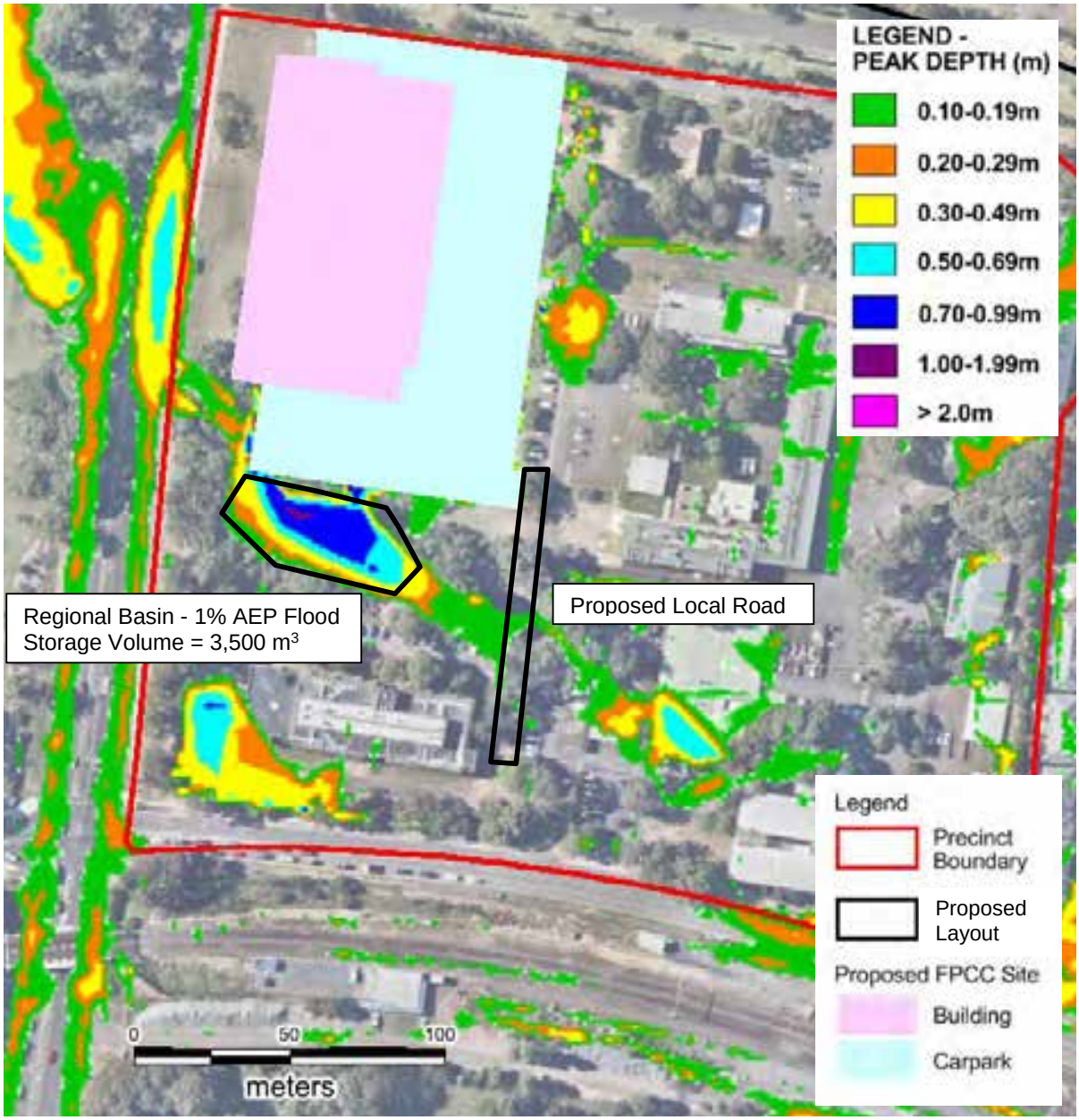

Figure 5-2 Indicative Location of Regional Basin and Proposed Road for Stage 1 100yr ARI Peak Depths

6 Conclusions

This flood impact assessment has been prepared by Cardno on behalf of NSW Health Infrastructure to assess the potential flood impacts associated with the development of the proposed Forensic Services Precinct in Lidcombe. The outcomes of the assessment are summarised below.

