Transport
for NSW

Central Precinct Renewal Program

Water Quality, Flooding and Stormwater Report

July 2022

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Acknowledgement of Country

We respectfully acknowledge the Traditional Custodians of the Central Precinct, the Gadigal and recognise the importance of place to Aboriginal people and their continuing connection to Country and culture. We pay our respect to Elders past, present and emerging.

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Document control

Authors	Arcadis Australia Pacific Pty Limited
Approved by	Transport for NSW
Branch	IP Development
Division	Infrastructure and Place (IP)

Versions

Version	Amendment notes
0.1	Final for CPRP Public Exhibition 2022

Abbreviations

Abbreviation	Definition
AEP	Annual Exceedance Probability - The probability of an event being equalled or exceeded within a year.
ARI	Average Recurrence Interval
BOOS	Bondi Ocean Outfall Sewer
CBD	Central Business District
CoS	City of Sydney Council
Council	City of Sydney Council
CPRP	Central Precinct Renewal Project
DCP	Development control plan
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
GANSW	Government Architect NSW
GFA	Gross floor area
IWCM	Integrated Water Cycle Management
LEP	Local Environment Plan
LGA	The City of Sydney local government area
mAHD	Elevation in metres with respect to the Australian Height Datum
NSW EPA	New South Wales Environmental Protection Authority
OSD	Over Station Development
PMF	Probable Maximum Flood
RL	Reduced level, measured in units of mAHD
SMP	Stormwater Management Plan
SSP	State Significant Precinct
SWC	Sydney Water Corporation
TfNSW	Transport for NSW
WSUD	Water Sensitive Urban Design

Definitions

Term	Definition
Amenity	The extent to which a place, experience or service is pleasant, attractive or comfortable. Improved features, facilities or services may contribute to increase amenity.
Annual Exceedance Probability (AEP)	The probability of an event being equalled or exceeded within a year.
Central Precinct	Central Precinct State Significant Precinct
Central Sydney	Land identified as Central Sydney under the Sydney Local Environmental Plan 2012 and represents the Metropolitan Centre of Sydney. Central Sydney includes Sydney's Central Business District
Character	The combination of the attributes, characteristics and qualities of a place (GANSW, 2021, Draft Urban Design Guide)
Community	Particular types of stakeholder and refers to groups of people in particular places who are both affected by our work and experience the outcomes and benefits of our activities
Control	A numerical standard that is applied in a prescriptive manner
Corridor	A broad, linear geographical area between places
Council	The City of Sydney Council
District Plan	means the Eastern City District Plan
Goods Line	The official name for the partly elevated walkway from Central Station to Darling Harbour following the route of a disused railway line
Interchange	A facility to transfer from one mode of transport or one transport service to another. For example, a station with an adjoining light rail stop
Lugeon Value	Used to estimate hydraulic conductivity (litres per minute per metre borehole at an overpressure of 1 megapascal)
Mobility	The ability to move or be moved easily and without constraints
Mortuary Station	The building formerly used as a railway station on the Rookwood Cemetery railway line, now disused
Over rail corridor development or Over Station Development	Development of air space over railway corridors
Permeability	Measure of how easily water can pass through material, dependent on pore size, tortuosity and surface area.
Planning instrument	Means any of the following: • strategic plan (comprising regional strategic plans and district strategic plans) and local strategic planning statements • environmental planning instrument (comprising State environmental planning policies and local environmental plans) development control plan
Precinct	Geographical area with boundaries determined by land use and other unique characteristics. For example, an area where there is an agglomeration of warehouses may be termed a freight precinct
Proponent	Transport for NSW

Term	Definition
Proposal	Proposed amendments to the planning framework
Public spaces	means areas that are publicly accessible where people can interact with each other and make social connections
Rail network	means the rail infrastructure in NSW
Railway corridor	The land within Central Precinct on which a railway is built; comprising all property between property fences, or if no fences, everywhere within 15m from the outermost rails. Under planning legislation rail corridor is defined as land: a) that is owned, leased, managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities: or b) that is zoned under an environmental planning instrument predominately or solely for development of the purpose of a railway or rail infrastructure facilities
Reference Master Plan	A non-statutory document that shows one way in which the precinct may develop in the future in accordance with the proposed amendments to the planning framework Note: Refer to the GANSW Advisory Note v2, dated 12/09/2018 for further guidance
Siding	A short stretch of rail track used to store rolling stock or enable trains on the same line to pass
State	The state of New South Wales
State Significant Precinct	The areas with state or regional planning significance because of their social, economic or environmental characteristics
Strategic Framework	The document prepared by Transport for NSW for Central Precinct in 2021 that addresses key matters including vision, priorities, public space, strategic connections, design excellence, identify sub-precincts for future detailed planning and also outlines the next steps in the State Significant Precinct process for Central Precinct
Strategic plan	The regional strategic plan, district strategic plan or a local strategic planning statement
Sub-precinct	The definable areas within Central Precinct SSP due to its unique local character, opportunities and constraints, either current or future. The Western Gateway is a sub-precinct
Sydney Metro	A fully-automated, high frequency rail network connecting Sydney
Tech Central	The State government initiative as set out in The Sydney Innovation and Technology Precinct Panel Report 2018. Previously known as the Sydney Innovation and Technology Precinct. Tech Central is located south of the Sydney central business district, surrounded by the suburbs of Redfern, Ultimo, Haymarket, Camperdown, Chippendale, Darlington, Surry Hills and Eveleigh
Transport for NSW	The statutory authority of the New South Wales Government responsible for managing transport services in New South Wales.
Transport interchange	A facility designed for transitioning between different modes, such as a major bus stop or train station
Transport modes	The five public transport modes are metro, trains, buses, ferries and light rail. The two active transport modes are walking and cycling
Vibrant streets / places	Places that have a high demand for movement as well as place with a need to balance different demands within available road space

