Attachment A13

Flood Study

ARUP

Lendlease

The O'Connell Precinct

Desktop Flood Assessment Report in Support of Request for Planning Proposal

Reference REP_C_0001_Desktop Flood Assessment for Planning Proposal

Issue B | 29 February 2024

Job number 276093

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Acronym Definitions

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
CBD	Central Business District
CoS	City of Sydney
DA	Development Application
CBD	Central Business District
DCP	Development Control Plan
DCW	Domestic Cold Water
DPIE	NSW Department of Planning, Industry and Environment
EPA	Environment Protection Authority
FDM	Floodplain Development Manual
FFL	Finished Floor Level
FPL	Flood Planning Level
LEP	Local Environmental Plan
LGA	Local Government Area
PMF	Probable Maximum Flood
CSPS	Central Sydney Planning Strategy
TfNSW	Transport for New South Wales

1. Executive Summary

This desktop flood assessment has been prepared in support of the Planning Proposal for the O'Connell Precinct. The assessment:

- Identifies the relevant flood requirements and guidelines;
- Assesses the existing flood conditions; and
- Determines the flood immunity requirements of the planning proposal.

The existing stormwater infrastructure and flood results (from the Transport for NSW *Sydney Light Rail Flood GIS Model (Model Version 107)"*) were assessed to inform the existing flood conditions of the Site.

The flood immunity assessment has been undertaken to inform the flood planning level (FPL) requirements for the proposed development. These levels vary depending on the flood level at each location and the type of threshold/ entrance, including basement entrances or ground floor and the type of development. The flood immunity assessment is intended to inform minimum threshold/ floor levels to be addressed by the architect in the detailed design.

The ground floor of a commercial development generally requires immunity to the 1% annual exceedance probability (AEP) flood levels. The 1% AEP flood levels surrounding the site are generally contained within the road reserve and compliance with flood planning requirements can typically be addressed through grading in the public domain. The portion of the Site fronting the western end of Spring Street (near Pitt Street) is likely to require minor elevating of the internal floor levels to achieve a finished floor level above the 1% AEP flood level.

This assessment has identified that the critical locations to be considered for flood immunity are the basement thresholds. Requirements for flood planning differ according to the flood affectation of individual locations. The western ends of Spring Street and O'Connell Street have been identified as being located within the floodplain. These locations require a flood planning level a minimum of the 1% AEP flood level +0.5m or the probable maximum flood (PMF) level (whichever greater). Achieving flood planning compliance passively through grading (or similar) is often not conducive with an activated, accessible and inclusive public domain. It will be necessary for the future design to respond to these requirements. Where locations are considered outside the floodplain, including Bent Street and the eastern ends of Spring and O'Connell Street, basement thresholds are required to be a minimum of 300mm above surrounding ground levels (typically measured from the adjacent gutter invert). This will typical be achieved through kerbs, footpath crossfall and minor grading internal to the site such as threshold ramps. Achieving this requirement for the retained Bent Street vehicle entrance ramp within the constraints of the heritage façade, vertical vehicle clearance requirements and the retention of the existing basement structure are challenged and require additional review during detailed design. One solution to be considered is an alternate flood planning requirement conducive to the constraints and risks and within consideration of the local grading which is generally falls away from the basement entrance.

The Planning Proposal is within the footprint of the existing building envelope. Therefore, it is not anticipated to have an adverse impact on the existing flooding of the precinct.

2. Introduction

This Desktop Flood Review has been prepared by Arup and supports a Request for a Planning Proposal to amend the Sydney Local Environmental Plan 2012 (Sydney LEP) and amendments proposed to the Sydney Development Control Plan 2012 (Sydney DCP 2012) in relation to the O'Connell Precinct. This report is submitted to the City of Sydney Council (Council) on behalf of the Proponent.

The O'Connell Precinct represents a significant opportunity in Central Sydney to renew a number of aging assets and deliver a highly engaging and multi-dimensional destination. The holistic reimaging of the Precinct will unlock a key site in the commercial heart of Sydney's Central Business District (CBD), bringing a sense of activity, wonder and respite to an established, but evolving locality.

This report should be read in conjunction with all supporting material associated with the Request for a Planning Proposal and DCP amendment, including the Planning Justification Report prepared by Ethos Urban.

2.1 Background

The Central Sydney Planning Strategy (CSPS) was first released in 2016 and sets out a 20-year land use vision, planning priorities and actions to achieve a place-led and people-led vision for growth in Central Sydney. The CSPS were endorsed by Council on 14 December 2020 and amendments to the Sydney LEP 2012 were gazetted in December 2021, supported by amendments to the Sydney DCP 2012.

The central aim of the CSPS is to support good growth while balancing the need to protect and enhance the public places that make the city unique. It provides the strategic direction to continue to position and strengthen Central Sydney as Australia's most productive and strategically important employment centre. Through 10 key moves, the CSPS balances opportunities for development to meet demands and achieve Council's job targets through to 2036, being 100,000 jobs unlocked through an additional 2.9 million square metres of employment generating floor space.

Importantly, the CSPS includes opportunities for increased height and density in key locations, balanced with environmental sustainability initiatives and sets criteria for excellence in urban design.

In this context, and over a number of years, the Proponent has brought together the individual sites within the O'Connell Precinct to amalgamate a collective Precinct with the intention to deliver a world class mixed-use commercial redevelopment.

The amendments sought to the Sydney LEP 2012 and Sydney DCP 2012 have been discussed with Council staff over a number of years, including presentations of the proposal to Council's Design Advisory Panel. These pre-lodgement discussions have informed the proposed amendments and scope of the assessment provided within this Report.

2.2 Site Location and Context

The O'Connell Precinct is located within the City of Sydney Local Government Area (LGA). The precinct is within the north-eastern portion of the Sydney CBD and is in immediate proximity to existing public transport infrastructure and a diverse mix of business, retail, cultural and entertainment destinations. The Precinct is also strategically located adjacent to the future Hunter Street metro station.

Specifically, the O'Connell Precinct has a total area of approximately 6,749m^2. It is irregular in shape and is bounded by Spring Street and Bent Street to the north, O'Connell Street to the south and south-east. The Precinct formally contains the following lots and street addresses:

- Lot 1 DP814858 or 1 O'Connell Street, Sydney
- Lot 2 DP172068, 8 Spring Street, Sydney
- Lot 1 DP176768 or 10-14 Spring Street, Sydney
- Lot 1 DP724946, 16 Spring Street, Sydney
- Lot 2 DP74923, 17 O'Connell Street, Sydney
- Lot 1 DP131917 or 19 O'Connell Street, Sydney
- Strata DP63932, 23 O'Connell Street, Sydney

Collectively, these lots and addresses are referred to as the 'Precinct' or 'Site' throughout this Report.

The Precinct includes a number of existing buildings, the majority of which are anticipated to be demolished to facilitate the renewal for the new commercial redevelopment. Of note, the heritage listed 19 O'Connell Street building will be retained, as well as the existing 1 O'Connell Street commercial building, including the heritage listed facades of 1 O'Connell Street.

The boundaries of the O'Connell Precinct are illustrated in Figure 1.

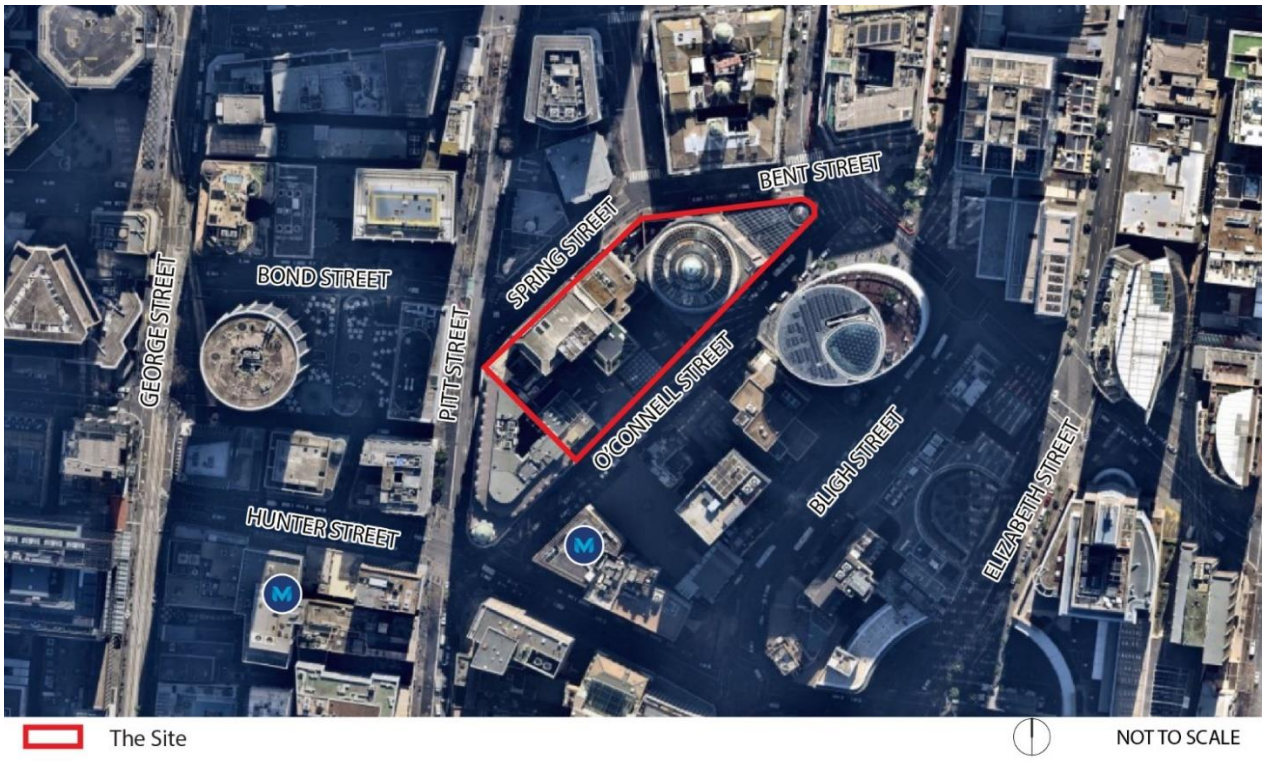


Figure 1 – Site aerial (Source: Ethos Urban on 30/08/2022)

2.3 Overview of the Proposal

The reimaging of the O'Connell Precinct will comprise an integrated mixed-use commercial development that retains the existing 1 O'Connell Street commercial building, protects existing heritage, introduces a highly permeable and activated ground

plane with enhanced public realm edges, provides opportunities for diverse cultural uses, and delivers premium grade commercial floor space in a new office tower.

The realisation of the O'Connell Precinct will be achieved through amendments to the Sydney LEP 2012 and Sydney DCP 2012.

The amendments sought to the Sydney LEP 2012 will encourage and facilitate the reimagining of the Precinct for a non-residential development by allowing for:

- an increased maximum Floor Space Ratio (FSR); and
- an increased maximum Building Height.

Supporting the amendments to the Sydney LEP 2012 is an amendment to the Sydney DCP 2012 which includes site-specific controls that address matters such as building envelope; pedestrian connections; parking; vehicular access and loading; design excellence; heritage; sustainability; and public art.

The proposed amendments will directly support Council's endorsed CSPS by unlocking additional employment generating floor space. They will also facilitate significant public benefits to be delivered on site, through new cultural and community uses, east-west through site link, enhanced activation and embellishment of the public domain.

For assessment purposes, the vision for the O'Connell Precinct has been articulated in a reference design prepared by Matt Pullinger Architect and Stewart Architecture (provided under separate cover). This reference design is provided as a supporting document with the Request for a Planning Proposal and DCP amendment, and serves as a baseline proof of concept.

2.4 Scope of Assessment

The scope of this assessment is to inform the flood planning level requirements for the planning proposal and assess the potential flood impacts. The planning proposal is as documented in the Stewart Architecture/ Matthew Pullinger Architect design proposal, dated 28/10/22 (hereafter referred to as The Reference Scheme). Key tasks include:

- Flood planning level requirements:
    - Determine existing flood risk; and
    - Determine flood planning criteria to inform finished flood levels (FFLs) and/ or threshold levels.
- Flood impact assessment

2.5 Input Information

The following input information was used as part of the desktop flood review:

- *Sydney Light Rail Flood GIS Model (Model Version 107)*, Transport for NSW, June 2017
- *"Interim Floodplain Management Policy"* by City of Sydney (CoS) dated May 2014.
- *"Sydney Local Environment Plan"*, by CoS, 2012
- *"Sydney Development Control Plan"* 2012
- *"A4 Stormwater Drainage Design"* contained within the *"Sydney Streets Technical Specification"*, by CoS, Version 2019

- *"Floodplain Development Manual"*, NSW Government/ Department of Infrastructure,1 April 2005
- City of Sydney Open Data
- The O'Connell Precinct Architectural Reference Scheme prepared by Stewart Architecture and Matthew Pullinger Architect:
  - A1000 GA Plans – Basement 03 28/10/2022
  - A1001 GA Plans – Basement 02 28/10/2022
  - A1002 GA Plans – Basement 01 28/10/2022
  - A1003 GA Plans – Basement Mezzanine 28/10/2022
  - A1004 GA Plans – Lower Ground 28/10/2022
  - A1005 GA Plans – Upper Ground 28/10/2022

Whilst undertaking this assessment, The City North Public Domain Plan has been released. It is understood to have been endorsed by Council for public exhibition and sets the aspirations and vision for upgrades to the public domain to be undertaken in the future. The plan presents opportunities for:

- Closure of Spring Street;
- Partial closure of O'Connell Street; and
- Expansion of the Bent Street and Gresham Street footpaths.

Depending upon the form of these proposals, there is a potential for changes to occur to the current local flooding. It is assumed that the potential implications will be addressed through the detailed design of the public domain works to mitigate against flooding risks and potential impacts on the O'Connell Precinct. For the basis of this assessment the City North Public Domain Plan proposal has not been factored into the assessment.

3. Relevant Flooding Legislation and Guidelines

3.1 Sydney Local Environment Plan 2012 – City of Sydney

The Sydney Local Environment Plan 2012 (LEP) is the CoS's principal planning document that typically applies to development with the CoS's local government area (LGA). The LEP includes the following requirements related to flood planning.

5.21 Flood planning

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into consideration projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause—

Considering Flooding in Land Use Planning Guideline means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.

flood planning area has the same meaning as it has in the Floodplain Development Manual.

Floodplain Development Manual means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.

3.2 EPA Act and NSW Floodplain Development Manual

Direction 4.3 of Section 117(2) in the EPA Act 1979, details the objectives and requirements with which developments in flood prone land must comply, making reference to the New South Wales Floodplain Development Manual (2005) (the FDM). The FDM outlines the NSW Government's Flood Prone Land Policy. The primary objective of this policy is to reduce the impact of flooding and flood liability on owners and occupiers of flood prone properties whilst recognising the benefits from the use, occupation and development of flood prone land.

