



Infrastructure NSW



# **Blackwattle Bay Precinct**

Flood Risk and Impact Assessment

October 2023

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Infrastructure NSW

# **Blackwattle Bay Precinct**

## **Flood Risk and Impact Assessment**

October 2023

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# Executive summary

Mott MacDonald has been engaged in the preparation of a flood risk and impact assessment to support the redevelopment of Blackwattle Bay Precinct. This report summarises the existing conditions and future development potential of Blackwattle Bay Precinct in terms of flood risk, with a focus on overland flow and emergency response. The study utilised a hydraulic model (TUFLOW) to perform flooding assessment along the watercourses and various overland flow paths on approach to Blackwattle Bay.

Various forms of flooding affect the area as described below. These descriptions focus on the 1% Annual Exceedance Probability (AEP) and the Probable Maximum Flood (PMF) magnitude events, with additional commentary on the minor storm events including the 5% AEP design storm for the local drainage network.

- **Pluvial:** Local intense storms of short duration do contribute to ponding through the precinct and overland flows, typically conveyed through the road reserves.
- **Coastal:** Coastal flood events do not typically cause wider inundation of the precinct. However, along the foreshore lower areas are subject to elevated water levels from Blackwattle bay in isolated locations. These locations grow in extent and flood depth with the effects of climate change on sea levels.

Flood modelling of the existing conditions and developed scenarios reveal the flooding condition before and after precinct development, with mapping prepared and attached as Appendices. The constraints of the existing flooding regime have been met in order to limit potential impacts that may require mitigation. Features of the existing floodplain including hydraulic categorisation have been preserved such that impacts are determined to be acceptable.

Mitigation of flood impacts has been integrated into the design solution for future development. The layout of precinct aligns to existing flow paths to maintain overland flow conditions as exist currently. Future precinct streets allow for excess flow in events with larger runoff volumes than the local pit and pipe system captures. Local pit and pipe system modification is recommended, with nominal sizing of future stormwater networks to the local precinct catchments to guide future site development.

The appropriate flood emergency response for future development will be bespoke and heavily depends on the composition of the proposed development. Flooding conditions in the precinct are typically worst in short flashy storm events as a result of the catchment scale and topographical context of the precinct. For this reason flood hazard is variable across the precinct and both shelter-in-place and evacuation strategies are discussed in the local context. The recommended strategy for emergency response in flood events is for evacuation, in accordance with advice from the NSW State Emergency Service (SES).

# 1 Introduction

## 1.1 Purpose of Report

This report summarises the existing conditions and future development potential of Blackwattle Bay Precinct in terms of hydrology, with a focus on overland flow flood risk and mitigation of flood impacts. A summary of the existing infrastructure, constraints posed by the current infrastructure, and potential for flooding across the precinct is provided to assist in identifying the development strategy that best addresses the constraints and provides a greater amenity to the community and environment alike.

## 1.2 Background

Infrastructure NSW proposed a long-term masterplan for the Blackwattle Bay precinct in alignment with broader state and local government objectives for the area which has now been adopted through a rezoning of the precinct (approved by the Department of Planning and Environment (DPE) in December 2022), with new Local Environmental Plan (LEP) provisions and Design Guidelines.

The precinct masterplan process provides the opportunity to shape public spaces to provide a greater amenity through engineering the public domain to manage flood risk and coordinate private development alike.

A flood study was undertaken with the rezoning by Cardno/Stantec and consulted with DPE's Environment and Heritage Group (EHG). The Blackwattle Bay Design Guidelines identify the need for a Flood Risk and Impact Assessment to be prepared prior to development in the precinct, and to consult with EHG.

### **Public spaces**

More than half the site will be open and accessible to the public.

### **Connection to the water**

A 20-30m wide waterfront promenade will complete the missing link to an otherwise 15km foreshore walk from Rozelle Bay to Woolloomooloo.

### **A green harbourside**

30,000 sqm of new open spaces on the waterfront.

### **A sustainable precinct**

Targeting Net Zero Carbon by 2041, with future development to deliver socially and environmentally sustainable outcomes and Green Star Communities ratings.

### **Connection with Country**

The renewed precinct will recognise and celebrate the traditional custodians of the land and waters of Blackwattle Bay – the Wangal and the Gadigal people.

### **A vibrant 24-hour precinct**

Creating jobs and homes surrounded by a working harbour, waterside parks, cafes, restaurants and retail at the doorstep of the new Sydney Fish Market.

### **Integrated transport to the CBD and beyond**

Multiple modes of transport accessible within 500m - Sydney Metro, light rail, bus, ferry and active transport links.

## **Design excellence**

High quality architecture for buildings and open space will be achieved across the precinct.

## **A direct boost to the NSW economy**

5,600 new jobs, a boost of around \$730 million to the state economy per year and attract an estimated \$3 billion of public and private capital investment.

### **1.3 Precinct Proposal**

Infrastructure NSW received development consent for a new Sydney Fish Market and upgrade to the existing market site together with interfacing public domain areas at the head of the bay, and construction is underway.

The Blackwattle Bay precinct masterplan interfaces with the Sydney Fish Market adjacent Bridge Road and includes land under both public and private ownership between Bank Street and Blackwattle Bay. The design for the Bank Street park area through to the northern extent of the precinct is underway, guided by a design brief developed in response to the community consultation in August and September 2022.

This risk management and flood impact assessment responds to key requirements of the Design Guidelines, and covers the entire precinct including Bank Street park and the sites under private ownership to provide a coordinated regional approach to design that realises benefits in terms of:

- A reduced flood risk profile under developed conditions
- A coordinated evacuation strategy

### **1.4 Previous Studies**

- Bays West Stormwater & Flooding Report (Mott MacDonald, 2022)
- Blackwattle Bay Seawall Assessment (Mott MacDonald, 2022)
- City of Sydney Council Blackwattle Bay Catchment Flood Study and Floodplain Risk Management Study (WMAwater, 2015)
- City of Sydney Council Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology (WMAwater, 2020)
- Flood Protection Elevations for Conceptual Design, The Bays (Mott MacDonald, 2021)
- Flooding and Water Quality Assessment Report, New Sydney Fish Market Concept Design, Stage 1 and Stage 2 (Cardno, 2019)
- Water, Riparian Land, Flooding and Stormwater Study, Blackwattle Bay State Significant Precinct (Cardno, 2021)

### **1.5 Precinct Objectives**

Blackwattle Bay Design Guidelines include objectives and provisions relating to flooding to ensure that proposed development is targeted to avoid flood impacts and provide a net improvement in the management of flood risk. The objectives of this study are aligned with the guidelines to address these matters relating to flooding. Specific Bank Street provisions within the guidelines give further direction around the management of existing flood hazard and specifically mitigation of impacts to ensure no increase in off site flooding due to the development in the precinct. Objectives as identified in the Design Guidelines as they relate to flooding:

- Manage stormwater to minimise flooding and reduce the effects of stormwater pollution on receiving waterways [4f]
- Ensure that development above the flood planning level as defined in the SLEP 2012 will minimise the impact of stormwater and flooding on other developments and the public domain both during the event and after the event. [4g]
- Ensure that flood risk management addresses public safety and protection from flooding. [4h]
- Mitigate identified risks of climate change and sea level rise [4k]
- Ensure development and infrastructure design is resilient to the effects of climate change [4m]

Table 1.1 provides the relevant section of this report where the assessment responds to the design guidelines provisions and details the future development approach which addresses each item. Note recent updates to guidance documents are noted where the previous guideline has been specified. Future development applications shall adopt the latest guidelines.

**Table 1.1: Implementation of Blackwattle Bay Design Guidelines Provisions**

| ID | Development Type/Aspect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Relevant Assessment and Discussion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | <p>A precinct-wide Flood Risk and Impact Assessment is to be prepared by Infrastructure NSW prior to the lodgement of the first Development Application in the precinct. The study should:</p> <ul style="list-style-type: none"> <li>a. be prepared in accordance with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, the Considering flooding in land use planning guidelines 2021 and any adopted flood study and/or floodplain risk management plan prepared by the City of Sydney Council</li> <li>b. to identify precinct-wide flood and risk mitigation for individual sites, public and open space</li> <li>c. consider additional duration frequency flood events</li> <li>d. consider emergency response and consultation with the SES</li> <li>e. be prepared in consultation with Environment and Heritage Group</li> </ul>                                                                                                                                                                                                                 | <p>Refer relevant sections for each sub-item below:</p> <ul style="list-style-type: none"> <li>a. Standards and guidelines described in section 5.1 including Council flood risk management study and plan considerations.</li> <li>b. The design for mitigation of flood hazard described in section 6.2.</li> <li>c. Section 3.4 provides discussion on flood duration and identification of critical events</li> <li>d. Emergency response considerations are discussed in section 6.3, and consultation discussion and outcomes are provided in section 8.</li> <li>e. Consultation discussion and outcomes are provided in section 8.</li> </ul> |
| 2  | <p>Development, including public and open spaces such as roads and parks are to be designed to comply with:</p> <ul style="list-style-type: none"> <li>a. any site-specific recommendations from the Flood Risk and Impact Assessment required in 1 above</li> <li>b. ensure there is no net loss in flood storage or floodway area because of the development</li> <li>c. all floor levels are to be at or above the Flood Planning Level identified in an adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 as adopted by the relevant Council, or as otherwise determined through a site-specific flood study prepared in consultation with Environment and Heritage Group</li> <li>d. notwithstanding 2b above, consideration may be provided to some or all of the non-residential floor levels having a freeboard of less than 500 mm above the 1% AEP flood level provided that satisfactory flood proofing is achievable to the Flood Planning Level. All entrances and evacuation</li> </ul> | <p>Refer relevant sections for each sub-item below:</p> <ul style="list-style-type: none"> <li>a. These are identified in this report.</li> <li>b. Discussion on the hydraulic function of the area is included in section 3.5.1. With considerations of hydraulic categorisation in Table 3.3.</li> <li>c. Future floor levels discussed in section 5.2.</li> <li>d. Future floor levels discussed in section 5.2.</li> <li>e. Future basement entry levels discussed in section 5.2.</li> <li>f. Coordinated design of the promenade interface with Blackwattle Bay is noted</li> </ul>                                                             |

| ID | Development Type/Aspect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Relevant Assessment and Discussion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <p>routes servicing any residential components must be above the Flood Planning Level.</p> <p>e. Basement car parking must have all access and potential water entry points above the Flood Planning Level and provide a clearly signposted flood free pedestrian evacuation route from the basement area separate to the vehicle access ramps</p> <p>f. Where access to the water is to occur, a suitable edge treatment such as a stepped naturalised embankment between the promenade and water is to be provided to ensure access to water is maintained regardless of sea level.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>in discussion of the stormwater strategy in section 7.1.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3  | <p>Potential flooding at Bank Street is to be mitigated to ensure no increase in off site flooding due to the development in the precinct. These measures may include, but are not limited to:</p> <ul style="list-style-type: none"> <li>a. upgrading existing and/or new drainage to carry flows from the impacted area on Bank Street to the discharge outlet across the proposed Miller Street reserve</li> <li>b. providing overland flow path at the rear of proposed development adjoining the impacted area on Bank Street to the discharge outlet across the proposed Miller Street reserve</li> <li>c. revisions to building layout to allow floodwaters to flow around the buildings to mitigate any predicted off-site impacts</li> <li>d. regarding Bank Street to introduce a flow path that connects the proposed flow path on the proposed Miller Street Reserve</li> <li>e. a combination of these measures, or other measures</li> <li>f. Flood mitigation and modification works must ensure they do not have an adverse impact on any surrounding property. The final mitigation design option is to be informed by consultation with Environment and Heritage Group and City of Sydney Council.</li> </ul>                                                                 | <p>Refer relevant sections for each sub-item below:</p> <ul style="list-style-type: none"> <li>a. The stormwater strategy, for future stormwater system configuration is detailed in section 7.1.</li> <li>b. Mitigation through stormwater system and overland flow optimisation is described in section 6.2.</li> <li>c. Potential options for developers are subject to detailed assessment of off-site impacts.</li> <li>d. Mitigation through stormwater system and overland flow optimisation is described in section 6.2.</li> <li>e. The mitigated flooding outcome is documented in section 6.2</li> </ul> |
| 4  | <p>Development applications for new buildings are to be subject to a site-specific flood study prepared in accordance with the NSW Floodplain Development Manual* 2005, the NSW Coastal Planning Guideline: Adapting to Sea Level Rise*, NSW Coastal Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments* and the NSW Flood Risk management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments*. The study is to include, but not limited to:</p> <ul style="list-style-type: none"> <li>a. a detailed topographical survey that defines flow paths, storage areas and hydraulic controls;</li> <li>b. flood modelling that uses appropriate hydrological and hydraulic techniques and incorporates boundary conditions</li> <li>c. relevant recommendations and/or mitigations from the precinct-wide Flood Risk and Impact Assessment required in 1 above</li> </ul> <p>The site-specific flood study is to show pre-development and post-development scenarios, and at a minimum is to include water surface contours, velocity vectors, velocity and depth product contours, delineation of flood risk precincts and flood profiles for the full range of events for total development including all structures and works.</p> | <p>This provision outlines the need for future development applications to consider this Flood Risk and Impact Assessment.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

Source: Blackwattle Bay Design Guidelines, INSW

Notes: \* The NSW Flood Risk Management Manual 2023 supersedes the manual and guidelines listed as being relevant to development applications.



## 1.6 Assessment Methodology

This flood risk assessment develops an understanding of the flood risk profile across the precinct and guides the development to achieve good outcomes with regard to future development flood immunity, stormwater management and evacuation strategies. The following detailed breakdown describes the approach taken in this assessment:

- Review design guidelines along with statutory and industry guidance on floodplain management.
- Review and update the latest catchment flood study for site specific flood modelling assessment of the baseline conditions, adding scenario capability for assessment of future climate change conditions
- Develop design case scenarios representing the precinct future development to assess potential flood impacts and refine the design in accordance with civil design principles for stormwater and flood risk management
- Align the future development design to meet site constraints and interfaces
- Prepare mitigation measures for integration to design for precinct management of stormwater and flood risk
- Provide indicative stormwater infrastructure layouts and sizing to assess future underground stormwater conveyance needs
- Prepare assessment of the flood hazard under existing and developed conditions. Identify the hydraulic categorisation of the flood susceptible areas of the precinct. Provide commentary on the appropriate flood emergency response for the future development, incorporating the latest guidance on flood emergency planning, and potential flood evacuation arrangements.
- Document findings in Flood Risk and Impact Assessment report (this report), with preparation of supporting detailed flood map references.
- Consult with the DPE EHG and SES on flood risk management, design principles and approach to development including rezoning, and design for emergency response.

The following report sections provide discussions and outcomes of the assessments and consultation listed above.

## 2 Model Development

The study utilised a hydraulic model (TUFLOW) to perform a flooding assessment along the watercourses and various overland flow paths.

### 2.1 Existing Flood Study and TUFLOW Model

The City of Sydney has provided the TUFLOW model developed by WMAwater as part of the 2015 Blackwattle Bay Catchment Flood Study, and Floodplain Risk Management Plan. The model was supplemented with additional input and configuration data in 2020 to address updates for new data and rainfall methodologies released with the Australian Rainfall and Runoff Guideline (ARR) of 2019.

A review of the TUFLOW model and its accompanying reports was carried out to assess its validity and assumptions, to identify any limitations of the modelling and form the basis of modelling for the Blackwattle Bay State Significant Precinct flooding assessment.

### 2.2 Updates to TUFLOW Model

The TUFLOW model was updated with new information, outlined below, to better predict the flood extents, levels, depths and flood hazards for the Blackwattle Bay Precinct.

#### Digital Elevation Model Update

The Digital Elevation Model (DEM) input to the TUFLOW model was updated with the latest information available for the new Sydney Fish Market development project. At the time of writing this project is under construction, with the final built form of the new structure and associated public domain applied to the existing scenario or baseline flooding assessment.

#### Rainfall Application

The rainfall application method to hydraulic modelling adopts pit based wetting of the model which distributes catchment inflow evenly across the pits within each catchment. With this approach the model is not wet at concentrated points in the lowest elevation of catchments. The selected approach is considered to provide a better representation given detailed pit/pipe data.

#### Hydrology Update for Climate Change

Climate change scenarios have been developed within the Council model taking the approach of proxy climate change events adopting higher rainfall intensities. This methodology aligned with discussions presented within Australian Rainfall and Runoff (ARR) guidelines is maintained, with discussion of the following events compared to the 1% AEP for sensitivity analysis on the changes due to rainfall intensity:

- 0.5% AEP, and 0.2% AEP, applied in combination with;
- sea level rise 1.3m, representing the Shared Socioeconomic Pathway (SSP) 8.5 projections with the 2100 horizon.

Refer to **Section 4 Climate Change** for further discussion including rainfall intensity and tailwater conditions from Blackwattle Bay encompassing potential further sea level rise scenarios.

#### Critical Storm Selection

Additional short duration storms were configured for analysis in the model, given the study area is a smaller scale for this precinct flooding assessment than the wider Blackwattle Bay

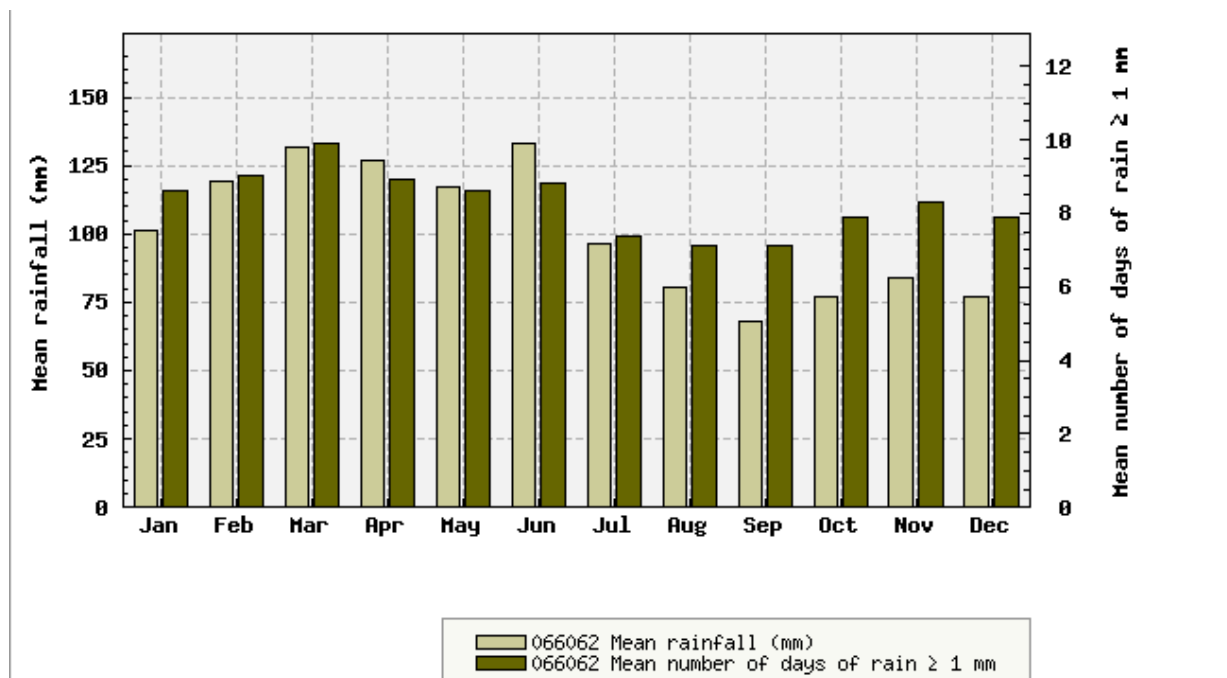
catchment. Typically 15min durations were added across various storm magnitudes to assess the worst case conditions in small catchments. Longer duration storms were configured for assessment in the extreme flooding scenarios to assess a wider range of potential conditions to inform the design for emergency response.