Executive summary

Arcadis has been engaged by Transport for NSW to prepare this Water Quality, Flooding and Stormwater Report as part of the Central State Significant Precinct (SSP) Study. This assessment addresses the study requirements issued by the NSW Department of Planning, Infrastructure and Environment (the Department) to guide preparation of the SSP Study, specifically the requirement to prepare a Water Quality, Flooding and Stormwater Report.

Existing conditions

In its existing state, the highly urbanised Central Precinct contributes pollutants to the downstream environment via stormwater runoff with little treatment. The Central Precinct Renewal Project (CPRP) provides the opportunity to increase water quality treatment for stormwater generated within and external to Central Precinct.

Several trunk stormwater drainage lines cross Central Precinct. The location, condition and capacity of these existing drainage networks may constrain the design of the CPRP. However, these drainage lines provide options for future connections and potential sources of stormwater for reuse applications.

During large rainfall events, ponding and overland flow paths form through the precinct providing flood storage and conveyance of flows. The flooding behaviour of Central Precinct may constrain the CPRP as flood impacts must be avoided. However, the CPRP provides the opportunity to further investigate local flood behaviour and explore options to reduce the existing flood risk for Central Precinct and surroundings.

Policies and plans

A summary of current policies and plans which apply to Central Precinct in relation to stormwater has been provided. These documents inform the planning framework and guide the development of the CPRP concept Stormwater Management Plan (SMP) provided.

Consultation

Ongoing stakeholder consultation has been undertaken with the City of Sydney (Council) Council as the consent authority and Sydney Water Corporation (SWC) as an asset owner. The consultation aimed to share information, understand needs and aspirations for the precinct and seek feedback as the SSP study developed. The information gathered has been used to inform the development of the CPRP concept SMP and recommendations provided.

Precinct Assessment

A high-level assessment of the potential impacts of the CPRP on stormwater quality and quantity has been undertaken based on the SSP Reference Master Plan provided. The over station development of the CPRP in particular is expected to significantly alter the hydrological response of the sub-catchment with regards to both quantity and quality.

Given the complex nature of the existing Central Precinct and the ultimate CPRP, detailed investigations are required to define the impacts of the CPRP and identify effective mitigation measures. In response to this need, a significant flood modelling exercise has been completed.

The CPRP flood model demonstrates potential flood level impacts at several locations within Central Precinct and surrounding areas. These flood level impacts are isolated and not widespread across the Central Precinct. In general, the flood impacts of the CPRP are exacerbating existing flood issues with the magnitude of the impact on peak flood levels being less than 0.1 metre in the 1% AEP and 0.5 metre in the Probable Maximum Flood at the vast majority of locations.

The design process provides the opportunity to further review and minimise flood impacts as well as explore opportunities to further mitigate the existing flood risk. It is recommended that ongoing flood modelling be undertaken to inform the Master Plan and design development aiming to avoid flood impacts and mitigate flood risk.

Concept Stormwater Management Plan

In response to the potential for adverse impacts, a concept SMP has been developed. The concept SMP conveys the CPRP aspirations for stormwater management and provides supporting principles to guide the design development.

The CPRP aspires to achieve a resilient and sustainable stormwater management outcome. An integrated water cycle management approach adopting best practice water sensitive urban design measures is at the centre of the concept SMP. The concept SMP aims to reduce flood risk, maximise stormwater quality treatment and reuse and support enhanced greening and urban cooling.

At the foundation of the concept SMP the following core stormwater management principles have been employed:

- Maintaining existing sub-catchment areas
- Preserving existing and creating adequate overland flow paths to the downstream
- Maintaining flood storage
- Maximising pervious areas
- Provision for stormwater detention
- Provision for stormwater quality treatment measures
- Identification and reduction of flood risk through design
- Consideration of a changing climate and extreme events.

Through these core principles, the potential impacts of the CPRP can be minimised with sustainability and resilience embedded.

