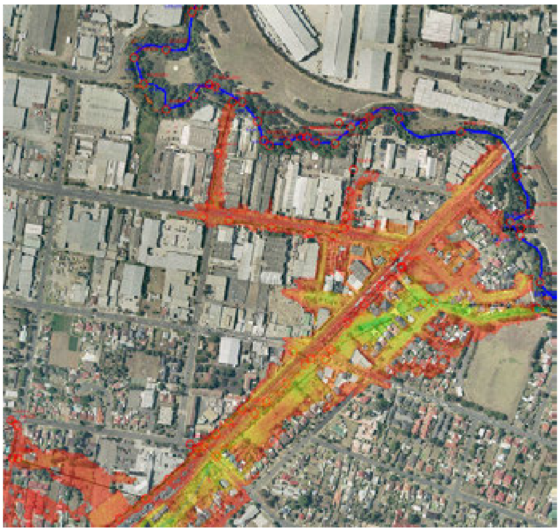
Smithfield Overland Flood Study



FINAL REPORT

- May 2011

In association with

FAIRFIELD CONSULTING SERVICES
A Division of Fairfield City Council

Smithfield Overland Flood Study

FINAL REPORT

- May 2011

Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

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Executive Summary

The local government area of Fairfield City is crossed by several major creeks, all of which are prone to mainstream flooding. In addition, parts of Fairfield City are at risk of overland flooding from stormwater that runs off from urbanised catchments to the creeks. Both types of flooding present a significant risk to life and property.

In order to address and mitigate this flood risk, Fairfield City Council is following the NSW Government's *Flood Prone Land Policy* and it's accompanying *Floodplain Development Manual (2005)*. The Manual outlines a floodplain risk management process, leading to the preparation and implementation of a floodplain risk management plan. Plans are to be prepared for both mainstream and local overland flooding.

A preliminary assessment of the risk of flooding from overland flows within the urban areas of Fairfield was undertaken in 2003-2004 as part of the *Fairfield City Overland Flood Study (SKM).* This study prioritised the 18 urban sub-catchments for more detailed investigation. The Smithfield sub-catchment, centred on Fairfield East, was ranked as the third highest priority.

In 2007, Sinclair Knight Merz (SKM), in association with Fairfield Consulting Services (FCS), was engaged by Council to undertake a detailed flood study of the Smithfield sub-catchment. The key objectives of the study were to describe the nature and extent of overland flooding within the sub-catchment and to prepare flood risk precinct maps for several events including the Probable Maximum Flood (PMF). This study would then provide the basis for preparing a floodplain risk management study and plan that would identify and recommend a range of measures to reduce the risk of overland flooding.

The methodology for undertaking the study was drawn from the *Canley Corridor Overland Flood Study (SKM)*, completed in 2009. Modelling of the major trunk drainage network, as well as selected flooding 'trouble spots', was found to be the most efficient method for producing reliable results.

The 292 ha Smithfield overland flow catchment is located in the north-eastern portion of the Fairfield LGA, to the south-west of Prospect Creek, and encompasses parts of the suburbs of Smithfield, Fairfield Heights and Fairfield West. The catchment is roughly bisected lengthways by the Cumberland Highway. The catchment is highly urbanised and comprises residential, industrial and commercial development.

The catchment generally drains in a north-easterly direction via a network of stormwater pipes and flow paths, with the main trunk sections of the network running alongside the Cumberland

Highway, before diverging from the Highway before the final 200m of pipe discharges into Prospect Creek, approximately 300m downstream of the Cumberland Highway bridge.

Because of urban and industrial development in the catchment, parts of the stormwater network were not designed to cater for the progressive increase in impervious area. Flooding problems along the main overland flow paths within the catchment are exacerbated by stormwater pipes built under private property and by development extending to the top of bank of open channels.

The adopted modelling approach used XP-STORM to simulate the urban sub-catchment hydrology, as well as the hydraulics of the stormwater pit and pipe network. Further, the approach using XP-STORM allowed modelling of the stormwater drainage system in conjunction with the overland flow in the two dimensional floodplain, with a dynamic link between the two components. The dynamic link between the one dimensional pipe network and two dimensional floodplain, provides the best representation of flood behaviour.

A one dimensional hydrologic and hydraulic model was initially established using topographic survey, spatial data and rainfall data. Relatively standard values for network and hydrologic parameters were assigned. A total of 259 pits and 278 pipes were represented in the model.

The floodplain in the XP-STORM model was defined as a two dimensional domain based on a 2m topographic grid. Open channels were represented in the model but fencelines were excluded. Buildings were treated as solid objects within the floodplain in which floodwaters could not flow through. A downstream boundary condition was assigned based on the stage hydrographs developed in Prospect Creek Flood Study (Bewsher Consulting, 2006).

The XP-STORM model was constructed such that overland flows may enter the next downstream pit if there is sufficient inlet capacity. Flows in excess of the inlet capacity, or flows that surcharge from the pipe network, form overland flow which are routed through the two dimensional domain. Although the model could not be calibrated because of a lack of historical data, model results were compared and found to agree relatively well with the findings from previous drainage investigations and Council's database of known flooding trouble spots.

Sensitivity analyses revealed that the XP-STORM model was not sensitive to changes in Manning's n roughness values and only partially sensitive to increases in rainfall intensities. Increasing blockage factors of pits increased flood depths in some residential areas at the upstream ends of the drainage network.

The model was run for the 20, 100, 200, 500, 2000, 10,000 year average recurrence interval (ARI) events and the PMF, for a range of storm durations from 30 minutes to three hours. The peak water level and velocity for each storm duration, at each 2D grid point, were extracted and used to form a 'peak of peaks' grid that was subsequently used a basis for the flood mapping.

Flood model results and the flood mapping for the 100 year ARI event indicate that:

- There are a number of overland flowpaths which originate in the upper catchment and carry stormwater in a north to north-west direction towards the Cumberland Highway. Stormwater is carried along Maud Street in the south of the catchment, across Reserve Street onto Rosemount Avenue. In the east of the catchment, stormwater is carried along Oxford Street, across Brennan Street and breaks through properties on Oxford Street to join the flow path along the Cumberland Highway. In the west of the catchment, there is a flowpath along O'Connell Street which carries stormwater south towards Brenan Street to the Cumberland Highway.
- Overland flooding is generally deepest in open space areas adjacent to the Highway, where flood water is ponding, particularly between Brenan Street and the Boulevard. Depths in these are in the range of 0.6-1.0m. Flood depths in excess of 1m are located in the flowpath between Rosemount Avenue and the Cumberland Highway. Typical depths of flooding at properties in the upper parts of the catchment are less than 0.3m. In the middle part of the catchment a number of properties in the Rosemount Avenue, Alexander Street and Brenan Street area are affected by overland flood depths between 0.5m and 0.8m. In the lower catchment, north of Horsley Drive, a small number or properties are affected by overland flood depths of up 1.2m.
- The depth of flooding in road corridors is typically less than 0.3m. Some roads experience flooding greater than 0.5m deep, and include Percy Street, Beemera Street, Ainslie Street, Musgrave Crescent, Reserve Street and Oxford Street. There are small sections of road on Rosemont Avenue and Alexander Street where overland flood depths are greater than 1m.
- Overland flow velocities within properties in the 100 year ARI event across the study area are typically less than 0.5m/s. There are some isolated areas (for example properties fronting the Cumberland Highway) where flow velocities are between 1-1.5m/s. Higher velocities, greater than 1.5m/s are observed on some streets, including the Cumberland Highway and Maud Street.

Flood risk precinct maps were prepared based on modelling of the 100 year ARI (medium risk) and PMF (low risk) events and using the flood risk precinct categories outlined in the Fairfield City-Wide Development Control Plan. The flood risk precinct mapping has identified:

- Approximately 1365 properties are within the floodplain outline defined by the PMF event.
- Areas of high flood risk occur in: the lower catchment south of Kiola Street; in the middle catchment at the Rosemont Avenue/Alexander Street intersection; and at the corner of Brenan Street and Cumberland Highway.
- The medium flood risk precinct follows the pattern of the trunk drainage system from the upper to lower catchment.

- The low flood risk precinct follows the outline of the medium flood risk precinct, widening at the junction of drainage lines. The low risk precinct widens from the medium flood risk precinct in the lower part of the catchment, downstream of Horsley Drive. A number of additional areas are included in the low risk flood precinct. These include the area between Tyrell Street and Rawson Road, the area to the west of the Cumberland Highway, adjacent to Brenan Street and O'Connell Street.

The flood risk precinct maps do not include mainstream flooding along Prospect Creek; this is included in the Prospect Creek Flood Study (Bewsher Consulting, 2006).

It is considered that the study has ultimately provided a good foundation from which to prepare the Smithfield Floodplain Risk Management Study and Plan as the next step in the floodplain risk management process.

1. Introduction

1.1. Background

The Local Government Area (LGA) of Fairfield City covers an area of around 102.5 km^2 and is located on a number of floodplains. These floodplains comprise the low-lying land next to the Georges River and the city's eight major creeks. These creeks span over 80km in length and flow into both the Georges River and Hawkesbury-Nepean catchments. Being within a floodplain means that many suburbs in the LGA are prone to flooding.

In addition to the City's creeks, there are a number of watercourses and tributaries throughout the LGA that have been piped over the years, especially in the period between post-World War II and the 1970s, as part of the increasing urbanisation. Most of these piped flow paths are in urban areas. This gives rise to the potential for damage to properties and hazard to residents due to flooding.

Flooding in Fairfield LGA can occur in two different ways. These are mainstream flooding and local overland flooding. Mainstream flooding is the inundation of normally dry land due to flood waters overflowing the natural or artificial banks of a stream, river, estuary, lake or dam. Conversely, local overland flooding is the inundation caused by local runoff during heavy storms, usually from stormwater pits and pipes which have exceeded their capacities, rather than overbank discharge. Overland flows eventually end up in the local creek system.

Both types of flooding can cause significant damage. For example, major mainstream flooding occurred along lower Prospect Creek and Cabramatta Creek in August 1986 and April-May 1988. The 1986 flood caused an estimated total damage of $4.8 million. A smaller flood in January 2001 caused damage to the upper reach of Prospect Creek.

In addition, there are different scales of local flooding. At the lower end of the scale, minor flooding may result from a number of sources including blockage of drainage pits and pipes. At the upper end of the scale, major flooding can occur due to water flowing along natural floodways or across land due to the runoff exceeding the capacity of the trunk drainage system.

To mitigate the risk of flooding the NSW Government has adopted the Flood Prone Land Policy, as outlined in the 2005 NSW Floodplain Development Manual (FDM). The FDM describes the process by which Councils can undertake flood studies and prepare floodplain risk management studies and plans.

In accordance with the floodplain risk management process, Council has prepared a number of flood studies for both mainstream and overland flooding, as well as floodplain risk management plans for the Georges River, Cabramatta Creek and Prospect Creek. Eventually, flood studies and floodplain risk management plans will be prepared for all the city's sub-catchments for both mainstream and overland flooding. The plans detail a range of flood modification, property modification and emergency response measures that can be used to reduce flood risk. This may include voluntary house raising, vegetation management of the creeks, the construction of detention basins and floodways and implementation of development controls. Development controls are outlined in Council's City Wide Development Control Plan (DCP).

In the past, FCC concentrated primarily on studying mainstream flooding from the City's creeks as this was considered to be the main source of flood risk in the LGA. However, flooding from major overland flow paths and the resulting flood risk was not well understood. FCC has therefore embarked upon a program of undertaking overland flood studies in order to identify these major overland flow paths and to address the requirements of the FDM.

Identifying properties at risk of overland flooding within the entire LGA is a major undertaking. Instead of undertaking detailed assessment for the entire LGA in one step, FCC decided to undertake overland flood studies in a number of stages. In 2003-2004, Sinclair Knight Merz (SKM) was engaged by FCC to undertake the *Fairfield City Overland Flood Study* (SKM, 2004). This was a preliminary assessment of the flood risk from overland flows within the urban areas of the Fairfield LGA. The study divided the LGA into 18 catchments and ranked each catchment in terms of the potential severity of overland flooding.

The *Fairfield City Overland Flood Study* identified the Smithfield catchment as the 3rd ranked out of the 18 sub-catchments in Fairfield LGA, in terms of the number of properties at high risk from flooding. The highest priority sub-catchment identified was Old Guildford; other priority catchments included Fairfield (2nd), and the Canley Heights (4th) catchments.

The *Canley Corridor Overland Flood Study* (SKM, 2009), which primarily covered the Canley Heights catchment, was undertaken as the first of a series of detailed overland flood studies by FCC, as there was a large amount of stormwater asset data readily available for use in the study, and because there was a significant amount of urban renewal occurring in the study area which warranted a detailed understanding of the nature of overland flooding in the catchment. The *Canley Corridor Overland Flood Study* was undertaken as a pilot study to evaluate a number of alternative flood modelling and mapping methodologies, based on different assumptions made about the capacity of the stormwater drainage system. The *Canley Corridor Overland Flood Study* defined the flood behaviour and identified the major overland flow paths within the Canley Corridor catchment, identified properties at risk of overland flooding for the preparation of flood risk precinct maps.

It was concluded from the *Canley Corridor Overland Flood Study* that the Smithfield, Old Guildford and Fairfield Overland Flood Studies should be undertaken using a similar methodology that was developed and selected as the preferred approach in the Canley Corridor study.

FCC subsequently commissioned SKM in 2007 to undertake an overland flood study for the Smithfield sub-catchment. This study was undertaken in association with Fairfield Consulting Services (FCS), a business unit division of FCC.

The Smithfield Overland Flood Study quantifies the scale of local overland flooding in the Smithfield catchment and will form the basis for preparing the floodplain risk management study and plan for the area.

1.2. Study Area

1.2.1. Description

The 292ha Smithfield catchment is located in the north east of Fairfield LGA, with Prospect Creek forming the catchment border to the north. The catchment is intersected by two major roads, Horsley Drive and Cumberland Highway, running east-west and north-south respectively. The study area locality is shown on **Figure 1-1**.

Figure 1-2 shows the study area in detail. The catchment is centred around Smithfield Road (which becomes the Cumberland Highway). The southern portion of the catchment is predominantly residential and includes the suburbs of Fairfield Heights and Fairfield West. The northern portion of the catchment is mixed and includes commercial and industrial uses. A number of small parks lie within the catchment, including Smithfield Park, Prospect View Park and playing fields adjacent to the Cumberland Highway and Bourke Road.

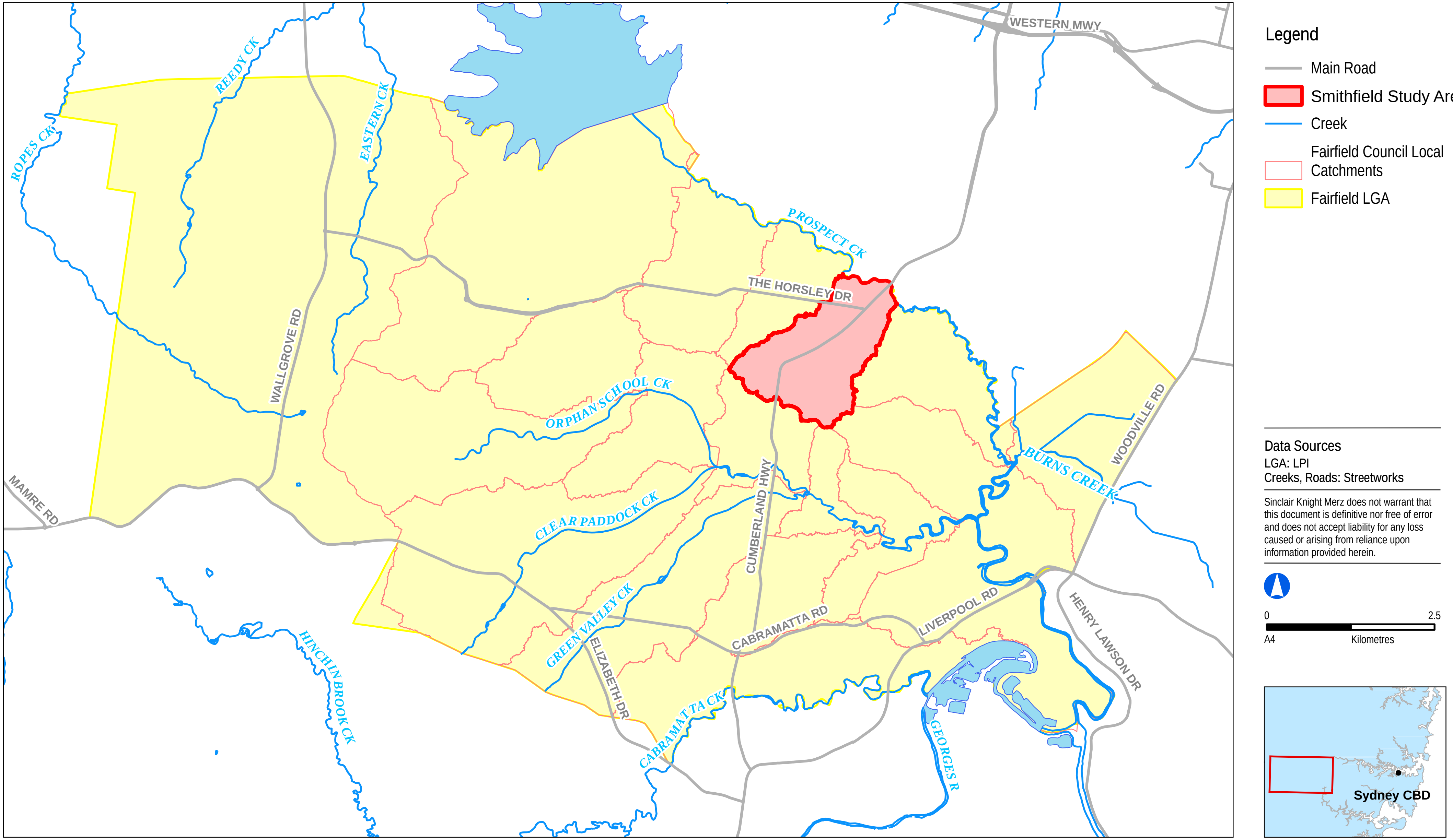

Figure 1-1 Locality

Smithfield Overland Flood Study

Version 1

GDA 1994 MGA Zone 56

April 7, 2010

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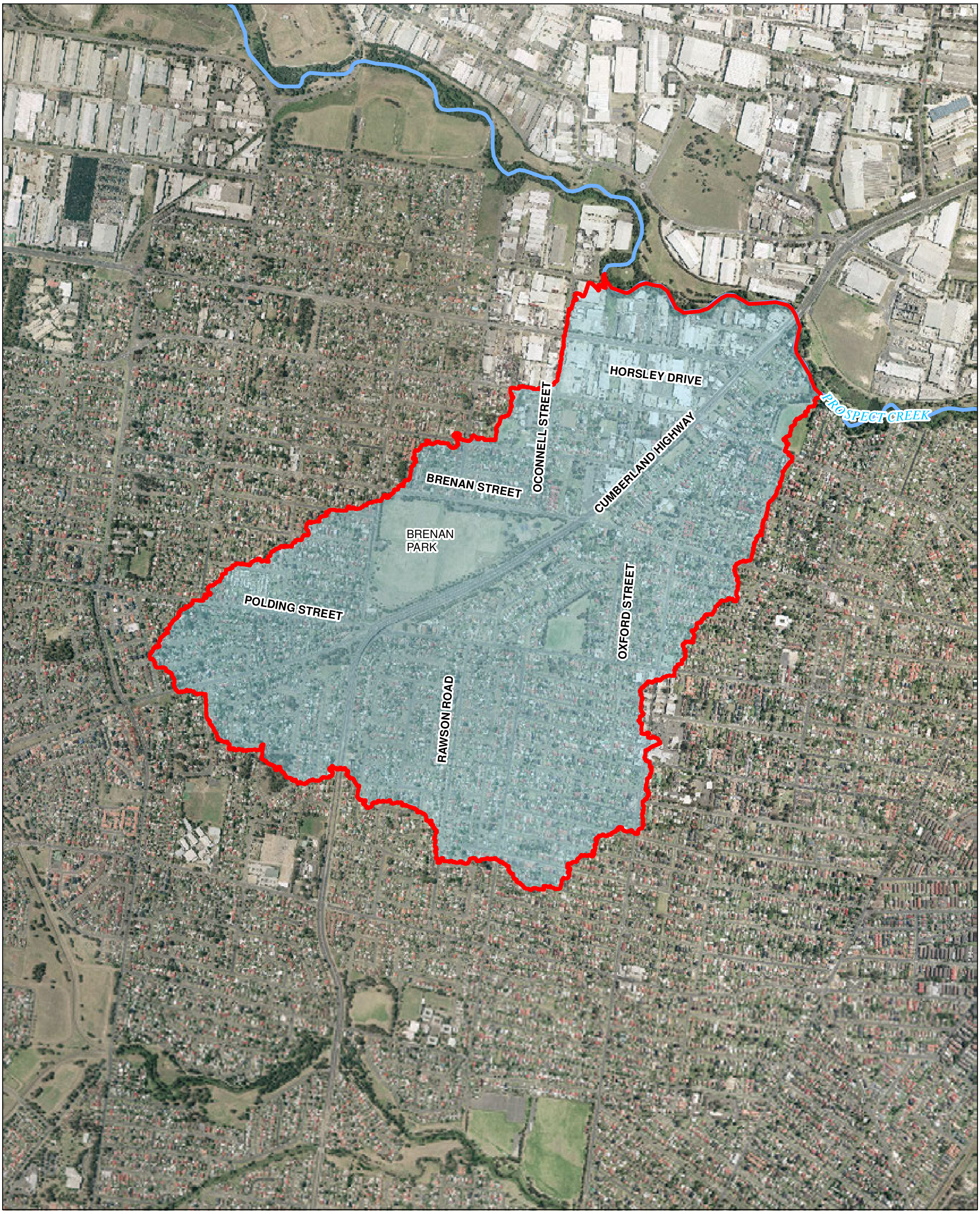


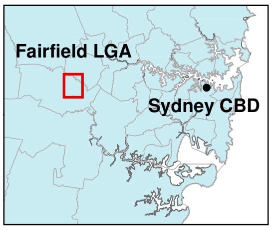
Legend

Smithfield Catchment

Creek

Data Sources
Aerial Photo: AUSIMAGE

0 0.5
A4 1:20,000 Kilometres



SKM FairfieldCity

Figure 1-2 Study Area

Smithfield Overland Flood Study Version 1

GDA 1994 MGA Zone 56

20 September, 2010
I:\ENVR\Projects\EN02294\Technical\GIS\Figures\Figure 2-1 Study Area.mxd

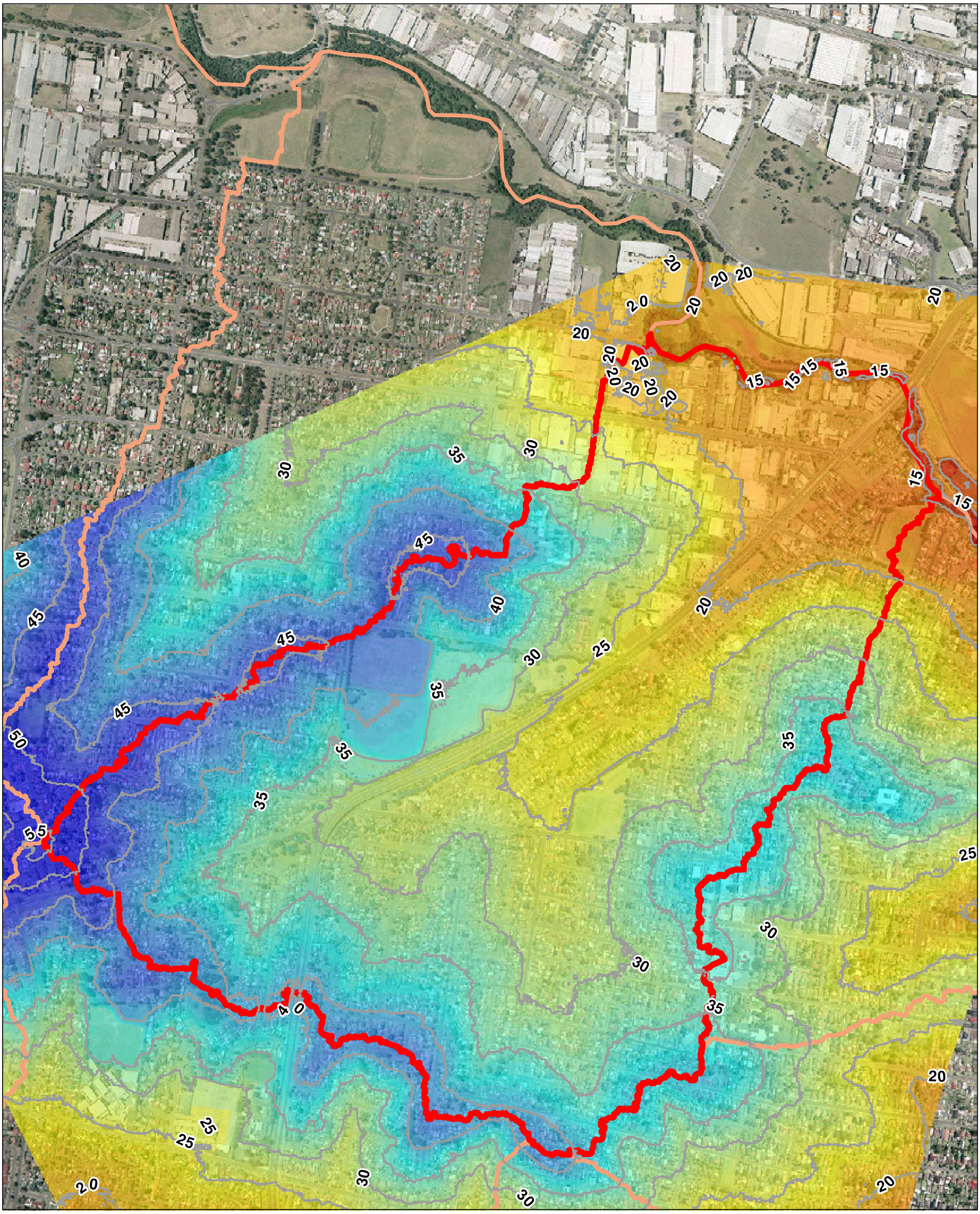
The topography of the study area is shown in **Figure 1-3**. Elevations in the study area range from 56 to 15m AHD. The highest elevations are located in the south west of the catchment in the vicinity of Garment and Brentwood Street.

The Smithfield catchment is situated on relatively flat terrain and drains towards Prospect Creek. Typical land slopes in the catchment area are 2%, both to the east and west of the Cumberland Highway.

The land use in the study area is primarily residential, mostly characterised by low density development. There are areas of commercial and industrial development in the northern portion of the catchment, north of Horsley Drive.

European settlement began in the area in the early 1800s. The area was characterised by wineries, market gardens, wood timber cutters, orchards and tanneries. Early settlers were particularly attracted to Smithfield by its good soil and dependable water supply. Smithfield was the first planned development in the Fairfield area. Although the original plan to establish Smithfield as Sydney's major market place did not reach fruition, Smithfield remained the main population centre until after the First World War (Western Sydney Libraries, 2010).

The stormwater drainage networks were, however, not designed to cater for the large increases in catchment imperviousness upstream as medium density and industrial development in the catchment expanded. Today, the existing drainage network in the Smithfield catchment is ageing and undersized in relation to current standards and, for this reason, overland flooding is a major problem within this catchment.



Legend

5m Contour
Smithfield Catchment
Fairfield City Council Catchments

DTM
Value
60m AHD
0m AHD

Data Sources
Aerial Photo: AUSIMAGE

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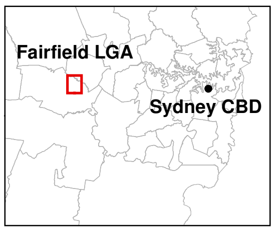
Kilometres
A4 1:15,000



SKM FairfieldCity

Figure 1-3 Study Area Topography

Smithfield Overland Flood Study Version 1

GDA 1994 MGA Zone 56

24 September, 2009
I:\ENVR\Projects\EN02294\Technical\GIS\Figures\Figure 1-3 Topography.mxd

1.2.2. Drainage Conditions

The drainage conditions in the study area are described below and shown in **Figure 1-4.**

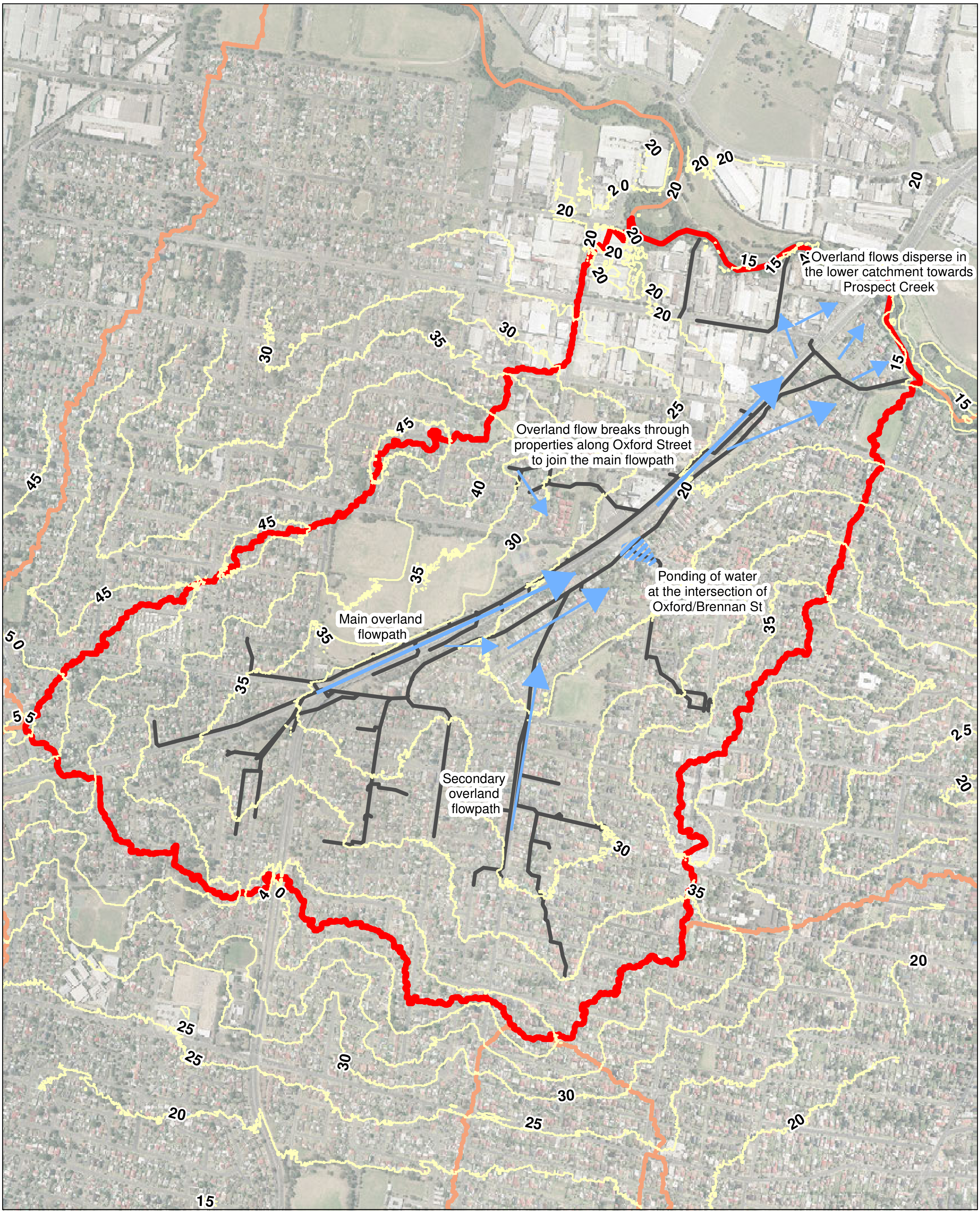
- Overland flow paths tend to follow the route of the stormwater drainage network
- Several overland flow branches in the upper catchment join to form an overland flowpath running north along the Cumberland Highway
- In the east of the catchment, stormwater is carried along Oxford Street, across Brennan Street and breaks through properties on Oxford Street to join the flow path along the Cumberland Highway. In the west of the catchment, there is a flowpath along O'Connell Street which carries stormwater south towards Brenan Street to the Cumberland Highway.
- All overland flow paths reach Prospect Creek, which bounds the north of the study area
- In the northern parts of the catchment the terrain is flatter leading to interflow between flowpaths
- Areas along Prospect Creek are also affected by mainstream flooding.

1.3. Study Objectives

Key objectives of this study are to:

- Identify the major overland flow paths within the Smithfield catchment study area.
- Determine the nature and extent of overland flooding and flood risk in the study area.
- Identify properties at risk of local overland flooding and quantify the risk of flooding to these properties.
- Produce flood model results (flood level, velocity and flow) for the 20, 100, 200, 500, 2,000 and 10,000 year ARI and PMF storm events
- Prepare flood extent (depth and velocity) maps and flood risk precinct maps for the study area for the 100 year ARI and PMF events.
- Assess the sensitivity of flood behaviour to changes in hydrologic and hydraulic characteristics in the catchment.

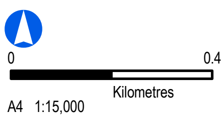
Originally, it was intended to also identify "Zones of Significant Flow" to determine those sections of overland flow paths through properties which would need to be kept clear in order to reduce flood risk. Due to time constraints, these zones will be identified in the floodplain risk management study and plan.

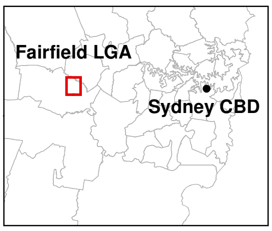


Legend

- 5m Contour
- Drainage Lines
- Smithfield Catchment
- Fairfield City Council Catchments
- Overland flowpath (indicative)

Data Sources
Aerial Photo: AUSIMAGE





SKM FairfieldCity

Figure 1-4 Overland Drainage Patterns

GDA 1994 MGA Zone 56

Smithfield Overland Flood Study | Version 1

24 September, 2009
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2. Review of Available Data

2.1. Topographic Survey

2.1.1. Airborne Laser Survey

Airborne Laser Survey (ALS), conducted in January 2003, was used to generate a Digital Terrain Model (DTM) for the entire Fairfield LGA. The DTM has subsequently been used in a number of projects undertaken for FCC, including this current study. The ALS data used had been filtered to reduce the density of points and to remove non-ground points such as buildings, bridges and over/underpasses.

2.1.2. Pit and Pipe Survey

The levels and dimensions of key pits and pipes were surveyed by FCC surveyors in 2007/2008. Typical details surveyed include:

Pits

- Pit name/asset number
- Pit coordinates (Easting, Northing)
- Pit surface level (m AHD)
- Pit invert level (m AHD)
- Pit type
- Pit entry dimensions – lintel length and/or inlet grate dimensions.

Pipes

- Pipe name/asset number
- Upstream and downstream invert levels (m AHD)
- Pipe length
- Conduit type – circular pipe or box culvert
- Dimensions – diameter or width/height
- Upstream and downstream node.

Data on the pits and pipes is contained in **Appendix A**.

Not all pits and pipes in the stormwater network were surveyed. Only key/critical pits and pipes, as identified by FCC, were surveyed for the purpose of developing a simplified stormwater network model. This is discussed further in **Section 3**.

2.2. AUSIMAGE™ Aerial Photography

AUSIMAGE™ aerial photography was used extensively in this study, mainly for data validation and presentation of results in the preparation of flood extent and risk maps. The aerial photography that was used was flown in March 2007. This photography is at a resolution of 0.15m.

2.3. Spatial Data

Various layers of GIS data were made available for this study from FCC, and through SKM's previous work within Fairfield LGA. These include:

- FCC digital cadastre and Local Environment Plan (LEP);
- Building polygon layer, derived in 2003/04 from 2002 aerial photography and updated based on recent aerial photography (where required); and
- Digital pit and pipe layer for the complete stormwater network.

Data from a surface impervious area (SIA) study undertaken for FCC by Lagen Spatial Pty Ltd became available in 2009 after the Smithfield Overland Flood Study commenced. The SIA study accurately identifies all impervious areas across the LGA, however it was not used in this study due to the late availability of the SIA data and project time constraints.

2.4. Rainfall Intensity-Frequency-Duration Data

This study uses design rainfall intensity-frequency-duration (IFD) data, derived for 33.875° S, 150.925° E (near Fairfield), issued in April 1997 by the Hydrometeorological Advisory Service of the Bureau of Meteorology. The IFD data provides average rainfall intensities for events up to and including the 100 year ARI event. The data was extrapolated to derive average rainfall intensities for the 200 and 500 year ARI events. Further detail on rainfall data is provided in **Section 3.2.5**. The IFD data is provided in **Appendix C.**

2.5. Record of Historical of Overland Flow Problems

FCC has kept a record of 'trouble spots' where the public has identified past stormwater flooding problems. This record includes a number of locations within the Old Guildford study area.

Based on investigations into these problem areas, FCC has subsequently developed their *Drainage Investigation Records* of properties historically affected by overland flooding since 1985.

Both these datasets have been made available for the study. They were used to identify the extent of the pipe network which required modelling, particularly where the trouble spot areas occur where pipe sizes are less than 900mm in diameter. The datasets were also used as a check for the final flood mapping.

3. Hydrologic and Hydraulic Model Development

3.1. Modelling Approach

The modelling approach adopted in the Smithfield Overland Flood Study consisted of the following aspects:

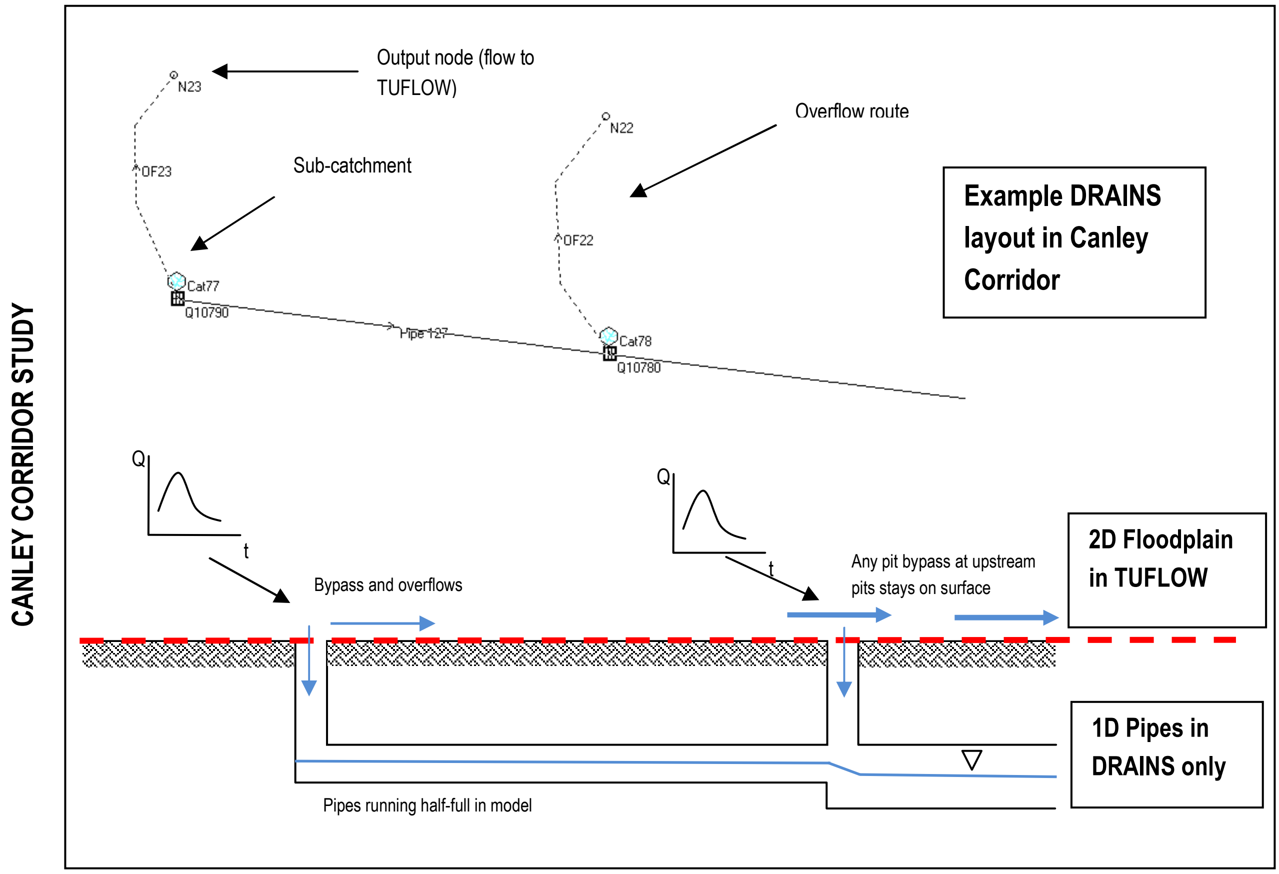
- Development of a XP-STORM model to represent the selected key/critical pits and pipes of the drainage network and the associated hydrology.
- Further development of the XP-STORM model to represent the 2D floodplain including topography, building polygons, surface roughness and boundary conditions.
- The XP-STORM model was then run for the duration of the flood events. Maximum flood levels, depths and velocities and flooding extents are output in result files.