## 3 Existing Conditions

### 3.1 Climate and Topography

Monthly average rainfall statistics and temperature statistics from the nearby Observatory Hill weather station is presented below, indicating the local conditions. This location is selected due to the long history of recorded data, from 1859 to 2020.

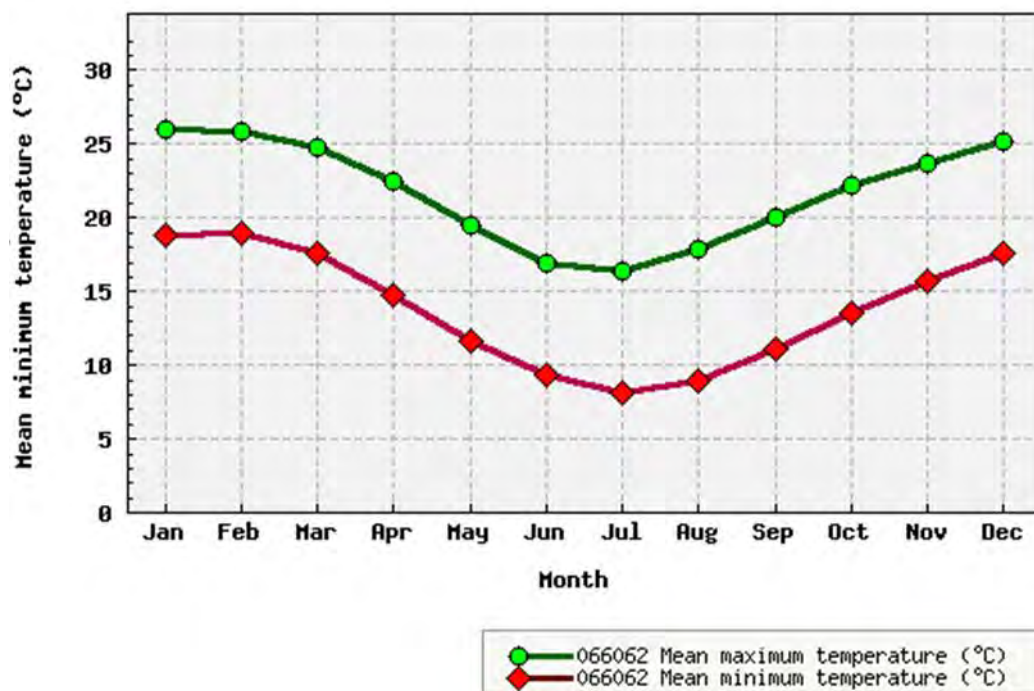
**Figure 3-1: Average Monthly Rainfall and days over 1mm rainfall**



Source: Australian Government, Bureau of Meteorology

The general trend in monthly rainfall totals is for larger total monthly rainfalls typically experienced during the first 6 months of the year through the Summer-Autumn-Winter period. There is also a trend to higher number of days exceeding 1mm of rainfall across this same 6 month period. The average monthly temperatures indicate Sydney's location as a coastal warm-temperate climate with average temperatures generally between 8 and 26°C.

**Figure 3-2: Average Monthly Temperatures**



Source: Australian Government, Bureau of Meteorology

## 3.2 Sources of Flooding

Various forms of flooding affecting the area are as described in the sections below. The resultant flooding varies in magnitude depending on the intensity of the storm event, combination of flooding sources and the base climate conditions that trigger the flooding. General descriptions below focus on the 1% Annual Exceedance Probability (AEP) or the Probable Maximum Flood (PMF) magnitude events to describe the flooded conditions.

### 3.2.1 Overland Flow

Local rainfall in the catchment is converted to runoff after falling on:

- Impervious surfaces, and
- Pervious surfaces in excess of the small rainfall amount that can infiltrate the soil.

Runoff accumulates in depressions in the topography, forming overland flow paths.

### 3.2.2 Coastal

Coastal flood events do not typically propagate far from the permanent extent of Blackwattle Bay to cause inundation of the precinct. However, when larger storm surge events are experienced, the lower lying areas of the precinct adjacent the bay become inundated. The drainage of local storms via the pit/pipe system and overland flows are impeded as the water level in Blackwattle Bay rises during any coincident coastal flood events. The position of Blackwattle Bay is relatively protected from sources of wave set-up and the risk of tidal flood levels along the Blackwattle Bay foreshore are not sensitive to wave run-up influences.

**Table 3.1: Design Still Water Levels for Fort Denison**

| % AEP                 | Design Still Water Level (m AHD) | Notes                             |
|-----------------------|----------------------------------|-----------------------------------|
| 1                     | 1.45                             |                                   |
| 2                     | 1.40                             |                                   |
| 5                     | 1.38                             | Interpolated magnitude            |
| 10                    | 1.35                             |                                   |
| 1 exceedance per year | 1.25                             | Coincident with the Peak HHWS(SS) |

Source: OEH Floodplain Risk Management Guide

The basis for the tidal conditions used in flood simulations are the adopted conditions within the previous Floodplain Risk Management Study. The design flood event scenarios for the 1% AEP flood adopts a 5% AEP ocean water level (approximately 1.38 mAHD in Sydney Harbour) coincidentally. The 5% AEP rainfall event is paired with an ocean water level of 1% AEP. For scenarios including climate change, the anticipated sea level rise is applied (added) to the relevant AEP harbour levels consistent with the SSP 8.5 2100 (upper bound of the 95% confidence interval) predictions.

**Table 3.2: Coincident Tidal and Storm Flood Magnitudes**

| Storm Flood Magnitude | Tidal Boundary Condition                       |
|-----------------------|------------------------------------------------|
| PMF                   | 1% AEP tidal peak                              |
| 0.2% AEP <sup>1</sup> | 5% AEP tidal peak with 2100 elevated sea level |
| 0.5% AEP <sup>2</sup> | 5% AEP tidal peak with 2100 elevated sea level |
| 1% AEP                | 5% AEP tidal peak                              |
| 5% AEP                | 5% AEP tidal peak                              |
| 10% AEP               | Peak HHWS (SS)                                 |
| 20% AEP               | Peak HHWS (SS)                                 |
| 0.5 EY                | Peak HHWS (SS)                                 |

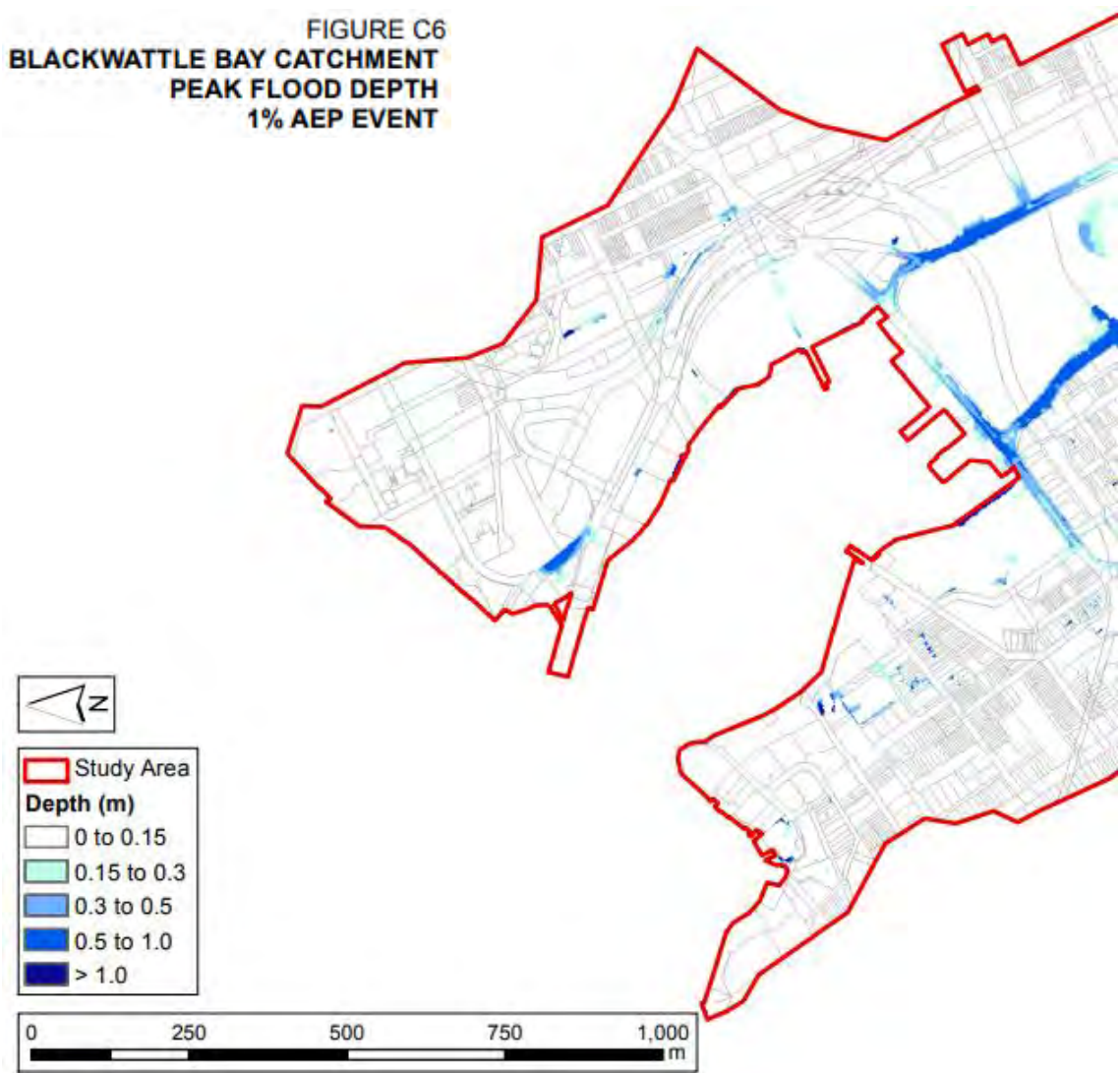
1. Climate change sensitivity of the 1% AEP with an approximate equivalent 23% rainfall uplift

2. Climate change sensitivity of the 1% AEP with an approximate equivalent 9% rainfall uplift

### 3.3 Regional Context

The following flood maps shows the flood impact of the 1% AEP and PMF events on the surrounding areas as per the Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology (WMAwater, 2020) This subsequent modelling exercise presents an update to the Blackwattle Bay Catchment Flood Study (WMAwater, 2020). Due to the large scale of the regional catchment relative to the study area, map extracts have been reproduced here with a focus on the bay foreshore area. The approach to representation of flooding at the regional scale has shown depths less than 0.15m as transparent. Critical storm duration analysis in the regional assessment identified an envelope of 30 minute to 60 minute duration storms covered worst case flooding conditions for the majority of the catchment area, discussed further in section 3.4. Whilst this assessment caters for the catchment wide flooding context, site specific duration assessment of flooding includes the 15 minute short duration storms as noted in section 2.2, and longer duration storms for emergency response planning.

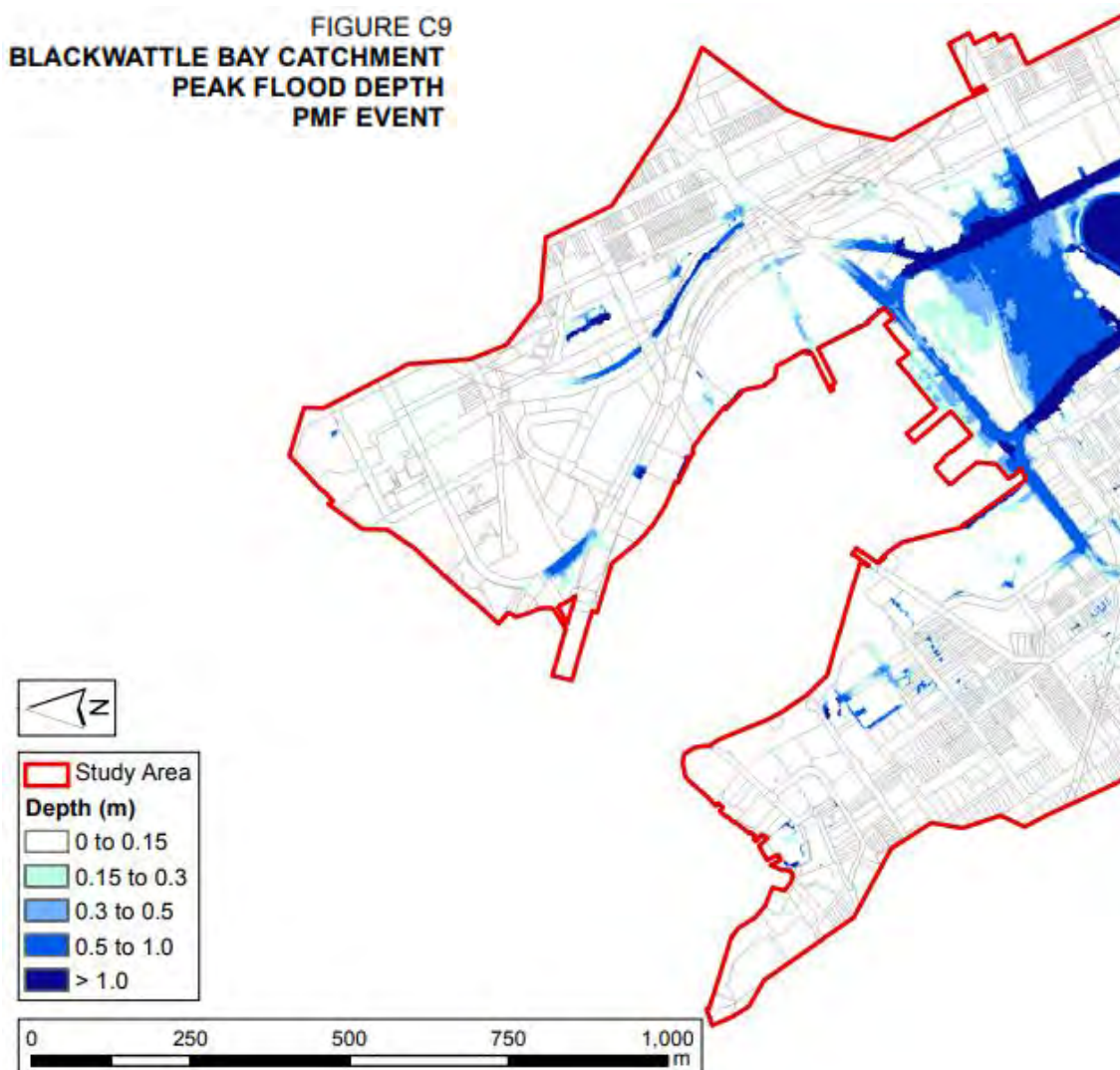
Figure 3-3: Existing Regional Flood Study – 1% AEP (extract)



Source: Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology: Volume 2 (WMAwater, 2020)



**Figure 3-4: Existing Regional Flood Study – PMF (extract)**



Source: *Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology: Volume 2* (WMAwater, 2020)

### 3.4 Flood Depth and Extent

The flooding experienced in the vicinity of the Blackwattle Bay State Significant Precinct site is typically overland flow and a result of short intense storms. Some trapped ponding locations continue to accumulate water in longer storms, however the vast majority of the study area is subject to the worst case flooding from overland flow only.

From review of the existing topographical conditions, the contributing catchment for the Bank Street road reserve is relatively small and worst case flooding conditions are likely from short duration storms with very high rainfall intensity. This is supported from inspection of the critical duration summary from the Blackwattle Bay Catchment Flood Study, with critical duration less than 60 minutes.

The following flood map indicates the worst case flooding in the 1% AEP under existing conditions, with the mapping an envelope result of multiple simulations to capture the range of conditions from short flashy storms to the longer duration events.



Refer to **Appendix A** for high resolution maps.