Existing Precinct

> The existing precinct has a concrete lined channel that has capacity close to the 100yr ARI event. The flood affectation of the precinct would not be described as mainstream flooding but rather overland flow in the channel, with minor stormwater affectation throughout the remainder of the site which can be suitably addressed through stormwater drainage in the future.

> The existing channel discharges overland flow from the site via a 1.5m W x 0.65m H box culvert under Joseph Street to the west, which has been calculated to have a capacity equivalent to less than the 20yr ARI under a 50% blockage scenario.

Stage 1 Development – FPCC Site

> The proposed Stage 1 development of the precinct involves the development of the FPCC site on the north-west side of the precinct and the replacement of the concrete lined channel with a 1.5m W x 0.45m H box culvert. This proposed design effectively removes the overland flow affectation of the low lying portions of the site with a minor volume of flood storage to the south of the elevated FPCC carpark.

> The provisional hazard for the majority of the precinct is low for the Stage 1 development meaning that the risk to life is acceptable.

> There are minor off-site flood impacts which are localized within the Joseph Street road reserve directly downstream of the site for the 20yr or 100yr ARI event. The flood impacts caused by the proposed development of the FPCC site in Stage 1 are considered negligible.

> There are no increases in flow off-site despite the fact that no allowance for OSD has been made within the modelling, and runoff from the roof and carpark are modelled as discharging directly to the drainage network. Therefore it is suggested that OSD requirements are not necessary for the FPCC site.

> The proposed floor level of 35.85m AHD is above the modelled 100yr plus 500mm freeboard therefore the preliminary FPCC design satisfies Councils floor level requirements.

> The proposed FPCC carpark is elevated above the 100yr plus 500mm freeboard therefore the design meets Councils flooding requirements. The proposed local road to the south-east of the site is flood free in the 100yr ARI event.

Stage 3 Development – Entire Forensic Services Precinct

> The proposed Stage 3 scenario involves the development of the remainder of the precinct which has been assessed assuming a 75% imperviousness throughout the precinct and a stormwater drainage network to be implemented in future with a capacity equivalent to the 5yr ARI.

> The proposed Stage 3 development causes negligible flood impacts off-site, with minor increases locally for Joseph Street for the 20yr ARI and Carnarvon Golf Course for the 100yr ARI. This is despite the fact that no allowance for OSD has been made for within the modelling, runoff from 75% imperviousness for the entire precinct modelled. Therefore it is suggested that OSD requirements are not necessary for the Forensic Precinct site.

> Due to the limited capacity of the Joseph Street culvert downstream there is a requirement for an allowance of minor flood storage in the 1% AEP event. To allow for this necessary flood storage it is recommended that in future stages of the development of the precinct an allowance be made for a regional detention basin south of the FPCC carpark with an approximate volume of 3,500 m^3.

Therefore it is concluded that both the Stage 1 and Stage 3 developments for the Forensic Services Precinct produce negligible flood impacts off-site and therefore the development it is assumed the development will satisfy Councils requirements.