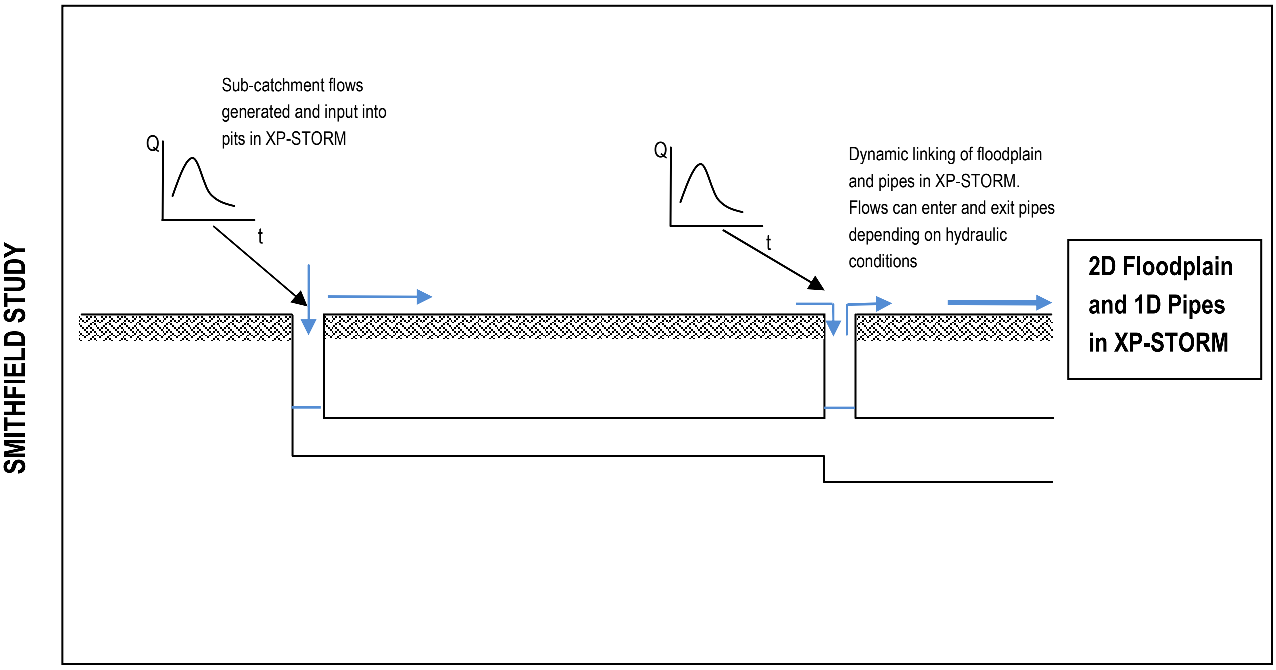
The adopted modelling approach in XP-STORM allowed a single model to simulate the small scale urban sub-catchment hydrology, as well as the hydraulics of the pit and pipe system. Further, the approach using XP-STORM allowed modelling of the stormwater drainage system in conjunction with the overland flow in the 2D floodplain, with a dynamic link between the two components.

Previously in the Canley Corridor Overland Flood Study, water surcharged from the pit (as determined in the DRAINS model), and was not allowed to re-enter the drainage system in the TUFLOW model. This led to a conservative depiction of overland flooding. The adopted approach removes this conservatism through a dynamic link and hence provides a more accurate description of the overland flooding behaviour. A schematic representation comparing the Canley Corridor and Smithfield Overland Flood Study modelling approaches is shown in **Figure 3-1.**

The preferred modelling approach chosen for this study was to incorporate modelling of the limited drainage network together with 2D flood hydraulic modelling, with some modification to suit the needs of the study as discussed above. This approach could potentially be used for modelling the remaining catchments in Fairfield LGA.

Figure 3-1 Comparison of Canley Corridor and Smithfield Overland Flood Study Modelling Approaches



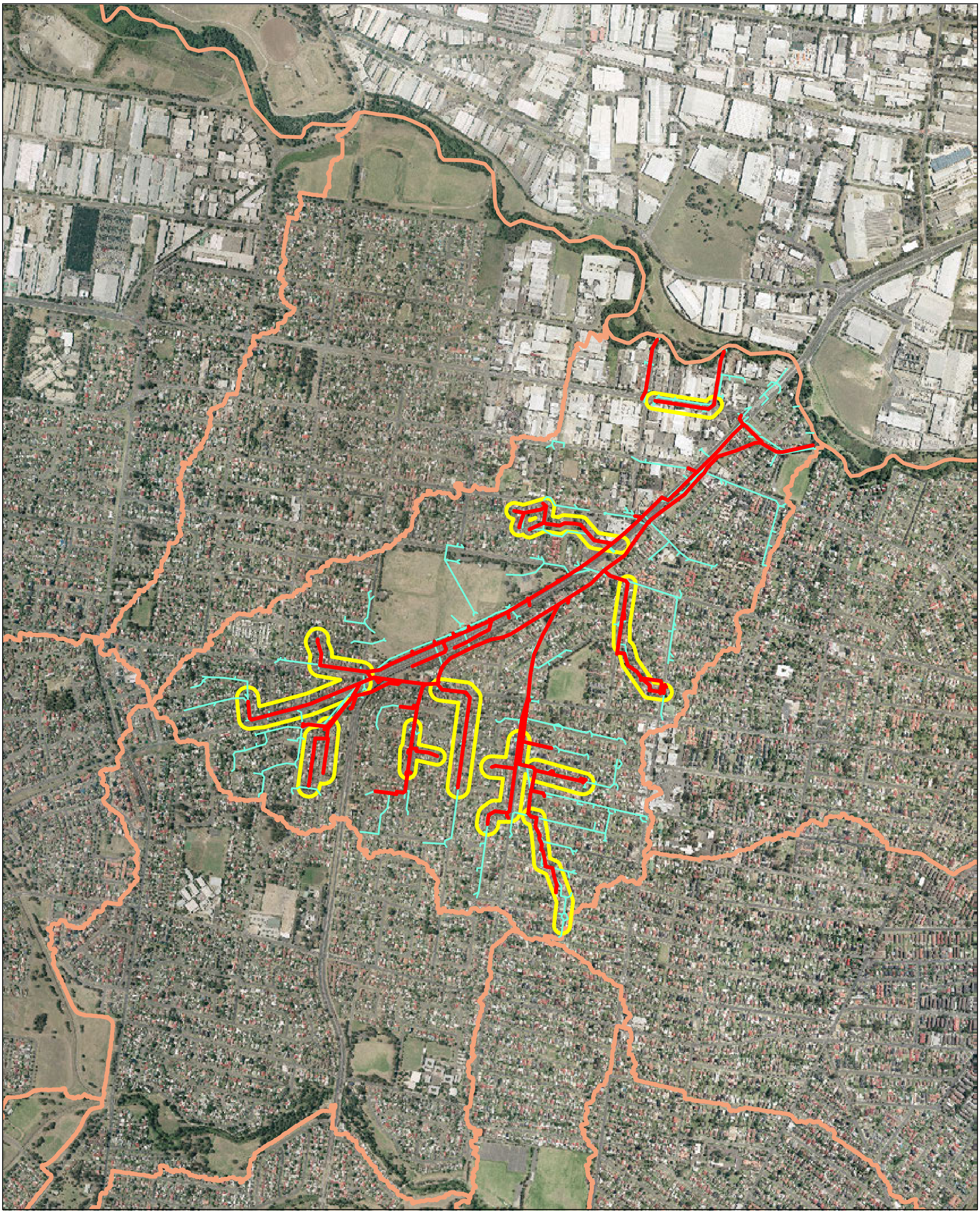


3.2. Drainage Network and Hydrologic Model Development

3.2.1. Drainage Network Layout

The limited drainage network to be modelled was selected by FCC staff, following a review of the data on the entire drainage network as well as the known drainage trouble spots. The modelled network typically comprised of pipes with a diameter greater than and equal to 900mm and their associated pits, with smaller pipes included as necessary at the known trouble spots to represent these locations in more detail. A total of 259 pits and 278 pipes were represented in the model. The modelled pipes, trouble spots and the entire pipe network are shown in **Figure 3-2**.

Following the importation of the pipe drainage network into the XP-STORM model, the open channel sections of the study area, Prospect Creek was incorporated into the model as a 1D element. Cross sections for Prospect Creek were extracted from the TUFLOW model developed as part of the Three Tributaries Overland Flood Study.



Legend

- Modelled Pipes
- Smithfield Pipes
- Trouble spots
- Fairfield City Council Catchments

Data Sources
Aerial Photo: AUSIMAGE

0 0.5
Kilometres
A4 1:20,000

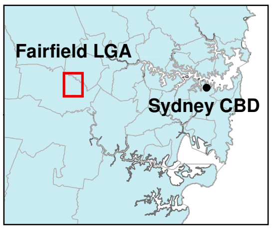


Figure 3-2 Modelled Network

GDA 1994 MGA Zone 56

Smithfield Overland Flood Study Version 1

24 September, 2009
I:\ENVR\Projects\EN02294\Technical\GIS\Figures\Figure 3-2 Modelled Network.mxd

3.2.2. Stormwater Network Parameters

The layout, dimensions and levels of the stormwater network were extracted from the GIS layer prepared by FCC and imported into XP-STORM. Stormwater network parameters were then chosen on the following basis:

- Standard pressure loss K_u parameters were used for the pits, based on whether they were at the head of a stormwater line (where a value of 5 was used) or a junction or inlet pit (where a value of 1.5 was used). The loss coefficients were entered as pipe entry losses in XP-STORM.
- Kerb inlet pits were grouped into the following sizes in order to categorise their inlet flow relationships: 1.0, 1.2, 1.5, 1.8, 2.0, 2.4, 2.7, 3.0, 3.3, 3.6, 4.2m lintel length.

  XP-STORM requires the user to define the pit inflow location for each pit type. The default pit inflow relationships for 'Hornsby-type pits" in the DRAINS model database were therefore adopted in the XP-STORM model, with the relationships interpolated as required for non-standard DRAINS model pit sizes.
- The depth-inflow relationship for grated pits, including a number of specialised, high-inlet capacity grated pits within the study area were estimated based on concurrent weir and orifice flow equation calculations, with the lesser of the weir and orifice flow estimates (for a specified flow depth) being taken as the effective inlet inflow. The inlet dimensions, blockage due to the pit inlet grate and the number of sides of the inlet exposed to flow were considered in the calculations.
- All pits with a surface inlet were set as being linked between the pit spill level and the 2D domain.
- The inflows into pits with a surface inlet, including both on-grade pits and sag pits, were defined using a depth/inflow relationship, with the depth calculated from the 2D surface characteristics. This method was considered to be the most appropriate approach in XP-STORM, where the pits are linked to a 2D domain. The alternative method of defining an approach flow/pit inflow relationship produced unrealistic pipe flow results.
- Blocking factors for on-grade and sag pits adopted for the model were 30% in the 20 year ARI and 50% in both the 100 year and PMF events. The blocking factor was imposed in the model by the pit inlet Efficiency Factor. The blocking factor was not applied to pits at the upstream end of drainage lines which were truncated for the limited drainage network.

A summary of the pit and pipe data is contained in **Appendix A.**

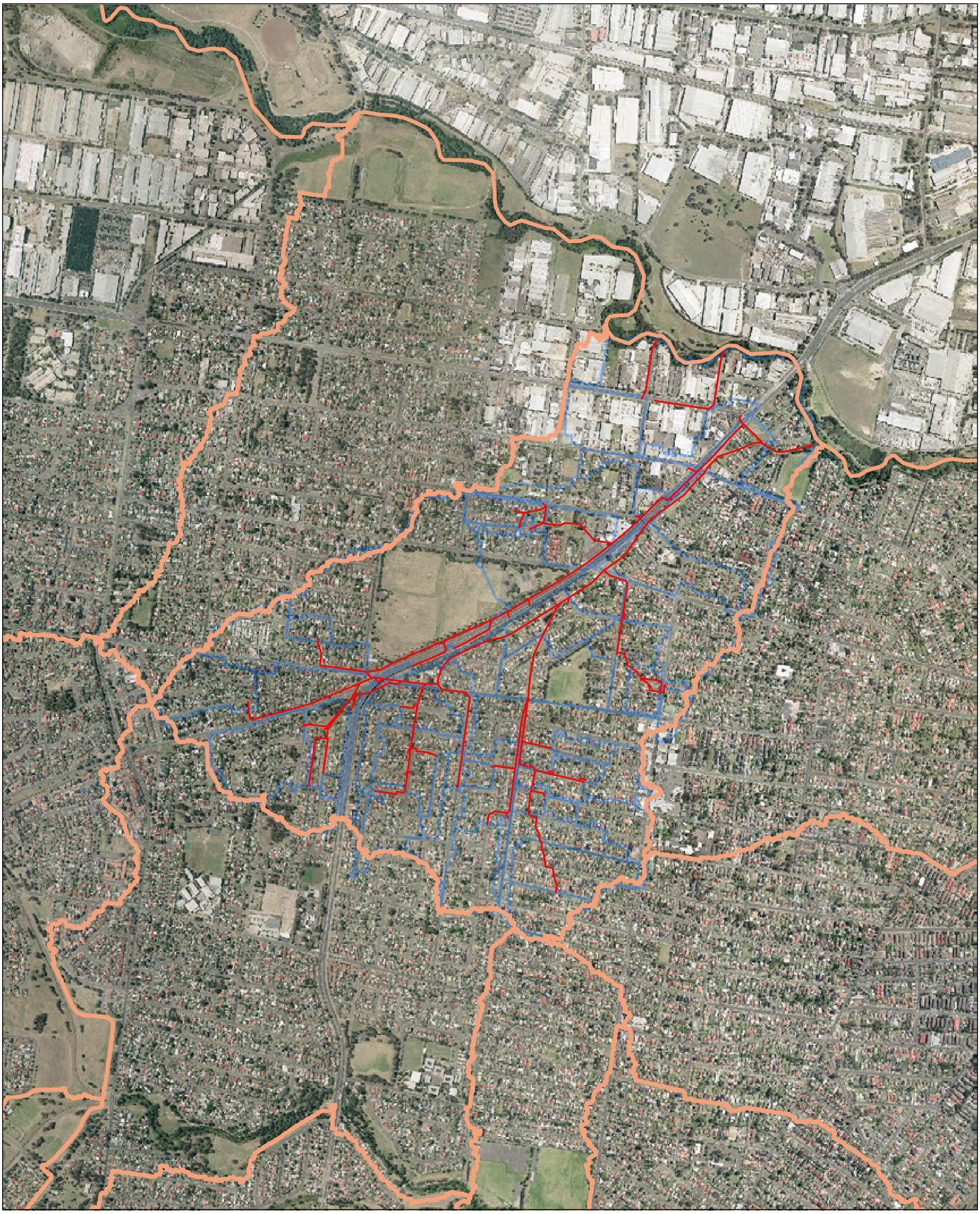
3.2.3. Sub-Catchment Data

Pit catchments were manually delineated by FCC for selected critical pits, based on topographic data, aerial photography, site observations and consideration of the likely connectivity of individual buildings to the kerb-and-gutter system and stormwater network. Model sub-catchments were only assigned to "critical pits" rather than all pits in the model. The critical pits were selected based on local knowledge of the study area, anecdotal evidence of problem areas and at most sag pits where ponding problems would occur. The pit sub-catchment boundaries were verified in the field by FCC staff.

Once the sub-catchment boundaries were finalised in GIS, the following parameters were measured or estimated for each sub-catchment:

- Sub-catchment areas were measured in GIS
- Impervious fractions were estimated using FCC LEP data on land use, plus estimated typical impervious fractions for each land use category.
- Runoff travel times (i.e. time of concentration) were estimated based on the length of each catchment and an estimated flow velocity of 1m/s for paved surfaces, and 0.5m/s for grassed surfaces.

The catchment layout is shown in **Figure 3-3** and detailed sub-catchment plans are presented in **Appendix C**. A summary of the sub-catchment data for the XP-STORM model is included in **Appendix A**.



Legend

- XP-STORM Modelled Pipe Network
- Fairfield City Council Catchments
- Smithfield Subcatchments

Data Sources
Aerial Photo: AUSIMAGE

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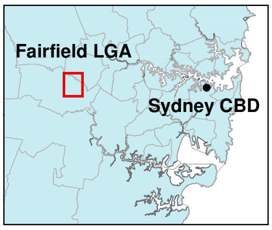


SKM FairfieldCity

Figure 3-3 Catchment Layout

GDA 1994 MGA Zone 56

Smithfield Overland Flood Study Version 1

24 September, 2009
I:\ENVR\Projects\EN02294\Technical\GIS\Figures\Figure 3-3 Catchment Layout.mxd

3.2.4. Hydrologic Parameters

The following hydrologic parameter values were adopted in the XP-STORM modelling:

- Rainfall Losses: Initial loss model and Horton continuing loss model. Refer to **Table 3-1** for parameter values.
- Runoff Generation: Unit Hydrograph – Time Area Method.

These are the same methods as the ILSAX model hydrologic method and the runoff method used in the Canley Corridor DRAINS model, and were adopted in order to maintain a common hydrologic modelling approach across the overland flood studies.

Table 3-1 Adopted Rainfall Loss Parameters

Losses	Parameter	Sub-Area	Value	Comment
Initial Losses	Depression Storage (mm)	Impervious Area Pervious Area	1mm 5mm	
	Manning's "n"	Impervious Area Pervious Area	0.014 0.03	
	Zero Detention (%)	Impervious Area	25%	
Continuing Losses (Horton Loss Model)	Max infiltration rate	Pervious Area	34.4mm/hr	Corresponds with DRAINS Soil Type 3 and Antecedent Moisture Condition 3*
	Min (Asymptotic) Infiltration		8.8mm/hr	
	Decay Rate of infiltration		0.0005/sec	Corresponds with DRAINS shape factor of 2 (h^1).*
	Max Infiltration Volume		0.0mm	

3.2.5. Design Rainfall

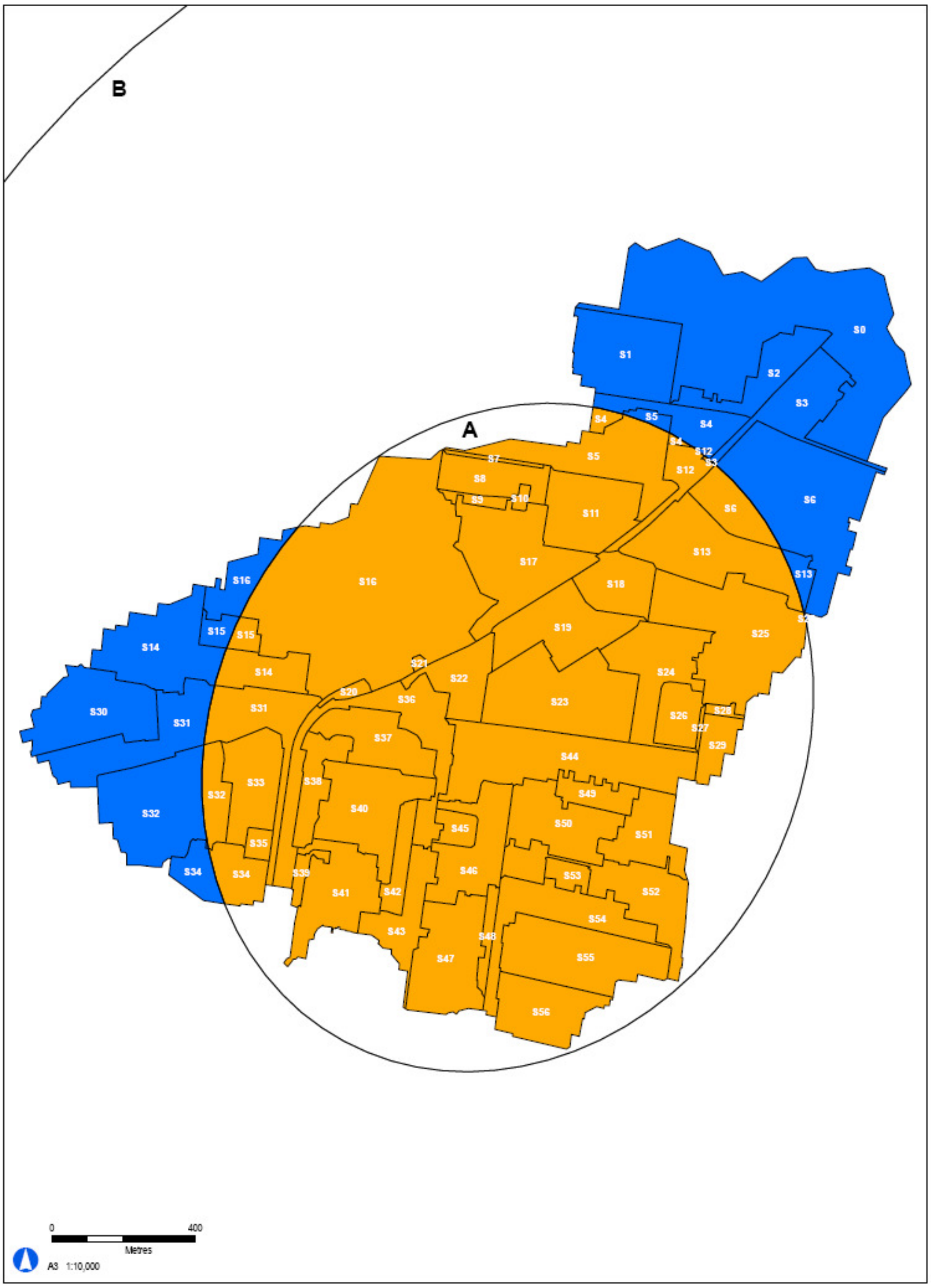
The storm events including the 20, 100, 200 and 500 year ARI events were modelled as Australian Rainfall and Runoff 1987 (ARR87) storms. Design storm time series were derived for these events based on the temporal patterns from *Australian Rainfall and Runoff Volume 2* (Institution of Engineers, 1987) for design storms in Australian Rainfall Zone 1, and from the average rainfall intensities produced by the FCC IFD data.

The average storm event rainfall intensity for storm events up to and including the 500 year ARI event are presented in **Appendix B**.

Design rainfall time series were derived for the Probable Maximum Precipitation (PMP) events, based on the Generalised Short Duration Method (GSDM) in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method* (BOM, 2003).

The Smithfield study area is 2.9 km^2 which is larger than the GSDM Ellipse A area of 2.6 km^2. However, as approximately 90% of the study area is included in this Ellipse A, it was considered appropriate to adopt the Ellipse A PMP rainfall depths for all catchments in the study area. Ellipse A and B are shown in **Figure 3-4**.

- **Figure 3-4 PMP Rainfall Ellipses**



The design rainfall time series for the 2,000 and 10,000 year ARI events were derived using the method for determining rainfall from extreme storm events (between 500 year ARI and the PMP) in *Australian Rainfall and Runoff –Volume 1 Book 6* (Institution of Engineers, 1997). A notional PMP event AEP of 10^{-7} was assumed given the catchment size and based on guidance in the method. A GSDM temporal pattern was adopted for all modelled extreme rainfall events, that is, the extreme storm events were assumed to have the same temporal pattern as the PMP event.

The average rainfall intensity for the extreme storm events are presented in **Appendix B**.

3.3. Two Dimensional Hydraulic Model Development

3.3.1. Model Topography

The topography of the catchment is represented in the model using a 2m grid. This level of precision in the grid is considered necessary in order to represent detailed flood behaviour in a fully developed catchment. Representing individual buildings and roads requires a fine grid structure to be able to represent the full flow width of the road and with grid spacing at least as small as a typical opening between properties.

The basis of the topographic grid used in the XP-STORM model is the ALS survey. **Figure 1-3** shows ground elevations within the Smithfield catchment based on this data.

3.3.2. Open Channels

Open channels represented in the XP-STORM model include a 35km reach of Prospect Creek, which bounds the Smithfield catchment to the north. Cross section data was provided by Council from an existing model of Prospect Creek.

3.3.3. Building Polygons

This study considers buildings as solid objects in the floodplain. This means that buildings form impermeable boundaries within the model, and that while water can flow around buildings, it cannot flow across their footprint. This approach is consistent with the other overland flow studies that are being undertaken or have been completed within Fairfield LGA.

This approach is considered to be more appropriate than the alternative approach of including these areas within the active floodplain. Given the number of buildings within the floodplain, it was not considered practical to verify whether each building would be likely to provide storage of floodwaters during a flood (e.g. slab on ground or raised with a clear understorey space) or would not allow flood storage (e.g. raised on fill or raised with an impermeable understorey). Further, whether floodwaters enter a particular building may vary between flood events depending on factors such as whether doors or windows are open, and whether these openings are exposed to the flows. Assuming each building in the floodplain is impermeable to floodwaters is expected to give a conservative and satisfactory estimate of flood behaviour.

The buildings were removed using a GIS dataset of building polygons generated by SKM. The building polygons were then superimposed on the model grid and used to make model computational cells inactive.

3.3.4. Property Fencelines

Fencelines have not been explicitly represented in the model and floodwaters can flow across them freely. Although fences may obstruct overland flood flows in some parts of the catchment, experience indicates that representing fences in the hydraulic model requires making unvalidated assumptions about depths at which fences overflow or fail. Also, including fence lines would have required on-site identification of fence type, blockage and structural strength for individual properties. This was beyond the scope of this study.

The potential obstruction to flow caused by fences has generally been represented by increasing the cell roughness (Manning's n values) for certain land uses, as described in **Section 3.3.5**. The limitation of this approach is that the flood levels may be slightly overestimated and flow velocities slightly underestimated for flooding within properties depending on the actual locations of obstructions and the interaction of flood flows with these obstructions. However, this approach does preserve the likely typical flooding behaviour, in which floodwaters use the road corridor as the preferential flow path.

3.3.5. Surface Roughness

All parts of the study area within the XP-STORM model were assigned hydraulic roughness values according to land use type and ground cover as summarised in **Table 3-2**. These are based on standard reference values for Manning's n in *Open Channel Hydraulics* (Chow, 1959) and typical values used in previous FCC flood studies. The relatively high Manning's n values for the commercial, industrial and residential land uses account for expected obstructions such as minor structures (sheds, etc.) and fences.

- **Table 3-2 XP-STORM Model Grid Hydraulic Roughness Values**

Land Use Type	Assumed Manning's n Roughness
Roads or Car parks	0.02
Commercial / Industrial / High Density Residential	0.20
Open Space (with trees)	0.05
Open Space (grass only)	0.035

Land Use Type	Assumed Manning's n Roughness
Medium and low density Residential	0.15
Heavily vegetated areas	0.10
Moderately dense vegetation along creek	0.08

3.4. Boundary Conditions

3.4.1. Local Sub-Catchment Inflows

These are flows originating from the local overland flow sub-catchments within the study area. Flow hydrographs for these sub-catchments are the hydrologic and drainage component of the XP-STORM model. These sub-catchments have been identified as "pit catchments" (those delineated upstream of a stormwater pit) and "non-pit catchments" (the remaining sub-catchments which are not attached to a pit).

Runoff generated in the pit catchments is input into the drainage network via the pit inlets. Flows in excess of the pit inlet capacity are input into the 2D model domain as point inflows, subsequently forming overland flow. The generation of these flows is discussed in **Section 3.2.3** and **Section 3.2.4**. The inflow series are applied as point inflows directly onto the grid. Applying inflows onto a two-dimensional grid in this way can overestimate the depth of the flooding at particular points. However, in this instance the sub-catchments are relatively small, and the error associated with this simplification was found to be small.

Pit surcharge flows, caused when flows in the drainage network exceed network capacity and spill out of the pits and into the 2D domain, would similarly form overland flow in the model.

Note that pits at the top of each truncated drainage line branch, which have relatively large catchments assigned to them, were modelled with zero blockage to allow a more realistic estimate of the pit inflows into the pipe network.

Flows from non-pit catchments are input directly into the modelled creek network, and therefore do not contribute to flooding in the model until the creek channel capacity is exceeded.

The location of the sub-catchment boundaries are shown in **Appendix C**.

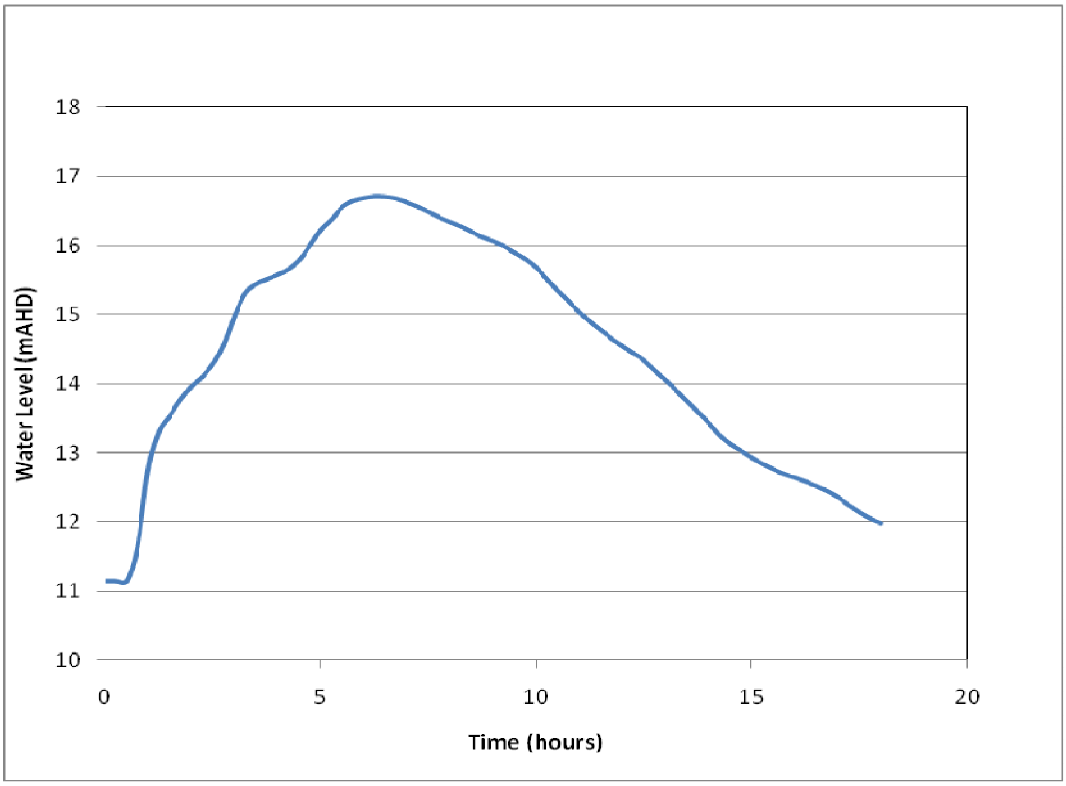
3.4.2. Downstream Boundaries

Water level hydrographs were extracted from the existing Prospect Creek TUFLOW model at cross section reference *xs93* and input as tailwater boundary conditions to the Smithfield overland flood model. As an example, **Figure 3-5** shows the stage hydrograph at the downstream end of the Prospect Creek reach.

The critical storm event for Prospect Creek at this location is 9 hours. This duration was adopted for the downstream boundary condition. The critical duration for the downstream portion of the Smithfield catchment is typically 3 hours. Consequently, coincident peaks from the local stormwater catchments and the peak from the Prospect Creek mainstream catchment, have not been modelled.

The adopted concurrent storm ARI's in the overland flooding and the mainstream creek catchment, are summarised in **Table 3-3** and relate to the tailwater boundary conditions selected for each overland flood event.

- **Figure 3-5 Water level hydrograph at downstream boundary of Prospect Creek for 100 year ARI**



- **Table 3-3 Adopted Concurrent Storm Events**

Storm Event in Smithfield Local Catchment	Flooding in Prospect Creek
20 year ARI	20 year ARI
100 year ARI	100 year ARI
200, 500, 2000 and 10,000 year ARI and PMF events	100 year ARI

3.4.3. Mainstream Channel Inflow Boundaries

Creek inflows at the upstream ends of the modelled sections of Prospect Creek were extracted from the TUFLOW model results for the Prospect Creek Flood Study (Bewsher Consulting, 2006). Prospect Creek borders the study area to the north and effectively forms the boundary of the overland flood study area for inundation mapping. Prospect Creek is represented as 1D elements of the XP-STORM model. It is not intended to reproduce the mainstream flood levels and extents as part of this study, as this has been undertaken as part of the Prospect Creek Flood Study.

3.5. Initial Model Runs

3.5.1. Model Configuration and Stability

XP-STORM models, if configured appropriately, are typically numerically stable. However, models often require “debugging” during their initial development in order to rectify issues in the model which cause model instability and inaccuracy. Several such issues were encountered in the Smithfield model. These issues are described below:

- Pit inlet flows were initially not being represented realistically. XP-Software recommended the use of pit configuration parameters “2D_WEIR_LEN” = 2, which resolved this issue.
- A review of the hydraulic grade line in the modelled pipes indicated that there was a reversal of flow in some pipes. The cause of this was identified as being the incorrect settings defining inflows at pit inlets, specifically due to the pit inflow relationships being defined as approach flow versus inflow. The model was interpreting this data in an unexpected manner. This problem was successfully rectified by defining the relationships as depth at the pit inlet versus inflow.

3.5.2. Quality Assurance

The Smithfield XP-STORM model was set up concurrently with the Old Guildford XP-STORM model (SKM, 2010). Although different study areas, the model set ups followed the same modelling principles and underlying assumptions. The Old Guildford model was selected from the two concurrent studies for a peer review. This was undertaken in December 2008 by XP-Software, the developers of XP-STORM to ensure the model was configured appropriately. Changes included modification of configuration parameters, (such as 2D_WEIR_LEN, MIN_LEN and VERT_WALLS values). The changes in these parameters were recommended for model stability. The review also prompted consideration of roughness parameters and the use of inactive areas. In response to these items it was noted to XP Software that assumptions were consistent with other flood studies produced for Fairfield City Council. Details of the recommendations from the review are contained in **Appendix H**.

3.6. Model Calibration and Verification

3.6.1. Historical Flood Events

Rigorous model calibration and verification of overland flood models cannot generally be carried out since direct measurements of overland flows are usually not available. There are no references available to correlate an observed flooding depth with a comparable storm event in the study area.

3.6.2. Trouble Spots

FCC has maps showing past flooding 'trouble spots', which identify the location of known problems. These maps have been used in this study to validate the performance of the XP-STORM model, and as an indication of whether the 2D hydraulic model extends far enough into the catchment. Trouble spots are shown in **Figure 3-2**.

3.7. Sensitivity Analysis

3.7.1. Overview

Sensitivity analyses were conducted to determine the sensitivity of the flood behaviour to variations in the adopted model parameters. The following scenarios were assessed for the 100 year ARI event:

- Catchment surface roughness: The impact of a 5% increase in Manning's n in the 2D model domain was assessed;
- Stormwater pit blockage: An increase in blockage factor from the design value of 50% blocked in the 100 year ARI event to 75% blocked in the sensitivity analysis scenario (i.e. the pit inlet has 25% capacity of an unblocked pit inlet); and
- Increased rainfall intensity: An increase in the 100 year ARI rainfall intensity of 10%, to simulate the potential impacts of climate change on overland flooding.

The resulting flood depths were compared to the design 100 year ARI flood depths. The results are discussed below.

3.7.2. Impact of Increased Catchment Roughness

Flood depths are not sensitive to an increase in catchment roughness. A 5% increase in Mannings n across the 2d domain resulted in changes in flood depth varying from +/- 5 to 45mm in the study area. Average changes in depths are +/- 15mm.

3.7.3. Impact of Increased Pit Blockage

Flood behaviour is typically insensitive to increased pit inlet blockage in the catchment, with the following exceptions:

- Flood depths are up to 150mm deeper in the upstream reaches of the drainage network. Areas most affected include residential areas in the vicinity of Kihilla/Maud Street and Quivros Avenue, north of Magellan Street.
- Flood depths up to 40mm deeper in the residential area on the south east corner of the Neville Street and O'Connell Street intersection.
- Minor decreases in flood levels of up to 100mm occur at the downstream reaches of the model where the drainage lines join Prospect Creek.

3.7.4. Impact of Increased Rainfall Intensity

As part of Councils plan to determine the effect of climate change on flooding, it was decided to alter the rainfall intensity in the catchment to reflect a possible climate change effect. Bewsher Consulting is preparing the Georges River and Prospect Creek Climate Change Sensitivity Assessment, which has recommended that an increase of rainfall by 10% to be used to simulate the effect of climate change on rainfall. This is in line with current guidance from Department of Climate Change and Water, now Office of Environment and Heritage. Flood depths typically increased less than 50mm in the 100 year ARI after the 10% rainfall increase across the catchment area.

3.7.5. Conclusions from Sensitivity Analyses

In summary, flood behaviour in the overland floodplain in the Smithfield XP-STORM model is not sensitive to small changes in Manning's n coefficients selected. Therefore uncertainties about this parameter are not likely to affect the outcomes of any overland floodplain management measures which are implemented. However, prior to the commencement of any floodplain management measures being considered a review of selected Mannings n coefficients should be undertaken to ensure any changes in the catchment landuse are adequately represented in the model.

Increased pit blockage has an impact on overland flow paths in some residential areas which have already been identified as 'trouble spots' by Council. While some pit blockage has already been adopted in the design case, the occurrence of higher degrees of blockage is possible depending on catchment conditions and other circumstances which are not foreseeable. Council should take the potential increased flood depths into consideration in developing overland floodplain management strategies for Smithfield.

Flood levels are partially sensitive to an increase in rainfall intensity with some areas having increases of up to 50mm in flood depths. The increase in flood depth is most likely attributable to the limited capacity of the drainage network in these locations and the subsequent overland flowpaths being confined by surrounding topography. Council should consider the impact of increased rainfall due to climate change when planning floodplain management options.

4. Flood Model Results

4.1. Flood Depth and Velocity Mapping

Detailed flood depth and velocity mapping for the 20, 100 and 2,000 year ARI flood and PMF events are included in **Appendix D** and **Appendix E**. The mapping was developed by following the approach detailed below:

- The validated XP-STORM model was run for the 20, 100, 200, 500, 2,000 and 10,000 year ARI and PMF events for a range of storm durations from 30 minutes to 3 hours.
- The peak water level for each storm duration, at each grid point in the model of the catchment, was extracted and used to form a 'peak of peaks' grid of flood depth and velocity. The grid was then refined to remove shallow depth flooding as discussed in **Section 4.1.1.**
- The peak flood depth and velocity was mapped for the events described above. The 2,000 ARI event was selected for mapping as an intermediate flood event between the 100 year ARI and the PMF events.
- The spaces representing buildings in the floodplain which are surrounded by flooding were not filled in for the purposes of the flood depth mapping presented in this report.

4.1.1. Initial Flood Mapping

After stabilising and reviewing the model, the model was run in order to produce initial results and to map the extent of flooding. The process of mapping flood extent was then refined in order to provide the most relevant and useful information.

For instance, the initial flood depth maps produced in XP-STORM were manually refined to remove isolated patches and minor fingers of shallow-depth flooding of less than 150mm, and are not shown in the flood mapping presented in this report. The rationale for this is that such areas could be considered as areas of "nuisance" or "localised" flooding caused by local drainage rather than actual overland flooding. For example, ponding of stormwater within the roadway may not be a part of the main body of overland flood flows.