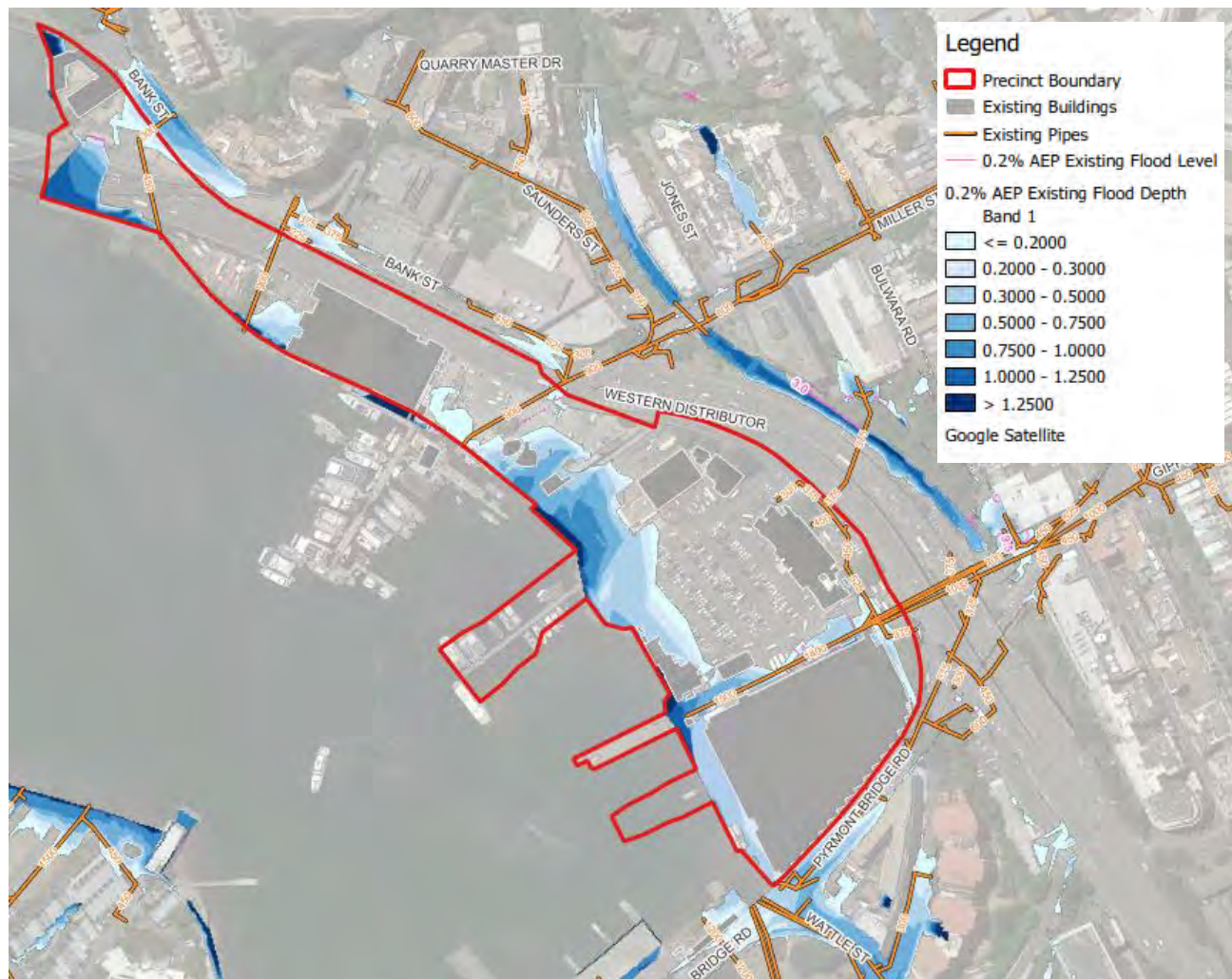
**Figure 3-5: Existing 1% AEP Flood Depth**



Source: Blackwattle Bay State Significant Precinct Flood Risk and Impact Assessment

The predicted climate change conditions discussed in section 4 have been applied to the modelling and result in a future 1% AEP flooding condition as indicated below for the 23% uplift in rainfall intensity projected conditions.

**Figure 3-6: Existing 1% AEP Flood Depth with climate change**



Source: Blackwattle Bay State Significant Precinct Flood Risk and Impact Assessment

## 3.5 Constraints

### 3.5.1 Hydraulic constraints

The urban drainage network in the vicinity of Blackwattle Bay Precinct comprises traditional pit and pipe systems and larger concrete box culverts through Wentworth Park which convey flow of the original watercourses which ran into Blackwattle Bay before development.

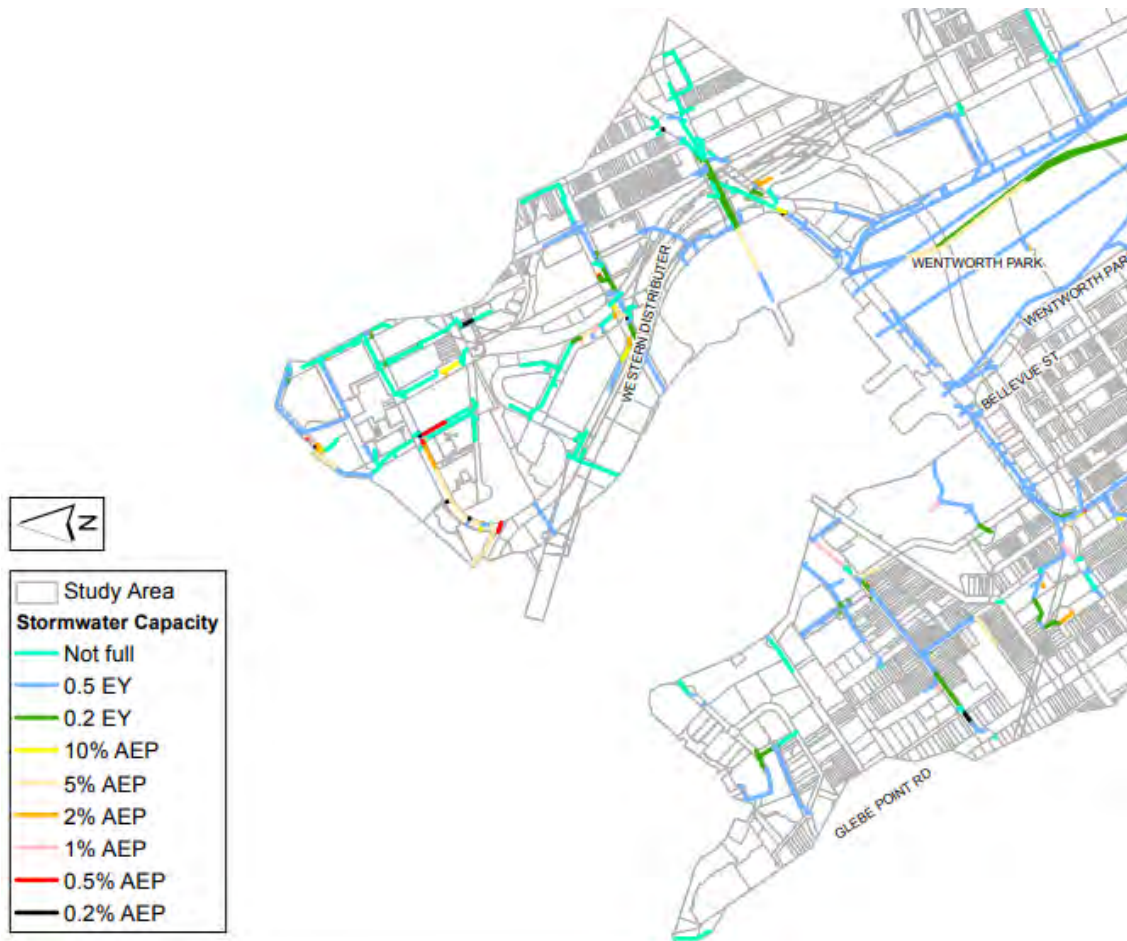
The local pipe system owned by Council typically addresses nuisance ponding and collects local overland flow from the street network.

The culvert system was historically constructed to achieve a high flow efficiency within a relatively small plan area and to create the functional park over, Sydney Water owns the majority of these larger culverts. Tailwater conditions from Blackwattle Bay provide a variable downstream condition for the urban drainage network including these major culverts.

The tailwater condition of the tidal plane within Blackwattle Bay is a key constraint to the stormwater system provision for future development, particularly with future sea level rise. Any detailed pipe design by future developers should cater for this constraint to discharge flows at times of high tides/storm tides.



**Figure 3-7: Constraints in pipe system capacity**



Source: Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology: Volume 1 (WMAwater, 2020)

The Bank Street park area sits adjacent a low capacity pipe (0.5 EY) as identified in the Blackwattle Bay Catchment Flood Study, with a relatively large catchment draining to the sag position. Council's flood model indicates a 225mm diameter pipe draining this sag in the road reserve is undersized and results in ponding from the smallest of flood events (0.5 EY). Detailed survey of the area has confirmed the pipe diameter crossing the road is 300mm, connected to a 450mm diameter pipe continuing through to the discharge at Blackwattle Bay. The catchment size draining to this location increases through the range of storm magnitudes; as the capacity of discrete upstream pipe systems are exceeded, larger upstream areas then overflow into the Bank Street sag. In major to extreme storm events the catchment is up to 5 ha once these upstream pipe systems become drowned. As noted in section 2.2, the flood model was updated to distribute water across all pits within each sub-catchment to approximate discrete building hydraulics connections to the stormwater system and allow surcharge of the piped system across the sub-catchment in events in excess of the piped system capacity.

**Figure 3-8: Constraints in the Bank Street pipe system**

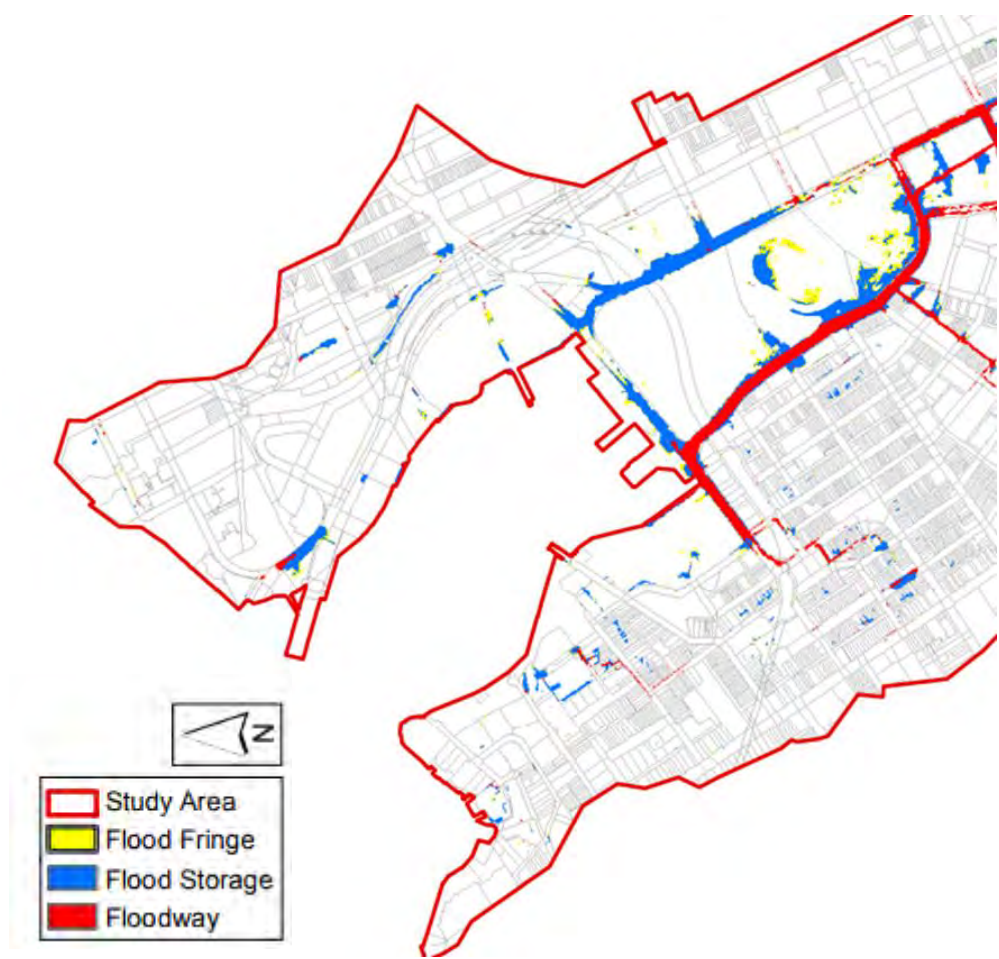


Source: Blackwattle Bay State Significant Precinct – Flood Risk and Impact Assessment

### 3.5.1.1 Hydraulic Function (floodplain categorisation)

The topography of the study area and the proximity to the Blackwattle Bay waterbody results in minimal areas that are classified as Flood Fringe, Flood Storage or Floodway. The catchment flood study identifies Bridge Road and Pyrmont Bridge Road as having flood storage present, with a floodway identified on Wentworth Park Road continuing across Bridge Road to the bay, south of the study area. At the Bank Street sag an area of Flood storage is identified, corresponding with the ponding discussed in section 3.4. Other small areas within the lot areas are not significant.

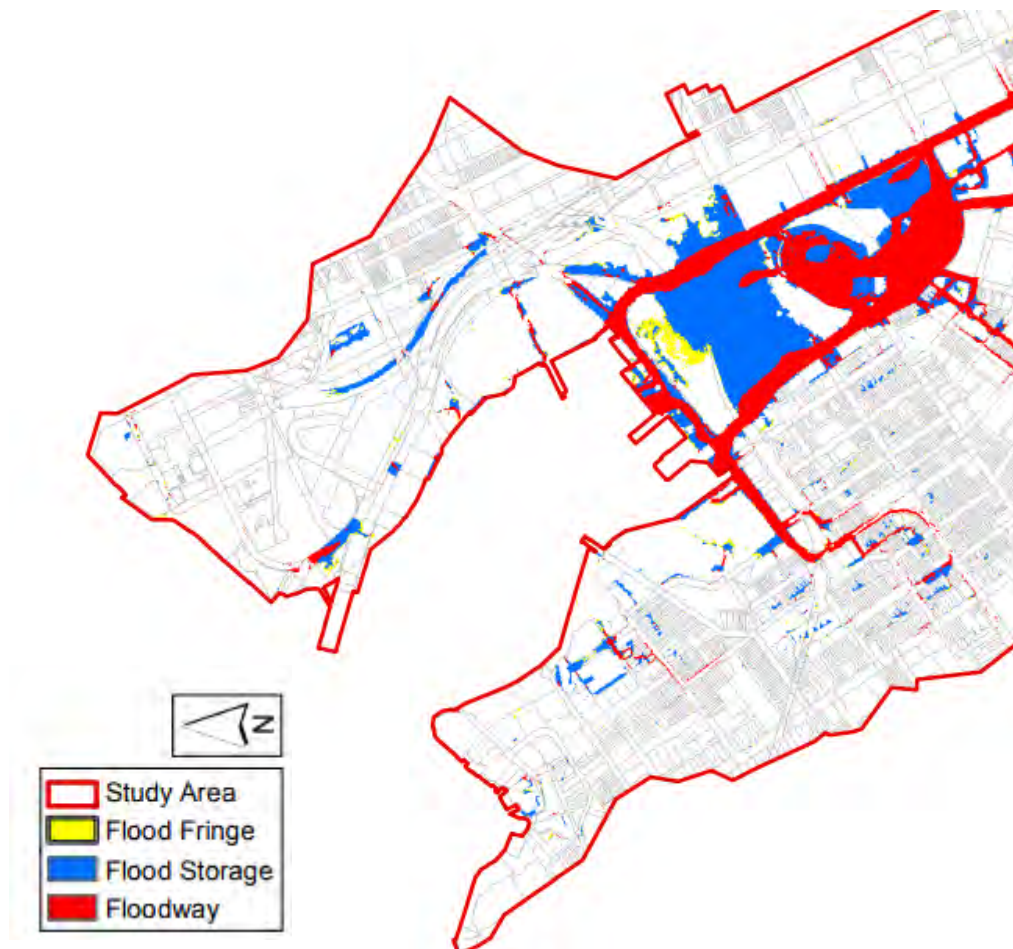
**Figure 3-9: 1% AEP Hydraulic Categorisation**



Source: Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology: Volume 2 (WMAwater, 2020)



**Figure 3-10: PMF Hydraulic Categorisation**



Source: Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology: Volume 2 (WMAwater, 2020)

The hydraulic categorisation of the land identifies important features of the floodplain including flow paths and flood storage, and effectively maps constraints to potential development that would be inconsistent with catchment objectives. The wider catchment objectives include;

- only developing outside high flood hazard areas,
- only developing in areas where flood impacts to adjacent properties is avoided,
- only developing in accordance with flood planning directives and;
- only rezoning where the appropriate emergency management procedures are feasible for development to achieve.

The general wider catchment principles can be summarised:

- flood storage is preserved where it is required to minimise the potential peak flood effects on downstream areas, and
- floodways are preserved such that the conveyance of flooded areas is not limited where reduced conveyance could compromise adjacent and upstream flooded areas.

The following table summarises the hydraulic categorisation under existing conditions that informs design of the precinct. The precinct consideration was assessed through the design iterations to result in a developed scenario that responds to these hydraulics constraints. The developed scenario hydraulic (floodplain) categorisation is presented in Appendix E.

**Table 3.3: Hydraulic Constraints**

| Location                                                     | Hydraulic Constraint                                       | Event  | Precinct Consideration                                                                                                                                                                         |
|--------------------------------------------------------------|------------------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bank Street sag point                                        | Predominantly flood Storage with some Floodway             | 1% AEP | To be reduced through design. The Flood Storage and Floodway area is not beneficial to management of local or regional flood hazards.                                                          |
|                                                              | Flood Storage and Floodway                                 | PMF    |                                                                                                                                                                                                |
| Bank Street and adjacent lot areas                           | Minimal areas of flood storage                             | 1% AEP | To be eliminated through design. Flood fringe, storage or floodway areas are not beneficial in managing local or regional flood hazards.                                                       |
|                                                              | Predominantly flood Storage with some Floodway             | PMF    |                                                                                                                                                                                                |
| Old Sydney Fish Market carpark                               | Flood Storage                                              | 1% AEP | Floodway to be preserved through allowance of overland flow route in future precinct street. Flood Storage not beneficial to management of local or regional flood hazards.                    |
|                                                              | Flood Storage and Floodway                                 | PMF    |                                                                                                                                                                                                |
| Pymont Bridge Road                                           | Flood Storage                                              | 1% AEP | Floodway to be preserved through allowance of overland flow route in future precinct street. Flood Storage not beneficial to management of local or regional flood hazards.                    |
|                                                              | Flood Storage and Floodway                                 | PMF    |                                                                                                                                                                                                |
| Bridge Road and Bridge Road/Wentworth Park Road Intersection | Flood Storage in Bridge Road, Floodway at the intersection | 1% AEP | Floodway is managed by Sydney Fish Market development maintaining the discharge of floodway to Blackwattle Bay. Flood Storage not beneficial to management of local or regional flood hazards. |
|                                                              | Flood Storage and Floodway                                 | PMF    |                                                                                                                                                                                                |

Note: Summary here of the defining hydraulic categorisation in individual areas, with small or discrete areas of alternate hydraulic categorisation omitted where not significant for analysis.

### 3.5.2 Environmental constraints

There are topographical constraints to the conveyance of stormwater by gravity along the precinct foreshore towards the Bank Street park as existing surface levels vary considerably. There is a trapped low-point within the road reserve of Bank Street that is a key consideration of hydraulic hazard and the design incorporates mitigation of this known constraint.

