# WATERLOO METRO QUARTER OVER STATION DEVELOPMENT

## Environmental Impact Statement
## Appendix O – Stormwater Management Strategy and Flood Impact Assessment

## SSD-10438 Basement Car Park

Detailed State Significant Development
Development Application

Prepared for **Waterloo Developer Pty Ltd**

30 September 2020

| Reference | Description |
|---|---|
| Applicable SSD Applications | SSD-10438 Basement Carpark |
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| Document Number | WMQ-BSMT-WSP-DR-RPT-001 |
| Status | Final |
| Version | 2 |
| Date of Issue | 31 July 2020 |
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# 1. Glossary and abbreviations

| Reference | Description |
|---|---|
| ACHAR | Aboriginal Cultural Heritage Assessment Report |
| ADG | Apartment Design Guide |
| AEP | Annual Exceedance Probability |
| AHD | Australian height datum |
| AQIA | Air Quality Impact Assessment |
| AR&R | Australian Rainfall & Runoff |
| ARI | Annual Recurrence Interval |
| BC Act | Biodiversity Conservation Act 2016 |
| BCA | Building Code of Australia |
| BC Reg | Biodiversity Conservation Regulation 2017 |
| BDAR | Biodiversity Development Assessment Report |
| CEEC | critically endangered ecological community |
| CIV | capital investment value |
| CMP | Construction Management Plan |
| Concept DA | A concept DA is a staged application often referred to as a 'Stage 1' DA. The subject application constitutes a detailed subsequent stage application to an approved concept DA (SSD 9393) lodged under section 4.22 of the EP&A Act. |
| Council | City of Sydney Council |
| CPTED | Crime Prevention Through Environmental Design |
| CSSI approval | critical State significant infrastructure approval |
| CTMP | Construction Traffic Management Plan |
| DA | development application |
| DCP | Development Control Plan |
| DPIE | NSW Department of Planning, Industry and Environment |
| DRP | Design Review Panel |
| EP&A Act | Environmental Planning and Assessment Act 1979 |

| Reference | Description |
|---|---|
| EPA | NSW Environment Protection Authority |
| EPA Regulation | Environmental Planning and Assessment Regulation 2000 |
| EPBC Act | Environment Protection and Biodiversity Conservation Act 1999 |
| ESD | ecologically sustainable design |
| FPL | Flood Planning Level |
| GANSW | NSW Government Architect's Office |
| GFA | gross floor area |
| HIA | Heritage Impact Assessment |
| IAP | Interchange Access Plan |
| IFD | Intensity-Frequency-Duration |
| LGA | Local Government Area |
| NCC | National Construction Code |
| OSD | over station development OR on site detention |
| PIR | Preferred Infrastructure Report |
| POM | Plan of Management |
| PSD | Permissible Site Discharge |
| PSI | Preliminary Site Investigation |
| RMS | Roads and Maritime Services |
| SEARs | Secretary's Environmental Assessment Requirements |
| SEPP | State Environmental Planning Policy |
| SEPP 55 | State Environmental Planning Policy No 55—Remediation of Land |
| SEPP 65 | State Environmental Planning Policy No. 65 – Design Quality of Residential Apartment Development |
| SRD SEPP | State Environmental Planning Policy (State and Regional Development) 2009 |
| SREP Sydney Harbour | State Regional Environmental Plan (Sydney Harbour Catchment) 2005 |
| SSD | State significant development |

| Reference | Description |
|---|---|
| SSD DA | State significant development application |
| SLEP | Sydney Local Environmental Plan 2012 |
| Transport for NSW | Transport for New South Wales |
| TIA | Traffic Impact Assessment |
| The proposal | The proposed development which is the subject of the detailed SSD DA |
| The site | The site which is the subject of the detailed SSD DA |
| VIA | Visual Impact Assessment |
| WDAG | Waterloo Metro Quarter Design Amenity Guidelines (March 2020) |
| WMQ | Waterloo Metro Quarter |
| WMP | Waste Management Plan |
| WQFSR | Water Quality, Flooding and Stormwater Report, Waterloo Metro Quarter (October 2018) |
| WSUD | Water Sensitive Urban Design |

## 2. Executive summary

This Stormwater Management and Flood Impact Assessment has been prepared by WSP to accompany a detailed State significant development (SSD) development application (DA) for the Basement Car Park over station development (OSD) at the Waterloo Metro Quarter site.

This report has been prepared to address the relevant conditions of the concept SSD DA (SSD 9393) and the Secretary's Environmental Assessment Requirements (SEARs) issued for the detailed SSD DA (SSD 10438).

The flood study aims to:

- Assess the flood risk within and around the vicinity of the site;
- Establish mitigation measures required to ensure the sustainability and safety of the proposed scheme over its lifetime; and
- Address study requirements to demonstrate the feasibility of the proposed development.

To improve the understanding of the flood mechanisms at the site and surrounding area detailed hydraulic modelling have been undertaken for the existing and post development conditions.

Hydraulic modelling has been undertaken using a modified version of City of Sydney Council flood model for the Alexandra Canal Catchment flood study.

The hydraulic model results were used to inform the proposed development design.

Floor planning levels have been defined as per design requirements indicated in the Water Quality, Flooding and Stormwater Report, Waterloo Metro Quarter (October 2018) and Waterloo Design Amenity Guidelines (March – 2020).

The hydraulic model results for the baseline and proposed scenario were used to assess the flood impact of the proposed development to the existing flood conditions.

The Basement Car Park is not expected to negatively affect the flood conditions.

The flood study has been produced in consultation with the City of Sydney Council.

There is no Stormwater Management relevant to the Basement Car Park DA as all the stormwater above the basement is collected by the Northern and Central Precinct Developments. Refer to the Appendix O Stormwater Management Strategy and Flood Impact Assessment Reports for the Northern Precinct (SSD-10440) and Central Precinct (SSD-10439) for further details.

The OSD tank for the Building 2 and Cope Street Plaza catchments is included in the scope of work for the Basement Car Park (SSD-10438) and it is located below grade in Church Square.

# 3. Introduction

This report has been prepared to accompany a detailed State significant development (SSD) development application (DA) for the Basement Car Park over station development (OSD) at the Waterloo Metro Quarter site. The detailed SSD DA is consistent with the concept approval (SSD 9393) granted for the maximum building envelope on the site, as proposed to be modified.

The Minister for Planning, or their delegate, is the consent authority for the SSD DA and this application is lodged with the NSW Department of Planning, Industry and Environment (DPIE) for assessment.

The detailed SSD DA seeks development consent for the design, construction and operation of:

Basement Car Park

- 2-storey shared basement car park and associated excavation
- Ground level structure
- carparking for the commercial Building 1, residential Building 2, social housing Building 4, Waterloo Congregational Church and Sydney Metro
- service vehicle spaces
- commercial end-of-trip and bicycle storage facilities
- retail end-of-trip and bicycle storage facilities
- residential storage facilities
- shared plant and services
- in ground OSD tank for building 2 and Cope St Plaza catchments, located in Church Square

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 9 April 2020 and issued for the detailed SSD DA.

| Item | Description of requirement | Section reference (this report) |
|---|---|---|
| 16 | The EIS shall:<br>- Include an assessment of flood impact having regard to the requirements of Sydney LEP 2012 and the recommendations of the Concept Water Quality, Flooding and Stormwater Report dated 31 August 2018.<br>- Include a stormwater management strategy that considers the relevant local council stormwater management policy, including details of onsite stormwater capture, storage and re-use measures developed for the site | Stormwater: N/A<br>Flooding: 9.2, 9.3, 9.4 and 9.5 |

***Table 1 - SEARs requirements***

This report has also been prepared in response to the following conditions of consent issued for the concept SSD DA (SSD 9393) for the OSD as summarised in the table below.

| Item | Description of requirement | Section reference (this report) |
|---|---|---|
| B26 | The Concept Conditions of Consent state:<br>Future development applications shall be accompanied by a Flood and Stormwater Impact Assessment. The Assessment must demonstrate the conclusions and recommendations of the Concept Water Quality, Flooding and Stormwater Report dated 31 October 2018 prepared by AECOM. | Stormwater: N/A<br>Flooding: 9.2, 9.3, 9.4 9.5 and 9.6 |
| 3S | The objectives of the Waterloo Metro Quarter Design and Amenity Guidelines (March 2020) are:<br>• To improve quality and reduce stormwater runoff<br>• To manage flooding impacts and provide design responses that are integrated with the public domain and ensure street activation. | Stormwater: N/A<br>Flooding: 9.3 – 9.4 – 9.5 |

***Table 2 - Conditions of Concept Approval***

# 4. The site

The site is located within the City of Sydney Local Government Area (LGA). The site is situated about 3.3 kilometres south of Sydney CBD and eight kilometres northeast of Sydney International Airport within the suburb of Waterloo.

The Waterloo Metro Quarter site comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street (refer to Figure 1). The heritage-listed Waterloo Congregational Church at 103–105 Botany Road is within this street block but does not form a part of the Waterloo Metro Quarter site boundaries.

The Waterloo Metro Quarter site is a rectangular shaped allotment with an overall site area of approximately 1.287 hectares.

The Waterloo Metro Quarter site comprises the following allotments and legal description at the date of this report. Following consolidation by Sydney Metro (the Principal) the land will be set out in deposited plan DP1257150.

- 1368 Raglan Street (Lot 4 DP 215751)
- 59 Botany Road (Lot 5 DP 215751)
- 65 Botany Road (Lot 1 DP 814205)
- 67 Botany Road (Lot 1 DP 228641)
- 124-128 Cope Street (Lot 2 DP 228641)
- 69-83 Botany Road (Lot 1, DP 1084919)
- 130-134 Cope Street (Lot 12 DP 399757)
- 136-144 Cope Street (Lots A-E DP 108312)
- 85 Botany Road (Lot 1 DP 27454)
- 87 Botany Road (Lot 2 DP 27454)
- 89-91 Botany Road (Lot 1 DP 996765)
- 93-101 Botany Road (Lot 1 DP 433969 and Lot 1 DP 738891)
- 119 Botany Road (Lot 1 DP 205942 and Lot 1 DP 436831)
- 156-160 Cope Street (Lot 31 DP 805384)
- 107-117A Botany Road (Lot 32 DP 805384 and Lot A DP 408116)
- 170-174 Cope Street (Lot 2 DP 205942).

The detailed SSD DA applies to the Northern Precinct (the site) of the Waterloo Metro Quarter site. The site has an area of approximately 5,120sqm. The subject site comprises the following allotments and legal description at the date of this report.

Northern Precinct

- 1368 Raglan Street (Lot 4 DP 215751)
- 59 Botany Road (Lot 5 DP 215751)
- 65 Botany Road (Lot 1 DP 814205)
- 67 Botany Road (Lot 1 DP 228641)
- 124–128 Cope Street (Lot 2 DP 228641)

- 69–83 Botany Road (Lot 1, DP 1084919)
- 130–134 Cope Street (Lot 12 DP 399757).

The boundaries of the overall site are identified at Figure 1, and the subject site of the detailed SSD DA is identified at Figures 2 and 3. The site is reasonably flat with a slight fall to the south.

The site previously included three to five storey commercial, light industrial and shop top housing buildings. All previous structures except for an office building at the corner of Botany Road and Wellington Street have been demolished to facilitate construction of the new Sydney Metro Waterloo station. As such the existing site is predominately vacant and being used as a construction site. Construction of the Sydney metro is currently underway on site in accordance with critical State significant infrastructure approval (CSSI 7400).


***Figure 1 - Aerial image of the site***
***Source: Urbis***

The area surrounding the site consists of commercial premises to the north, light industrial and mixed-use development to the south, residential development to the east and predominantly commercial and light industry uses to the west.

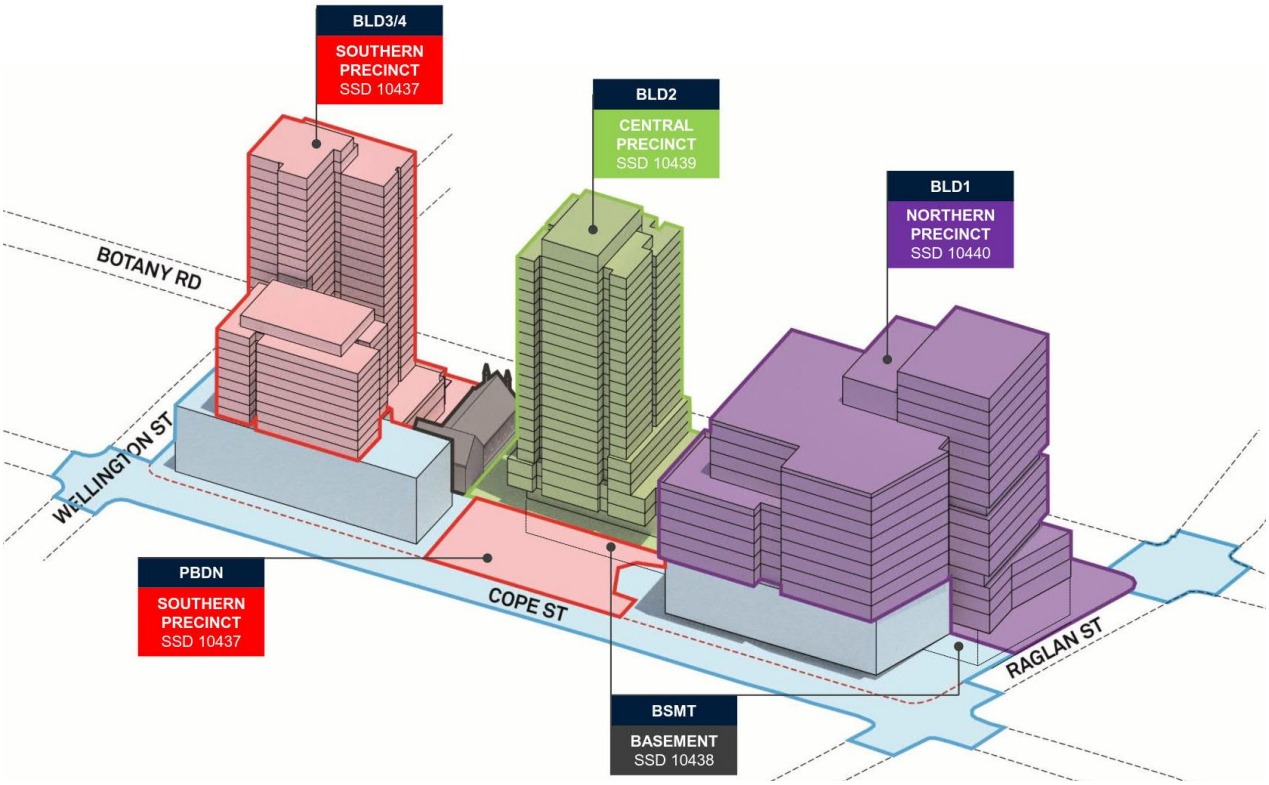



***Figure 2 - Waterloo Metro Quarter site, with sub-precincts identified***
***Source: HASSELL***

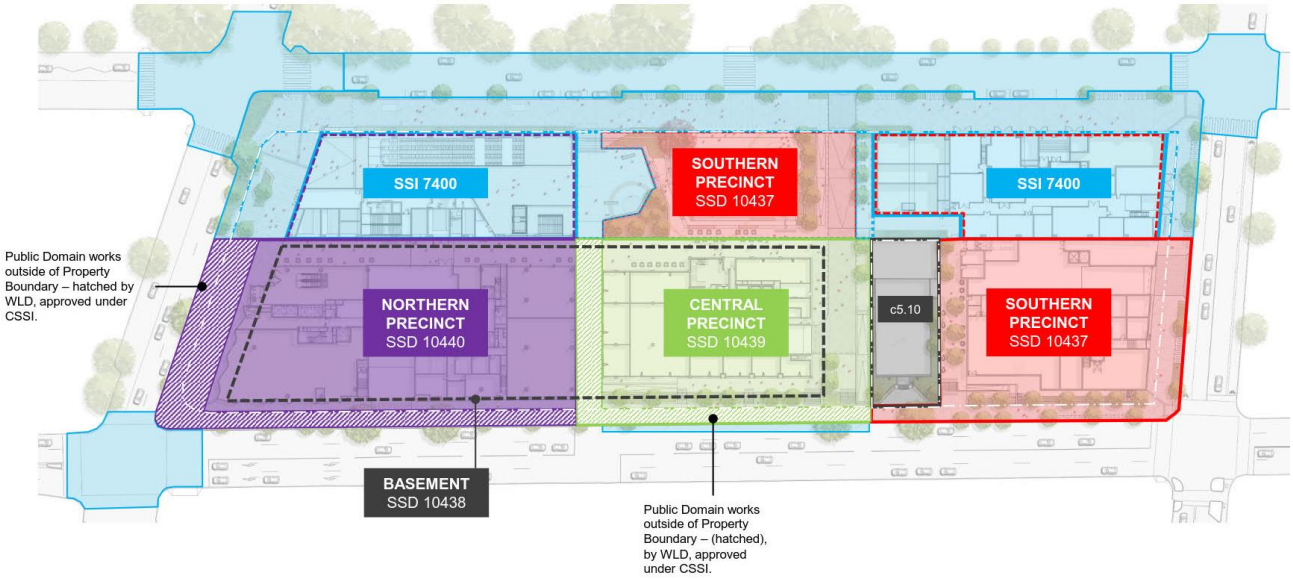



***Figure 3 - Waterloo Metro Quarter site, with sub-precincts identified***
***Source: Waterloo Developer Pty Ltd***

# 5. Background

## 5.1 About Sydney Metro

Sydney Metro is Australia's biggest public transport project. Services started in May 2019 in the city's North West with a train every four minutes in the peak. A new standalone railway, this 21st century network will revolutionise the way Sydney travels.

There are four core components:

### 5.1.1 Sydney Metro North West

This project is now complete and passenger services commenced in May 2019 between Rouse Hill and Chatswood, with a metro train every four minutes in the peak. The project was delivered on time and $1 billion under budget.

### 5.1.2 Sydney Metro City & Southwest

Sydney Metro City & Southwest project includes a new 30km metro line extending metro rail from the end of Metro Northwest at Chatswood, under Sydney Harbour, through new CBD stations and southwest to Bankstown. It is due to open in 2024 with the ultimate capacity to run a metro train every two minutes each way through the centre of Sydney.

Sydney Metro City & Southwest will deliver new metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and new underground metro platforms at Central Station. In addition, it will upgrade and convert all 11 stations between Sydenham and Bankstown to metro standards.

### 5.1.3 Sydney Metro West

Sydney Metro West is a new underground railway connecting Greater Parramatta and the Sydney CBD. This once-in-a-century infrastructure investment will transform Sydney for generations to come, doubling rail capacity between these two areas, linking new communities to rail services and supporting employment growth and housing supply between the two CBDs.

The locations of seven proposed metro stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays.

The NSW Government is assessing an optional station at Pyrmont and further planning is underway to determine the location of a new metro station in the Sydney CBD.

### 5.1.4 Sydney Metro Greater West

Metro rail will also service Greater Western Sydney and the new Western Sydney International (Nancy Bird Walton) Airport. The new railway line will become the transport spine for the Western Parkland City's growth for generations to come, connecting communities and travellers with the rest of Sydney's public transport system with a fast, safe and easy metro service.

The Australian and NSW governments are equal partners in the delivery of this new railway.

The Sydney Metro project is illustrated below.