APPENDIX A
FIGURES

Cardno Job 80816199
April 2016

Existing Conditions

Figure A1 - 20yr ARI Flood Depth Profiles

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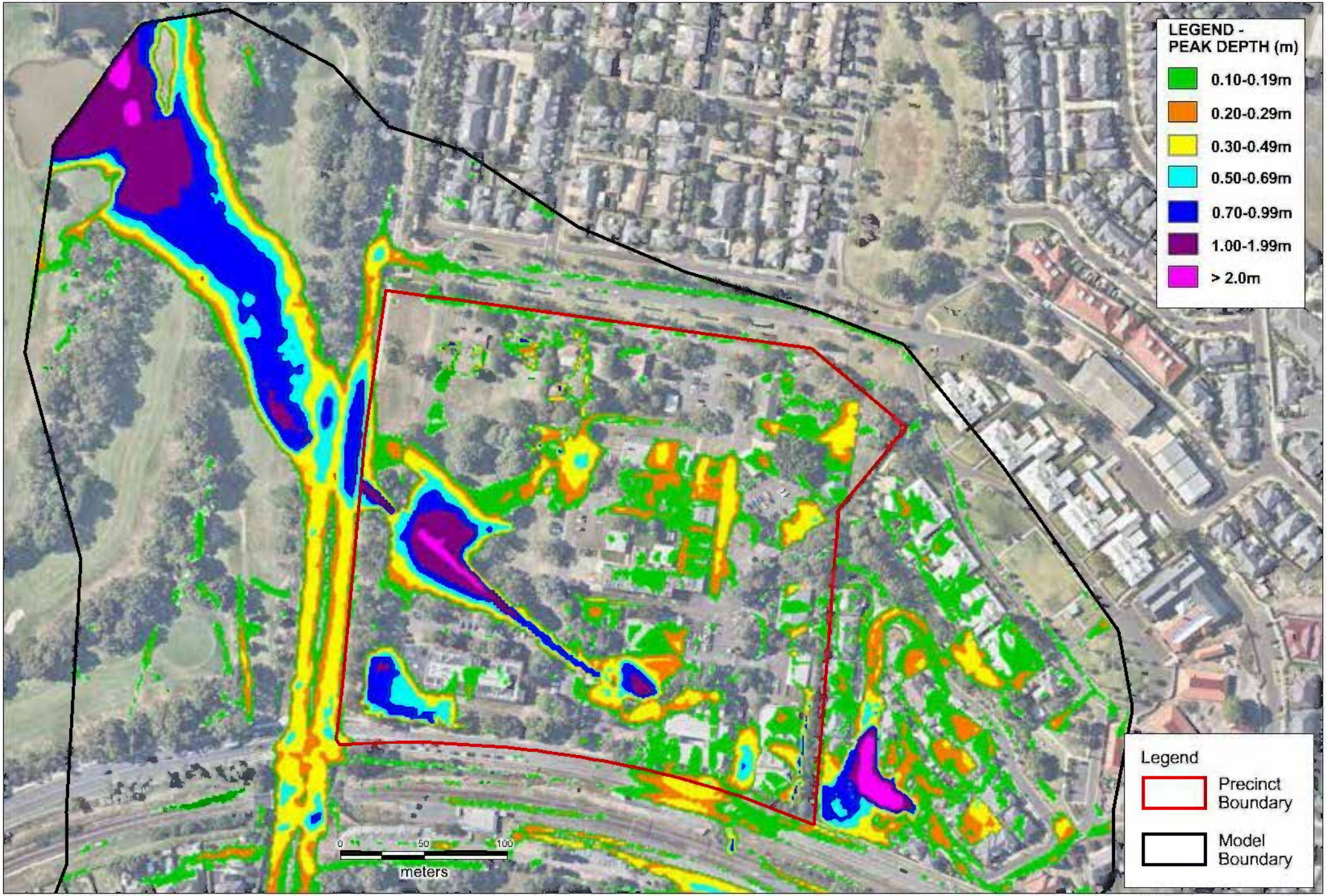
Existing Conditions