Recommendations

Recommendations have been provided to support the ongoing Master Plan and design development of the CPRP, including:

- Regular assessment of design against the developed concept SMP
- Development of a detailed integrated water cycle management plan with associated water quality analysis
- Ongoing flood modelling to reassess flood impacts and opportunities to mitigate flow risk
- Ongoing stakeholder consultation

The CPRP provides a significant opportunity to reduce stormwater pollution and mitigate flood risk for Central Precinct and the surrounding areas. As a water sensitive precinct, CPRP could set a new benchmark in Sydney for precinct level redevelopment.

1. Introduction

Located within the heart of Eastern Harbour City, Central Precinct is Australia's busiest transport interchange. The precinct currently holds latent potential with all its inherent advantages of location and transport connections to revitalise Central Sydney. Capitalising on Central Precinct's prime location within Tech Central, a NSW Government commitment to create the biggest technology hub of its kind in Australia, Central Precinct presents the ultimate transformative opportunity to deliver a connected destination for living, creativity and jobs. The renewal of Central Precinct will provide a world-class transport interchange experience, important space for jobs of the future, improved connections with surrounding areas, new and improved public spaces and social infrastructure to support the community.

1.1 Tech Central

1.1.1 Overview

The NSW Government is committed to working with the local community to develop the biggest innovation district of its kind in Australia. Bringing together six neighbourhoods near the Sydney CBD (Haymarket, Ultimo, Surry Hills, Camperdown, Darlington North Eveleigh and South Eveleigh), Tech Central is a thriving innovation ecosystem that includes world-class universities, a world-leading research hospital, 100 + research institutions, investors and a wide range of tech and innovation companies. The vision for Tech Central is for it to be a place where universities, startups, scaleups, high-tech giants and the community collaborate to solve problems, socialise and spark ideas that change our world. It is also for it to be place where centring First Nations voices, low carbon living, green spaces, places for all people and easy transport and digital connections support resilience, amenity, inclusivity, vitality and growth.

Tech Central is an essential component of the Greater Sydney Region Plan's Eastern Harbour City Innovation Corridor. It aims to leverage the existing rich heritage, culture, activity, innovation and technology, education and health institutions within the precinct as well as the excellent transport links provided by the Central and Redfern Station transport interchanges.

The Central Precinct is located within the Haymarket neighbourhood of Tech Central. Planned to become the CBD for Sydney's 21st century, this neighbourhood is already home to The Quantum Terminal (affordable coworking space in the iconic Central Station Sydney Terminal Building) the Scaleup Hub (affordable and flexible workspace for high-growth technology scaleups) and is soon to be the home of Atlassian's headquarters. It is also in close proximity to a number of important education and research institutions.

The planned urban renewal of the Central Precinct has been identified as a key project to achieving the vision for Tech Central.

1.1.2 Background & Context

In August 2018, the NSW Government established the Sydney Innovation and Technology Precinct Panel (the Panel) comprising representatives from various industry, health, education, government agencies and key community members. In December 2018 'The Sydney Innovation and Technology Precinct Panel Report' was produced, setting out the Panel's recommendations for a pathway to delivering a successful innovation and technology district at Tech Central.

In February 2019, the NSW Government adopted the Panel's report and committed to delivering the following:

- 25,000 additional innovation jobs
- 25,000 new STEM and life sciences students
- 200,000 m² for technology companies, and
- 50,000 m² of affordable space for startups and scaleups

In February 2019, the Greater Sydney Commission released a Place Strategy for the area that is now known as Tech Central (Camperdown-Ultimo Collaboration Area Place Strategy, GSC). The Place Strategy, developed collaboratively by a range of stakeholders involved in planning for Tech Central's future, was prepared to inform public and private policy and investment decisions by identifying and recognising the complex, place-specific issues inhibiting growth and change. The strategy identifies shared objectives for the place and sets out priorities and actions to realise the vision for the area under the key themes of Connectivity, Liveability, Productivity, Sustainability and Governance.

Both the Panel Report and Place Strategy recognise the importance of the Central Precinct to Tech Central's future.

In July 2019, Central Precinct was declared a nominated State Significant Precinct (SSP) in recognition of its potential to boost investment and deliver new jobs. The SSP planning process for Central Precinct will identify a new statutory planning framework for Central Precinct. This involves two key stages:

- **Stage 1**: Development of a draft Strategic Vision which has since evolved into the Central Precinct Strategic Framework
- **Stage 2**: Preparation of an SSP study with associated technical analysis and community and stakeholder consultation.

In March 2021, the Central Precinct Strategic Framework was adopted representing the completion of Stage 1 of the planning process to develop a new planning framework for Central Precinct. The Strategic Framework outlines the vision, planning priorities, design principles, and the proposed future character of sub-precincts within Central Precinct.

This is intended to inform and guide further detailed planning and design investigations as part of this SSP Study (Stage 2 of the SSP planning process). This SSP Study intends to amend the planning controls applicable to Central Precinct under the SSP SEPP 2005 to reflect the vision and planning priorities set for the Precinct under the Strategic Framework. Study Requirements were issued in December 2020 to guide the investigations and the proposed new planning controls.