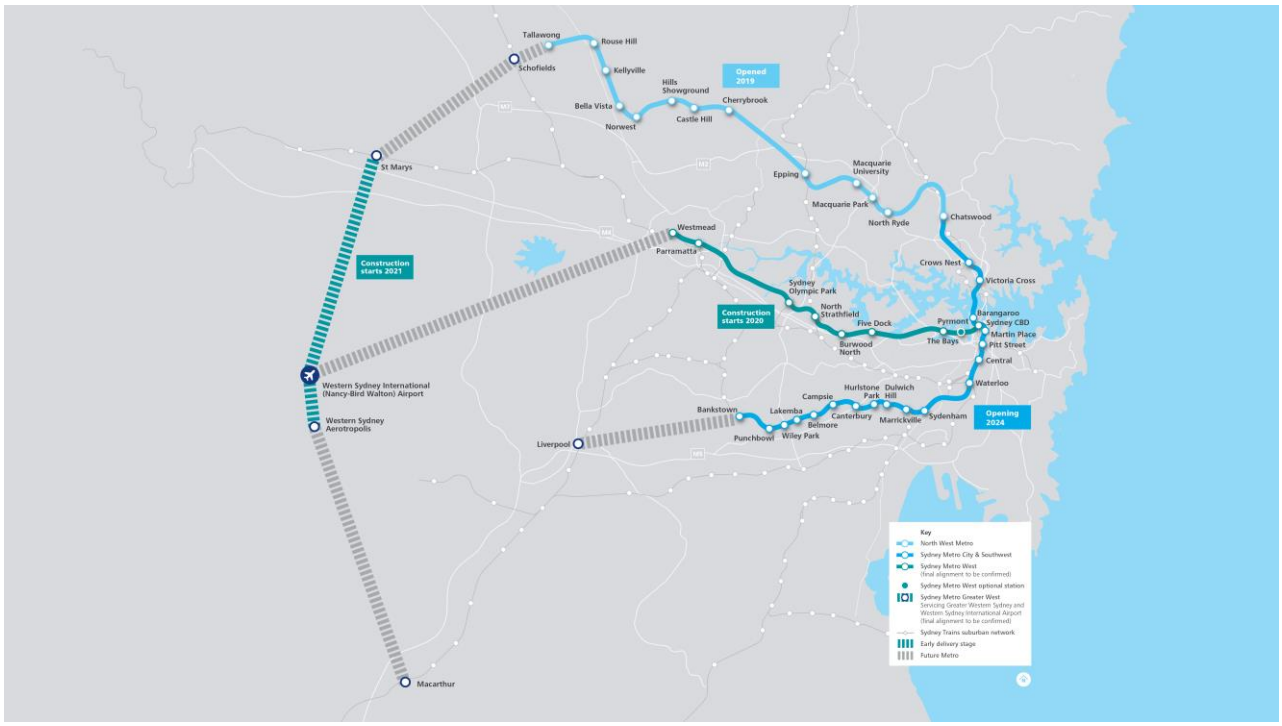



***Figure 4 - Sydney Metro alignment map***
***Source: Sydney Metro***

## 5.2 Sydney Metro CSSI Approval (SSI 7400)

On 9 January 2017, the Minister for Planning approved the Sydney Metro City & Southwest - Chatswood to Sydenham project as a critical State significant infrastructure (CSSI) project (reference SSI 7400) (CSSI approval). The terms of the CSSI approval includes all works required to construct the Sydney Metro Waterloo Station. The CSSI approval also includes the construction of below and above ground works within the metro station structure for appropriate integration with the OSD.

With regards to CSSI related works, any changes to the 'metro station box' envelope and public domain will be pursued in satisfaction of the CSSI conditions of approval and do not form part of the scope of the concept SSD DA or detailed SSD DA for the OSD.

Except to the extent described in the EIS or Preferred Infrastructure Report (PIR) submitted with the CSSI application, any OSD buildings and uses do not form part of the CSSI approval and will be subject to the relevant assessment pathway prescribed by the EP&A Act.

The delineation between the approved Sydney Metro works, generally described as within the two 'metro station boxes' and surrounding public domain works, and the OSD elements are illustrated in Figure 5.

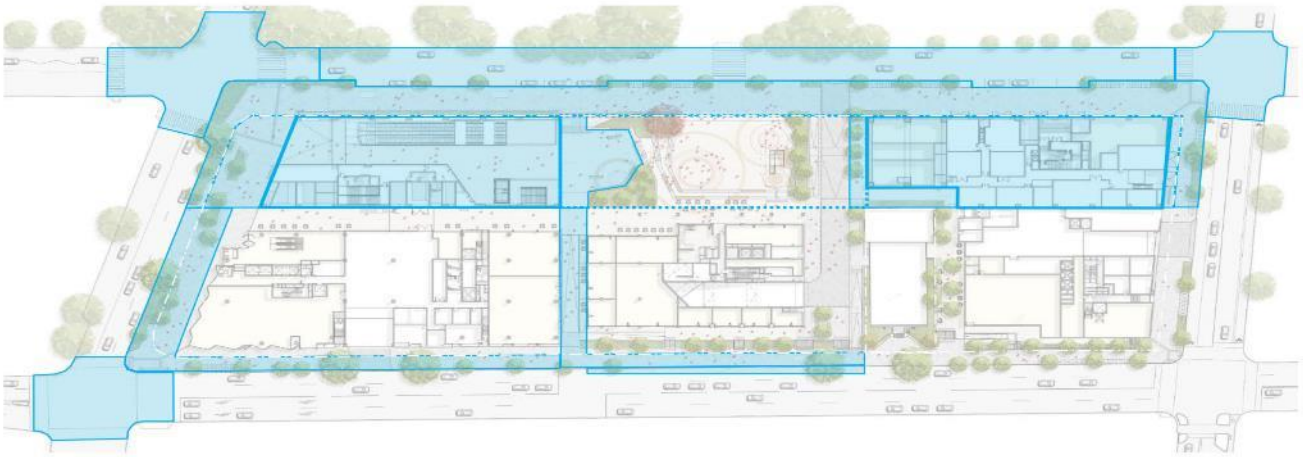


***Figure 5 - CSSI Approval scope of works***
***Source: WL Developer Pty Ltd***

## 5.3 Concept Approval (SSD 9393)

As per the requirements of clause 7.20 of the *Sydney Local Environmental Plan 2012* (SLEP), as the OSD exceeds a height of 25 metres above ground level (among other triggers), development consent is first required to be issued in a concept DA (formerly known as Stage 1 DA).

Development consent was granted on 10 December 2019 for the concept SSD DA (SSD 9393) for the Waterloo Metro Quarter OSD including:

- a maximum building envelope for podium, mid-rise and tower buildings
- a maximum gross floor area of 68,750 sqm, excluding station floor space
- conceptual land use for non-residential and residential floor space
- minimum 12,000 sqm of non-residential gross floor area including a minimum of 2,000 sqm of community facilities
- minimum 5% residential gross floor area as affordable housing dwellings
- 70 social housing dwellings
- basement car parking, motorcycle parking, bicycle parking, and service vehicle spaces.

The detailed SSD DA seeks development consent for the OSD located within the Northern Precinct of the site, consistent with the parameters of this concept approval. Separate SSD DAs have been prepared and will be submitted for the Southern and Central Precincts and basement car park proposed across the Waterloo Metro Quarter site.

A concurrent amending concept SSD DA has been prepared and submitted to the DPIE which proposed to make modifications to the approved building envelopes at the northern precinct and central building. This amending concept SSD DA does not impact the proposed development within the southern precinct.

# 6. Proposed development

## 6.1 Waterloo Metro Quarter Development

The Waterloo Metro Quarter OSD comprises four separate buildings, a basement carpark and public domain works adjacent to the Waterloo Metro station.

Separate SSD DAs will be submitted concurrently for the design, construction and operation of each building in the precinct;

- Southern precinct SSD-10437,
- Basement Car Park SSD-10438,
- Central precinct SSD-10439, and
- Northern precinct-SSD-10440.

An overview of the Development is included below for context. This detailed SSD DA seeks development consent for the design, construction and operation of the Northern Precinct:

### 6.1.1 Southern Precinct

The Southern Precinct comprises:

- 25-storey residential building (Building 3) comprising student accommodation, to be delivered as a mixture of studio and twin apartments with approximate capacity of 474 students
- 9 storey residential building (Building 4) above the southern station box to accommodate 70 social housing dwellings
- ground level retail tenancies including Makerspace and gymnasium lobby, and loading facilities
- level 1 and level 2 gymnasium and student accommodation communal facilities
- landscaping and private and communal open space at podium and roof top levels to support the residential accommodation
- new public open space including the delivery of the Cope Street Plaza, including vehicle access to the site via a shared way from Cope Street, expanded footpaths on Botany and Wellington Streets and public domain upgrades
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

### 6.1.2 Basement Car Park (subject DA)

The Basement Car Park comprises:

- 2-storey shared basement car park and associated excavation comprising
- Ground level structure
- Carparking for the Commercial Building 1, Residential Building 2, social housing Building 4, Waterloo Congregational Church and Sydney Metro
- Service vehicle bays
- commercial end of trip and bicycle storage facilities

- Retail end of trip and bicycle storage facilities
- residential storage facilities
- shared plant and services
- in ground OSD tank for building 2 and Cope St Plaza catchments, located in Church Square

### 6.1.3 Central Precinct

The Central Precinct comprises:

- 24-storey residential building (Building 2) comprising approximately 126 market residential and 24 affordable housing apartments, to be delivered as a mixture of 1 bedroom, 2 bedroom and 3 bedroom apartments
- Ground level retail tenancies, community hub, precinct retail amenities and basement car park entry
- level 1 and level 2 community facilities (as defined in the SLEP) intended to be operated as a childcare centre
- landscaping and private and communal open space at roof top levels to support the residential accommodation
- new public open space including the delivery of the Church Square, including vehicle access to the basement via a shared way from Cope Street, expanded footpaths and public domain upgrades on Botany Road
- external licensed seating areas
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

### 6.1.4 Northern Precinct

The Northern Precinct comprises:

- 17-storey commercial building (Building 1) comprising Commercial floor space, with an approximate capacity of 4000 workers
- ground level retail tenancies, loading dock facilities serving the northern and central precinct including Waterloo metro station
- landscaping and private open space at podium and roof top levels to support the commercial tenants
- new public open space including the delivery of the Raglan Street Plaza, Raglan Walk and expanded footpaths on Raglan Street and Botany Road and public domain upgrades
- external licensed seating areas
- signage zone locations
- utilities and service provision
- stratum subdivision (staged).

# 7. Study methodology

## 7.1 Stormwater Management

There is no Stormwater Management relevant to the Basement Car Park DA as all the stormwater above the basement is collected by the Building 1 and Building 2 roof. Refer to the Appendix O Stormwater Management Strategy and Flood Impact Assessment Reports for the Northern Precinct (SSD-10440) and Central Precinct (SSD-10439) for further details.

## 7.2 Flood Study

The aims of the flood study are to:

- Assess the flood risk within and around the vicinity of the site;
- Establish mitigation measures required to ensure the sustainability and safety of the proposed scheme over its lifetime; and
- Address study requirements listed in Section 3 to demonstrate the feasibility of the proposed development.

The following objectives have been completed:

- Undertake consultations with City of Sydney flood engineer to present the proposed scheme and clarify council requirements for the flood study;
- Undertake a desktop research/review of flood information (i.e. flood study and historic records of flooding) available for the site and surrounding area to inform the overall strategy of the proposed scheme;
- Obtain council adopted hydraulic model to define flood conditions at the site and surrounding area;
- Refine and upgrade council hydraulic model with the latest topography survey undertaken to produce an accurate and up-to-date representation of the flood mechanisms at the site and surrounding area (i.e. water level, water depth, water velocity and flood hazard);
- Update council hydraulic model to reflect the proposed development configuration (i.e. proposed scenario) to describe flood mechanisms at the site and surrounding area;
- Use the hydraulic model results to inform the building design layout;
- Undertake a flood impact assessment to estimate changes generated by the proposed scheme to the flood mechanisms (i.e. water levels, flood extent, water velocity and flood hazard) on adjacent areas;
- Undertake a climate change sensitivity analysis to address residual food risks associated to climate change;
- Demonstrate how the proposed development satisfies project requirements;

This report has been informed by and refers where appropriate to the following documents and policies:

- Water Quality, Flooding and Stormwater Report, Waterloo Metro Quarter (October 2018);
- Waterloo Design Amenity Guidelines (March – 2020);
- Interim floodplain management policy (City of Sydney Council);

- Waterloo Metro Quarter State Significant Precinct Study (October 2018);
- Study Requirements, Nominated State Significant Precinct – Waterloo (March 2018);
- Floodplain Development Manual NSW (April 2005);
- Australian Rainfall and Runoff 2019 (ARR2019) guidelines;
- Alexandra Canal Floodplain Risk Management Study Plan (City of Sydney);
- Alexandra Canal Model Conversion (City of Sydney – 2015);

# 8. Flooding Context

The following section provides an overview of the flood context for the site area. Data used to inform this section was derived from the Alexandra Canal Floodplain Risk Management Study and Plan Report (City of Sydney 2014), Alexandra Canal Model Conversion (City of Sydney 2015) and discussion with council flood engineer.

## 8.1 Alexandra Canal Catchment

The project site lies within the Alexandra Canal catchment. The Alexandra Canal catchment covers approximately 12 km$^2$ of Sydney Local Government area. Figure 6 below shows the extent of the Alexandra Canal catchment (i.e. catchment area extent is represented by the pink polygon).

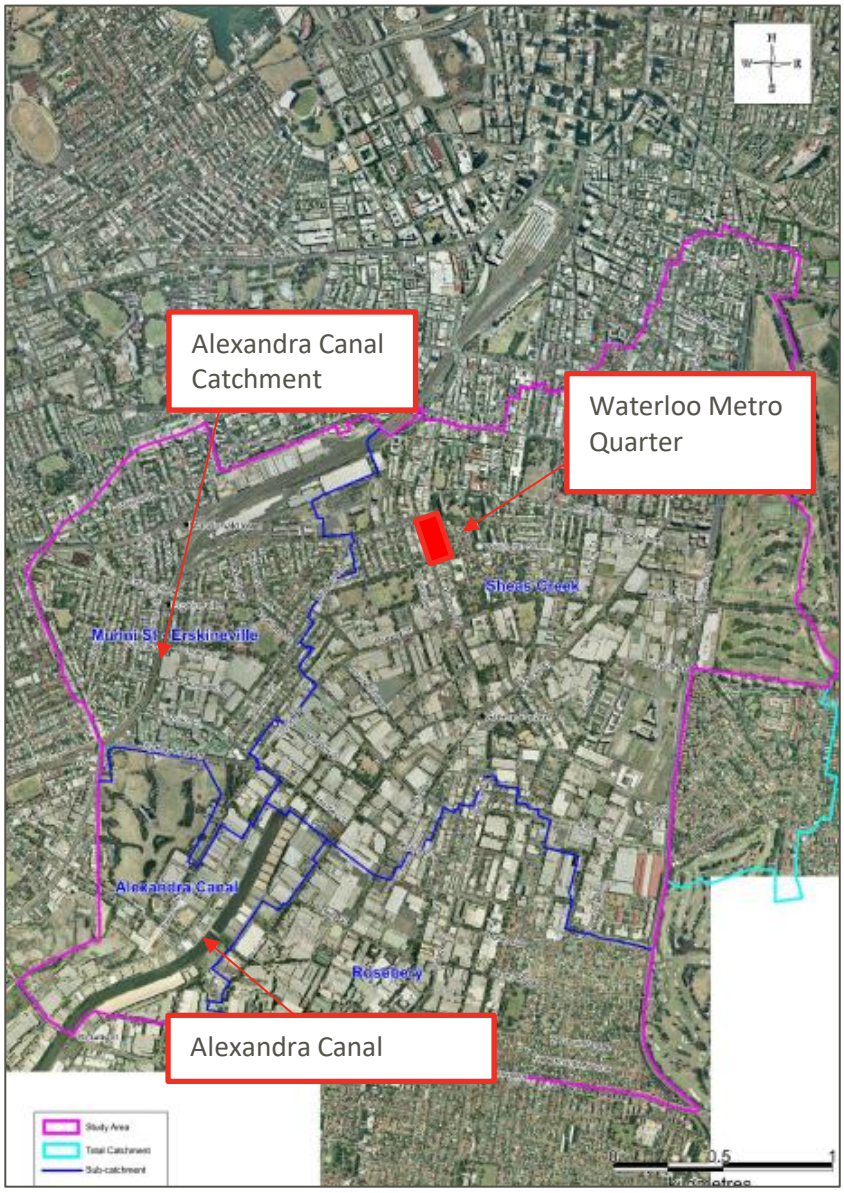



***Figure 6: Alexandra Canal Catchment (figure extracted from Floodplain Risk Management Plan – City of Sydney)***

Most of the catchment is fully developed and consists predominantly of medium to high-density housing, commercial and industrial development with some large open spaces that include

Moore Park, Playing Fields, Moore Park Golf Course, The Australian Golf Course, Sidney Park, Redfern Park, Waterloo Park and Alexandria Park.

Catchment topography ranges from approximately 55-60 m AHD (i.e. highest area) at the north east to 10 - 5 m AHD to the south west (i.e. lowest area). Figure 7 below and Appendix 1 include an overview of the catchment and site topography.

The catchment drains into the Alexandra Canal with the eastern area draining towards south-west and the western area draining in south - south-east direction. Topography gradually slopes from north, north east and east towards Alexandra Canal at south west.

There are topography depressions (low points) within the catchment area where runoff water can escape only via pit and pipe system. These areas due to topographical and development constraints can result in ponding and flooding of properties and roads during flood events.

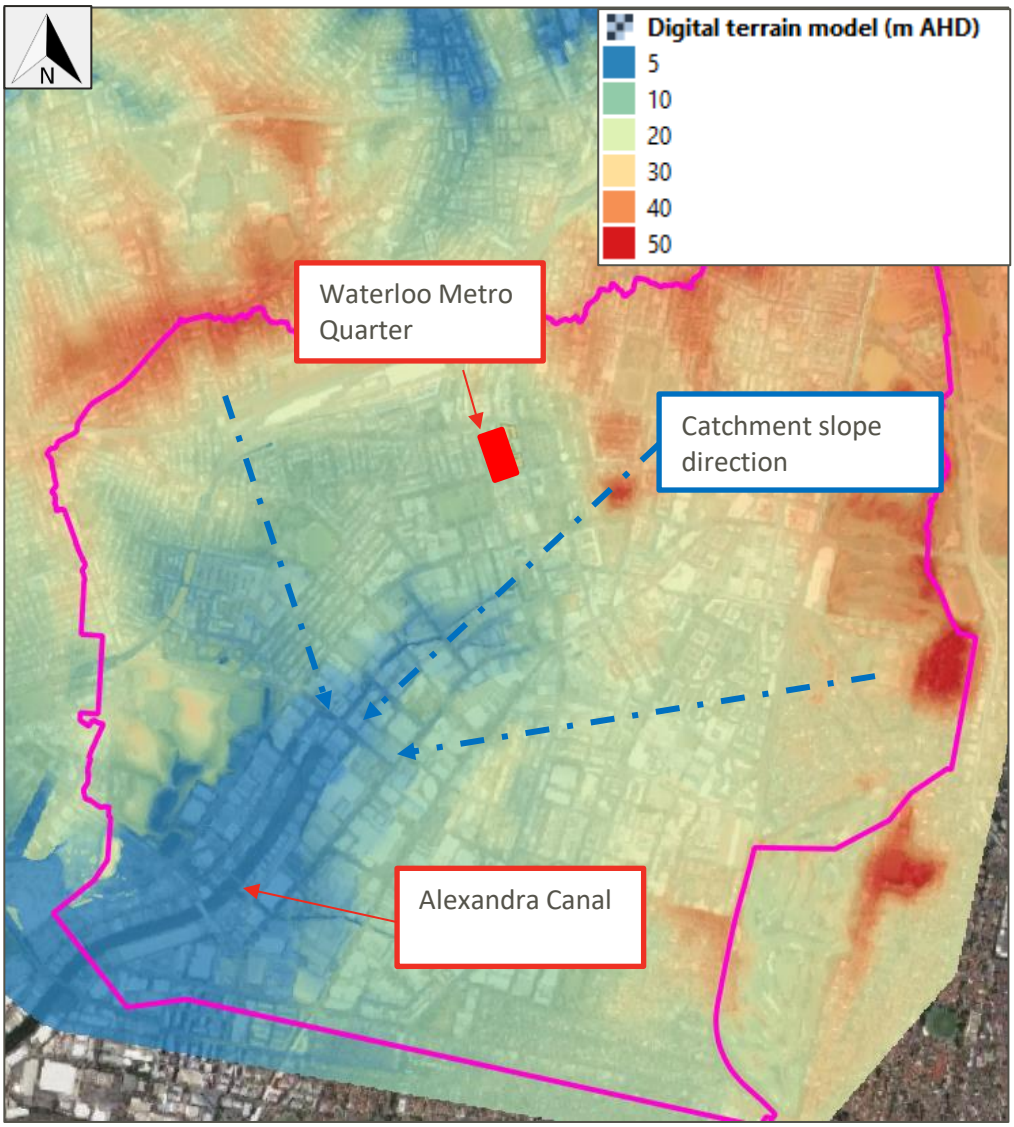



***Figure 7: The Alexandra Canal Catchment topography***

Around the site area (i.e. Waterloo Metro Quarter) the topography ranges from approximately 17-17.5 to 14-15 m AHD.

At the north of the site (i.e. Raglan Street) the topography ranges from approximately 16.5 - 17 m AHD at the intersection of Raglan Street and Botany Road to 16 – 16.5 m AHD at the intersection of Raglan and Cope Street.

To the East of the site (i.e. Cope Street), the topography ranges from approximately 16- 16.5 m AHD at the intersection of Raglan and Cope Street to 14.5 - 15 m AHD at the intersection of Cope and Wellington street.

To the West (i.e. Botany Road), the topography ranges from approximately 16.5 - 17 m AHD at the intersection of Raglan Street and Botany Road to 14.5 – 15 m AHD at the intersection of Botany Road and Wellington Street.