## 4 Climate Change

Climate change guidance from the Australian Rainfall and Runoff (2019) documentation refers to research undertaken in developing an interim recommendation to factor rainfall based on temperature scaling. The recommended methodology outlined in Understanding and Managing Flood Risk (DPE, 2023) is to:

- a) adopt temperature projections from the CSIRO future climates tool, and apply 7% change in rainfall intensity for each degree of change in mean temperature, or
- b) select larger magnitude floods (ie. 0.5% and 0.2% AEP) for use as proxy climate change events for the 1% AEP flood magnitude.

Sea level projections are recommended based on the International Panel on Climate Change's (IPCC) Sixth assessment report changes in mean sea level guidance. These projections were used to derive factors, applied to specific climate change scenarios in the flood modelling, to reveal flooding responses under future climate change conditions.

### 4.1 Sea Level Rise

The 95% confidence interval projection for the shared socioeconomic pathway (SSP) 8.5 for sea level rise to the year 2100 was selected for the precinct as it is a broad scale rezoning. These projections are documented in the IPCC Assessment Report 6 (AR6) data (DPE, 2023). This latest projection exceeds the previous CoastAdapt guidance which is approximately 0.9m, for the year 2090.

Further rises beyond this outlook, to 2150, are also provided within the IPCC report with a wider range of sea level rise beyond 2m in the upper bound of the 95% confidence interval. The planning response to the uncertainty of projections is discussed in section 4.3.

#### Tailwater conditions

The elevated sea level has been applied through tidal curves at the downstream boundary conditions of the flood model to simulate the effects of the tidal behaviour under future conditions.

#### Backwater flooding

Backwater flooding events occur when the dominant source of flooding is downstream of the area of interest and not predominantly a function of the urban overland flows. An extreme tidal surge event is one such scenario whereby extreme sea levels produce flooding of the lower lying areas of land from Blackwattle Bay.

### 4.2 Rainfall intensity changes

The Australian Rainfall and Runoff guidance on rainfall intensity is to use the RCP 4.5 and 8.5 projections on climate futures and directs practitioners to the Bureau of Meteorology's datahub tool for rainfall intensity increase projections. For this region of NSW coast, the projection for 2090 is an increase in rainfall intensity of 19.7% under RCP 8.5. As a comparison the 7% uplift approach for each degree of warming detailed by DPE (2023) results in a 26% increase by 2090 for the East Coast South region.

The approach adopted in this study is to assess the 0.5% AEP and 0.2% AEP events relative to the 1% AEP to give a range of conditions to be expected under future scenarios with increased temperatures resulting in the rainfall uplift. General increases in rainfall from the 1% AEP to the



larger 0.5% and 0.2% AEP events are approximately 9% and 23% increases in rainfall intensity respectively.

4.3 Planning response

Blackwattle Bay Design Guidelines provide recommended Development Application requirements for new buildings. The application is:

- to be subject to a site-specific flood study prepared in accordance with the following documents, noting that The NSW Flood Risk Management Manual 2023, gazetted on 30th June 2023 supersedes the documents listed below;
  - the NSW Floodplain Development Manual 2005,
  - the NSW Coastal Planning Guideline: Adapting to Sea Level Rise, NSW Coastal Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments and
  - the NSW Flood Risk management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments.
- to include a flooding specific response that provides:
  - a detailed topographical survey that defines flow paths, storage areas and hydraulic controls;
  - flood modelling that uses appropriate hydrological and hydraulic techniques and incorporates boundary conditions
  - relevant recommendations and/or mitigations from the precinct-wide Flood Risk and Impact Assessment (this study).

Planning guidance on rezoning is provided in Support for Emergency Management Planning guideline EW01 (DPE, 2023) and notes the key considerations in land use decisions which include the vulnerability of likely occupants, flood free locations for sheltering, the availability of services and structural adequacy of the development. These considerations have been taken into account in deriving the recommendations for Flood Planning Levels (FPL) in this assessment and also the development of the emergency response strategy.

Recommendations in this report adopt floor levels that are derived from the 2090 climate horizon 1% AEP flooding conditions, with critical infrastructure or below ground floor areas subject to a higher protection level (larger magnitude flood) than the FPL for ground floors. Refer section 5.2 for further discussion on planning controls.

Responses to ongoing sea level rise (beyond 2100) include both adaption and avoidance techniques to address the challenge of future sea levels and various risks including inundation or flooding resulting from storm surge and/or local rainfall driven flooding. Avoidance techniques are typically conservative in their approach. These techniques have the benefit of reducing the likelihood of future costly adaption exercises, but potentially front load development costs.

Table 4.1: Climate Change Avoidance and Adaptation

| Avoidance Techniques                                                                                                                                | Adaptation Techniques                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Raising development FPLs for rezoning proposals in preparation for future sea level rise beyond the design life of the current proposed development | Staged uplift of development FPLs as development sites are updated/recycled                                                                                                 |
| Retreat from vulnerable coastal areas                                                                                                               | Respond to realised increases in sea levels over time with planning changes (rezoning or controls) on land use that reduce risk without requiring raising building levels * |

\*An example of this approach is the consideration of repurposing habitable floor levels where re-development is proposed after such time that freeboard is potentially compromised by continuing sea level rise

## 5 Redevelopment Opportunity

Planning is underway for the implementation of the precinct, to the structure plan indicated in Figure 5.1.

**Figure 5.1: Blackwattle Bay future development structure plan**



Source: Blackwattle Bay Design Guidelines, INSW

### 5.1 Current Planning Context

Current planning controls related to flood management are specified across the following documents:

- City of Sydney's Local Environment Plan (LEP) 2012;
- City of Sydney's Development Control Plan (DCP) 2012;
- City of Sydney's Interim Floodplain Management Policy (2014); and
- NSW State Government's Flood Prone Land Policy, including;
  - Standard Instrument (Local Environment Plans) Amendment (Flood Planning) Order 2021
  - Environmental Planning and Assessment Amendment (Flood Planning) Regulation 2021
  - State Environmental Planning Policy Amendment (Flood Planning) 2021

Sydney LEP (2012) requires the consent authority to be satisfied that all proposed development adequately protects the safety of property and life, and avoids adverse impacts on stormwater drainage, flood behaviour and the environment. This includes:

- That proposed development will not experience undue flood risk; and
- That existing development will not be adversely flood affected through increased damage or hazard as a result of any new development.

To satisfy Council that the development complies with these requirements a flood study may need to be undertaken as part of the Development Application submission in addition to establishing flood planning levels for the development. Council requires ancillary development issues to be considered in the assessment of proposed development of flood prone land of residential and industrial/commercial properties as summarised in Table 5.1.

**Table 5.1: Council Ancillary Requirements**

| Development Type/Aspect              | Objective                                                                                                                                                                                                                                                                                                                                                                                                                     | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Residential properties               | <ul style="list-style-type: none"> <li>• To minimise the damage to residential properties from flooding; and</li> <li>• To minimise risk to human life from the inundation of residential properties and to minimise economic cost to the community resulting from flooding.</li> </ul>                                                                                                                                       | <ul style="list-style-type: none"> <li>• The proposed residential building or dwelling must be free from flooding up to and including the 1% AEP flood and must meet the Flood Planning Level Requirements; and</li> <li>• The proposed residential building or dwelling should not increase the likelihood of flooding on other developments, properties or infrastructure.</li> </ul>                                                                                                                                                                                                                                                                                 |
| Industrial and Commercial Properties | <ul style="list-style-type: none"> <li>• To minimise the damage to industrial and commercial properties from flooding; and</li> <li>• To minimise risk to human life from the inundation of industrial and commercial properties and to minimise economic cost to the community resulting from flooding</li> </ul>                                                                                                            | <ul style="list-style-type: none"> <li>• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements; and</li> <li>• The proposed industrial or commercial development should not increase the likelihood of flooding on other developments, properties or infrastructure.</li> </ul>                                                                                                                                                                                                                                                                     |
| Car Parking                          | <ul style="list-style-type: none"> <li>• To minimise the damage to motor vehicles from flooding;</li> <li>• To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures of the safety of people, or damage other property; and</li> <li>• To minimise risk to human life from the inundation of basement and other car park or driveway areas.</li> </ul> | <ul style="list-style-type: none"> <li>• The proposed car park should not increase the risk of vehicle damage by flooding inundation;</li> <li>• The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure;</li> <li>• The proposed garage or car park must meet the Flood Planning Level Requirements; and</li> <li>• Open car parking- The minimum surface level of open space car parking subject to inundation should be designed giving regard to vehicle stability in terms of depths and velocity during inundation by flood waters. Where this is not possible, it shall be</li> </ul> |

| Development Type/Aspect            | Objective                                                                                                                                                                                  | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    |                                                                                                                                                                                            | demonstrated how the objectives will be met.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Filling of Flood Prone Land</b> | <ul style="list-style-type: none"> <li>To ensure that any filling of land that is permitted as part of a development consent does not have a negative impact on the floodplain.</li> </ul> | <ul style="list-style-type: none"> <li>Unless a floodplain risk management plan for the catchment has been adopted, which allows filling to occur, filling for any purpose, including the raising of a building platform in flood-prone areas is not permitted without Council approval. Application for any must be supported by a flood assessment report from a suitably qualified engineer which certifies that the filling will not increase flood affection elsewhere.</li> </ul> |

Source: Section 5 of Council's *Interim Floodplain Management Policy (2014)*

In addition to the above requirements, the following building floor level requirements are to be met for Industrial/Commercial developments as per Council's *Interim Floodplain Management Policy (2014)*:

**Table 5.2: Council Flood Planning Levels**

| Development Type / Aspect           | Objective                                          | Type of Flooding                      | Flood Planning Level                                                                                                                                                                                       |
|-------------------------------------|----------------------------------------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Residential</b>                  | Habitable rooms                                    | Mainstream flooding                   | 1% AEP Flood + 0.5m                                                                                                                                                                                        |
|                                     |                                                    | Local drainage flooding               | 1% AEP Flood + 0.5m<br>or<br>Two times the depth of flow with a minimum of 0.3m above the surrounding surface if the depth of flow in the 1% AEP flood is less than 0.25m                                  |
|                                     |                                                    | Outside floodplain                    | 0.3m above surrounding ground level                                                                                                                                                                        |
|                                     | Non-habitable rooms                                | Mainstream or local drainage flooding | 1% AEP Flood level                                                                                                                                                                                         |
| <b>Industrial / Commercial</b>      | Business                                           | Mainstream or local drainage flooding | Merits approach presented by the applicant with a minimum of the 1% AEP Flood level.                                                                                                                       |
|                                     | Residential floors within tourist establishments   | Mainstream or local drainage flooding | 1% AEP Flood + 0.5m                                                                                                                                                                                        |
|                                     | Retail Floor Levels                                | Mainstream or local drainage flooding | Merits approach presented by the applicant with a minimum 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation. |
| <b>Below-ground garage/car park</b> | Single property owner with not more than 2 spaces. | Mainstream or local drainage flooding | 1% AEP flood level + 0.5m                                                                                                                                                                                  |
|                                     | All other below ground car parks                   | Mainstream or local drainage flooding | 1% AEP flood level + 0.5m or the PMF (whichever is the higher)                                                                                                                                             |

Source: Council's *Interim Floodplain Management Policy (2014)*

Building floor levels as designed by developers are typically assessed against flood levels from the Blackwattle Bay Catchment *FRMS* basis flood model held by Council. The FPL is the water surface level of the relevant 'planning flood' plus a freeboard. The "planning flood" for all development in all areas of the city is the 1% AEP event.

Recent amendments to the planning guidance including *Planning Circular 21-006* ensures planning proposals consider the flood risks and do not permit residential accommodation in high hazard areas and other land uses on flood prone land where the development cannot effectively evacuate. Approval authorities can develop Special Flood Considerations (SFC) for additional requirements in high hazard areas where additional emergency planning requirements are considered appropriate.

## 5.2 Future Planning Control

Future planning controls for floor level based around the opportunity to provide an increased amenity within the precinct are under development. A Flood Planning Level (FPL) assumes a baseline flood level and applies freeboard to specify the minimum level for potential development. This approach can vary depending on the land use, but an FPL applying to habitable floors of new structures should adopt the future climate horizon flood levels and apply a 0.5m freeboard. The reason for variation by land use is to ensure that the activation of the streetscape is consistent throughout the precinct, noting some areas are lower lying or subject to greater overland flows through the adjacent road reserve. The FPL (m AHD) indicated in Figure 5-2 below applies to the future development, protecting to the 1% AEP flood level in the 2100 climate horizon, accounting for 23% increase in rainfall intensity and sea level rise of 1.3m (upper end of the 95% confidence interval projections).



**Figure 5-2: Floor Levels and Proposed Precinct Structures**



Source: Blackwattle Bay State Significant Precinct – Flood Risk and Impact Assessment

Refer to Appendix F for high resolution map.

## 5.2.1 Emergency Management

### 5.2.1.1 DRAFT guidelines for Shelter-in-place (SIP)

The following draft guidance has been prepared for NSW, and exhibited, but has not been adopted and doesn't reflect the preference of the SES for the emergency response strategy for flooding in new developments or rezoning. If adopted in the future it provides general principles when considering whether to apply SIP controls. Noting that evacuation off-site is always preferable, SIP may be used where:

- The duration for flood inundation is less than six hours



- The development is not located in an area of high-risk (eg, floodways and H5 or H6 flood hazard areas)
- Access to on-site systems to provide power, water and sewerage services during and beyond the event for the full range of flooding
- The location of storage of food, water and medical emergency for SIP purposes should be above the PMF level and available during and beyond the event for the full range of flooding
- SIP floor level is above PMF
- SIP provides a minimum floor space per person
- SIP must be structurally safe and accessible during floods up to the PMF.

Education is critical to ensuring that the community is aware of actions to be taken before, during and after SIP and the key triggers that require SIP. If SIP is proposed there needs to be ongoing community education campaigns for the areas where SIP will apply.

As the areas surrounding Blackwattle Bay are also subject to the same local flash flooding driven flood hazards, there are similar safety concerns in evacuation routes as there are within the precinct itself. Future developer designs should provide safe refuge areas within the development to cater for occupants potentially reluctant to evacuate, given the potential for shallow water temporarily ponding in public domain areas in short intense storms.

#### 5.2.1.2 Support for Emergency Management Guideline

These guidelines provide information on the roles of stakeholders in emergency management and planning. The environment that is prone to flood hazard is broken into emergency response classifications of the community which guides the development of appropriate strategies to mitigate hazards.

Recommendations on planning decisions are provided to guide the future development of areas within or adjacent flood prone land to ensure that development is compatible with existing emergency response plans, and further plans are developed appropriately.

Residual risks of flood hazards throughout the precinct are to be treated with the following key considerations throughout the detailed design development:

- Limiting exposure of people to floodwaters, improving the grading of open spaces to manage overland flow
- Provision of adequate open spaces which are publicly accessible for the itinerant population

### 5.3 Water sensitive design options

Through various stormwater quality improvement opportunities, the construction of new precinct streets, local drainage and lot based drainage systems can facilitate an improved runoff water quality to the trunk drainage system of Sydney Water and Council's local drainage system.

To achieve the desired environmental outcomes with regard to water re-use, rainwater capture from roofs to on-lot rainwater tanks for landscape irrigation and potential internal building reuse in toilets are to be adopted.

Further discussion on the integration of WSUD features into the public domain including potential harvesting and reuse of stormwater is included in the associated Blackwattle Bay Precinct Water Sensitive Urban Design (WSUD) Strategy Report (Mott MacDonald 2023).

## 5.4 Creek naturalisation

The constraints section of this report identifies the limitation of potential use of land with steep topography, existing utility assets and available land for future development preventing creek naturalisation of existing trunk drainage culverts.

There is potential for the opportunity to utilise the Wentworth Park area for naturalised channel sections replacing the trunk culvert system under longer term horizons subject to the loss of functional park area. Naturalisation of the channel through lowering of the existing culvert walls is possible, with lowered overbank areas potentially:

- Increasing flow conveyance capacity of the channel
- Allowing infiltration of stormwater into vegetated overbank areas
- Improving the local habitat potential for various flora and fauna.

**Figure 5-3: Potential lowered bank profiles**



Source: Powells Creek concept naturalisation. © Sydney Water

## 5.5 Local nuisance areas

Within the urban drainage network there are locations of susceptibility to fairly regular nuisance flooding and in larger events, significant hazards to the community. Typically, these locations coincide with elements of the urban drainage network where the capacity of the infrastructure are low. Refer Figure 5.4 for area locations.

### **Bank Street sag point - ponding and overtopping into Blackwattle Bay (Area 1)**

To address the ponding constraints within Bank Street the Blackwattle Bay Design Guidelines and flooding provisions give direction as to possible treatment through infrastructure and design coordination:

- Upgrade existing and/or new drainage to carry flows from the impacted area on Bank Street to the discharge outlet across the proposed Miller Street reserve (Bank Street park)

- Provide overland flow path at the rear of proposed development adjoining the impacted area on Bank Street to the discharge outlet across the proposed Miller Street reserve (Bank Street Park)
- Introduction of a relief flow path that connects ponded road reserve areas to designated low areas in Bank Street Park for overland flow
- The layout of proposed structures allows floodwaters to flow overland through the park to mitigate any potential off-site impacts

An overland flow corridor was established in preliminary designs (as exhibited) for the proposed development of Bank Street Park between Bank Street and Blackwattle Bay, north of the Western Distributor foundations and pier structure. This feature allows overflow from the Bank Street sag location with resulting flood levels within the sag of approximately RL 4.0m AHD.

A piped solution alone is not recommended due to the risk of blockage and residual overland flows, therefore the two measures in combination are to be adopted. Providing a new 0.6m diameter pipe to drain the sag point has the capacity to freely drain the sag point.

#### **Miller Street - ponding and sheet flow beneath the Western Distributor (Area 2)**

This intersection receives overland flow from upstream areas in Miller Street and the adjacent developments. The area is sensitive to additional overland flow as the road reserve is already ponded from regular events. The design for precinct interface includes stormwater mitigation to offset any impacts of the future development and increase the stormwater inlet capacity of the pipe system to better drain the ponded road reserve.

**Figure 5.4: Stormwater Management Opportunity Locations**



Source: Blackwattle Bay State Significant Precinct – Flood Risk and Impact Assessment



## 6 Flood Modelling Results

The following discussion includes reference to flooding conditions that can be observed on the flood maps, provided as outputs of this study. All flood maps are available in the Appendices.