3.3 Interim Floodplain Management Policy - City of Sydney

The City of Sydney Interim Floodplain Management Policy (2014) provides controls related to flood risk in the City of Sydney LGA. The Policy was written to be read in conjunction with the Sydney LEP 2012 and Sydney DCP 2012. Key flood planning level requirements related to the proposed development are summarised in Table 1:

Table 1 – Flood planning level requirements

Development#	Flood Planning Level
Industrial or commercial, business • subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level
Industrial or commercial, retail floor levels • subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Below-ground car park* • outside floodplain	0.3m above the surrounding surface
Below-ground car park* • subject to mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is the higher)
Critical Facilities – Floor Level • Mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is the higher)
Critical Facilities – Access to and from critical facility within development site • Mainstream or local drainage flooding	1% AEP flood level

* The criteria for below ground car park includes any intended use for spaces located below the surrounding surface levels e.g. car parking, retail, commercial uses etc. The flood planning level applies to all penetrations to below-ground levels which may include lifts, escalator pit drainage, ventilation openings etc.

It is noted that additional criteria apply to other development types which may appropriate depending upon planned development for the site. These include schools/ childcare, housing for older people or people with disabilities, sewer management.

3.4 Sydney Development Control Plan 2012 – City of Sydney

The Sydney Development Control Plan 2012 (DCP) generally applies to development within the CoS LGA. It includes controls related to flooding and stormwater

management, in addition to other planning controls, that must be adhered to. Particular controls related to stormwater and flood management are included in Section 3.7 of the DCP. The following section summarise the key requirements relevant to the project.

3.4.1 Flooding

Section 3.7.1 of the DCP includes a summary of controls related to flooding for development proposals. Where sites include land at or below the flood planning level, a site-specific flood study is required. Further direction on flood planning is provided in the Interim Floodplain Management Policy (2014) which was discussed in Section 3.3.

4. Review of Existing Site Conditions

This assessment has considered the Site and the public domain immediately adjacent.

4.1 Buildings

The Site is currently occupied by existing buildings which consist of retail and commercial spaces. These existing buildings have ground level access to the street frontages including Spring, O'Connell and Bent Streets.

4.2 Topography

The topography of the site was obtained from City of Sydney Open Data as 1m contours. Refer to Figure 2.

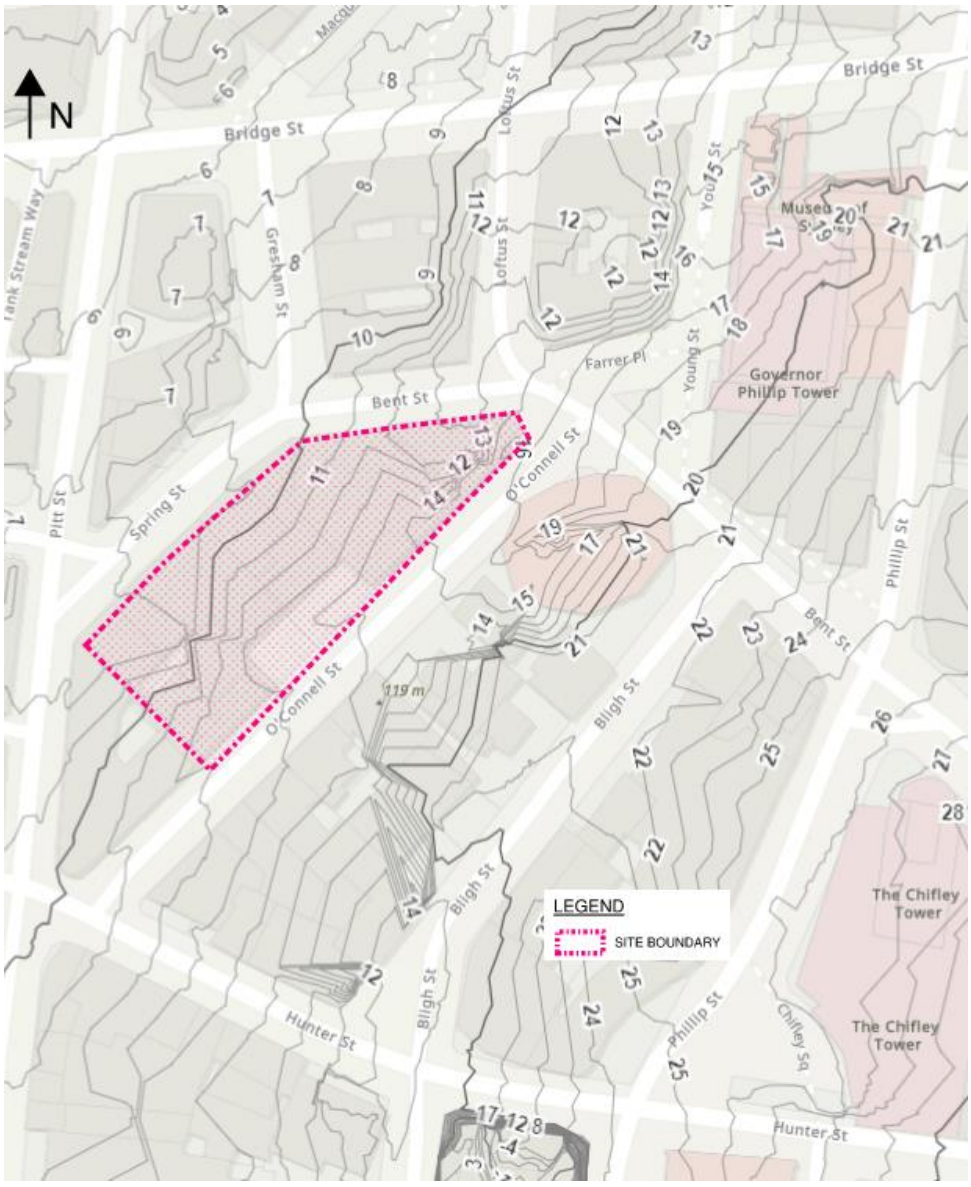


Figure 2 – Existing contour plan (Source: City of Sydney Open Data on 07/06/2021)

The precinct generally falls in a north west direction with grading influenced by how the road network cuts across the terrain. The site generally grades towards Pitt Street which forms a gully in the terrain.

4.3 Stormwater

The existing stormwater infrastructure plan is shown as green in Figure 3. Buildings and local public domain stormwater pits/ pipes connect to trunk stormwater culverts and drain in a west and north direction discharging to Sydney Harbour. The trunk stormwater lines within the Precinct are mostly located within the road carriageways including Pitt, Spring, O'Connell, Loftus and Young Street. The exception to this is the trunk main passing beneath the city block between Bligh and O'Connell Streets. Many of these trunk stormwater assets are classified as Sydney Water Heritage Sites and are made up of concrete, reinforced concrete and/or brick conduits. Heritage sites are indicated in pink hatching in Figure 4. The CoS and Sydney Water are the authorities which own and maintain the stormwater network in the area.

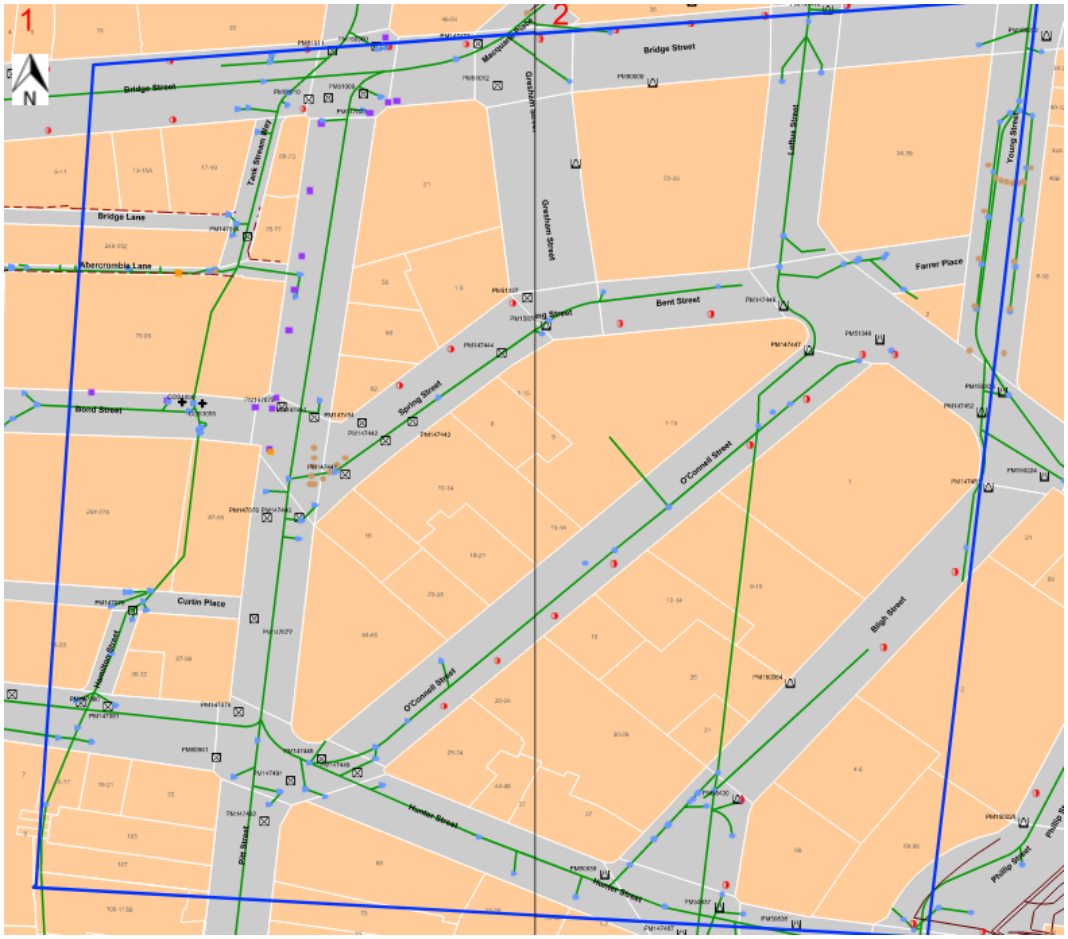


Figure 3 – Existing stormwater infrastructure plan (Source: City of Sydney DBYD dated 19/03/2021; stormwater lines in green)

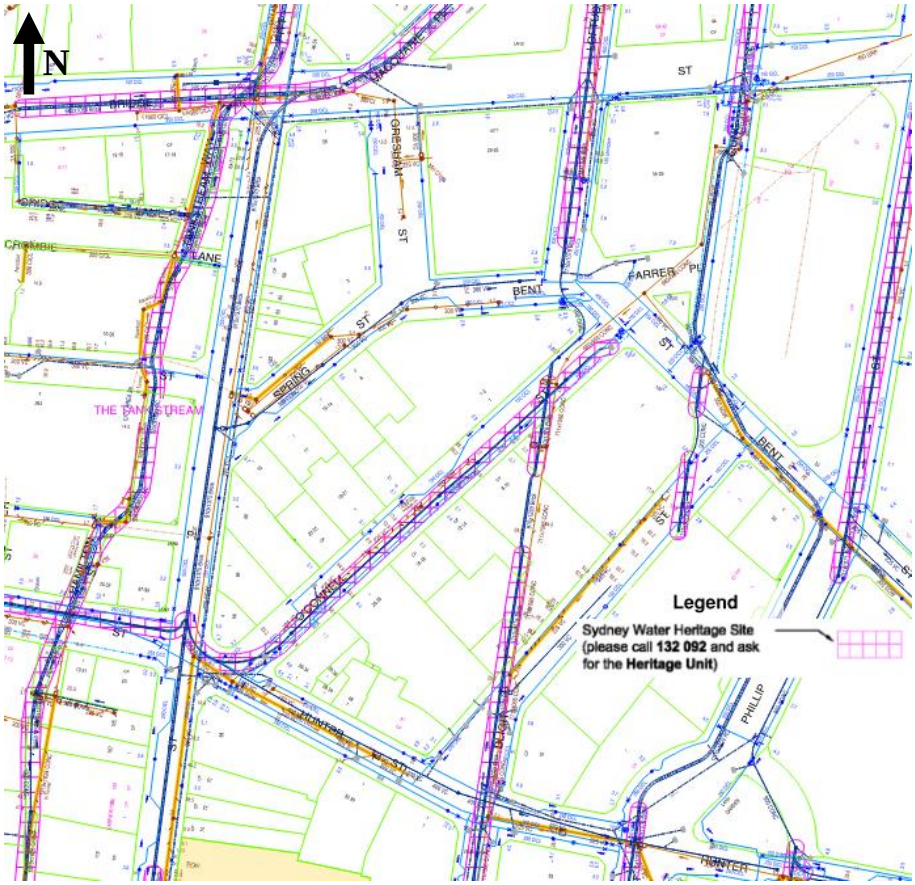


Figure 4 – Identification of Sydney Water Heritage Sites (Source: Sydney Water DBYD dated 19/03/2021)

4.4 Flooding

The existing flood conditions were assessed based upon *"Sydney Light Rail Flood GIS Model (Model Version 107)"* by Transport for NSW dated June 2017. This flood model is an adaption of the BMT WBM City Area Catchment Flood Study completed on behalf of the City of Sydney.

4.4.1 Review of Flood Model Results

Results of the 1% AEP and PMF peak flood depths and levels are indicated in Figure 5 and Figure 6, respectively. The flood model results used to determine the depths include a 50% blockage factor for all pits, and no climate change factor. Sample locations have been selected based upon key locations for the proposed Site and approximate the alignment of the existing kerb. The results are shown in Table 2.