Figure 8 below shows the topography in the proximity of the site area. Topography Survey for the site area is included in Appendix 2

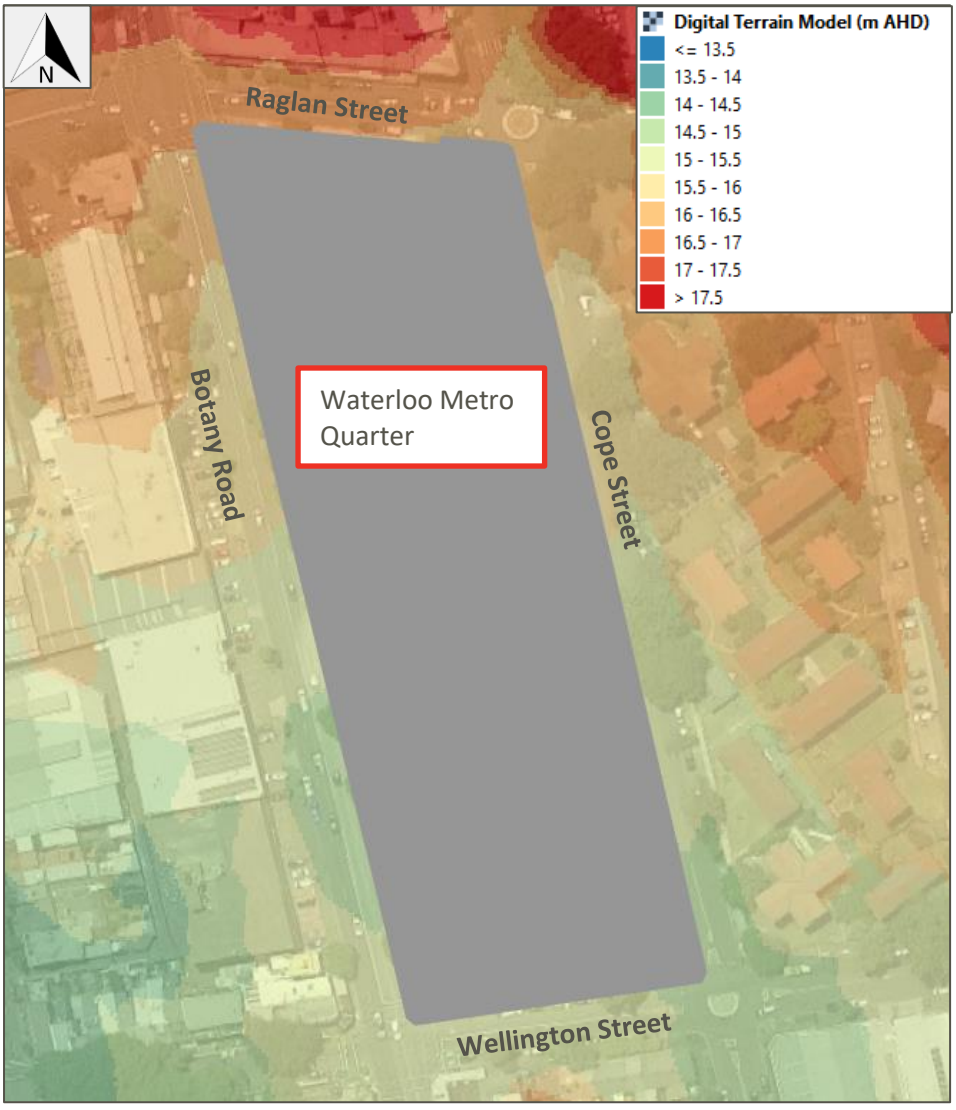



***Figure 8: Waterloo Metro Quarter – Over Station Development topography***

The drainage systems in the Alexandra Canal catchment consist of open channels, covered channels, in ground pipes, culverts and pits that convey runoff within the catchment to Alexandra which discharges into Cooks River.

Flooding within the catchments is mainly a combination of overland flow and mainstream flooding. Mainstream flooding issues tend to occur around Alexandra Canal and the open channels.

## 8.2 Historic record of flooding

There are records of flooding in the proximity of the site area. Pictures included in Figure 9 below shows flooding occurred in 2011; Figure 9 is extracted from the Water Quality, Flooding and Stormwater Report prepared for Waterloo Metro Quarter in 2018.

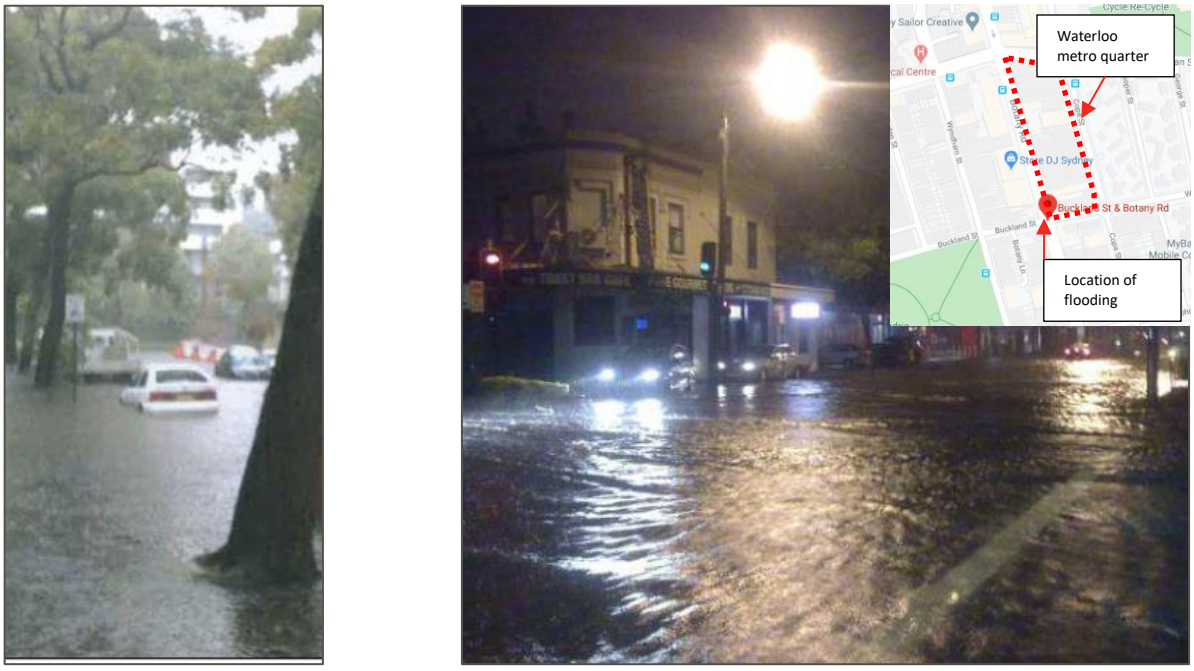



**Figure 9: Hunter Street (left), Botany Road & Buckland Street Intersection (right) – Photo taken May 2011.**

WSP has requested records of flooding to City of Sydney Council; at the time of writing this report the information has not been provided by the Council.

## 8.3 City of Sydney hydraulic model

WSP engaged with City of Sydney Council on 15th of April 2020 to obtain the latest hydraulic model the council has available to describe the flood conditions (i.e. water level, water depth, water velocity and flood hazard) at the site area.

The City of Sydney Council provided WSP with the Alexandra Canal Flood model. The City of Sydney flood engineer confirmed that the Alexandra Canal Flood model is the hydraulic model currently 'adopted' by the council to assess the flood conditions within the Alexandra Canal Catchment.

Alexandra Canal Flood model was developed for the City of Sydney Council in 2015 by BMT WBM. The hydraulic model is a combined 1 dimensional – 2 dimensional TUFLOW hydraulic model and the hydrology model is a DRAINS ILSAX model for catchment inflows.

For this flood study WSP updated the council hydraulic model. Section 9.1 below describes the hydraulic modelling methodology adopted. The hydraulic modelling methodology was discussed with the City of Sydney flood engineer during a project meeting held in April 2020.

# 9. Flood Study

The purpose of this section is to demonstrate the feasibility of the proposed development from a flood risk perspective.

The flood study aims to demonstrate that:

- The proposed development (i.e. Basement Car Park) has been designed consistent with the requirements reported in Table 1 and Table 2 of Section 3 above;
- Flood mitigation measures have been considered and implemented in the design to offset adverse flooding impacts during extreme events;
- The proposed development has negligible flood impact on the adjacent land; and,
- Safe refuge can be provided within the proposed development and site area during extreme flood conditions;

To inform the flood study detailed hydraulic modelling has been undertaken for the existing and post development conditions.

Section 9.1 below summarises the hydraulic modelling assessment and describes the flood conditions (i.e. water depth, flood hazard and water velocity) at the site and surrounding area that might occur during a range of flood events (i.e. 20 year ARI, 100 year ARI and PMF flood events).

Section 9.2 describes the Climate Change (CC) sensitivity analysis that has been produced as per the latest guidelines (Australian Rainfall Runoff 2019 – ARR2019). Climate change effects have been considered in the design process.

Section 9.3 presents the flood impact of the proposed development on the adjacent land. City of Sydney Council has been consulted to define the requirements for the flood impact assessment.

Section 9.4 describes the flood mitigation measures adopted to alleviate the flood risk at the proposed development. This section has been produced following the recommendations of the Design and Amenity Guidelines (March 2020) – Section 3S and the DCP provided in the Water Quality, Flooding and Stormwater Report (October 2018).

Section 9.5 describes the emergency responses identified that reduce the consequences of flooding for occupants of the proposed development.

## 9.1 Hydraulic Modelling

As mentioned above, the flood study has been informed by detailed hydraulic modelling that defines flood mechanisms and conditions at the site and surrounding area.

The hydraulic modelling was based on an updated version of the Alexandra Canal catchment flood model (developed by BMT in 2015).

The Alexandra Canal catchment flood model was provided to WSP by City of Sydney Council in April 2020.

As discussed in Section 8.3 the Alexandra Canal catchment flood model is currently ‘adopted’ by City of Sydney Council to inform flood conditions within the Alexandra Canal catchment.

The following improvements have been made to the existing model to ensure its suitability of use for the project:

- The software version was upgraded from 2013-12-AD to the latest software release (i.e. 2020-01-AB) to enable the use of GPU HPC modelling. This modelling approach ensures significantly faster model run times and negligible mass error;
- An additional storm duration (i.e. 90 minutes critical storm) was added to the existing storm durations to refine the definition of water level, velocity and flood hazard at the site and surrounding areas for the 100 year ARI;
- The PMF model run duration was extended to ensure peak water levels at the site and surrounding areas are properly captured;
- Adjustment have been made to the model to improve model instabilities that occurred during the PMF runs; and,
- The latest topographic survey has been included in the model to improve the representation of the terrain surfaces at the site and surrounding areas (refer to Appendix 5 for topography survey details).

Two model scenarios were analysed for assessing the flood conditions at the site and surrounding areas. The model scenarios are:

- baseline scenario which represents the pre-development site conditions; and,
- proposed scenario which represents the post-development site conditions.

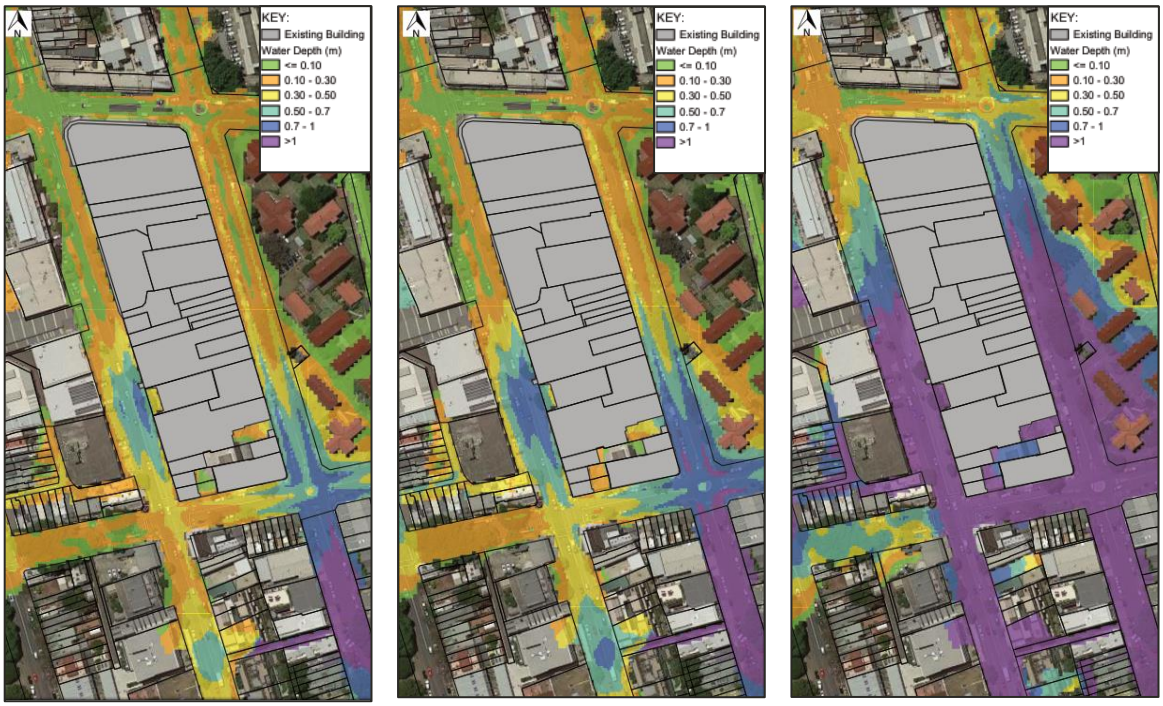
### 9.1.1 Baseline Scenario

The baseline scenario model defined the flood conditions at the site and surrounding area for the pre-development conditions. The 20, 100 year ARI and PMF flood events were considered.

The model results show that the site and surrounding area are expected to be affected by flooding during the 20, 100 year ARI and PMF flood events.

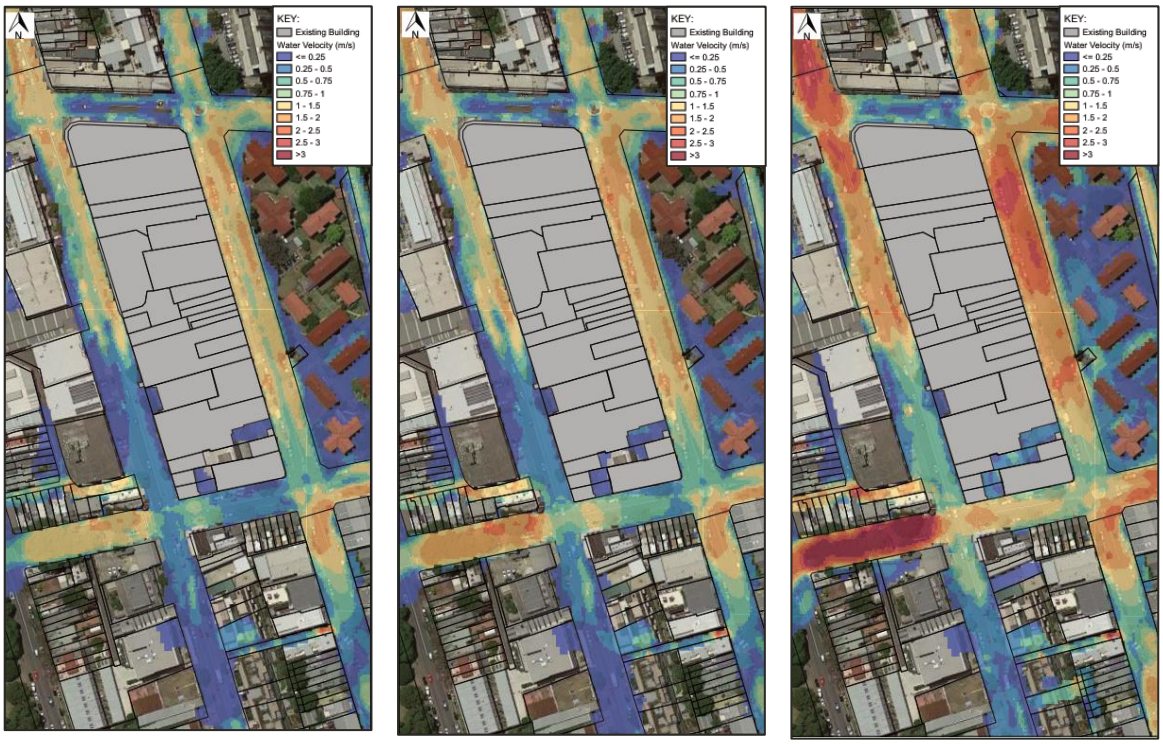
Maximum water depth, water velocity and flood hazard maps for the baseline scenario are shown in Figure 10,11 and 12 below; high resolution maps are included in the following appendices:

- Appendix 3: Water Depth – Baseline Scenario (20, 100 year ARI and PMF flood event);
- Appendix 4: Water Velocity – Baseline Scenario (20, 100 year ARI and PMF flood event); and,
- Appendix 5: Flood Hazard – Baseline Scenario (20, 100 year ARI and PMF flood event).




*20 year ARI* *100 year ARI* *PMF*

**Figure 10: Water Depth – Baseline Scenario**




*20 year ARI* *100 year ARI* *PMF*

**Figure 11: Water Velocity – Baseline Scenario**


*20 year ARI* *100 year ARI* *PMF*

**Figure 12: Flood Hazard – Baseline Scenario**

### 9.1.2 Proposed Scenario

The following adjustments were made to the baseline scenario to represent the proposed development configuration:

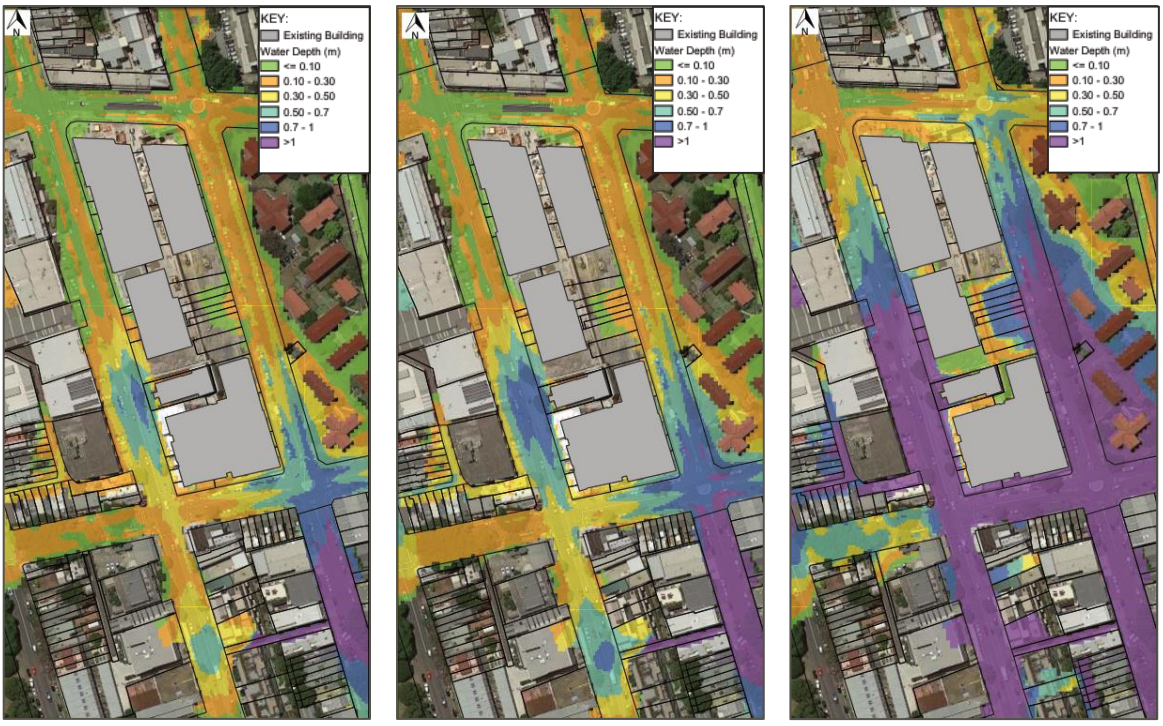
1. Topography data has been updated to reflect the proposed site configuration. Refer to the civil design report (i.e. Appendix CC) for a detailed discussion on the proposed development topography.
2. New building layout and material definition to represent the proposed buildings configuration.

The proposed scenario defined the flood conditions at the site and surrounding area for the post-development conditions. The 20, 100 year ARI and PMF flood events were assessed.

As per the baseline scenario the model results show that site and surrounding area are expected to be affected by flooding during the 20, 100 year ARI and PMF flood events.