### 6.1 Design scenario results

The maps attached in Appendices A to C indicate the flooding conditions under the developed scenario. Changed flooding conditions indicate flow paths along the new precinct roads following the major-minor flow system. In this approach the overland flows that are in excess of the piped system follow the precinct roads through the discharge into Blackwattle Bay.

Flood hazard is generally H1 across the precinct for the minor storm events, with some isolated areas of H2 and H3 at sag locations, and higher hazard along the gutter line of Bridge Road and Miller Street upstream or adjacent the precinct. In 1% AEP events the H1 hazard is still representative of the conditions across the local precinct streets, with H2, and H3 hazard zones larger than in the minor events at sag points. The PMF event presents high hazard conditions north of Bank Street sag, in Miller Street and along Bridge Road to Wentworth Park. The high hazard conditions are relatively short in their duration at Bank Street and Miller Street, however the high hazard at Bridge Road could be prolonged and is discussed further in section 6.3.

Maps D.1 to D.7 of Appendix D indicate the flood impacts as a result of the project, with the majority of impacts observed along the project interface with Bank Street where level changes of local overland flow routes influence flooding locally.

Maps E.1 to E.5 of Appendix E indicate the preservation of the small areas of flood storage in ponded areas around the precinct. The detailed output of the precinct study floodplain categorisation indicates much wider extents of flood fringe than the regional catchment assessment by Council due to the inclusion of 15min duration storm events and mapping of full model outputs without cut-off depths.

### 6.2 Mitigation of flooding

The worst case flooding experienced across the site is due to short events, where localised storms of high intensity contribute larger runoff volumes than the stormwater system has capacity for. Therefore the mitigation of these worst case flood events involves the:

- Provision of overland flow paths to accommodate overland flows which are in excess of the piped system capacity, and;
- Increases to the piped system capacity to capture greater proportions of the runoff volume.

The overland flow optimisation for mitigating flood hazard includes the provision of wider flow paths where flows can continue downstream at a shallower depth and grading generally to reduce the depth of ponded areas where they occur. This approach must be adopted through the development of the foreshore detailed designs to further eliminate ponding areas such as the Gipps St extension through the former fish market site. Continuity of local streetscape grading to the edge of the promenade will enable overland flows to escape and minimise ponding.

Pit and pipe system upgrades at Bank Street sag point and at the Miller Street intersection at Bank Street serve to capture more water into the piped system to relieve local nuisance ponding in the road reserve.

The stormwater strategy described in section 7.1 covers the pipe system capacity mitigation potential.

### 6.3 Emergency Response/Evacuation Strategy

The opportunities for evacuation are limited to the Pyrmont direction as alternatives through the Wentworth Park area are subject to worse flooding conditions and in some cases high hazard areas. Evacuation to Pyrmont is logical however it is noted that most streets in the area will have low hazard flooding in the most intense 15 to 60minute duration storm events. In longer duration storms evacuation is not required as the flood risk in precinct streets is lower due to the relatively steep terrain of the area and proximity to Blackwattle Bay where overland flows dissipate.

The area of Blackwattle Bay precinct and surrounds is typically flooded to worst case conditions in short and intense storms. Generally the areas susceptible to flooding experience low hazard conditions, H1 and H2 of the hazard classification of flood hazard mapping in Appendix A. Some areas of lower lying topography adjacent the new Sydney Fish Market, Wentworth Park, and within some existing intersections have higher flood hazards (H3 and above) as a result of deeper ponding.

- Wattle Street, from frequent events through to extreme events
- Bank Street sag point, from frequent events through to extreme events
- Gipps Street at the intersection with Bank Street, from frequent events through to extreme events
- Bridge Road, from major (rare) events through to extreme events
- Miller Street, from major (rare) events through to extreme events

Through consultation the SES advised that it doesn't consider SIP suitable as the flood emergency response plan for rezonings and evacuation is the recommended approach to cater for safety of the likely residents, businesses and visitors that would be present based on the proposed development mix.

The preferred evacuation routes are indicated in Appendix H, noting the relatively low hazard environment provides for route options being available to individuals in the case of intense storms and flooding. The evacuation routes do not make use of the City of Sydney emergency planning assembly areas, despite the proximity to Wentworth Park nominated assembly area. This is due to the higher hazard experienced at Bridge Road on approach to Wentworth Park and the duration of inundation being longer at Wentworth Park as discussed below.

#### 6.3.1 Refuge and Muster Points

The nominated evacuation routes are directed towards The Star casino given the location via rising road access from Blackwattle Bay, 24hour operation, visibility from Miller Street, safety from flood inundation and general amenities available. Given the topography and catchment scale, inundation of streets likely lasts less than approximately 1 hour. Muster points at the following locations are recommended, which provide adequate accessible open space and the opportunity to reassess the need for evacuation given the worst of flooding conditions may have passed.

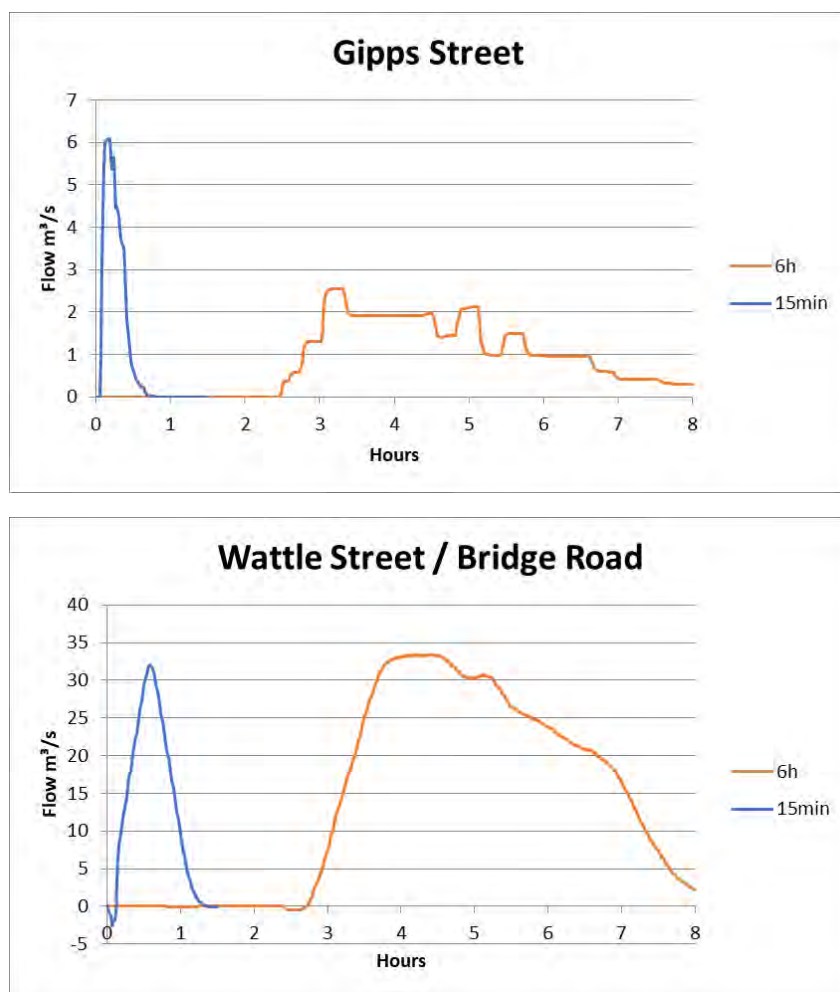
- City West Office Park courtyard, Saunders Street Pyrmont
- Bank Street, south of Miller Street within the precinct public domain areas
- Union Square, Miller Street and Harris Street intersection

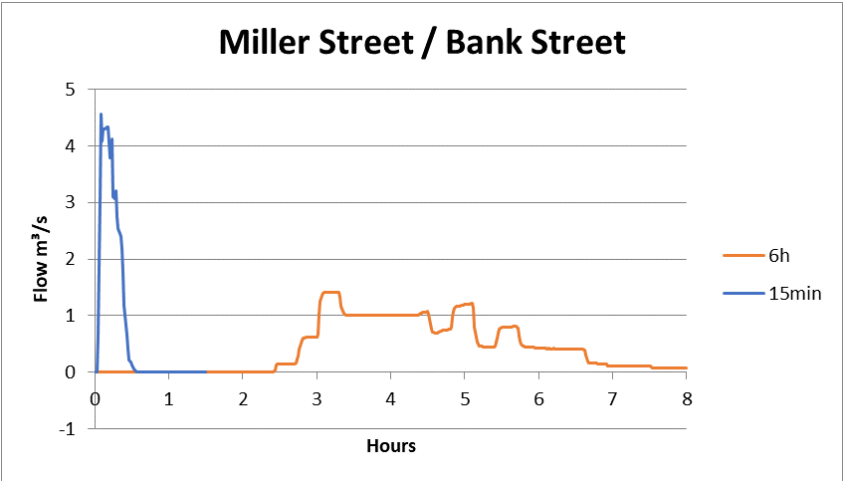


## Bridge Road / Wentworth Park Hazard

The relative flow rates of short and long duration flooding is presented at key locations below to identify the type of overland flow response experienced by the catchment in each situation. For areas in and around the precinct (Miller Street and Gipps Street) there are significantly lower flood hazards experienced in long duration storms due to the flows in short storms being of a higher order of magnitude. Conversely in Bridge Road on approach to the Wattle Street road reserve and into Wentworth Park, the contributing flows from the eastern upstream catchment are significant and in longer duration storms the peak flows are extended, proving unsuitable for evacuation.

**Figure 6.1: PMF Flow rates in key locations**





Due to hazard areas within the existing roads adjacent the precinct, and the short nature of worst case flooding (typically 15 minute to 60 minute storms) design for SIP as backup for failed evacuation is recommended, subject to individual development meeting the requirements set out in section 5.2.1.

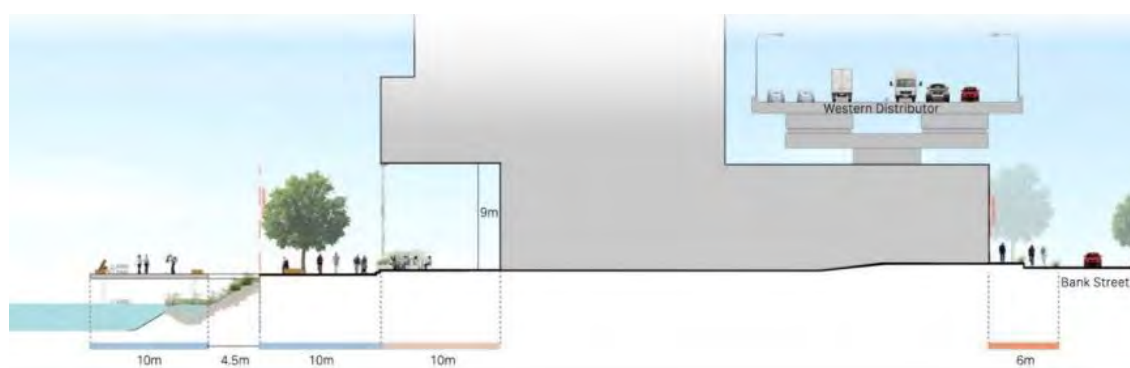
## 7 Storm Water Management

### 7.1 Stormwater Strategy

The existing seawall is likely to receive rehabilitation or replacement with future development, to improve sections which won't have the appropriate design life or change/reconfigure for the purpose of achieving the foreshore promenade. The strategy to reduce the impacts of existing stormwater system constraints on upstream areas through constructing a new pipe system for Blackwattle Bay Precinct local catchments will require stormwater design and seawall/promenade design coordination.

Options available for the seawall replacement sections including shallow or deepwater structural foundations are key in determining an appropriate culvert design level. For the purpose of the flooding assessment the assumption is made that any new pipe adopts the depth of the existing stormwater system where it discharges through the seawall. This configuration is subject to the detailed design of stormwater system, seawall/revetment and optimisation by developers.

**Figure 7.1: Stormwater Design Coordination**



Source: Blackwattle Bay Design Guidelines, INSW

### 7.2 Stormwater Modelling

In assessing the overland flow and resulting flood hazard through the precinct, the small catchment contributing to the majority of the precinct means the causes for worst case flooding conditions are typically surcharging flows or flows in excess of the pit and pipe system capacity.

#### 7.2.1 Model Parameters

A DRAINS analysis of the stormwater network has been adopted for preliminary system sizing for relief of local and trunk system constraints. The ILSAX methodology for assessing pipe capacity for the median temporal pattern from 10 representative temporal patterns was used in accordance with ARR2019. The design storm magnitude selected for analysis of the pipe size is the 5% AEP, with additional flows from larger events to drain overland in the minor/major system approach.

The existing catchments are largely impervious serving to create a relatively large runoff volume from the precinct area. High impervious percentages were retained for sizing of the stormwater

system to provide for sufficient pipe size estimates draining the future development lot areas and road reserves.

### 7.2.2 Existing System

The areas of Pyrmont to the north are captured via pit and pip networks and drained through the precinct via trunk drainage pipes within the land adjacent the waterfront. Limited local drainage connections to the trunk system are assumed for the local precinct catchments. Trunk pipes vary in size and ownership:

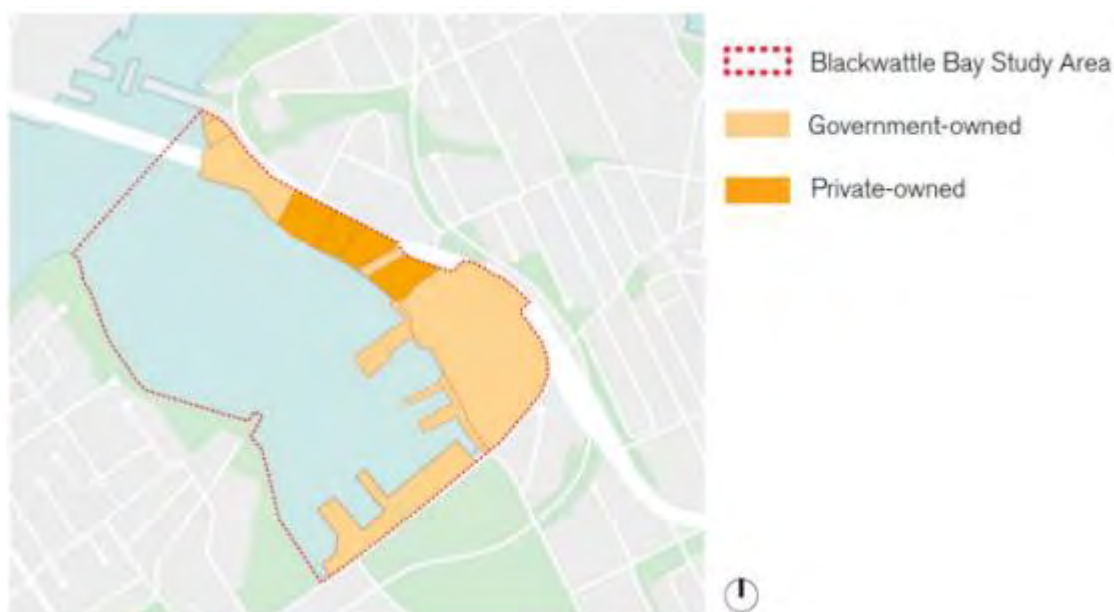
Sydney Water Corporation (SWC) owned drainage assets:

- Gipps Street 1500mm diameter pipe, through government owned land (old Fish Market)
- Miller Street 900mm diameter pipe, through government owned land (TfNSW)

Council owned drainage assets:

- Quarry Master Drive 900mm diameter pipe, through government owned land (TfNSW)
- Bank Street 300mm diameter pipe (to 450mm discharge pipe), through government owned land (TfNSW)

**Figure 7.2: Precinct Ownership areas**



Source: FJMT, Blackwattle Bay State Significant Precinct

### 7.2.3 Proposed System

Nominal pipe sizes for the developed conditions have been provided. These are the recommended minimum pipe diameter to cater for the local catchment runoff, assuming a free draining network. During detailed design there are opportunities to consider replacement/upsizing of the existing Council or Sydney Water asset to best utilise existing easements however this introduces coordination with the existing asset owner and is subject to the existing system being serviceable for an appropriate connection. Pending the development progression (lot size and staging) additional discharge locations to Blackwattle Bay could be required to facilitate development.

Preliminary combined upsizing options for the existing trunk system is presented in Appendix G.

This future stormwater system sizing is subject to further refinement during detailed design for consolidated and individual developments alike, however the benefits of the strategy is observed through review of the flooding behaviour post development.

#### **7.2.4 Results**

The pipes indicated on flood maps for the developed scenario provide sufficient capacity to drain the precinct catchments in a free-draining scenario. That is, sizing of the proposed precinct drainage pipes requires re-assessment where the new precinct pipe is proposed to connect into the existing trunk drainage lines owned by Council or Sydney Water. Due to the upstream catchment areas connected to the existing drainage lines, the hydraulic grade of the existing trunk system in the vicinity of the precinct may preclude a free-draining connection of local stormwater pipes.

## 8 Consultation

In 2022 the initial assessment of flooding for the Blackwattle Bay Precinct future redevelopment was put on exhibition and feedback was sought from stakeholders including:

- SES
- DPE, Environment and Heritage Group

In response to these submissions, further assessment and documentation was provided regarding the flood emergency procedures for the precinct.

Consultation on the proposed development configuration and arrangements for mitigation of flood risk and impacts is being carried out with the SES and EHG on this Flood Risk and Impact Assessment report and precinct design updates generally.