1.2 Central Precinct vision

Central Precinct will be a vibrant and exciting place that unites a world-class transport interchange with innovative and diverse businesses and high-quality public spaces. It will embrace design, sustainability and connectivity, celebrate its unique built form and social and cultural heritage and become a centre for the jobs of the future and economic growth.

1.3 Case for change

Over the coming years, Central Station will come under increasing pressure as technological innovations progress, investment in transport infrastructure increases and daily passenger movements increase.

Sydney Metro, Australia's biggest public transport project, will result in the delivery of a new generation of world-class, fast, safe, and reliable trains enabling faster services across Sydney's rail network. In 2024, Sydney Metro's Central Station will open with daily passenger movements forecast to increase from 270,000 persons to 450,000 persons over the next 30 years.

In its current state, Central Station is underperforming as Australia's major transport interchange – it's currently a hole in the heart of Sydney's CBD, lacking connectivity, activation and quality public spaces.

The renewal of Central Precinct will expand and revitalise Central Station, and transform this underutilised part of Sydney from a place that people simply move through to one where they want to visit, work, relax, connect and socialise. Its renewal also presents the potential to deliver on the strategic intent and key policies of regional, district and local strategic plans, providing for a city-shaping opportunity that can deliver economic, social and environmental benefit. Specifically, it will:

- make a substantial direct and indirect contribution to achieving the Premier's Priorities by facilitating upgrades to Sydney's largest and most significant public transport interchange, improving the level of service for users and visitors, and supporting the creation of new jobs and housing
- implement the recommendations of the NSW State Infrastructure Strategy 2018-2038, in particular the upgrading of the major transport interchange at Central to meet future customer growth
- contribute to key 'Directions' of the Greater Sydney Region Plan, to deliver 'a city supported by infrastructure', help create 'a city of great places', support 'a well connected city', deliver new 'jobs and skills for the city' and create 'an efficient city'
- implement the outcomes envisaged within the Eastern City District Plan including reinforcing the Harbour CBD's role as the national economic powerhouse of Australia and supporting its continued growth as a Global International City
- deliver on the shared objectives and priorities for Tech Central, the future focal point of Sydney's innovation and technology community, which aims to boost innovation,

economic development and knowledge intensive jobs while creating an environment that foster collaboration and the exchanging of ideas

- deliver an outcome that responds to the overarching vision and objectives of the Central Sydney Planning Strategy. In particular it will assist with implementing a number of ‘key moves’ outlined in the strategy, including to ‘ensure development responds to its context’, ‘ensure infrastructure keeps pace with growth’, ‘move people more easily’, ‘protect, enhance and expand Central Sydney’s heritage, public places and spaces’, and to ‘reaffirm commitment to design excellence.’

1.4 About this report

The purpose of this report is to provide a detailed stormwater assessment of the proposed changes, and consider any potential impacts that may result within and surrounding the Central Precinct. This report addresses study requirement 13.1 Water Quality, Flooding and Stormwater. The main body of this report responds to the study requirements related to stormwater quality and quantity. **Appendix B** specifically addresses the hydrogeology component of the study requirements.

The report is related and aligned to several other reports being prepared as part of the SSP Study. In particular the Central Precinct Renewal Program Green Infrastructure Study, Pollution Assessment, Sustainability Framework, Environmental Sustainability Study and Climate Adaptation Plan as outlined in **Section 3.8**. The relevant study requirements, considerations and consultation requirements, and location of where these have been responded to is outlined in **Table 1** below.

1.4.1 SSP Study requirements

Table 1: Study requirements, considerations, and consultation requirements

Ref	Requirement or consideration	Summary response	Where addressed
Study requirement			
13.1_A	Identifies the existing situation, including constraints, opportunities, key issues and existing network capacity	**Chapter 2** outlines the existing situation in relation to stormwater quality and quantity. An overview of the existing conditions for land use, topography, the stormwater drainage network infrastructure, estimated flood regime and stormwater quality is provided. For each of these aspects the constraints, opportunities and key issues are highlighted.	**Chapter 2**: Existing environment, addresses this study requirement.
13.1_B	Assesses the potential impacts of the proposal on the hydrology and hydrogeology of the precinct and adjoining areas	An assessment of the proposal on stormwater quality and quantity is provided in **Chapter 5**. This includes an assessment of the master plan as well as a flood impact assessment based on a developed Precinct Flood Model. The complete documentation of the Precinct Flood Model has been provided as **Appendix C**. An assessment of hydrogeology has been documented separately, and is provided as **Appendix B**.	**Chapter 5**: Precinct assessment, **Appendix C:** Precinct Flood Model Report, and **Appendix B**: Hydrogeology Impact Assessment, address this requirement.