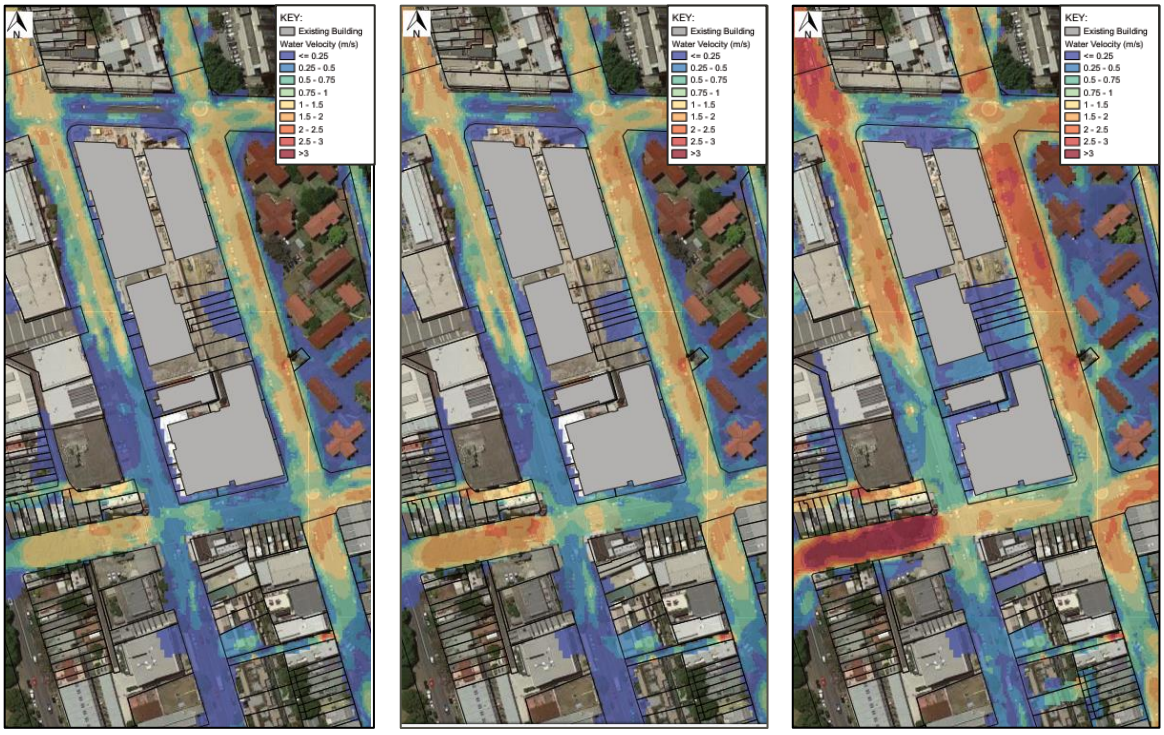
Maximum water depth, maximum water velocity and flood hazard maps for the proposed scenario are reported in Figure 13,14 and 15 below; high resolution maps are included in the following appendices:

- Appendix 6: Water Depth (for the 20, 100 year ARI and PMF flood event);
- Appendix 7: Water Velocity (for the 20, 100 year ARI and PMF flood event); and,
- Appendix 8: Flood Hazard (for the 20, 100 year ARI and PMF flood event).




*20 year ARI* *100 year ARI* *PMF*

**Figure 13: Water Depth – Proposed Scenario**




20 year ARI 100 year ARI PMF

**Figure 14: Water Velocity – Proposed Scenario**


*20 year ARI* *100 year ARI* *PMF*

**Figure 15: Flood Hazard – Proposed Scenario**

The differences in the flood conditions (i.e. flood impact) between the baseline and proposed scenario are discussed in Section 9.3.

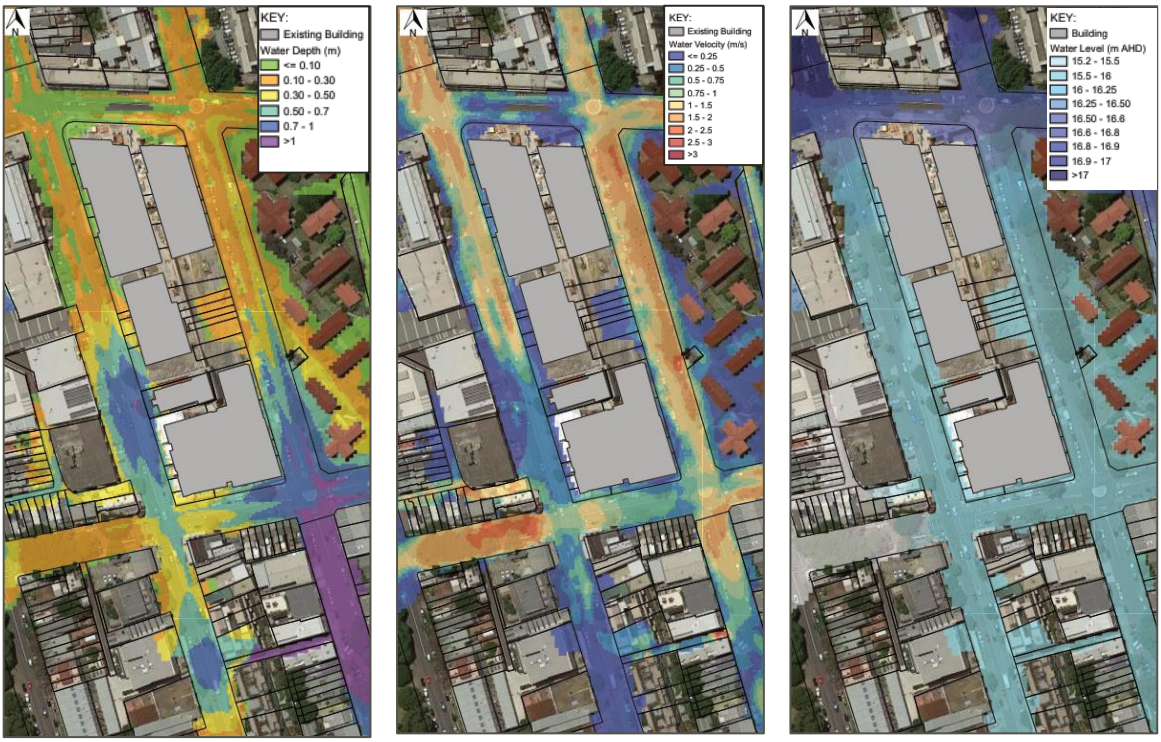
## 9.2 Climate Change analysis

A climate change sensitivity analysis has been undertaken for the 100 year ARI to assess the possible effects of climate change (CC) to the flood conditions.

As indicated in the Water Quality, Flooding and Stormwater Report, Waterloo Metro Quarter (October 2018), key climate change factors considered with respect to this project include:

- an increase in rainfall intensity of 10%, which corresponds to 2100 conditions predicted under Representative Concentration Pathways (RCPs) 4.5 emission scenarios (ARR2019).
- Sea level rise of 90 cm by 2100 as per the NSW Government Coastal Planning Guideline was also considered.

Proposed development scenario model result maps for climate change are included in Figure 16 below and Appendix 9.




*Water Depth* *Water Velocity* *Water Level*

**Figure 16: 100 year ARI with Climate Change - Proposed Scenario**

The Climate Change scenario shows that water level around the site area might increase up to 70 mm; this is in line with the climate change sensitivity analysis presented in the *Waterloo Metro Quarter State Significant Precinct Study (October 2018)* which demonstrated that Climate Change might generate water level increases of up to 60 mm around the site area.

Section 9.4 shows how climate changes effects have been considered in implementing flood risk mitigation measures (i.e. definition of minimum flood planning level).

## 9.3 Flood Impact Assessment

The proposed development flood impact has been assessed for the 20, 100 year ARI and PMF flood events.

Flood impact has been assessed by comparing the baseline and proposed scenario model results for water level and flood hazard.

### 9.3.1 Project Requirements

City of Sydney Council was consulted on the 15th of April 2020 to discuss project requirements to be considered in the flood impact assessment.

Council confirmed that the proposed development flood impact has to demonstrate no increase in water level (i.e. afflux) on the adjacent land.

Council considered 10 mm an acceptable tolerance for afflux (i.e. no increase in water level by more than 10 mm).

### 9.3.2 Post development flood Impact

The flood impact discussed below, shows the changes caused by the proposed Waterloo Metro Quarter Area (i.e. refer as proposed site configuration) to the baseline flood conditions (i.e. pre-development).

The proposed site configuration includes:

- demolition of the existing buildings and inclusion of new buildings;
- changes to the topography within the site;
- reconfiguration of the intersection between Raglan and Cope Street (i.e. removal of the roundabouts);
- reconfiguration of the intersection between Cope and Wellington Streets (i.e. removal of the roundabouts); and,
- carriageway narrowing (i.e. footpath widening) and raised threshold along Cope Street.

Refer to Appendix 12 for details of the proposed site configuration.

Flood impacts generated by the proposed site configuration are presented below.

Section 9.3.3 discusses the flood impact generated by the Basemen Car Park development solely.

**Afflux (i.e. changes in water level)**

Figure 17 to 23 present the afflux maps for the overall site development. For further detail refer to afflux maps included in Appendix 10.

- 100 year ARI flood event

Figure 17 below shows the afflux at the site and surrounding area for the 100 year ARI flood event.

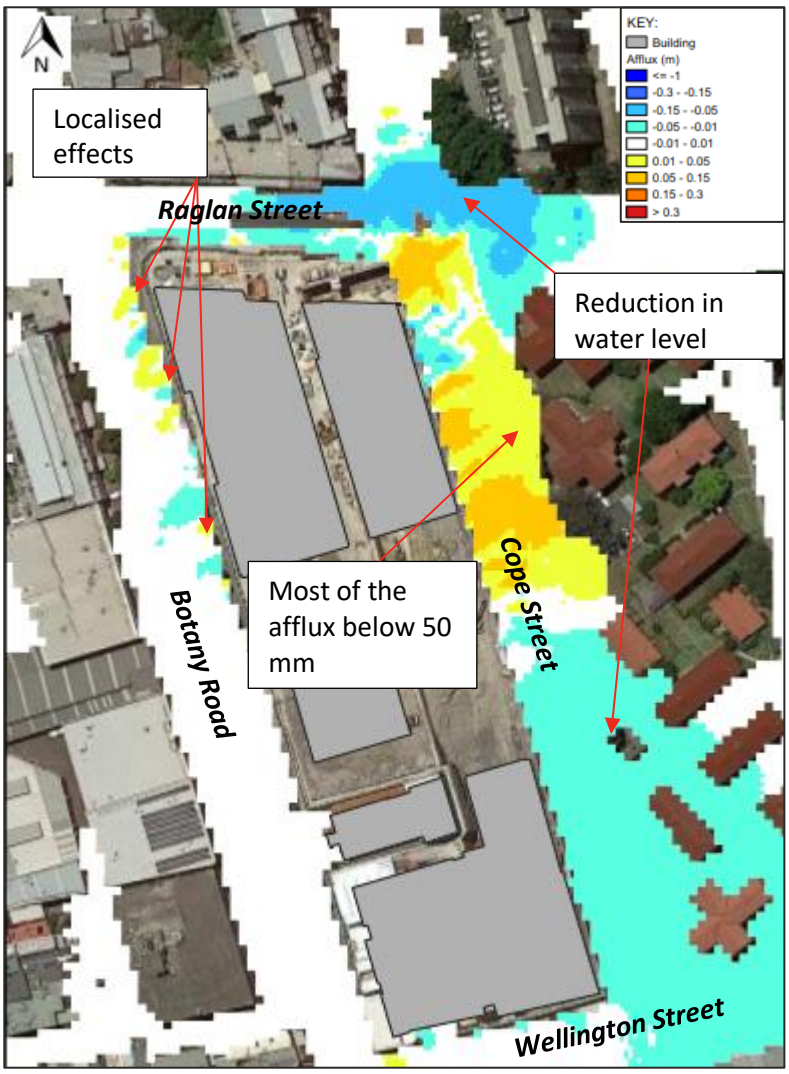



**Figure 17: 100 year ARI – Afflux map**

***Raglan Street***: Increase in water levels at the intersection with Cope Street is expected to be up to 80 mm. Reduction in water level is expected along Raglan Street up to 90 mm.

***Cope Street:*** Increase in water levels is expected between 80 to 100 mm in limited areas; most of the afflux along Cope Street is expected to be below 50 mm. Reductions in water level are also expected along Cope Street and on adjacent land.

Figure 18 below shows the water level graph at location *Po9* for both the baseline and proposed scenario during the 100 year ARI flood event.

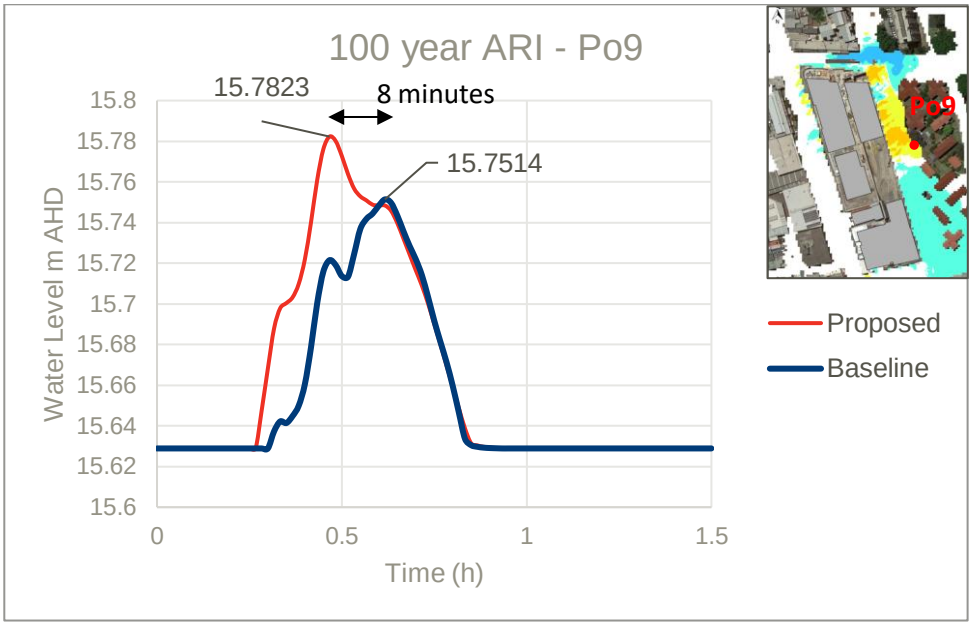



**Figure 18: Water Level vs Time at point Po9 - 100 year ARI**

Figure 18 shows that afflux of 31 mm is predicted to occur for 8 minutes at location Po9 during the 100 year ARI flood event; after 8 minutes the water level decreases and aligns with the baseline scenario conditions.

Figure 19 shows 71 mm increases in water level in Cope Street. This occurs for 14 minutes at location P10 during the 100 year ARI flood event. It has to be noted from Figure 19 below that despite the 71 mm increase in water level at location P10 the water depth increase is limited to 33 mm; this is due to the proposed raised topography in Cope Street.

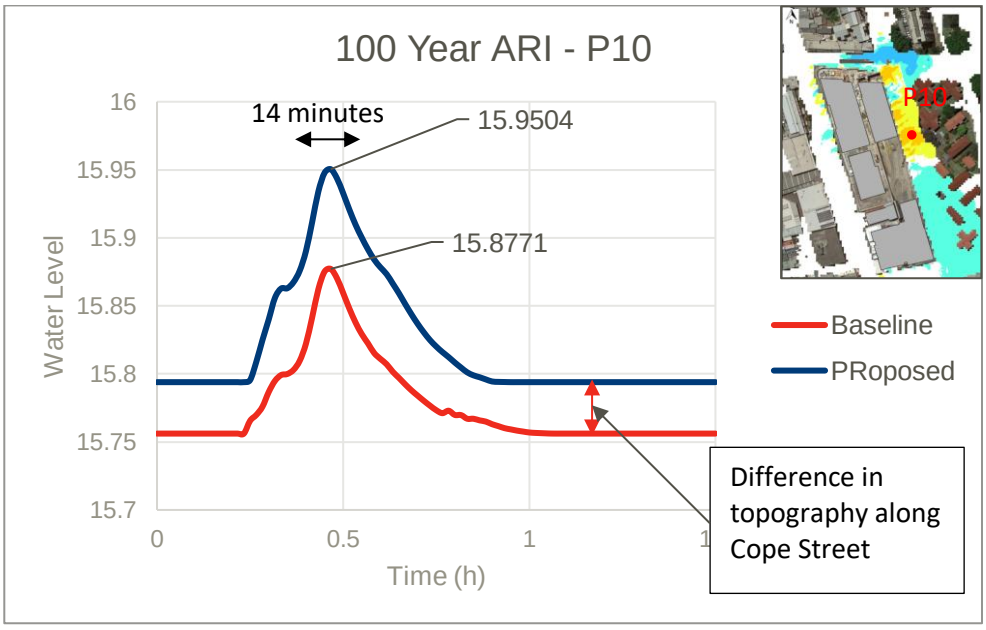



**Figure 19: Water Level vs Time at point P10 – 100 year ARI**

***Wellington Street:*** No increase in water level.

***Botany Road:*** Negligible increase in water level. Figure 17 shows localised areas along the footpath where there are increases in water level (up to 40 mm) that alternate to reductions in water level (up to 50 mm); these are limited effects that are attributed to the hydraulic model representation of the topography and therefore deemed within model tolerance.

- 20 year ARI flood event

Figure 20 below shows the afflux at the site area for the 20 year ARI flood event.

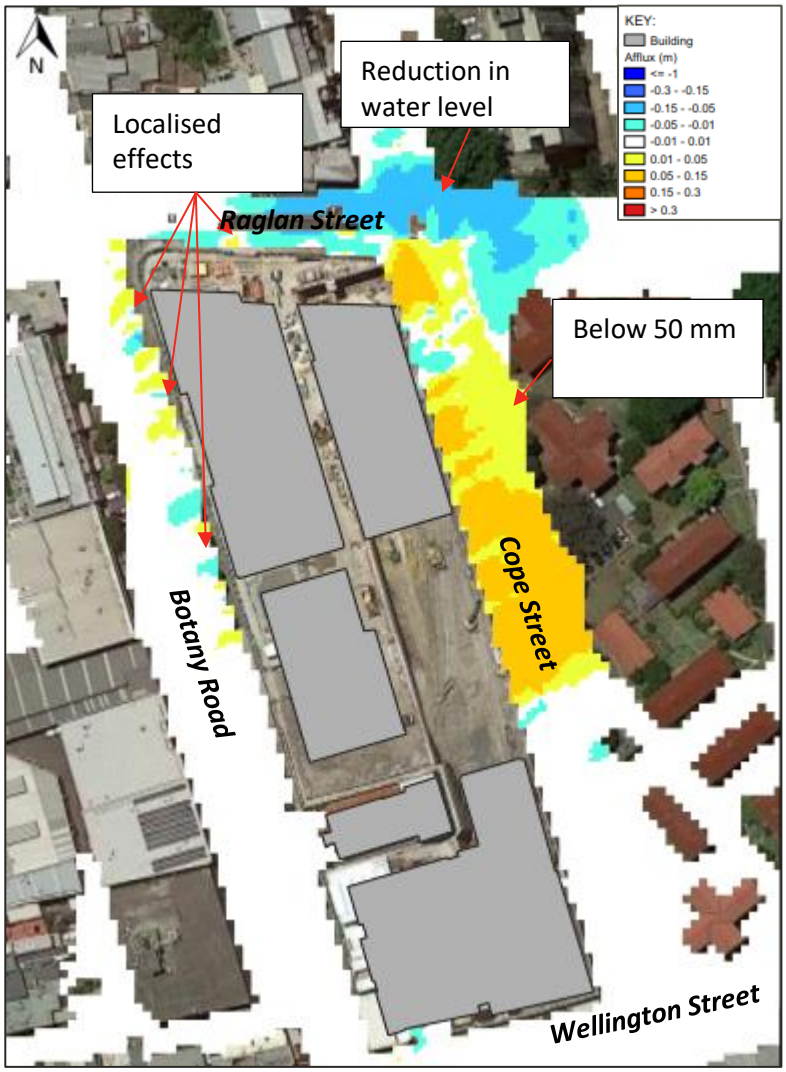



**Figure 20: 20 year ARI – Afflux map**

***Raglan Street:*** Increase in water levels is limited at the intersection with Cope Street where afflux is expected to be up to 70-75 mm. Reduction in water level is also expected along Raglan Street up to 65 mm.

***Cope Street:*** Increase in water levels is expected up to 70 – 80 mm.

Figure 21 below shows the increase in water level during the flood event at location Po9 for the baseline and proposed scenario.

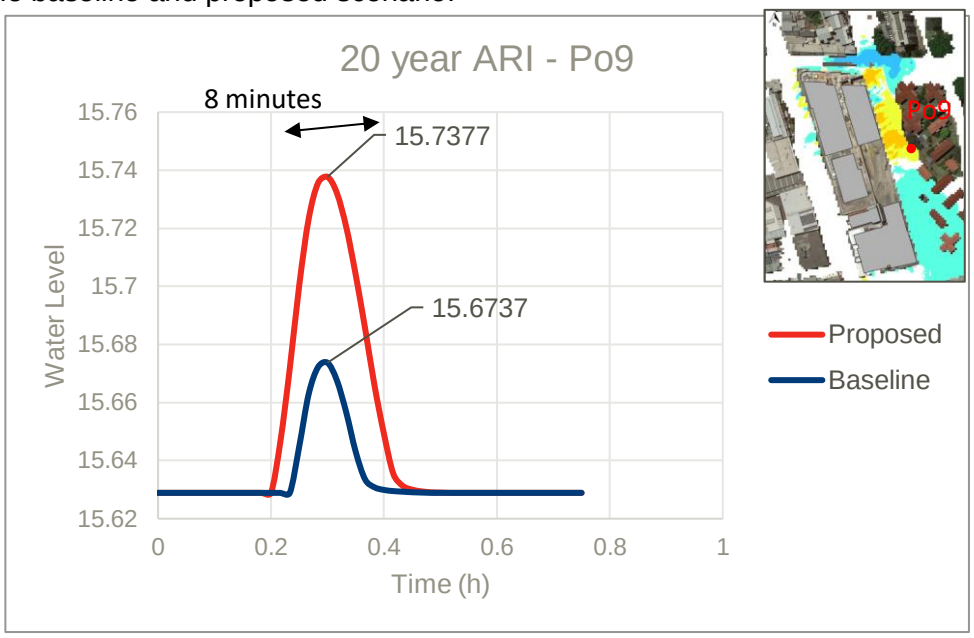



**Figure 21: Water Level vs Time at point Po9 - 20 year ARI**

Figure 21 shows that afflux of 64 mm is predicted to occur for 8 minutes at location Po9 during the 20 year ARI flood event.