**Table 8.1: Stakeholder submissions and feedback**

| Item                                                                                    | Correspondence                                                                                | Outcomes                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The flood emergency management strategy of 'shelter in place'                           | Response to submissions report and technical response dated 9/11/2022                         | The requirement for shelter-in-place strategy was removed from the recommendations for emergency response.                                                                                                                                                                                                                         |
| Queries made in relation to the magnitude of flood events in the 1% AEP and PMF events. | Response to submissions report and technical response dated 19/10/2022                        | Modelling amendments provided in response to submissions addressed the magnitude of flooding queries.                                                                                                                                                                                                                              |
| Impacts queries for events greater than 1% AEP.                                         |                                                                                               | Impacts for larger events than the 1% AEP were provided in the response.                                                                                                                                                                                                                                                           |
| Mitigation strategies for flood hazard and impacts were queried                         |                                                                                               | Mitigation strategies were noted to be addressed by subsequent design stages.                                                                                                                                                                                                                                                      |
| Future epoch for sea level rise were suggested for further analysis.                    |                                                                                               | Review of future planning horizons was undertaken. The planning recommendations for the State Significant Precinct regarding the response to flooding shall remain as indicated in section 4, with adaptive pathways applied in the future, in accordance with planning guidance.                                                  |
| SES and EHG discussion/presentation on Flood Risk and Impact Assessment report.         | 20 <sup>th</sup> July meeting to discuss outstanding flood risk and emergency planning items. | Revision D of the Flood Risk and Impact Assessment to be provided to SES and EHG to review recent design updates and comment on the inclusion of meeting discussion items/advice.<br>Confirmation on reference IPCC data, mitigation measures and efforts to address hazard, and preferred evacuation approach not to include SIP. |



## 9 Conclusion

In response to the Blackwattle Bay Design Guidelines, the flood risk across the precinct has been assessed under existing and developed conditions. Historical development of infrastructure in an isolated manner has led to the present day situation of constrained land use and lower amenity for residents, businesses, visitors and the environment. Through integrated design and flood risk assessment for the precinct as a whole, the opportunity to realise the full potential of the site in terms of access and recreational activities along the foreshore and future development is balanced with site grading to achieve improvements in flood risk outcomes.

To facilitate the redevelopment of the precinct, constraints identified in this report will be managed in both a short term and long term horizon to support the transition to an improved development offering for the community, and adaptation to the changing climate. Individual development contributions to the net improvement in flood risk through infrastructure upgrades are summarised in section 7.2.

The limited flood storage areas of the site are maintained, although shouldn't be considered a mandatory requirement where they constrain a better development outcome. This is due to the flood storage of small scale areas in relatively steep terrain not providing significant benefit in terms of flood risk management to the adjacent area.

Specific mitigations are proposed to:

- the precinct generally, in terms of grading for management of overland flow, and FPLs that respond to the anticipated actions of climate change
- areas that require additional capacity of stormwater drainage. This is proposed in the form of additional pit and pipe system capacity and also provision for overland flow, where the pit/pipe system capacity is exceeded.

## 10 References

- Blackwattle Bay Catchment Flood Study Model Update – ARR2019 Hydrology (WMAwater, 2020)
- Blackwattle Bay Seawall Assessment (Mott MacDonald, 2022)
- Considering flooding in land use planning guidelines (Planning Circular 21-006), Department of Planning, Industry and Environment 2021
- CSIRO and Bureau of Meteorology, Climate Change in Australia website (<http://www.climatechangeinaustralia.gov.au/>), cited June 2022
- Draft Shelter-in-place Guideline, Department of Planning and Environment 2022
- Flood risk management manual, The policy and manual for the management of flood liable land (DPE, 2023)  
supersedes the Floodplain Development Manual (2005)
- NSW Flood Prone Land Policy and associated Floodplain Risk Management Guidelines
  - Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways (OEH 2015)
  - Flood Impact and Risk Assessment, Flood risk management guideline LU01 (DPE, 2023)
  - Flood Risk Management Measures, Flood risk management guideline MM01 (DPE, 2023)
  - Support for emergency management planning, Flood risk management guideline EM01 (DPE, 2023)
  - Understanding and Managing Floor Risk, Flood risk management guideline - series FB (DPE, 2023)
- Powells Creek naturalisation project archive, <https://www.sydneywatertalk.com.au/powells> (accessed June 2022)
- *Understanding sea-level rise and climate change, and associated impacts on the coastal zone*. CoastAdapt Information Manual 2, National Climate Change Adaptation Research Facility, Gold Coast. (Siebentritt, M., 2016)

## A. Flood Depth Maps

**Map A.1: Existing Conditions - 0.5 EY - Flood Depth**

**Map A.2: Developed Conditions - 0.5 EY - Flood Depth**

**Map A.3: Existing Conditions - 0.2 EY - Flood Depth**

**Map A.4: Developed Conditions - 0.2 EY - Flood Depth**

**Map A.5: Existing Conditions - 10% AEP - Flood Depth**

**Map A.6: Developed Conditions - 10% AEP - Flood Depth**

**Map A.7: Existing Conditions - 5% AEP - Flood Depth**

**Map A.8: Developed Conditions - 5% AEP - Flood Depth**

**Map A.9: Existing Conditions - 1% AEP - Flood Depth**

**Map A.10: Developed Conditions - 1% AEP - Flood Depth**

**Map A.11: Existing Conditions with 9% Climate Change - 1% AEP - Flood Depth**

**Map A.12: Developed Conditions with 9% Climate Change - 1% AEP - Flood Depth**

**Map A.13: Existing Conditions with 23% Climate Change - 1% AEP - Flood Depth**

**Map A.14: Developed Conditions with 23% Climate Change - 1% AEP - Flood Depth**

**Map A.15: Existing Conditions - PMF - Flood Depth**

**Map A.16: Developed Conditions - PMF - Flood Depth**



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

0.5 EY Existing Flood Level

#### 0.5 EY Existing Flood Depth

##### Band 1

<= 0.2000

0.2000 - 0.3000

0.3000 - 0.5000

0.5000 - 0.7500

0.7500 - 1.0000

1.0000 - 1.2500

> 1.2500

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



## Legend

- ▬ Precinct Boundary
- ▬ Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes
- ▬ 0.5 EY Developed Flood Level

### 0.5 EY Developed Flood Depth

#### Band 1

- ▬ <= 0.2000
- ▬ 0.2000 - 0.3000
- ▬ 0.3000 - 0.5000
- ▬ 0.5000 - 0.7500
- ▬ 0.7500 - 1.0000
- ▬ 1.0000 - 1.2500
- ▬ > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.2  
Developed Conditions - 0.5 EY - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

0.2 EY Existing Flood Level

#### 0.2 EY Existing Flood Depth

##### Band 1

<= 0.2000
  0.2000 - 0.3000
  0.3000 - 0.5000
  0.5000 - 0.7500
  0.7500 - 1.0000
  1.0000 - 1.2500
  > 1.2500

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



## Legend

- ▬ Precinct Boundary
- ▬ Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes
- ▬ 0.2 EY Developed Flood Level

### 0.2 EY Developed Flood Depth

#### Band 1

- ▬ <= 0.2000
- ▬ 0.2000 - 0.3000
- ▬ 0.3000 - 0.5000
- ▬ 0.5000 - 0.7500
- ▬ 0.7500 - 1.0000
- ▬ 1.0000 - 1.2500
- ▬ > 1.2500

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Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.4  
Developed Conditions - 0.2 EY - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## Legend

- ▬ Precinct Boundary
- Existing Buildings
- Existing Pipes
- 10% AEP Existing Flood Level

### 10% AEP Existing Flood Depth

#### Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

### Notes:

Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.5  
Existing Conditions - 10% AEP - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



### Legend

- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes
- 10% AEP Developed Flood Level

10% AEP Developed Flood Depth

Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

5% AEP Existing Flood Level

5% AEP Existing Flood Depth

Band 1

<= 0.2000

0.2000 - 0.3000

0.3000 - 0.5000

0.5000 - 0.7500

0.7500 - 1.0000

1.0000 - 1.2500

> 1.2500

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



## Legend

- ▬ Precinct Boundary
- ▬ Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes
- ▬ 5% AEP Developed Flood Level

### 5% AEP Developed Flood Depth

#### Band 1

- ▬ <= 0.2000
- ▬ 0.2000 - 0.3000
- ▬ 0.3000 - 0.5000
- ▬ 0.5000 - 0.7500
- ▬ 0.7500 - 1.0000
- ▬ 1.0000 - 1.2500
- ▬ > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.8  
Developed Conditions - 5% AEP - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes
- 1% AEP Existing Flood Level

1% AEP Existing Flood Depth  
Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



## Legend

- ▬ Precinct Boundary
- ▬ Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes
- ▬ 1% AEP Developed Flood Level

### 1% AEP Developed Flood Depth

#### Band 1

- ▬ <= 0.2000
- ▬ 0.2000 - 0.3000
- ▬ 0.3000 - 0.5000
- ▬ 0.5000 - 0.7500
- ▬ 0.7500 - 1.0000
- ▬ 1.0000 - 1.2500
- ▬ > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.10  
Developed Conditions - 1% AEP - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## Legend

- ▬ Precinct Boundary
- Existing Buildings
- Existing Pipes
- 0.5% AEP Existing Flood Level

### 0.5% AEP Existing Flood Depth

#### Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.11  
Existing Conditions with 9% Climate Change -  
1% AEP - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.5% AEP Developed Flood Level

0.5% AEP Developed Flood Depth

Band 1

<= 0.2000

0.2000 - 0.3000

0.3000 - 0.5000

0.5000 - 0.7500

0.7500 - 1.0000

1.0000 - 1.2500

> 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.

M

M

MOTT  
MACDONALD

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we are

insw

Infrastructure  
New South Wales

075150 m

Coordinate System

GDA 2020 MGA 56

Original Size

A3

Drawn

JR

Height Datum

AHD

Check

JM

Scale

1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.12  
Developed Conditions with 9% Climate Change -  
1% AEP - Flood Depth

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



## Legend

- ▬ Precinct Boundary
- Existing Buildings
- Existing Pipes
- 0.2% AEP Existing Flood Level

### 0.2% AEP Existing Flood Depth

#### Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

### Notes:

Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |                 |
|---------------------------------------------------------------------------------------|-----|-----------------|
| 0                                                                                     | 75  | 150 m           |
|  |     |                 |
| Coordinate System                                                                     |     | GDA 2020 MGA 56 |
| Original Size                                                                         | A3  | Drawn JR        |
| Height Datum                                                                          | AHD | Check JM        |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.13  
Existing Conditions with 23% Climate Change -  
1% AEP - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



### Legend

- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes
- 0.2% AEP Developed Flood Level

0.2% AEP Developed Flood Depth

Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



## Legend

- ▬ Precinct Boundary
- Existing Buildings
- Existing Pipes
- PMF Existing Flood Level

PMF Existing Flood Depth

Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.15  
Existing Conditions - PMF - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## Legend

- ▬ Precinct Boundary
- Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes
- ▬ PMF Developed Flood Level

### PMF Developed Flood Depth Band 1

- <= 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.5000
- 0.5000 - 0.7500
- 0.7500 - 1.0000
- 1.0000 - 1.2500
- > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered  
from mapping.



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|                                                                                       |     |                 |
|---------------------------------------------------------------------------------------|-----|-----------------|
| 0                                                                                     | 75  | 150 m           |
|  |     |                 |
| Coordinate System                                                                     |     | GDA 2020 MGA 56 |
| Original Size                                                                         | A3  | Drawn JR        |
| Height Datum                                                                          | AHD | Check JM        |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map A.16  
Developed Conditions - PMF - Flood Depth

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## **B. Flood Hazard Maps**

**Map B.1: Existing Conditions - 0.5 EY - Flood Hazard**

**Map B.2: Developed Conditions - 0.5 EY - Flood Hazard**

**Map B.3: Existing Conditions - 0.2 EY - Flood Hazard**

**Map B.4: Developed Conditions - 0.2 EY - Flood Hazard**

**Map B.5: Existing Conditions - 10% AEP - Flood Hazard**

**Map B.6: Developed Conditions - 10% AEP - Flood Hazard**

**Map B.7: Existing Conditions - 5% AEP - Flood Hazard**

**Map B.8: Developed Conditions - 5% AEP - Flood Hazard**

**Map B.9: Existing Conditions - 1% AEP - Flood Hazard**

**Map B.10: Developed Conditions - 1% AEP - Flood Hazard**

**Map B.11: Existing Conditions with 9% Climate Change - 1% AEP - Flood Hazard**

**Map B.12: Developed Conditions with 9% Climate Change - 1% AEP - Flood Hazard**

**Map B.13: Existing Conditions with 23% Climate Change - 1% AEP - Flood Hazard**

**Map B.14: Developed Conditions with 23% Climate Change - 1% AEP - Flood Hazard**

**Map B.15: Existing Conditions - PMF - Flood Hazard**

**Map B.16: Developed Conditions - PMF - Flood Hazard**



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

**0.5 EY Existing Flood Hazard Band 1**

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.5 EY Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |    |
|-------------------|-----|-----------------|----|
| 075150 m          |     | Scale           |    |
|                   |     | 1:2,500         |    |
| Coordinate System |     | GDA 2020 MGA 56 |    |
| Original Size     | A3  | Drawn           | JR |
| Height Datum      | AHD | Check           | JM |

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map B.2

Developed Conditions - 0.5 EY - Flood Hazard

Project Number:

Revision No:

Date:

703100678

5

29/09/2023



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

0.2 EY Existing Flood Hazard  
Band 1

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.2 EY Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

10% AEP Existing Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

10% AEP Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

5% AEP Existing Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite



Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

5% AEP Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

1% AEP Existing Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

1% AEP Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |    |
|-------------------|-----|-----------------|----|
| 075150 m          |     | Scale           |    |
|                   |     | 1:2,500         |    |
| Coordinate System |     | GDA 2020 MGA 56 |    |
| Original Size     | A3  | Drawn           | JR |
| Height Datum      | AHD | Check           | JM |

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map B.10

Developed Conditions - 1% AEP - Flood Hazard

Project Number:

Revision No:

Date:

703100678

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29/09/2023



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

#### 0.5% AEP Existing Flood Hazard Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |
|-------------------|-----|
| 075150 m          |     |
| Coordinate System |     |
| GDA 2020 MGA 56   |     |
| Original Size     | A3  |
| Height Datum      | AHD |
| Drawn             | JR  |
| Check             | JM  |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map B.11

Existing Conditions with 9% Climate Change -

1% AEP - Flood Hazard

|                 |            |
|-----------------|------------|
| Project Number: | 703100678  |
| Revision No:    | 5          |
| Date:           | 29/09/2023 |



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

#### 0.5% AEP Developed Flood Hazard

##### Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |     |                        |       |       |  |
|------------------------|-----|------------------------|-------|-------|--|
| 0                      |     | 75                     |       | 150 m |  |
| <div><div></div></div> |     | <div><div></div></div> |       |       |  |
| Coordinate System      |     | GDA 2020 MGA 56        |       |       |  |
| Original Size          | A3  |                        | Drawn | JR    |  |
| Height Datum           | AHD |                        | Check | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map B.12

Developed Conditions with 9% Climate Change - 1% AEP - Flood Hazard

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

0.2% AEP Existing Flood Hazard  
Band 1

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

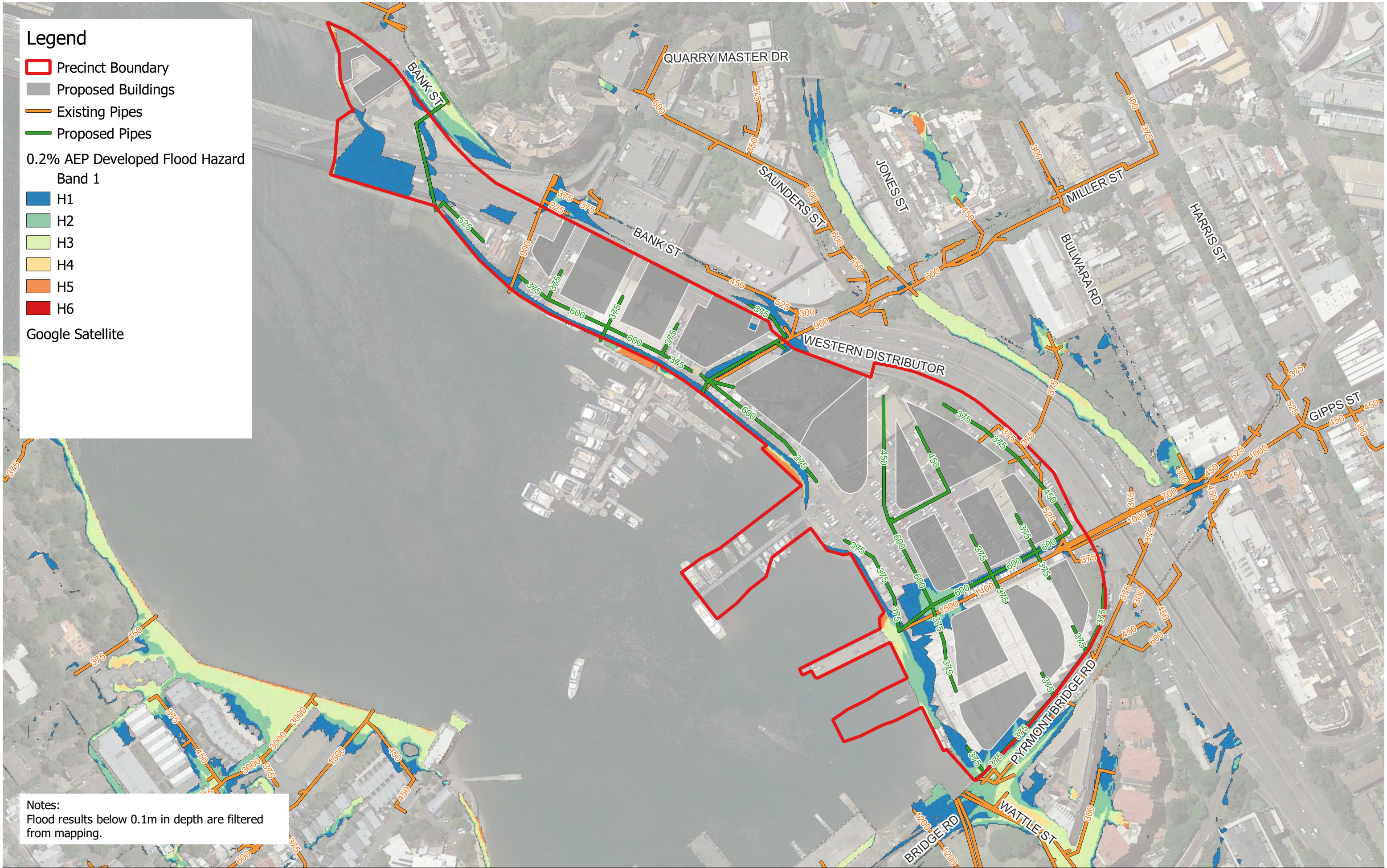
- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes

0.2% AEP Developed Flood Hazard

Band 1

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



Legend

Precinct Boundary

Existing Buildings

Existing Pipes

PMF Existing Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

PMF Developed Flood Hazard

Band 1

H1

H2

H3

H4

H5

H6

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



## C. Flood Velocity Maps

**Map C.1: Existing Conditions - 0.5 EY - Flood Velocity**

**Map C.2: Developed Conditions - 0.5 EY - Flood Velocity**

**Map C.3: Existing Conditions - 0.2 EY - Flood Velocity**

**Map C.4: Developed Conditions - 0.2 EY - Flood Velocity**

**Map C.5: Existing Conditions - 10% AEP - Flood Velocity**

**Map C.6: Developed Conditions - 10% AEP - Flood Velocity**

**Map C.7: Existing Conditions - 5% AEP - Flood Velocity**

**Map C.8: Developed Conditions - 5% AEP - Flood Velocity**

**Map C.9: Existing Conditions - 1% AEP - Flood Velocity**

**Map C.10: Developed Conditions - 1% AEP - Flood Velocity**

**Map C.11: Existing Conditions with 9% Climate Change - 1% AEP - Flood Velocity**

**Map C.12: Developed Conditions with 9% Climate Change - 1% AEP - Flood Velocity**

**Map C.13: Existing Conditions with 23% Climate Change - 1% AEP - Flood Velocity**

**Map C.14: Developed Conditions with 23% Climate Change - 1% AEP - Flood Velocity**

**Map C.15: Existing Conditions - PMF - Flood Velocity**

**Map C.16: Developed Conditions - PMF - Flood Velocity**



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

**0.5 EY Existing Flood Velocity Band 1**

- <0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

Google Satellite



**Notes:**  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.5 EY Developed Flood Velocity

Band 1

<0.5
  0.5 - 1.0
  1.0 - 1.5
  1.5 - 2.0
  >2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |     |    |                 |       |  |
|------------------------|-----|----|-----------------|-------|--|
| 0                      |     | 75 |                 | 150 m |  |
| <div><div></div></div> |     |    |                 |       |  |
| Coordinate System      |     |    | GDA 2020 MGA 56 |       |  |
| Original Size          | A3  |    | Drawn           | JR    |  |
| Height Datum           | AHD |    | Check           | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map C.2  
Developed Conditions - 0.5 EY - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

0.2 EY Existing Flood Velocity  
Band 1

- <0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

Google Satellite



**Notes:**  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.2 EY Developed Flood Velocity

Band 1

<0.5
  0.5 - 1.0
  1.0 - 1.5
  1.5 - 2.0
  >2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |     |    |                 |       |  |
|------------------------|-----|----|-----------------|-------|--|
| 0                      |     | 75 |                 | 150 m |  |
| <div><div></div></div> |     |    |                 |       |  |
| Coordinate System      |     |    | GDA 2020 MGA 56 |       |  |
| Original Size          | A3  |    | Drawn           | JR    |  |
| Height Datum           | AHD |    | Check           | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map C.4  
Developed Conditions - 0.2 EY - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



**Legend**

- Precinct Boundary
- Existing Buildings
- Existing Pipes

10% AEP Existing Flood Velocity  
Band 1

- <0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- >2.0

Google Satellite



**Notes:**  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

10% AEP Developed Flood Velocity

Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |    |       |  |
|-------------------|-----|-----------------|----|-------|--|
| 0                 |     | 75              |    | 150 m |  |
| <div></div>       |     | <div></div>     |    |       |  |
| Coordinate System |     | GDA 2020 MGA 56 |    |       |  |
| Original Size     | A3  | Drawn           | JR |       |  |
| Height Datum      | AHD | Check           | JM |       |  |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map C.6

Developed Conditions - 10% AEP - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

5% AEP Existing Flood Velocity Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |     |    |                 |       |  |
|------------------------|-----|----|-----------------|-------|--|
| 0                      |     | 75 |                 | 150 m |  |
| <div><div></div></div> |     |    |                 |       |  |
| Coordinate System      |     |    | GDA 2020 MGA 56 |       |  |
| Original Size          | A3  |    | Drawn           | JR    |  |
| Height Datum           | AHD |    | Check           | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map C.7  
Existing Conditions - 5% AEP - Flood Velocity

Project Number:

703100678

Revision No:

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Date:

29/09/2023



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

5% AEP Developed Flood Velocity

Band 1

<0.5
  0.5 - 1.0
  1.0 - 1.5
  1.5 - 2.0
  >2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

1% AEP Existing Flood Velocity  
Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

1% AEP Developed Flood Velocity

Band 1

<0.5
  0.5 - 1.0
  1.0 - 1.5
  1.5 - 2.0
  >2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |       |       |  |
|-------------------|-----|-----------------|-------|-------|--|
| 0                 |     | 75              |       | 150 m |  |
| <div></div>       |     | <div></div>     |       |       |  |
| Coordinate System |     | GDA 2020 MGA 56 |       |       |  |
| Original Size     | A3  |                 | Drawn | JR    |  |
| Height Datum      | AHD |                 | Check | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map C.10  
Developed Conditions - 1% AEP - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

#### 0.5% AEP Existing Flood Velocity Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |                 |
|-------------------|-----------------|
| 075150 m          |                 |
| <div></div>       |                 |
| Coordinate System | GDA 2020 MGA 56 |
| Original Size     | A3              |
| Height Datum      | AHD             |
| Drawn             | JR              |
| Check             | JM              |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map C.11

Existing Conditions with 9% Climate Change -

1% AEP - Flood Velocity

|                 |            |
|-----------------|------------|
| Project Number: | 703100678  |
| Revision No:    | 5          |
| Date:           | 29/09/2023 |



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.5% AEP Developed Flood Velocity

Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |  |     |                 |       |    |
|------------------------|--|-----|-----------------|-------|----|
| 0                      |  | 75  |                 | 150 m |    |
| <div><div></div></div> |  |     |                 |       |    |
| Coordinate System      |  |     | GDA 2020 MGA 56 |       |    |
| Original Size          |  | A3  |                 | Drawn | JR |
| Height Datum           |  | AHD |                 | Check | JM |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map C.12

Developed Conditions with 9% Climate Change - 1% AEP - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



### Legend

Precinct Boundary

Existing Buildings

Existing Pipes

0.2% AEP Existing Flood Velocity

Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.2% AEP Developed Flood Velocity

Band 1

<0.5

0.5 - 1.0

1.0 - 1.5

1.5 - 2.0

>2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                        |     |    |                 |       |  |
|------------------------|-----|----|-----------------|-------|--|
| 0                      |     | 75 |                 | 150 m |  |
| <div><div></div></div> |     |    |                 |       |  |
| Coordinate System      |     |    | GDA 2020 MGA 56 |       |  |
| Original Size          | A3  |    | Drawn           | JR    |  |
| Height Datum           | AHD |    | Check           | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map C.14

Developed Conditions with 23% Climate Change

- 1% AEP - Flood Velocity

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



**Legend**

-  Precinct Boundary
-  Existing Buildings
-  Existing Pipes

PMF Existing Flood Velocity  
Band 1

-  <0.5
-  0.5 - 1.0
-  1.0 - 1.5
-  1.5 - 2.0
-  >2.0

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

PMF Developed Flood Velocity

Band 1

<0.5
  0.5 - 1.0
  1.0 - 1.5
  1.5 - 2.0
  >2.0

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.



## **D. Flood Impact Maps**

**Map D.1: Afflux - Flood Depth Difference - 0.5 EY**

**Map D.2: Afflux - Flood Depth Difference - 0.2 EY**

**Map D.3: Afflux - Flood Depth Difference - 10% AEP**

**Map D.4: Afflux - Flood Depth Difference - 5% AEP**

**Map D.5: Afflux - Flood Depth Difference - 1% AEP**

**Map D.6: Afflux - Flood Depth Difference - 1% AEP with Climate Change**

**Map D.7: Afflux - Flood Depth Difference - PMF**



## Legend

- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes

### 0.5 EY Flood Depth Difference

#### Band 1

- $\leq -0.2$
- $-0.2 - -0.1$
- $-0.1 - -0.01$
- $-0.01 - 0.01$
- $0.01 - 0.1$
- $0.1 - 0.2$
- $> 0.2$

### 0.5 EY Flood Difference

#### Band 1

- Was Wet Now Dry
- Was Dry Now Wet

Google Satellite

### Notes:

Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.1  
Afflux - Flood Depth Difference - 0.5 EY

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



### Legend

- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes

0.2 EY Flood Depth Difference  
Band 1

- $\leq -0.2$
- $-0.2 - -0.1$
- $-0.1 - -0.01$
- $-0.01 - 0.01$
- $0.01 - 0.1$
- $0.1 - 0.2$
- $> 0.2$

0.2 EY Flood Difference  
Band 1

- Was Wet Now Dry
- Was Dry Now Wet

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

#### 1% AEP Flood Depth Difference Band 1

<= -0.2

-0.2 - -0.1

-0.1 - -0.01

-0.01 - 0.01

0.01 - 0.1

0.1 - 0.2

> 0.2

#### 1% AEP Flood Difference Band 1

Was Wet Now Dry

Was Dry Now Wet

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |    |
|-------------------|-----|-----------------|----|
| 075150 m          |     | Scale1:2,500    |    |
| Coordinate System |     | GDA 2020 MGA 56 |    |
| Original Size     | A3  | Drawn           | JR |
| Height Datum      | AHD | Check           | JM |

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.3  
Afflux - Flood Depth Difference - 10% AEP

Project Number: 703100678

Revision No: 5

Date: 29/09/2023



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

5% AEP Flood Depth Difference

Band 1

<= -0.2

-0.2 - -0.1

-0.1 - -0.01

-0.01 - 0.01

0.01 - 0.1

0.1 - 0.2

> 0.2

5% AEP Flood Difference

Band 1

Was Wet Now Dry

Was Dry Now Wet

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.

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we are insw

Infrastructure  
New South Wales

075150 m

Scale  
1:2,500

|                   |     |                 |    |
|-------------------|-----|-----------------|----|
| Coordinate System |     | GDA 2020 MGA 56 |    |
| Original Size     | A3  | Drawn           | JR |
| Height Datum      | AHD | Check           | JM |

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.4  
Afflux - Flood Depth Difference - 5% AEP

Project Number:  
Revision No:  
Date:

703100678  
5  
29/09/2023



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

1% AEP Flood Depth Difference

Band 1

<= -0.2

-0.2 - -0.1

-0.1 - -0.01

-0.01 - 0.01

0.01 - 0.1

0.1 - 0.2

> 0.2

1% AEP Flood Difference

Band 1

Was Wet Now Dry

Was Dry Now Wet

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.

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we are insw

Infrastructure  
New South Wales

075150 m

Coordinate SystemGDA 2020 MGA 56

Original SizeA3

Height DatumAHD

DrawnJR

CheckJM

Scale1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.5  
Afflux - Flood Depth Difference - 1% AEP

Project Number:703100678

Revision No:5

Date:29/09/2023



## Legend

- ▬ Precinct Boundary
- ▬ Proposed Buildings
- ▬ Existing Pipes
- ▬ Proposed Pipes

### 0.2% AEP Flood Depth Difference

Band 1

- ▬  $\leq -0.2$
- ▬  $-0.2 - -0.1$
- ▬  $-0.1 - -0.01$
- ▬  $-0.01 - 0.01$
- ▬  $0.01 - 0.1$
- ▬  $0.1 - 0.2$
- ▬  $> 0.2$

### 0.2% AEP Flood Difference

Band 1

- ▬ Was Wet Now Dry
- ▬ Was Dry Now Wet

Google Satellite

### Notes:

Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.6  
Afflux - Flood Depth Difference - 1% AEP with  
Climate Change

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## Legend

- Precinct Boundary
- Proposed Buildings
- Existing Pipes
- Proposed Pipes

### PMF Flood Depth Difference

#### Band 1

- $\leq -0.2$
- $-0.2 - -0.1$
- $-0.1 - -0.01$
- $-0.01 - 0.01$
- $0.01 - 0.1$
- $0.1 - 0.2$
- $> 0.2$

### PMF Flood Difference

#### Band 1

- Was Wet Now Dry
- Was Dry Now Wet

Google Satellite

### Notes:

Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map D.7  
Afflux - Flood Depth Difference - PMF

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## **E. Floodplain Hydraulic Categorisation Maps**

**Map E.1: Developed Conditions - 0.5 EY Floodplain Categorisation**

**Map E.2: Developed Conditions - 0.2 EY Floodplain Categorisation**

**Map E.3: Developed Conditions – 10% AEP Floodplain Categorisation**

**Map E.4: Developed Conditions – 5% AEP Floodplain Categorisation**

**Map E.5: Developed Conditions – 1% AEP Floodplain Categorisation**

**Map E.6: Developed Conditions – PMF Floodplain Categorisation**



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.5 EY Floodplain Categorisation

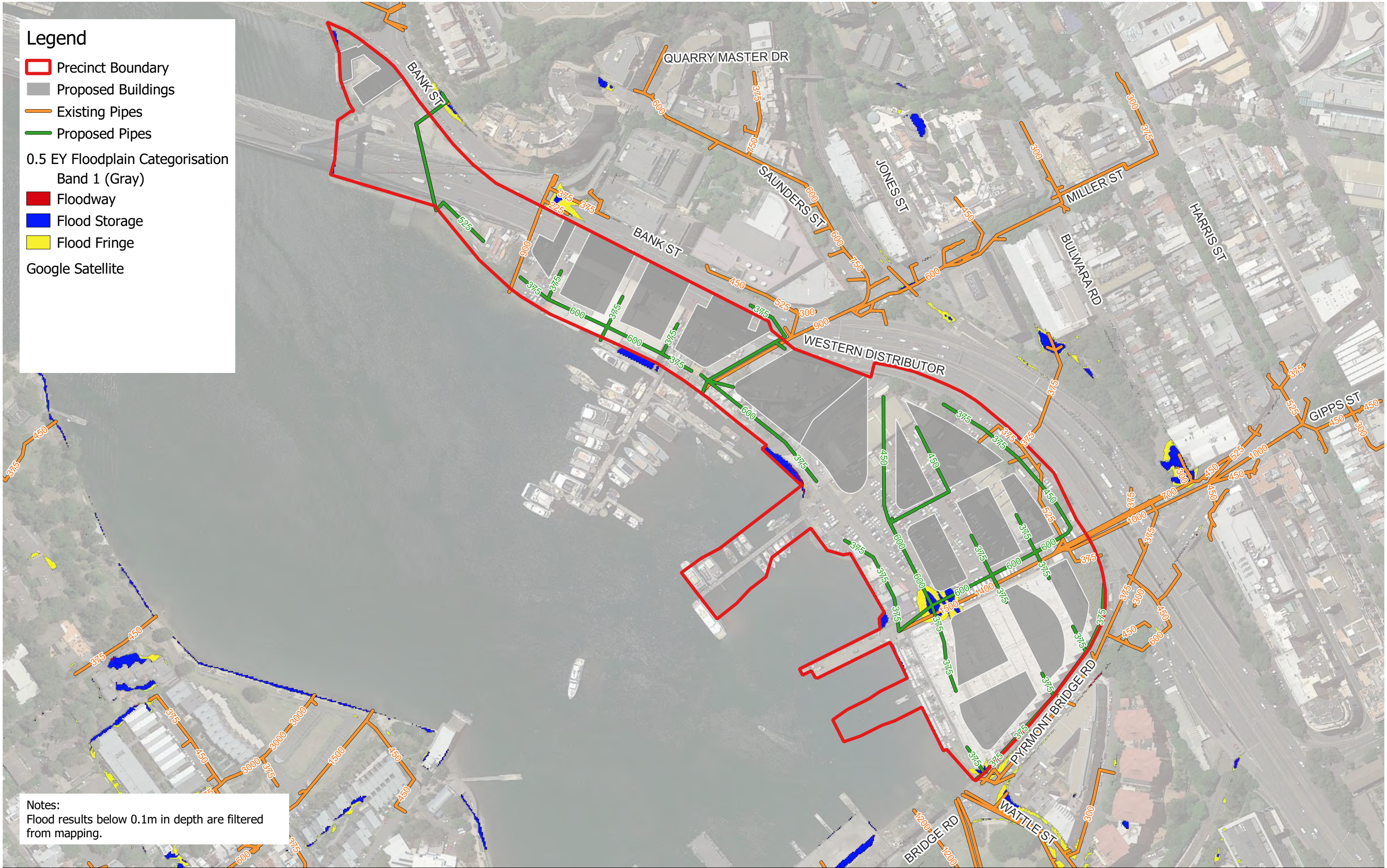
Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

0.2 EY Floodplain Categorisation

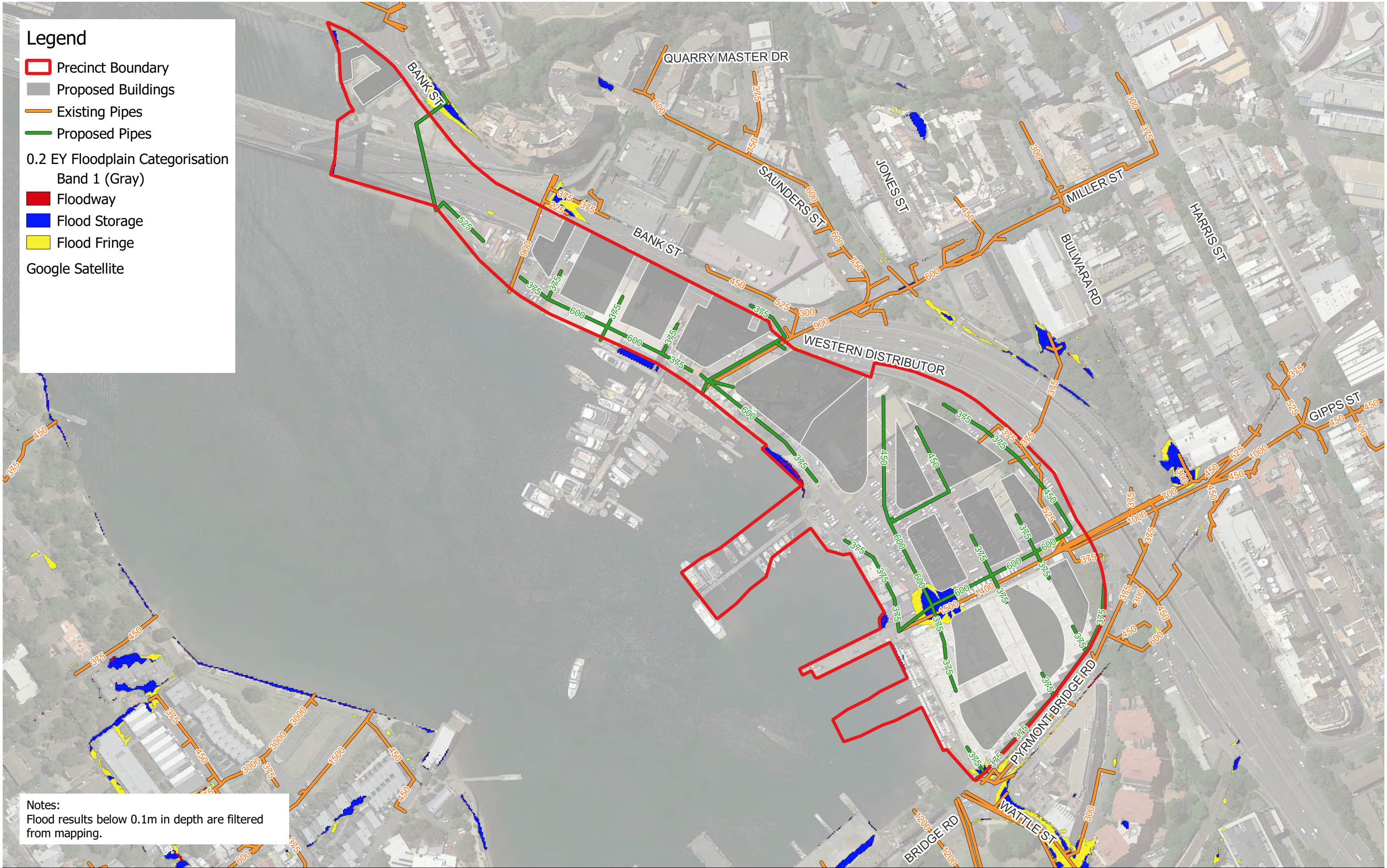
Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