The 150mm threshold depth was chosen by FCC as it generally corresponds with the height of the road kerb, hence flow less than this depth would typically be contained in the roadway. Overall, there were very few areas of minor flooding that were removed from the flood mapping.

4.2. Overview of Flood Behaviour

The following findings on flood behaviour in the study area have been drawn from analysis of the model results and flood depth and velocity mapping.

4.2.1. General

- Overland flowpaths within the study area are closely aligned with the stormwater network; overland flows are carried in a northerly direction towards Prospect Creek.
- There are a number of overland flowpaths which originate in the upper catchment and carry stormwater in a north to north-west direction towards the Cumberland Highway. Stormwater is carried along Maud Street in the south of the catchment, across Polding Street and north towards Reserve Street. Overland flows continue between properties on Reserve Street towards Rosemount Avenue. Overland flow also follows a north-east direction along Reserve Street and joins the main flow path at the Alexander/Rosemount Avenue junction. In the east of the catchment, stormwater is carried north along Oxford Street, across Brennan Street and breaks through properties on Oxford Street to join the flow path along the Cumberland Highway. In larger events, overland flow paths develop along Oxford Street, north of The Boulevard. In the west of the catchment, there is a flowpath along O'Connell Street which carries stormwater south towards Brenan Street to the Cumberland Highway.
- Overland flooding is generally deepest in open space areas adjacent to the Highway, where flood water is ponding, particularly between Brenan Street and the Boulevard. 100 year ARI flood depths in these areas are in the range of 0.6-1.0m. Flood depths in excess of 1m are located in the flowpath between Rosemount Avenue and the Cumberland Highway in the vicinity of Alexander Street. 100 year ARI flood depths on the Boulevard between Oxford Street and the Cumberland Highway are between 0.5 and 0.7m. Typical depths of flooding at properties in the upper parts of the catchment are less than 0.3m. In the middle part of the catchment a number of properties in the Rosemount Avenue, Alexander Street and Brenan Street area are affected by overland flood depths between 0.5m and 0.8m. In the lower catchment, north of Horsley Drive, a small number of properties are affected by overland flood depths of up 1.2m.
- The depth of flooding in road corridors is typically less than 0.3m in the 100 year ARI event. Some roads experience flooding greater than 0.5m deep, and include Percy Street, Beemera Street, Ainslie Street, Musgrave Crescent, Reserve Street and Oxford Street. There are small sections of road on Rosemont Avenue and Alexander Street where overland flood depths are greater than 1m.
- Overland flow velocities within properties in the 100 year ARI event across the study area are typically less than 0.5m/s. There are some isolated areas (for example properties fronting the Cumberland Highway) where flow velocities are between 1-1.5m/s. Higher velocities, greater

than 1.5m/s are observed on some streets, including the Cumberland Highway and Maud Street.

4.2.2. Detailed descriptions

In order to present some detail on flooding behaviour in the study area, a discussion of results at a number of location are provided below. Reference to these areas is made as they have typically been identified as 'trouble spots' within the catchment.

4.2.2.1. Smithfield Road/Corryong Street

- Overland flooding in the 100 year ARI event occurs along Corryong Street with depths ranging from 0.2m to 0.5m. This flowpath re-joins the main overland flowpath along Smithfield Road towards the Cumberland Highway.
- Overland flooding also affects properties between Iris Street and Corryong Street in the 100 year ARI event. Flooding depths are up to 0.3m in this vicinity where overland flows follow a south east direction to join Smithfield Road.
- The main flowpath along Smithfield road has flood depths ranging from 0.1 to 0.5m in the 100 year event
- Overland flow breaks out from the Smithfield Road flowpath through properties to the south towards Quiros Avenue. Flooding depths in the vicinity of these properties is typically 0.15-0.2m.

4.2.3. Magellan Street and Quiros Avenue

- Two distinctive overland flowpaths follow the drainage lines which run along Quiros Avenue and between the properties on Tasman Parade and Quiros Avenue, north of Magellan Street. These flowpaths converge north of Quiros Avenue and form an overland flowpath towards the Cumberland Highway.
- 100 year ARI flood depths in this area are on average 0.3-0.4 m, with some small areas of flood depths up to 0.8m (particularly at Magellan Street). Flowpath width between the properties is on average 30m.
- Due to the relatively flat topography at the junction of Smithfield Road and the Cumberland Highway, there are small flowpaths which pass through the open space to the east of Tasman Parade. These are generally shallow at a depth of 0.15m.

4.2.4. Hamersley Street and Ainslie Street

- Overland flowpaths follow the drainage lines in northerly direction along Hammersley Steet to the junction of Ainslie Street. Flood depths are typically 0.2 to 0.3 m but increase to depths of 0.7 and 0.8 m when flood water ponds at properties on Ainslie Street.
- In larger events, overland flow extends along Ainslie Street and then joins overland flow along Musgrave Avenue to the north

4.2.5. Maud Street/Kihilla Street

- A number of overland flowpaths exist in this area, which follow the main drainage lines. In addition, overland flow also breaks out and flows between properties on Nile Street, Beemera Street and Kihilla Street. Overland flooding is confined to the eastern side of Maud Street between Nile Street and Kihilla Street due to the lower topography in this area.
- Overland flow depths in the 100 year ARI event at properties along Kihilla Street are 0.3 to 0.5m. Overland flow depths increase to 0.8 metres in behind the properties along Karabar Street.
- Overland flow breaks out from Kihilla Street along Montague Street and rejoins the main Maud Street flowpath at in the vicinity of Karabar Street. Flood depths along this path are 0.3 to 0.5m. In larger events (2,000 year and PMF) overland flow continues north along Montague Street and affects a greater number of properties along Bodalla and Karabar Street. Flood depths in the PMF event are up to 0.9m in these areas.

4.2.6. O'Connell Street

- Overland flow breaks out at the eastern edge of Braeside Avenue and flows across O'Connell Street in a south east direction towards the Cumberland Highway. Flood depths are generally shallow through properties on O'Connell Street and Brenan Street, being 0.15m in the 100 year ARI event and increasing to 0.5m in the PMF event.
- The overland flowpaths passing through the properties in the vicinity are up to 80m wide in the PMF event.

4.2.7. Victoria Street

- Overland flow on Victoria Street follows the drainage line with flood depths along the road up to 0.2m in the 100 year ARI event.

- In larger events overland flow passes between industrial properties located between Victoria Street and Robert Street. Flood depths are up to 1m in the PMF event in this vicinity as water ponds in the car park of the industrial properties.

4.3. Peak Flood Flows and Levels

The peak flow and peak levels at a number of selected roads in the catchment are reported in **Appendix F** for each ARI storm event. The flow given is the total overland flow passing across selected locations (not including pipe flows) at the peak of each ARI flood event. This is reported for the storm duration giving the highest peak flow for the selected event. The road locations are shown and detailed in **Appendix F**.

The critical storm duration varies across the catchment area, and includes the 30 minute, 90 minute, 2 hour and 3 hour events. These are detailed in **Table F-1** in **Appendix F**.

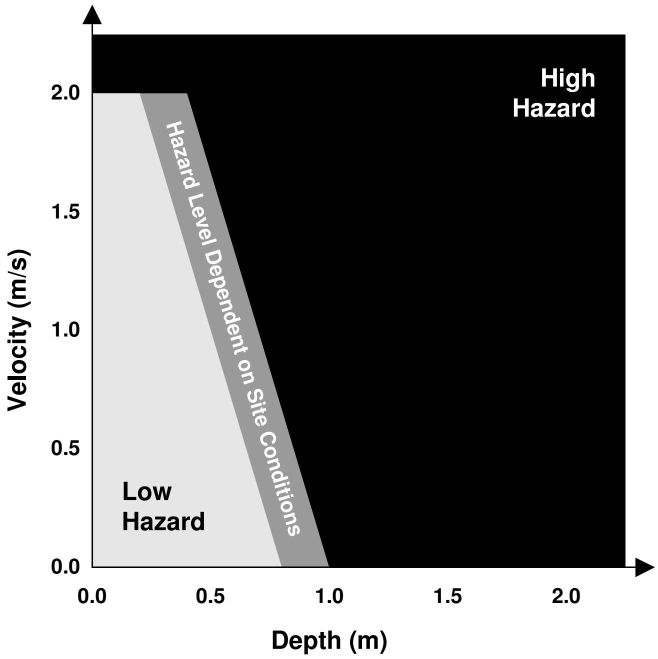
4.4. Flood Risk Precincts

Flood risk precinct mapping has been prepared for the Smithfield catchment and is included in **Appendix G**. The flood risk maps were developed from GIS analysis and interpretation of the 100 year ARI and PMF event peak depth and velocity grids, based on the FCC flood risk precinct categories described in **Table 4-1.** The flood risk precinct definitions were derived from the hydraulic hazard category diagram presented in the FDM, shown in **Figure 4-1**.

- **Table 4-1 FCC Flood Risk Precincts (Fairfield City Wide DCP, 2006)**

Risk Precinct	Description
High	The area of land below the 100 year ARI flood outline that is subject to high hydraulic hazard (for preparation of the draft flood risk precincts, this has been taken as the provisional 'High Hazard' zone Figure L2 of Appendix L in the NSW Floodplain Development Manual (2005) as reproduced in **Figure 4-1**.
Medium	Land below the 100 year ARI flood outline that is not in the High Risk Flood Precinct
Low	All other land within the floodplain (i.e. within the extent of the PMF) but not identified within either the High Risk or Medium Risk Precincts.

▪ **Figure 4-1 Hydraulic Hazard Category Diagram (reproduced from Figure 6-1 in *NSW Floodplain* Development *Manual*)**



The flood risk precinct maps show solid precinct outlines, which have been reviewed and refined by FCC with consideration of flood evacuation requirements and other floodplain risk management issues. This has included some smoothing of the flood extent to account for local irregularities in the modelled ground surface, and street and property outlines.

The Fairfield City Wide DCP requires areas which were initially assigned a medium flood risk rating but are surrounded by the high risk precinct to also be upgraded to a high flood risk. Issues relating to the evacuation of these areas, which may become cut off during flood events, necessitates that they be allocated a high flood risk. The flood risk of islands of low, or no flood risk, is not required to be upgraded, in accordance with the DCP.

As discussed in **Section 3.3.3**, buildings were treated as solid objects in the floodplain, within which floodwater cannot flow or be stored. The resulting flood depth and velocity maps show blank spots at these locations. Since Council provides the flood risk coding on the entire property and not just the building on it, the flood risk precinct maps required the appropriate risk to be shown across the entire property (as well as through the building footprint).

In order to do this, two methods were used:

▪ A line was drawn connecting each end of the flood profile across the building for standard residential buildings

- For larger developments ground levels across the property were reviewed and compared to the flood level. The risk precinct was extended across the property footprint if the ground level was lower than the flood level.

The flood risk mapping has identified the following about the extents of the precincts:

- 1,365 properties are included in the floodplain outline defined by the Probable Maximum Flood (PMF) flood event. This includes:
  - 44 parcels in the High Risk Precinct
  - 439 parcels in the Medium Risk Precinct
  - 882 parcels in the Low risk Precinct.
- Areas of high flood risk occur in: the lower catchment south of Kiola Street; in the middle catchment at the Rosemont Avenue/Alexander Street intersection; and at the corner of Brenan Street and Cumberland Highway.
- The medium flood risk precinct follows the pattern of the trunk drainage system from the upper to lower catchment.
- The low flood risk precinct follows the outline of the medium flood risk precinct, widening at the junction of drainage lines. The low risk precinct widens from the medium flood risk precinct in the lower part of the catchment, downstream of Horsley Drive. A number of additional areas are included in the low risk flood precinct. These include the area between Tyrell Crescent and Rawson Road, the area to the west of the Cumberland Highway, adjacent to Brenan Street and O'Connell Street.

5. Conclusions

The Smithfield Overland Flood Study has achieved its objectives to:

- Define flood behaviour and identify the major overland flow paths within the Old Guildford catchment; and
- Identify properties at risk of local overland flooding and to prepare flood risk precinct maps.

The study's modelling approach consisted of a XP-STORM model that dynamically linked the 2D floodplain and 1D stormwater drainage network to assess flood behaviour and determine flood risk to properties. The model allows flows to be transferred in and out of the drainage network depending on the hydraulic conditions. This approach is considered to be able to efficiently produce a reliable representation of overland flood behaviour compared to those used by Council previously.

The amount and quality of the data available to define physical features in the study area, including the ground surface, open channels, pits and pipes and building footprints, was adequate for the development of the study models, though information on historical flood events in the study area was lacking. Council should, if practical, collect flood marks in overland flood areas following flood events to permit a more thorough model calibration and validation process for future overland flood studies.

Sensitivity analysis indicates that the overland flood behaviour is typically not sensitive to variation in floodplain roughness or increased rainfall intensity. Hence, overland flood depth estimates are not expected to be significantly impacted by uncertainties in these parameters.

Overland flood depths are likely to increase if a high degree of pit blockage occurs during a flood event. This should be taken into consideration during the development of overland flood risk management strategies during the floodplain risk management study phase.

The overland flood risk precinct delineation process itself has been developed over a number of years in consultation with FCC. It clearly and objectively defines the level of flood affectation of each part of the study area. Consideration of the flood event ARI in determining the flood risk, in addition to the hydraulic hazard posed by flood events to life and property, is particularly appropriate for the urban setting of the study area. By definition it provides an indication of the probability of a property being flood affected during a given time frame, in addition to the degree of hazard that it would experience.

The study has ultimately provided a good foundation from which to prepare the floodplain risk management study and plan as the next step in the floodplain risk management process.

6. References

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Appendix A Model Stormwater Pit, Pipe and Sub-Catchment Data

Table A-1 Smithfield XP-STORM Node and Pit Data

Note: Table below includes data for modelled pits and nodes, including dummy nodes

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
10/10	309725.6	6252261	17.2	0	
100/10	309730.2	6252264	17.44	0	
1000/100	308868.6	6250963	29	0	
1000/110	308857.4	6250877	29.88	0	
1000/120	308868.5	6250866	29.85	0	
1000/140	308889	6250861	30	0	
1000/150	308900	6250781	31.37	0	
1000/160	308905.5	6250771	31.43	0	
1000/180	308922.2	6250688	33.13	0	
1000/190	308921.3	6250680	32.95	0	
1000/20	308923.6	6251565	24	1	On Grade 2.0m Lintel
1000/200	308948.4	6250673	33.15	1	On Grade 2.0m Lintel
1000/210	308961	6250592	34.65	0	
1000/220	308961	6250583	34.55	0	
1000/30	308913.1	6251546	24.31	0	
1000/40	308878.6	6251470	24.94	0	
1000/50	308866.2	6251399	25.38	1	On Grade 2.0m Lintel
1000/60	308864.3	6251386	25.5	1	On Grade 2.0m Lintel
1000/70	308858.2	6251312	25.95	0	
1000/80	308875.5	6251049	28.03	0	
1000/90	308884.4	6251038	28.21	0	
1050/20	308834.1	6251231	26.53	1	On Grade 1.8m Lintel
1050/30	308823.5	6251151	27.29	1	On Grade 1.5m Lintel
120/10	309660.1	6252328	18.6	1	On Grade 2.0m Lintel
120/75	309380.4	6252046	20.87	1	On Grade 3.0m Lintel
120/100	309306.5	6252007	21.09	1	On Grade 3.0m Lintel
120/120	309266.4	6251969	21.25	1	On Grade 3.0m Lintel
120/130	309216.2	6251922	22.2	1	On Grade 3.0m Lintel
120/140	309171.1	6251884	22.95	1	On Grade 3.0m Lintel
120/150	309121.5	6251845	23.8	1	On Grade 3.0m Lintel
120/160	309072.6	6251810	24.17	1	On Grade 2.0m Lintel
120/170	309038.5	6251787	24.64	0	
120/180	309011.2	6251769	24.88	1	On Grade 3.0m Lintel
120/20	309622.4	6252292	18.81	1	On Grade 2.0m Lintel

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
120/190	308971.9	6251744	25.15	1	On Grade 3.0m Lintel
120/200	308931.1	6251720	25.56	1	On Grade 3.0m Lintel
120/210	308859.8	6251677	26.07	1	On Grade 3.0m Lintel
120/230	308721	6251599	26.9	1	On Grade 3.0m Lintel
120/245	308638.9	6251566	27.4	0	
120/30	309590.2	6252256	19.03	1	On Grade 2.0m Lintel
120/330	308255.7	6251406	30.74	1	On Grade 2.0m Lintel
120/40	309557.8	6252221	19.2	1	On Grade 2.0m Lintel
120/50	309476.8	6252141	19.54	1	On Grade 2.0m Lintel
120/60	309440.4	6252105	19.38	1	On Grade 2.0m Lintel
1000/105	308866.6	6250954	29.3	0	
1680/10	308523	6251367	28.06	1	On Grade 2.0m Lintel
1680/100	308025.8	6251207	32.8	0	
1680/110	308015.5	6251202	32.81	1	On Grade 1.5m Lintel
1680/30	308475.2	6251359	28.41	1	On Grade 1.8m Lintel
1680/40	308384.2	6251371	28.7	1	On Grade 1.8m Lintel
1680/60	308229.8	6251363	30.37	1	On Grade 2.0m Lintel
1680/70	308220	6251346	30.73	1	On Grade 2.0m Lintel
1680/80	308105.7	6251201	32.3	0	
1680/90	308036.1	6251210	32.42	0	
120/240	308640.2	6251563	27.25	1	On Grade 3.0m Lintel
120/250	308582.6	6251538	27.6	1	On Grade 3.0m Lintel
120/270	308511.1	6251507	28.24	1	On Grade 3.0m Lintel
1770/10	308463.5	6251349	28.47	0	
1770/100	308397.8	6250960	34.65	1	On Grade 1.8m Lintel
1770/30	308443.5	6251277	28.6	0	
1770/50	308429.8	6251196	29.55	0	
1770/60	308419.5	6251121	31.2	1	On Grade 1.8m Lintel
1770/70	308415.7	6251093	31.86	1	On Grade 1.8m Lintel
1770/80	308408.2	6251036	32.84	1	On Grade 1.8m Lintel
1770/90	308405.5	6251015	33.1	1	On Grade 1.8m Lintel
1810/10	308440.1	6251120	31.1	1	On Grade 1.8m Lintel
1810/20	308440.1	6251110	31.1	1	On Grade 2.7m Lintel
1810/30	308486.6	6251104	31.38	1	On Grade 1.8m Lintel
1810/40	308518.4	6251091	31.85	1	On Grade 2.7m Lintel
1820/10	308410.7	6251113	31.45	1	On Grade 1.8m Lintel
1830/10	308419.6	6251029	32.9	1	On Grade 1.8m Lintel

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
1840/10	308402.2	6251031	33.06	1	On Grade 1.5m Lintel
1840/20	308401.1	6251021	33.15	1	On Grade 1.8m Lintel
1880/10	308370.9	6251360	28.93	1	On Grade 1.8m Lintel
2030/10	308110.5	6251194	32.43	0	
120/110	309283.1	6251984	20.96	1	On Grade 1.0m Lintel
340/10	308925.4	6251959	30.35	0	
340/20	308915.3	6251962	30.46	0	
340/30	308924.8	6252023	33.45	1	On Grade 2.0m Lintel
340/40	308825.8	6251954	34.88	1	On Grade 2.0m Lintel
340/50	308823.6	6251945	34.9	1	On Grade 1.8m Lintel
350/10	308861.7	6251937	32.93	0	
360/10	308913	6252034	34.48	1	On Grade 2.0m Lintel
560/05	309590	6252602	16.79	0	
560/20	309562.2	6252472	18.82	1	On Grade 2.0m Lintel
560/30	309555	6252425	18.88	1	On Grade 2.0m Lintel
560/40	309551.7	6252403	18.99	1	On Grade 2.0m Lintel
660/05	309338.4	6252645	18.6	0	
660/10	309310.4	6252547	19.28	1	On Grade 2.0m Lintel
660/20	309296	6252452	19.8	1	On Grade 2.0m Lintel
840/100	309351.3	6251331	34.15	1	On Grade 2.7m Lintel
840/110	309364.1	6251330	34.08	1	On Grade 1.8m Lintel
840/30	309140.9	6251784	22.87	0	
840/40	309162.6	6251764	23.03	1	On Grade 1.0m Lintel
840/50	309228.8	6251736	23.74	1	On Grade 2.4m Lintel
840/60	309206.2	6251587	25.8	1	On Grade 2.0m Lintel
840/70	309189.7	6251478	27.8	1	On Grade 1.2m Lintel
840/80	309263.7	6251407	29.55	0	
840/90	309279.1	6251383	30.2	1	On Grade 0.8m Lintel
920/10	309216	6251604	25.83	1	On Grade 2.0m Lintel
960/10	309188.6	6251472	27.88	1	On Grade 3.6m Lintel
970/10	309278.1	6251375	30.3	1	On Grade 1.0m Lintel
980/20	309368	6251358	34.38	1	On Grade 2.0m Lintel
990/10	309372.3	6251350	34.7	1	On Grade 2.0m Lintel
Oct-30	309526.3	6252169	19.09	1	On Grade 2.0m Lintel
210/10	309306.8	6251966	20.82	0	
120/70	309403.8	6252069	19.73	1	On Grade 2.0m Lintel
120/300	308303.7	6251413	29.8	1	On Grade 2.0m Lintel

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
120/290	308348.6	6251437	29.2	1	On Grade 2.0m Lintel
1880/20	308338.9	6251364	29.26	1	On Grade 2.0m Lintel
1880/30	308270.8	6251330	29.74	1	On Grade 2.0m Lintel
1880/40	308216.4	6251317	30.95	0	
120/295	308342.1	6251436	29.57	0	
120/280	308428.7	6251471	28.7	1	On Grade 3.0m Lintel
120/286	308424.3	6251483	31.35	0	
120/260	308545.7	6251522	27.8	1	On Grade 3.0m Lintel
120/285	308427.3	6251475	28.7	0	
120/276	308507	6251519	30.275	0	
120/275	308509.6	6251510	28.23	0	
1201/10	308542.2	6251511	28.14	1	On Grade 3.0m Lintel
1201/20	308547.2	6251500	28.53	1	On Grade 3.0m Lintel
1201/30	308551.1	6251491	28.3	1	On Grade 3.0m Lintel
1201/40	308546.4	6251480	27.94	1	On Grade 3.0m Lintel
1201/50	308491.9	6251456	28.46	1	On Grade 3.0m Lintel
1201/60	308425	6251427	28.88	1	On Grade 3.0m Lintel
120/255	308581.3	6251541	27.75	0	
120/256	308577.7	6251550	30.08	0	
120/246	308635.2	6251575	30.44	0	
120/235	308712.9	6251601	26.61	0	
1202/10	308711.7	6251563	26.86	1	On Grade 2.0m Lintel
120/220	308781.7	6251630	26.5	1	On Grade 3.0m Lintel
120/225	308786	6251608	26.65	1	On Grade 3.0m Lintel
120/215	308855.9	6251680	26	1	
120/216	308862.7	6251653	26.06	1	On Grade 3.0m Lintel
120/205	308928.3	6251723	25.24	0	
120/195	308968.2	6251747	24.9	0	
1202/40	308582.8	6251496	27.84	1	On Grade 2.0m Lintel
1202/20	308672.3	6251543	27.23	1	On Grade 2.0m Lintel
1202/30	308627.3	6251516	27.56	1	On Grade 2.0m Lintel
1050/25	308830.8	6251206	26.85	1	On Grade 1.8m Lintel
340/36	308805.7	6252006	34.48	0	
10-May	309920.8	6252251	15.08	0	
1820/20	308409	6251104	31.7	1	On Grade 1.8m Lintel
1680/05	308534.3	6251413	28.06	0	
210/26	309005.8	6251664	23.23	1	On Grade 1.8m Lintel

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
210/20	309009	6251682	23.33	0	
1680/50	308272.1	6251381	29.96	1	On Grade 2.0m Lintel
1000/75	308824.4	6251061	28.46	0	
Oct-20	309703	6252260	17.2	0	
340/35	308841.4	6251999	33.645	0	
210/30	308971	6251658	23.9	0	
980/05	309365.1	6251351	34.41	0	
840/56	309206.6	6251599	25.97	0	
840/55	309214.6	6251638	25.13	0	
840/114	309350.5	6251325	34.15	1	On Grade 1.8m Lintel
840/115	309363.4	6251326	34.12	1	On Grade 1.8m Lintel
1680/26	308520.1	6251362	28.34	0	
1680/25	308520.9	6251368	28.1	0	
1680/06	308532.2	6251413	27.7	0	
840/95	309280.3	6251382	30.28	1	On Grade 1.0m Lintel
210/25	308998.6	6251675	23.2	0	
1680/75	308196.6	6251305	31.37	0	
1880/25	308310.2	6251350	29.74	0	
280/10	309273	6251982	20.87	1	On Grade 1.0m Lintel
280/20	309255.6	6251987	27.76	1	On Grade 1.0m Lintel
120/05	309663.9	6252328	18.6	0	
1290/10	308932.3	6251027	28.3	0	
1300/10	308946.2	6251037	28.12	0	
1310/10	308951.4	6251031	28.48	1	On Grade 1.8m Lintel
1290/20	308948.9	6251023	28.57	1	On Grade 1.8m Lintel
1290/30	309046	6251000	30.46	0	
1320/10	309053.1	6251007	30.58	1	On Grade 2.0m Lintel
1320/20	309072.5	6251003	30.83	1	On Grade 1.8m Lintel
1290/40	309063.2	6250996	30.76	0	
1290/50	309066.3	6250995	30.91	1	On Grade 1.8m Lintel
1330/05	309062.1	6250992	30.77	0	
1380/10	308914.1	6250953	29.3	0	
1390/10	308918	6250942	29.82	1	On Grade 1.5m Lintel
1240/10	308840.4	6251145	26.85	0	
1240/20	308943.7	6251121	28.24	1	On Grade 1.8m Lintel
1000/72	308835.8	6251146	27.18	0	
1050/40	308809	6251045	28.89	1	On Grade 1.8m Lintel

SKM

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
1050/50	308800.9	6250986	29.7	1	On Grade 2.2m Lintel
1050/60	308787.3	6250886	30.76	1	On Grade 1.0m Lintel
1080/10	308736	6251055	29.99	0	
1080/20	308721.6	6251051	30.12	1	On Grade 1.8m Lintel
1050/70	308779.4	6250879	30.76	0	
1050/80	308733.6	6250886	32.76	1	On Grade 2.0m Lintel
1050/90	308710	6250871	33.21	1	On Grade 1.8m Lintel
1050/100	308705.5	6250838	32.93	0	
1090/10	308777.6	6250870	30.75	0	
1090/20	308783.7	6250861	30.77	1	On Grade 1.8m Lintel
1770/110	308391.6	6250955	34.86	1	On Grade 1.8m Lintel
1770/120	308366.8	6250959	34.57	0	
1770/130	308365.7	6250950	34.58	0	
1770/140	308340.9	6250953	35.23	1	On Grade 1.8m Lintel
1870/10	308286.9	6250960	36.93	1	On Grade 1.8m Lintel
1720/20	308536.3	6251340	28.26	1	
1720/30	308624.4	6251329	29.85	1	On Grade 2.4m Lintel
1720/40	308631.1	6251321	30.1	1	On Grade 2.4m Lintel
1720/50	308640.1	6251307	30.47	0	
1720/60	308628.5	6251225	32.41	1	On Grade 1.8m Lintel
1720/70	308613.9	6251118	33.11	1	On Grade 1.8m Lintel
1720/80	308607.3	6251068	33.46	1	On Grade 1.8m Lintel
1720/90	308594.3	6250974	34.63	1	On Grade 2.7m Lintel
1720/10	308524.1	6251353	28.31	1	On Grade 1.8m Lintel
1780/10	308429.8	6251279	28.52	0	
1780/20	308428.1	6251270	28.71	0	
1780/30	308381.1	6251276	29.58	1	On Grade 1.8m Lintel
120/340	308225.9	6251410	31.72	1	On Grade 2.0m Lintel
120/350	308163.3	6251418	33.59	1	On Grade 2.0m Lintel
120/360	308080.4	6251430	34.86	1	On Grade 2.0m Lintel
460/10	308070.9	6251518	37.2	0	
460/20	308072.1	6251527	37.3	1	On Grade 2.0m Lintel
1910/10	308172.8	6251340	31.33	1	On Grade 2.0m Lintel
1910/20	308106.5	6251312	32.41	1	On Grade 2.0m Lintel
1910/30	307994.7	6251272	33.76	1	On Grade 2.0m Lintel
1910/40	307972.5	6251266	34.23	1	On Grade 2.0m Lintel
1910/50	307910.1	6251250	35.68	1	On Grade 2.0m Lintel

SKM

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
1910/60	307885.6	6251243	36.12	1	On Grade 2.0m Lintel
1910/70	307822.6	6251226	38	1	On Grade 2.0m Lintel
1910/80	307817.2	6251233	38.66	1	On Grade 2.0m Lintel
1910/90	307811.6	6251295	39.25	1	On Grade 2.0m Lintel
560/50	309531.2	6252387	18.76	1	On Grade 3.0m Lintel
2040/10	308103.6	6251195	32.09	1	On Grade 1.5m Lintel
2040/20	308096.8	6251192	32.09	1	On Grade 1.5m Lintel
2070/10	308017	6251212	32.64	1	On Grade 1.5m Lintel
2030/20	308105.5	6251157	32.86	0	
2030/30	308103.3	6251157	32.74	1	On Grade 1.5m Lintel
2030/40	308062.7	6251158	32.88	0	
2030/50	308054.9	6251096	33.48	0	
2050/10	308110	6251156	32.74	1	On Grade 1.5m Lintel
2050/40	308092.8	6251028	35.89	1	On Grade 1.5m Lintel
2050/30	308099.5	6251077	34.65	1	On Grade 1.5m Lintel
2050/20	308106	6251124	33.56	1	On Grade 1.5m Lintel
2030/60	308049.6	6251059	34.2	0	
2030/70	308042.3	6251005	35.21	0	
2030/80	308038.6	6250980	35.47	0	
560/10	309569	6252515	19.3	1	On Grade 2.0m Lintel
560/60	309486.3	6252394	18.82	1	On Grade 3.0m Lintel
560/70	309411.5	6252405	19.27	1	On Grade 3.0m Lintel
560/80	309331	6252417	19.6	1	On Grade 3.0m Lintel
660/30	309281.5	6252425	19.9	1	On Grade 2.0m Lintel
1160/10	308861.3	6251299	25.97	0	
150/20	309652.9	6252362	18.6	0	
150/10	309647.2	6252350	18.8	1	On Grade 1.8m Lintel
180/10	309455.3	6252166	19.1	0	
120/45	309488.6	6252152	19.38	0	
30-Oct	309516.3	6252150	18.9	0	
1680/07	308763.3	6251533	25.2	1	SIP 1.2m with grate
210/15	309308.9	6251964	20.7	0	
1880/60	308193.8	6251269	31.01	0	
1880/50	308200.2	6251271	31.25	0	
1680/76	308180.5	6251286	30.92	0	
1680/45	308285.6	6251385	30.13	0	
1680/44	308298.1	6251366	29.95	0	

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
1680/43	308315.2	6251381	29.73	0	
120/90	309330.4	6252031	21.09	1	On Grade 3.0m Lintel
120/80	309356.5	6252056	21.09	1	On Grade 3.0m Lintel
Node260	309305.3	6252675	20.23	0	
Node261	309356.9	6252645	19.65	0	
Node262	309386.8	6252608	19.42	0	
Node263	309408	6252562	18.91	0	
Node264	309442.9	6252567	19.15	0	
Node265	309467.6	6252580	19.01	0	
Node266	309481.7	6252580	19.68	0	
Node267	309498.1	6252568	19.66	0	
Node268	309533.9	6252566	19.46	0	
Node269	309564.9	6252597	19.35	0	
Node270	309598.7	6252617	18.91	0	
Node271	309657.1	6252614	18.9	0	
Node272	309775.6	6252589	19.25	0	
Node273	309883.2	6252502	16.92	0	
Node274	309906.6	6252433	17.21	0	
Node275	309869.8	6252415	17.19	0	
Node276	309888.5	6252390	17.15	0	
Node277	309927.2	6252299	17.24	0	
Node279	309397.7	6252571	19.73	0	
Node288	309241	6253002	20.31	0	
Node289	309288.5	6252936	20.83	0	
Node290	309260.9	6252819	20.34	0	
Node291	309210.1	6252747	20.37	0	
Node292	309149.1	6252731	20.6	0	
Node293	309167.5	6252681	20.14	0	
Node294	309209.2	6252631	21.54	0	
Node295	309263.4	6252660	21.47	0	
Node296	310054.1	6252153	14.93	0	
Node297	310097.5	6252130	16.48	0	
Node298	310149.6	6252151	16.71	0	
Node299	310189.6	6252153	16.85	0	
Node300	310227.7	6252199	14.46	0	
SO_1	309273.6	6252830	20.34	0	
SO_2	309293.2	6252679	20.23	0	

Name	Node X	Node Y	Ground Elevation m AHD	Inlet Capacity Flag (Note:0 = sealed pit; 1 = pit inlet)	Approach Depth Reference (Note: all pits rated by approach depth)
S0_3	309542.1	6252606	17.79	0	
S0_4	309890.4	6252405	17.15	0	
Node307	309963.1	6252241	15.18	0	

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Table A-2 Smithfield XP-STORM Pipe and Link Data

Note: Table below includes data for modelled pipes and links, including dummy links

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
120ak	120/130	120/120	19.91	19.27	Rectangular	1.2	2.4	68.31	0.014	Pressure Change Coeff.	1.5
589.1	10/10	10/05	14.48	13.28	Circular	1.8	0	206.52	0.014	Pressure Change Coeff.	1.5
589.2	10/10	10/05	14.48	13.28	Circular	1.8	0	206.52	0.014	Pressure Change Coeff.	1.5
589.3	10/10	10/05	14.48	13.28	Circular	1.8	0	206.52	0.014	Pressure Change Coeff.	1.5
589.4	10/10	10/10	14.48	13.28	Circular	1.8	0	206.52	0.014	Pressure Change Coeff.	1.5
120ba	100/10	10/10	14.79	14.48	Circular	1.8	0	5.83	0.014	Pressure Change Coeff.	1.5
1000m	1000/100	1000/90	27.36	26.82	Circular	1.05	0	77.23	0.014	Pressure Change Coeff.	1.5
1000k	1000/110	1000/105	28.43	28.29	Circular	0.9	0	77.38	0.014	Pressure Change Coeff.	1.5
1000j	1000/120	1000/110	28.61	28.43	Circular	0.9	0	16.11	0.014	Pressure Change Coeff.	1.5
1000i	1000/140	1000/120	28.95	28.66	Circular	0.75	0	20.95	0.014	Pressure Change Coeff.	1.5
1000h	1000/150	1000/140	29.77	28.95	Circular	0.75	0	85.2	0.014	Pressure Change Coeff.	1.5
1000g	1000/160	1000/150	29.9	29.77	Circular	0.75	0	11.41	0.014	Pressure Change Coeff.	1.5
1000f	1000/180	1000/160	31.78	29.9	Circular	0.675	0	87.89	0.014	Pressure Change Coeff.	1.5
1000e	1000/190	1000/180	31.82	31.78	Circular	0.675	0	8.32	0.014	Pressure Change Coeff.	1.5
1000w	1000/20	210/30	21.95	21.14	Circular	1.65	0	104.47	0.014	Pressure Change Coeff.	1.5
1000d	1000/200	1000/190	31.92	31.82	Circular	0.675	0	27.8	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
1000c	1000/210	1000/200	33.66	31.94	Circular	0.525	0	84.44	0.014	Pressure Change Coeff.	1.5
1000b	1000/220	1000/210	33.89	33.66	Circular	0.525	0	8.86	0.014	Pressure Change Coeff.	1.5
1000v	1000/30	1000/20	22.12	21.95	Circular	1.5	0	19.95	0.014	Pressure Change Coeff.	1.5
1000u	1000/40	1000/30	22.79	22.12	Circular	1.5	0	85.72	0.014	Pressure Change Coeff.	1.5
1000t	1000/50	1000/40	23.6	22.79	Circular	1.5	0	71.49	0.014	Pressure Change Coeff.	1.5
1000s	1000/60	1000/50	23.6	23.6	Circular	1.5	0	14.03	0.014	Pressure Change Coeff.	1.5
1000r	1000/70	1000/60	24.17	23.6	Circular	1.5	0	73.77	0.014	Pressure Change Coeff.	1.5
1000o	1000/80	1000/75	26.23	26	Circular	1.2	0	52.45	0.014	Pressure Change Coeff.	1.5
1000n	1000/90	1000/80	26.62	26.36	Circular	1.05	0	14.05	0.014	Pressure Change Coeff.	1.5
1050j	1050/20	1000/70	24.92	24.17	Circular	1.05	0	85.09	0.014	Pressure Change Coeff.	1.5
1050h	1050/30	1050/25	25.55	25.18	Circular	0.9	0	55.62	0.014	Pressure Change Coeff.	1.5
120az	120/10	100/10	16.12	14.79	Circular	1.8	0	92.29	0.014	Pressure Change Coeff.	1.5
120ay	120/10	120/05	16.12	16.1	Circular	1.8	0	3.88	0.014	Pressure Change Coeff.	1.5
120aq	120/75	120/70	17.83	17.7	Rectangular	1.2	2.4	32.64	0.014	Pressure Change Coeff.	1.5
120an	120/100	120/90	18.74	18.43	Rectangular	1.2	2.4	33.3	0.014	Pressure Change Coeff.	1.5
120al	120/120	120/110	19.27	19.05	Rectangular	1.2	2.4	22.97	0.014	Pressure Change Coeff.	1.5
120aj	120/140	120/130	20.46	19.91	Circular	1.65	0	58.77	0.014	Pressure Change Coeff.	1.5
120ai	120/150	120/140	21.06	20.46	Circular	1.65	0	63.17	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
120ah	120/160	120/150	21.63	21.06	Circular	1.65	0	60.5	0.014	Pressure Change Coeff.	1.5
120ag	120/170	120/160	22.01	21.63	Circular	1.65	0	40.32	0.014	Pressure Change Coeff.	1.5
120af	120/180	120/170	22.33	22.01	Circular	1.65	0	33.33	0.014	Pressure Change Coeff.	1.5
120ax	120/20	120/10	16.35	16.12	Circular	1.8	0	52.75	0.014	Pressure Change Coeff.	1.5
120ae	120/190	120/180	22.54	22.33	Circular	1.65	0	46.19	0.014	Pressure Change Coeff.	1.5
120ac	120/200	120/190	22.72	22.54	Circular	1.65	0	47.72	0.014	Pressure Change Coeff.	1.5
120aa	120/210	120/200	23	22.72	Circular	1.65	0	83.19	0.014	Pressure Change Coeff.	1.5
120v	120/230	120/220	24	23.6	Circular	1.65	0	68.09	0.014	Pressure Change Coeff.	1.5
120s	120/245	120/240	25.55	25	Circular	0.375	0	3.16	0.014	Pressure Change Coeff.	1.5
120aw	120/30	120/20	16.61	16.35	Circular	1.8	0	47.91	0.014	Pressure Change Coeff.	1.5
120d	120/330	120/300	28.6	27.85	Circular	1.2	0	48.5	0.014	Pressure Change Coeff.	1.5
1680i	120/330	1680/50	28.6	28.2	Circular	0.6	0	29.84	0.014	Pressure Change Coeff.	1.5
120av	120/40	120/30	16.84	16.61	Circular	1.8	0	48.21	0.014	Pressure Change Coeff.	1.5
120at	120/50	120/45	17.3	17.23	Rectangular	1.2	2.4	15.97	0.014	Pressure Change Coeff.	1.5
120as	120/60	120/50	17.5	17.3	Rectangular	1.2	2.4	51.16	0.014	Pressure Change Coeff.	1.5
1000l	1000/105	1000/100	28.29	27.61	Circular	0.9	0	9.31	0.014	Pressure Change Coeff.	1.5
1680r	1680/10	1680/25	26.4	26.37	Circular	0.375	0	2.53	0.014	Pressure Change Coeff.	1.5
1680b	1680/100	1680/90	31.16	31.07	Circular	0.825	0	10.9	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
1680a	1680/110	1680/100	31.58	31.16	Circular	0.825	0	11.45	0.014	Pressure Change Coeff.	1.5
1680p	1680/30	1680/26	26.46	26.2	Circular	1.5	0	44.86	0.014	Pressure Change Coeff.	1.5
1680o	1680/40	1680/30	26.63	26.46	Circular	1.35	0	91.54	0.014	Pressure Change Coeff.	1.5
1680h	1680/60	1680/50	28.82	28.2	Circular	1.05	0	45.82	0.014	Pressure Change Coeff.	1.5
1680g	1680/70	1680/60	29.11	28.82	Circular	1.05	0	19.92	0.014	Pressure Change Coeff.	1.5
1680d	1680/80	1680/76	30.21	29.79	Circular	1.05	0	113.3	0.014	Pressure Change Coeff.	1.5
1680c	1680/90	1680/80	31	30.37	Circular	0.9	0	70.02	0.014	Pressure Change Coeff.	1.5
120t	120/240	120/230	25	24.65	Circular	1.5	0	88.31	0.014	Pressure Change Coeff.	1.5
120q	120/250	120/240	25.4	25	Circular	1.5	0	62.74	0.014	Pressure Change Coeff.	1.5
120m	120/270	120/260	25.85	25.67	Circular	1.5	0	37.7	0.014	Pressure Change Coeff.	1.5
1770l	1770/10	1680/30	26.52	26.46	Circular	1.05	0	15.86	0.014	Pressure Change Coeff.	1.5
1770e	1770/100	1770/90	33.15	32.29	Circular	0.525	0	56.12	0.014	Pressure Change Coeff.	1.5
1770k	1770/30	1770/10	26.99	26.52	Circular	1.05	0	74.33	0.014	Pressure Change Coeff.	1.5
1770j	1770/50	1770/30	28.09	26.99	Circular	0.9	0	82.92	0.014	Pressure Change Coeff.	1.5
1770i	1770/60	1770/50	29.84	28.3	Circular	0.675	0	76.12	0.014	Pressure Change Coeff.	1.5
1770h	1770/70	1770/60	30.65	30.04	Circular	0.6	0	28.17	0.014	Pressure Change Coeff.	1.5
1770g	1770/80	1770/70	31.95	30.65	Circular	0.6	0	57.48	0.014	Pressure Change Coeff.	1.5
1770f	1770/90	1770/80	32.29	32	Circular	0.525	0	20.8	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
1810d	1810/10	1770/60	30	29.84	Circular	0.45	0	20.56	0.014	Pressure Change Coeff.	1.5
1810c	1810/20	1810/10	30.23	30.07	Circular	0.375	0	9.39	0.014	Pressure Change Coeff.	1.5
1810b	1810/30	1810/20	30.57	30.27	Circular	0.375	0	46.69	0.014	Pressure Change Coeff.	1.5
1810a	1810/40	1810/30	30.98	30.57	Circular	0.375	0	34.11	0.014	Pressure Change Coeff.	5
1820b	1820/10	1770/60	30.75	30.24	Circular	0.375	0	11.66	0.014	Pressure Change Coeff.	1.5
1830a	1830/10	1770/80	32.35	32.08	Circular	0.375	0	13.36	0.014	Pressure Change Coeff.	1.5
1840b	1840/10	1770/80	32.4	32.02	Circular	0.375	0	7.84	0.014	Pressure Change Coeff.	1.5
1840a	1840/20	1840/10	32.5	32.4	Circular	0.375	0	9.21	0.014	Pressure Change Coeff.	1.5
1880h	1880/10	1680/40	26.66	26.63	Circular	1.2	0	17.11	0.014	Pressure Change Coeff.	1.5
2030h	2030/10	1680/76	30.47	29.79	Circular	0.9	0	140.67	0.014	Pressure Change Coeff.	1.5
120am	120/110	120/100	19.05	18.74	Rectangular	1.2	2.4	32.98	0.014	Pressure Change Coeff.	1.5
340g	340/10	120/140	29.62	20.46	Circular	0.6	0	276.35	0.014	Pressure Change Coeff.	1.5
340f	340/20	340/10	29.72	29.62	Circular	0.525	0	10.45	0.014	Pressure Change Coeff.	1.5
340e	340/30	340/20	32.56	29.72	Circular	0.375	0	62.77	0.014	Pressure Change Coeff.	1.5
340b	340/40	340/35	33.98	33.27	Circular	0.375	0	47.96	0.014	Pressure Change Coeff.	1.5
340a	340/50	340/40	34.18	33.98	Circular	0.375	0	9.27	0.014	Pressure Change Coeff.	5
350a	350/10	340/20	32.25	29.72	Circular	0.525	0	58.8	0.014	Pressure Change Coeff.	5
360a	360/10	340/30	33.52	33	Circular	0.375	0	15.82	0.014	Pressure Change Coeff.	1.5