Figure 22 shows that increase in water level of 70 mm is predicted to occur for 8 minutes at location P10 during the 20 year ARI flood event. As per Figure 19 above, 70 mm increase in water level corresponds to 32 mm water depth increase at location P10; this is due to proposed raised topography in Cope Street.

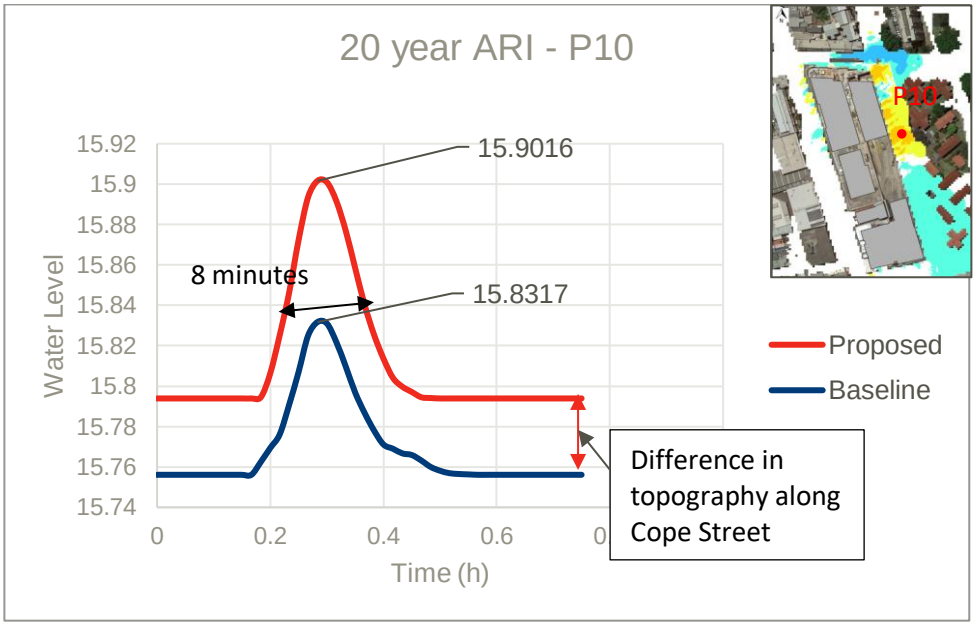



**Figure 22: Water Level vs Time at point P10**

***Wellington Street***: No increase in water level.

***Botany Road:*** No increase in water level. Figure 20 shows localised areas along the footpath where there are increases in water level (below 30 mm) that alternate to reductions in water level (up to 50 mm); these are limited effects that are attributed to the hydraulic model representation of the topography and therefore within the model tolerance.

- PMF flood event

Figure 23 below shows the afflux at the site area for the PMF flood event.

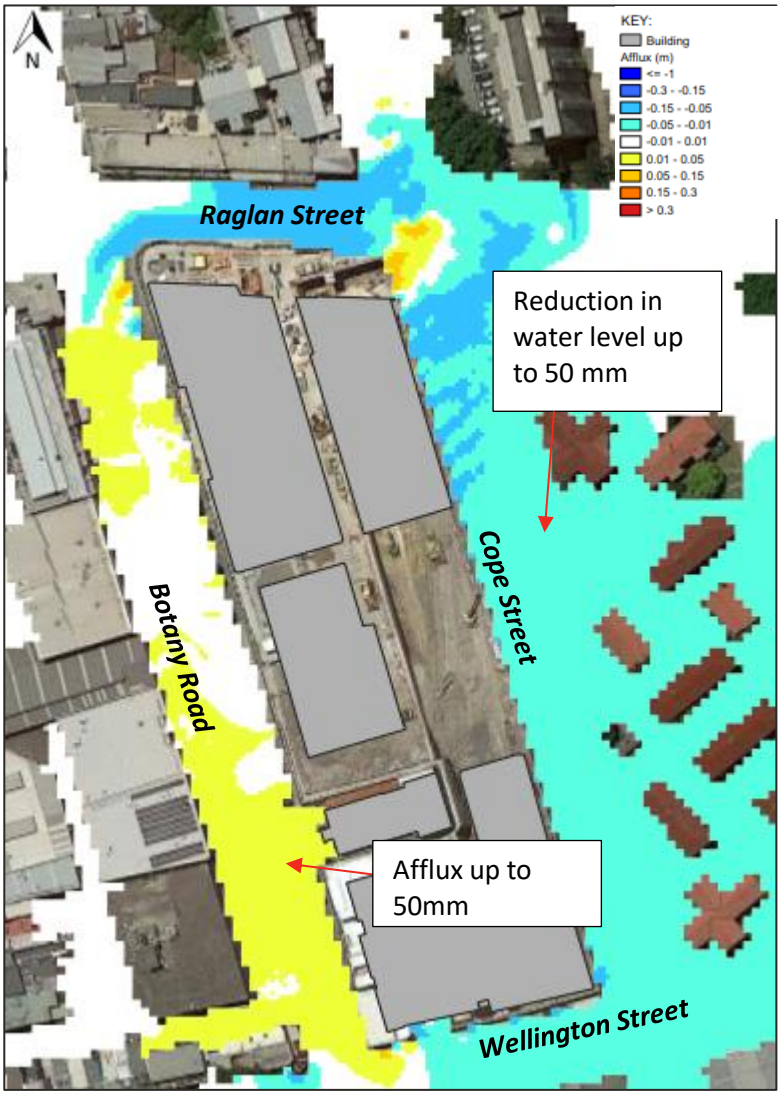



**Figure 23: PMF – Afflux map**

***Raglan Street:*** Increase in water levels at the intersection with Cope Street where afflux is expected to be up to 60-70 mm within a limited area. Reduction in water level is also expected along Raglan Street up to 70 mm.

***Cope Street:*** No Increase in water levels. Reduction in water level is expected along Cope Street up to 70 mm.

***Wellington Street:*** Increases in water level (i.e. 15 to 40 mm) in a limited area at the intersection with Botany Road.

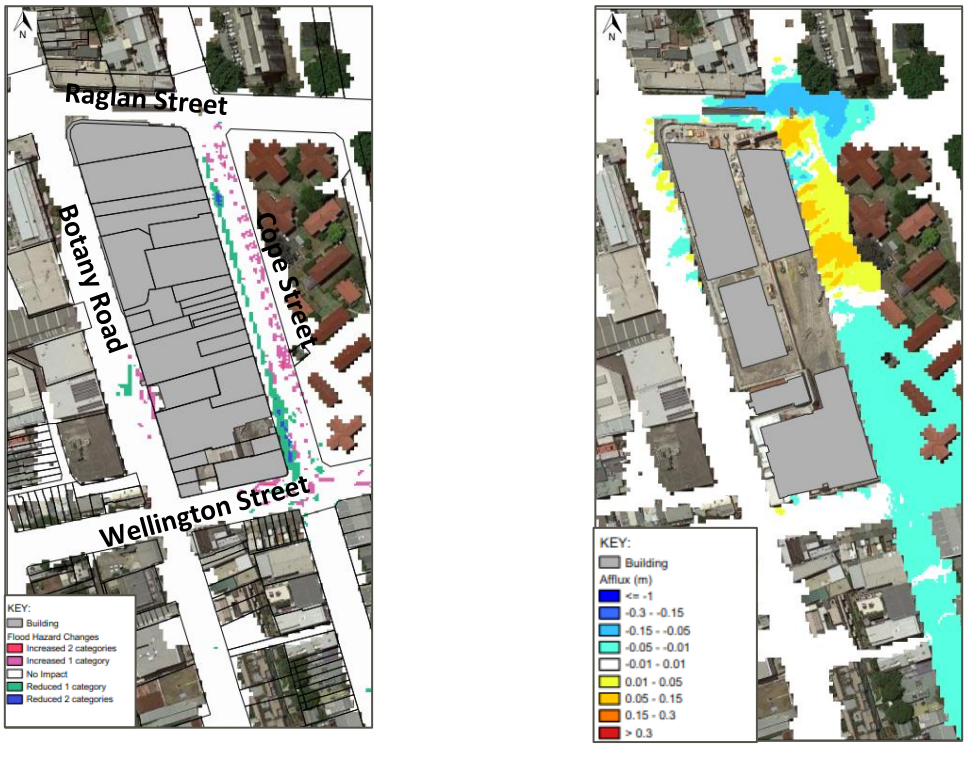
***Botany Road:*** Increase in water levels is expected to be below 50 mm.

### Change in flood hazard

The below section describes the changes in flood hazard generated by the proposed development. Refer to flood impact maps include in Appendix 10 for further details.

- 100 year ARI flood event

Figure 24 below shows the changes in flood hazard for the 100 year ARI flood event.




*Flood Hazard Changes* *Afflux*

**Figure 24: 100 year ARI – Flood Hazard Changes**

***Raglan Street:*** No change.

***Cope Street:*** No increase in flood hazard to private properties (i.e. east of Cope Street). Limited changes in flood hazard along Cope street. As indicated in Figure 24 the proposed development generates reduction in flood hazard along the west side of Cope Street (reduction from High Hazard to Transitional Hazard and reduction from Transitional Hazard to Low Hazard). Flood hazard is increased in a limited area along Cope Street from Low Hazard to Transitional Hazard).

***Wellington Street:*** No increase in flood hazard to private properties. Limited changes along Wellington street (i.e. reduction to flood hazard from high to transitional hazard; increase from low to transitional hazard).

***Botany Road:*** No increase in flood hazard to private properties (outside the street). Hazard changes are present only in limited areas where flood hazard is reduced from transitional to low hazard and increased from low to transitional; there are no increases in water depth in this area.

- 20 year ARI flood event

Figure 25 below shows the changes in flood hazard for the 20 year ARI flood event.


*Flood Hazard Changes*


*Afflux*

**Figure 25: 20 year ARI – Flood Hazard Changes**

***Raglan Street:*** No Change.

***Cope Street:*** No increase in flood hazard to private properties (i.e. east of Cope Street). Limited changes in flood hazard along Cope street. Figure 25 shows that the proposed site configuration generates reduction in flood hazard along the west side of Cope Street (reduction from High Hazard to Transitional Hazard and reduction from Transitional Hazard to Low Hazard). Flood hazard is increased in a limited area along Cope Street (i.e. from Low Hazard to Transitional Hazard).

***Wellington Street:*** No increase in flood hazard to private properties. Limited changes at the crossing between Wellington street and Cope Street (i.e. reduction from high to transitional hazard; increase from low to transitional hazard)

***Botany Road:*** No changes in flood hazard.

- PMF flood event

Figure 26 below shows the changes in flood hazard for the 20 year ARI flood event.


*Flood Hazard Changes*


*Afflux*

**Figure 26: PMF – Flood Hazard Changes**

***Raglan Street:*** No increase in flood hazard to private properties. Flood hazard changes are expected at the intersection between Raglan and Cope Street (i.e. increase in flood hazard from low to transitional hazard and reduction from transitional to low hazard).

***Cope Street:*** No increase in flood hazard to private properties (outside Cope Street). Reduction in flood hazard along Cope street and private properties to the west of Cope street (i.e. from transitional to low hazard).

***Wellington Street:*** No changes in flood hazard.

***Botany Road:*** No increase in flood hazard to private properties. Limited increase in flood hazard to the East side of Botany Road (next to the Northern Precinct).

### 9.3.3 Flood Impact Considerations

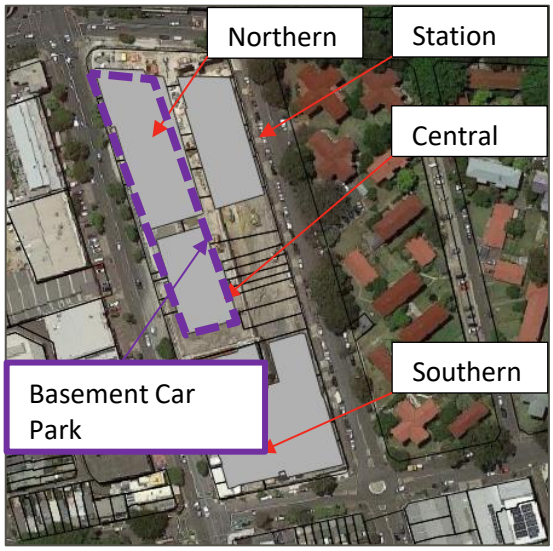
Afflux to the east of Cope street, is expected to be limited to 8 minutes for the 20 and 100 year ARI flood events; afflux in Cope street is predicted to occur for approximately 8 to 14 minutes during the 20 and 100 year ARI flood events.

The results presented in Section 9.3.2 showed that there is negligible afflux for the 20 and 100 year ARI events along Botany Road, Raglan Street and Wellington Street, with any areas of increased flood level or hazard offset by areas where the flood level and hazard are reduced; the proposed changes to the footpath levels along Botany Road, Raglan and Wellington Street are not expected to worsen the existing flood conditions.

Furthermore, the proposed buildings are not expected to negatively affect the existing flood conditions for the following reasons:

1. the proposed building footprints occupy a reduced area in respect to the existing buildings as shown in Figure 27;
2. the proposed building footprints do not exceed the existing building boundaries as shown in Figure 27 below;
3. There are open areas within the site (e.g. Cope Street Plaza – refer to Figure 3 and Appendix 15 for details ) that facilitate the water conveyance.


*Existing scenario*




*Proposed scenario*


Footprints coparison

**Figure 27: Building footprint comparison: existing and proposed development scenario.**

There is no increase in flood hazard to private properties. There are limited changes in flood hazard within street areas where increases in flood hazard (from low to transitional hazard) alternate to reduction in flood hazard (from transitional to low hazard).

PMF afflux along Botany Road is below 50 mm which is deemed to be reasonable for the PMF event; no increase in flood hazard is present in areas affected by PMF afflux.

PMF afflux at the intersection of Raglan and Cope street occurs only in a limited area at the intersection. Afflux is below 65 mm which is deemed reasonable for the PMF event.

For the considerations presented above the Basement Car Park is expected to have negligible impact on the existing flood conditions.

At the time of writing of this report mitigation measures are being tested along Cope Street to further reduce the flood impact along Cope Street. These mitigation measures are not expected to generate negative flood impact in Raglan Street, Botany Road and Wellington Street

## 9.4 Flood Planning Levels

As introduced in Section 9.1, the site and surrounding area may be affected by flooding with the key source of flood risk expected to be surface water runoff.

The hydraulic model results presented in Section 9.1.2 have been used to inform design solutions for the Basement Car Park.

The flood risk mitigation measures have been identified by protecting the ingresses points to the basement car park with floor levels above flood planning levels.

A meeting was held with City of Sydney Council flood engineer on 15th of April 2020 to discuss design requirements for the proposed development.

Council flood engineer recommended to use the Interim Floodplain Management Policy produced by the council as design criteria for the project area.

The Interim Floodplain Management Policy was adopted in the Stage 1 report: *Water Quality, Flooding and Stormwater Report (October 2018) (WQFSR)* to define the design requirements for Waterloo Metro Quarter.

Project requirements have been extracted from the WQFSR and Waterloo Metro Quarter Design Amenity Guidelines (March 2020) (WDAG).

Section 9.4.1 below summarises the project design requirements.

Section 9.4.2 presents the proposed floor levels in comparison with the project design requirements.

### 9.4.1 Project Requirements

Section 4.1.2 and Section 4.8.5 of the WQFSR defines the recommended minimum building floor levels for the development site.

Table 3 below governs the permissible minimum building floor levels and below ground development flood planning levels for the Metro Quarter development as defined within the WQFSR.

| Flood Planning Levels | | |
|---|---|---|
| Residential | Habitable rooms | 1% AEP / 100 year ARI flood level + 0.5 m or PMF (whichever is higher) |
| | Non-habitable rooms such as a laundry or garage (excluding below-ground car parks) | 1% AEP / 100 year ARI flood level |
| Industrial or Commercial | Retail Floor Levels | 1% AEP / 100 year ARI flood.<br>Stepped up zone inside property for shelter in place evacuation for emergency response. |
| Below ground garage/ car park | All other belowground car parks | 1% AEP / 100 year ARI flood level + 0.5 m or the PMF (whichever is the higher) |

| Flood Planning Levels | |
|---|---|
| Area Contiguous with Waterloo Metro Station (including Station entrances) | To be compliant with the Critical State Significant Infrastructure Sydney Metro City & Southwest Chatswood to Sydenham Conditions of Approval dated 9 January 2017 |

***Table 3:*** **Flood Planning Level for Metro Quarter (Water Quality, Flooding and Stormwater Report – October 2018)**

### 9.4.2 Flood planning levels

As described above, the results of the hydraulic model produced for the proposed development have been used to inform building floor levels.

Minimum building floor levels have been defined in accordance with project requirements indicated in Table 3.

Climate change (refer to Section 9.2 above) was considered in the design of the building floor levels.

It is noted that the ground floor structure of the Northern and Southern precinct form part of the Basement Car Park development application.

As indicated in Figure 28 below (refer to Appendix 11 for further details) there are seven points of access to the Basement Car Park. Three are located at the ground floor of the Northern Precinct and four are located at ground floor of the Central Precinct.

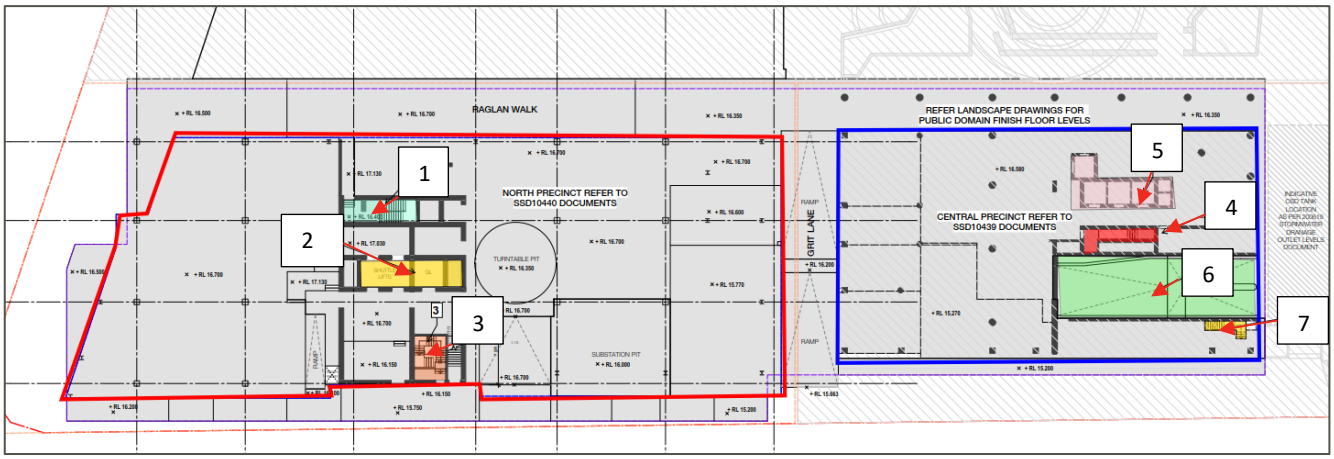



***Figure 28: Basement Car Park***

Table 4 below compares the floor levels next to the basement access points (as indicated in Figure 28) with the maximum water levels and minimum project requirements (i.e. Table 3).

| Area | Classification | Project Requirements (refer to Table 3) | Flood Level as per hydraulic model results (m AHD) | Proposed minimum Flood planning level (m AHD) | Compliant |
|---|---|---|---|---|---|
| 1 | Access to underground car park - from Northern Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.800<br>100ARI+0.5 m= 17.115 | 17.13 | Yes |
| 2 | Access to underground car park - from Northern Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | From Raglan Street:<br>PMF= 16.800<br>100ARI+0.5 m= 17.115<br>From Botany Road:<br>PMF= 16.453<br>100ARI+0.5 m= 16.646 | 17.130 (protecting flooding from Raglan Street)<br>16.70 (protecting flooding from Botany Road | Yes |
| 3 | Access to underground car park - from Northern Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.462<br>100 ARI +0.5 m = 16.543 | 16.55 | Yes |
| 4 | Access to underground car park - from Central Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.598<br>100 ARI +0.5 m = 16.249 | 16.72 | Yes |
| 5 | Access to underground car park - from Central Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.598<br>100 ARI +0.5 m = 16.249 | 16.72 | Yes |
| 6 | Access to underground car park - from Central Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.56<br>100 ARI +0.5 m = 16.249 | 16.58 | Yes |
| 7 | Access to underground car park - from Central Precinct | PMF or 1 in 100 year + 500 mm (whichever is higher) | PMF= 16.56<br>100 ARI +0.5 m = 16.249 | 16.58 | Yes |

***Table 4:*** **Design Flood Planning Levels – Floor Level**

The basement car park is protected from flooding by defining floor levels of the nearest access points to the basement above the maximum PMF or the 100 year ARI +0.5 m water level.