Ref	Requirement or consideration	Summary response	Where addressed
13.1_C	Includes a concept stormwater management plan outlining the general stormwater management measures for the proposal	The concept stormwater management plan provided as **Chapter 6** is a high-level overview of the stormwater management strategy. The aspirations for the precinct are outlined along with guiding principles which aim to avoid impacts off-site and embedded sustainability and resilience. Both stormwater quality and quantity are addressed. Alignments with the other SSP studies are also highlighted.	**Chapter 6**: Concept Stormwater Management Plan, and **Figure 23:** Concept Stormwater Management Plan, address this requirement.
13.1_D	Includes a flood risk assessment identifying flooding behaviours and flood impacts resulting from the proposal and providing recommendations for appropriate flood planning levels	A flood impact assessment based on a developed Precinct Flood Model is provided as **Section 5.3**. Recommendations are provided in **Chapter 7**, and in particular **Section 7.2.3** provides recommendations in relation to flood planning levels. The complete documentation of the Precinct Flood Model has been provided as **Appendix C**.	**Section 5.3:** Flood impact assessment, **Chapter 7**: Recommendations, **Section 7.2.3:** Flood Planning, and **Appendix C:** Precinct Flood Model Report, address this requirement
13.1_E	Provides concept level details of drainage to address stormwater flows on the precinct	Concept level details of the precinct stormwater management are embedded in the concept stormwater management plan provided as **Chapter 6**. Both stormwater quality and quantity are addressed. The level of detail provided in the concept stormwater management plan is considered suitable given the nature of the planning framework being proposed.	**Chapter 6**: Concept Stormwater Management Plan, and **Figure 23:** Concept Stormwater Management Plan, address this requirement.
13.1_F	Informs and supports the preparation of the proposed planning framework including any recommended planning controls or DCP/Design Guideline	Recommendations for planning controls are provided in **Section 7.2.** This addresses both stormwater quality and quantity and provides recommendations in relation to flood planning levels.	**Section 7.2:** Planning controls, addresses this requirement.
13.1_G	Provides an analysis of the proposal measured as % difference in flooding shown in flood depth contours and hazard maps	A flood impact assessment based on a developed Precinct Flood Model is provided as **Section 5.3**. The difference in peak flood levels for the 10% AEP, 1% AEP and PMF rainfall events as a result of the CPRP is mapped as **Figure 17**, **Figure 18** and **Figure 19**. Flood hazard mapping is also provided as **Figure 20**, **Figure 21** and **Figure 22.** The complete documentation of the Precinct Flood Model, including additional flood mapping has also been provided as **Appendix C**.	**Section 5.3:** Flood impact assessment, **Chapter 7**: Recommendations, **Section 7.2.3:** Flood Planning, and **Appendix C:** Precinct Flood Model Report, address this requirement

Ref	Requirement or consideration	Summary response	Where addressed
Study consideration			
13.1	A particular focus on water quality, the extent to which proposed development protects, maintains or restores water health and the community's environmental values and use of waterways for Sydney Harbour (also known as the NSW WQO);	Water quality is addressed throughout this Water Quality, Flooding and Stormwater report, in particular: • The context of the existing water quality is provided in **Section 2.5**. • Stormwater quality treatment in the concept stormwater management plan is specifically addressed in **Section 6.4**. • Recommendations with regards to planning controls are provided in **Section 7.2.2**. Stormwater quality is also further discussed in the Central Precinct Pollution Assessment prepared for the SSP study.	**Section 2.5:** Water quality, **Section 6.4:** Stormwater quality improvement and reuse, and **Section 7.2.2**: Civil drainage, address this requirement
	No increase to existing flooding and that flooding is reduced where possible;	A flood impact assessment based on a developed Precinct Flood Model is provided as **Section 5.3**. The difference in peak flood levels for the 10% AEP, 1% AEP and PMF rainfall events as a result of the CPRP is mapped as **Figure 17**, **Figure 18** and **Figure 19**. This flood impact assessment conducted to date has been based on a representation of a possible design of the precinct. The final design of the precinct may vary from this and would include additional refinement of the flood modelling. The current assessment is considered suitable for the purpose of the SSP requirements. Through the ongoing design development of the precinct, the built form (particularly at ground level) and stormwater infrastructure network can be adjusted to mitigate flood impacts. This is reflected in the contents of **Chapter 6** and **Chapter 7**. The recommended planning controls and provisions (**Section 7.2.3**) aim to avoid flood impacts off-site in line with the City of Sydney's Interim Floodplain Management Policy. The complete documentation of the Precinct Flood Model, including additional flood mapping and further discussion of potential flood impacts and recommendations are provided as **Appendix C**.	**Section 5.3:** Flood impact assessment, **Chapter 6**: Concept Stormwater Management Plan, **Chapter 7**: Recommendations, **Section 7.2.3:** Flood Planning, and **Appendix C:** Precinct Flood Model Report, address this requirement
	Flood risk impact across the catchment area and all adjoining land uses;	The flood impact assessment as documented in **Section 5.3** and **Appendix C**, considers the flood behaviour and potential impacts within and surrounding the precinct. Consideration of flood risk is reflected in the contents of **Chapter 6** and **Chapter 7,** and more specifically **Section 7.2.3**. The complete documentation of the Precinct Flood Model, including further discussion of potential flood impacts and recommendations are provided as **Appendix C**.	**Section 5.3:** Flood impact assessment, **Chapter 6**: Concept Stormwater Management Plan, **Chapter 7**: Recommendations, **Section 7.2.3:** Flood Planning, and