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Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
Dummy2	560/05	Node270	15.74	14.3	Trapezoidal	1	5	5	0.014	Pressure Change Coeff.	1.5
560g	560/20	560/10	16.5	16.29	Circular	0.9	0	43.53	0.014	Pressure Change Coeff.	1.5
560f	560/30	560/20	16.75	16.5	Circular	0.9	0	48.09	0.014	Pressure Change Coeff.	1.5
560e	560/40	560/30	16.87	16.75	Circular	0.9	0	22.13	0.014	Pressure Change Coeff.	1.5
Dummy1	660/05	Node261	17.6	15.5	Trapezoidal	1	5	5	0.014	Pressure Change Coeff.	1.5
660a	660/10	660/05	18.28	17.6	Circular	0.9	0	104.03	0.014	Pressure Change Coeff.	1.5
660b	660/20	660/10	18.8	18.28	Circular	0.9	0	96.2	0.014	Pressure Change Coeff.	1.5
840e	840/100	840/95	32.9	29.13	Circular	0.45	0	101.76	0.014	Pressure Change Coeff.	1.5
840b	840/110	840/100	33.03	32.9	Circular	0.375	0	12.71	0.014	Pressure Change Coeff.	1.5
593.1	840/30	210/10	19.87	18.09	Circular	1.8	0	249.65	0.014	Pressure Change Coeff.	1.5
593.2	840/30	210/10	19.87	18.09	Circular	1.8	0	249.65	0.014	Pressure Change Coeff.	1.5
840o	840/40	840/30	21.02	19.87	Circular	0.9	0	29.03	0.014	Pressure Change Coeff.	1.5
840n	840/50	840/40	22.42	21.02	Circular	0.9	0	74.08	0.014	Pressure Change Coeff.	1.5
840k	840/60	840/56	24.3	24.1	Circular	0.75	0	11.32	0.014	Pressure Change Coeff.	1.5
840j	840/70	840/60	26.6	24.38	Circular	0.675	0	111.24	0.014	Pressure Change Coeff.	1.5
840i	840/80	840/70	28.56	26.6	Circular	0.6	0	114.66	0.014	Pressure Change Coeff.	1.5
840h	840/90	840/80	29.12	28.58	Circular	0.525	0	28.63	0.014	Pressure Change Coeff.	1.5
920a	920/10	840/55	24.98	23.61	Circular	0.375	0	33.46	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
960a	960/10	840/70	26.88	26.75	Circular	0.375	0	5.7	0.014	Pressure Change Coeff.	1.5
970a	970/10	840/90	29.41	29.12	Circular	0.3	0	7.73	0.014	Pressure Change Coeff.	1.5
980a	980/20	980/05	33.47	33.4	Circular	0.3	0	7.25	0.014	Pressure Change Coeff.	5
990a	990/10	980/05	33.85	33.78	Circular	0.3	0	7.3	0.014	Pressure Change Coeff.	1.5
591.1	10/30	10/20	16.4	14.76	Circular	1.8	0	202.51	0.014	Pressure Change Coeff.	1.5
591.2	10/30	10/20	16.4	14.76	Circular	1.8	0	202.51	0.014	Pressure Change Coeff.	1.5
591.3	10/30	10/20	16.4	14.76	Circular	1.8	0	202.51	0.014	Pressure Change Coeff.	1.5
592.1	210/10	30/10	18.09	16.67	Circular	1.8	0	279.38	0.014	Pressure Change Coeff.	1.5
592.2	210/10	30/10	18.09	16.67	Circular	1.8	0	279.38	0.014	Pressure Change Coeff.	1.5
592.3	210/10	30/10	18.09	16.67	Circular	1.8	0	279.38	0.014	Pressure Change Coeff.	1.5
120ar	120/70	120/60	17.7	17.5	Rectangular	1.2	2.4	51.2	0.014	Pressure Change Coeff.	1.5
120e	120/300	120/290	27.85	27.4	Circular	1.2	0	50.61	0.014	Pressure Change Coeff.	1.5
120g	120/290	120/280	27.25	26.55	Circular	1.35	0	87.01	0.014	Pressure Change Coeff.	1.5
1880g	1880/20	1880/10	26.73	26.66	Circular	1.2	0	32.11	0.014	Pressure Change Coeff.	1.5
1880e	1880/30	1880/25	27.94	27.8	Circular	1.2	0	44.53	0.014	Pressure Change Coeff.	1.5
1880d	1880/40	1880/30	29.52	27.94	Circular	1.2	0	56.02	0.014	Pressure Change Coeff.	1.5
120f	120/295	120/290	27.3	27.25	Circular	0.9	0	6.54	0.014	Pressure Change Coeff.	1.5
120j	120/280	120/270	26.55	25.85	Circular	1.35	0	89.67	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
120h	120/286	120/285	30.6	28.1	Circular	0.375	0	8.99	0.014	Pressure Change Coeff.	1.5
120n	120/260	120/250	25.67	25.4	Circular	1.5	0	40.05	0.014	Pressure Change Coeff.	1.5
120i	120/285	120/280	27.1	26.8	Circular	0.375	0	3.59	0.014	Pressure Change Coeff.	1.5
120k	120/276	120/275	29.9	27.4	Circular	0.375	0	8.94	0.014	Pressure Change Coeff.	1.5
120l	120/275	120/270	26.4	26.1	Circular	0.375	0	3.62	0.014	Pressure Change Coeff.	1.5
1201f	1201/10	120/260	26.86	26.8	Circular	0.525	0	11.24	0.014	Pressure Change Coeff.	1.5
1201e	1201/20	1201/10	26.92	26.86	Circular	0.375	0	11.99	0.014	Pressure Change Coeff.	1.5
1201d	1201/30	1201/20	27	26.92	Circular	0.375	0	10.24	0.014	Pressure Change Coeff.	1.5
1201c	1201/40	1201/30	27.08	27	Circular	0.375	0	12.27	0.014	Pressure Change Coeff.	1.5
1201b	1201/50	1201/40	27.45	27.08	Circular	0.375	0	59.41	0.014	Pressure Change Coeff.	1.5
1201a	1201/60	1201/50	27.9	27.45	Circular	0.375	0	72.71	0.014	Pressure Change Coeff.	1.5
120p	120/255	120/250	25.95	25.4	Circular	0.375	0	3.34	0.014	Pressure Change Coeff.	1.5
120o	120/256	120/255	29.45	26.95	Circular	0.375	0	9.59	0.014	Pressure Change Coeff.	1.5
120r	120/246	120/245	29.05	26.55	Circular	0.375	0	9.91	0.014	Pressure Change Coeff.	1.5
120u	120/235	120/230	24.7	24.65	Circular	0.9	0	8.39	0.014	Pressure Change Coeff.	1.5
1202d	1202/10	120/230	26.05	25.8	Circular	0.375	0	36.76	0.014	Pressure Change Coeff.	1.5
120x	120/220	120/210	23.6	23	Circular	1.65	0	90.94	0.014	Pressure Change Coeff.	1.5
120w	120/225	120/220	25.6	25.55	Circular	0.375	0	22.75	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
120y	120/215	120/210	24.25	24.2	Circular	0.525	0	5.28	0.014	Pressure Change Coeff.	1.5
120z	120/216	120/210	25	24.9	Circular	0.375	0	23.42	0.014	Pressure Change Coeff.	1.5
120ab	120/205	120/200	24.25	23.7	Circular	0.525	0	3.92	0.014	Pressure Change Coeff.	1.5
120ad	120/195	120/190	24.05	22.7	Circular	0.525	0	4.63	0.014	Pressure Change Coeff.	1.5
1202a	1202/40	1202/30	26.76	26.52	Circular	0.375	0	48.94	0.014	Pressure Change Coeff.	1.5
1202c	1202/20	1202/10	26.36	26.05	Circular	0.375	0	44.22	0.014	Pressure Change Coeff.	1.5
1202b	1202/30	1202/20	26.52	26.36	Circular	0.375	0	52.38	0.014	Pressure Change Coeff.	1.5
1050i	1050/25	1050/20	25.18	24.92	Circular	0.9	0	25.34	0.014	Pressure Change Coeff.	1.5
340c	340/36	340/35	33.9	33.27	Circular	0.375	0	36.42	0.014	Pressure Change Coeff.	5
Link307	10/05	Node307	14	12.3	Trapezoidal	1	10	5	0.014	Pressure Change Coeff.	1.5
1820a	1820/20	1820/10	30.93	30.79	Circular	0.375	0	9.4	0.014	Pressure Change Coeff.	1.5
1680t	1680/05	1680/06	26.46	26.43	Circular	0.375	0	2.15	0.014	Pressure Change Coeff.	1.5
210c	210/26	210/20	21.77	21.6	Circular	0.9	0	18.43	0.014	Pressure Change Coeff.	1.5
594.1	210/20	840/30	20.73	19.87	Circular	1.8	0	167.39	0.014	Pressure Change Coeff.	1.5
594.2	210/20	840/30	20.73	19.87	Circular	1.8	0	167.39	0.014	Pressure Change Coeff.	1.5
1680j	1680/50	1680/45	28.2	27.63	Circular	1.05	0	14.34	0.014	Pressure Change Coeff.	1.5
1000p	1000/75	1000/72	26	25.52	Circular	1.2	0	85.77	0.014	Pressure Change Coeff.	1.5
588.1	10/20	10/10	14.76	14.48	Circular	1.8	0	22.73	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
588.2	10/20	10/10	14.76	14.48	Circular	1.8	0	22.73	0.014	Pressure Change Coeff.	1.5
588.3	10/20	10/10	14.76	14.48	Circular	1.8	0	22.73	0.014	Pressure Change Coeff.	1.5
340d	340/35	340/30	33.27	32.56	Circular	0.375	0	87.61	0.014	Pressure Change Coeff.	1.5
550.1	210/30	210/25	21.14	20.8	Circular	1.8	0	32.72	0.014	Pressure Change Coeff.	1.5
550.2	210/30	210/25	21.14	20.8	Circular	1.8	0	32.72	0.014	Pressure Change Coeff.	1.5
980b	980/05	840/110	33.4	33.2	Circular	0.3	0	20.61	0.014	Pressure Change Coeff.	1.5
840l	840/56	840/55	24.1	23.61	Circular	0.75	0	39.96	0.014	Pressure Change Coeff.	1.5
840m	840/55	840/50	23.61	22.42	Circular	0.9	0	99.18	0.014	Pressure Change Coeff.	1.5
840c	840/114	840/100	32.97	32.9	Circular	0.375	0	5.84	0.014	Pressure Change Coeff.	1.5
840a	840/115	840/110	33.1	33.03	Circular	0.375	0	4.67	0.014	Pressure Change Coeff.	1.5
1680q	1680/26	1680/25	26.2	26.1	Circular	1.8	0	6.63	0.014	Pressure Change Coeff.	1.5
1680s	1680/25	1680/06	26.1	25.9	Circular	1.8	0	46.46	0.014	Pressure Change Coeff.	1.5
1680u	1680/06	1680/07	25.9	22.63	Circular	1.8	0	268.05	0.014	Pressure Change Coeff.	1.5
840g	840/95	840/90	29.12	29.02	Circular	0.525	0	1.38	0.014	Pressure Change Coeff.	1.5
616.1	210/25	210/20	20.8	20.73	Circular	1.8	0	12.17	0.014	Pressure Change Coeff.	1.5
616.2	210/25	210/20	20.8	20.73	Circular	1.8	0	12.17	0.014	Pressure Change Coeff.	1.5
1680f	1680/75	1680/70	29.7	29.11	Circular	1.05	0	46.98	0.014	Pressure Change Coeff.	1.5
1880c	1680/75	1880/40	29.7	29.52	Circular	1.05	0	22.84	0.014	Pressure Change Coeff.	1.5

SKM

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
1880f	1880/25	1880/20	26.9	26.73	Circular	1.2	0	31.28	0.014	Pressure Change Coeff.	1.5
280b	280/10	120/110	19.6	19.51	Circular	0.9	0	10.38	0.014	Pressure Change Coeff.	1.5
280a	280/20	280/10	19.8	19.6	Circular	0.45	0	18.57	0.014	Pressure Change Coeff.	1.5
1290e	1290/10	1000/90	27.1	26.92	Circular	0.675	0	49.15	0.014	Pressure Change Coeff.	1.5
1300a	1300/10	1290/10	27.47	27.1	Circular	0.375	0	16.94	0.014	Pressure Change Coeff.	1.5
1310a	1310/10	1290/20	27.9	27.67	Circular	0.375	0	8.71	0.014	Pressure Change Coeff.	1.5
1290d	1290/20	1290/10	27.47	27.2	Circular	0.525	0	17.11	0.014	Pressure Change Coeff.	1.5
1290c	1290/30	1290/20	28.96	27.47	Circular	0.525	0	99.49	0.014	Pressure Change Coeff.	1.5
1320b	1320/10	1290/30	29.22	29.06	Circular	0.45	0	10.07	0.014	Pressure Change Coeff.	1.5
1320a	1320/20	1320/10	29.93	29.68	Circular	0.45	0	19.82	0.014	Pressure Change Coeff.	1.5
1290b	1290/40	1290/30	29.2	29.06	Circular	0.375	0	17.59	0.014	Pressure Change Coeff.	1.5
1290a	1290/50	1290/40	29.31	29.25	Circular	0.375	0	3.19	0.014	Pressure Change Coeff.	1.5
1330a	1330/05	1290/40	30.21	29.94	Circular	0.375	0	4.01	0.014	Pressure Change Coeff.	1.5
1380a	1380/10	1000/100	28.15	27.61	Circular	0.6	0	46.56	0.014	Pressure Change Coeff.	1.5
1390a	1390/10	1380/10	28.58	28.15	Circular	0.375	0	11.32	0.014	Pressure Change Coeff.	1.5
1240b	1240/10	1000/72	26.4	26.2	Circular	0.45	0	4.7	0.014	Pressure Change Coeff.	1.5
1240a	1240/20	1240/10	27.04	26.4	Circular	0.45	0	105.88	0.014	Pressure Change Coeff.	1.5
1000q	1000/72	1000/70	25.52	24.17	Circular	1.2	0	168	0.014	Pressure Change Coeff.	1.5

SKM

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1050g	1050/40	1050/30	27.09	25.6	Circular	0.75	0	107.24	0.014	Pressure Change Coeff.	1.5
1050f	1050/50	1050/40	28.1	27.09	Circular	0.675	0	59.58	0.014	Pressure Change Coeff.	1.5
1050e	1050/60	1050/50	29.03	28.1	Circular	0.675	0	101.15	0.014	Pressure Change Coeff.	1.5
1080b	1080/10	1050/40	28.95	27.39	Circular	0.45	0	73.55	0.014	Pressure Change Coeff.	1.5
1080a	1080/20	1080/10	29.35	28.97	Circular	0.375	0	14.95	0.014	Pressure Change Coeff.	1.5
1050d	1050/70	1050/60	29.3	29.21	Circular	0.675	0	10.17	0.014	Pressure Change Coeff.	1.5
1050c	1050/80	1050/70	30.85	29.41	Circular	0.6	0	46.1	0.014	Pressure Change Coeff.	1.5
1050b	1050/90	1050/80	31.11	30.91	Circular	0.525	0	27.71	0.014	Pressure Change Coeff.	1.5
1050a	1050/100	1050/90	31.64	31.33	Circular	0.525	0	34.07	0.014	Pressure Change Coeff.	1.5
1090b	1090/10	1050/70	29.62	29.43	Circular	0.375	0	9.93	0.014	Pressure Change Coeff.	1.5
1090a	1090/20	1090/10	29.7	29.65	Circular	0.375	0	10.3	0.014	Pressure Change Coeff.	1.5
1770d	1770/110	1770/100	33.24	33.21	Circular	0.525	0	7.6	0.014	Pressure Change Coeff.	1.5
1770c	1770/120	1770/110	33.34	33.24	Circular	0.525	0	24.92	0.014	Pressure Change Coeff.	1.5
1770b	1770/130	1770/120	33.47	33.36	Circular	0.525	0	9.32	0.014	Pressure Change Coeff.	1.5
1770a	1770/140	1770/130	34.01	33.53	Circular	0.45	0	24.98	0.014	Pressure Change Coeff.	1.5
1870a	1870/10	1770/140	35.78	34.17	Circular	0.375	0	54.36	0.014	Pressure Change Coeff.	1.5
1720h	1720/20	1720/10	26.97	26.86	Circular	0.375	0	18.54	0.014	Pressure Change Coeff.	1.5
1720g	1720/30	1720/20	27.49	26.97	Circular	0.525	0	88.54	0.014	Pressure Change Coeff.	1.5

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1720f	1720/40	1720/30	27.85	27.49	Circular	0.525	0	10.31	0.014	Pressure Change Coeff.	1.5
1720e	1720/50	1720/40	29	28.45	Circular	0.525	0	16.1	0.014	Pressure Change Coeff.	1.5
1720d	1720/60	1720/50	30.35	29	Circular	0.525	0	83.86	0.014	Pressure Change Coeff.	1.5
1720c	1720/70	1720/60	31.27	30.43	Circular	0.525	0	107.71	0.014	Pressure Change Coeff.	1.5
1720b	1720/80	1720/70	32.04	31.37	Circular	0.525	0	51.12	0.014	Pressure Change Coeff.	1.5
1720a	1720/90	1720/80	32.95	32.04	Circular	0.525	0	95.2	0.014	Pressure Change Coeff.	1.5
1720i	1720/10	1680/26	26.86	26.46	Circular	1.05	0	9.25	0.014	Pressure Change Coeff.	1.5
1780c	1780/10	1770/30	27.06	26.99	Circular	0.375	0	13.71	0.014	Pressure Change Coeff.	1.5
1780b	1780/20	1780/10	27.26	27.12	Circular	0.375	0	9.33	0.014	Pressure Change Coeff.	1.5
1780a	1780/30	1780/20	28.46	27.27	Circular	0.375	0	47.28	0.014	Pressure Change Coeff.	1.5
120c	120/340	120/330	29.6	28.6	Circular	0.6	0	30.02	0.014	Pressure Change Coeff.	1.5
120b	120/350	120/340	31.2	29.6	Circular	0.6	0	63.09	0.014	Pressure Change Coeff.	1.5
120a	120/360	120/350	32.85	31.2	Circular	0.6	0	83.51	0.014	Pressure Change Coeff.	1.5
460b	460/10	120/360	36.27	32.85	Circular	0.375	0	91.31	0.014	Pressure Change Coeff.	1.5
460a	460/20	460/10	36.39	36.27	Circular	0.375	0	9.25	0.014	Pressure Change Coeff.	5
1910o	1910/10	1680/60	29.5	28.82	Circular	0.825	0	61.63	0.014	Pressure Change Coeff.	1.5
1910n	1910/20	1910/10	30.3	29.5	Circular	0.75	0	71.62	0.014	Pressure Change Coeff.	1.5
1910m	1910/30	1910/20	33	30.3	Circular	0.75	0	118.86	0.014	Pressure Change Coeff.	1.5

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1910l	1910/40	1910/30	33.5	33	Circular	0.675	0	22.89	0.014	Pressure Change Coeff.	1.5
1910k	1910/50	1910/40	34.2	33.5	Circular	0.675	0	64.46	0.014	Pressure Change Coeff.	1.5
1910j	1910/60	1910/50	34.42	34.2	Circular	0.675	0	25.21	0.014	Pressure Change Coeff.	1.5
1910i	1910/70	1910/60	36.7	34.42	Circular	0.6	0	63.36	0.014	Pressure Change Coeff.	1.5
1910h	1910/80	1910/70	37.23	36.7	Circular	0.6	0	9.21	0.014	Pressure Change Coeff.	1.5
1910g	1910/90	1910/80	37.86	37.23	Circular	0.6	0	62.32	0.014	Pressure Change Coeff.	1.5
560d	560/50	560/40	16.98	16.87	Circular	0.9	0	26.16	0.014	Pressure Change Coeff.	1.5
2040b	2040/10	2030/10	30.93	30.63	Circular	0.9	0	6.86	0.014	Pressure Change Coeff.	1.5
2040a	2040/20	2040/10	31.14	31.06	Circular	0.375	0	7.43	0.014	Pressure Change Coeff.	1.5
2070a	2070/10	1680/100	31.83	31.43	Circular	0.375	0	10.19	0.014	Pressure Change Coeff.	1.5
2030g	2030/20	2030/10	31.07	30.63	Circular	0.75	0	37.74	0.014	Pressure Change Coeff.	1.5
2030f	2030/30	2030/20	31.16	31.14	Circular	0.75	0	2.21	0.014	Pressure Change Coeff.	1.5
2030e	2030/40	2030/30	31.45	31.16	Circular	0.75	0	40.5	0.014	Pressure Change Coeff.	1.5
2030d	2030/50	2030/40	31.99	31.53	Circular	0.75	0	62.23	0.014	Pressure Change Coeff.	1.5
2050d	2050/10	2030/20	31.68	31.53	Circular	0.375	0	4.62	0.014	Pressure Change Coeff.	1.5
2050a	2050/40	2050/30	34.99	33.58	Circular	0.375	0	49.21	0.014	Pressure Change Coeff.	5
2050b	2050/30	2050/20	33.58	32.44	Circular	0.375	0	48.32	0.014	Pressure Change Coeff.	1.5
2050c	2050/20	2050/10	32.44	31.68	Circular	0.375	0	31.57	0.014	Pressure Change Coeff.	1.5

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2030c	2030/60	2030/50	32.72	32.14	Circular	0.6	0	37.86	0.014	Pressure Change Coeff.	1.5
2030b	2030/70	2030/60	33.4	32.72	Circular	0.6	0	54.57	0.014	Pressure Change Coeff.	1.5
2030a	2030/80	2030/70	33.88	33.4	Circular	0.6	0	25.24	0.014	Pressure Change Coeff.	1.5
560h	560/10	560/05	16.14	15.74	Circular	1.05	0	89.48	0.014	Pressure Change Coeff.	1.5
560c	560/60	560/50	17.36	17.14	Circular	0.75	0	45.28	0.014	Pressure Change Coeff.	1.5
560b	560/70	560/60	17.79	17.44	Circular	0.675	0	75.57	0.014	Pressure Change Coeff.	1.5
560a	560/80	560/70	18.32	17.94	Circular	0.525	0	81.25	0.014	Pressure Change Coeff.	1.5
660c	660/30	660/20	19.1	18.8	Circular	0.375	0	30.34	0.014	Pressure Change Coeff.	1.5
1160a	1160/10	1000/70	24.97	24.83	Circular	0.375	0	13.52	0.014	Pressure Change Coeff.	1.5
150b	150/20	150/10	17.7	17.57	Circular	0.6	0	13.16	0.014	Pressure Change Coeff.	1.5
150a	150/10	120/10	16.6	16.12	Circular	0.75	0	25.07	0.014	Pressure Change Coeff.	1.5
180a	180/10	120/45	18.3	17.94	Circular	0.525	0	36.28	0.014	Pressure Change Coeff.	1.5
120au	120/45	120/40	17.23	16.84	Rectangular	1.2	2.4	97.84	0.014	Pressure Change Coeff.	1.5
705.1	30/10	10/30	16.67	16.4	Circular	1.8	0	21.48	0.014	Pressure Change Coeff.	1.5
705.2	30/10	10/30	16.67	16.4	Circular	1.8	0	21.48	0.014	Pressure Change Coeff.	1.5
705.3	30/10	10/30	16.67	16.4	Circular	1.8	0	21.48	0.014	Pressure Change Coeff.	1.5
1680v	1680/07	210/30	22.63	21.14	Circular	1.8	0	241.99	0.014	Pressure Change Coeff.	1.5
210f	210/15	210/10	19.2	19.17	Circular	0.525	0	3.41	0.014	Pressure Change Coeff.	1.5

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1880a	1880/60	1880/50	29.81	29.79	Circular	0.6	0	6.89	0.014	Pressure Change Coeff.	1.5
1880b	1880/50	1880/40	29.79	29.52	Circular	0.6	0	48.51	0.014	Pressure Change Coeff.	1.5
711.1	1680/76	1680/75	29.79	29.7	Circular	1.05	0	24.79	0.014	Pressure Change Coeff.	1.5
711.2	1680/76	1680/75	29.79	29.7	Circular	0.9	0	24.79	0.014	Pressure Change Coeff.	1.5
1680l	1680/45	1680/44	27.63	27.54	Circular	1.2	0	22.38	0.014	Pressure Change Coeff.	1.5
1680k	1680/45	1680/43	27.63	27.46	Circular	1.2	0	29.81	0.014	Pressure Change Coeff.	1.5
1680m	1680/44	1680/43	27.54	27.46	Circular	1.2	0	22.31	0.014	Pressure Change Coeff.	1.5
1680n	1680/43	1680/40	27.46	26.63	Circular	1.2	0	69.56	0.014	Pressure Change Coeff.	1.5
120ao	120/90	120/80	18.43	18.08	Rectangular	1.2	2.4	36.59	0.014	Pressure Change Coeff.	1.5
120ap	120/80	120/75	18.08	17.83	Rectangular	1.2	2.4	25.94	0.014	Pressure Change Coeff.	1.5
Link260	Node260	Node261	15.18	15.42	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link261	Node261	Node262	15.42	14.56	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link262	Node262	Node279	14.56	14.87	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link264	Node263	Node264	14.13	14.56	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link265	Node264	Node265	14.13	14.16	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link266	Node265	Node266	14.16	14.15	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link267	Node266	Node267	14.42	14.4	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link268	Node267	Node268	14.4	14.32	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
Link269	Node268	Node269	14.32	14.82	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link270	Node269	Node270	14.82	14.2	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link271	Node270	Node271	14.2	13.23	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link273	Node271	Node272	13.23	13.58	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link274	Node272	Node273	13.58	12	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link275	Node273	Node274	12	12.51	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link276	Node274	Node275	12.51	12.49	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link277	Node275	Node276	12.49	12.35	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link280	Node276	Node277	12.35	12.44	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link305	Node277	Node307	12.44	11.75	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link263	Node279	Node263	14.87	14.13	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link285	Node288	Node289	16.41	16.05	Natural	1.5	0	10	0.014	Pressure Change Coeff.	1.5
Link286	Node289	Node290	16.05	16.01	Natural	1.5	0	10	0.014	Pressure Change Coeff.	1.5
Link287	Node290	Node291	16.01	16.17	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link288	Node291	Node292	16.17	16.01	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link289	Node292	Node293	16.71	16.25	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link290	Node293	Node294	16.25	15.21	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link291	Node294	Node295	15.21	15.14	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation mAHD	Downstream Invert Elevation mAHD	Shape	Diameter (Height) m	Bottom Width m	Length m	Roughness	Entrance/Exit Loss Type	Pressure Change Coefficient Ku
Link292	Node295	Node260	15.14	15.18	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link294	Node296	Node297	11.5	11.59	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link295	Node297	Node298	11.59	11.01	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link296	Node298	Node299	11.01	11.15	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link297	Node299	Node300	11.15	11	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5
Link301	S0_1	Node290	16.05	16.01	Trapezoidal	0.05	5	5	0.014	Pressure Change Coeff.	1.5
Link302	S0_2	Node260	15.23	15.18	Trapezoidal	0.05	1	5	0.014	Pressure Change Coeff.	1.5
Link303	S0_3	Node269	14.87	14.82	Trapezoidal	0.05	1	5	0.014	Pressure Change Coeff.	1.5
Link309	S0_4	Node276	12.55	12.5	Trapezoidal	0.05	1	5	0.014	Pressure Change Coeff.	1.5
Link306	Node307	Node296	11.75	11.5	Natural	0	0	10	0.014	Pressure Change Coeff.	1.5

Table A-3 Smithfield XP-STORM Sub-Catchment Data

Catchment code	XP-STORM node	Area (ha)			Travel Length (m)	Slope (%)
		Total	Sub-Catch1 (Impervious)	Sub-Catch 2 (Pervious)		
S0	S0_1 to S0_4	24.05	12.61	11.45	325	4.072
S14	120/330	8.87	4.84	4.03	591	2.742
S15	460/20	1.43	0.72	0.72	166	4.028
S16	120/235	30.49	9.98	20.51	807	1.493
S17	120/170	7.78	3.03	4.75	500	4.490
S18	840/30	3.09	1.62	1.47	217	1.326
S19	210/20	5.37	2.58	2.79	344	0.385
S20	1201/60	0.41	0.37	0.04	154	0.241
S21	1202/40	0.13	0.12	0.01	42	0.658
S22	1680/07	3.00	1.42	1.58	297	1.930
S23	1000/30	8.46	3.19	5.27	455	2.218
S24	840/56	5.12	2.62	2.50	500	2.264
S25	840/50	10.11	5.06	5.06	482	3.523
S26	840/80	2.03	1.04	0.99	211	4.131
S27	840/100	0.14	0.07	0.07	83	4.228
S28	980/20	0.29	0.15	0.15	114	1.435
S29	840/110	1.62	1.13	0.49	121	1.379
S30	1910/90	6.32	3.16	3.15	466	4.072
S31	1680/45	10.00	6.20	3.80	838	2.689
S32	1680/110	9.22	4.47	4.75	419	2.695
S33	1680/76	4.14	1.77	2.37	344	1.337
S34	2030/80	3.64	1.58	2.06	184	2.106
S35	2050/40	0.59	0.30	0.30	103	2.924
S36	1680/05	6.64	4.03	2.61	523	2.119
S37	1770/10	3.95	1.93	2.02	116	0.172
S38	1780/30	2.41	1.21	1.21	364	2.490
S39	1870/10	0.64	0.31	0.33	210	1.915
S40	1770/50	5.99	3.00	3.00	346	1.848
S41	1770/100	5.06	2.53	2.53	838	1.211
S42	1810/40	1.59	0.80	0.80	306	2.647
S43	1720/90	3.17	1.59	1.59	315	2.194
S44	1160/10	9.61	5.21	4.40	497	2.170
S45	1080/20	0.98	0.49	0.49	144	1.878
S46	1050/30	4.66	2.23	2.43	419	2.333
S47	1050/100	5.86	2.86	3.00	375	2.072
S48	1090/20	0.84	0.42	0.42	309	2.739
S49	1240/20	1.68	0.84	0.84	243	3.032
S50	1240/10	4.76	2.38	2.38	327	1.352
S51	1290/50	3.41	1.87	1.54	273	2.141
S52	1000/100	5.64	2.92	2.72	715	1.310
S53	390/10	0.87	0.44	0.44	157	1.764
S54	1000/110	5.05	2.53	2.53	339	2.549

Catchment code	XP-STORM node	Area (ha)			Travel Length (m)	Slope (%)
		Total	Sub-Catch1 (Impervious)	Sub-Catch 2 (Pervious)		
S55	1000/160	6.98	3.44	3.54	387	1.626
S56	1000/220	4.27	2.14	2.14	234	3.409

Appendix B IFD and Design Rainfall Intensity Data

■ **Table B-1 Average Rainfall Intensities for Storm Events up to 500 year ARI (mm/hr)**

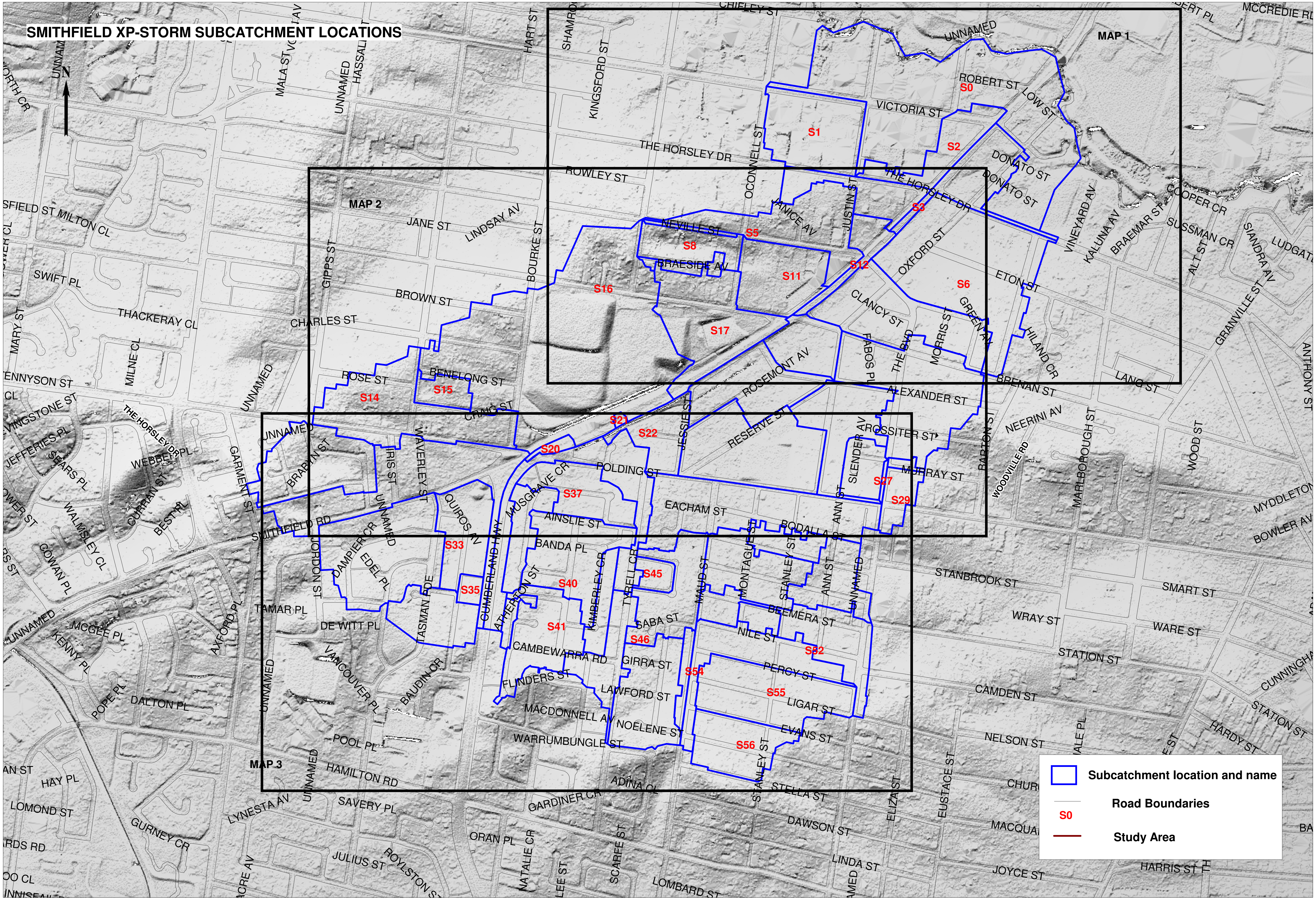
Duration	Event ARI			
	20 year	100 year	200 year	500 year
15min	109.2	140.0	N/A	N/A
30min	77.2	98.9	108.6	121.4
45min	61.8	79.3	N/A	N/A
1hr	52.5	67.3	73.8	82.4
1.5hr	41.3	53.1	58.3	65.3
2hr	34.7	44.7	49.2	55.2
3hr	27.0	34.9	38.6	43.4

* N/A = Not estimated

■ **Table B-2 Average Rainfall Intensities for Extreme Storm Events (mm/hr)**

Duration	Event ARI		
	2,000 year	10,000 year	PMP
30min	166.6	214.0	460
1hr	117.1	152.7	340
1.5hr	91.3	118.5	260
2hr	77.1	100.1	220
3hr	59.3	76.2	163