Section 9.4.2 demonstrates that floor planning levels are above the minimum criteria as indicated in Section 9.4.1.

Flood compatible material (i.e. waterproof material) will be used for the building ground floor area to avoid water infiltration to underground levels or lower areas.

The perimetral walls around the ingress points to the basement will be realised to be above FPLs to avoid any water infiltration into the basement during an extreme flood event.

## 9.5 Emergency Planning

A flood warning and evacuation plan will be produced to inform the residents and managers of the building on the procedures to adopt to in case of an emergency associated to flood risk.

Emergency response measures have been identified in adopting appropriate FPLs (refer to Section 9.4.2) that ensure that the occupants of the development can remain safe within the building in case of a flood emergency.

### 9.5.1 Safe Refuge / Emergency Response

This section aims to demonstrate that all the occupants of basement car park are safe from a flood risk perspective; this section is not intended to be read as an evacuation plan.

In case of a flood emergency the basement car park is not expected to be affected by flooding as the ingress points to basement car park are protected by surrounding floor level designed above the PMF and 1 in 100 year ARI + 500 mm water level.

In case of a flood emergency occupants of the basement car park can access the upper floors (i.e. to Northern and Southern Precinct) and wait until the flood emergency is finished.

## 9.6 Residual risks

The residual risk related is mitigated by the possibility to access uppers floor in case of a flood emergency.

Area 1 and 2 are linked to the Northern Precinct. Floor levels next to Area 1 and 2 are designed above the PMF and 100 year ARI + 500 mm water level.

Area 4 and 5 are linked to the Central Precinct. Floor levels next to Area 4 and 5 are designed above the PMF and 100 year ARI + 500 mm water level.

# 10. Conclusion

This flood study has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 8 April 2020 and issued for the detailed SSD DA (refer to Table 1 for project requirements).

This flood study has also been prepared in response to the conditions of consent issued for the concept SSD DA (SSD 9393) for the OSD and the Waterloo Design and Amenity Guidelines (refer to Table 2).

Hydraulic model results showed that the site area might be affected by flooding with the key source of flood risk expected to be surface water flooding.

Hydraulic modelling has been undertaken to assess the flood risk at the site and the impact that the proposed development would have on flood risk in the surrounding areas.

The flood impact assessment showed that:

- There is negligible afflux for the 20 and 100 year ARI events along Botany Road, Raglan Street and Wellington Street;
- In the PMF flood event afflux along Botany Road is below 50 mm; this is deemed to be acceptable for the PMF event. No increase in flood hazard is present in areas affected by PMF afflux;
- In the PMF flood event afflux at the intersection of Raglan and Cope street occurs only in a limited area. Afflux is below 65 mm. This is deemed acceptable for the PMF event;
- Afflux to the east of Cope street, is expected to be limited to 8 minutes for the 20 and 100 year ARI flood events; afflux in Cope street might occur for approximately 8 to 14 minutes during the 20 and 100 year ARI flood events;
- The afflux along Cope Street is generated by changes to the local topography (i.e. along Cope street and at the intersection with Raglan Street); it is not a result of the Basement Car Park (SSD-10438)
- The proposed building footprints occupy a reduced area in respect to the existing buildings and do not exceed the existing building boundaries. As such the proposed buildings are not expected to negatively affect the existing flood conditions; and,
- There is no increase in flood hazard to private properties. There are limited changes in flood hazard within street areas where increases in flood hazard (from low to transitional hazard) alternate to reduction in flood hazard (from transitional to low hazard).

The hydraulic model demonstrated that the proposed development has a negligible impact on the existing flood regime.

Point of ingresses to underground car park have been protected adopting flood planning levels above the PMF or 100 year ARI + 500 mm (whichever is higher).

The residual risk related is mitigated by the possibility to access uppers floor in case of a flood emergency.

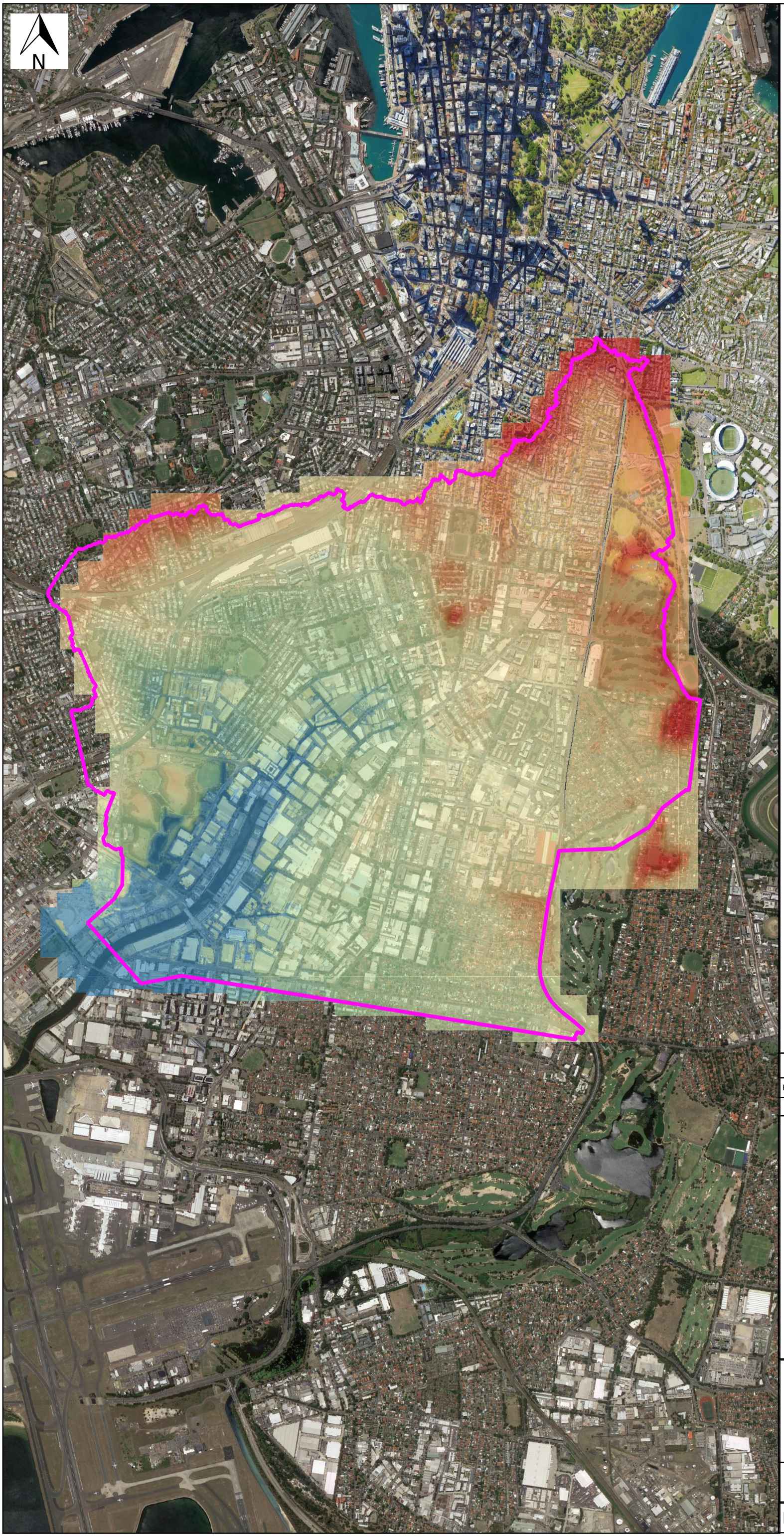
There is no Stormwater Management relevant to the Basement Car Park DA as all the stormwater above the basement is collected by the Northern and Central Precinct Developments. Refer to the

Appendix O Stormwater Management Strategy and Flood Impact Assessment Reports for the Northern Precinct (SSD-10440) and Central Precinct (SSD-10439) for further details.

The OSD tank for the Building 2 and Cope Street Plaza catchments is included in the Basement Car Park (SSD-10438), and it is located below grade in Church Square.

# 11. Appendices

## Appendix 1 - Catchment Topography




KEY:

Catchment Extent

Elevation m AHD

- 5
- 10
- 20
- 30
- 40
- 50

0 15 30 45 m

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# Waterloo - OSD

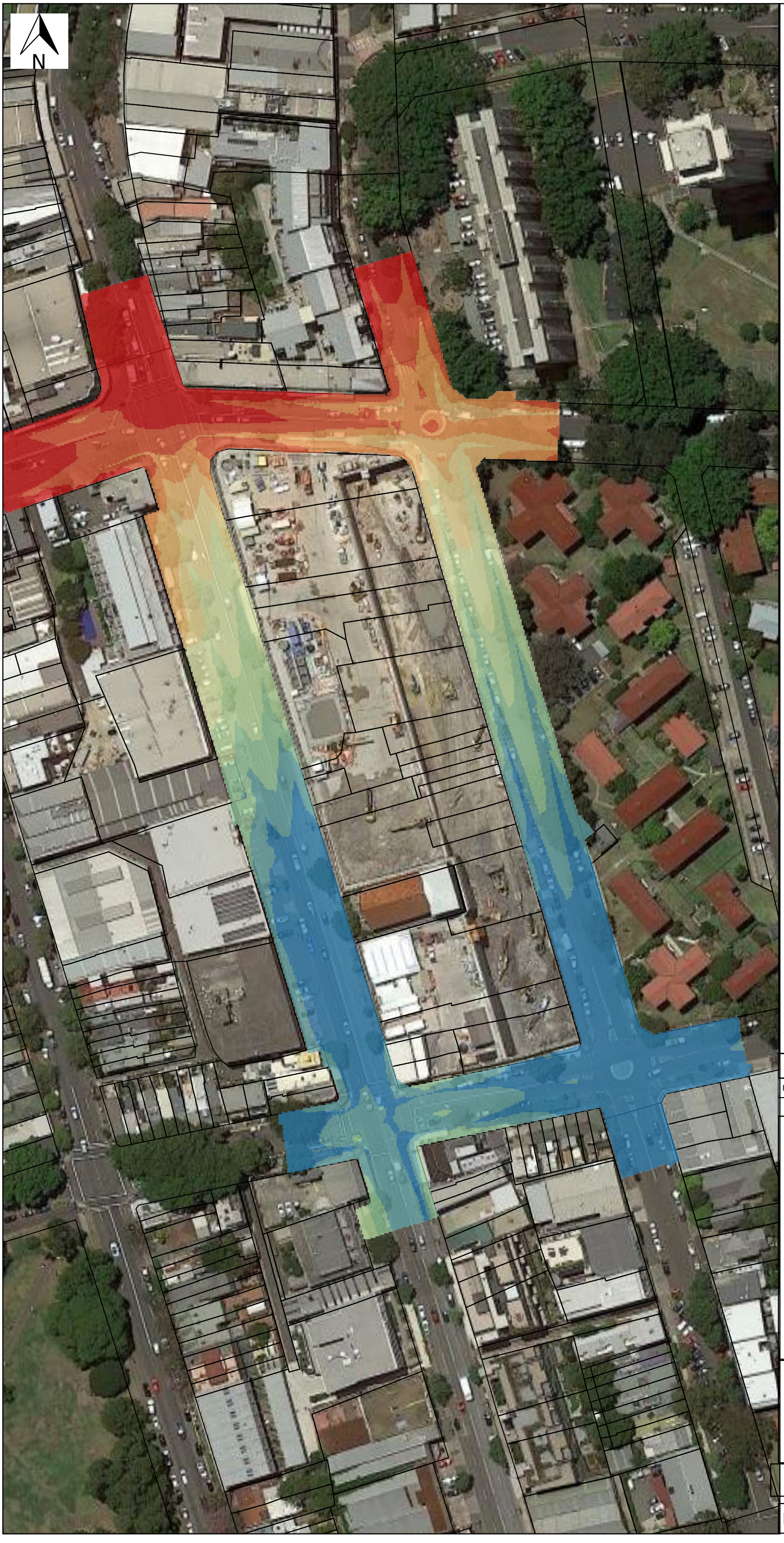
## Alexandra Canal Catchment Topography

Scale: 1:25000

21/07/20

Project Number: PS119449

## Appendix 2 - Topography Survey




KEY:

Elevation m AHD

- <= 15.2
- 15.2 - 15.4
- 15.4 - 15.6
- 15.6 - 15.8
- 15.8 - 16
- 16 - 16.2
- 16.2 - 16.4
- 16.4 - 16.6
- 16.6 - 16.8
- > 16.8

0 15 30 45 m

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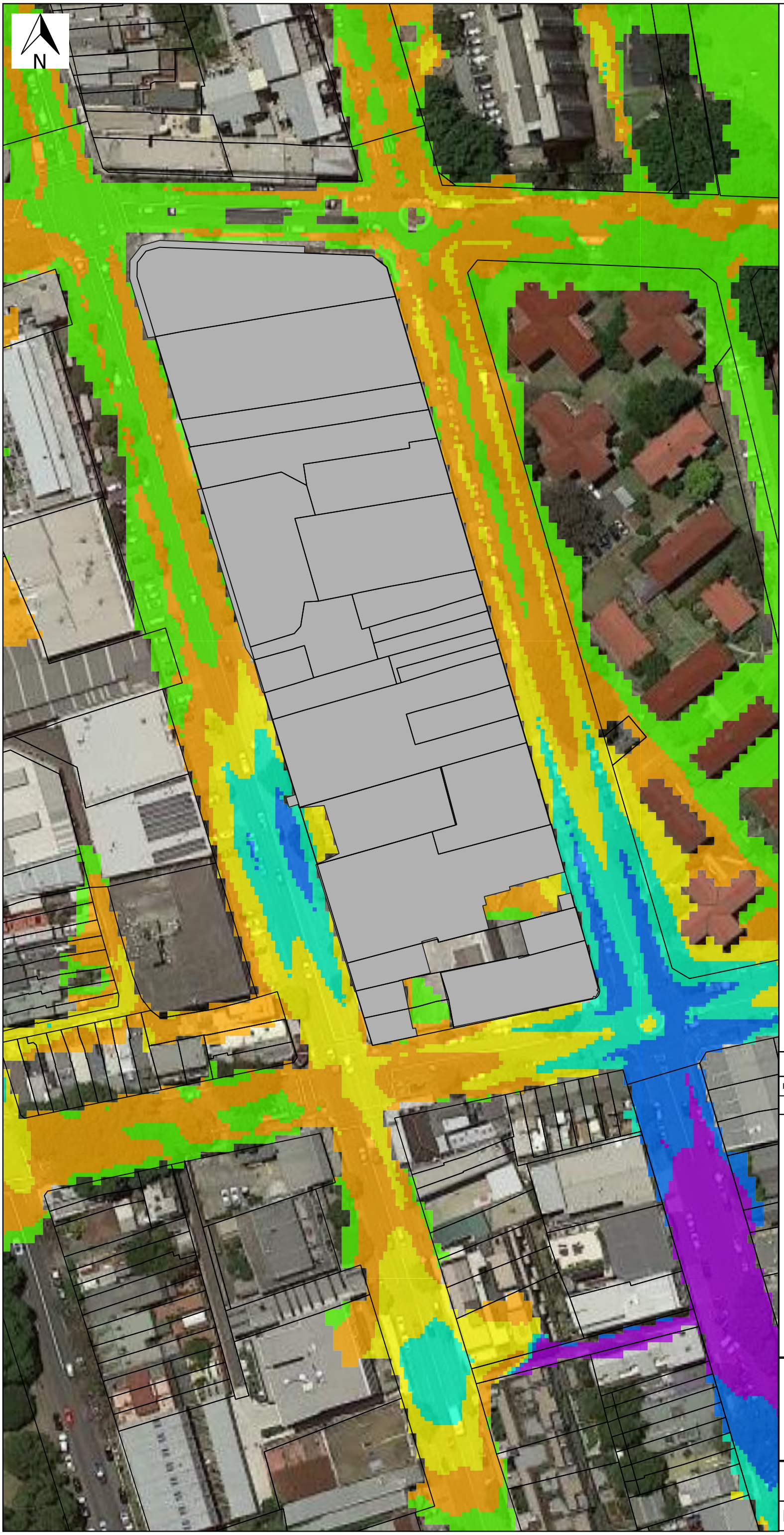
Alexandra Site Topography

Scale: 1:1250

23/07/20

Project Number: PS119449

## Appendix 3 Water Depth - Baseline Scenario




KEY:

- Existing Building

Water Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.7
- 0.7 - 1
- >1

0 15 30 45 m

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# Waterloo - OSD

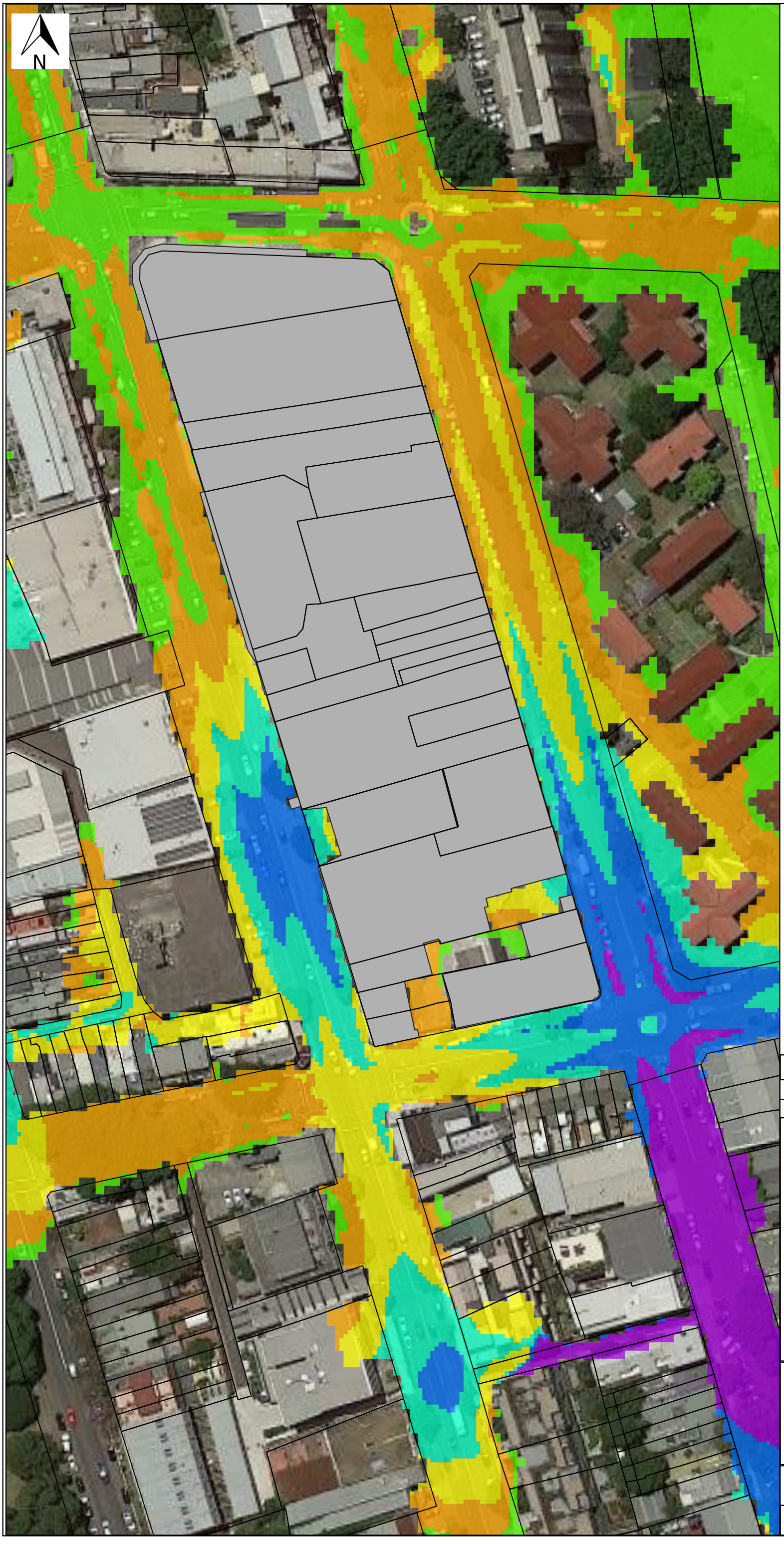
## Existing Scenario - 5% AEP

## Water Depth

Scale: 1:1000 | 24/07/20

Project Number: PS119449

Created by: AUMZ501756 - 2020-07-24 15:53:46 - U:\Projects\AU\PS119xxx\PS119449_Waterloo_OSD_work\4_WIP\Docs\Flood study\Flood Map\Existing Flood Map.qgz