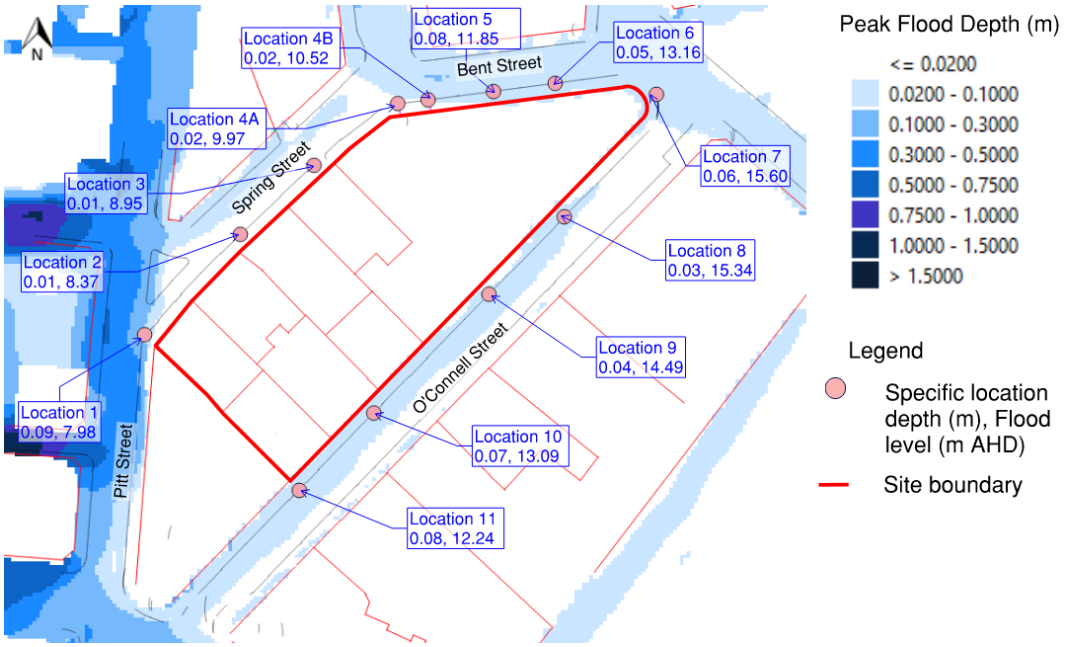


Figure 5 – Peak Flood Depths and Levels 1% AEP (100 yr ARI) ("Sydney Light Rail Flood GIS Model (Model Version 107)" by Transport for NSW, June 2017)

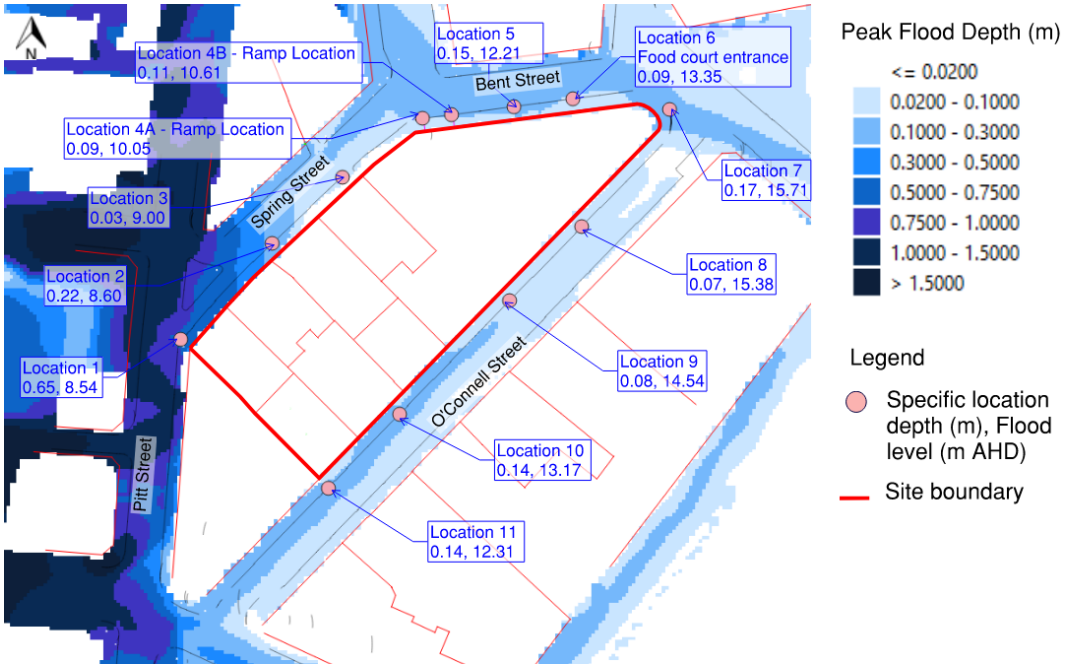


Figure 6 – Peak Flood Depths and Levels Probable Maximum Flood (PMF) ("Sydney Light Rail Flood GIS Model (Model Version 107)" by Transport for NSW, June 2017)

Table 2 – Peak Flood Depths and Flood Levels at Reference Locations ("Sydney Light Rail Flood GIS Model (Model Version 107)" by Transport for NSW, June 2017)

Location ID	Location Description	1% AEP		PMF	
		Flood Depth (m)*	Flood Level (mAHD) *	Flood Depth (m)*	Flood Level (mAHD)*
1	Spring Street, adjacent to southern site boundary	0.09	7.98	0.65	8.54
2	Spring Street, mid-block	0.01	8.37	0.22	8.60
3	Spring Street, adjacent to northern proposed building boundary	0.01	8.95	0.03	9.00
4A	Existing, southern retained basement loading dock entrance	0.02	9.97	0.09	10.05
4B	Existing, northern retained basement loading dock entrance	0.02	10.52	0.11	10.61
5	Proposed future access to food court	0.08	11.85	0.15	12.21
6	Bent Street, access to proposed Wintergarden	0.05	13.26	0.09	13.35
7	O'Connell Street, access to proposed Wintergarden	0.06	15.60	0.17	15.71
8	O'Connell Street, adjacent to northern proposed building boundary	0.03	15.34	0.07	15.38
9	O'Connell Street, northern mid-block	0.04	14.49	0.08	14.54
10	O'Connell Street, southern mid-block	0.07	13.09	0.14	13.17
11	O'Connell Street, adjacent to southern site boundary	0.08	12.24	0.14	12.31

* Flood depths and levels have been provided at the approximate kerb alignment located perpendicular to reference location.

For the 1% AEP flood event the following is noted:

- 20 – 100mm flood depth is identified in Bent and O'Connell Streets.
- Flood depths adjacent to the Spring Street site boundary are less than 20mm and are assumed to be contained within the kerb and gutter. Depths further north along Bent Street are between 20 – 100mm.

For the PMF flood event the following is noted:

- Spring Street – Generally up to 100 – 300mm flood depth with increasing depth of up to 750 – 1000mm near the intersection with Pitt Street

- Bent Street – 20 – 300mm of flood depth
- O'Connell Street – < 100mm flood depth at northern end. Increasing up to 150mm of flood depth at southern corner of the site boundary.

A review of the flood model results indicated that the reported flood levels were measuring at higher elevations than would be expected based upon a combination of flood depths and the site topographical survey. The flood model is based upon LiDAR survey which is less accurate than topographic survey and applies an average level over a 2x2m area. As a result, the surface does not define a kerb profile. A comparison between the flood model tin (Triangular Irregular Network) and the topographical survey tin indicated that the flood model surface was frequently at higher elevations than the topographical survey surface. Therefore, the results from the flood model were at risk of over-estimating flood levels. Figure 7 shows a sample cross section at a location in O'Connell Street where the flood model surface is consistently above the topographical surface.

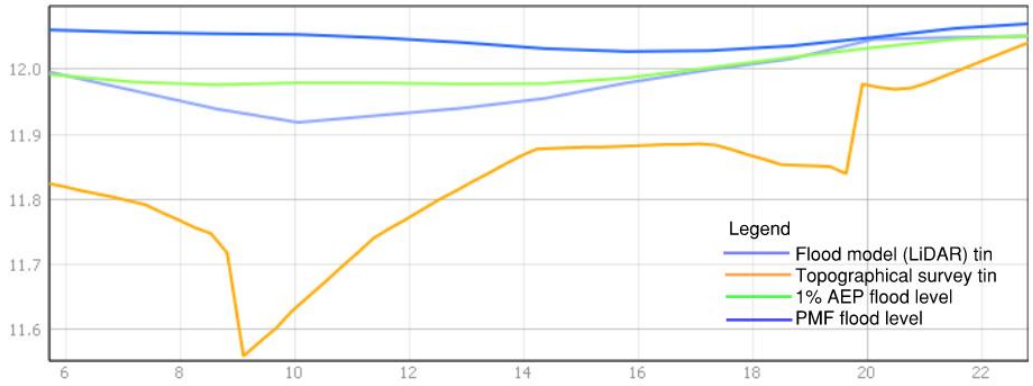


Figure 7 – Comparison of Tins and Flood Levels ("Sydney Light Rail Flood GIS Model (Model Version 107)" by Transport for NSW, June 2017)

To avoid this over-estimation of flood levels and provide more accurate flood levels to inform flood risk and flood planning level requirements, an overland flow assessment was undertaken. The overland flow assessment utilises flow rates from the TuFLOW flood model and applies the Manning's equation to a location specific cross section extracted from the detailed site topographical survey. Key locations were identified for assessment, such as at the basement car park ramp entrance. The assessment was completed for the 1% AEP and PMF critical durations.

Figure 8 provides a plan of the assessed cross section locations. Table 2 summarises the 1% AEP and PMF peak flood levels at each cross section location. Detailed results for each cross section is included in Appendix A.

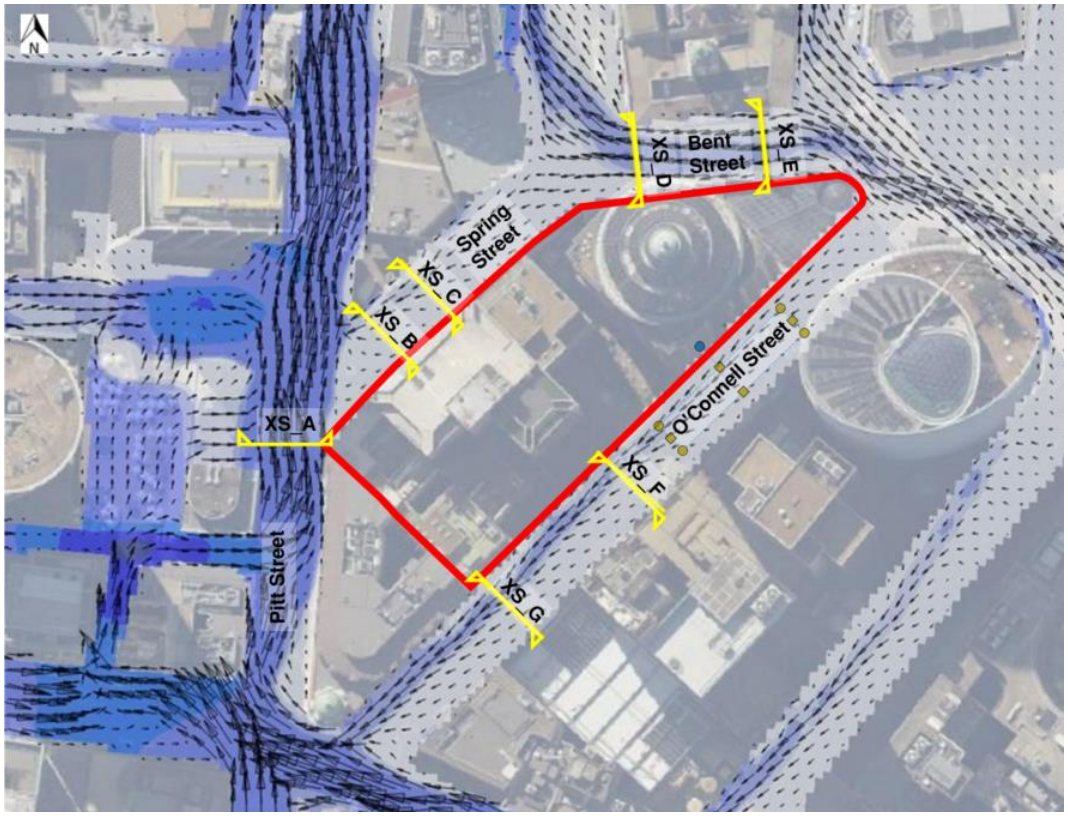


Figure 8 – Cross Section Location Plan

Section	1% AEP		PMF	
	Flow (m^3/s)	Peak Flood Level (mAHD)	Flow (m^3/s)	Peak Flood Level (mAHD)
A	13.73	7.874	66.55	8.214
B	0.27	7.801	2.26	7.912
C	0.22	8.171	2.14	8.324
D	1.40	10.116	5.27	10.218
E	1.08	12.985	4.77	13.071
F	0.39	13.402	1.46	13.475
G	0.59	12.081	2.13	12.164

Table 3 – Summary of Flood Level Results at Key Cross Section Locations

Typically, the road cross sections for Spring Street and Bent Street are such that the nearside kerb and gutter to the Site is elevated higher than the opposite side. Therefore, the overland flow is concentrated in the opposite kerb and gutter. Figure 9 illustrates this scenario at cross-section C for the PMF event. As a result, most of the site to these frontages are not subject to PMF Flooding. The exception to this scenario is at the intersection between Spring Street and Pitt Street where the significant flows in Pitt Street result in the Site being subjected to flooding in both the 1% AEP and PMF events. The

results of the overland flow assessment for the 1% AEP and PMF events are indicated Figure 10 and Figure 11, respectively.

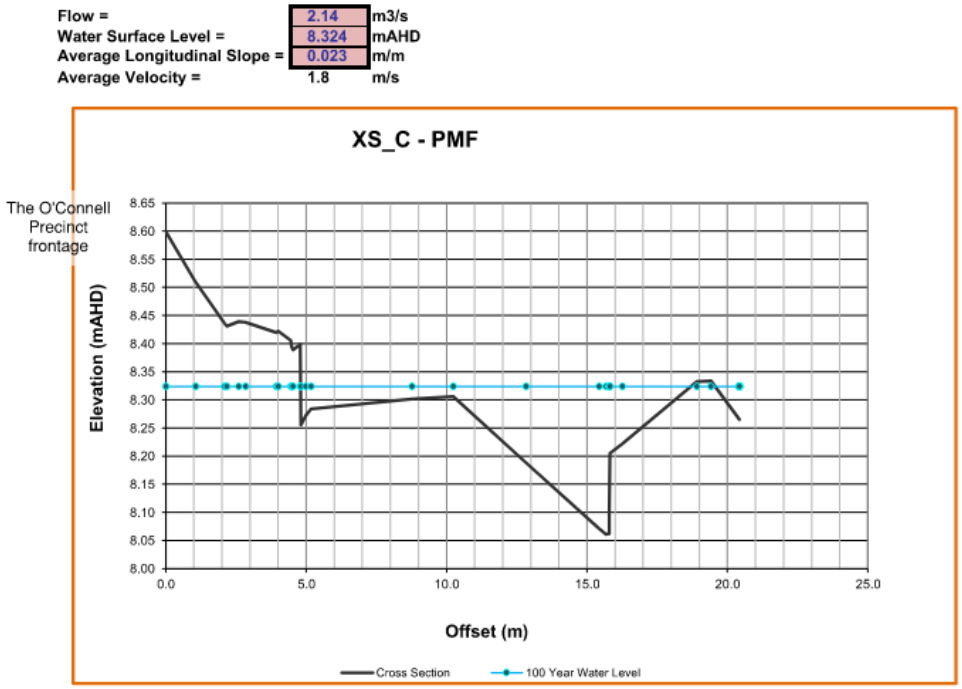


Figure 9 – Cross Section C Overland Flow Assessment, Peak PMF Flow

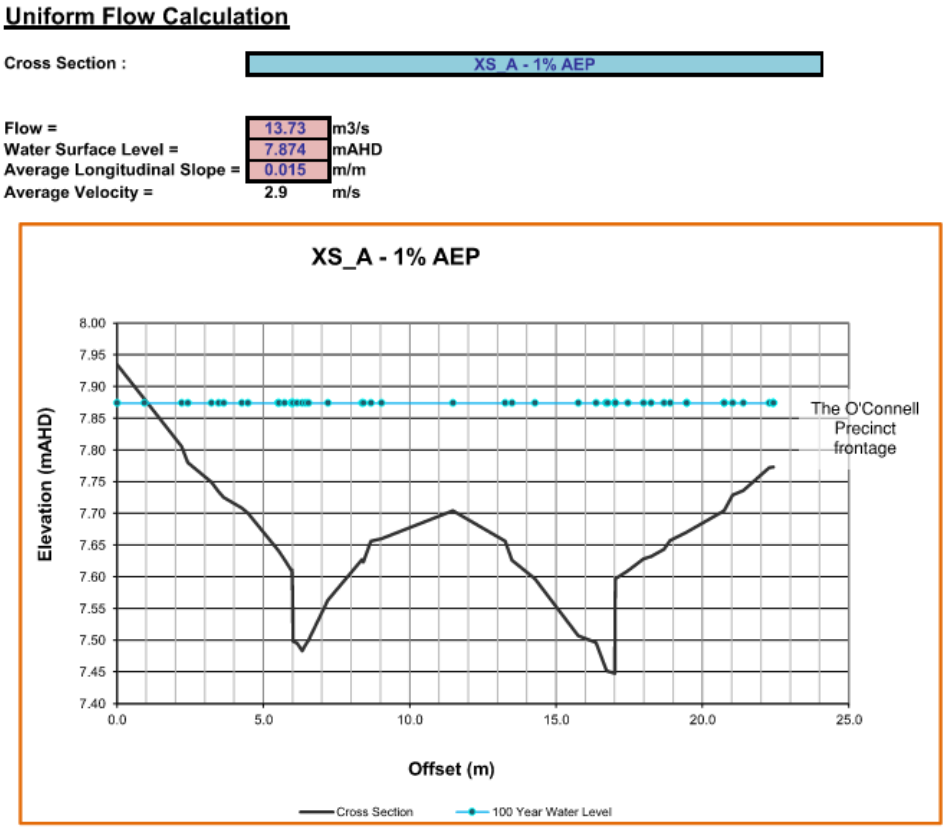


Figure 10 – Cross Section A Overland Flow Assessment, Peak 1% AEP Flow

Uniform Flow Calculation

Cross Section :	XS_A - PMF	
Flow =	66.55	m3/s
Water Surface Level =	8.214	mAHD
Average Longitudinal Slope =	0.015	m/m
Average Velocity =	5.4	m/s