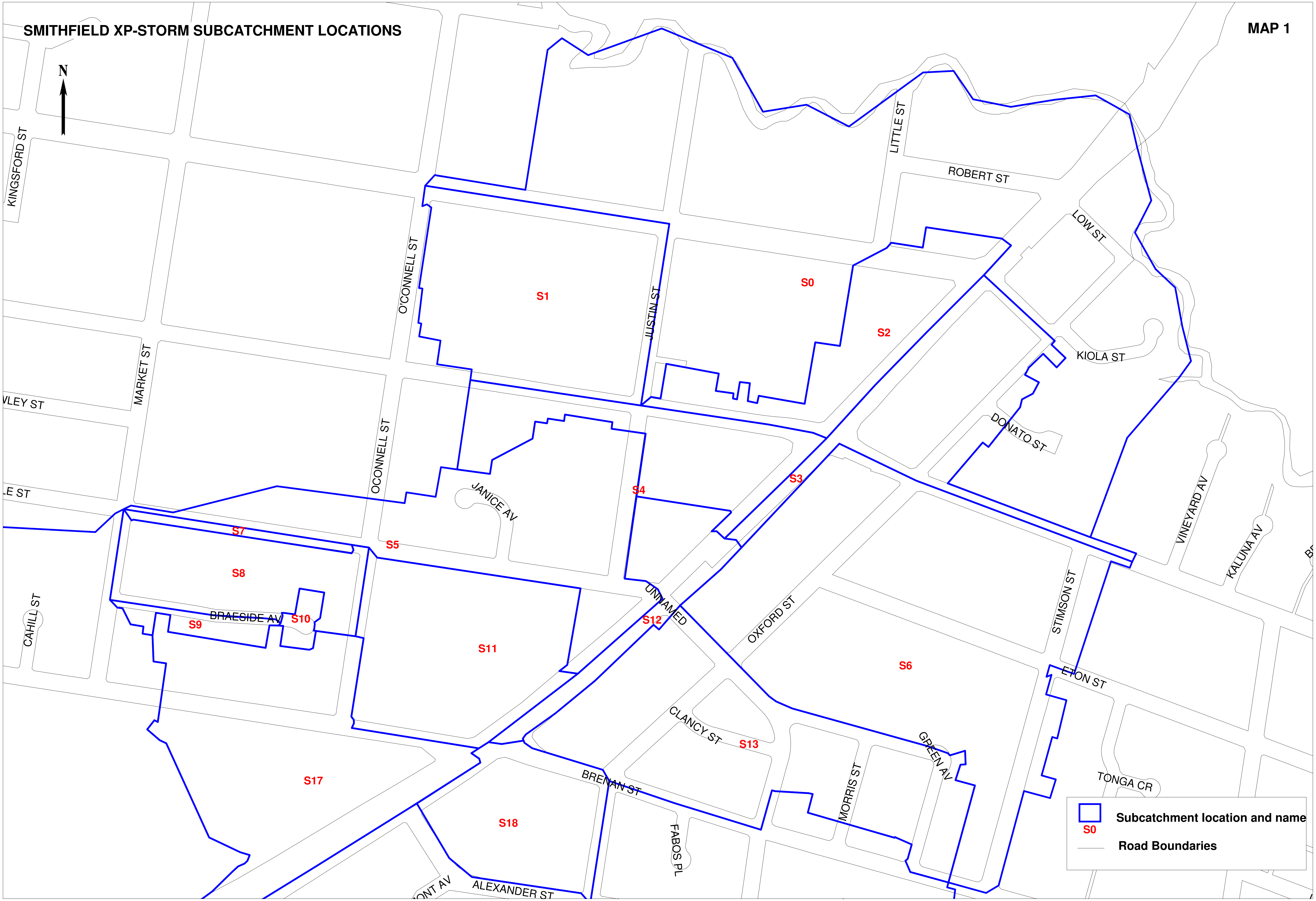
Appendix C Detailed Sub-Catchment Plans

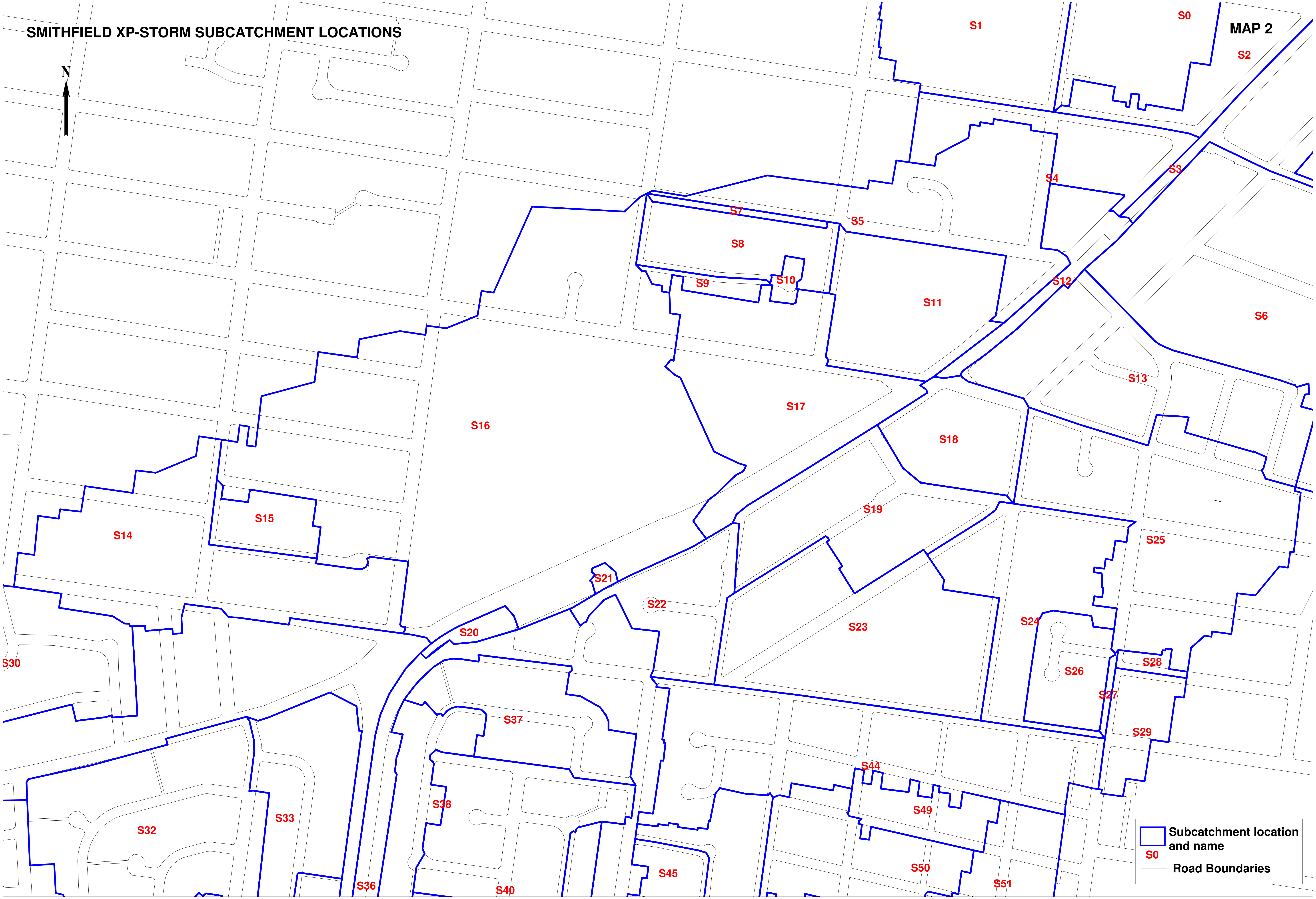


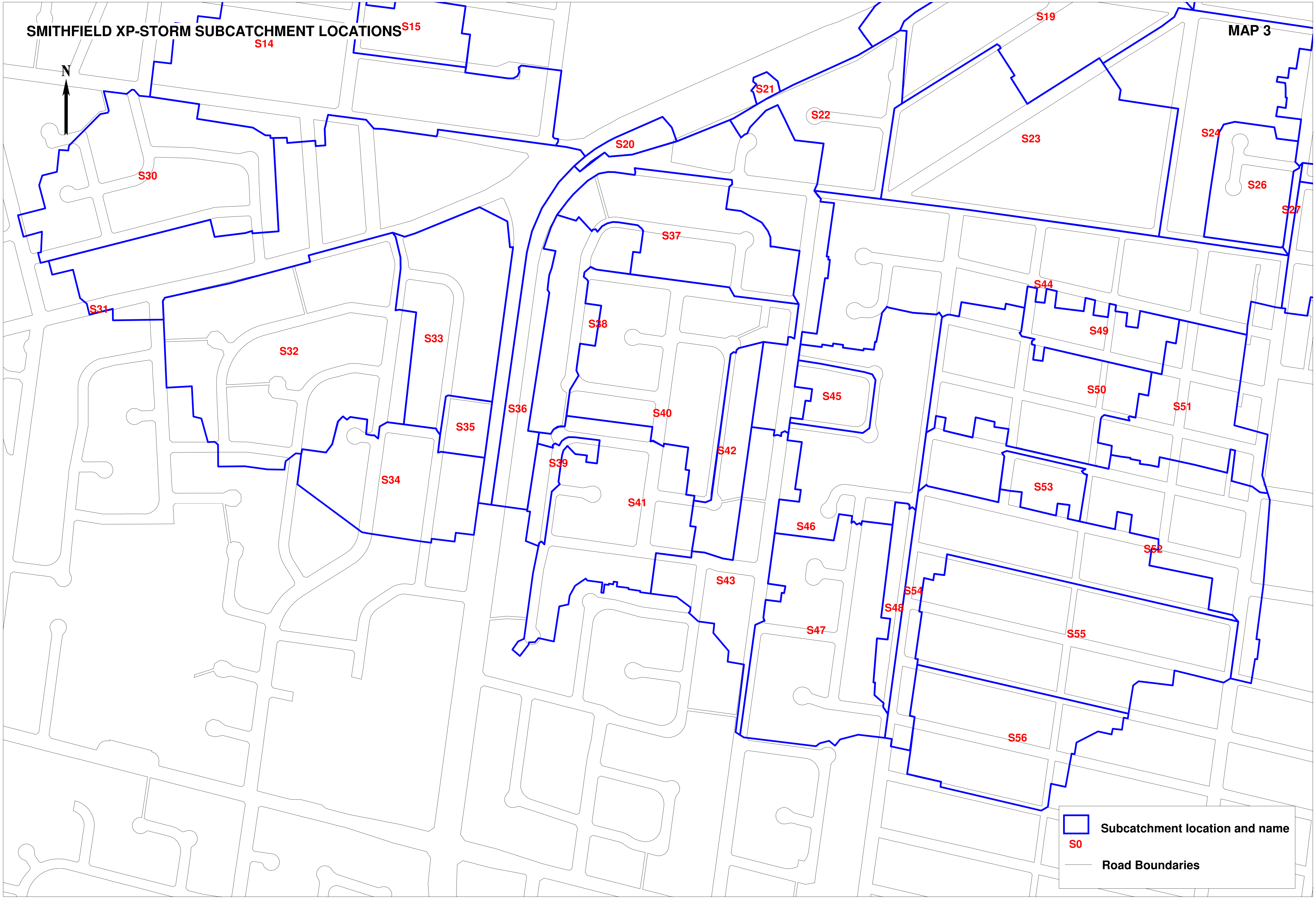
SMITHFIELD XP-STORM SUBCATCHMENT LOCATIONS
N
MAP 1
MAP 2
MAP 3
S0
S1
S2
S3
S5
S6
S8
S11
S12
S14
S15
S16
S17
S20
S21
S22
S27
S29
S33
S35
S37
S40
S41
S45
S46
S52
S54
S55
S56
Subcatchment location and name
Road Boundaries
S0
Study Area

SMITHFIELD XP-STORM SUBCATCHMENT LOCATIONS

MAP 1

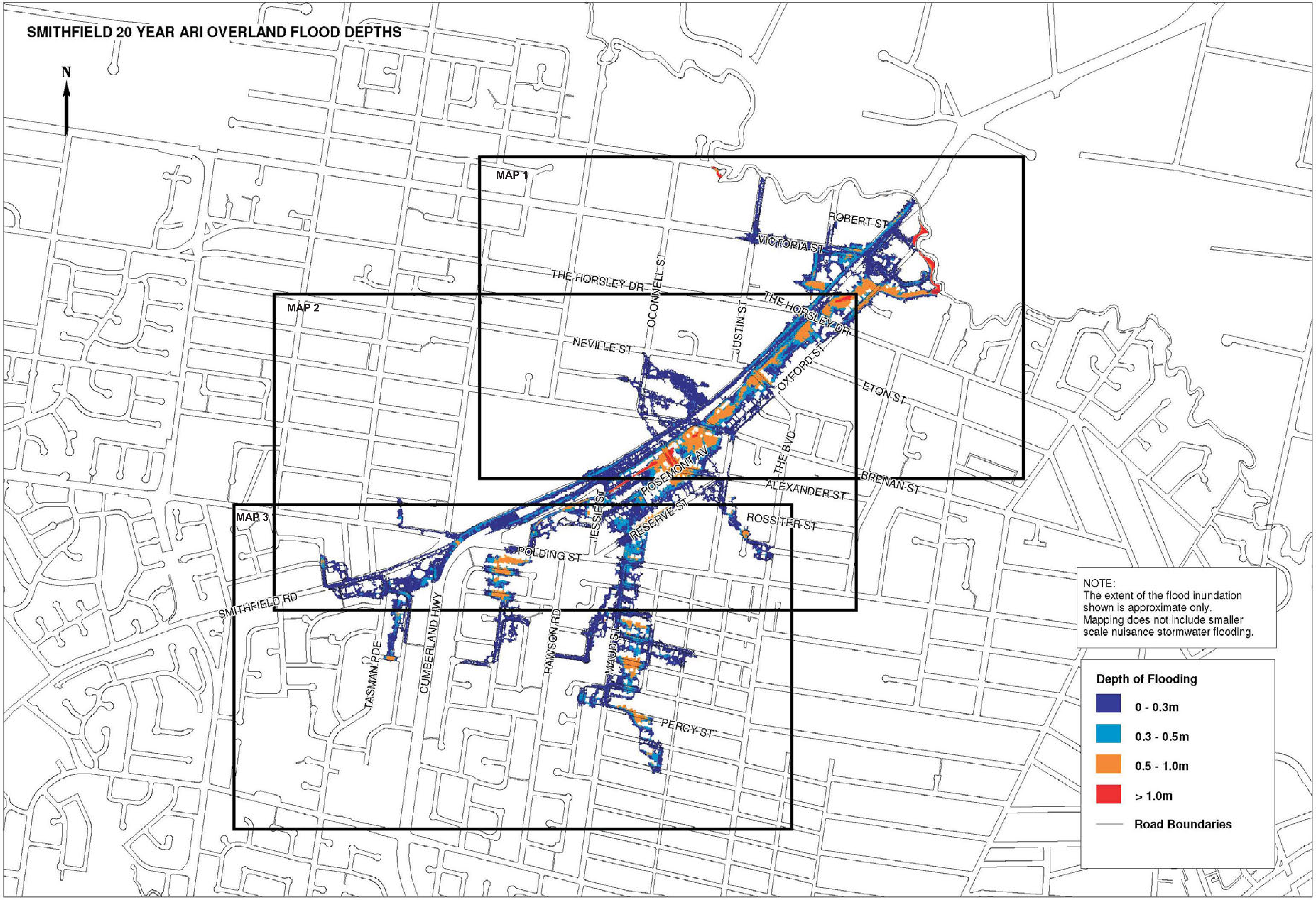



SMITHFIELD XP-STORM SUBCATCHMENT LOCATIONS
MAP 2
N
S0
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
S20
S21
S22
S23
S24
S25
S26
S27
S28
S29
S30
S32
S33
S36
S37
S38
S40
S44
S45
S49
S50
S51
Subcatchment location and name
S0
Road Boundaries

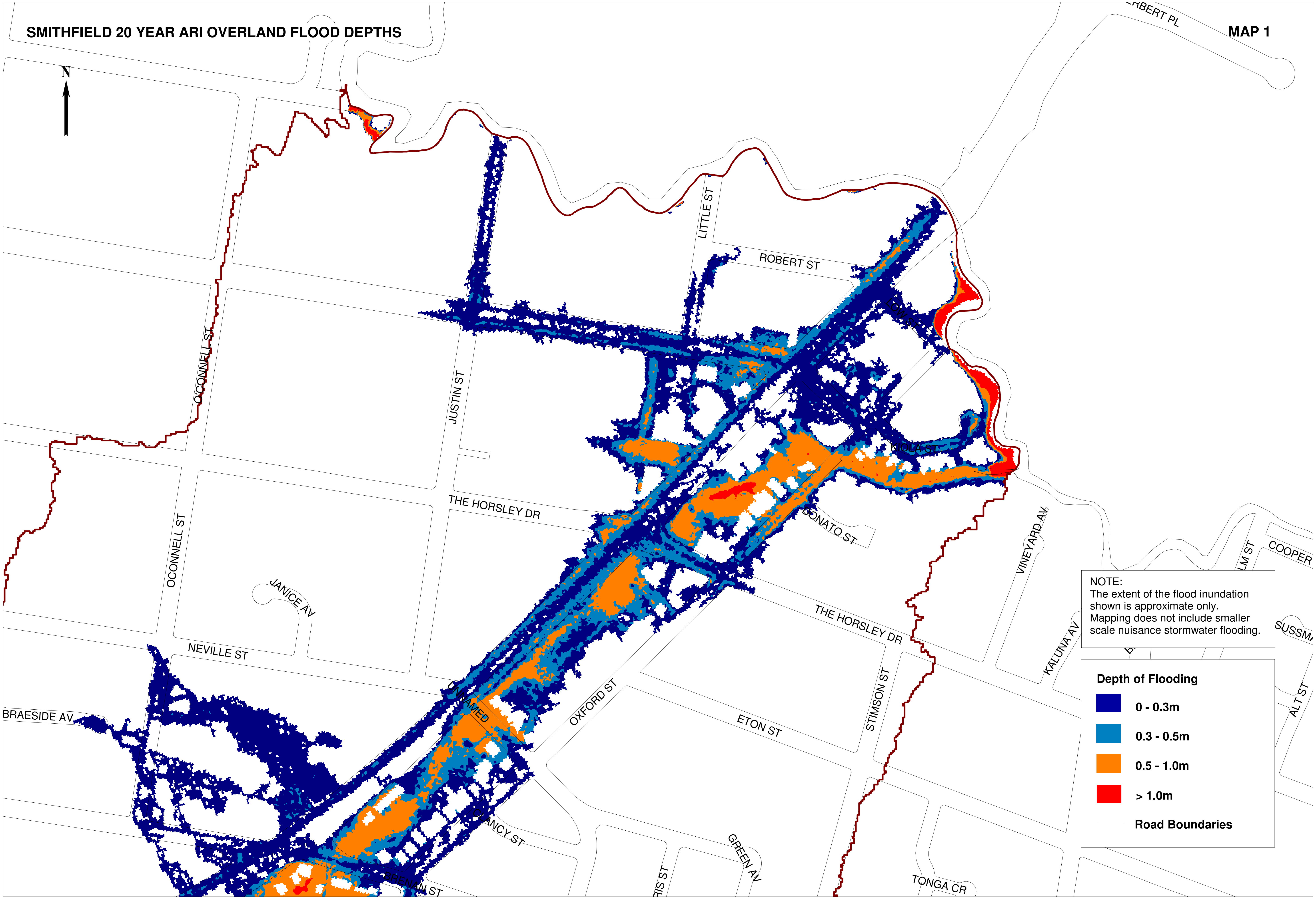

SMITHFIELD XP-STORM SUBCATCHMENT LOCATIONS
MAP 3
N
S14
S15
S19
S20
S21
S22
S23
S24
S26
S27
S30
S31
S32
S33
S34
S35
S36
S37
S38
S39
S40
S41
S42
S43
S44
S45
S46
S47
S48
S49
S50
S51
S52
S53
S54
S55
S56
Subcatchment location and name
S0
Road Boundaries

Appendix D Flood Depth Mapping

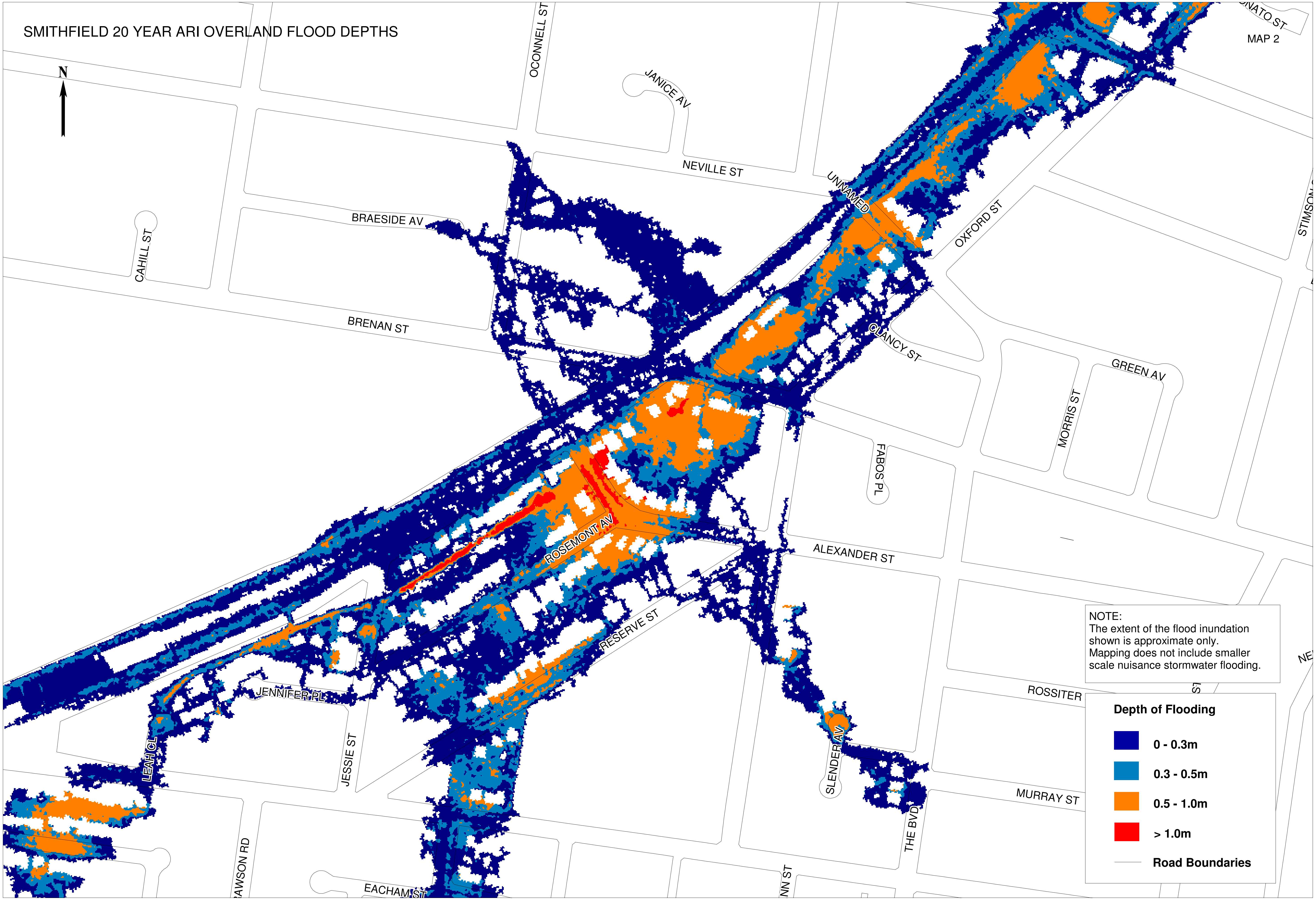
- Flood depths for 20, 100, 2,000 year ARI and PMF events presented
- Flood height contours for the 100 year ARI presented



SMITHFIELD 20 YEAR ARI OVERLAND FLOOD DEPTHS
N
MAP 1
MAP 2
MAP 3
ROBERT ST
VICTORIA ST
THE HORSLEY DR
OCONNELL ST
JUSTIN ST
THE HORSLEY DR
NEVILLE ST
OXFORD ST
ETON ST
THE BVD
ROSEMONT AV
BRENAN ST
ALEXANDER ST
JESSIE ST
RESERVE ST
ROSSITER ST
POLDING ST
SMITHFIELD RD
CUMBERLAND HWY
RAWSON RD
MAUD ST
TASMAN PDE
PERCY ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries


SMITHFIELD 20 YEAR ARI OVERLAND FLOOD DEPTHS
MAP 1
N
LITTLE ST
ROBERT ST
O'CONNELL ST
JUSTIN ST
THE HORSLEY DR
BONATO ST
VINEYARD AV
COOPER
OCONNELL ST
JANICE AV
NEVILLE ST
THE HORSLEY DR
KALUNA AV
BRAESIDE AV
OXFORD ST
ETON ST
STIMSON ST
ALT ST
GREEN AV
TONGA CR
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries

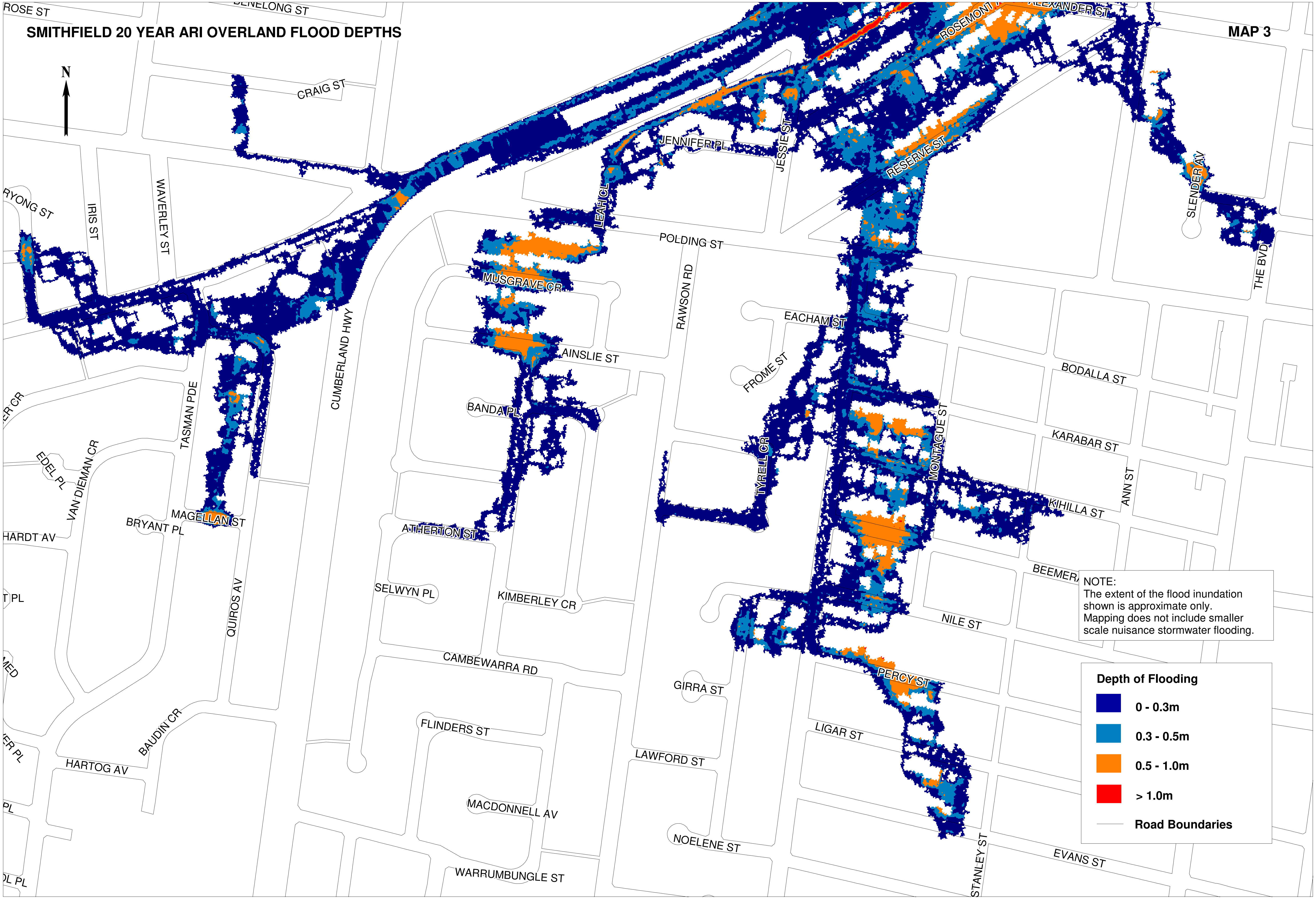
SMITHFIELD 20 YEAR ARI OVERLAND FLOOD DEPTHS

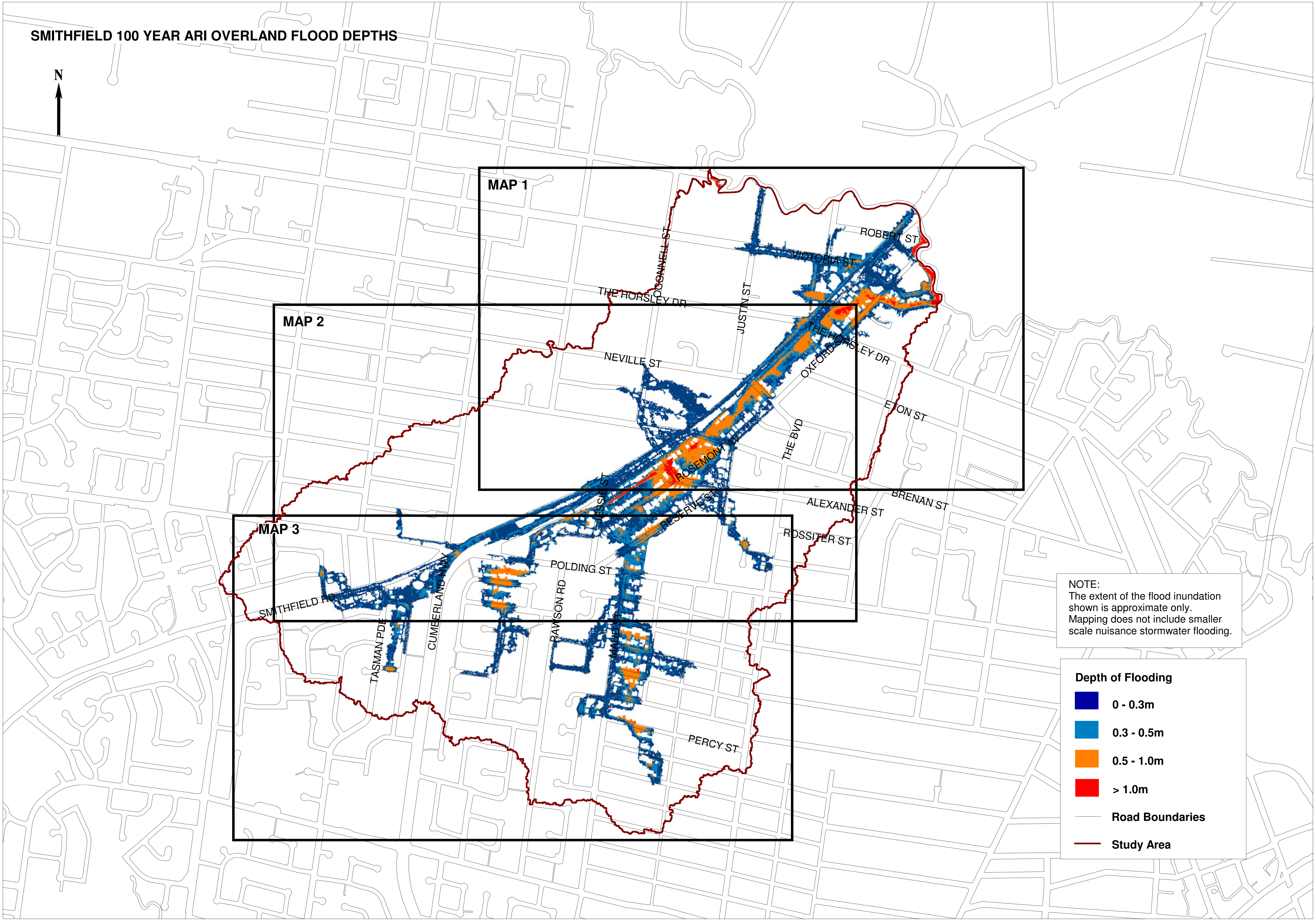


NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.

Depth of Flooding

- 0 - 0.3m
- 0.3 - 0.5m
- 0.5 - 1.0m
- > 1.0m
- Road Boundaries


SMITHFIELD 20 YEAR ARI OVERLAND FLOOD DEPTHS
MAP 3
N
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries
ROSE ST
BENELONG ST
CRAIG ST
ROSEMONT
ALEXANDER ST
JENNIFER PL
JESSIE ST
RESERVE ST
SLENDER AV
THE BVD
LEAH CL
POLDING ST
IRIS ST
WAVERLEY ST
MUSGRAVE CR
RAWSON RD
EACHAM ST
FROME ST
AINSLIE ST
BODALLA ST
CUMBERLAND HWY
TASMAN PDE
BANDA PL
MONTAGUE ST
KARABAR ST
TYRELL CR
ANN ST
KIHILLA ST
EDEL PL
VAN DIEMAN CR
MAGELLAN ST
BRYANT PL
ATHERTON ST
HARDT AV
BEEMERA
SELWYN PL
KIMBERLEY CR
QUIROS AV
NILE ST
CAMBEWARRA RD
GIRRA ST
PERCY ST
FLINDERS ST
LIGAR ST
BAUDIN CR
LAWFORD ST
HARTOG AV
MACDONNELL AV
NOELENE ST
STANLEY ST
EVANS ST
WARRUMBUNGLE ST



SMITHFIELD 100 YEAR ARI OVERLAND FLOOD DEPTHS
N
MAP 1
MAP 2
MAP 3
ROBERT ST
VICTORIA ST
O'DONNELL ST
JUSTIN ST
THE HORSLEY DR
NEVILLE ST
OXFORD
ETON ST
THE BVD
ROSEMONT AV
JESSIE ST
RESERVE ST
BRENAN ST
ALEXANDER ST
ROSSITER ST
POLDING ST
SMITHFIELD RD
CUMBERLAND HWY
RAWSON RD
TASMAN PDE
PERCY ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries
Study Area

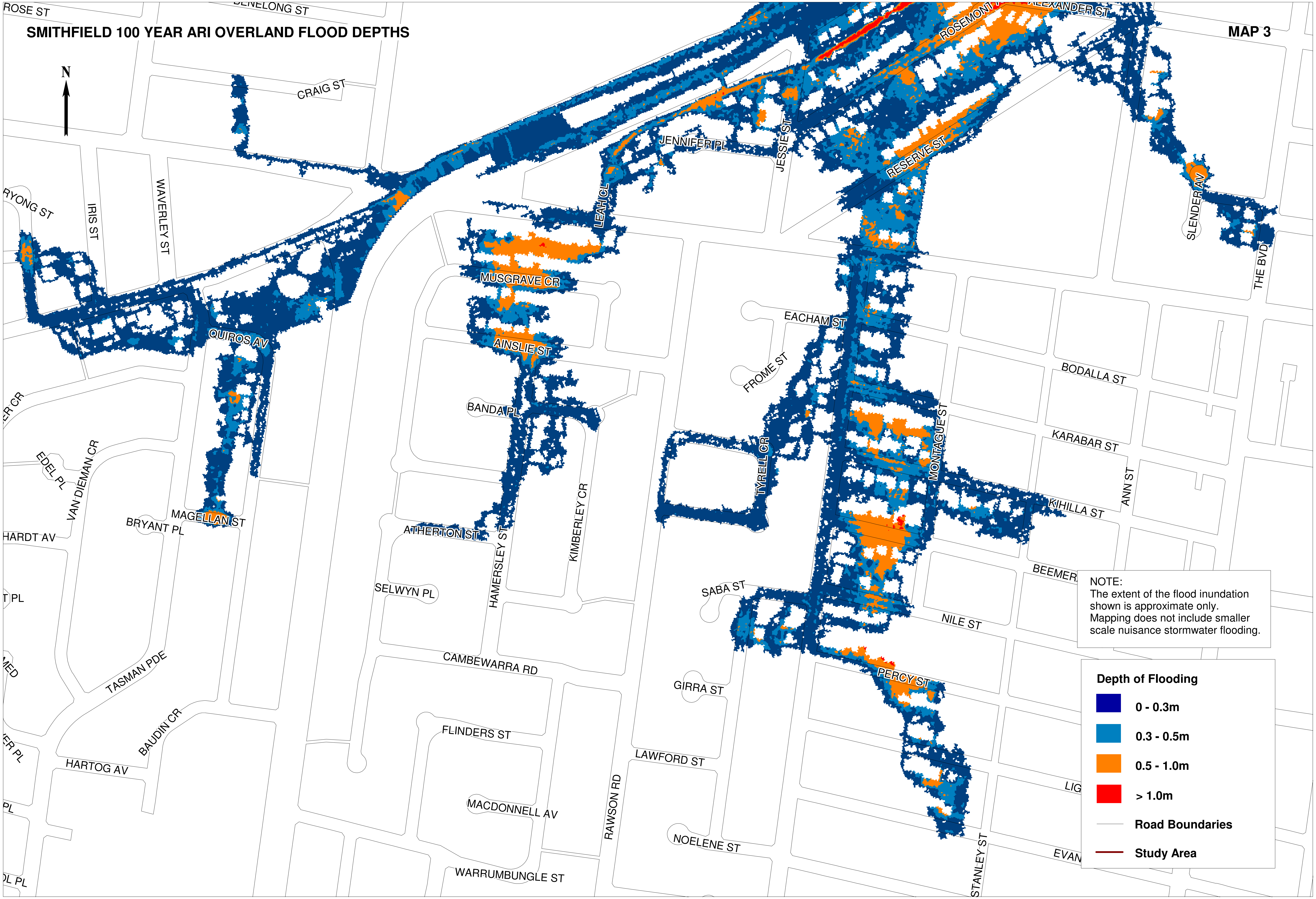
SMITHFIELD 100 YEAR ARI OVERLAND FLOOD DEPTHS

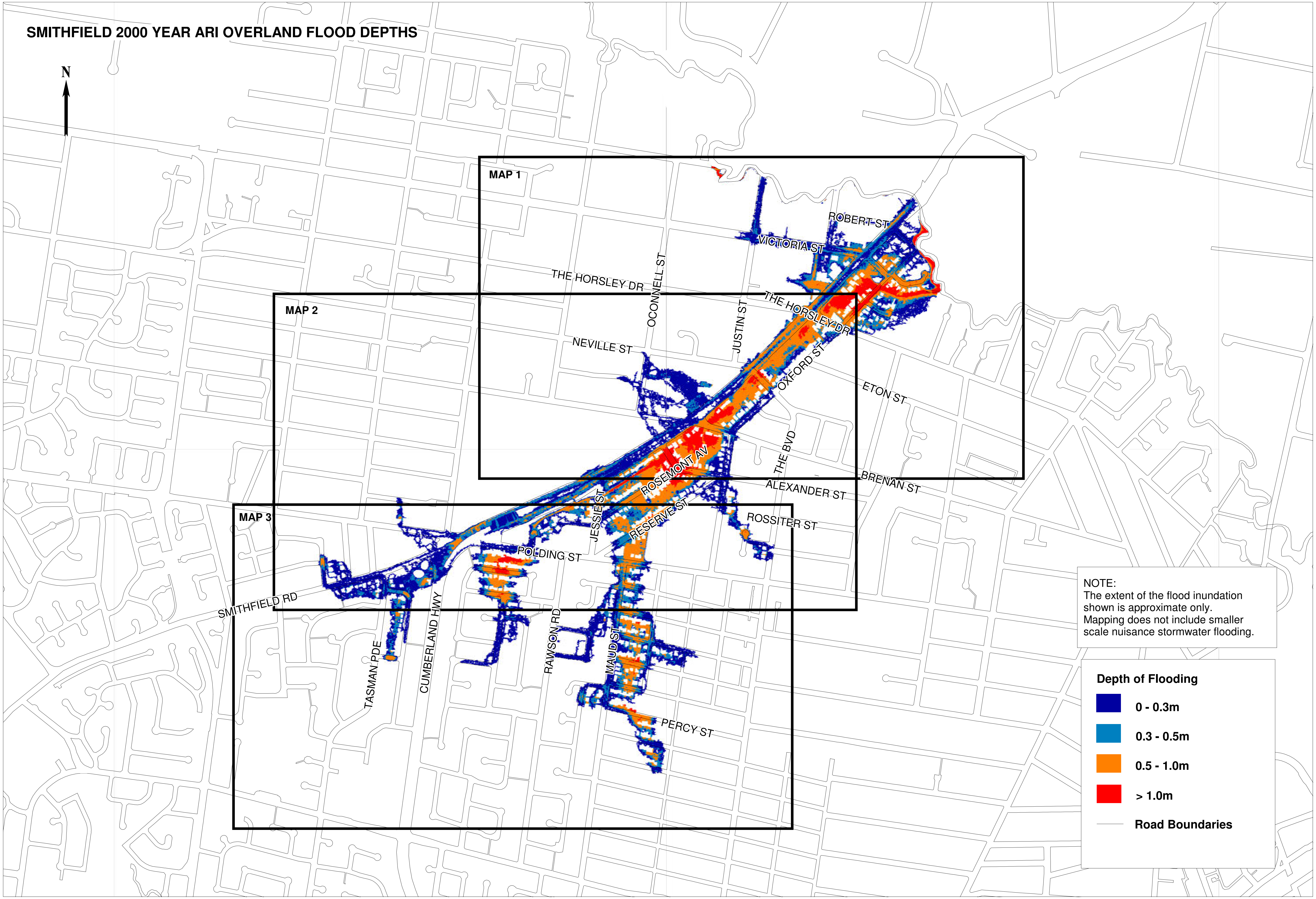
MAP 1


SMITHFIELD 100 YEAR ARI OVERLAND FLOOD DEPTHS
MAP 2
OCONNELL ST
JANICE AV
NEVILLE ST
MARKET ST
BRAESIDE AV
CAHILL ST
UNNAMED
CLANCY ST
GREEN AV
MORRIS ST
BRENAN ST
FABOS PL
STIMSON
ALEXANDER ST
ROSEMONT AV
JENNIFER PL
JESSIE ST
RESERVE ST
LEAH CL
OXFORD ST
SLENDER AV
THE BVD
ROSSITER
MURRAY ST
RAWSON RD
EACHAM ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries

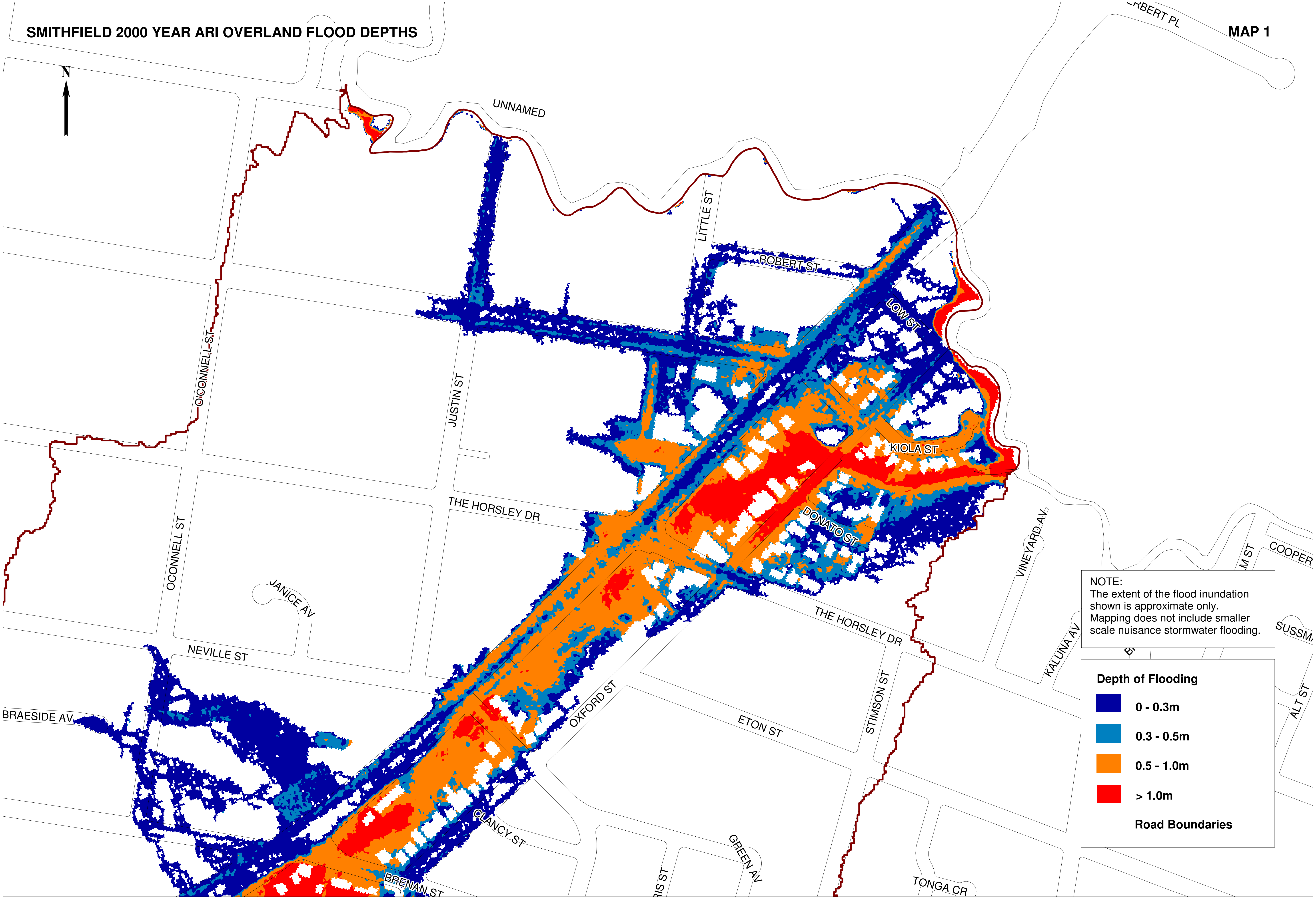
SMITHFIELD 100 YEAR ARI OVERLAND FLOOD DEPTHS

MAP 3

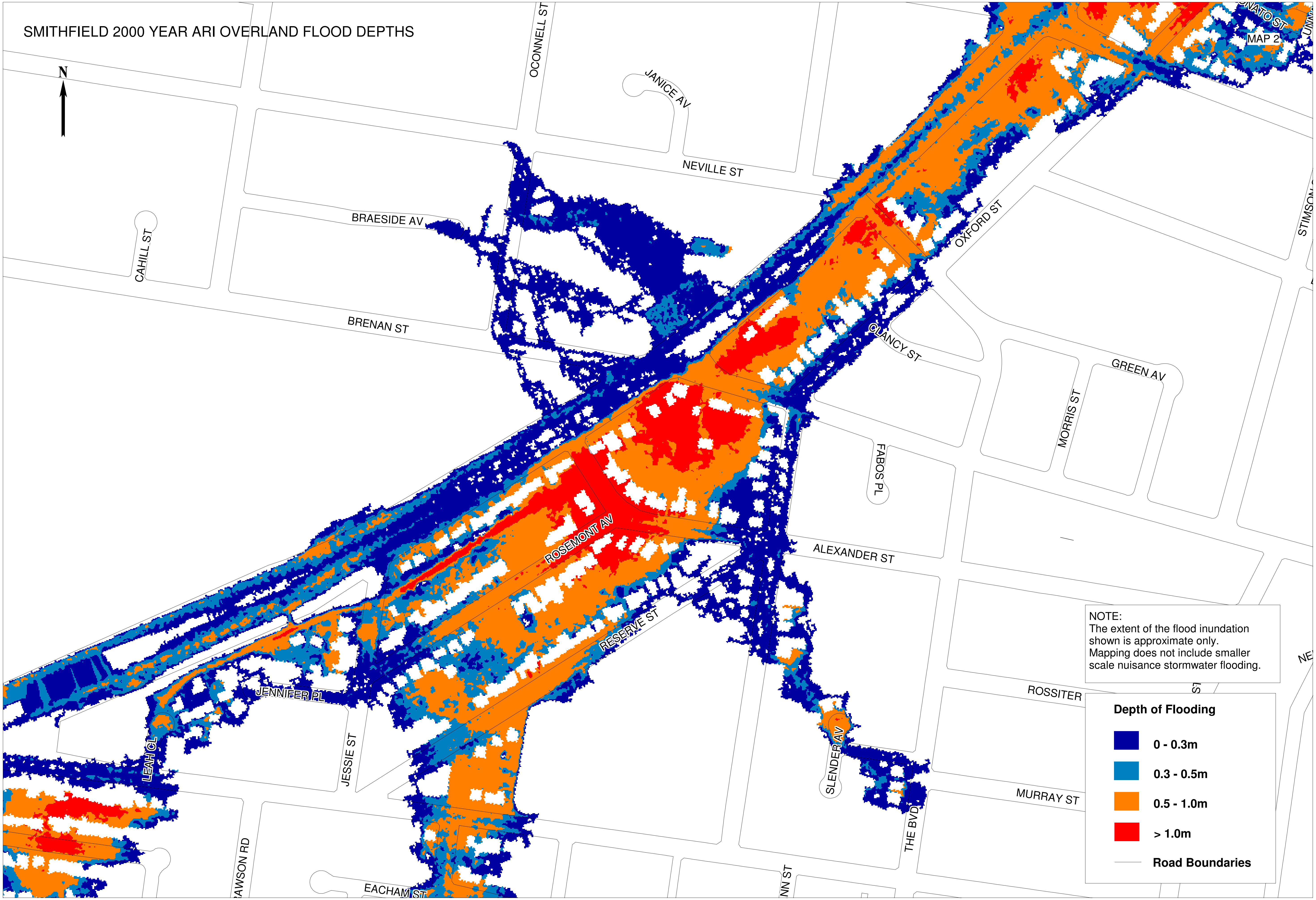




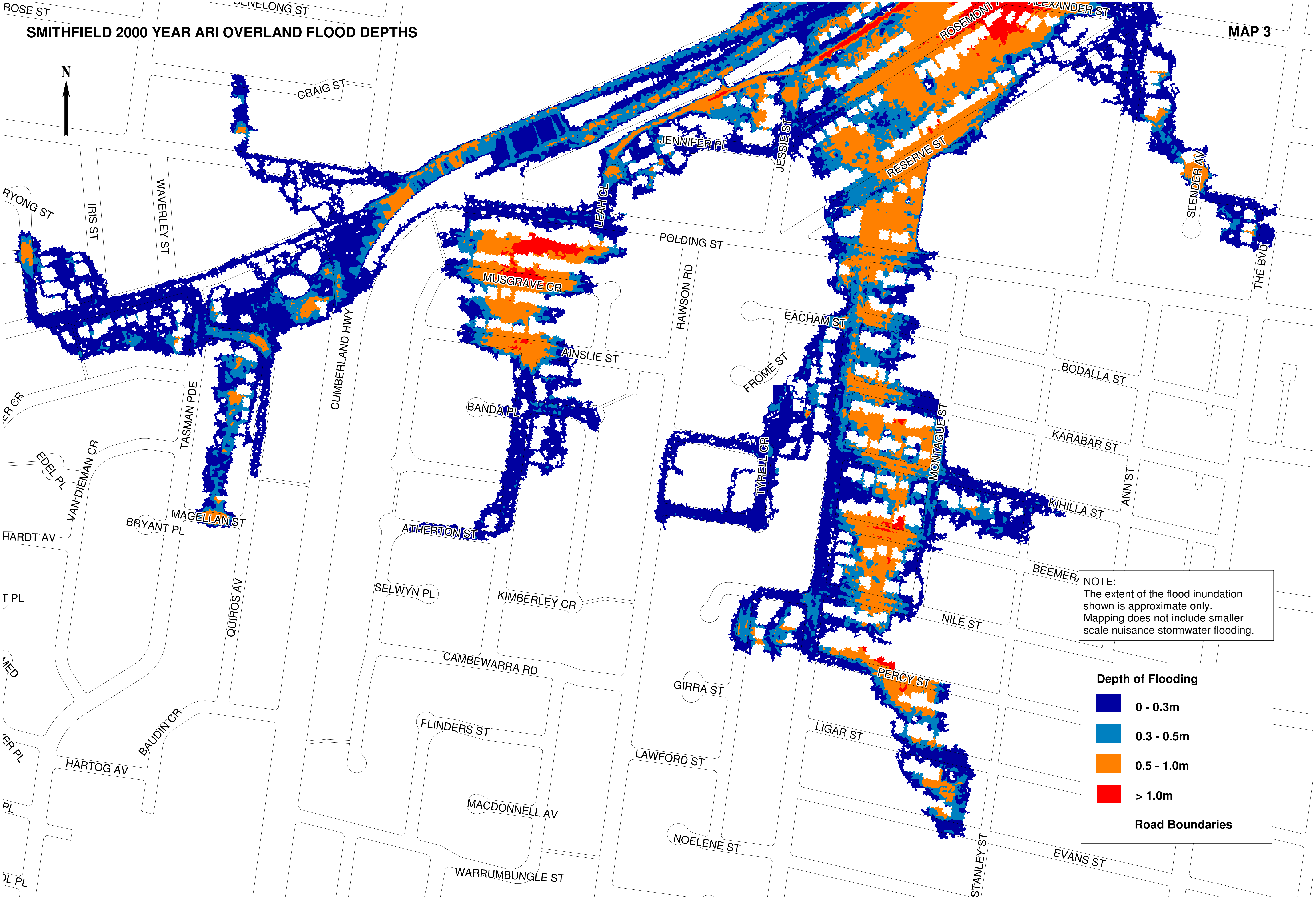
SMITHFIELD 2000 YEAR ARI OVERLAND FLOOD DEPTHS
N
MAP 1
MAP 2
MAP 3
ROBERT ST
VICTORIA ST
THE HORSLEY DR
OCONNELL ST
THE HORSLEY DR
JUSTIN ST
NEVILLE ST
OXFORD ST
ETON ST
THE BVD
ROSEMONT AV
BRENAN ST
ALEXANDER ST
JESSIE ST
RESERVE ST
ROSSITER ST
POLDING ST
SMITHFIELD RD
CUMBERLAND HWY
RAWSON RD
MAUD ST
TASMAN PDE
PERCY ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries



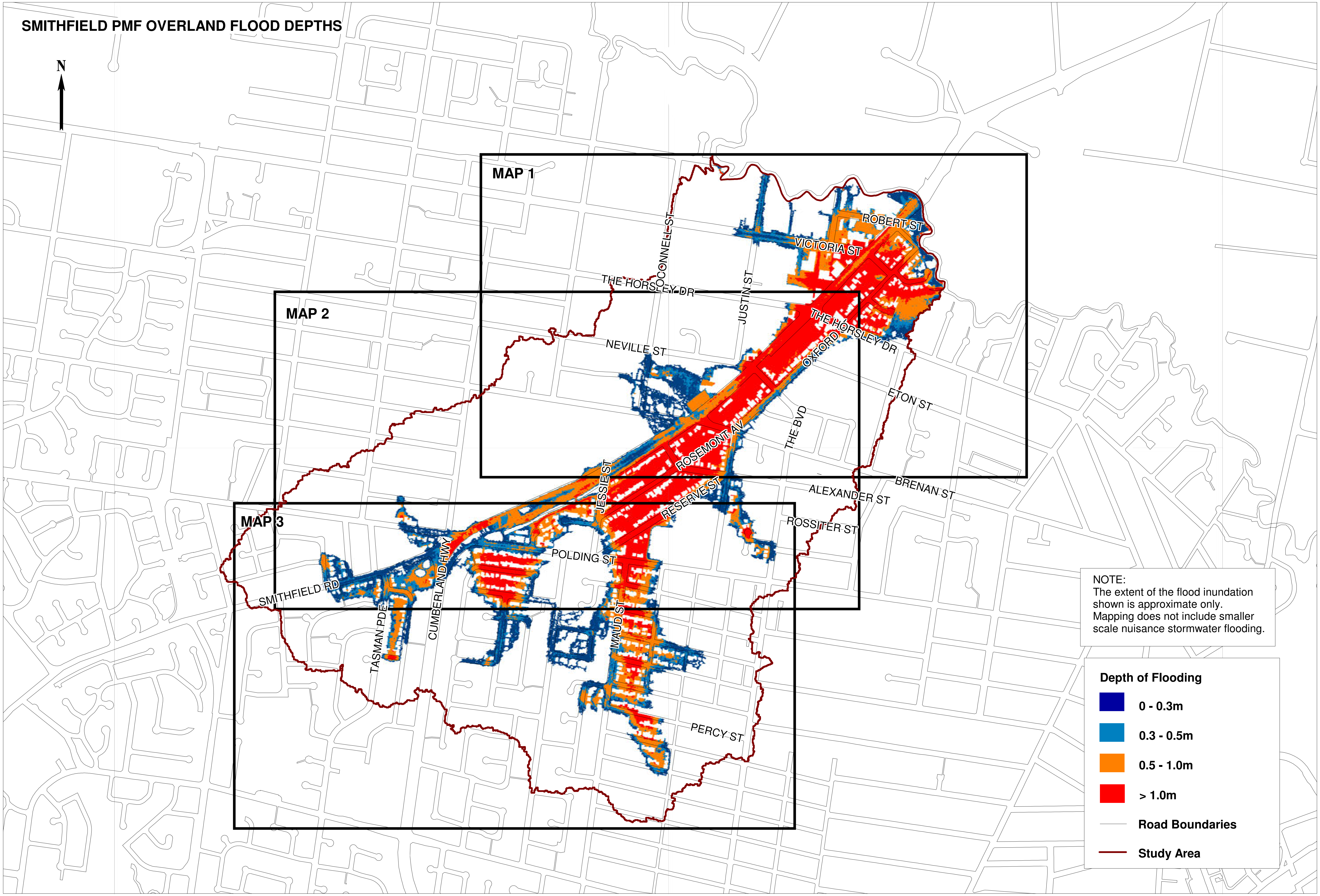
SMITHFIELD 2000 YEAR ARI OVERLAND FLOOD DEPTHS
MAP 1
N
UNNAMED
LITTLE ST
ROBERT ST
LOW ST
O'CONNELL ST
JUSTIN ST
KIOLA ST
THE HORSLEY DR
DONATO ST
OCONNELL ST
JANICE AV
VINEYARD AV
COOPER
NEVILLE ST
THE HORSLEY DR
KALUNA AV
SUSSM
BRAESIDE AV
OXFORD ST
ETON ST
STIMSON ST
ALT ST
CLANCY ST
GREEN AV
BRENAN ST
TONGA CR
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries



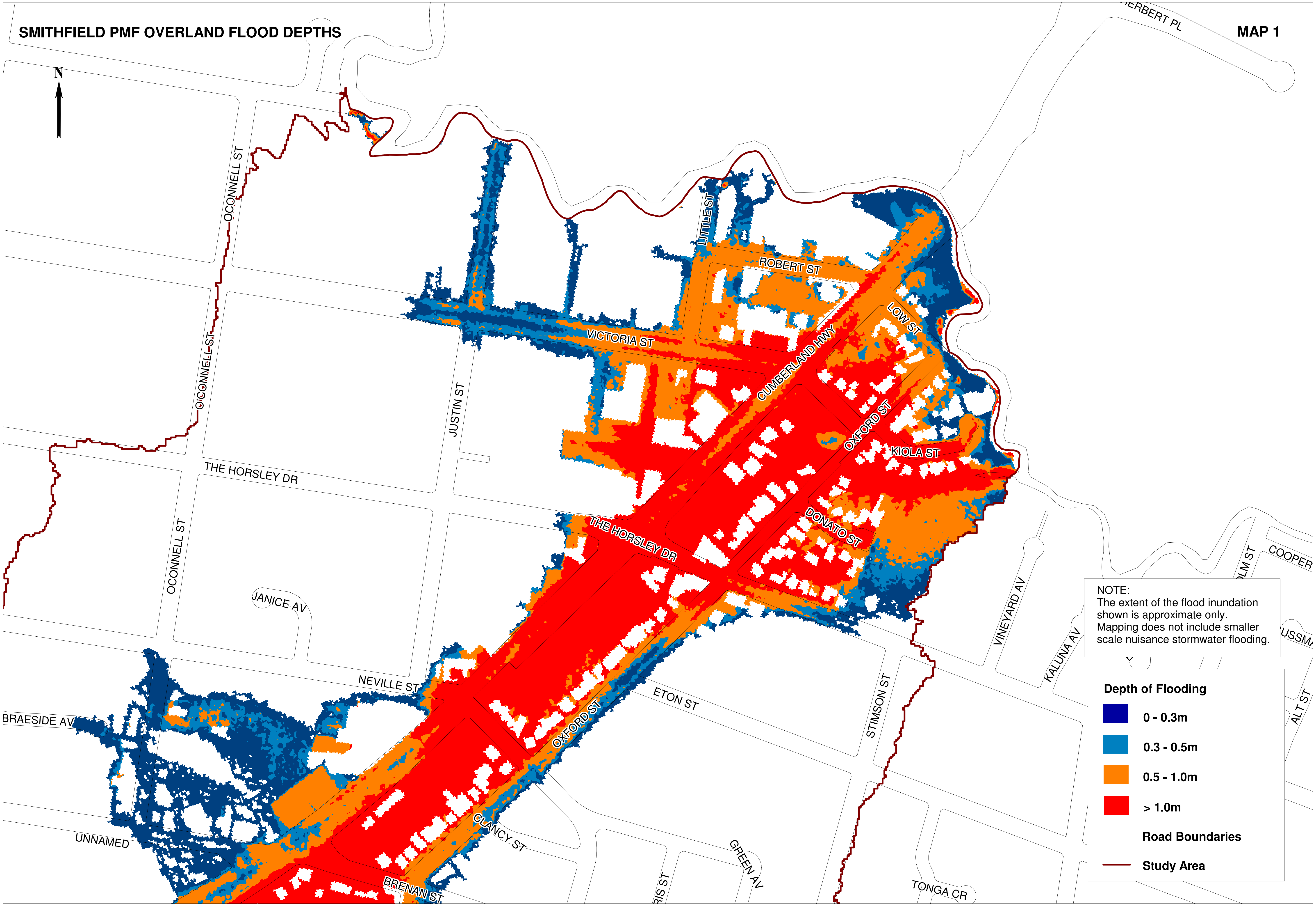
SMITHFIELD 2000 YEAR ARI OVERLAND FLOOD DEPTHS
N
OCONNELL ST
JANICE AV
NEVILLE ST
BRAESIDE AV
CAHILL ST
BRENAN ST
OXFORD ST
CLANCY ST
GREEN AV
MORRIS ST
FABOS PL
STIMSON
MAP 2
ROSEMONT AV
ALEXANDER ST
RESERVE ST
JENNIFER PL
JESSIE ST
LEAH CL
SLENDER AV
ROSSITER
MURRAY ST
THE BVD
EACHAM ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries


SMITHFIELD 2000 YEAR ARI OVERLAND FLOOD DEPTHS
MAP 3
N
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries
ROSE ST
BENELONG ST
CRAIG ST
IRIS ST
WAVERLEY ST
CUMBERLAND HWY
TASMAN PDE
MAGELLAN ST
BRYANT PL
VAN DIEMAN CR
EDEL PL
HARDT AV
QUIROS AV
BAUDIN CR
HARTOG AV
MUSGRAVE CR
AINSLIE ST
BANDA PL
ATHERTON ST
SELWYN PL
KIMBERLEY CR
CAMBEWARRA RD
FLINDERS ST
MACDONNELL AV
WARRUMBUNGLE ST
LEAH CL
JENNIFER PL
JESSIE ST
POLDING ST
RAWSON RD
EACHAM ST
FROME ST
TYRELL CR
GIRRA ST
LAWFORD ST
NOELENE ST
ROSEMONT ST
ALEXANDER ST
RESERVE ST
MONTAGUE ST
BODALLA ST
KARABAR ST
KIHILLA ST
ANN ST
BEEMERA
NILE ST
PERCY ST
LIGAR ST
STANLEY ST
EVANS ST
SLENDER AV
THE BVD

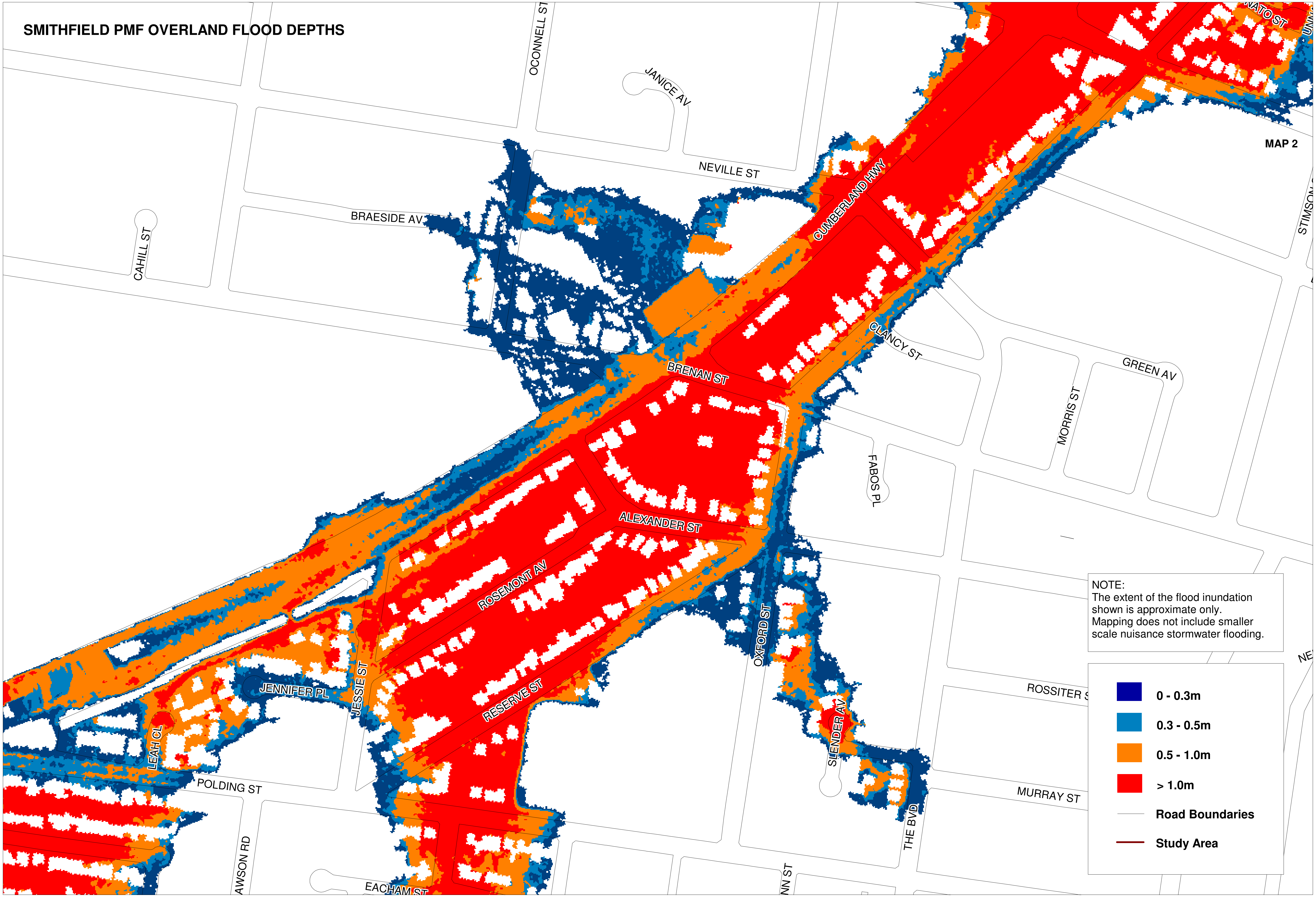
SMITHFIELD PMF OVERLAND FLOOD DEPTHS



NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.


SMITHFIELD PMF OVERLAND FLOOD DEPTHS
MAP 1
N
HERBERT PL
OCONNELL ST
O'CONNELL ST
OCONNELL ST
LITTLE ST
ROBERT ST
VICTORIA ST
CUMBERLAND HWY
LOW ST
JUSTIN ST
OXFORD ST
KIOLA ST
THE HORSLEY DR
THE HORSLEY DR
DONATO ST
JANICE AV
NEVILLE ST
ETON ST
STIMSON ST
VINEYARD AV
KALUNA AV
COOPER
ALT ST
BRAESIDE AV
OXFORD ST
CLANCY ST
UNNAMED
BRENAN ST
GREEN AV
TONGA CR
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries
Study Area

SMITHFIELD PMF OVERLAND FLOOD DEPTHS

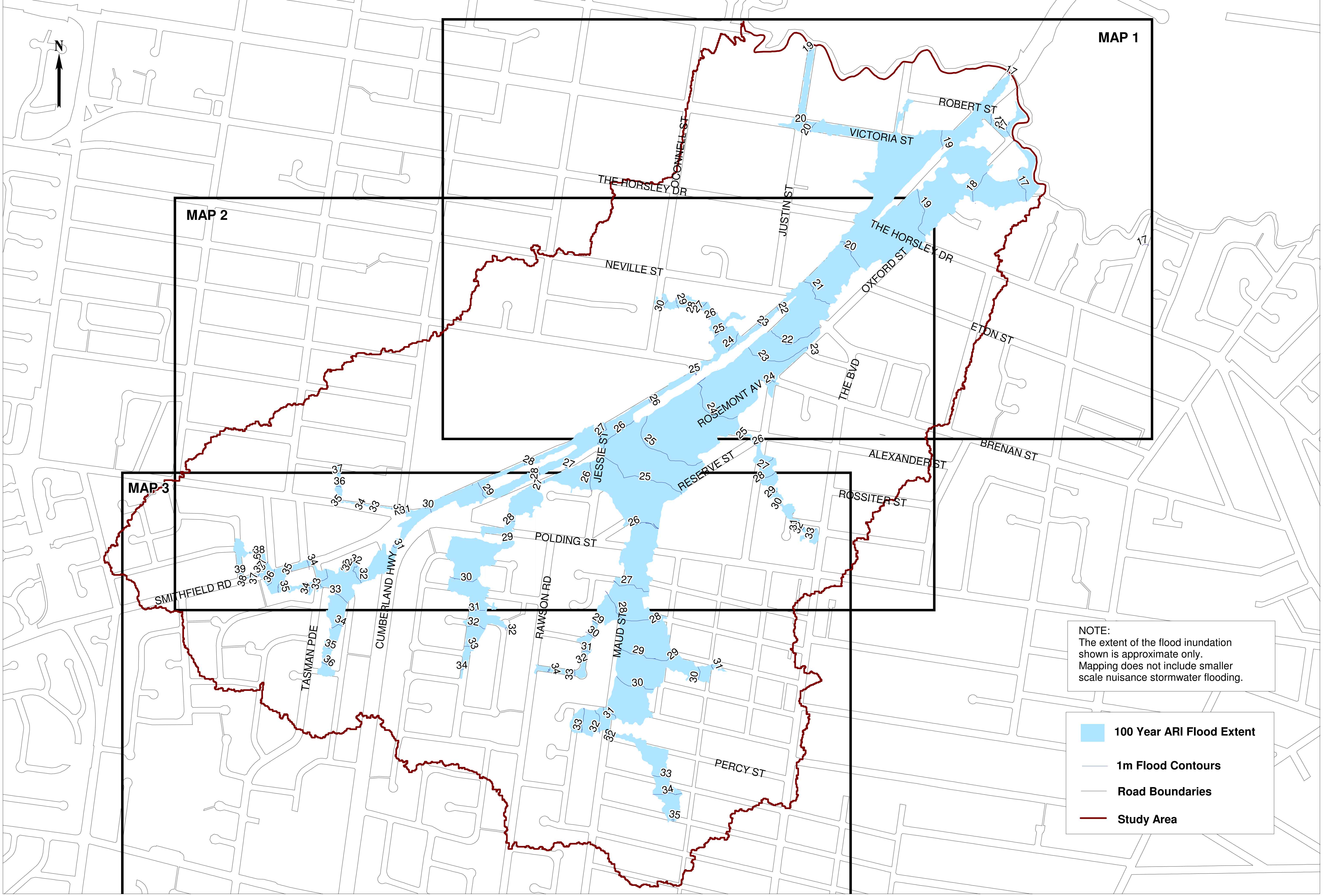


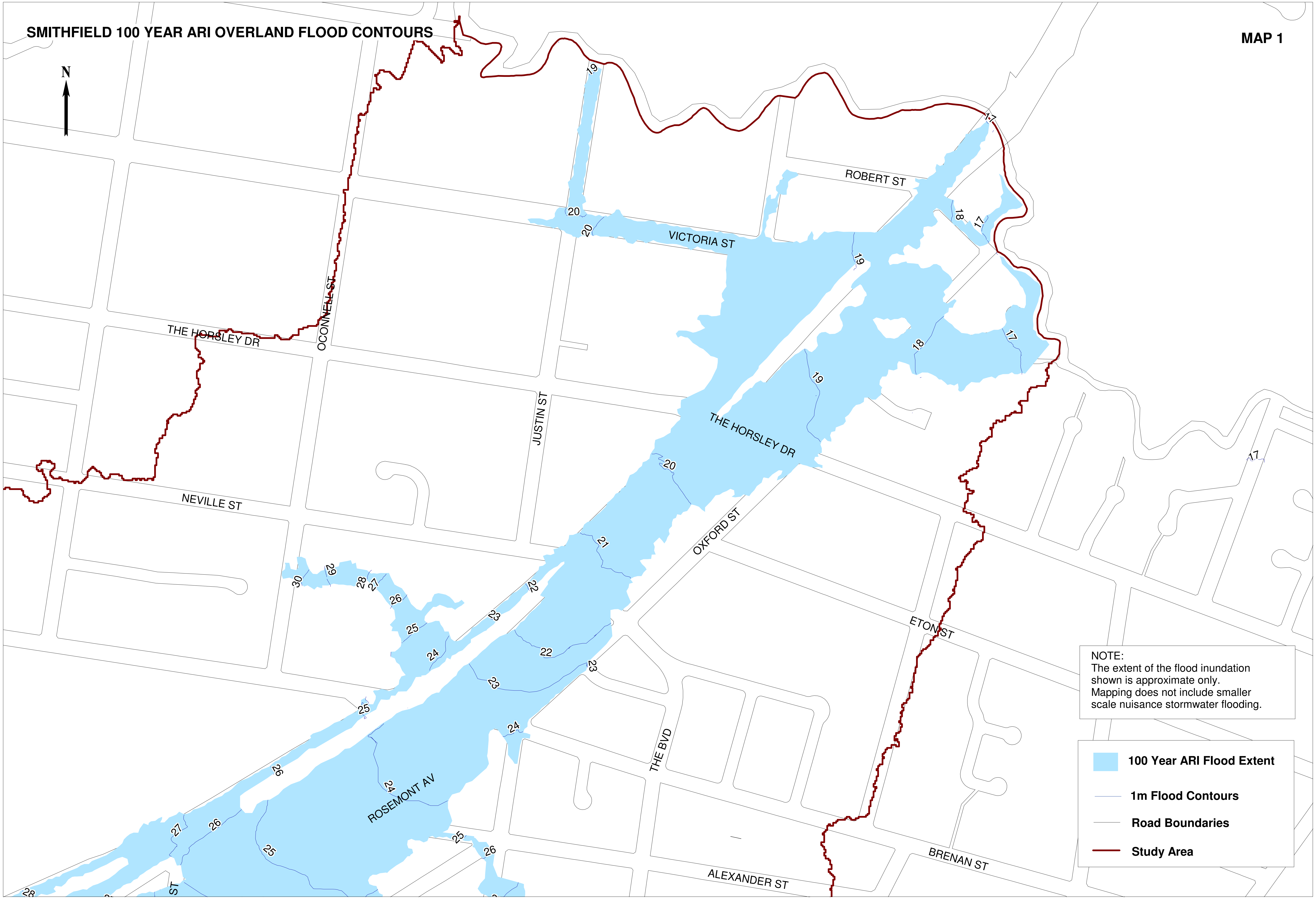
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.