Ref	Requirement or consideration	Summary response	Where addressed
			Appendix C: Precinct Flood Model Report, address this requirement
	How the planning framework will address water quality targets in Sydney DCP 2012; and	Recommendations for water quality targets are discussed in **Section 6.4** of the concept stormwater management plan, with further recommendations provided in **Section 7.1** and **Section 7.2.2**.	**Section 6.4:** Stormwater quality improvement and reuse, **Section 7.1:** Ongoing project development, and **Section 7.2.2**: Civil drainage, address this requirement
	WSUD options for the proposal.	Water sensitive urban design options are discussed in **Section 6.4** of the concept stormwater management plan, with further recommendations provided in **Section 7.1** and **Section 7.2.** Water sensitive urban design strategies are also discussed in the Central Precinct Renewal Program Green Infrastructure Study prepared as part of the SSP study.	**Section 6.4:** Stormwater quality improvement and reuse, **Section 7.1:** Ongoing project development, and **Section 7.2:** Planning controls, addresses this requirement.
Consultation			
13.1	The Study is to demonstrate that it has been undertaken in consultation with the City of Sydney's relevant specialists.	Consultation in relation to this report has been undertaken with the City of Sydney Council and Sydney Water as outlined in the Water Quality, Flooding and Stormwater Report.	**Chapter 4**: Consultation and **Appendix E**: Evidence of consultation address this matter
Author			
13.1	The study is to be prepared by a suitably qualified professional(s) with the necessary experience and expertise to undertake the required works.	This report has been prepared by Melanie Gostelow who holds the following qualifications and accreditations: • Bachelor of Engineering (Environmental) • Master of Engineering Science (Water Resources • Chartered Professional Engineer • Authorised Engineering Organisation (AEO) – Expert proficiency in civil engineering (stormwater & flooding) • Sydney Water C4 Stormwater Design & Verification Melanie is an Associate Technical Director for Stormwater Engineer with over 14 years' experience planning for and delivering sustainable water infrastructure across Australia. Her experience ranges from master planning and environmental impact assessments to the detailed design of stormwater infrastructure and flood impact assessments.	

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Ref	Requirement or consideration	Summary response	Where addressed
Guidance documents			
13.1	The following documents provide guidance for this Study: • The City's Interim Flood Policy; • NSW Environment Protection Authority's Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions; • Sydney DCP 2012; • Sydney Streets Technical Specifications; • the NSW State Government's Flood Prone Lands Policy and Floodplain Development Manual; • Blackwattle Bay Flood Study and Floodplain Management Study; and • City of Sydney Central Sydney Planning Strategy.	Key policies and plans which have informed this report are outlined in Chapter 3. The guidance documents listen in the SSP requirements for this report have been considered when defining the aspirations of the site and drafting recommendations for planning controls:	**Section 2.4.1**: CPRP Precinct Flood Model **Chapter 3**: Policies and Plans **Section 7.2**: Planning controls

1.5 Study Area

Central Precinct is located at the south-east edge of Central Sydney (refer to **Figure 1**). Central Precinct is surrounded by a number of suburbs including, Haymarket to the north, Chippendale to the south and Surry Hills to the south-east. It is located within the City of Sydney local government area (LGA) with an approximate gross site area of 24 hectares of Government owned land. The precinct comprises land bounded by Pitt Street and Regent Street to the west, Cleveland Street to the south, Eddy Avenue, Hay Street and Goulburn Street to the north and Elizabeth Street and Chalmer Street to the east.

Central Precinct has been an important site for transport operations for over 150 years. Today, Central Station is Australia's busiest transport interchanges and is the anchor of New South Wales's (NSW) rail network. It provides 24 platforms for suburban and Intercity and Regional train connections as well as a direct link to Sydney Airport. The broader transport interchange also caters for light rail, bus, coach and point to point connections such as taxis. The transport interchange will also form part of the Sydney Metro network, with new underground platforms to be provided for Sydney Metro services under Platform 13, 15 and 16 at Central Station. Sydney Metro services will begin in 2024. The precinct also comprises several significant heritage items including the state-heritage listed Sydney Terminal Building and the Clock Tower.