Figure A2 - 100yr ARI Flood Depth Profiles



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April 2016

Existing Conditions

Figure A3 - PMF Depth Profiles

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April 2016

Existing Conditions

Figure A4 - 20yr ARI Flood Velocity Profiles

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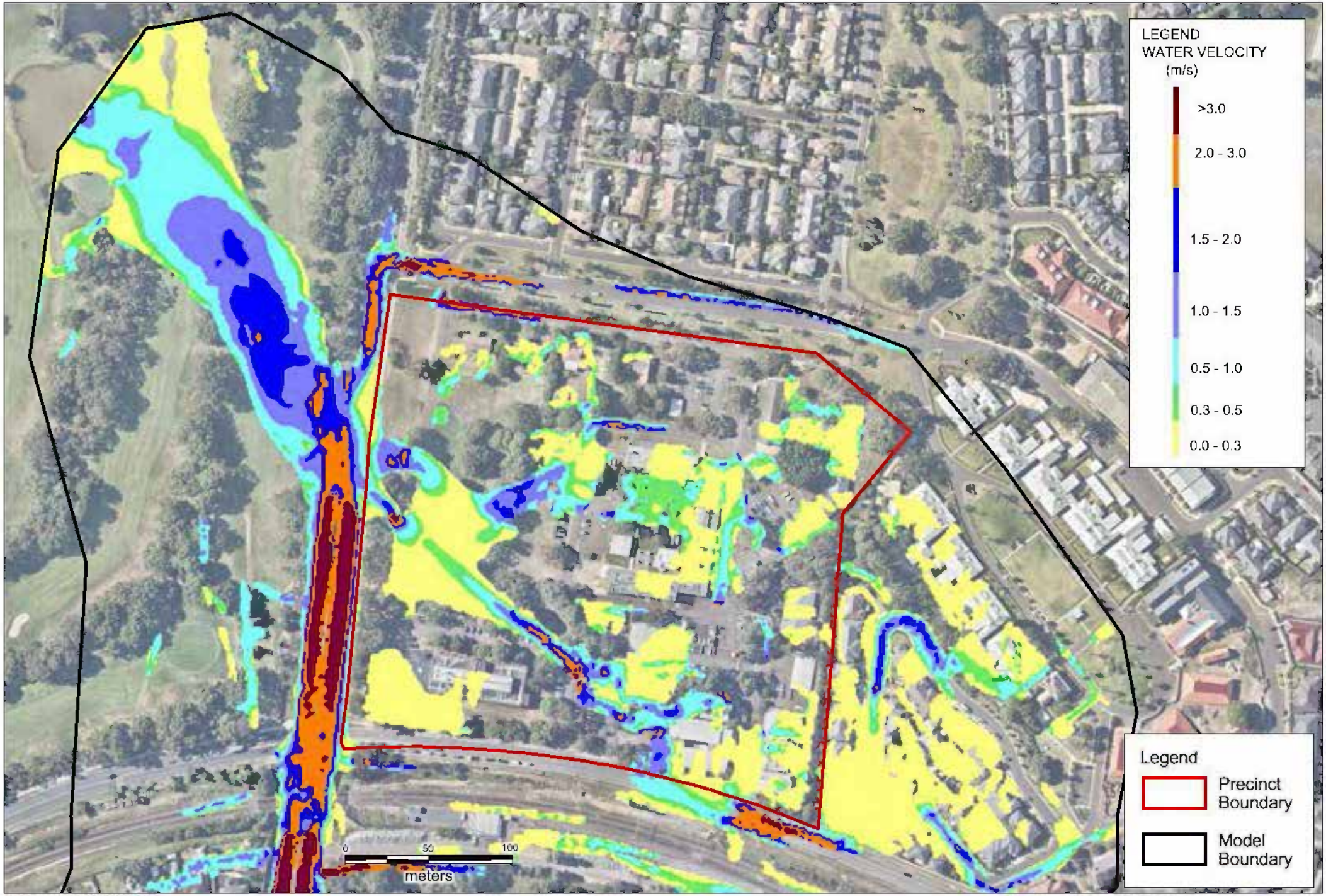
April 2016