- 0 - 0.3m
- 0.3 - 0.5m
- 0.5 - 1.0m
- > 1.0m
- Road Boundaries
- Study Area

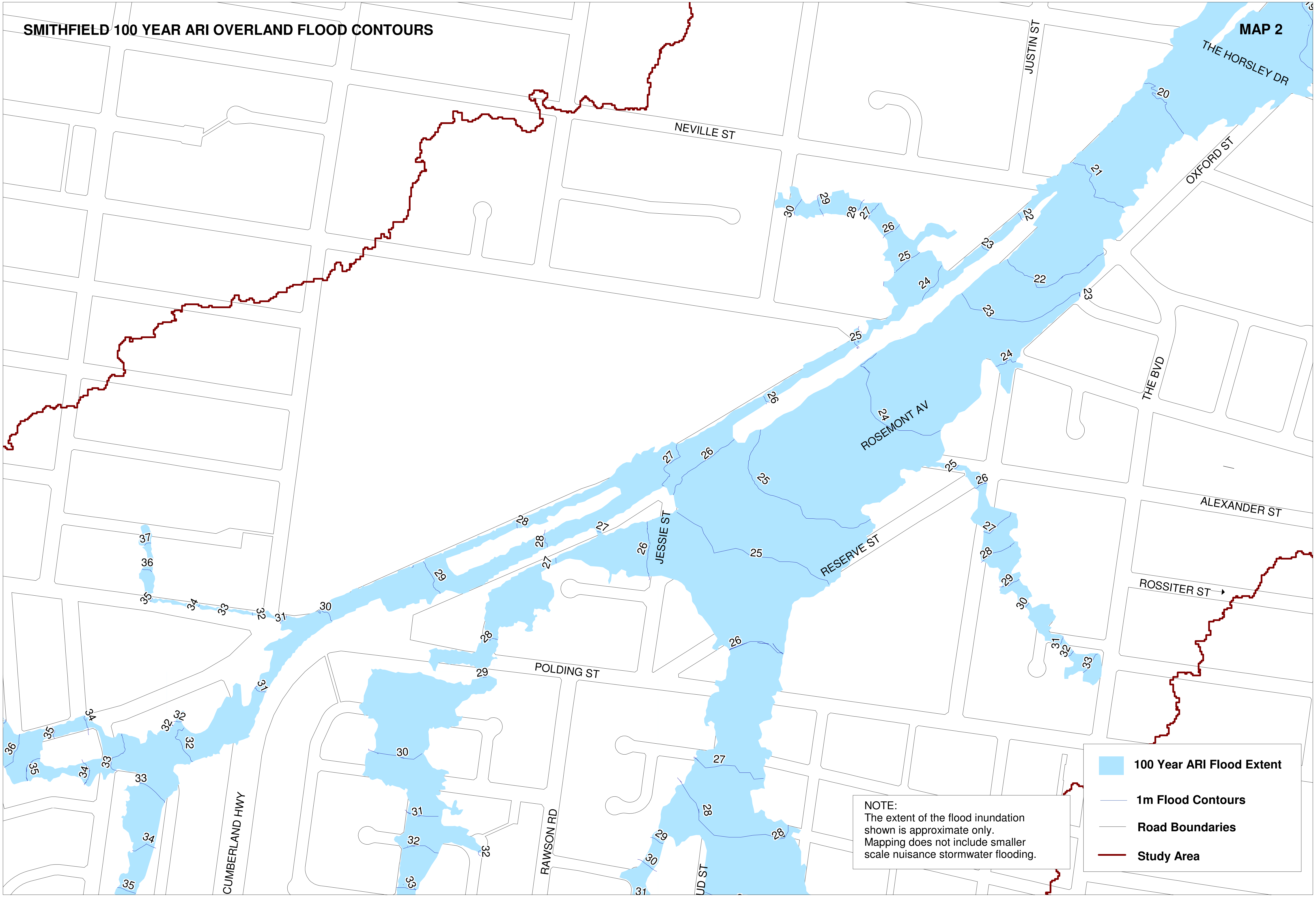
SMITHFIELD PMF OVERLAND FLOOD DEPTHS
MAP 3
N
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Depth of Flooding
0 - 0.3m
0.3 - 0.5m
0.5 - 1.0m
> 1.0m
Road Boundaries
Study Area
ROSE ST
BENELONG ST
CRAIG ST
ALEXANDER ST
ROSEMONT
JENNIFER PL
JESSIE ST
RESERVE ST
SLENDER AV
THE BVD
IRIS ST
WAVERLEY ST
SMITHFIELD RD
LEAH CL
POLDING ST
MUSGRAVE CR
EACHAM ST
AINSLIE ST
FROME ST
BODALLA ST
BANDA PL
MAUD ST
MONTAGUE ST
KARABAR ST
QUIROS AV
CUMBERLAND HWY
TYRELL CR
KIHILLA ST
ANN ST
EDEL PL
VAN DIEMAN CR
MAGELLAN ST
BRYANT PL
ATHERTON ST
HAMERSLEY ST
KIMBERLEY CR
BEEMERA
SELWYN PL
SABA ST
NILE ST
CAMBEWARRA RD
TASMAN PDE
PERCY ST
GIRRA ST
BAUDIN CR
FLINDERS ST
LAWFORD ST
HARTOG AV
RAWSON RD
MACDONNELL AV
NOELENE ST
WARRUMBUNGLE ST

SMITHFIELD 100 YEAR ARI OVERLAND FLOOD LEVEL CONTOURS





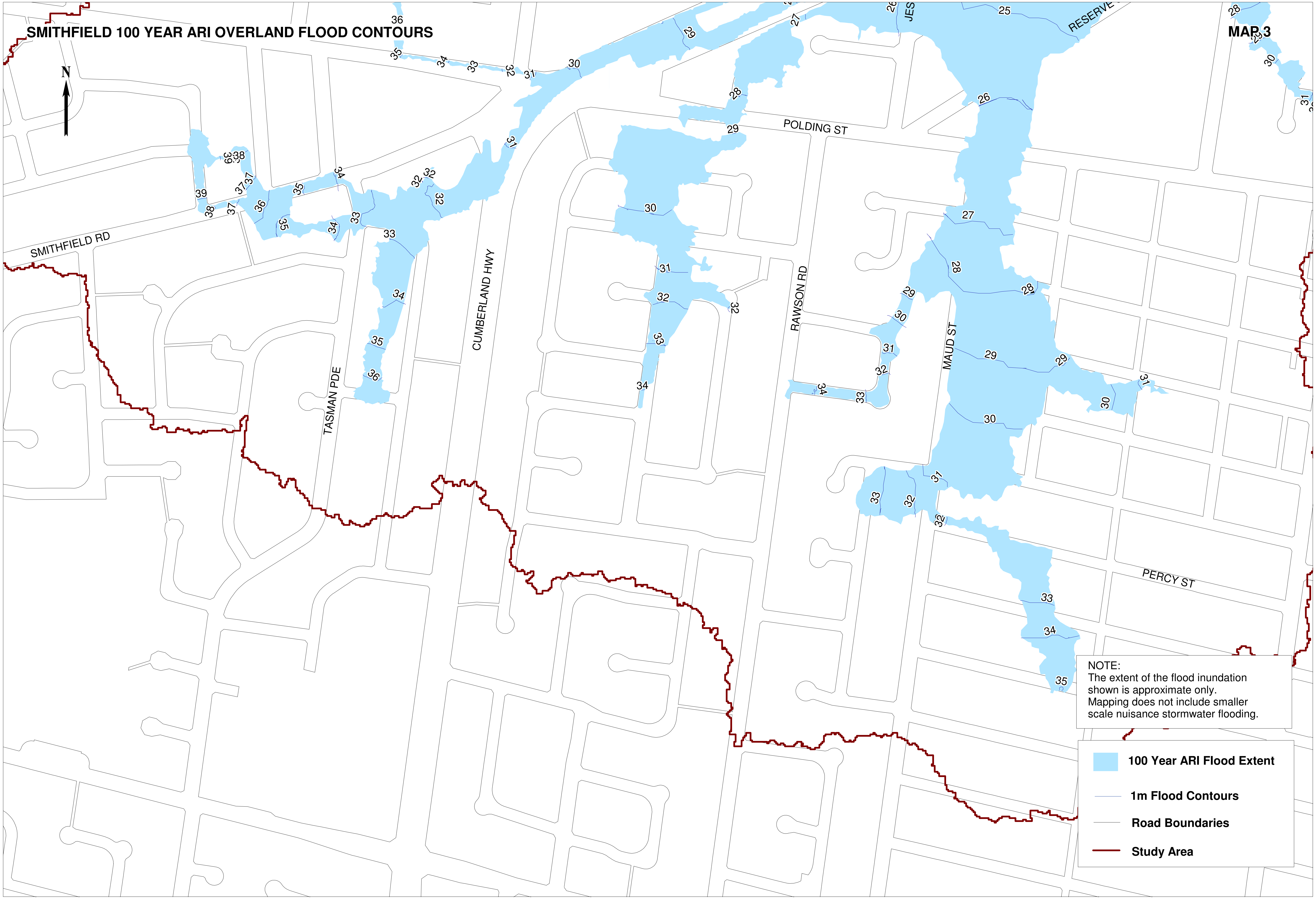
SMITHFIELD 100 YEAR ARI OVERLAND FLOOD CONTOURS
MAP 1
N
ROBERT ST
VICTORIA ST
THE HORSLEY DR
OCONNELL ST
JUSTIN ST
NEVILLE ST
THE HORSLEY DR
OXFORD ST
ETON ST
THE BVD
ROSEMONT AV
BRENAN ST
ALEXANDER ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
100 Year ARI Flood Extent
1m Flood Contours
Road Boundaries
Study Area



SMITHFIELD 100 YEAR ARI OVERLAND FLOOD CONTOURS
MAP 2
THE HORSLEY DR
NEVILLE ST
JUSTIN ST
OXFORD ST
THE BVD
ROSEMONT AV
ALEXANDER ST
ROSSITER ST
RESERVE ST
JESSIE ST
POLDING ST
CUMBERLAND HWY
RAWSON RD
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
100 Year ARI Flood Extent
1m Flood Contours
Road Boundaries
Study Area

SMITHFIELD 100 YEAR ARI OVERLAND FLOOD CONTOURS

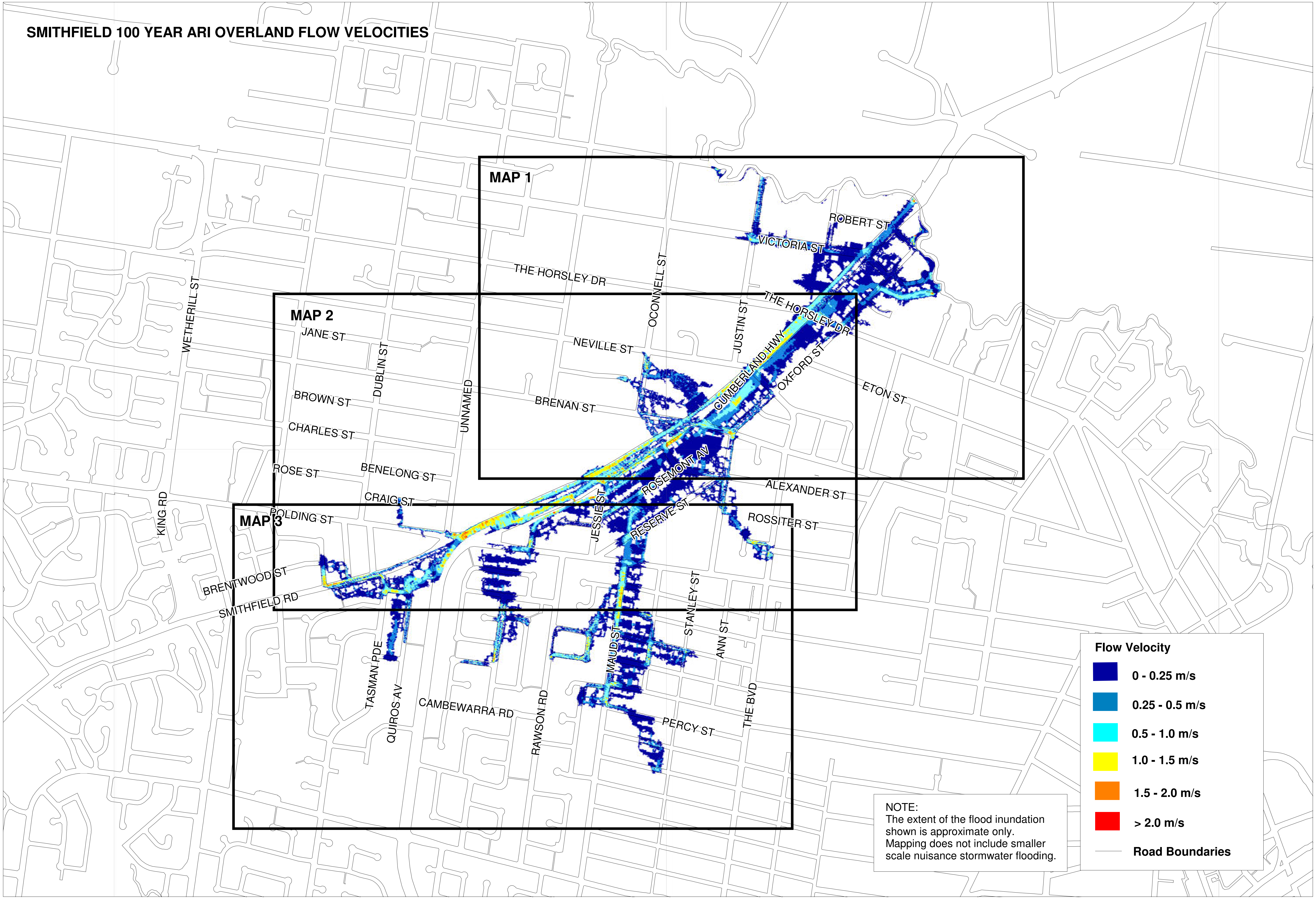
MAP 3



Appendix E Flow Velocity Mapping

- Flow velocity grids for 100 year ARI and PMF events presented

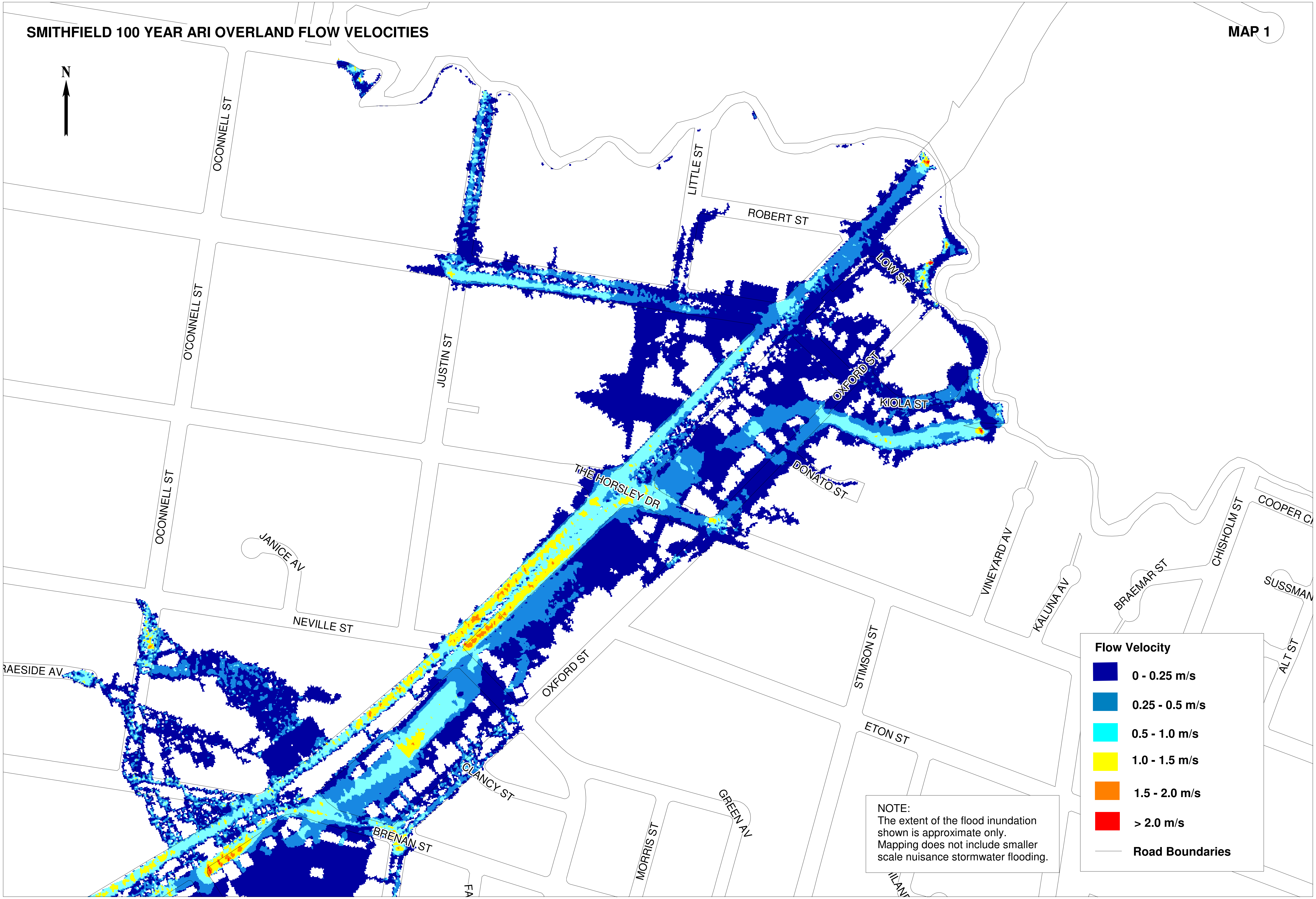
SMITHFIELD 100 YEAR ARI OVERLAND FLOW VELOCITIES



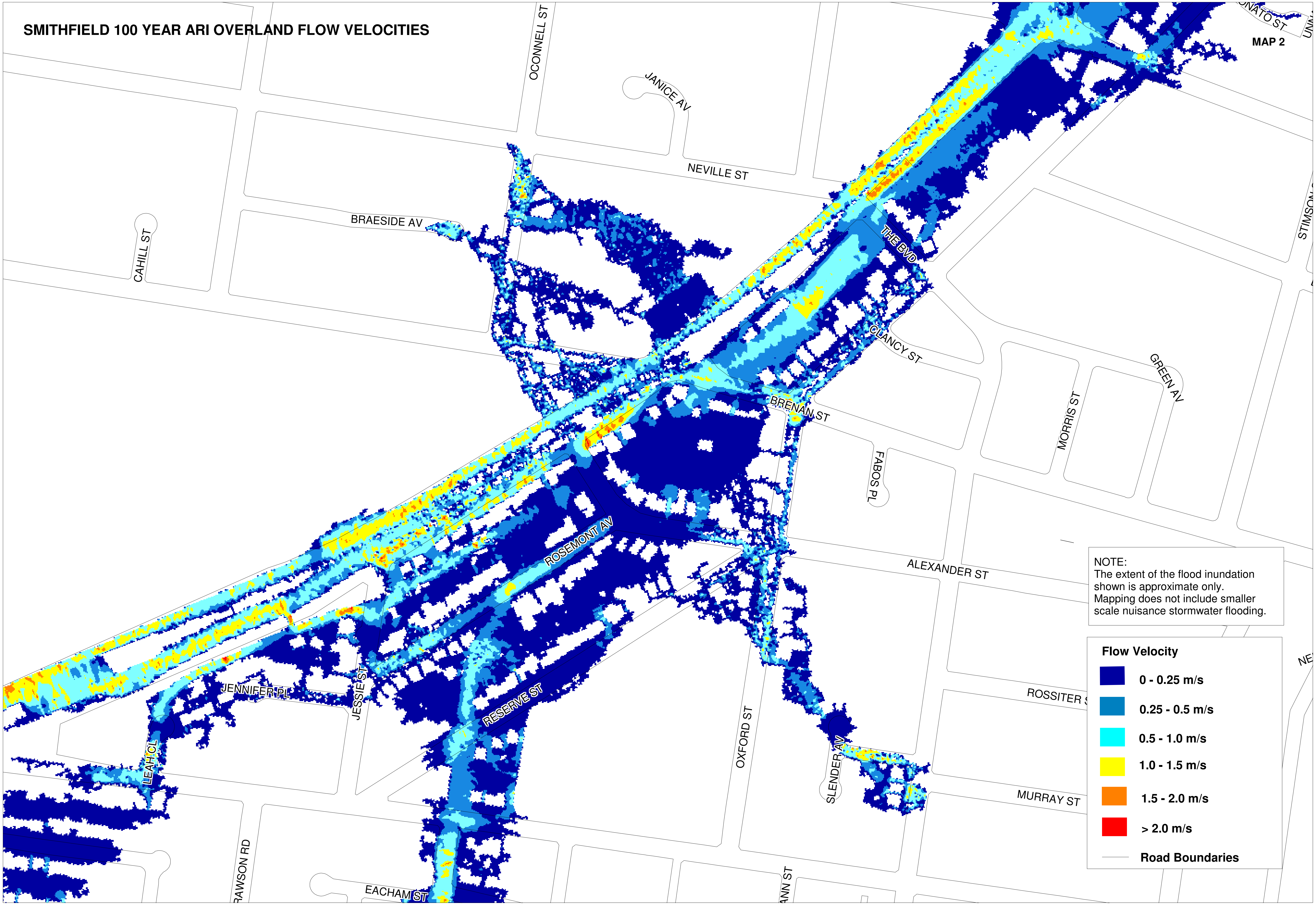
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.

Flow Velocity

- 0 - 0.25 m/s
- 0.25 - 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s
- Road Boundaries


SMITHFIELD 100 YEAR ARI OVERLAND FLOW VELOCITIES
MAP 1
N
OCONNELL ST
O'CONNELL ST
OCONNELL ST
LITTLE ST
ROBERT ST
JUSTIN ST
LOW ST
OXFORD ST
KIOLA ST
DONATO ST
THE HORSLEY DR
JANICE AV
NEVILLE ST
RAESIDE AV
OXFORD ST
VINEYARD AV
KALUNA AV
BRAEMAR ST
CHISHOLM ST
COOPER CR
SUSSMAN
ALT ST
STIMSON ST
ETON ST
CLANCY ST
BRENAN ST
GREEN AV
MORRIS ST
Flow Velocity
0 - 0.25 m/s
0.25 - 0.5 m/s
0.5 - 1.0 m/s
1.0 - 1.5 m/s
1.5 - 2.0 m/s
> 2.0 m/s
Road Boundaries
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.

SMITHFIELD 100 YEAR ARI OVERLAND FLOW VELOCITIES



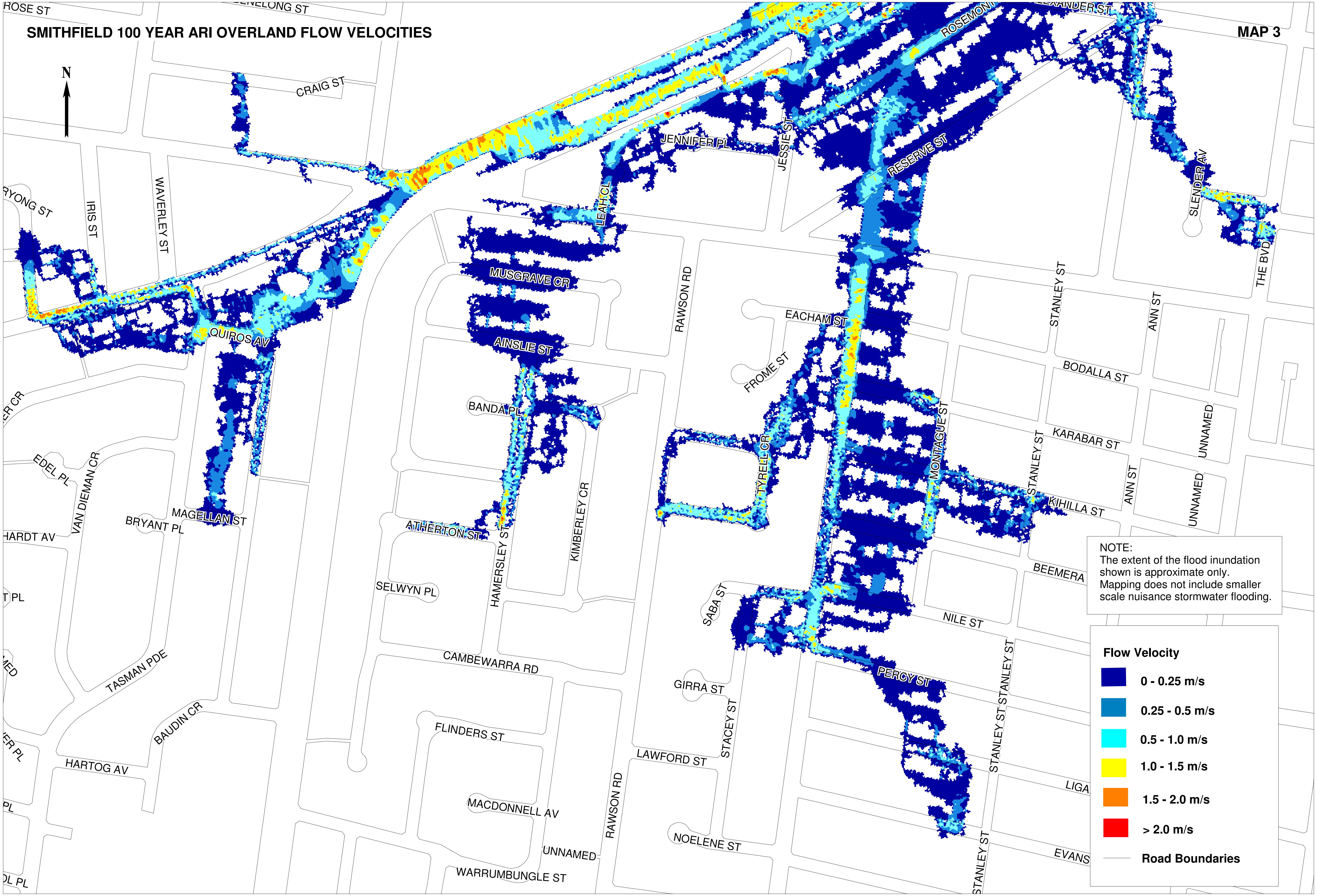
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.

Flow Velocity

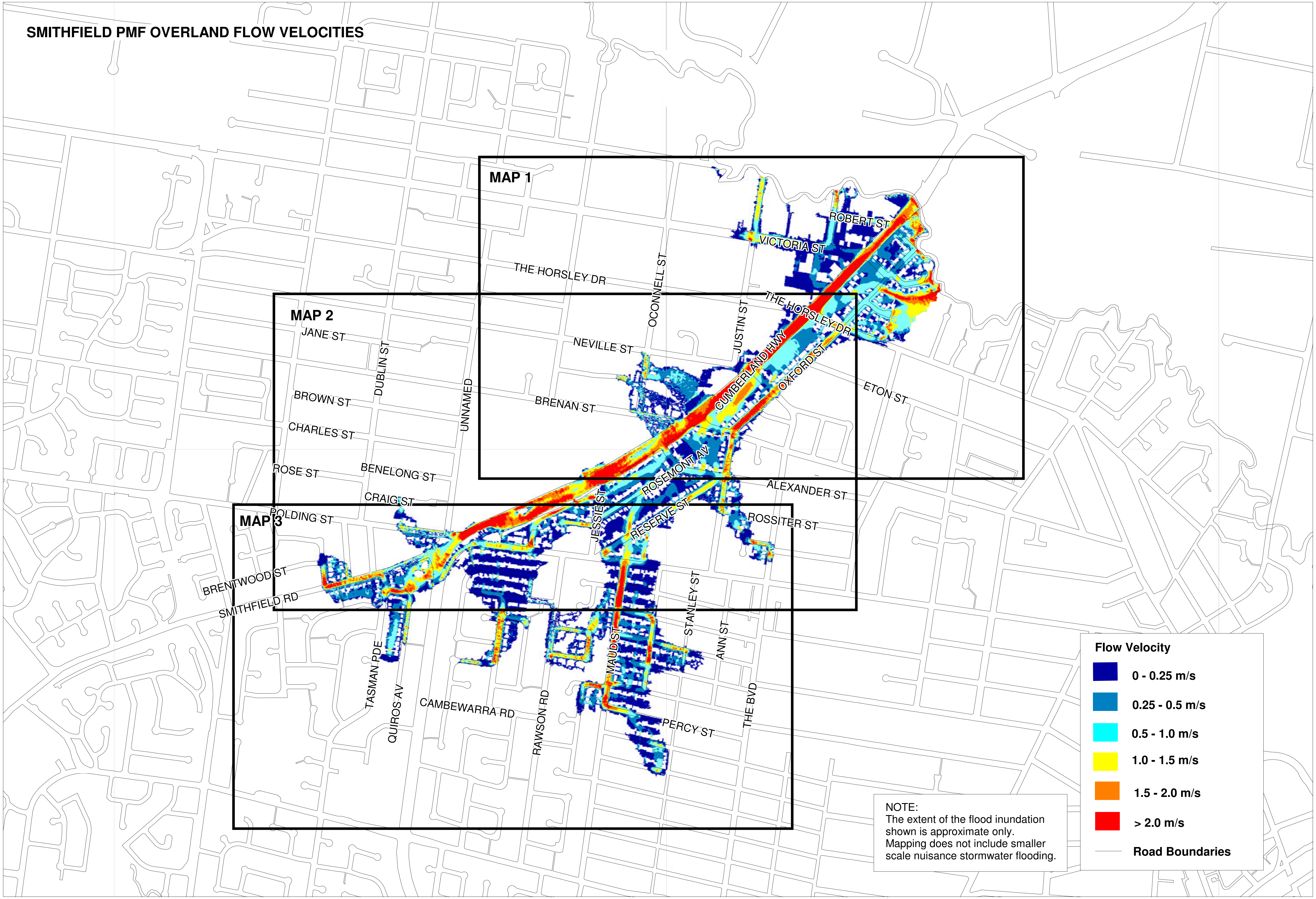
- 0 - 0.25 m/s
- 0.25 - 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s
- Road Boundaries

SMITHFIELD 100 YEAR ARI OVERLAND FLOW VELOCITIES

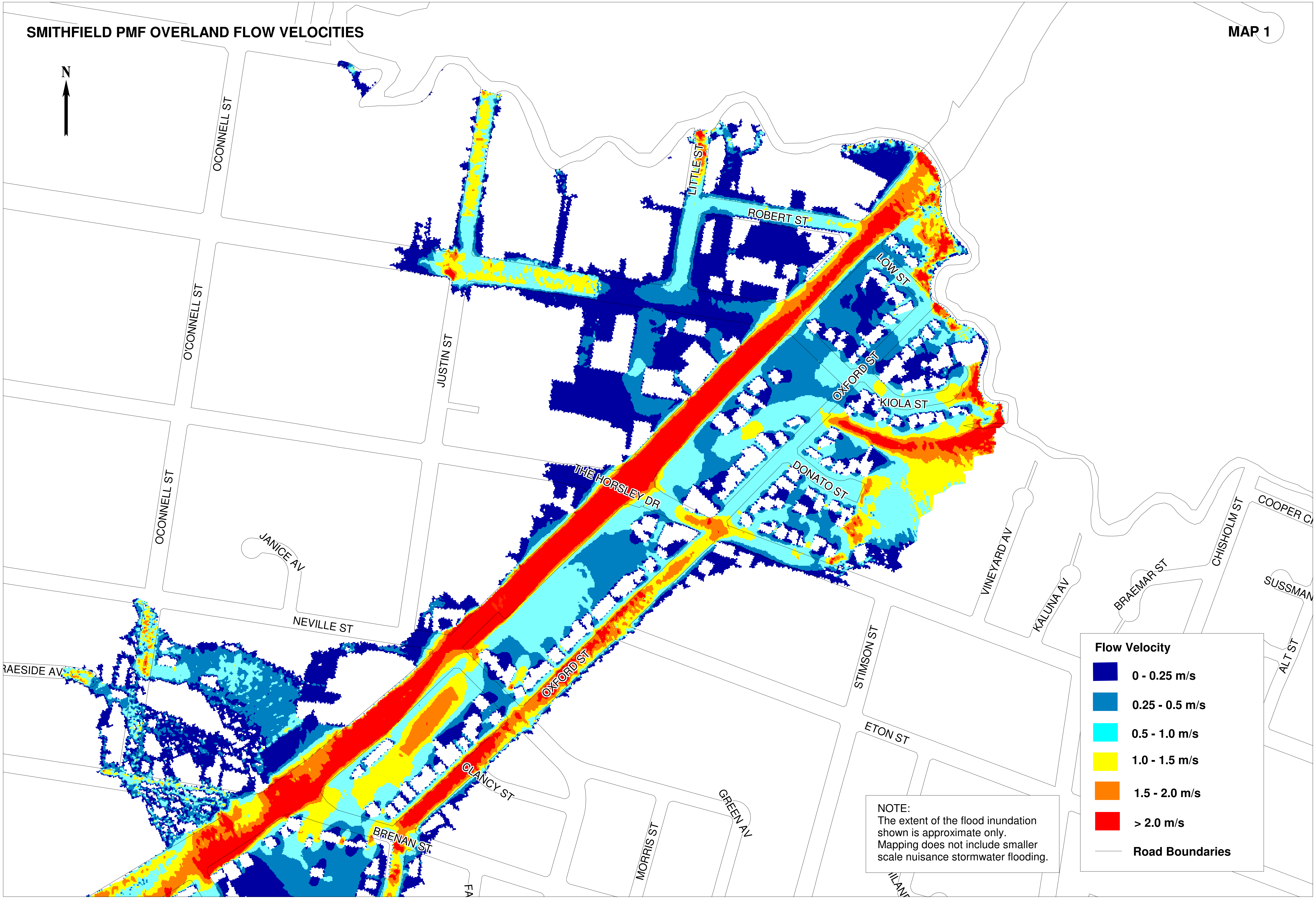
MAP 3

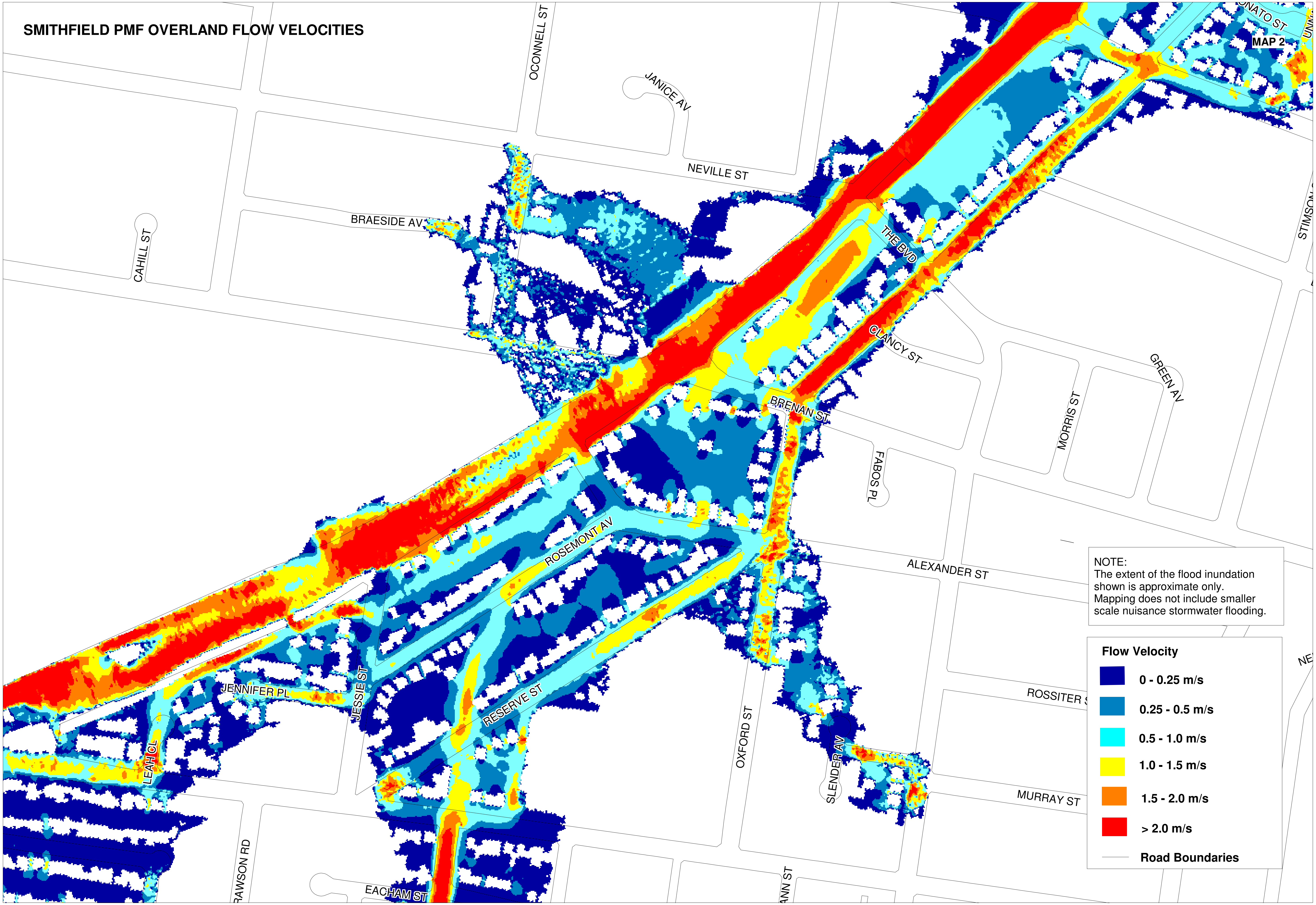


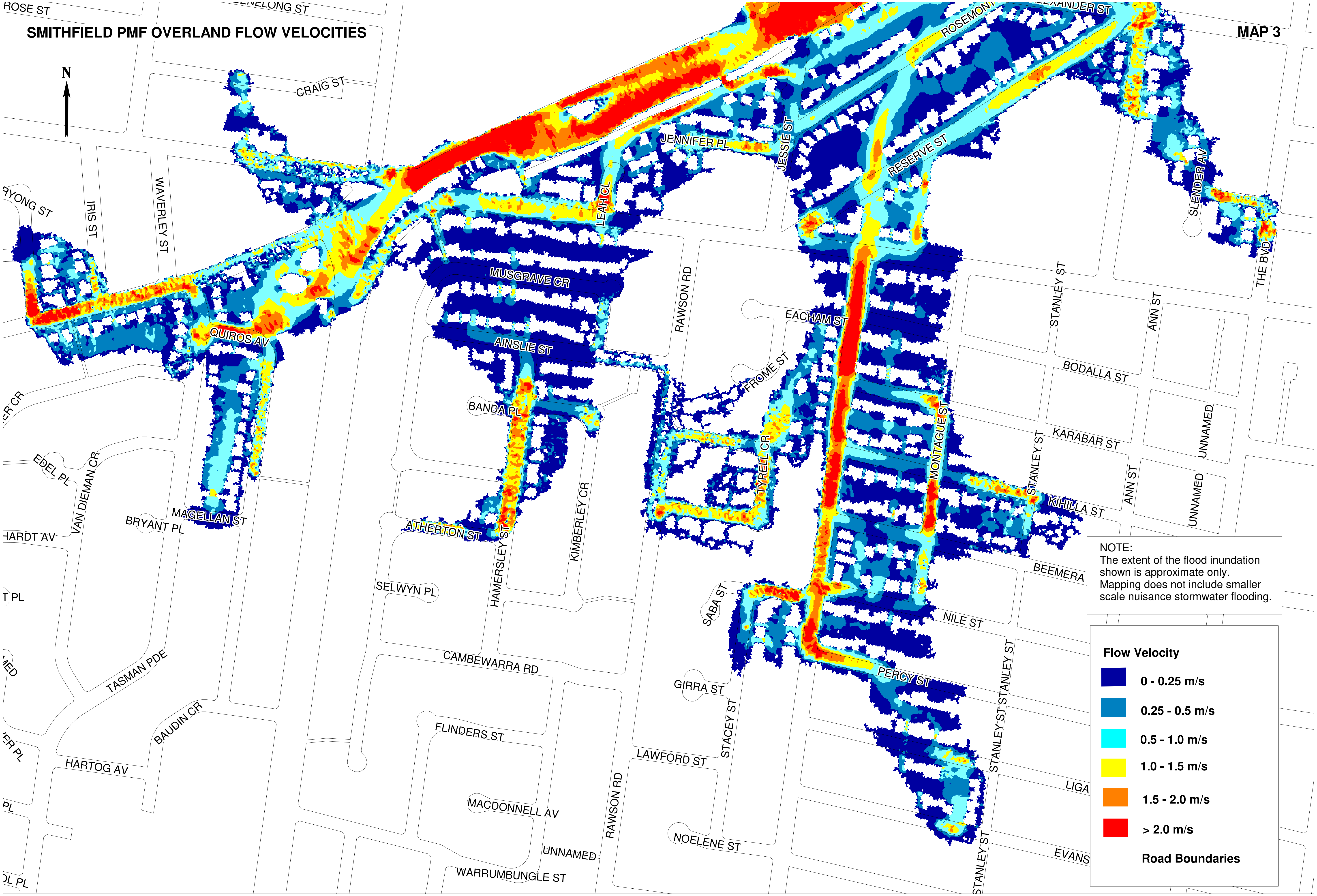
SMITHFIELD PMF OVERLAND FLOW VELOCITIES



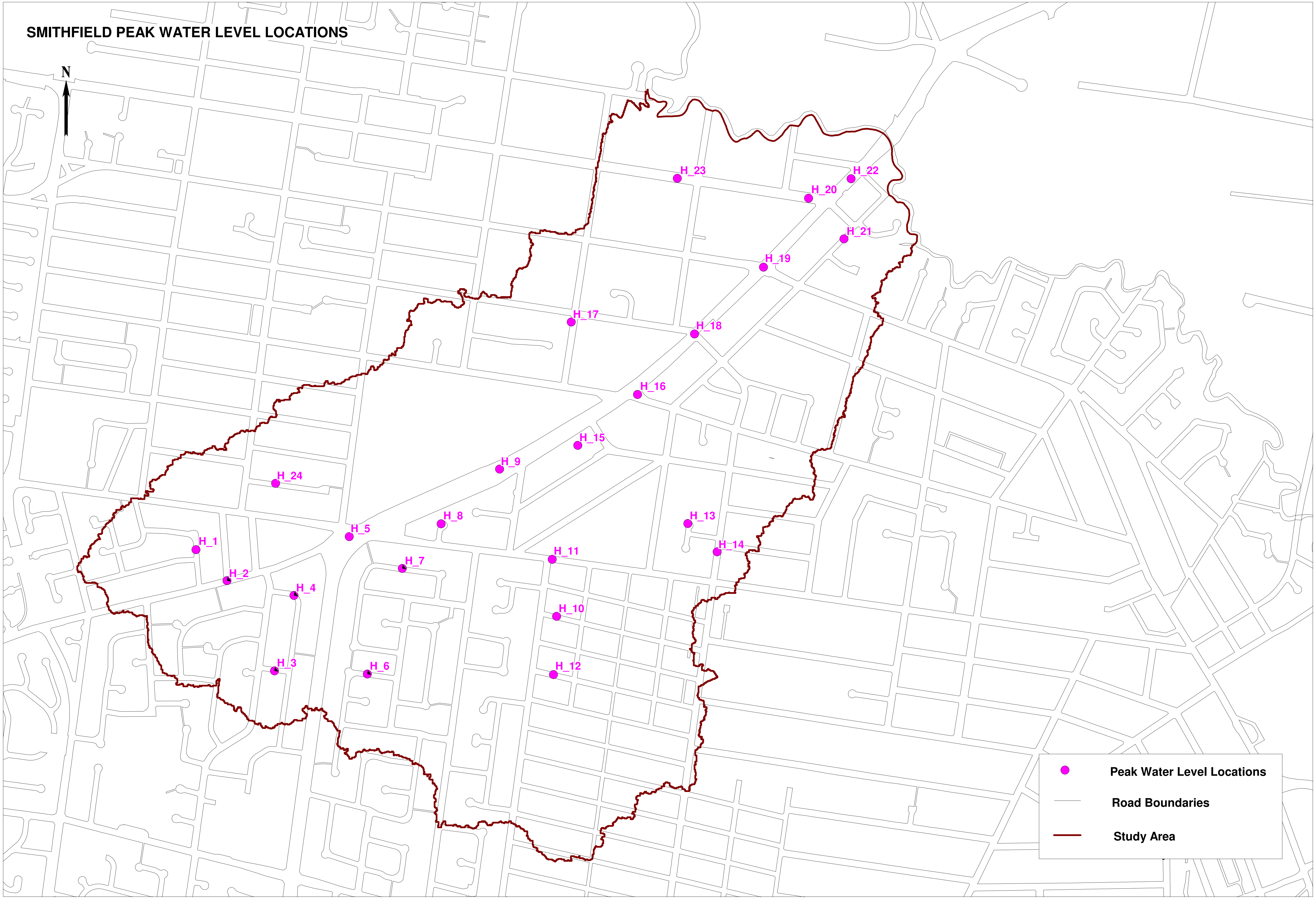
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.