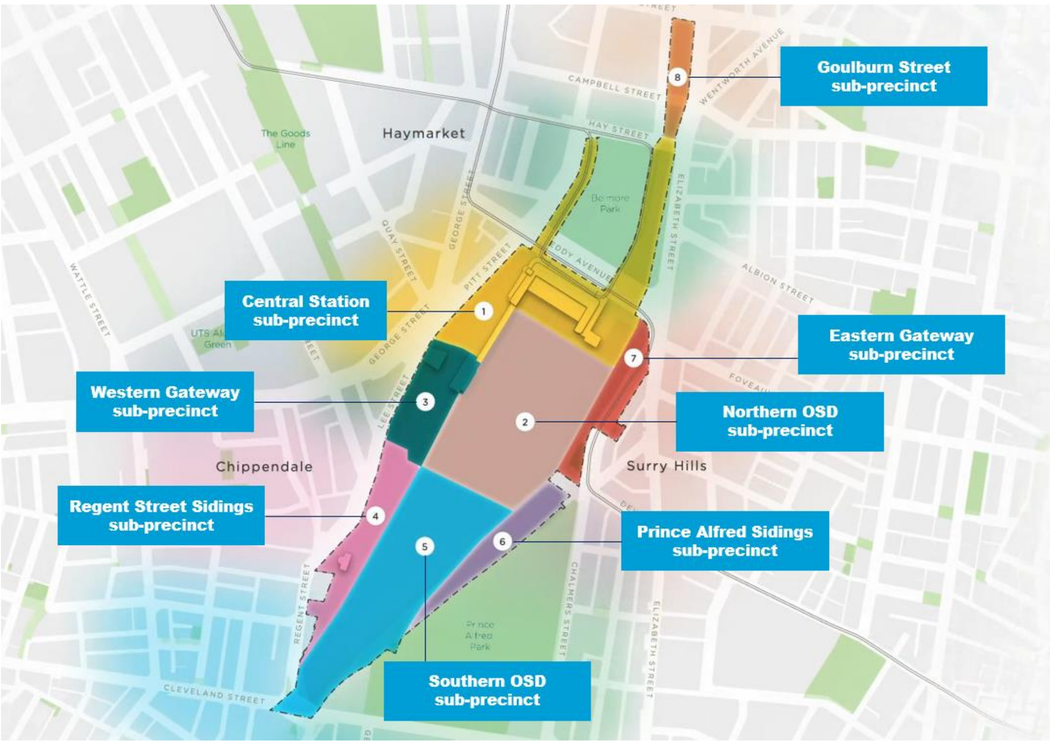
As part of the Strategic Framework, eight sub-precincts have been defined that reflect and positively respond to the varying character of the surrounding areas. These sub-precincts are:

- Central Station
- Northern Over Station Development
- Western Gateway
- Regent Street Sidings
- Southern Over Station Development
- Prince Alfred Sidings
- Eastern Gateway
- Goulburn Street.

The location of these sub-precincts and relevant boundaries is illustrated in **Figure 2**.

Figure 1: Location plan of Central Precinct

Figure 2: Central Precinct and sub-precincts



1.5.1 Planning priorities

To help realise the vision of Central Precinct and the desired local character of the sub-precincts, the following planning priorities have been developed and are grouped into five key themes as outlined in **Table 2** below.

Table 2: Central Precinct planning priorities

Theme	Planning priorities
Place and destination	• Unite the city by reconnecting with the surrounding suburbs • Shape a great place that is vibrant, diverse, active, inclusive and has a high level of amenity • Deliver a precinct which responds to its urban context and embeds design excellence Improve existing and providing additional connected public space in the precinct of high environmental amenity and comfort • Protect and celebrate the Precinct's heritage values • Create a people focussed precinct through a focus on public transport, cycling and walkability • Facilitate the precinct's focus on transport and economic diversity in tourism and across commercial sectors including office, business and retail.
People and community	• Design public spaces that promote health, equality and well-being • Promote social cohesion by providing spaces for gathering, connection, exchange, opportunity and cultural expression • Honour and celebrate the cultural heritage and identity of the Precinct's past and present Aboriginal community • Create a safe and intuitive precinct that promotes social access and inclusion • Support programs and initiatives that benefit communities and people

Theme	Planning priorities
	• Create a precinct that responds to the current and future needs of transport customers, workers, residents and visitors, including those of the broader local community.
Mobility and access	• Provide a world class, integrated and seamless transport interchange • Maintain the precinct's role as NSW's main transport interchange • Improve the transport customer experience, including wayfinding, pedestrian flows and interchange between different transport modes • Facilitate and enhancing connections within and towards key locations in southern Central Sydney • Deliver a people focussed precinct that is walkable, well connected, safe and puts people first • Design infrastructure that will adapt to future changes in transport and mobility.
Economy and innovation	• Advance Sydney's status as a global city • Support the creation of jobs and economic growth including new and emerging industries such as innovation and technology and explore the provision of space for cultural and creative uses and start-ups • Provide an active and diverse commercial hub with a rich network of complementary uses that nurture and support business • Support both the day and night economies of the precinct through diverse complementary uses, promoting liveability and productivity • Foster collaboration between major institutions in the precinct including transport, education, health and business • Create a smart precinct that incorporates digital infrastructure to support research and innovation.

1.5.2 Reference Master Plan

Architectus and Tyrrell Studio have prepared a Place Strategy, Urban Design Framework and a Public Domain Strategy which establishes the Reference Master Plan for Central Precinct. The Urban Design Framework and Public Domain Strategy provides a comprehensive urban design vision and strategy to guide future development of Central Precinct and has informed the proposed planning framework of the SSP Study.