#### 10% AEP Floodplain Categorisation

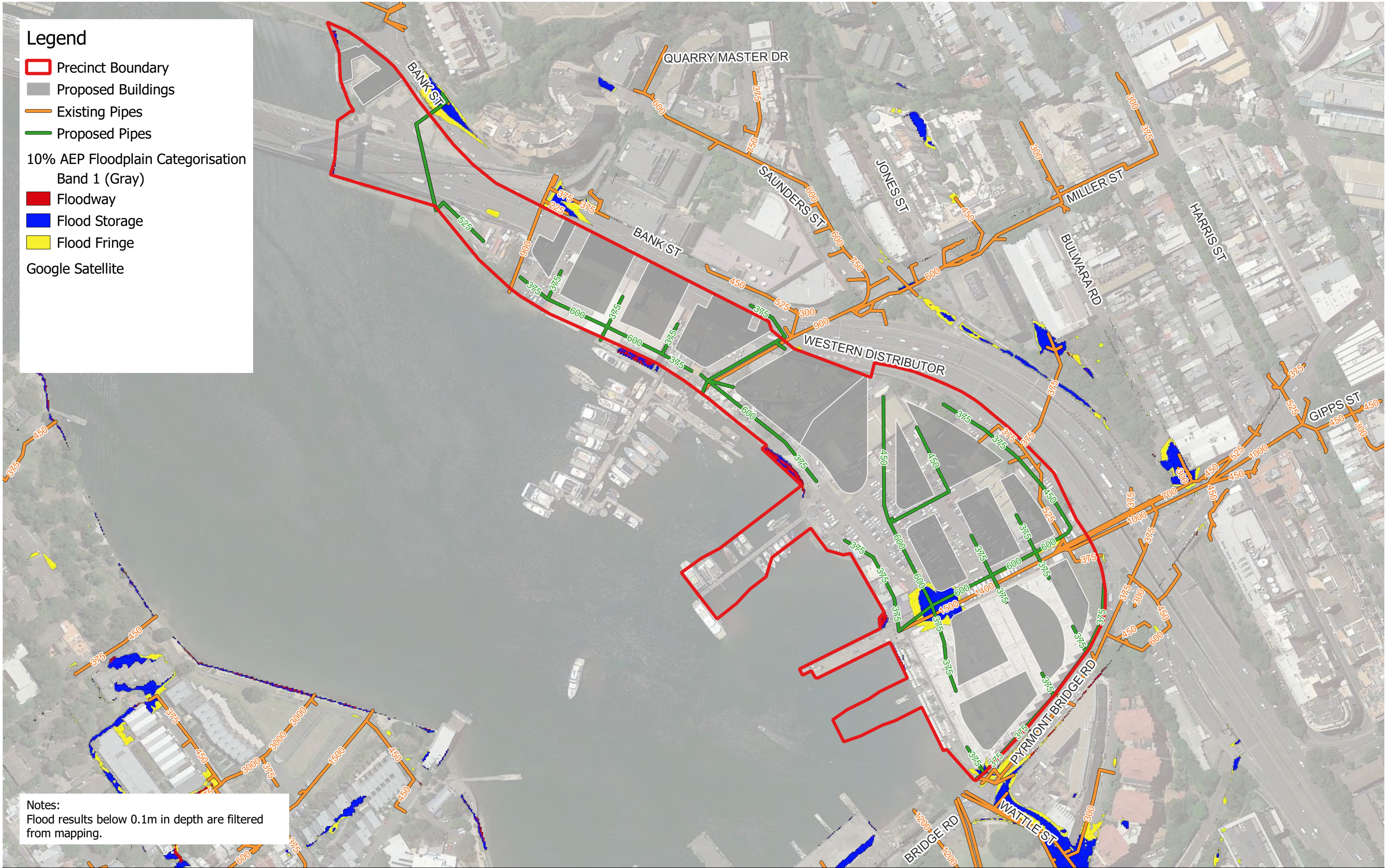
Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



### Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

#### 5% AEP Floodplain Categorisation

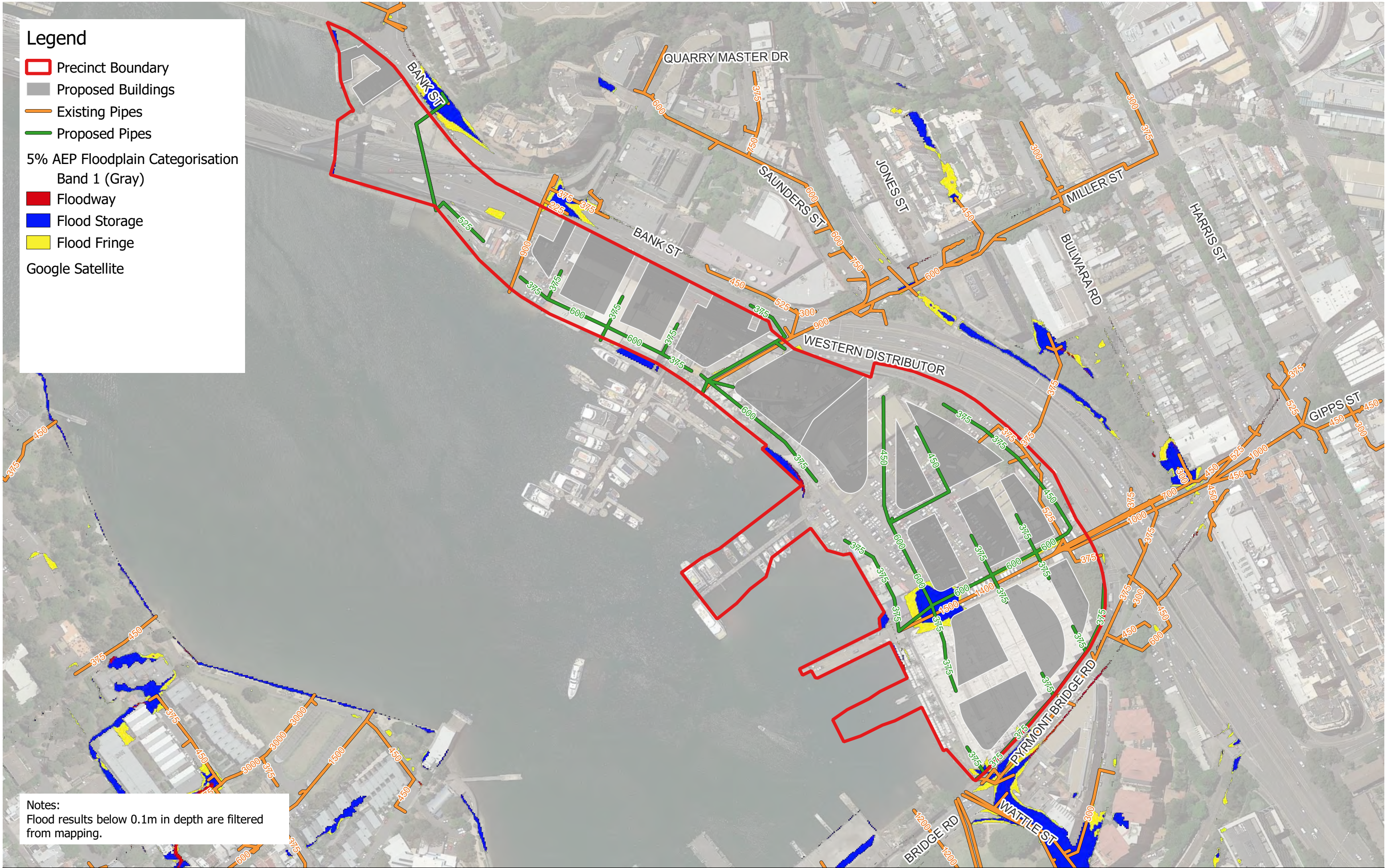
Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite





Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

1% AEP Floodplain Categorisation

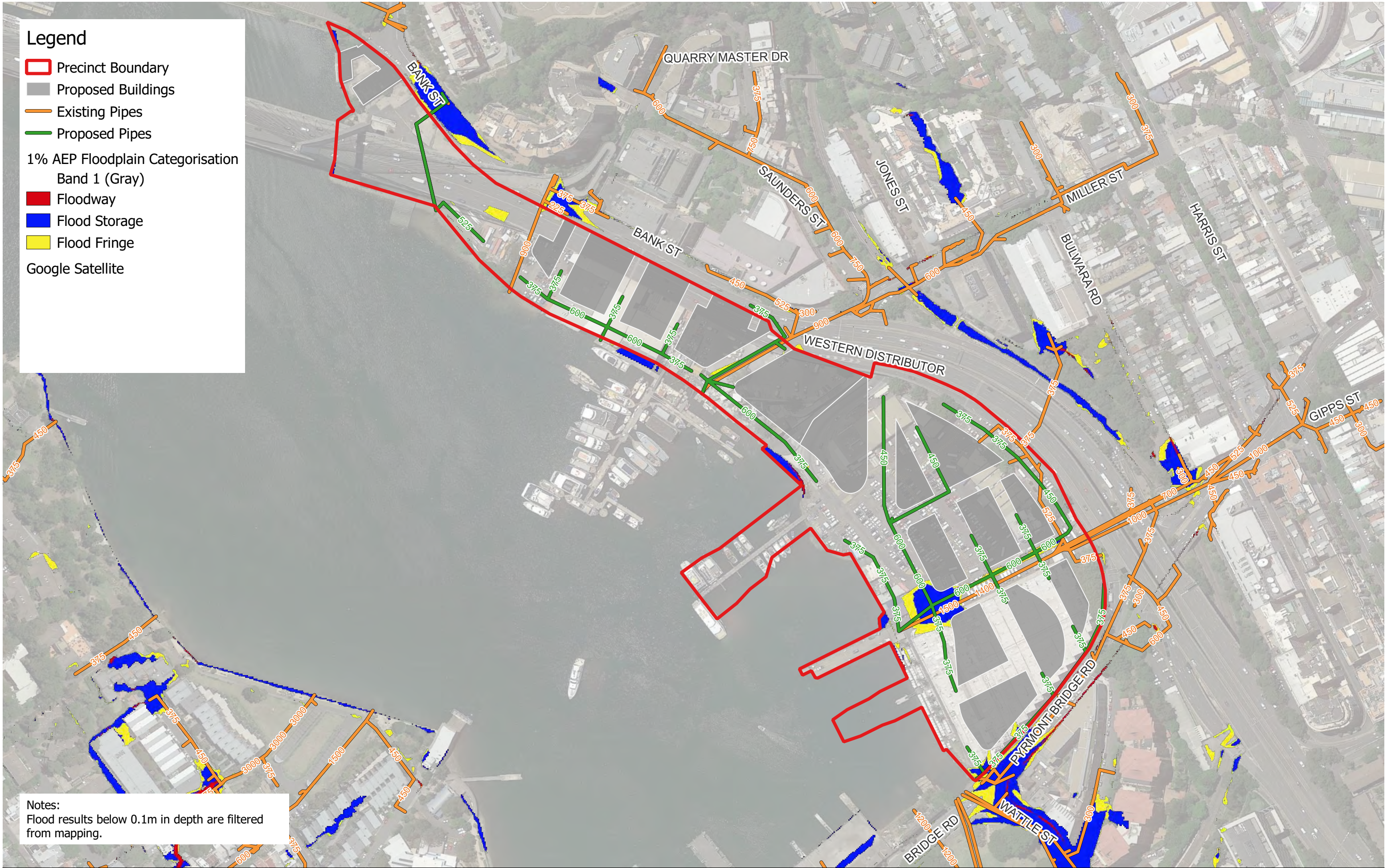
Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



Legend

Precinct Boundary

Proposed Buildings

Existing Pipes

Proposed Pipes

PMF Floodplain Categorisation

Band 1 (Gray)

Floodway

Flood Storage

Flood Fringe

Google Satellite

Notes:

Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |       |       |  |
|-------------------|-----|-----------------|-------|-------|--|
| 0                 |     | 75              |       | 150 m |  |
| <div></div>       |     | <div></div>     |       |       |  |
| Coordinate System |     | GDA 2020 MGA 56 |       |       |  |
| Original Size     | A3  |                 | Drawn | JR    |  |
| Height Datum      | AHD |                 | Check | JM    |  |

Scale

1:2,500

Blackwattle Bay Precinct

Flood Risk and Impact Assessment

Map E.6

Developed Conditions - PMF Floodplain

Categorisation

Project Number:

703100678

Revision No:

5

Date:

29/09/2023



# F. Flood Planning Level Map

Map F.1: Developed Conditions – 1% AEP Flood Planning Levels



# Legend

- Flood Planning Levels (m AHD)
  - ▭ Precinct Boundary
  - ▭ Proposed Buildings
  - Existing Pipes
  - Proposed Pipes
- 1% AEP Developed Flood Depth  
Band 1
- ≤ 0.2000
  - 0.2000 - 0.3000
  - 0.3000 - 0.5000
  - 0.5000 - 0.7500
  - 0.7500 - 1.0000
  - 1.0000 - 1.2500
  - > 1.2500

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.



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|                                                                                       |     |    |                 |       |  |
|---------------------------------------------------------------------------------------|-----|----|-----------------|-------|--|
| 0                                                                                     |     | 75 |                 | 150 m |  |
|  |     |    |                 |       |  |
| Coordinate System                                                                     |     |    | GDA 2020 MGA 56 |       |  |
| Original Size                                                                         | A3  |    | Drawn           | JR    |  |
| Height Datum                                                                          | AHD |    | Check           | JM    |  |

Scale  
1:2,500



Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map F.1  
Developed Conditions - 1% AEP - Flood Planning Levels

Project Number: 703100678  
Revision No: 5  
Date: 29/09/2023



## G. Stormwater System Upgrade Options

This summary provides preliminary options for the upsizing of existing trunk system to achieve the additional capacity required to service the new development of the precinct.

- The Council drainage system at Bank Street sag has a 300mm diameter pipe connected to a 450mm diameter pipe through the TfNSW (formerly RMS) land to Blackwattle Bay. To satisfy the Blackwattle Bay Design Guidelines in providing a benefit (not worsening) to flood hazard at the sag point generally, an upgraded 600mm diameter connection to Blackwattle Bay is proposed. This upsizing limits the developed conditions flood hazard in the 5% AEP event to H1. Under existing conditions this sag point has widespread H2 hazard transitioning to H3 as it overtops and spills out of the road reserve to the south.
- No upgrade is proposed to the Quarry Master Drive drainage system through the Bank Street Park (TfNSW land). The sites to the east of this location under private ownership are anticipated to provide their own internal stormwater management system for direct discharge to Blackwattle Bay. Indicative sizing of this system is indicated on the developed scenario flood maps.
- Miller Street trunk system upgrades involves replacement of the existing SWC 900mm diameter stormwater pipe with a new 1350mm diameter pipe through the TfNSW (formerly RMS) Miller Street road reserve extension. This single pipe is the equivalent of the existing 900mm diameter and additional 750mm diameter indicative line shown on the developed scenario flood maps. This option provides the 5% AEP capacity to the system, noting the existing SWC pipes do not meet this design capacity currently.
- The proposed Gipps Street reserve aligns with existing SWC 1.5m diameter trunk drainage line. Due to limited capacity of the existing trunk drainage line and anticipated cover constraints to this line a new trunk drainage line is proposed for the precinct drainage on the northern verge of future Gipps Street.
- The constraints to performing a stormwater upgrade to the existing trunk drainage line in Bridge Road are considerable, and it's assumed that development interfacing with Bridge Road is to provide additional and separate piped drainage network along the western verge of Bridge Road to discharge at Blackwattle Bay. Alternatively this drainage system could connect to the new/upgraded system in Gipps Street.



# H. Evacuation Routes



### Legend

- Potential Muster Points
- Vehicle Escape
- Pedestrian Escape
- Precinct Boundary
- Proposed Buildings

1% AEP Developed Flood Hazard  
Band 1

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite



Notes:  
Flood results below 0.1m in depth are filtered from mapping.



**Legend**

- Potential Muster Points
- Vehicle Escape
- Pedestrian Escape
- Precinct Boundary
- Proposed Buildings

PMF Developed Flood Hazard  
Band 1

- H1
- H2
- H3
- H4
- H5
- H6

Google Satellite

Notes:  
Flood results below 0.1m in depth are filtered from mapping.

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|                   |     |                 |       |       |  |
|-------------------|-----|-----------------|-------|-------|--|
| 0                 |     | 75              |       | 150 m |  |
| <div></div>       |     | <div></div>     |       |       |  |
| Coordinate System |     | GDA 2020 MGA 56 |       |       |  |
| Original Size     | A3  |                 | Drawn | JR    |  |
| Height Datum      | AHD |                 | Check | JM    |  |

Scale  
1:2,500

Blackwattle Bay Precinct  
Flood Risk and Impact Assessment

Map H.2  
Developed Conditions - PMF - Flood Evacuation Routes

|                 |            |
|-----------------|------------|
| Project Number: | 703100678  |
| Revision No:    | 5          |
| Date:           | 29/09/2023 |