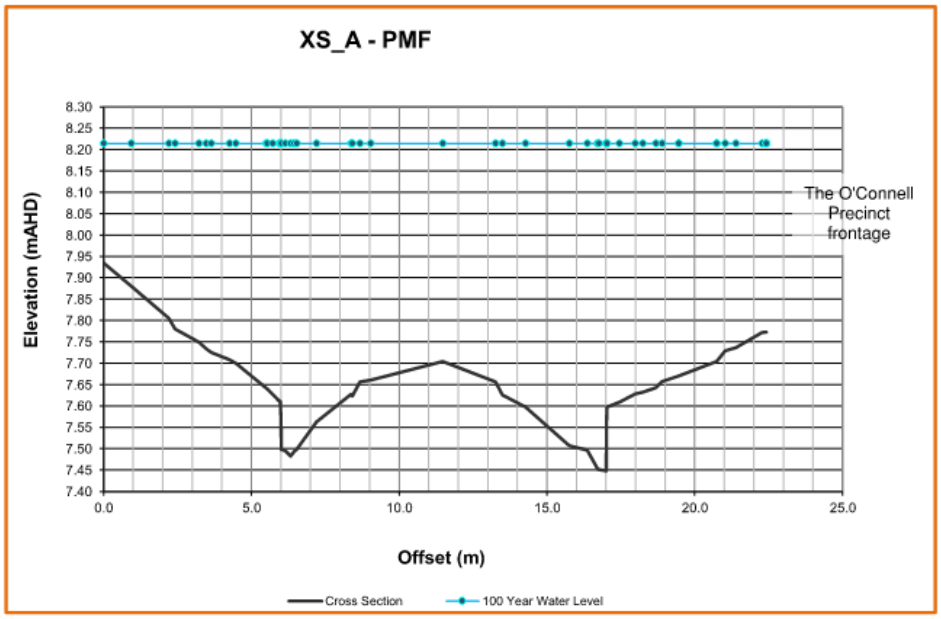


Figure 11 – Cross Section A Overland Flow Assessment, Peak PMF Flow

Typically, the road cross section for O'Connell Street is such that the nearside kerb and gutter to the Site is lower in elevation than the opposite side. Therefore, the overland flow is concentrated in the nearside kerb and gutter. Figure 12 illustrates this scenario at cross section G for the PMF event. The overland flow assessment indicates that the site is subject to flooding in the PMF event at locations F and G.

Uniform Flow Calculation

Cross Section :	XS_G - PMF	
Flow =	2.13	m3/s
Water Surface Level =	12.164	mAHD
Average Longitudinal Slope =	0.030	m/m
Average Velocity =	2.6	m/s

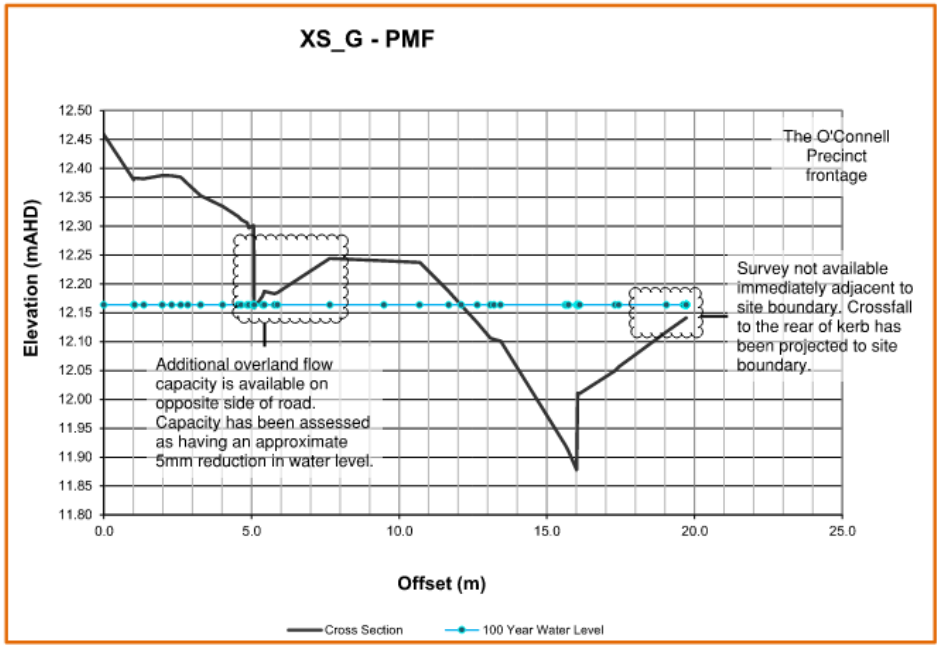


Figure 12 – Cross Section G Overland Flow Assessment, Peak PMF Flow

The existing flood hazard was assessed based upon the *"Sydney Light Rail Flood GIS Model (Model Version 107)"* by Transport for NSW dated June 2017. Results of the 1% AEP provisional flood hazard are indicated in Figure 13.

Provisional hydraulic hazard has been determined in the flood study using Figures L1 and L2 of the NSW Government *"Floodplain Development Manual"*. The flood hazard categorisation is based upon the depth and velocity of flooding. An extract of the categories is provided in Figure 14.

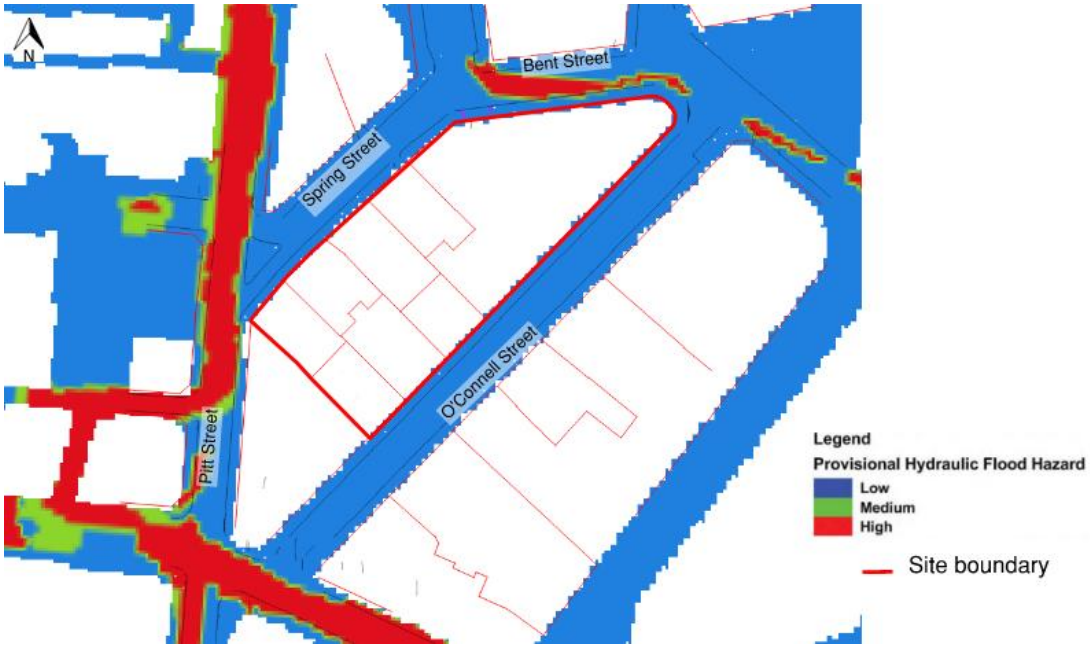


Figure 13 – Provisional Hydraulic Hazard 1% AEP (100 yr ARI) ("City Area Catchment Flood Study", BMT, October 2014)

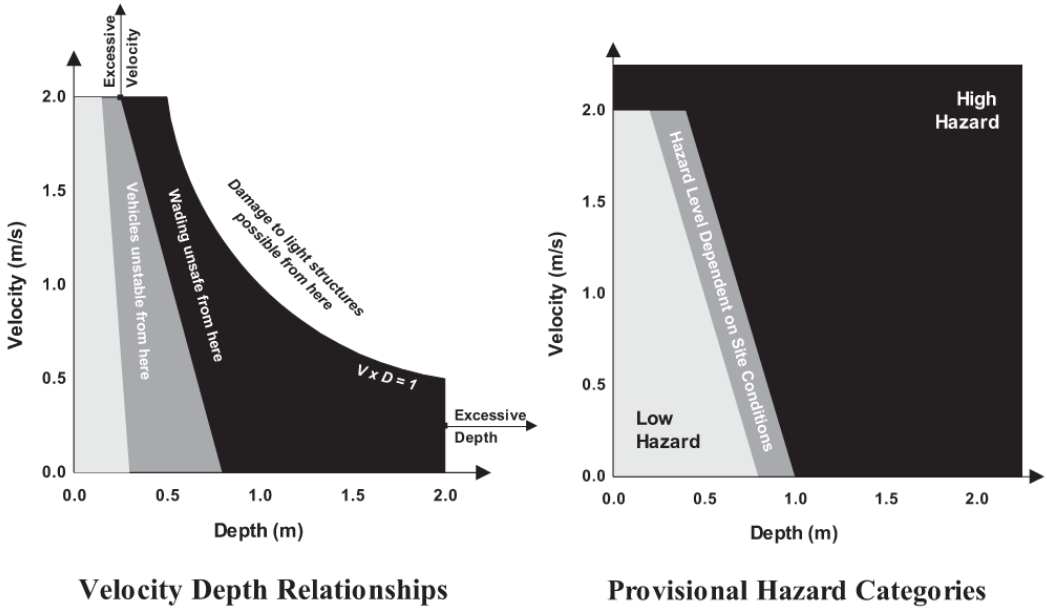


Figure 14 – Provisional Flood Hazard Categorisation (Source: "City Area Catchment Flood Study", BMT, October 2014)

For the 1% AEP flood event the following is noted:

- Extensive high hazard flooding is identified in Pitt street; and
- High hazard is identified in Bent Street.

5. Desktop Flood Review Findings

The desktop flood review includes an assessment of flood immunity of the Site and impacts on existing flooding resulting from the Planning Proposal. It is recognised that this is a desktop assessment only and is limited by the accuracy of the available information. More detailed site analysis will be required in future design stages to confirm the advice contained within this report.

5.1 Flood Immunity

5.1.1 Summary of Applied Flood Planning Level Requirements

Section 3 outlined the various flooding legislation and guidelines. This included identifying the FPL requirements which was summarised in Table 1. The requirements for buildings with basements varied depending on the existing flood condition. Specifically, the requirements varied depending upon whether a site is subject to mainstream or local drainage flooding (i.e. within the floodplain) or outside the floodplain. The CoS's *"Interim Floodplain Management Policy"* May 2014 identifies a floodplain as an *"the area of land which is subject to inundation by floods up to and including the probable maximum flood (PMF) event"*. Due to the variability of flood depths across the precinct, some street frontages would be considered within the floodplain and subject to one set of criteria whilst other street frontages would be considered outside the floodplain where an alternate criterion applies. For the purposes of determining FPLs, buildings frontages have been considered outside the floodplain where:

a) a PMF flood depth <250mm (on the basis that depths of 250mm would be contained within a typical road corridor consisting of 150mm high kerb and footpath crossfall of 2.5%); or

b) where the more detailed overland flow cross section analysis (included in Section 4.4.1) indicated a flood extent did not encroach to the site boundary.

A summary of floodplain classification according to location is provided in Table 4 and Figure 15.

Table 4 – Floodplain classification according to location

Location (Building Frontage)	Located within the Existing Floodplain	Located outside the Existing Floodplain
Spring Street – South/ west	✓	
Spring Street – North/ east		✓
Bent Street – West (adjacent to loading dock entry)		✓
Bent Street – East		✓
O'Connell Street – South/ west	✓	
O'Connell Street – North/ east		✓

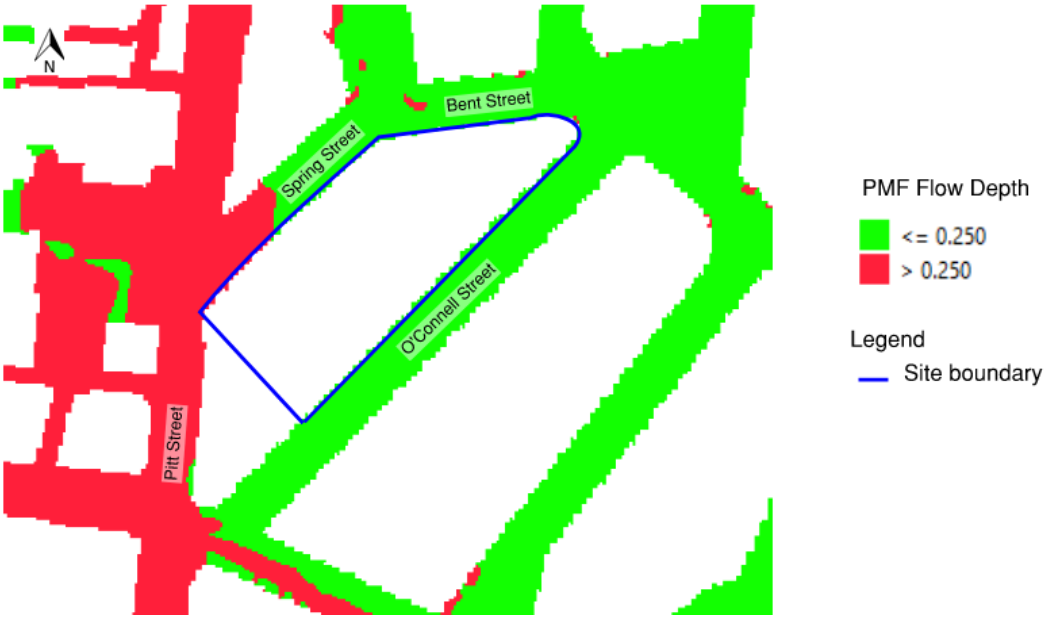


Figure 15 – Floodplain classification according to Peak Flood Depth Probable Maximum Flood (PMF) ("*Sydney Light Rail Flood GIS Model* (Model Version 107)" by Transport for NSW, June 2017)

A summary of the applicable FPLs according to location (within or outside the floodplain) is provided in Table 5.