Existing Conditions

Figure A5 - 100yr ARI Flood Velocity Profiles



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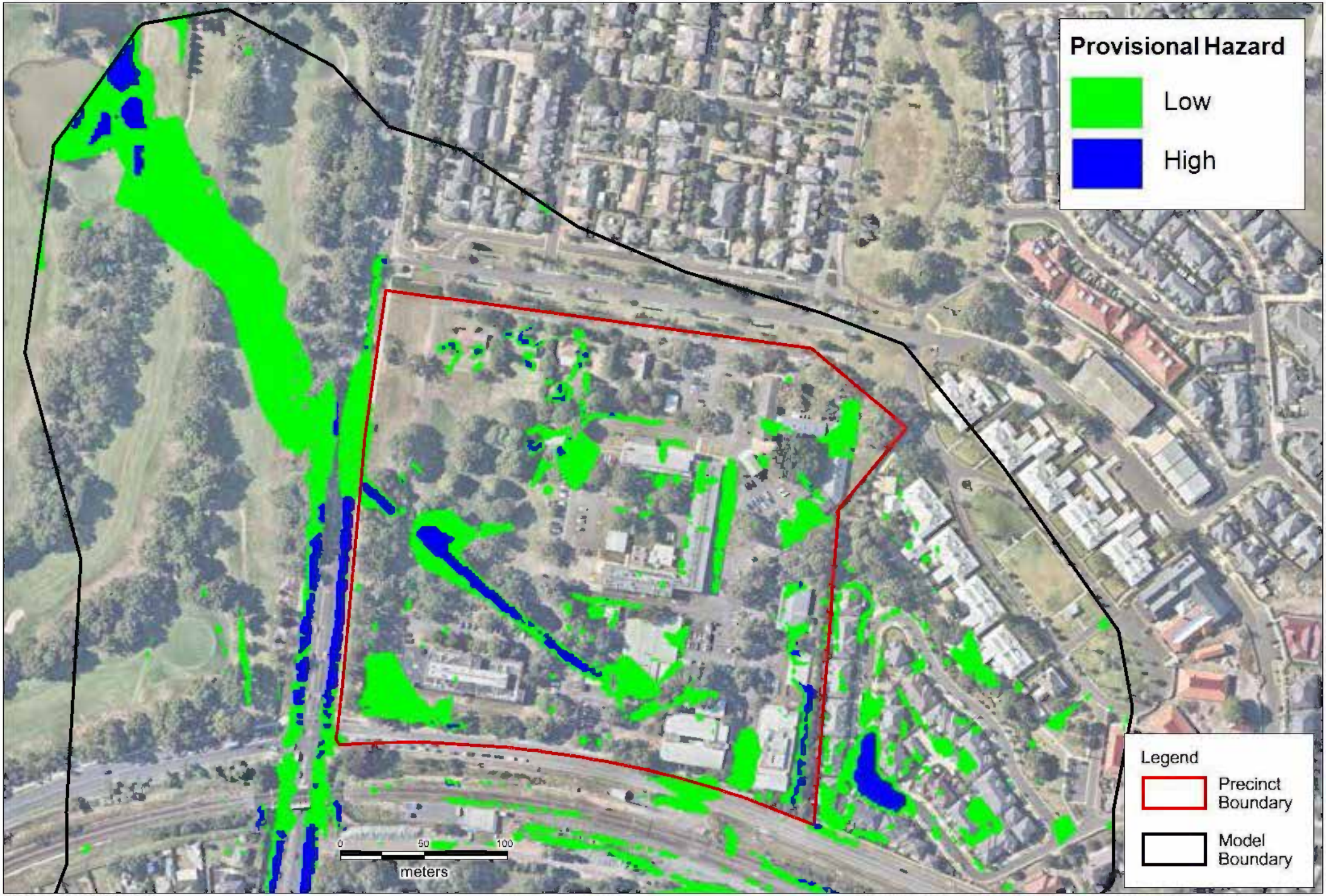
April 2016

Existing Conditions

Figure A6 - PMF Velocity Profiles



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April 2016

Existing Conditions

Figure A7 - 20yr ARI Provisional Hazard Profiles

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Existing Conditions

Figure A8 - 100yr ARI Provisional Hazard Profiles

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Existing Conditions

Figure A9 - PMF Provisional Hazard Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A10 - 20yr ARI Flood Depth Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A11 - 100yr ARI Flood Depth Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A12 - PMF Depth Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A13 - 20yr ARI Provisional Hazard Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A14 - 100yr ARI Provisional Hazard Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A15 - PMF Provisional Hazard Profiles

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Post-development Conditions - Stage 1 FPCC Site

Figure A16 - 20yr ARI Water Level Differences Less Exist

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Post-development Conditions - Stage 1 FPCC Site

Figure A17 - 100yr ARI Water Level Differences Less Exist

Cardno Job 80816199
April 2016

Post-development Conditions - Stage 3 Precinct

Figure A18 - 20yr ARI Flood Depth Profiles

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Post-development Conditions - Stage 3 Precinct

Figure A19 - 100yr ARI Flood Depth Profiles

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April 2016

Post-development Conditions - Stage 3 Precinct

Figure A20 - PMF Depth Profiles

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Post-development Conditions - Stage 3 Precinct

Figure A21 - 20yr ARI Provisional Hazard Profiles

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Post-development Conditions - Stage 3 Precinct

Figure A22 - 100yr ARI Provisional Hazard Profiles

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Post-development Conditions - Stage 3 Precinct

Figure A23 - PMF Provisional Hazard Profiles

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Post-development Conditions - Stage 3 Precinct

Figure A24 - 20yr ARI Water Level Differences Less Exist

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Post-development Conditions - Stage 3 Precinct

Figure A25 - 100yr ARI Water Level Differences Less Exist