KEY:

Existing Building

Water Depth (m)

<= 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 0.7

0.7 - 1

>1

0 15 30 45 m

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Waterloo - OSD

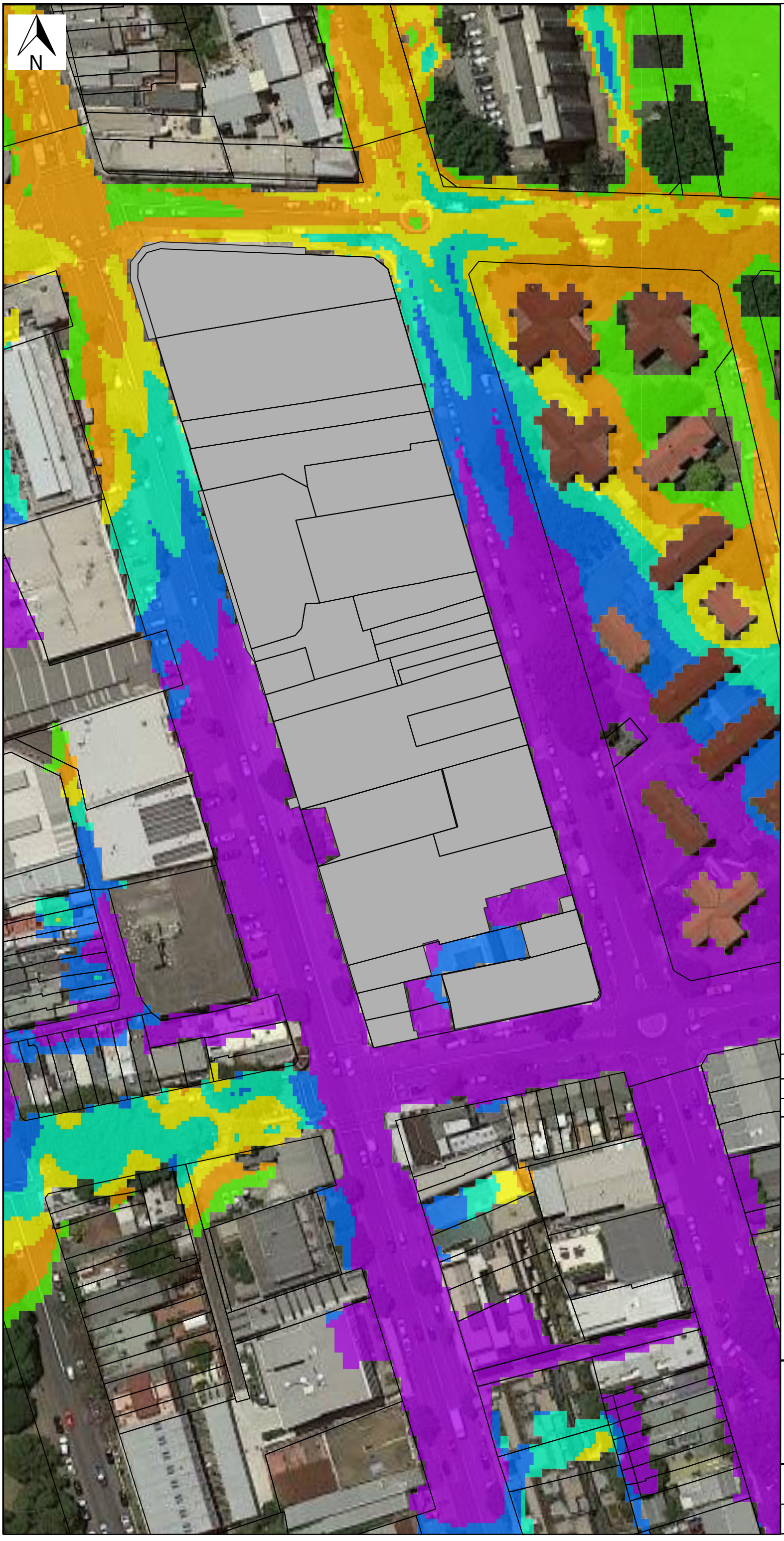
Existing Scenario - 1%AEP

Water Depth

Scale: 1:1000 | 24/07/20

Project Number: PS119449

Created by: AUMZ501756 - 2020-07-24 15:53:50 - U:\Projects\AU\PS119xxx\PS119449_Waterloo_OSD_work\4_WIP\Docs\Flood study\Flood Map\Existing Flood Map.qgz




KEY:

Existing Building

Water Depth (m)

<= 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 0.7

0.7 - 1

>1

0 15 30 45 m

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Waterloo - OSD

Existing Scenario - PMF

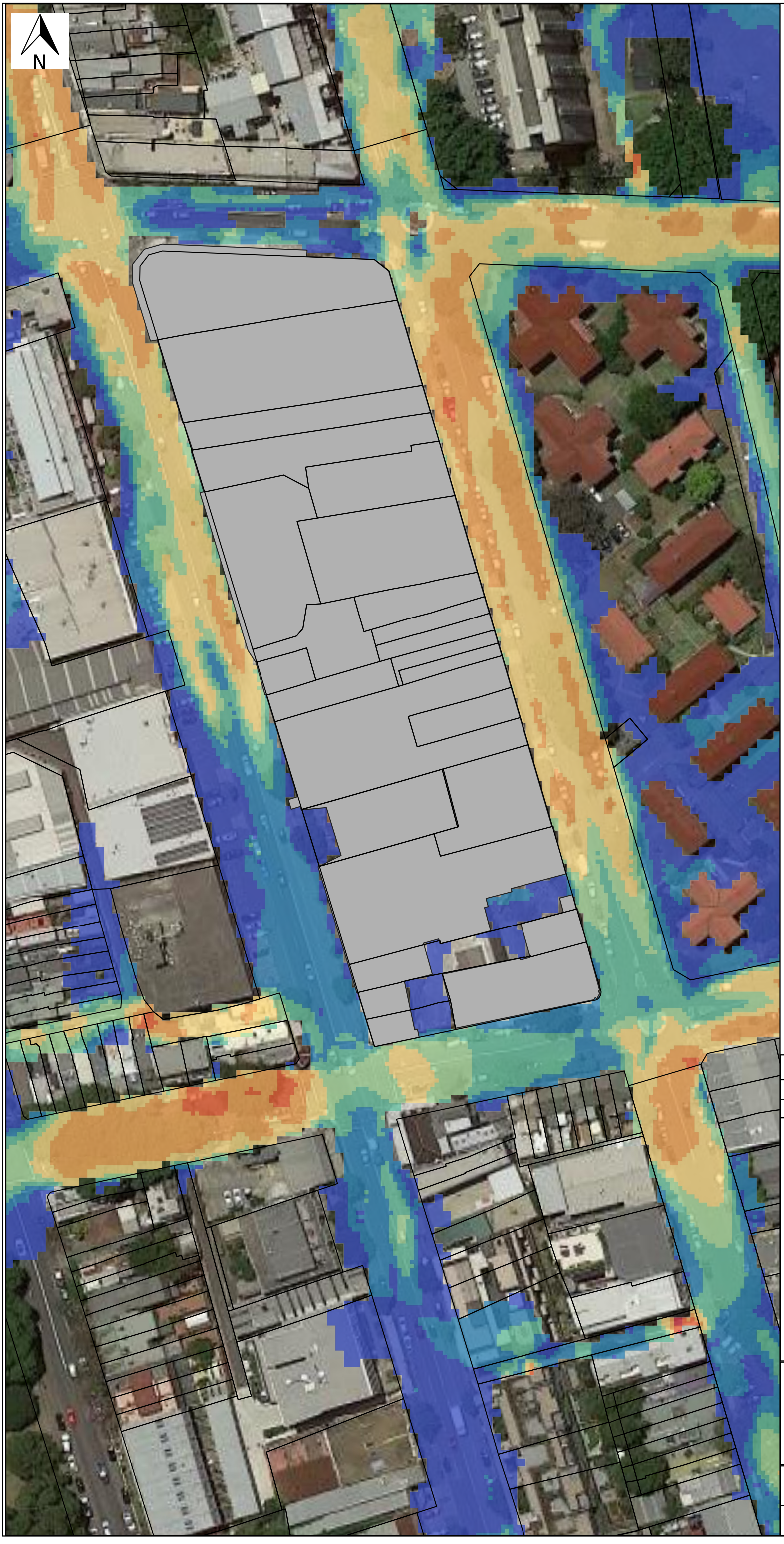
Water Depth

Scale: 1:1000

24/07/20

Project Number: PS119449

## Appendix 4 - Water Velocity Baseline Scenario




KEY:

Existing Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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# Waterloo - OSD

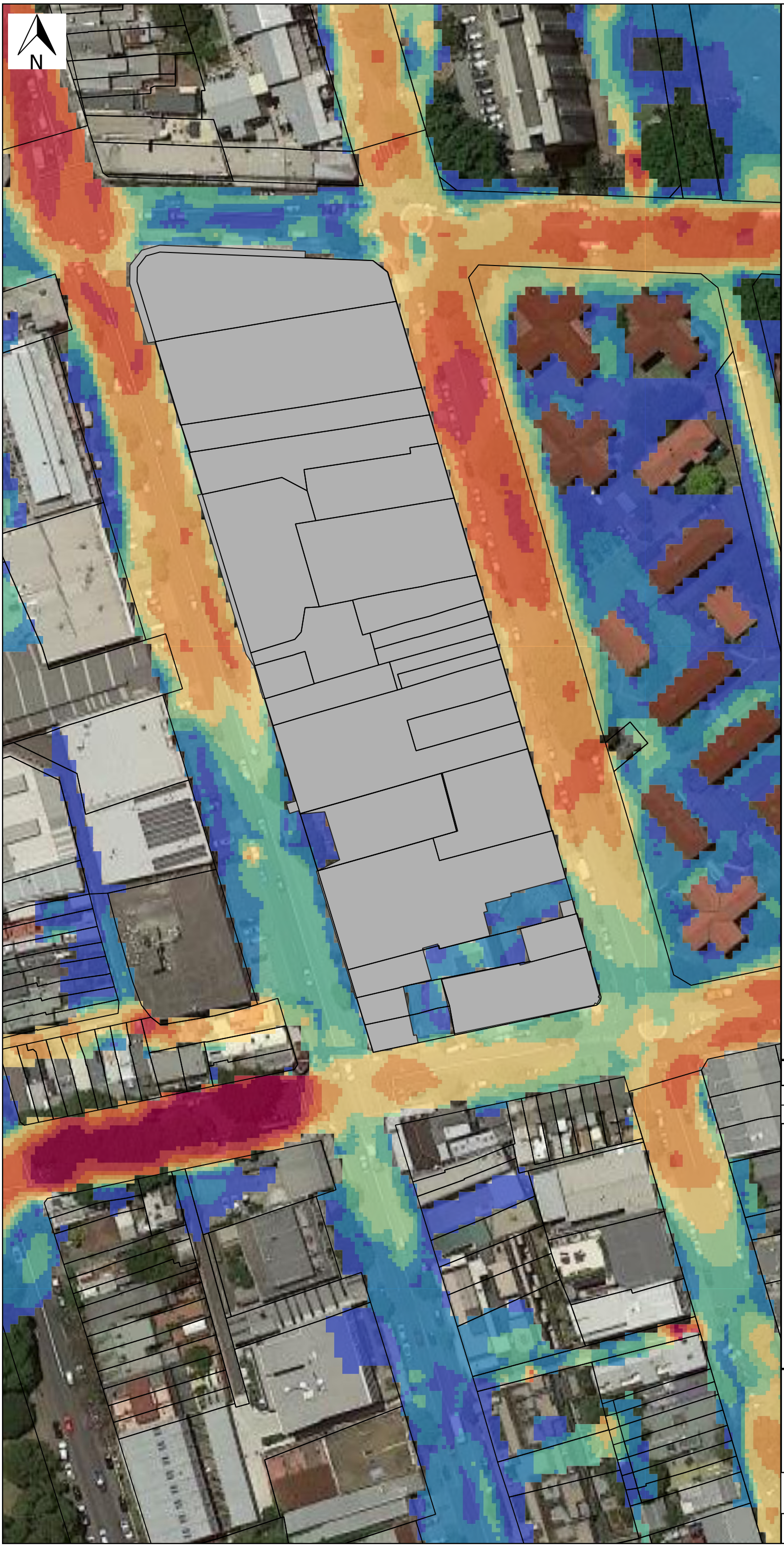
## Existing Scenario - 1%AEP

## Water Velocity

Scale: 1:1000 | 14/07/20

Project Number: PS119449

Created by: AUMZ501756 - 2020-07-14 16:22:16 - U:\Projects\AU\PS119xxx\PS119449_Waterloo_OSD_work\4_WIP\Docs\Flood study\Flood Map\Existing Flood Map.qgz




KEY:

Existing Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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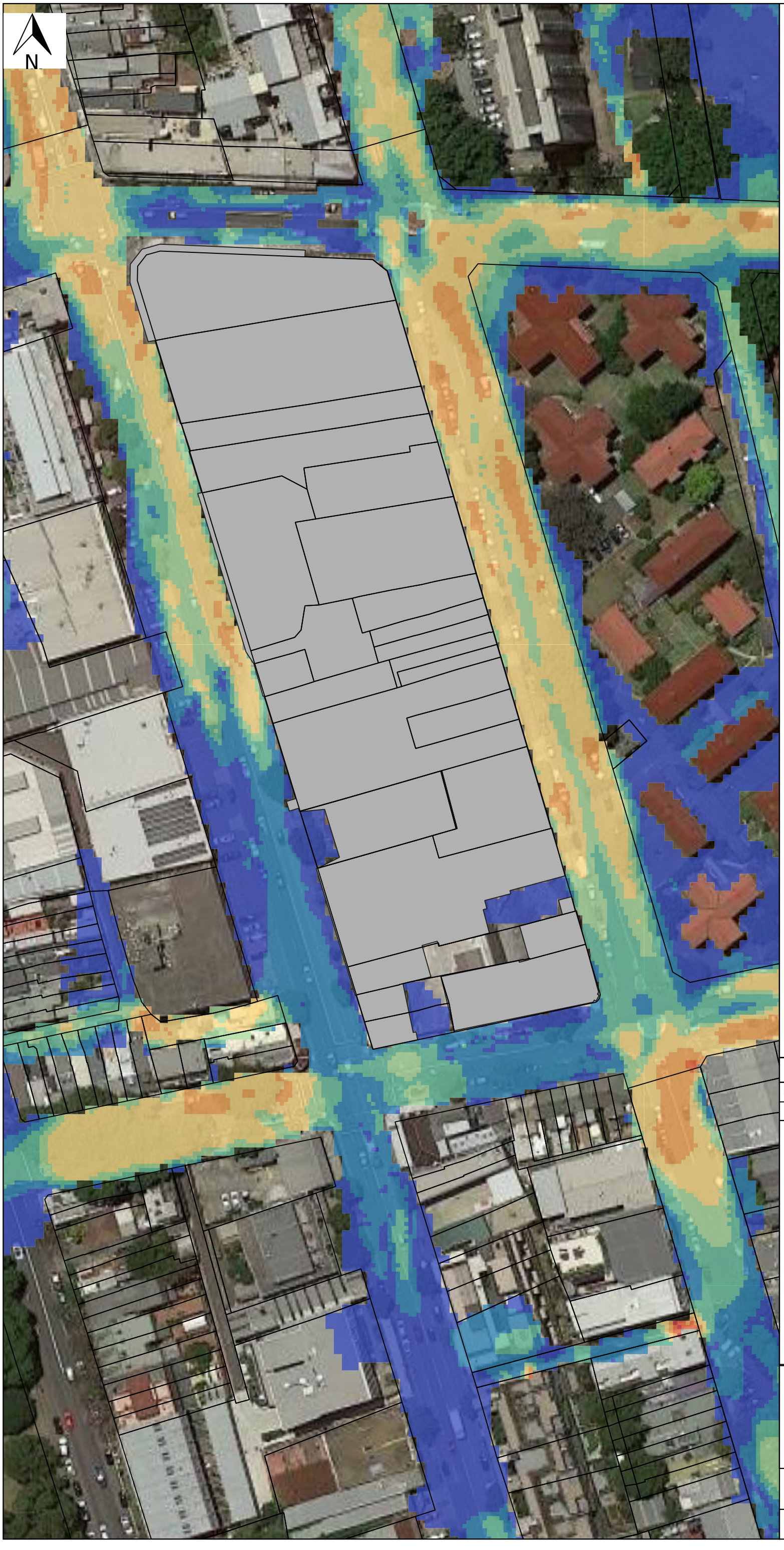
Waterloo - OSD

Existing Scenario - PMF

Water Velocity

1:1000 | 14/07/20

Project Number: PS119449




KEY:

Existing Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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Waterloo - OSD

Existing Scenario - 5%AEP
Water Velocity

| 1:1000 | 14/07/20 |
|---|---|

Project Number: PS119449

## Appendix 5 - Flood Hazard- Baseline Scenario


KEY:

Building

Flood Hazard

Low Hazard

Transitional Hazard

High Hazard

0 15 30 45 m

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# Waterloo - OSD

## Baseline - Food Hazard

## 20 year ARI

Scale: 1:1000

15/07/20

Project Number: PS119449


KEY:

- Building

Flood Hazard

- Low Hazard
- Transitional Hazard
- High Hazard

0 15 30 45 m

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# Waterloo - OSD

## Baseline - Flood Hazard

## 100 year ARI

Scale: 1:1000 | 15/07/20

Project Number: PS119449


KEY:

- Building

Flood Hazard

- Low Hazard
- Transitional Hazard
- High Hazard

0 15 30 45 m

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Waterloo - OSD

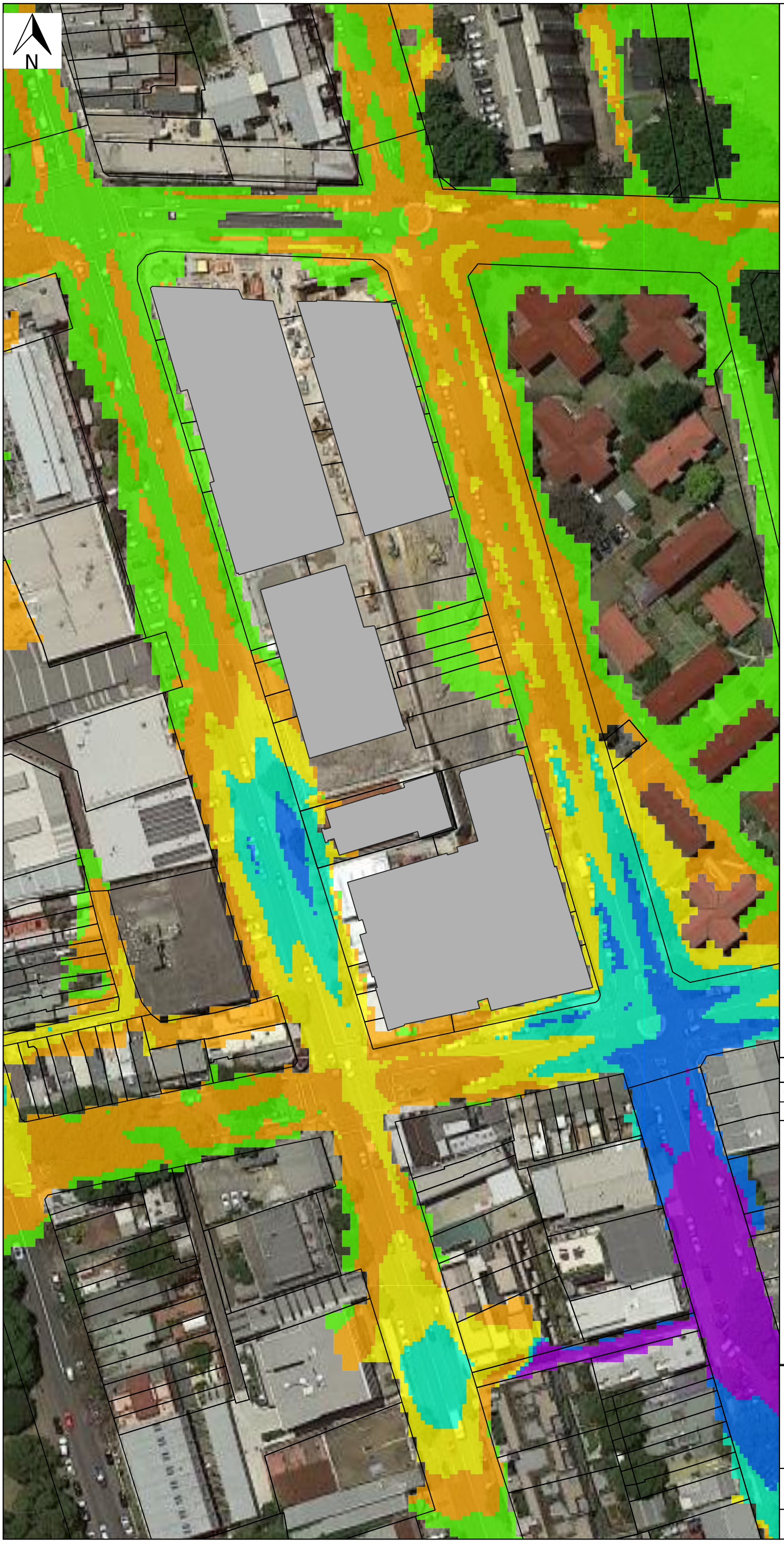
Baseline - Flood Hazard

PMF

Scale: 1:1000 | 15/07/20

Project Number: PS119449

## Appendix 6 - Water Depth - Proposed Scenario




KEY:

- Building

Water Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.7
- 0.7 - 1
- >1

0 15 30 45 m

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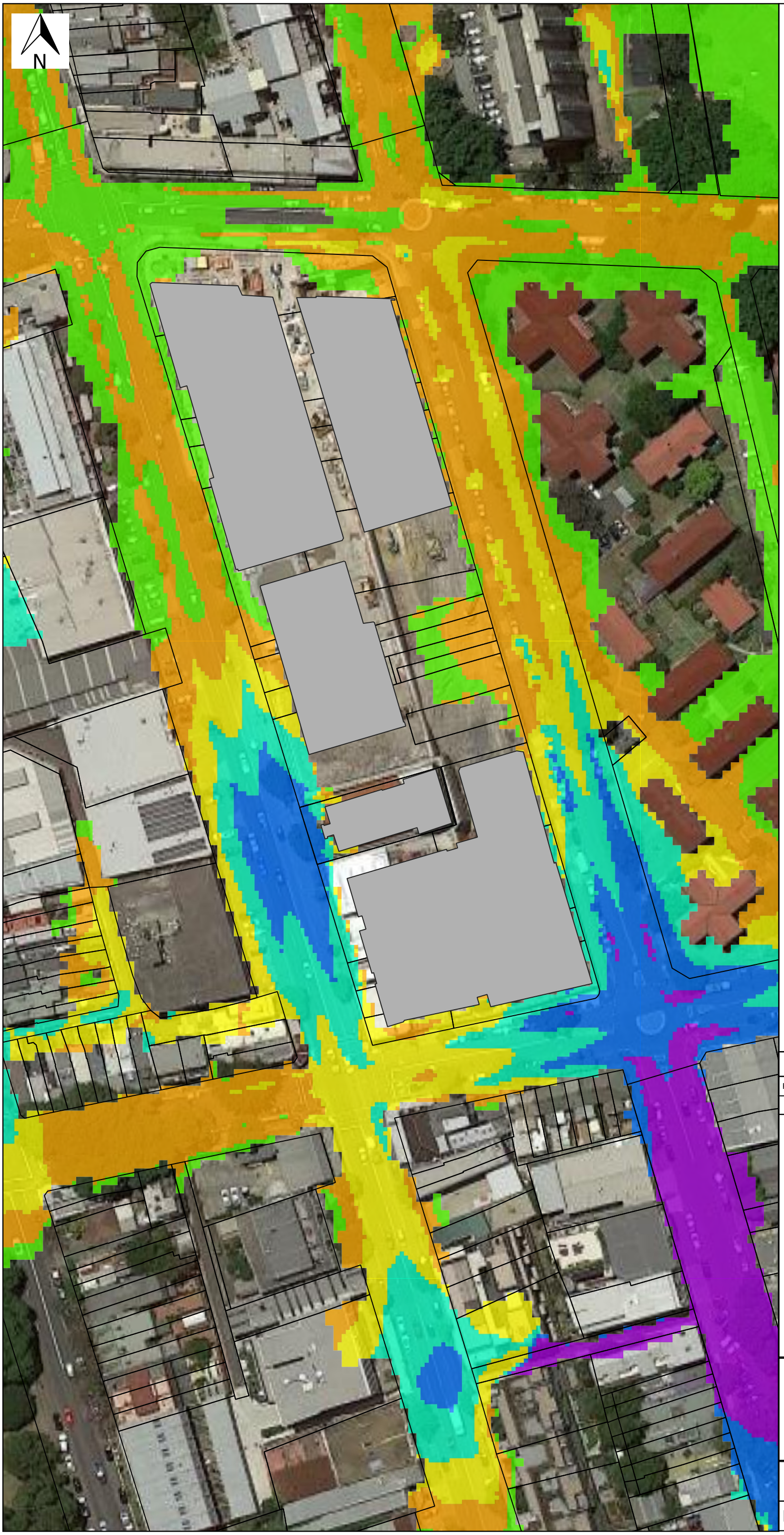
# Waterloo - OSD

## Proposed Scenario - 5%AEP Water Depth

1:1000 | 17/07/20

Project Number: PS119449




KEY:

- Building

Water Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.7
- 0.7 - 1
- >1

0 15 30 45 m

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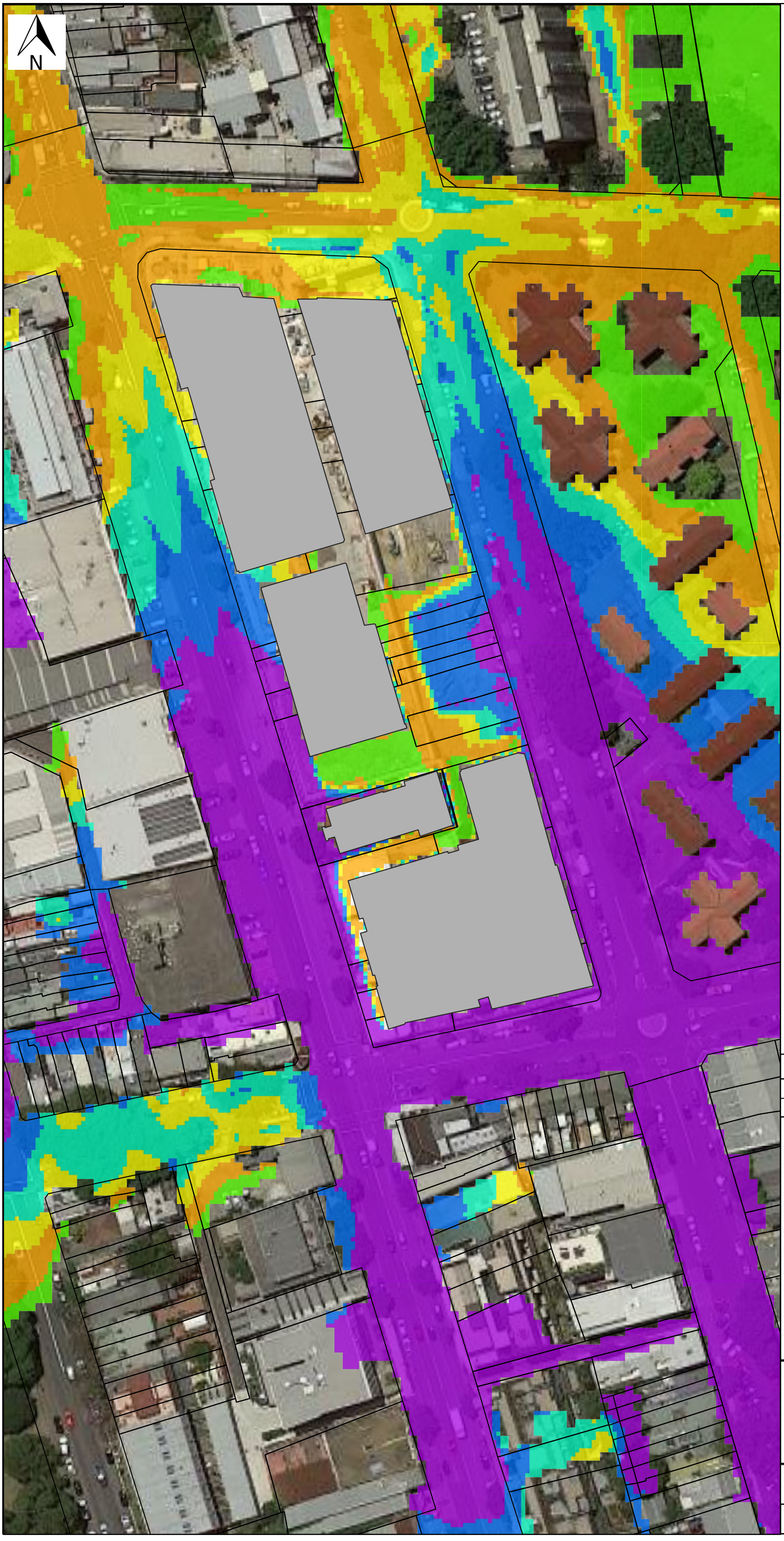
# Waterloo - OSD

## Proposed Scenario - 1% AEP

## Water Depth

Scale: 1:1000 | 17/07/20

Project Number: PS119449




KEY:

Building

Water Depth (m)

<= 0.10

0.10 - 0.30

0.30 - 0.50

0.50 - 0.7

0.7 - 1

>1

0 15 30 45 m

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# Waterloo - OSD

## Proposed Scenario - PMF

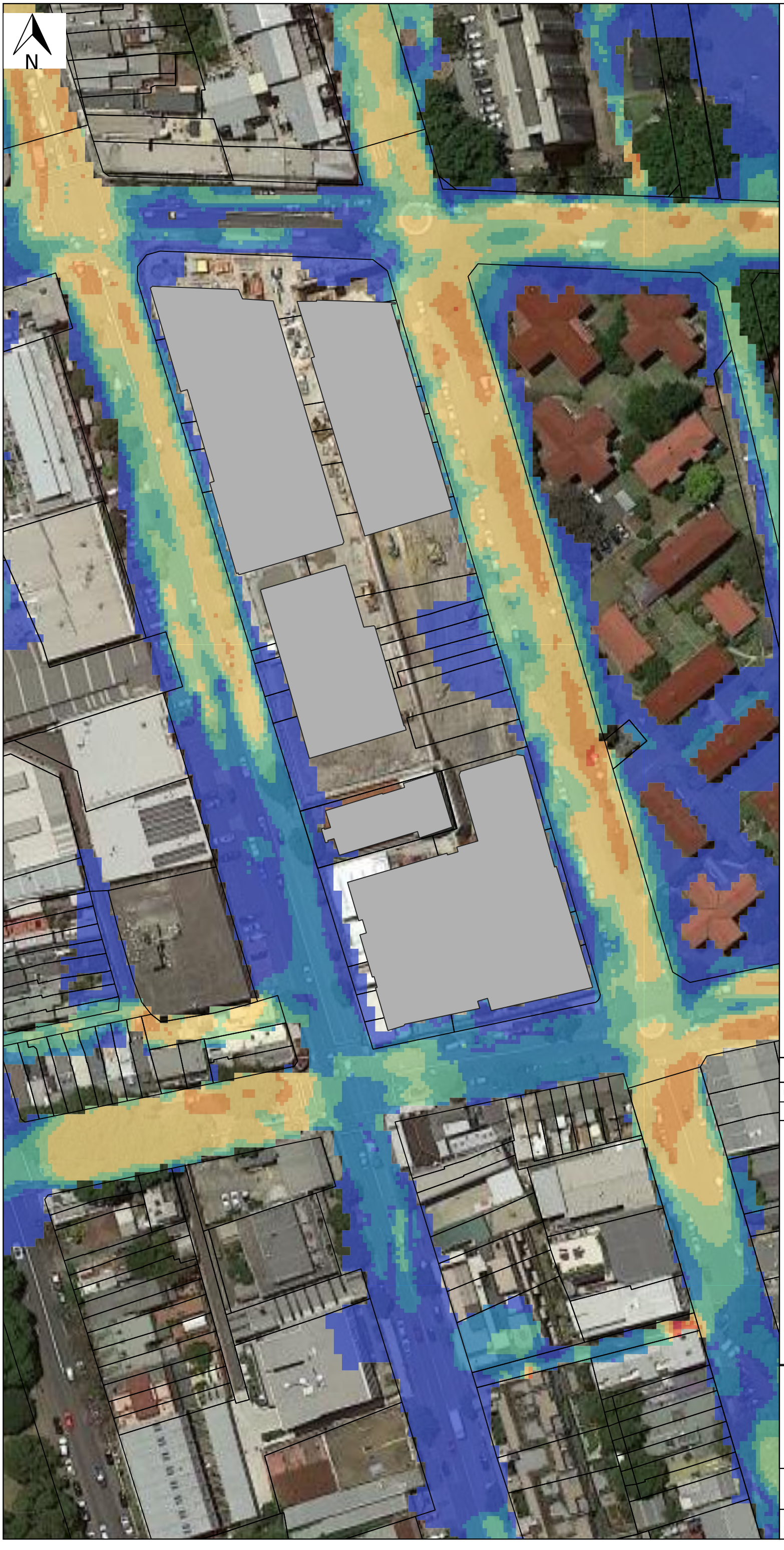
## Water Depth

Scale: 1:1000

17/07/20

Project Number: PS119449

## Appendix 7 - Water Velocity Proposed Scenario




KEY:

Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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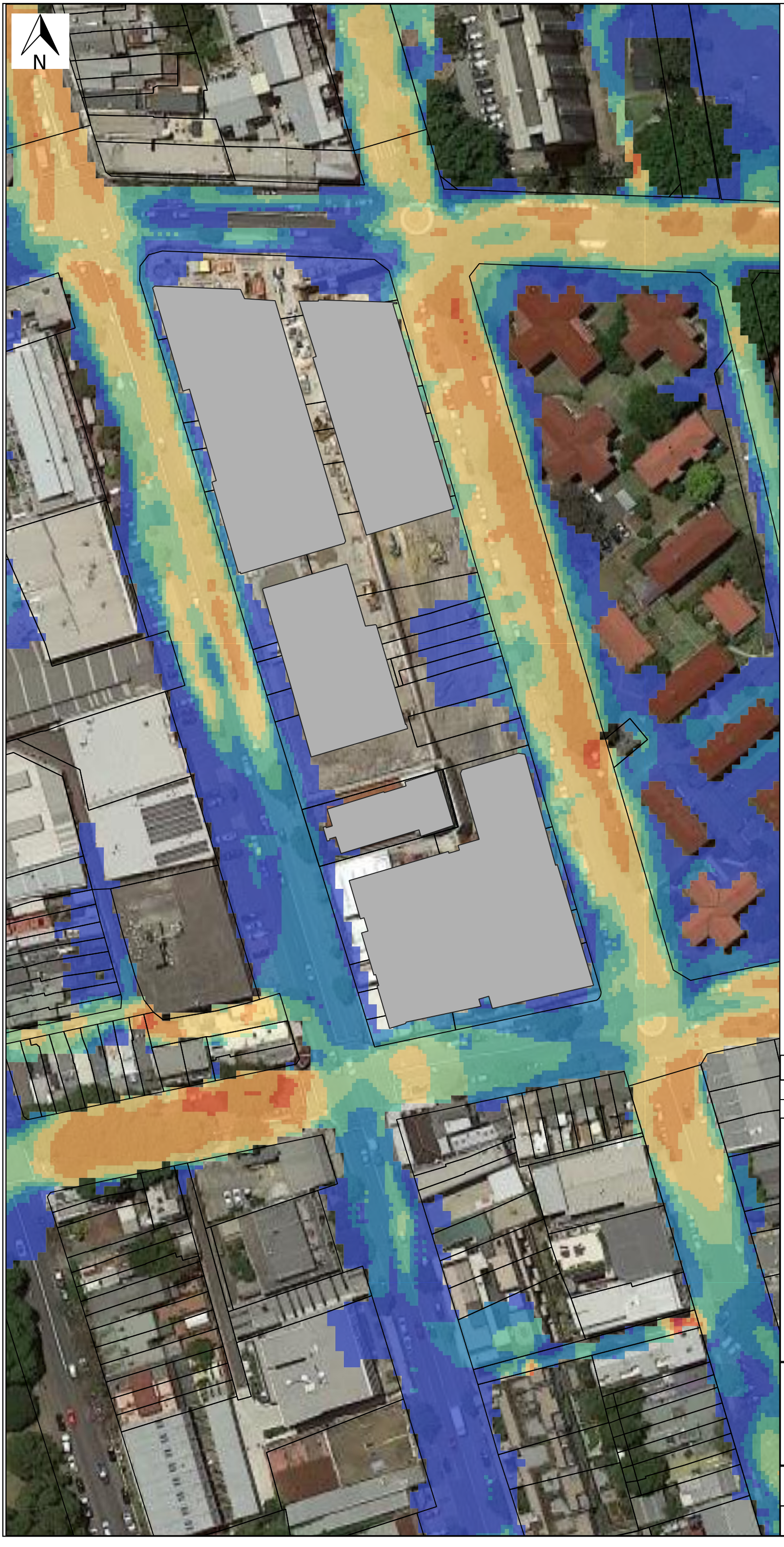
# Waterloo - OSD

## Proposed Scenario - 5%AEP Water Velocity

1:1000 | 17/07/20

Project Number: PS119449




KEY:

Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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Waterloo - OSD

Proposed Scenario - 1%AEP

Water Velocity

Scale: 1:1000 | 17/07/20

Project Number: PS119449

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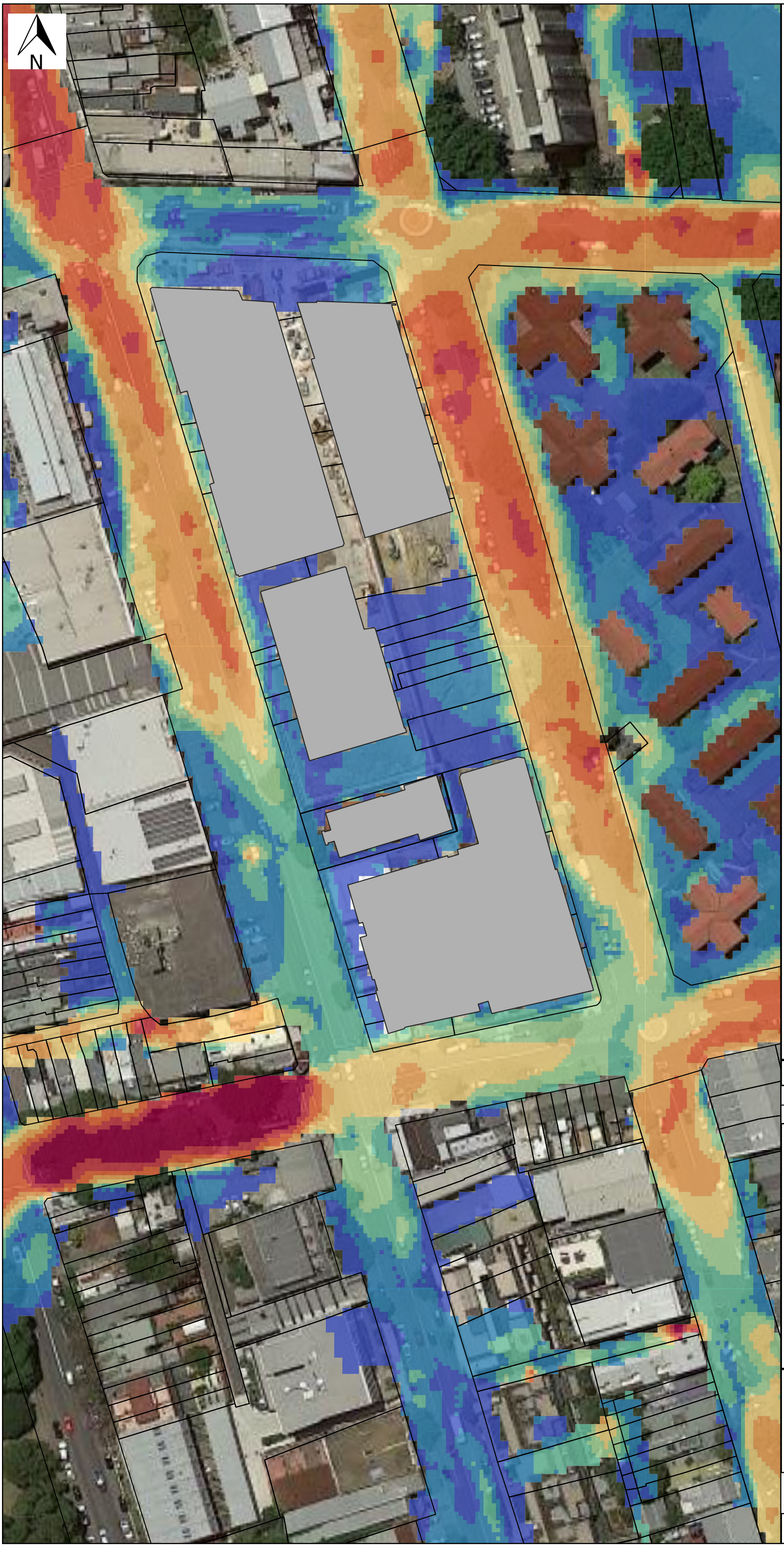


KEY:

Building

Water Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- >3

0 15 30 45 m

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Waterloo - OSD

Proposed Scenario - PMF

Water Velocity

1:1000 | 17/07/20

Project Number: PS119449

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