Table 5 – Application of FPL requirements

Development	Flood Planning Level	Located within the Existing Floodplain	Located outside the Existing Floodplain
Industrial or commercial, business - subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level	✓	✓
Industrial or commercial, retail floor levels - subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.	✓	✓
Below-ground car park* - outside floodplain	0.3m above the surrounding surface		✓
Below-ground car park* - subject to mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is the higher)	✓	
Critical Facilities – Floor Level - Mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is the higher)	✓	✓

Development	Flood Planning Level	Located within the Existing Floodplain	Located outside the Existing Floodplain
Critical Facilities – Access to and from critical facility within development site - Mainstream or local drainage flooding	1% AEP flood level	✓	✓

5.1.2 Broad Design Principles

The below is a summary of the broad design principles to be considered in design in relation to FPL requirements. These are considered broad in the absence of detailed site-specific flood modelling which will be required in future detailed design stages. This assessment has been undertaken based upon the existing site conditions and flood depths. There is potential that proposed alterations to footpath grading adjacent to the Site will alter flood depths which will need to be assessed through updates to the existing flood model. Therefore, the advice contained in this assessment is based upon existing flood information.

5.1.2.1 Ground Floor Development

Industrial and commercial ground floor levels including business and retail tenancies will be assessed based upon merits with a minimum FPL of the 1% AEP. The existing 1% AEP flood depth is typically <100mm flood depth. It is anticipated that maintaining a flow path for the 1% AEP can reasonably be achieved within the road corridor by providing a typical footpath crossfall which provides 1:40 falls away from door thresholds and a 150mm high kerb. The exception to this scenario is at the south/ west end of Spring Street (adjacent to Pitt Street) where the 1% AEP flood level of 7.874mAHD sits higher than the level at the site boundary of 7.75mAHD. Minor elevation of the ground flood levels will be required to achieve FPL compliance at this location for business and retail tenancies.

5.1.2.2 Basements/ Below-ground Facilities

The requirements for basements and below ground facilities depend on whether the location is within or outside of the floodplain. These locations are identified in Table 4. The requirements are defined in the following sections.

Locations outside the Floodplain

Locations outside the floodplain require a minimum FPL of 300mm above surrounding ground levels. Surrounding ground level of a typical road cross section is generally considered to be the adjacent gutter invert level. A summary of the estimated FPL at each of the locations identified outside the floodplain is provided in Table 6.

Table 6 – Summary of Minimum FPL Requirements Outside the Floodplain

Location	Estimated Existing Ground Level (mAHD)* – source: Survey by Rygate dated 10/06/2020)	Flood Planning Level (mAHD) – 300mm above surrounding ground level
3 – Spring Street (north)	8.72	9.02
4A – Bent Street	9.70	10.00
4B – Bent Street	10.28	10.58
5 – Bent Street	11.60	11.90
6 – Bent Street	12.98	13.28
7 – O'Connell Street	15.35	15.65
8 – O'Connell Street	15.26	15.56
9 – O'Connell Street	14.12	14.42
XS_B – Spring Street	7.940	8.24
XS_C – Spring Street	8.255	8.555
XS_E – Bent Street	10.255	10.555
XS_D – Spring Street	12.885	13.185

* Existing ground level has been provided at the kerb alignment (gutter invert) located perpendicular to key reference locations

Depending upon the corridor, this can in many instances be achieved through the kerb height and typical footpath crossfalls. In constrained locations (narrow road corridors or those with one-way crossfalls) the following measures may need to be considered during detailed design:

1. Increased kerb height. There is precedence within the CoS for increasing kerb heights from 150mm to 180mm;
2. Increasing footpath crossfalls from 2.5% to 3%; and/or
3. Introduce threshold ramps internal to buildings.

Locations within the Existing Floodplain

Locations within the floodplain require a minimum FPL of the 1% AEP + 0.5m or the PMF, whichever greater. For locations deemed within the floodplain (as identified in Table 4), the peak flood depths and levels for the 1% AEP and PMF flood events are provided in Table 7. The table also provides the minimum flood planning level requirements for basement thresholds.

Table 7 – Summary of Minimum FPL Requirements for Basement thresholds within the Floodplain

Location	Existing Ground Level at boundary (mAHD) – source: Survey by Rygate dated 10/06/2020)	1% AEP Peak Flood Level (mAHD)	PMF Peak Flood Level (mAHD)	1% AEP Peak Flood Level (mAHD) + 0.5m	Min. FPL*
A – Spring Street (south)	7.773	7.874	8.214	8.374	8.374
F – O'Connell Street (mid-block)	13.457	13.402	13.475	13.902	13.902
G – O'Connell Street (South)	12.141	12.081	12.164	12.581	12.581

* 1% AEP peak flood level + 0.5m or PMF peak flood level (whichever greater)

Noting the difference between the minimum FPL and existing ground level at the site boundary ranges between 440 and 600mm; compliance with these minimum FPLs will likely be challenging whilst maintaining street level activation in an accessible and equitable manner. A kerb and gutter and typical footpath crossfall grade will not achieve compliance within the width of a typical road corridor. Alternate solution/s should be considered if future design stages. For example, the overland flow depth in O'Connell Street (as assessed at location G) has an estimated depth of 203mm and 286mm in the 1% AEP and PMF events, respectively. The required flood planning level would be 703mm above the adjacent gutter invert level based upon the 1% AEP flood depth + 0.5m. This FPL achieves 417mm freeboard in the PMF event which is considerably higher than the actual PMF flow depth of 286mm. Consideration should be made for a more suitable freeboard reflective of the risks based upon the limited contributing catchment area and shallow flows whilst balancing the benefits of an activated, accessible and inclusive public domain. This may include consideration of a FPL equivalent to the PMF level or 300mm above surrounding ground levels.

5.1.2.3 Critical Facilities

Critical facilities are defined in the CoS's *"Interim Floodplain Management Policy"* to include "hospitals and ancillary services, communication centres, police, fire SES, major transport facilities, sewerage and electricity plants; any installations containing critical infrastructure control equipment and any operational centres for use in a flood".

The Precinct includes provision for a private substation. It is unclear if the CoS's definition of "electricity plants" is limited to public electrical infrastructure, however for the purpose of infrastructure resilience it is recommended that the applicable basement FPL requirement for the flood classification be applied.

5.1.3 Assessment of Proposal

The flood impact assessment of the planning proposal, addresses:

1. Proposed building development;
2. Modifications to the Wintergarden; and
3. Existing retained basement vehicle entry on Bent Street.

5.1.3.1 Proposed building development

Ground floor industrial and commercial tenancies are anticipated to achieve FPL compliance through levels and grading in the road corridor (inclusive of footpath).

The key considerations for the Planning Proposal is addressing the flood planning level requirements for the basement thresholds. This being:

- 300mm above surrounding ground levels for:
    - Spring Street (excluding the western end, intersecting with Pitt Street);
    - O'Connell Street (eastern end); and
    - Bent Street.
- Greater of 1% AEP + 0.5m of PMF flood level for
    - Spring Street (western end); and
    - O'Connell Street (western end).

The above requirements do not address the options for agreeing alternate FPL requirements with the CoS.

The Reference Scheme has looked to address the above requirements through provisions identified below. Some elements of the design will require refinement during future detailed design subject to identification of location specific flood levels.

1. Fire egress stairs to basement levels, rising to meet FPL requirements prior to descending to the basement levels;
2. Restricting ground floor lift access at locations within flood affected areas;
3. Internal site grading/ ramping to achieve minimum FPL requirements and crested thresholds;

5.1.3.2 Modifications to the Wintergarden

The proposed Wintergarden is within the footprint of the existing building. Therefore, the planning proposal is not anticipated to have an impact on existing overland flow paths, reduce floodplain storage or to have an adverse flood impact.

5.1.3.3 Existing retained basement vehicle entry on Bent Street.

The existing basement entrance is located on Bent Street, opposite Gresham Street. The current entrance is a two-lane wide entrance, with a small pedestrian walkway on the side of the entrance. It is understood that the existing façade is heritage listed. The current arrangement of the entrance is shown in Figure 16.

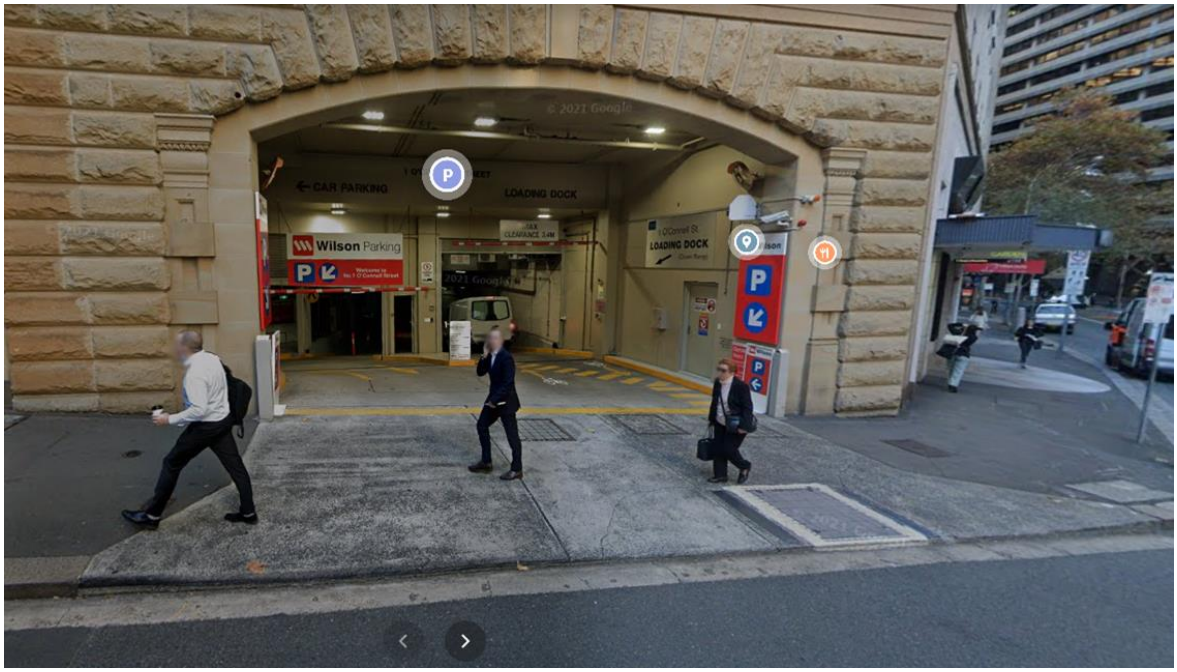


Figure 16 – Existing Bent Street Basement Car Park Entrance (Source: Google Streetview, 23 March 2022)

Our understanding is that the existing car park entrance opening, including its current width and threshold level, will be maintained in the proposed case, due to the heritage identification. However, it is likely that the vehicle crossover and footpath finishes will be upgraded on conjunction with public domain works (if required) to tie-in with existing road levels and boundary levels. Therefore, any resulting changes to finished levels would be considered minor and no worsening of existing flooding conditions are anticipated as a result of the planning proposal.

A section through the road corridor adjacent to the car park entrance was considered in the overland flow assessment at Location D indicated in Figure 8. This cross section and the PMF flow depths are provided in Figure 17.

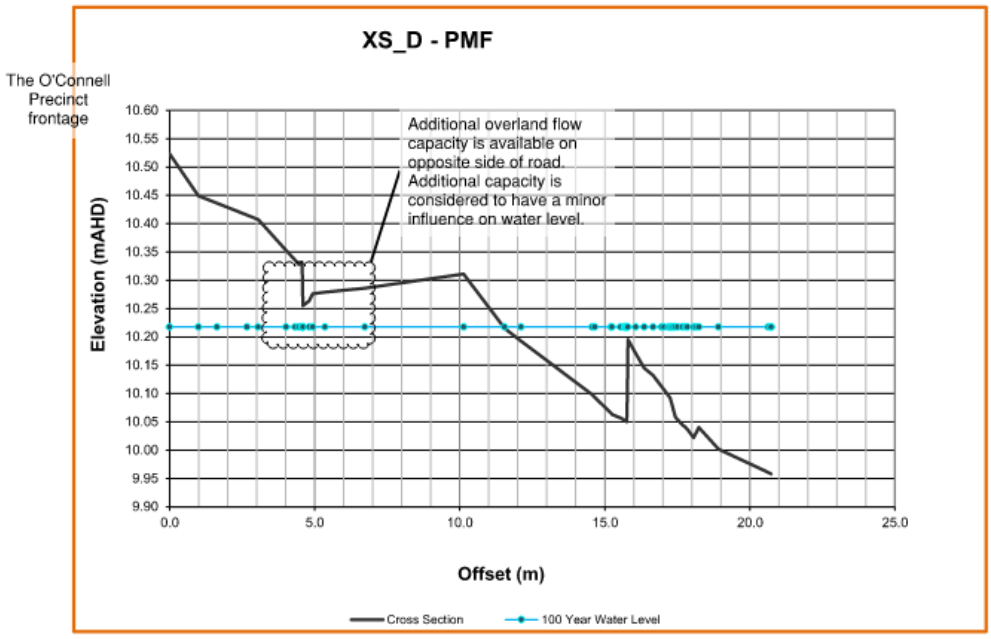


Figure 17 – Cross Section D Overland Flow Assessment, Peak PMF Flow

The cross section indicates a crowned road and that the kerb and gutter on the opposite side of Bent Street (north side) is at a lower elevation than the nearside (south side). Furthermore, Gresham Street, which is directly opposite the car park entrance has a gradient to the north. The PMF overland flow does not encroach the site boundary. Therefore, the basement vehicle entrance is considered outside the PMF floodplain extent. On this basis, the City of Sydney's *"Interim Floodplain Management Policy"* May 2014 indicates a Flood Planning Level (FPL) requirement of 0.3m above the surrounding surface (typically taken as the nearside gutter invert). The current cross section achieves a boundary level approximately 265mm above gutter invert level; indicating that FPL compliance is not achieved. Alternative solutions should be considered in future design stages.

5.2 Flood Impact Assessment

As discussed in Section 5.1, the CoS LEP does not permit development which significantly adversely affects flood behaviour resulting in detrimental increases in the potential flood affectation of other developments or properties.