SMITHFIELD PMF OVERLAND FLOW VELOCITIES
MAP 1
N
OCONNELL ST
O'CONNELL ST
OCONNELL ST
JUSTIN ST
LITTLE ST
ROBERT ST
LOW ST
OXFORD ST
KIOLA ST
DONATO ST
THE HORSLEY DR
JANICE AV
NEVILLE ST
RAESIDE AV
OXFORD ST
CLANCY ST
BRENAN ST
MORRIS ST
GREEN AV
ETON ST
STIMSON ST
VINEYARD AV
KALUNA AV
BRAEMAR ST
CHISHOLM ST
COOPER CL
SUSSMAN
ALT ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Flow Velocity
0 - 0.25 m/s
0.25 - 0.5 m/s
0.5 - 1.0 m/s
1.0 - 1.5 m/s
1.5 - 2.0 m/s
> 2.0 m/s
Road Boundaries

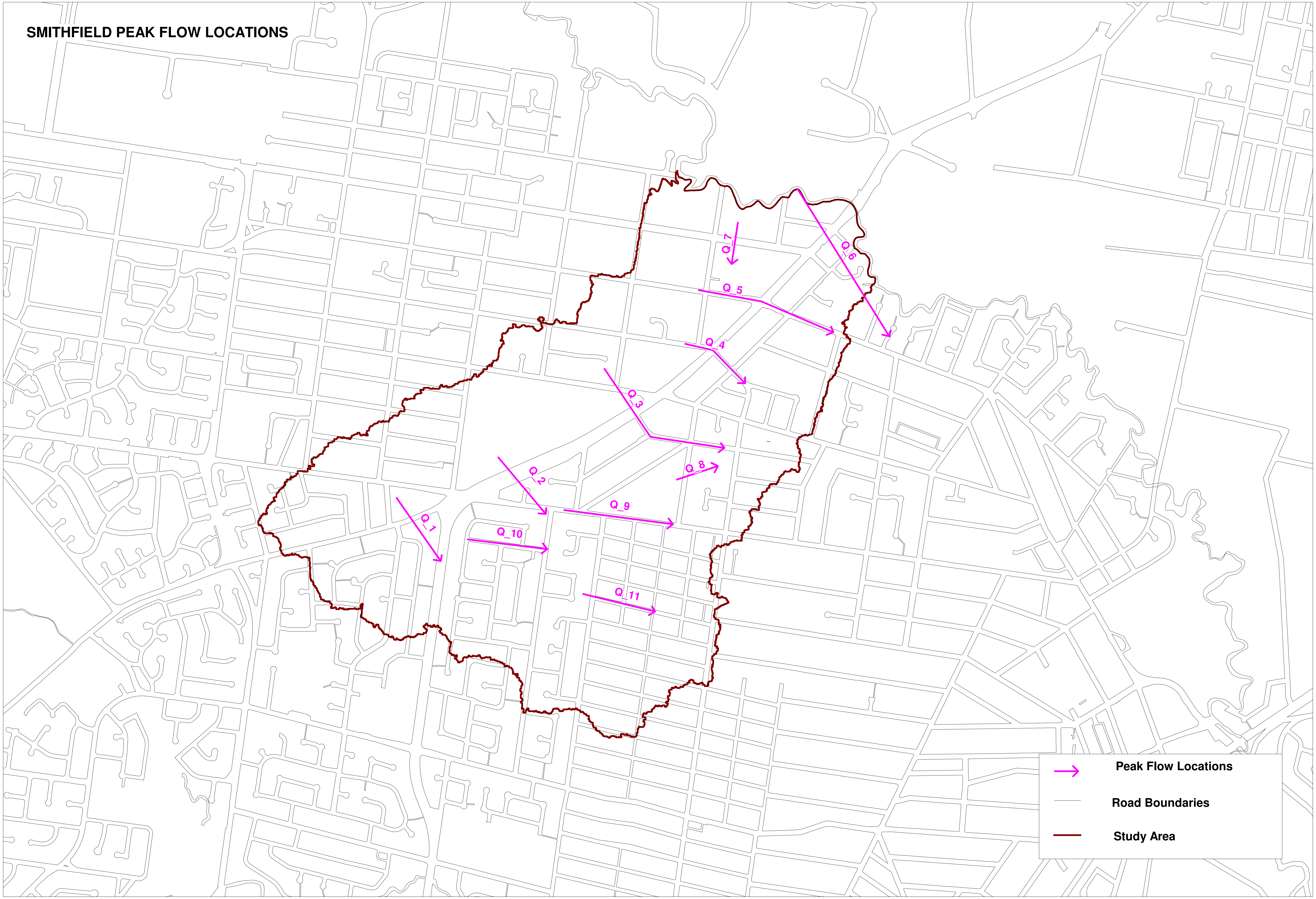

SMITHFIELD PMF OVERLAND FLOW VELOCITIES
MAP 2
OCONNELL ST
JANICE AV
NEVILLE ST
BRAESIDE AV
CAHILL ST
THE BVD
CLANCY ST
GREEN AV
MORRIS ST
BRENAN ST
FABOS PL
STIMSON
ROSEMONT AV
ALEXANDER ST
JENNIFER PL
JESSIE ST
RESERVE ST
OXFORD ST
ROSSITER
LEAH CL
SLENDER AV
MURRAY ST
RAWSON RD
EACHAM ST
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Flow Velocity
0 - 0.25 m/s
0.25 - 0.5 m/s
0.5 - 1.0 m/s
1.0 - 1.5 m/s
1.5 - 2.0 m/s
> 2.0 m/s
Road Boundaries


SMITHFIELD PMF OVERLAND FLOW VELOCITIES
MAP 3
N
NOTE:
The extent of the flood inundation shown is approximate only.
Mapping does not include smaller scale nuisance stormwater flooding.
Flow Velocity
0 - 0.25 m/s
0.25 - 0.5 m/s
0.5 - 1.0 m/s
1.0 - 1.5 m/s
1.5 - 2.0 m/s
> 2.0 m/s
Road Boundaries
CRAIG ST
IRIS ST
WAVERLEY ST
QUIROS AV
MAGELLAN ST
BRYANT PL
VAN DIEMAN CR
EDEL PL
TASMAN PDE
BAUDIN CR
HARTOG AV
MUSGRAVE CR
AINSLIE ST
BANDA PL
ATHERTON ST
HAMERSLEY ST
KIMBERLEY CR
SELWYN PL
CAMBEWARRA RD
FLINDERS ST
MACDONNELL AV
UNNAMED
WARRUMBUNGLE ST
LEAH CL
JENNIFER PL
JESSIE ST
RAWSON RD
EACHAM ST
FROME ST
TYRELL CR
SABA ST
GIRRA ST
STACEY ST
LAWFORD ST
NOELENE ST
RESERVE ST
ROSEMONT
MONTAGUE ST
PERCY ST
NILE ST
BEEMERA
KIHILLA ST
STANLEY ST
KARABAR ST
BODALLA ST
ANN ST
UNNAMED
SLENDER AV
THE BVD
LIGA
EVANS

Appendix F Peak Flows and Water Levels



SMITHFIELD PEAK WATER LEVEL LOCATIONS
N
H_1
H_2
H_3
H_4
H_5
H_6
H_7
H_8
H_9
H_10
H_11
H_12
H_13
H_14
H_15
H_16
H_17
H_18
H_19
H_20
H_21
H_22
H_23
H_24
Peak Water Level Locations
Road Boundaries
Study Area


SMITHFIELD PEAK FLOW LOCATIONS
Q_1
Q_2
Q_3
Q_4
Q_5
Q_6
Q_7
Q_8
Q_9
Q_10
Q_11
Peak Flow Locations
Road Boundaries
Study Area

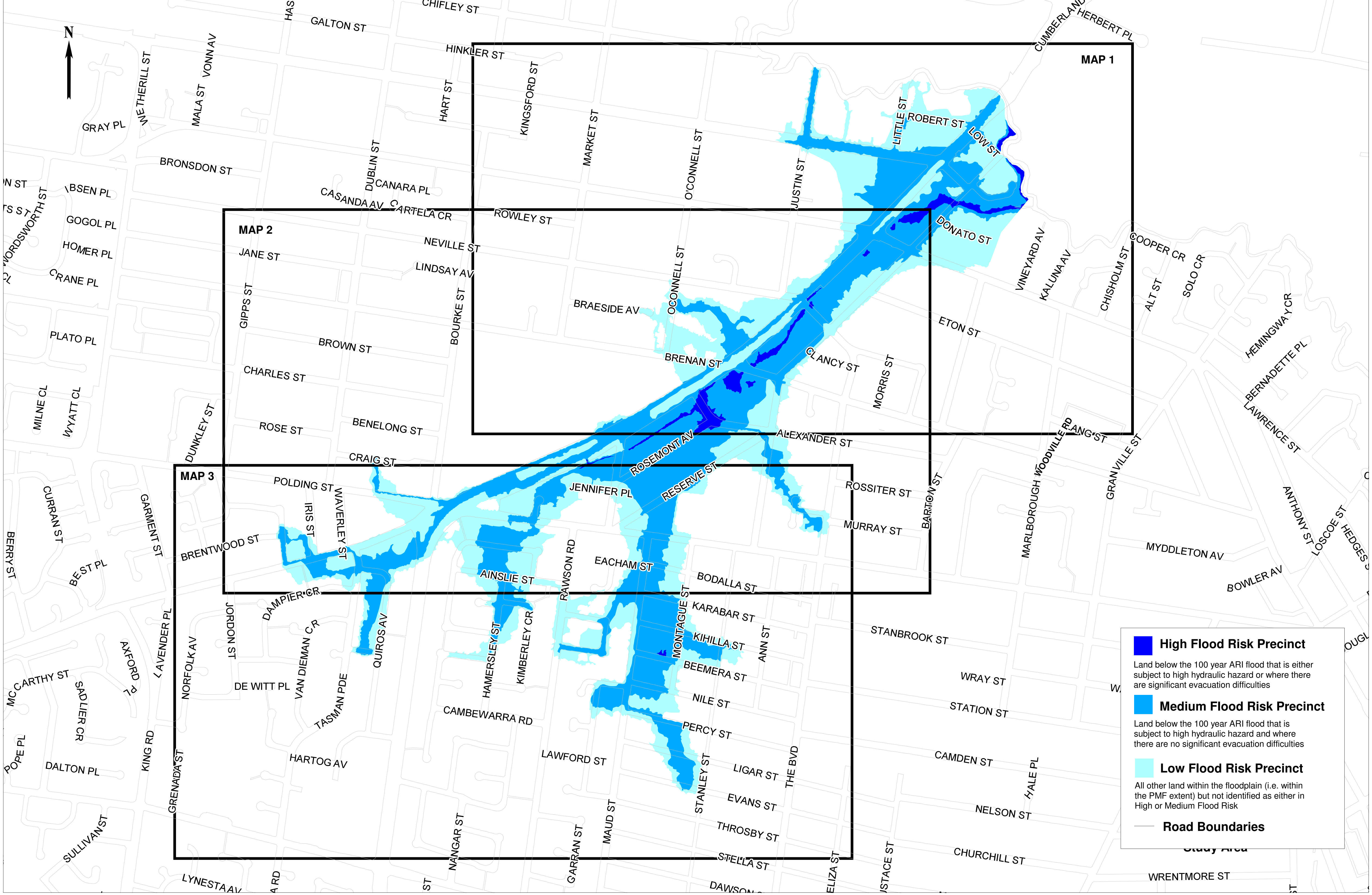
SKM

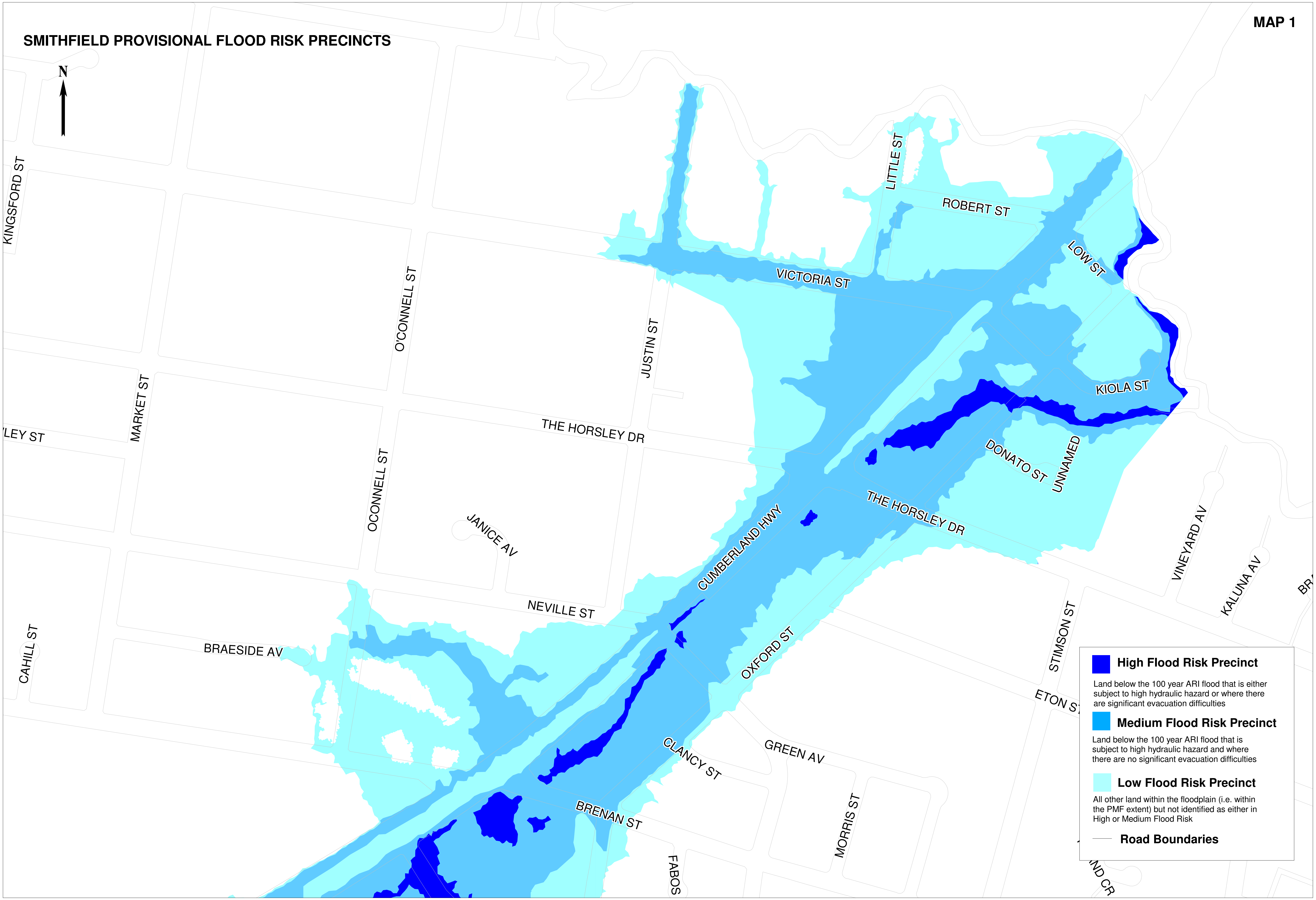
Table F-1 Peak Flows and Water Levels at Selected Locations

ID	Name	Event ARI (years)						
		20	100	200	500	2,000	10,000	PMF
Peak Water Level (m AHD)								
H_1	Corryong Street	39.72	39.75	39.76	39.78	39.81	39.86	40.10
H_2	Iris Street	39.72	36.22	36.22	36.22	36.22	36.22	36.28
H_3	Magellan Street	36.21	36.23	36.24	36.26	36.28	36.34	36.70
H_4	Quivros Avenue	32.49	32.51	32.54	32.56	32.62	32.68	32.95
H_5	Smithfield Road	30.56	30.61	30.64	30.68	30.77	30.91	31.48
H_6	Atherton Street	36.50	36.50	36.50	36.50	36.50	36.50	36.54
H_7	Musgrave Crescent	29.42	29.52	29.59	29.68	29.88	30.06	30.68
H_8	Leah Close	27.80	27.84	27.85	27.88	27.92	28.00	28.49
H_9	Cumberland Highway	27.45	27.45	27.45	27.50	27.60	27.69	28.14
H_10	Karabar Street	27.59	27.67	27.71	27.78	27.89	28.05	28.62
H_11	Polding Street	26.46	26.50	26.52	26.60	26.75	26.94	27.50
H_12	Beemera Street	29.86	29.91	29.94	29.97	30.02	30.10	30.41
H_13	Slender Avenue	30.37	30.40	30.44	30.50	30.53	30.66	31.16
H_14	The Boulevard	34.20	34.20	34.20	34.20	34.20	34.21	34.25
H_15	Rosemount Avenue	24.65	24.74	24.81	24.90	25.10	25.36	26.13
H_16	Brenan Street	23.38	23.46	23.54	23.64	23.81	24.05	24.70
H_17	O'Connell Street	33.01	33.01	33.01	33.01	33.01	33.05	33.06
H_18	Cumberland highway	21.39	21.43	21.48	21.57	21.75	21.97	22.90
H_19	The Horsley Drive	19.71	19.75	19.77	19.81	19.94	20.10	20.84
H_20	Victoria Street	19.01	19.02	19.04	19.05	19.09	19.20	19.85
H_21	Oxford Street	18.02	18.18	18.28	18.39	18.61	18.80	19.46
H_22	Low Street	18.79	18.80	18.81	18.82	18.86	18.98	19.56
H_23	Victoria Street	20.40	20.40	20.40	20.40	20.40	20.40	20.55
H_24	Craig Street	38.31	38.31	38.31	38.31	38.31	38.31	38.31
Peak Flow (m^3/s)								
Q_1	Smith South	3.5	4.5	5.2	6.3	8.7	12.7	33.1
Q_2	Cumberland Hwy	8.5	10.0	11.4	13.4	18.1	27.0	71.6
Q_3	Alexander St	13.9	17.8	21.5	26.7	40.3	62.0	188.9
Q_4	Boulevarde	13.3	17.1	20.9	26.6	40.2	62.4	217.0
Q_5	Horsley Drive	13.5	18.8	23.3	29.5	45.9	70.7	240.5
Q_6	Smith North	10.8	15.8	19.7	25.7	43.5	67.6	231.4
Q_7	Justine St	1.7	2.0	2.0	2.2	2.4	3.1	9.4
Q_8	Alexander St South	1.1	1.2	1.4	1.7	2.0	2.9	8.8
Q_9	Polding St	5.6	6.9	7.9	10.5	15.6	24.8	72.6
Q_10	Ainslie St	1.1	1.4	1.7	2.0	2.5	3.7	10.4
Q_11	Beemera St	2.7	4.3	5.1	6.2	8.5	12.6	33.2

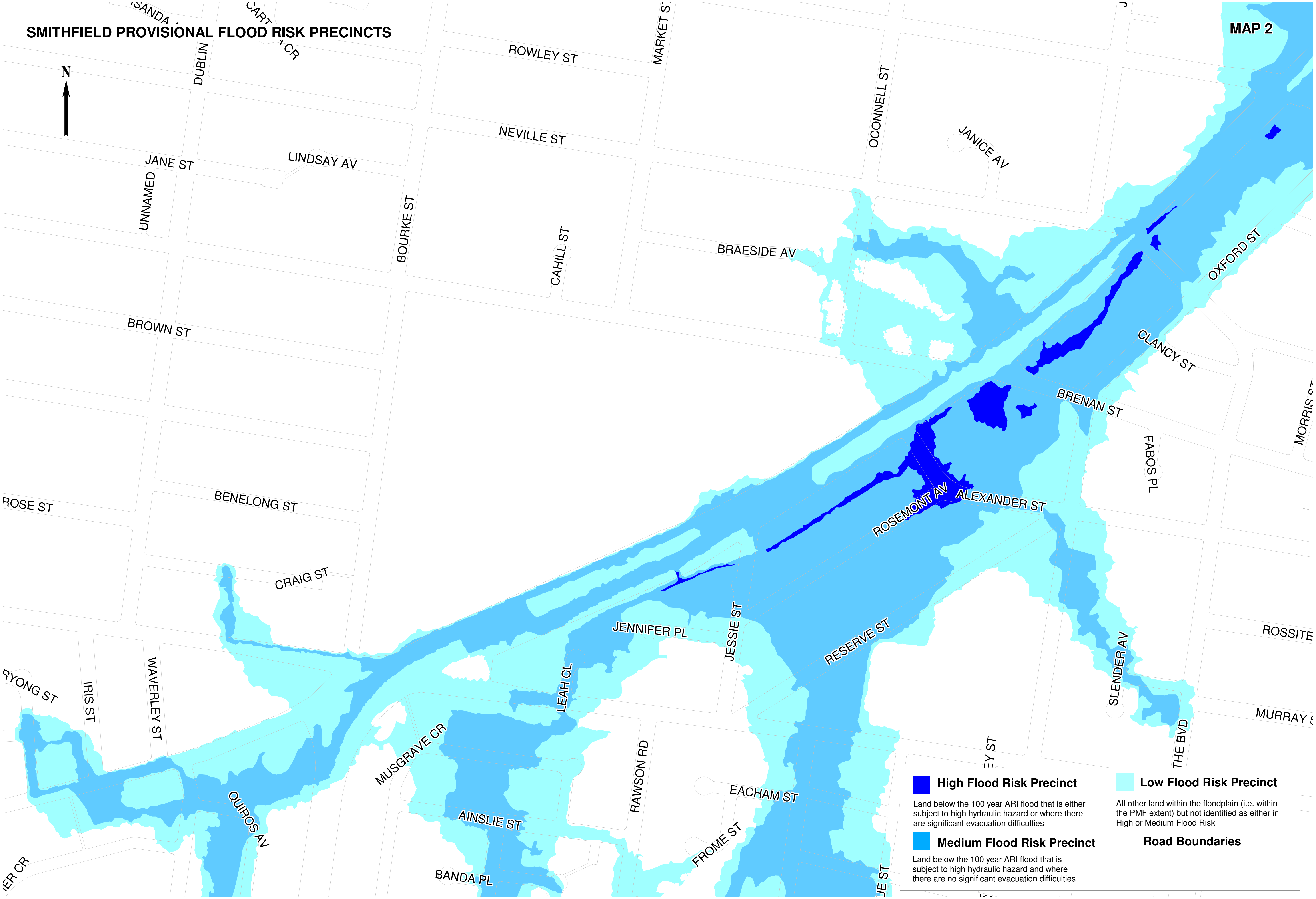
Appendix G Flood Risk Precinct Mapping

SMITHFIELD PROVISIONAL FLOOD RISK PRECINCTS

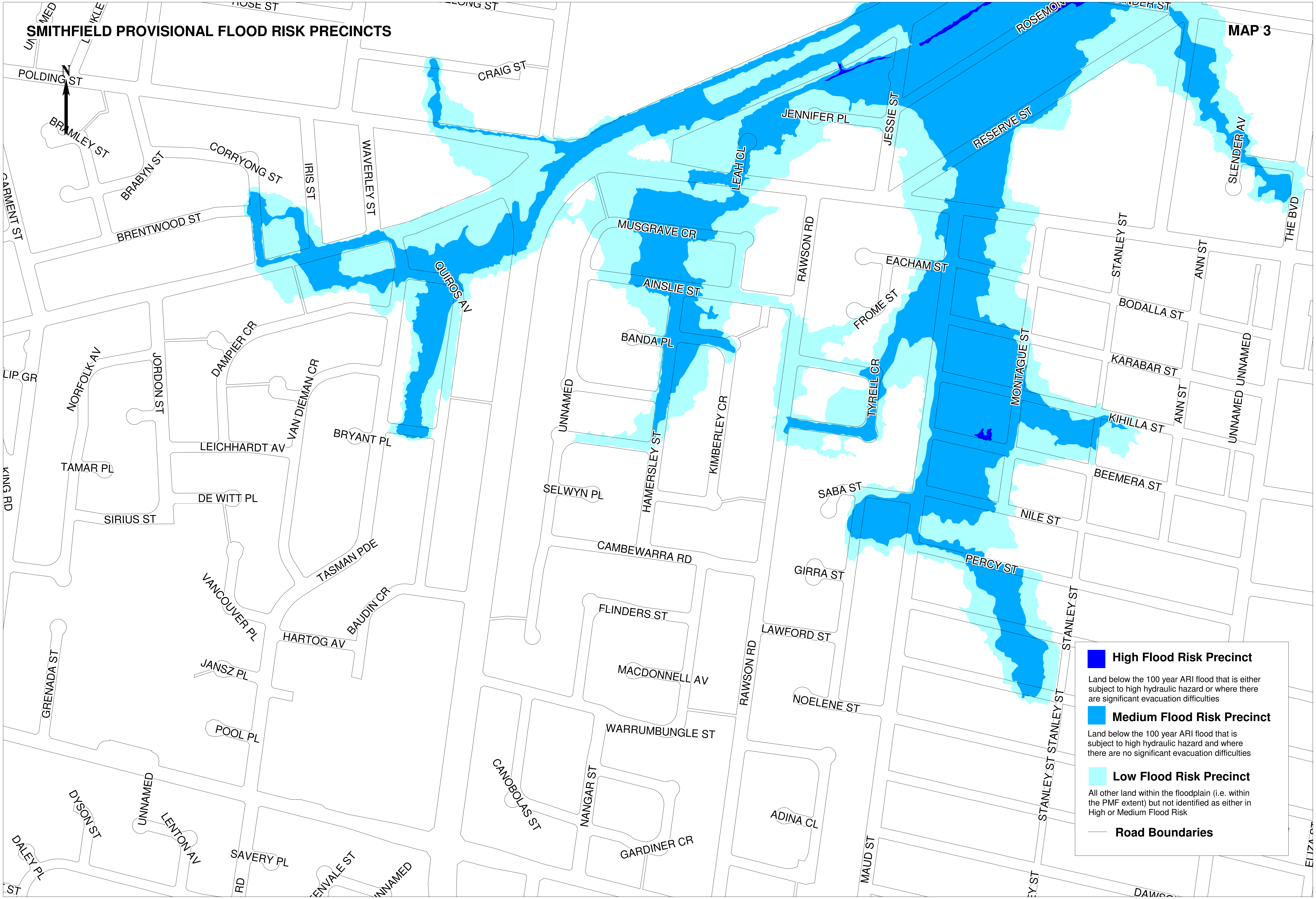




MAP 1
SMITHFIELD PROVISIONAL FLOOD RISK PRECINCTS
N
KINGSFORD ST
MARKET ST
O'CONNELL ST
OCONNELL ST
JUSTIN ST
LITTLE ST
ROBERT ST
VICTORIA ST
LOW ST
KIOLA ST
DONATO ST
UNNAMED
THE HORSLEY DR
THE HORSLEY DR
CUMBERLAND HWY
JANICE AV
NEVILLE ST
BRAESIDE AV
CAHILL ST
OXFORD ST
CLANCY ST
GREEN AV
BRENAN ST
FABOS
MORRIS ST
STIMSON ST
ETON ST
VINEYARD AV
KALUNA AV
High Flood Risk Precinct
Land below the 100 year ARI flood that is either subject to high hydraulic hazard or where there are significant evacuation difficulties
Medium Flood Risk Precinct
Land below the 100 year ARI flood that is subject to high hydraulic hazard and where there are no significant evacuation difficulties
Low Flood Risk Precinct
All other land within the floodplain (i.e. within the PMF extent) but not identified as either in High or Medium Flood Risk
Road Boundaries



SMITHFIELD PROVISIONAL FLOOD RISK PRECINCTS
MAP 2
N
ROWLEY ST
MARKET ST
NEVILLE ST
OCONNELL ST
JANICE AV
DUBLIN
JANE ST
LINDSAY AV
UNNAMED
BOURKE ST
CAHILL ST
BRAESIDE AV
OXFORD ST
BROWN ST
CLANCY ST
BRENAN ST
MORRIS ST
FABOS PL
ROSE ST
BENELONG ST
ALEXANDER ST
ROSEMONT AV
CRAIG ST
JENNIFER PL
JESSIE ST
RESERVE ST
ROSSITE
IRIS ST
WAVERLEY ST
LEAH CL
SLENDER AV
MURRAY S
MUSGRAVE CR
RAWSON RD
THE BVD
QUIROS AV
EACHAM ST
AINSLIE ST
FROME ST
BANDA PL
High Flood Risk Precinct
Land below the 100 year ARI flood that is either subject to high hydraulic hazard or where there are significant evacuation difficulties
Medium Flood Risk Precinct
Land below the 100 year ARI flood that is subject to high hydraulic hazard and where there are no significant evacuation difficulties
Low Flood Risk Precinct
All other land within the floodplain (i.e. within the PMF extent) but not identified as either in High or Medium Flood Risk
Road Boundaries


SMITHFIELD PROVISIONAL FLOOD RISK PRECINCTS
MAP 3
N
High Flood Risk Precinct
Land below the 100 year ARI flood that is either subject to high hydraulic hazard or where there are significant evacuation difficulties
Medium Flood Risk Precinct
Land below the 100 year ARI flood that is subject to high hydraulic hazard and where there are no significant evacuation difficulties
Low Flood Risk Precinct
All other land within the floodplain (i.e. within the PMF extent) but not identified as either in High or Medium Flood Risk
Road Boundaries
POLDING ST
BRAMLEY ST
BRABYN ST
CORRYONG ST
BRENTWOOD ST
IRIS ST
WAVERLEY ST
CRAIG ST
QUIROS AV
JENNIFER PL
JESSIE ST
LEAH CL
RESERVE ST
SLENDER AV
THE BVD
MUSGRAVE CR
AINSLIE ST
BANDA PL
RAWSON RD
EACHAM ST
FROME ST
TYRELL CR
MONTAGUE ST
STANLEY ST
ANN ST
BODALLA ST
KARABAR ST
KIHILLA ST
UNNAMED
BEEMERA ST
NILE ST
SABA ST
PERCY ST
GIRRA ST
LAWFORD ST
NOELENE ST
ADINA CL
MAUD ST
DAMPIER CR
NORFOLK AV
JORDON ST
VAN DIEMAN CR
BRYANT PL
LEICHHARDT AV
TAMAR PL
DE WITT PL
SIRIUS ST
TASMAN PDE
VANCOUVER PL
BAUDIN CR
HARTOG AV
JANSZ PL
GRENADA ST
POOL PL
DYSON ST
LENTON AV
DALEY PL
SAVERY PL
SELWYN PL
HAMERSLEY ST
KIMBERLEY CR
CAMBEWARRA RD
FLINDERS ST
MACDONNELL AV
WARRUMBUNGLE ST
CANOBOLAS ST
NANGAR ST
GARDINER CR
GARMENT ST
KING RD

Appendix H Model Quality Assurance Review Recommendations

The Smithfield XP-STORM model was set up using the same principles and assumptions as the Old Guildford Overland Flood Study XP-STORM model (SKM, 2010). From the two models, the Old Guildford XP-STORM model was selected for a Quality Assurance review. This was undertaken by Ashis Dey, XP-Software, in December 2008. **Table I-1** presents the comments from the QA review and responses in consideration of the comments. Based on the findings of the review of the Old Guildford model, appropriate changes and adjustments were also made to the Smithfield model.

- **Table I-1 QA review comments and recommendations**

Comment	Response
Node533 has user inflow – 110m3/s peak. Node539 has user inflow – 75m3/s peak. How were these flow calculated? Correct prediction is essential for accurate flood modelling.	Flows were extracted from Burns Creek TUFLOW model
Multiple entry of same variable is not recommended in XP-Table. 2nd entry of SLOPE, AREA, SUBCATCHMENT FLAG etc has been deleted in "Catchment Data" Table.	OK
Same loss rate (HORTON infiltration) has been applied for all catchments. Impervious catchments should have less loss rate than pervious catchments. Has any calibration been done to set up the loss rate?	No suitable data available to perform model calibration. Loss rates were selected to be consistent with Canley Corridor Overland Flood Study DRAINS model.
40ha catchment's runoff is draining to node A/620/90 (peak flow =55m3/s). Although the subsurface pipe (1.5m dia) should have a capacity to drain a significant amount of water, but it is not draining any water because of inlet restriction (max capture 0.01m^3/s). Not sure about modelling objective here.	This pit is a sealed pit. By default sub-catchment flows are input into the pipe system in the pit if a sub-catchment is linked to the pit, as was the case here. This caused unrealistic buildup of flow volume and head in the pit causing flow reversal in upstream pipes. Application of dummy pit inlet with limited capacity forces the model to input flows on the surface.
Flood extent has extended to model boundary (there is huge inactive zone around bottom right part of Node533), which is not expected. Flood depth is over 1.5m along inactive boundary line. Well defined physical boundary is essential to predict the accurate flood extent.	The model extent has been defined well beyond the area of interest for this study (i.e. LGA boundary) to allow for such interaction of flow with the model boundary. Flow behaviour along the LGA boundary/study area was considered to be realistic and beyond the influence of the flow/model boundary interaction. Topographic data was not available in adjacent LGAs to extend the model any further.

Buildings have been modelled as inactive area – have other options been considered?	The adopted methodology was selected in agreement with FCC and is consistent with the other overland flood studies for FCC. Other methods have been considered in the selection process.
2D head and 1D stage history at downstream of Node516 – seems setting are appropriate; however, how was the data obtained? Correct prediction is essential for accurate flood modelling.	Data was extracted from Burns Creek TUFLOW model
What does DumPipe1/Link544/DumPipe2 represent? Link DumPipe2 diameter =0.05m ????	Dummy link defined here to allow flows into Holroyd LGA at Yennora Station to be captured and fed to the model outlet. This was necessary as XP-STORM does not permit multiple model outlets.
What does 19m (RL) break line around Node536 represent? Although it has no significant effect on results.	Required to capture Yennora Station overflows and feed into dummy channel for discharge at model outlet.
2D_WEIR_LEN and 2D_ORIF_AREA > only one should be used. If both are used only the last one is considered. 2D_WEIR_LEN=10 seems very high. Suggestion is 2.	OK. No guidance was given in user manual.
MINLEN configuration parameter should be used with care. Very short MINLEN may create model instability. This model has pipes less than 1m. If possible, it would be wise to exclude or modify those short pipes.	Noted.
It is suggested that VERT_WALLS configuration parameter should be used when open channels are connected to 2D.	OK. No guidance was given in user manual.
0.05sec time step in Hydraulics is not used during simulation. XPSWMM uses adaptive time step to maintain the model stability. Minimum time step in xpswmm is 0.5sec.	Noted.
Some nodes (such as A/10/205) are modeled as “Sealed”. Sealed option should only be used to model the bolted manhole.	Sealed option was specifically used to model bolted lid pits.
Some nodes (such as B/680/05) are modeled as “Ponding Allowed”. “Ponding Allowed” option is not usually recommended. What does the downstream dummy link represent?	Ponding allowed option required for pipe line outlets (headwalls) at the creeks. other options did not provide desirable hydraulic outcomes. Dummy links required to link the headwall nodes to the creek channel model nodes.
2D Roughness in Residential/Commercial/Industrial area is 0.15-0.20 seems a bit high. Also all the buildings are blocked as inactive area. Has any calibration been done to judge the roughness? The combined effect of high roughness and blocked building may cause higher flood depths.	Calibration data was not available. High Manning’s n was selected in agreement with FCC to account for unmodelled obstructions on urban lots including fences.

Glossary

Term	Description
Annual Exceedance Probability (AEP)	Term used to describe the chance of a flood of a given or larger size occurring in any one year, expressed as a percentage. Eg. a 1% AEP flood means there is a 1% (ie. one-in-100) chance of a flood of that size or larger occurring in any one year (see ARI).
Australian Height Datum (AHD)	A common national plain of level corresponding approximately to mean sea level. All flood levels, floor levels and ground levels are normally provided in metres AHD (m AHD)
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.
catchment	A catchment is the area of land from which rainwater drains into a common point such as a reservoir, pond, lake, river or creek. In urban areas such as Fairfield, the majority of the rainwater is collected by gutters and pipes and then flows through stormwater drains into the stormwater system.
conveyance	A direct measure of the flow carrying capacity of a particular cross-section of a stream or stormwater channel. (For example, if the conveyance of a channel cross-section is reduced by half, then the flow carrying capacity of that channel cross-section will also be halved).
discharge	The rate of flow of water measured in terms of volume per unit time, eg. cubic metres per second (m^3/s). Also known as **flow**. Discharge is different from the speed/velocity of flow which is a measure of how fast the water is moving.
extreme flood	An estimate of the probable maximum flood, which is the largest flood likely to ever occur.
flood	A 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 as defined by the FDM before entering a watercourse.
flood awareness	An appreciation of the likely effects of flooding and a knowledge of the relevant flood warning and evacuation procedures.
flood hazard	The potential for damage to property or harm to persons during a flood or a situation with a potential to cause loss. In relation to this study, the hazard is flooding which has the potential to cause harm or loss to the community. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.
flood level	The height of the flood described as either a depth of water above a particular location (eg. 1m above floor level) or as a depth of water related to a standard level such as Australian Height Datum (eg. flood level is 5m AHD).
flood liable/flood prone land	Land susceptible to flooding up to the PMF. The term flood liable or flood prone land covers the entire floodplain.

Term	Description
floodplain	The area of land that is subject to inundation by floods up to and including the PMF event.
Floodplain Development Manual (FDM)	Refers to the document dated April 2005, published by the New South Wales Government and entitled “Floodplain Development Manual: the management of flood liable land”.
Floodplain Risk Management Plan (FRMP)	A plan prepared for one or more floodplains in accordance with the requirements of the FDM or its predecessors.
Floodplain Risk Management Study (FRMS)	A study prepared for one or more floodplains in accordance with the requirements of the FDM or its predecessors.
flood risk	The chance of something happening that will have an impact. It is measured in terms of consequences and probability (likelihood). In the context of this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
flood risk precinct	An area of land with similar flood risks and where similar development controls may be applied by a Council to manage the flood risk. The flood risk is determined based on the existing development in the precinct or assuming the precinct is developed with normal residential uses. Usually the floodplain is categorised into three flood risk precincts 'low', 'medium' and 'high', although other classifications can sometimes be used. *High Flood Risk: T*his has been defined as the area of land below the 100-year flood event that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties. *Medium Flood Risk:* This has been defined as land below the 100-year flood level that is not within a high flood risk precinct. This is land that is not subject to a high hydraulic hazard or where there are no significant evacuation difficulties. *Low Flood Risk:* This has been defined as all land within the floodplain (i.e. within the extent of the probable maximum flood) but not identified within either a high flood risk or a medium flood risk precinct. The low flood risk precinct is that area above the 100-year flood event.
flood study	A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood events.
hydraulics	The study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydraulic hazard	The hazard as determined by the provisional criteria outlined in the FDM in a 100 year flood event.

Term	Description
hydrology	The study of rainfall and runoff process; in particular, the evaluation of peak discharges, flow volumes and the derivation of hydrographs (graphs that show how the discharge or stage/flood level at any particular location varies with time during a flood).
local drainage	Term given to small scale inundation in urban areas outside the definition of major drainage as defined in the FDM. Local drainage problem invariably involve shallow depths (less than 0.3m) with generally little danger to personal safety.
local overland flooding	The inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
mainstream flooding	The inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
overland flow path	The path that floodwaters can follow if they leave the confines of the main flow channel or pipe system. Overland flow paths can occur through private properties or along roads.
peak discharge	The maximum discharge or flow during a flood measured in cubic metres per second (m^3/s).
probable maximum flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.
probable maximum precipitation (PMP)	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 the estimation of the probable maximum flood.
probability	A statistical measure of the expected chance of flooding (see ARI).
risk	See *flood risk.*
runoff	The amount of rainfall that ends up as flow in a stream. Also known as rainfall excess.
velocity	The term used to describe the speed of floodwaters, usually in metres per second (m/s).
water level	See *flood level.*
water surface profile	A graph showing the height of the flood (ie. water level or flood level) at any given location along a watercourse at a particular time.
zone of significant flow	The area of the floodplain where a significant discharge of water occurs during floods. Should the area within this boundary be fully or partially blocked, a significant distribution of flood flows or increase in flood levels would occur.