The planning proposal is limited to the site boundary with potential for minor adjustment to footpath levels/ grading adjacent to the site boundary during refurbishment of the immediate public domain. Therefore, no adverse flood impact is anticipated as result of the development.

6. Limitations of Desktop Flood Assessment

The limitations of the desktop flood review are as follows:

- This assessment informs the preliminary FPL requirements for Architectural planning proposal (The Reference Scheme). This scheme indicates limited flood levels at nominated locations. Therefore, a more detailed analysis is required in future design stages to confirm flood planning requirements at each door/ egress location.
- Flood modelling/assessment of the site has not been undertaken as part of this review. This assessment has been based upon the existing flood conditions only. Detailed flood modelling and assessment of results will be required in subsequent design stages to capture detailed site survey and any proposed alterations to the adjacent public domain.
- It has been identified in this desktop flood assessment that there are inconsistencies between the LiDAR surface utilised in the TuFLOW model and the site-specific topographical survey. These inconsistencies have potential to provide misleading results. Therefore it is recommended that in future detailed design stages that a site specific flood assessment be undertaken to confirm the results and flood planning requirements presented in this report.
- The assessment has not considered The City North Public Domain Plan which is currently for public exhibition. The potential for changes to the existing flooding will need to be addressed through the detailed design of the public domain works. It would be anticipated that this future design work would look to mitigate against flooding risks and impacts as a result of the planned public domain works.

Appendix A

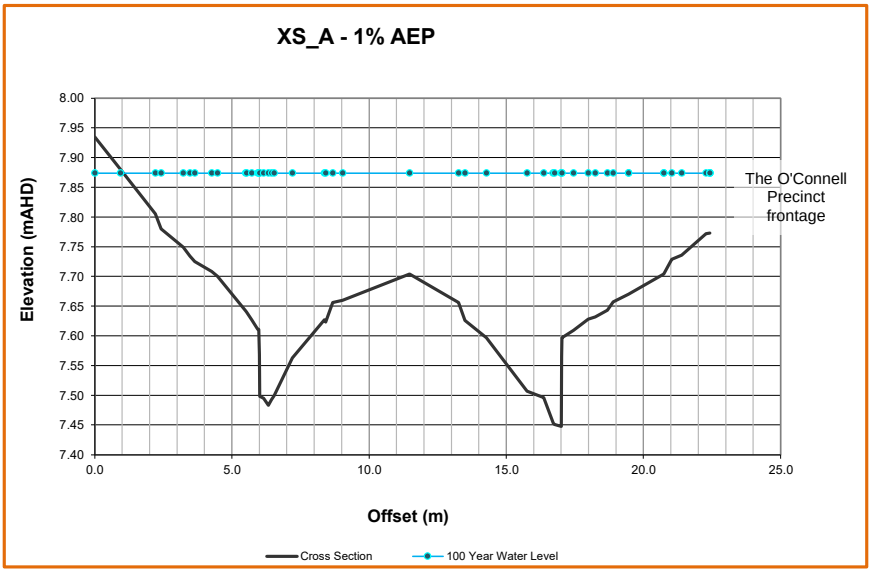
Cross Section Peak Flood Level Calculations, 1% AEP and PMF

ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_A - 1% AEP

Flow =	13.73	m3/s
Water Surface Level =	7.874	mAHD
Average Longitudinal Slope =	0.015	m/m
Average Velocity =	2.9	m/s



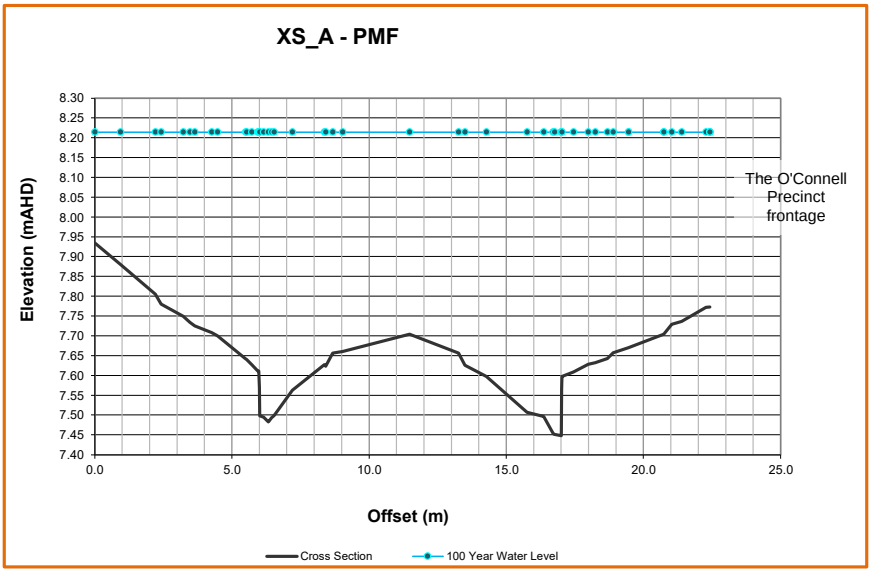
Offset	Elevation (mAHD)	Manning's n
0.00	7.935	0.015
0.94	7.880	0.015
2.21	7.805	0.015
2.42	7.780	0.015
3.22	7.749	0.015
3.47	7.734	0.015
3.64	7.725	0.015
4.27	7.708	0.015
4.47	7.700	0.015
5.50	7.642	0.015
5.53	7.640	0.015
5.73	7.627	0.015
5.95	7.611	0.015
5.99	7.611	0.015
6.00	7.569	0.015
6.02	7.498	0.015
6.15	7.495	0.015
6.33	7.483	0.015
6.44	7.493	0.015
6.54	7.499	0.015
7.20	7.563	0.015
8.38	7.627	0.015
8.42	7.623	0.015
8.68	7.656	0.015
9.04	7.660	0.015
11.48	7.704	0.015
13.26	7.656	0.015
13.49	7.626	0.015
14.27	7.597	0.015
15.76	7.507	0.015
16.37	7.496	0.015
16.71	7.453	0.015
16.77	7.451	0.015
17.00	7.448	0.015
17.02	7.565	0.015
17.03	7.597	0.015
17.45	7.609	0.015
17.99	7.628	0.015
18.25	7.632	0.015
18.68	7.643	0.015
18.90	7.657	0.015
19.46	7.670	0.015
19.46	7.670	0.015
20.74	7.704	0.015
20.74	7.704	0.015
21.03	7.729	0.015
21.39	7.736	0.015
22.28	7.772	0.015
22.42	7.773	0.015

ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_A - PMF

Flow =	66.55	m3/s
Water Surface Level =	8.214	mAHD
Average Longitudinal Slope =	0.015	m/m
Average Velocity =	5.4	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	7.935	0.015
0.94	7.880	0.015
2.21	7.805	0.015
2.42	7.780	0.015
3.22	7.749	0.015
3.47	7.734	0.015
3.64	7.725	0.015
4.27	7.708	0.015
4.47	7.700	0.015
5.50	7.642	0.015
5.53	7.640	0.015
5.73	7.627	0.015
5.95	7.611	0.015
5.99	7.611	0.015
6.00	7.569	0.015
6.02	7.498	0.015
6.15	7.495	0.015
6.33	7.483	0.015
6.44	7.493	0.015
6.54	7.499	0.015
7.20	7.563	0.015
8.38	7.627	0.015
8.42	7.623	0.015
8.68	7.656	0.015
9.04	7.660	0.015
11.48	7.704	0.015
13.26	7.656	0.015
13.49	7.626	0.015
14.27	7.597	0.015
15.76	7.507	0.015
16.37	7.496	0.015
16.71	7.453	0.015
16.77	7.451	0.015
17.00	7.448	0.015
17.02	7.565	0.015
17.03	7.597	0.015
17.45	7.609	0.015
17.99	7.628	0.015
18.25	7.632	0.015
18.68	7.643	0.015
18.90	7.657	0.015
19.46	7.670	0.015
19.46	7.670	0.015
20.74	7.704	0.015
20.74	7.704	0.015
21.03	7.729	0.015
21.39	7.736	0.015
22.28	7.772	0.015
22.42	7.773	0.015

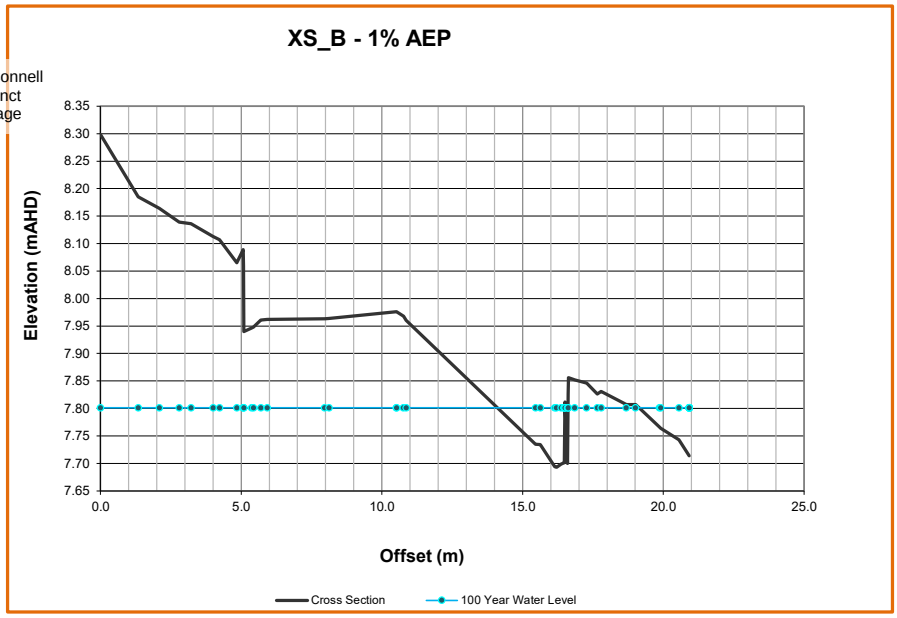
ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_B - 1% AEP

Flow =	0.27	m3/s
Water Surface Level =	7.801	mAHD
Average Longitudinal Slope =	0.021	m/m
Average Velocity =	1.3	m/s

The O'Connell Precinct frontage



Offset	Elevation (mAHD)	Manning's n
0.00	8.299	0.015
1.34	8.185	0.015
2.09	8.164	0.015
2.80	8.139	0.015
3.22	8.136	0.015
4.01	8.113	0.015
4.23	8.107	0.015
4.85	8.065	0.015
5.07	8.089	0.015
5.08	8.059	0.015
5.10	7.940	0.015
5.37	7.946	0.015
5.44	7.948	0.015
5.70	7.961	0.015
5.93	7.962	0.015
7.97	7.963	0.015
8.12	7.964	0.015
10.51	7.976	0.015
10.52	7.976	0.015
10.77	7.968	0.015
10.86	7.960	0.015
15.46	7.735	0.015
15.63	7.734	0.015
16.14	7.694	0.015
16.20	7.693	0.015
16.37	7.699	0.015
16.47	7.701	0.015
16.48	7.701	0.015
16.48	7.701	0.015
16.51	7.812	0.015
16.59	7.700	0.015
16.62	7.826	0.015
16.63	7.856	0.015
16.85	7.852	0.015
17.27	7.846	0.015
17.65	7.826	0.015
17.79	7.831	0.015
18.68	7.807	0.015
19.01	7.807	0.015
19.87	7.766	0.015
19.91	7.764	0.015
20.56	7.743	0.015
20.92	7.714	0.015

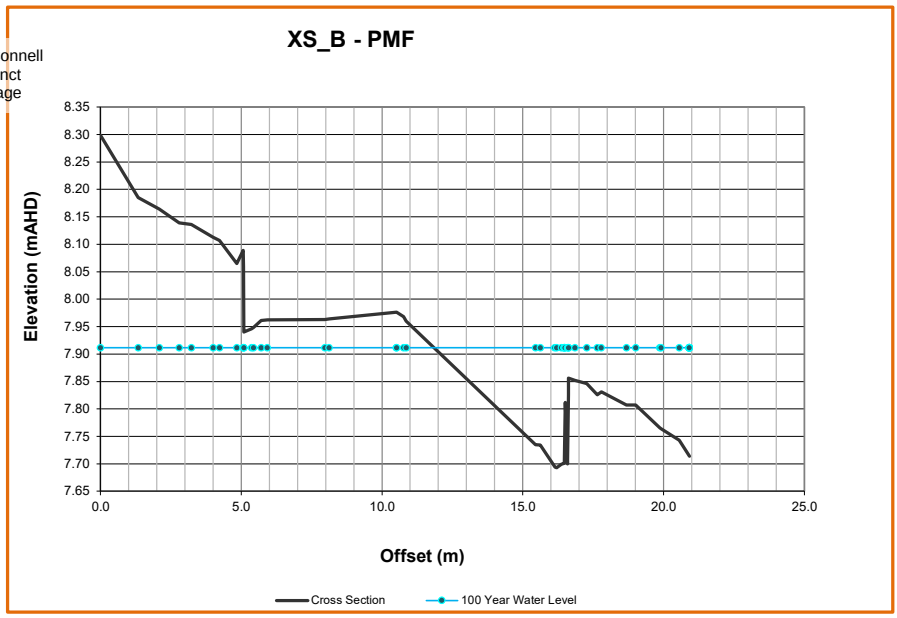
ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd. KS

Uniform Flow Calculation

Cross Section : XS_B - PMF

Flow =	2.26	m3/s
Water Surface Level =	7.912	mAHD
Average Longitudinal Slope =	0.021	m/m
Average Velocity =	2.2	m/s

The O'Connell Precinct frontage



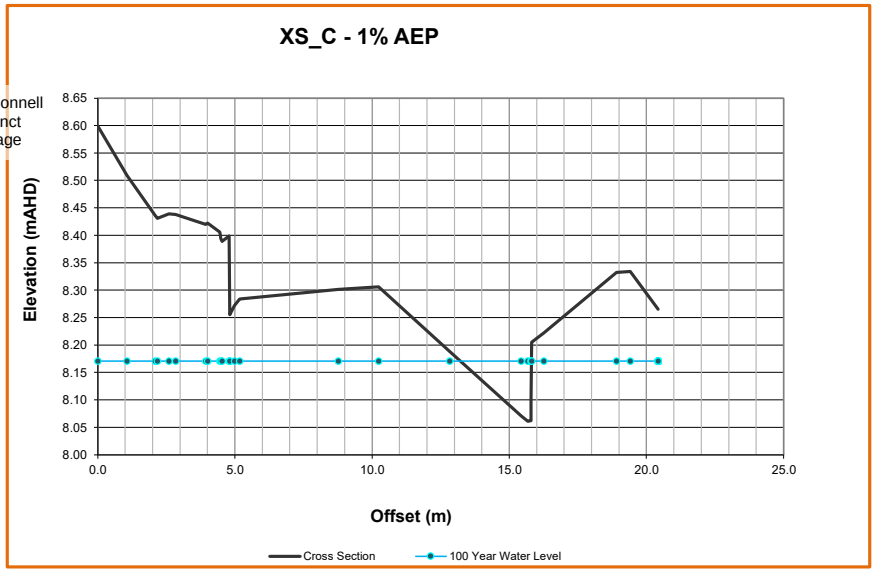
Offset	Elevation (mAHD)	Manning's n
0.00	8.299	0.015
1.34	8.185	0.015
2.09	8.164	0.015
2.80	8.139	0.015
3.22	8.136	0.015
4.01	8.113	0.015
4.23	8.107	0.015
4.85	8.065	0.015
5.07	8.089	0.015
5.08	8.059	0.015
5.10	7.940	0.015
5.37	7.946	0.015
5.44	7.948	0.015
5.70	7.961	0.015
5.93	7.962	0.015
7.97	7.963	0.015
8.12	7.964	0.015
10.51	7.976	0.015
10.52	7.976	0.015
10.77	7.968	0.015
10.86	7.960	0.015
15.46	7.735	0.015
15.63	7.734	0.015
16.14	7.694	0.015
16.20	7.693	0.015
16.37	7.699	0.015
16.47	7.701	0.015
16.48	7.701	0.015
16.48	7.701	0.015
16.51	7.812	0.015
16.59	7.700	0.015
16.62	7.826	0.015
16.63	7.856	0.015
16.85	7.852	0.015
17.27	7.846	0.015
17.65	7.826	0.015
17.79	7.831	0.015
18.68	7.807	0.015
19.01	7.807	0.015
19.87	7.766	0.015
19.91	7.764	0.015
20.56	7.743	0.015
20.92	7.714	0.015

ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_C - 1% AEP

Flow =	0.22	m3/s
Water Surface Level =	8.171	mAHD
Average Longitudinal Slope =	0.023	m/m
Average Velocity =	1.5	m/s



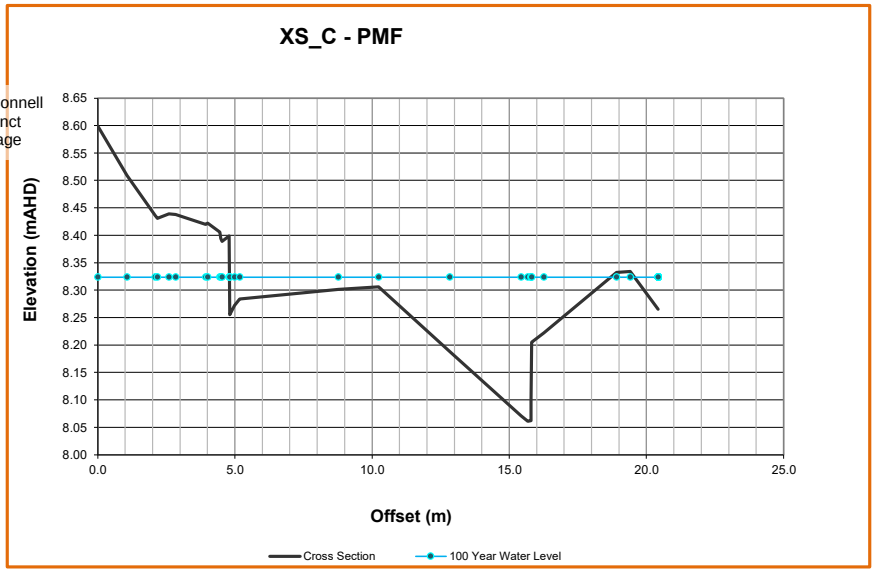
Offset	Elevation (mAHD)	Manning's n
0.00	8.599	0.015
1.07	8.509	0.015
2.09	8.436	0.015
2.17	8.431	0.015
2.59	8.439	0.015
2.84	8.438	0.015
3.93	8.420	0.015
4.01	8.422	0.015
4.45	8.406	0.015
4.49	8.394	0.015
4.53	8.389	0.015
4.79	8.399	0.015
4.80	8.330	0.015
4.82	8.255	0.015
4.98	8.272	0.015
5.17	8.284	0.015
8.77	8.301	0.015
10.24	8.306	0.015
12.83	8.188	0.015
15.44	8.071	0.015
15.68	8.061	0.015
15.79	8.062	0.015
15.80	8.098	0.015
15.81	8.205	0.015
16.26	8.222	0.015
18.91	8.332	0.015
19.41	8.334	0.015
20.43	8.265	0.015

ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_C - PMF

Flow =	2.14	m3/s
Water Surface Level =	8.324	mAHD
Average Longitudinal Slope =	0.023	m/m
Average Velocity =	1.8	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	8.599	0.015
1.07	8.509	0.015
2.09	8.436	0.015
2.17	8.431	0.015
2.59	8.439	0.015
2.84	8.438	0.015
3.93	8.420	0.015
4.01	8.422	0.015
4.45	8.406	0.015
4.49	8.394	0.015
4.53	8.389	0.015
4.79	8.399	0.015
4.80	8.330	0.015
4.82	8.255	0.015
4.98	8.272	0.015
5.17	8.284	0.015
8.77	8.301	0.015
10.24	8.306	0.015
12.83	8.188	0.015
15.44	8.071	0.015
15.68	8.061	0.015
15.79	8.062	0.015
15.80	8.098	0.015
15.81	8.205	0.015
16.26	8.222	0.015
18.91	8.332	0.015
19.41	8.334	0.015
20.43	8.265	0.015

ARUP	Job No.	Sheet No.	Rev.
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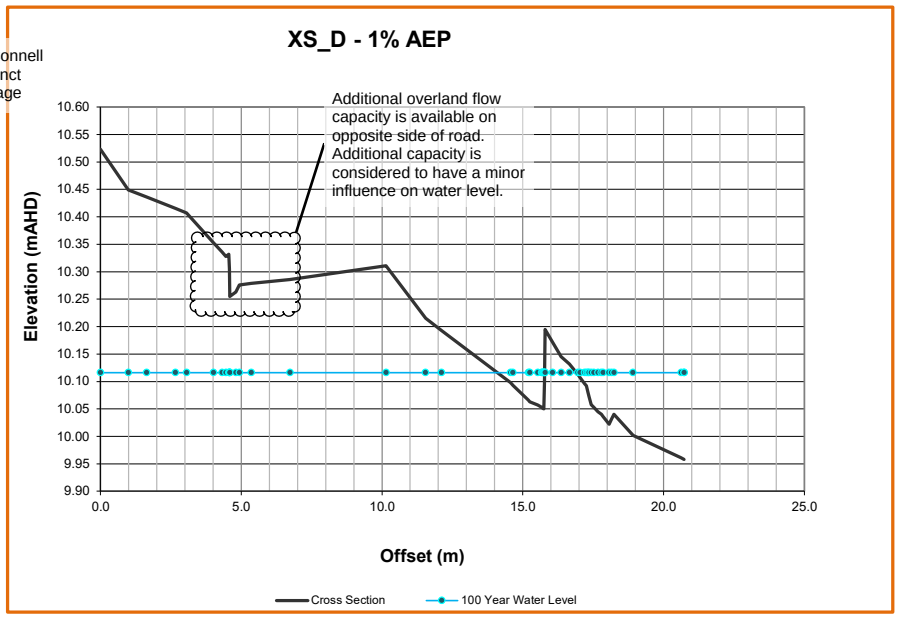
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd. KS

Uniform Flow Calculation

Cross Section : XS_D - 1% AEP

Flow =	1.40	m3/s
Water Surface Level =	10.116	mAHD
Average Longitudinal Slope =	0.065	m/m
Average Velocity =	3.2	m/s

The O'Connell Precinct frontage



Offset	Elevation (mAHD)	Manning's n
0.00	10.523	0.015
0.99	10.449	0.015
1.63	10.436	0.015
2.67	10.415	0.015
3.06	10.407	0.015
4.02	10.353	0.015
4.32	10.336	0.015
4.46	10.328	0.015
4.56	10.332	0.015
4.59	10.305	0.015
4.59	10.261	0.015
4.59	10.255	0.015
4.81	10.263	0.015
4.94	10.276	0.015
5.35	10.279	0.015
6.73	10.286	0.015
10.14	10.311	0.015
11.55	10.215	0.015
12.11	10.193	0.015
14.57	10.098	0.015
14.65	10.093	0.015
15.21	10.066	0.015
15.25	10.063	0.015
15.54	10.057	0.015
15.67	10.053	0.015
15.70	10.052	0.015
15.73	10.051	0.015
15.75	10.050	0.015
15.77	10.097	0.015
15.80	10.195	0.015
16.06	10.171	0.015
16.36	10.145	0.015
16.66	10.132	0.015
16.95	10.113	0.015
17.04	10.107	0.015
17.20	10.096	0.015
17.26	10.092	0.015
17.32	10.080	0.015
17.36	10.073	0.015
17.43	10.058	0.015
17.52	10.053	0.015
17.68	10.045	0.015
17.79	10.040	0.015
17.85	10.036	0.015
18.07	10.022	0.015
18.15	10.031	0.015
18.24	10.040	0.015
18.92	10.002	0.015
20.63	9.961	0.015
20.73	9.958	0.015

ARUP	Job No.	Sheet No.	Rev.
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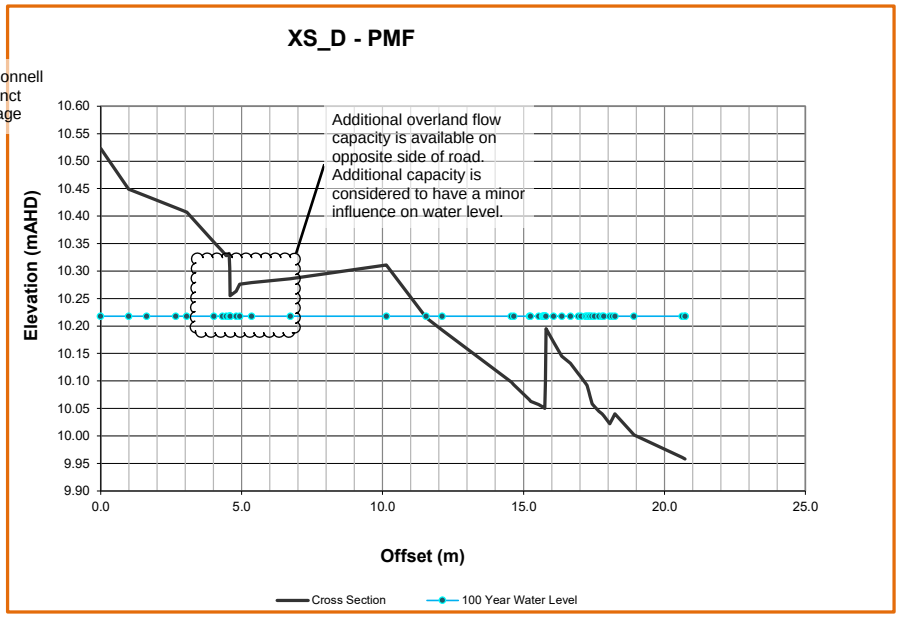
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by EB	Date 17/10/2022	Chd. KS

Uniform Flow Calculation

Cross Section : XS_D - PMF

Flow =	5.27	m3/s
Water Surface Level =	10.218	mAHD
Average Longitudinal Slope =	0.065	m/m
Average Velocity =	4.4	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	10.523	0.015
0.99	10.449	0.015
1.63	10.436	0.015
2.67	10.415	0.015
3.06	10.407	0.015
4.02	10.353	0.015
4.32	10.336	0.015
4.46	10.328	0.015
4.56	10.332	0.015
4.59	10.305	0.015
4.59	10.261	0.015
4.59	10.255	0.015
4.81	10.263	0.015
4.94	10.276	0.015
5.35	10.279	0.015
6.73	10.286	0.015
10.14	10.311	0.015
11.55	10.215	0.015
12.11	10.193	0.015
14.57	10.098	0.015
14.65	10.093	0.015
15.21	10.066	0.015
15.25	10.063	0.015
15.54	10.057	0.015
15.67	10.053	0.015
15.70	10.052	0.015
15.73	10.051	0.015
15.75	10.050	0.015
15.77	10.097	0.015
15.80	10.195	0.015
16.06	10.171	0.015
16.36	10.145	0.015
16.66	10.132	0.015
16.95	10.113	0.015
17.04	10.107	0.015
17.20	10.096	0.015
17.26	10.092	0.015
17.32	10.080	0.015
17.36	10.073	0.015
17.43	10.058	0.015
17.52	10.053	0.015
17.68	10.045	0.015
17.79	10.040	0.015
17.85	10.036	0.015
18.07	10.022	0.015
18.15	10.031	0.015
18.24	10.040	0.015
18.92	10.002	0.015
20.63	9.961	0.015
20.73	9.958	0.015

ARUP	Job No.	Sheet No.	Rev.
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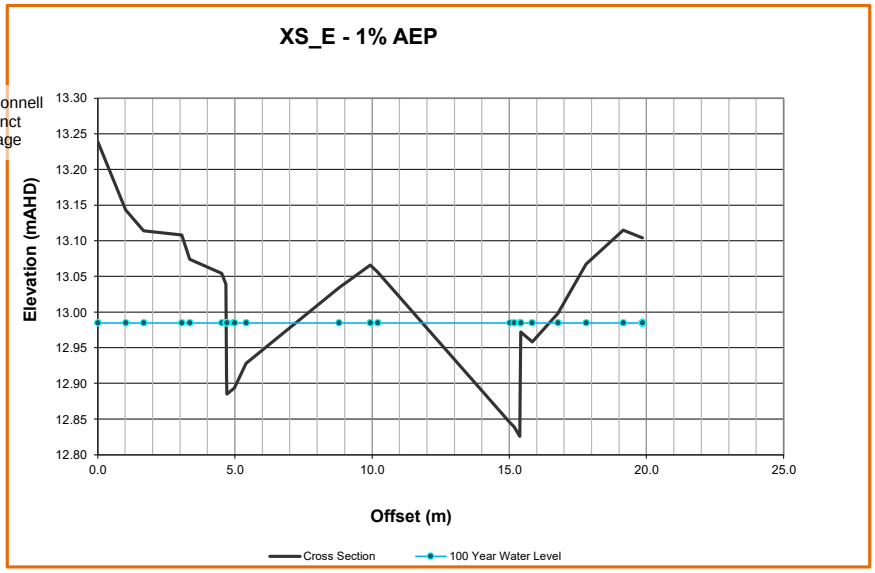
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_E - 1% AEP

Flow =	1.08	m3/s
Water Surface Level =	12.985	mAHD
Average Longitudinal Slope =	0.075	m/m
Average Velocity =	2.6	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	13.239	0.015
1.03	13.143	0.015
1.68	13.114	0.015
3.06	13.108	0.015
3.35	13.074	0.015
4.52	13.054	0.015
4.68	13.039	0.015
4.70	12.908	0.015
4.71	12.885	0.015
4.95	12.892	0.015
4.99	12.894	0.015
5.40	12.928	0.015
8.79	13.034	0.015
9.94	13.066	0.015
9.94	13.066	0.015
10.21	13.056	0.015
15.02	12.845	0.015
15.18	12.839	0.015
15.38	12.826	0.015
15.40	12.886	0.015
15.43	12.972	0.015
15.84	12.958	0.015
16.78	12.998	0.015
17.80	13.067	0.015
19.15	13.115	0.015
19.85	13.104	0.015

ARUP	Job No.	Sheet No.	Rev.
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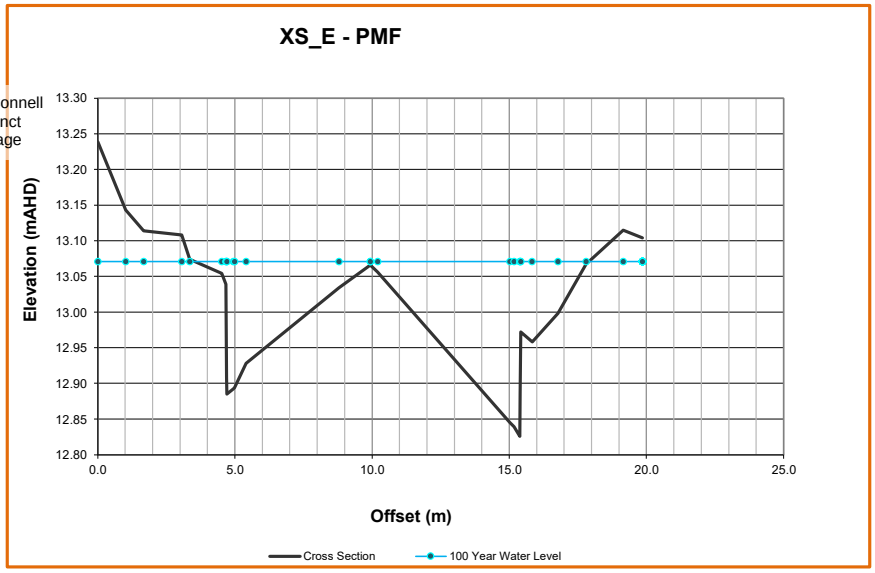
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_E - PMF

Flow =	4.77	m3/s
Water Surface Level =	13.071	mAHD
Average Longitudinal Slope =	0.075	m/m
Average Velocity =	3.6	m/s



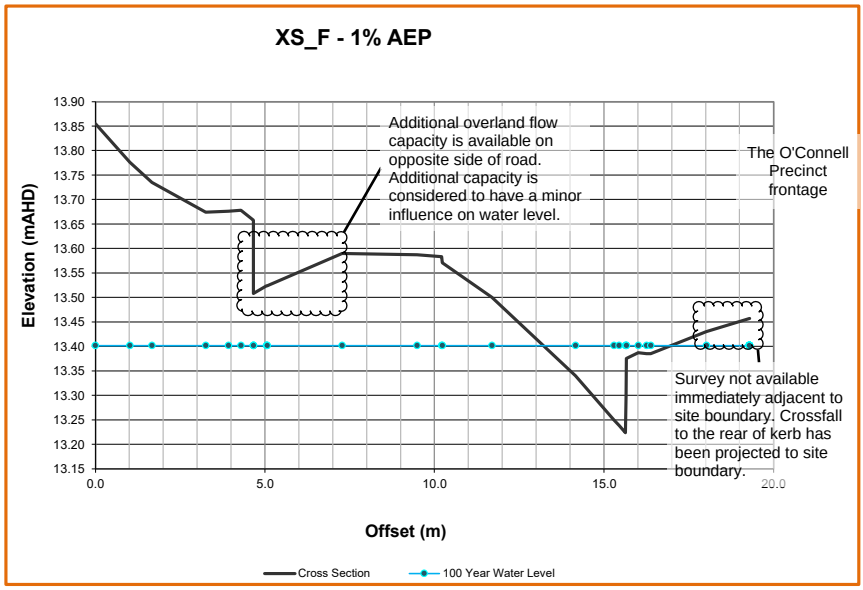
Offset	Elevation (mAHD)	Manning's n
0.00	13.239	0.015
1.03	13.143	0.015
1.68	13.114	0.015
3.06	13.108	0.015
3.35	13.074	0.015
4.52	13.054	0.015
4.68	13.039	0.015
4.70	12.908	0.015
4.71	12.885	0.015
4.95	12.892	0.015
4.99	12.894	0.015
5.40	12.928	0.015
8.79	13.034	0.015
9.94	13.066	0.015
9.94	13.066	0.015
10.21	13.056	0.015
15.02	12.845	0.015
15.18	12.839	0.015
15.38	12.826	0.015
15.40	12.886	0.015
15.43	12.972	0.015
15.84	12.958	0.015
16.78	12.998	0.015
17.80	13.067	0.015
19.15	13.115	0.015
19.85	13.104	0.015

ARUP	Job No.	Sheet No.	Rev.
	276093		A
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by EB	Date 17/10/2022	Chd KS

Uniform Flow Calculation

Cross Section : XS_F - 1% AEP

Flow =	0.39	m3/s
Water Surface Level =	13.402	mAHD
Average Longitudinal Slope =	0.029	m/m
Average Velocity =	1.7	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	13.855	0.015
1.02	13.776	0.015
1.67	13.735	0.015
3.25	13.674	0.015
3.92	13.676	0.015
4.29	13.678	0.015
4.66	13.658	0.015
4.66	13.615	0.015
4.66	13.508	0.015
5.05	13.524	0.015
5.06	13.524	0.015
5.07	13.524	0.015
7.28	13.590	0.015
9.49	13.587	0.015
10.21	13.583	0.015
10.23	13.571	0.015
11.70	13.500	0.015
14.16	13.340	0.015
15.29	13.250	0.015
15.45	13.238	0.015
15.63	13.224	0.015
15.65	13.297	0.015
15.66	13.375	0.015
16.01	13.387	0.015
16.26	13.385	0.015
16.38	13.385	0.015
18.02	13.430	0.015
19.29	13.457	0.015

ARUP	Job No.	Sheet No.	Rev.
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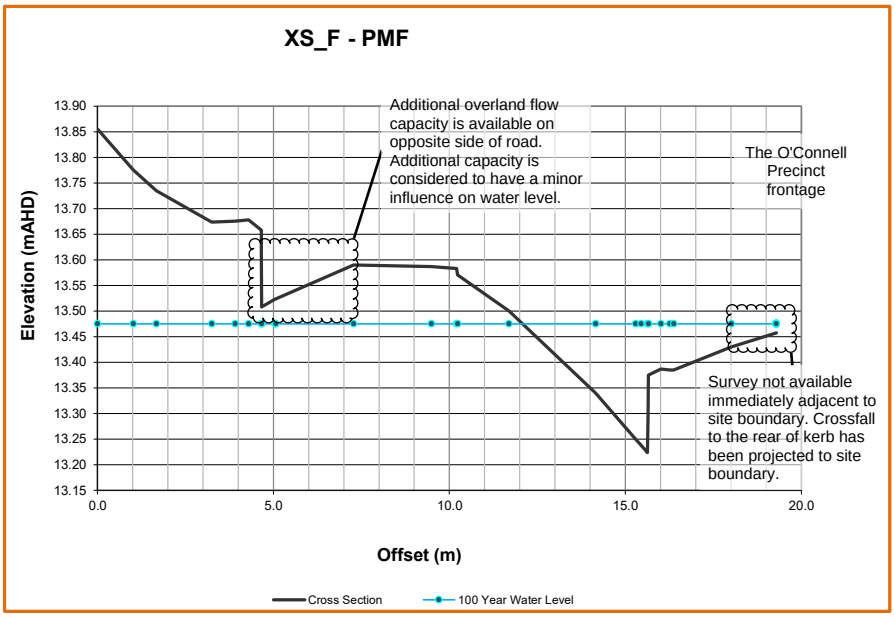
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_F - PMF

Flow =	1.46	m3/s
Water Surface Level =	13.475	mAHD
Average Longitudinal Slope =	0.029	m/m
Average Velocity =	2.3	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	13.855	0.015
1.02	13.776	0.015
1.67	13.735	0.015
3.25	13.674	0.015
3.92	13.676	0.015
4.29	13.678	0.015
4.66	13.658	0.015
4.66	13.615	0.015
4.66	13.508	0.015
5.05	13.524	0.015
5.06	13.524	0.015
5.07	13.524	0.015
7.28	13.590	0.015
9.49	13.587	0.015
10.21	13.583	0.015
10.23	13.571	0.015
11.70	13.500	0.015
14.16	13.340	0.015
15.29	13.250	0.015
15.45	13.238	0.015
15.63	13.224	0.015
15.65	13.297	0.015
15.66	13.375	0.015
16.01	13.387	0.015
16.26	13.385	0.015
16.38	13.385	0.015
18.02	13.430	0.015
19.29	13.457	0.015

ARUP	Job No.	Sheet No.	Rev.
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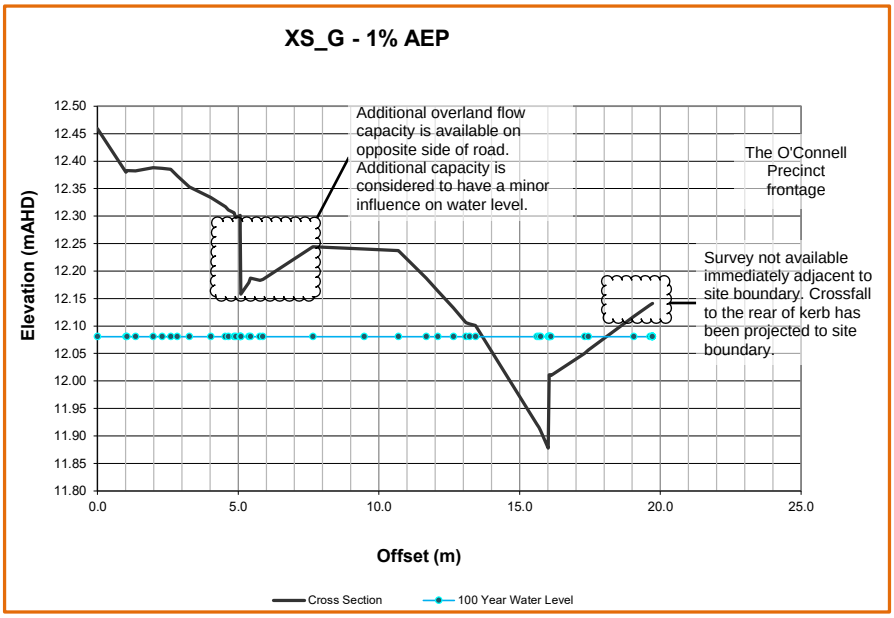
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_G - 1% AEP

Flow =	0.59	m3/s
Water Surface Level =	12.081	mAHD
Average Longitudinal Slope =	0.030	m/m
Average Velocity =	1.9	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	12.459	0.015
1.01	12.380	0.015
1.04	12.383	0.015
1.36	12.382	0.015
1.98	12.388	0.015
2.30	12.387	0.015
2.61	12.385	0.015
2.84	12.373	0.015
3.27	12.353	0.015
4.02	12.334	0.015
4.54	12.317	0.015
4.66	12.311	0.015
4.86	12.306	0.015
4.91	12.297	0.015
5.07	12.301	0.015
5.08	12.275	0.015
5.10	12.158	0.015
5.38	12.179	0.015
5.44	12.187	0.015
5.77	12.183	0.015
5.88	12.185	0.015
7.65	12.244	0.015
9.48	12.240	0.015
10.69	12.237	0.015
11.68	12.187	0.015
12.10	12.163	0.015
12.65	12.133	0.015
13.09	12.106	0.015
13.22	12.104	0.015
13.44	12.101	0.015
15.62	11.921	0.015
15.68	11.916	0.015
15.74	11.910	0.015
16.02	11.878	0.015
16.04	12.005	0.015
16.05	12.011	0.015
16.08	12.011	0.015
16.11	12.010	0.015
17.31	12.050	0.015
17.44	12.056	0.015
19.05	12.117	0.015
19.63	12.138	0.015
19.72	12.141	0.015

ARUP	Job No.	Sheet No.	Rev.
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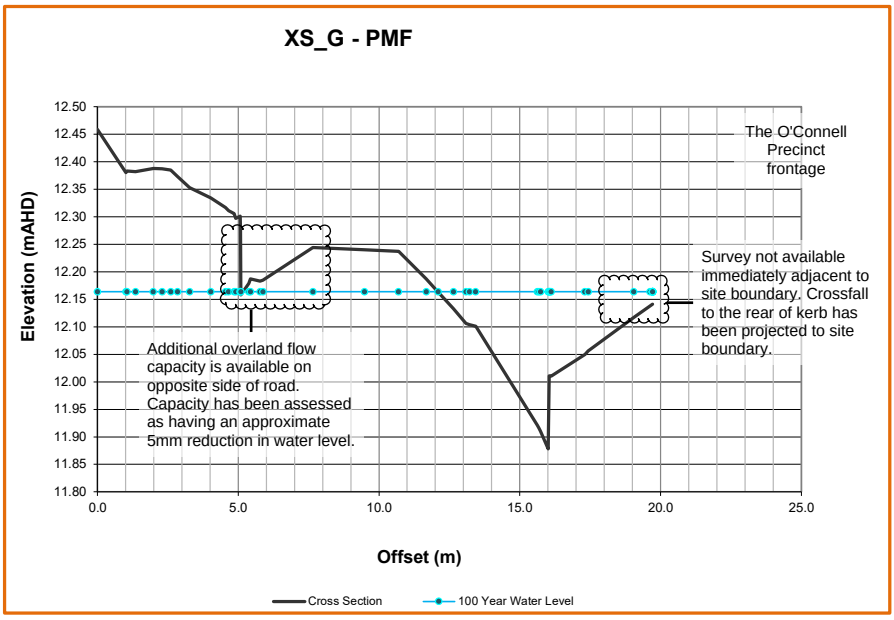
	Member/Location	Sydney	
Job Title: The O'Connell Precinct	Drg. Ref.		
Calculation	Made by: EB	Date: 17/10/2022	Chd.: KS

Uniform Flow Calculation

Cross Section : XS_G - PMF

Flow =	2.13	m3/s
Water Surface Level =	12.164	mAHD
Average Longitudinal Slope =	0.030	m/m
Average Velocity =	2.6	m/s



Offset	Elevation (mAHD)	Manning's n
0.00	12.459	0.015
1.01	12.380	0.015
1.04	12.383	0.015
1.36	12.382	0.015
1.98	12.388	0.015
2.30	12.387	0.015
2.61	12.385	0.015
2.84	12.373	0.015
3.27	12.353	0.015
4.02	12.334	0.015
4.54	12.317	0.015
4.66	12.311	0.015
4.86	12.306	0.015
4.91	12.297	0.015
5.07	12.301	0.015
5.08	12.275	0.015
5.10	12.158	0.015
5.38	12.179	0.015
5.44	12.187	0.015
5.77	12.183	0.015
5.88	12.185	0.015
7.65	12.244	0.015
9.48	12.240	0.015
10.69	12.237	0.015
11.68	12.187	0.015
12.10	12.163	0.015
12.65	12.133	0.015
13.09	12.106	0.015
13.22	12.104	0.015
13.44	12.101	0.015
15.62	11.921	0.015
15.68	11.916	0.015
15.74	11.910	0.015
16.02	11.878	0.015
16.04	12.005	0.015
16.05	12.011	0.015
16.08	12.011	0.015
16.11	12.010	0.015
17.31	12.050	0.015
17.44	12.056	0.015
19.05	12.117	0.015
19.63	12.138	0.015
19.72	12.141	0.015