The Reference Master Plan includes:

- Approximately 22,000 sqm of publicly accessible open space comprising:
  - Central Green – a 6,000 square metre publicly accessible park located in immediately south of the Sydney Terminal building
  - Central Square – 7,000 square metre publicly accessible square located at the George Street and Pitt Street junction
  - Mortuary Station Gardens – a 4,470 square metre publicly accessible park (excluding Mortuary Station building) located at Mortuary Station
  - Henry Deane Plaza – a publicly accessible plaza located in the Western Gateway sub-precinct
  - Eddy Avenue Plaza – a 1,680 square metre publicly accessible plaza located in the north-eastern portion of the Sydney Terminal building

  - Western Terminal Extension Building Rooftop - a 970sqm publicly accessible space above the Western Terminal Extension Building Rooftop.
- Approximately 269,500 square metres of office gross floor area (GFA)
- Approximately 22,850 square metres of retail GFA
- Approximately 53,600 square metres of hotel GFA
- Approximately 84,900 square metres of residential accommodation GFA, providing for approximately 850 dwellings (assuming 1 dwelling per 100sqm GFA). The Central Precinct SSP Study will include the commitment to deliver 15 percent of any new residential floor space as affordable housing.
- Approximately 47,250 square metres of education/tech space GFA
- Approximately 22,500 square metres of student accommodation GFA
- Approximately 14,300 square metres of community/cultural space GFA.

The key features of the Indicative Reference Master Plan, include:

- A network of new and enhanced open spaces linked by green connections. This will include:
  - A Central Green (Dune Gardens) at the north of Central Precinct that will create a new civic public realm extension of the Sydney Terminal building and a new vantage point for Central Sydney
  - A new Central Square which will deliver on the vision for a new public square at Central Station, as one of three major public spaces within Central Sydney connected by a people-friendly spine along George Street
  - Mortuary Station Park at Mortuary Station that will be a key public domain interface between Chippendale and the over-station development. that will draw on the story of Rookwood Cemetery and the Victorian Garden context with the established rail heritage of the Goods Line and the rail lines
  - Henry Deane Plaza which will prioritise the pedestrian experience, improving connectivity and pedestrian legibility within the Western Gateway sub-precinct and provide clear direct links to and from the State heritage listed Central Station and its surrounds
  - Eddy Avenue Plaza – will transform into a high-amenity environment with significant greening and an enhanced interface with the Sydney Terminal building.
- A new network of circulation that will establish a clear layer of legibility and public use of the place. This will include:
  - A 15 - 24 metre wide Central Avenue that is laid out in the spirit of other street layouts within Central Sydney and which responds to the position of the Central clocktower, providing new key landmark views to the clocktower. Central Avenue will be a place for people to dwell and to move through quickly. It brings together the threads of character from the wider city and wraps them
  - Three over-rail connections to enhance access and circulation through Central Precinct, as well as provide pedestrian and bicycle cross connections through the precinct

- The extension of public access along the Goods Line from Mortuary Station Gardens, offering a new connection to Darling Harbour
- New vertical transportation locations throughout the precinct allowing for seamless vertical connections.
- An active recreation system supports health and well-being through its running and cycling loops, fitness stations, distributed play elements, informal sports provision, and additional formal recreation courts.
- a network of fine grain laneways that are open to the sky

The proposed land allocation for Central Precinct is described in **Table 3** below.

Table 3 Breakdown of allocation of land within Central Precinct (note: below figures, except for total Central SSP area, excludes WGP)

Land allocation	Proposed
Open-air rail corridor	101,755 sqm
Developable area	119,619 sqm
Public open space	19,185 sqm / 16% of Developable area
Other publicly accessible open space (Including movement zones, streets and links)	41,773 sqm / 35% of Developable area
Building area	58,661 sqm / 49% of Developable area
Central SSP total area (incl. WGP)	**23.8 ha**

The Indicative Reference Master Plan for Central Precinct is illustrated in **Figure 3** below.

Figure 3: Reference Master Plan

Sub-precinct		Total GFA per sub-precinct (sqm)*
S	Station (terminal building)	**15,800**
		15,800
A	OSD Block A	**165,400**
	A1	66,900
	A2	48,900
	A3	39,400
	A4	4,100
	A5	3,000
	A6	3,100
B	OSD Block B	**88,900**
	B1	42,700
	B2	37,200
	B3	4,000
	B4	5,000
C	OSD Block C	**109,700**
	C1	32,700
	C2	28,500
	C3	42,800
	C4	3,400
	C5	2,300
D	Regent Street Sidings Block D	**65,000**
	D1	33,300
	D2	31,700
E	Prince Alfred Sidings Block E	**20,900**
F	Goulburn St Car Park	**49,200**
Total GFA (excluding Western Gateway)		**514,900**
WG	Western Gateway	**275,000**

Source*: Architectus and Tyrrell Studio (2022)*

2. Existing environment

The existing environment of Central Precinct has been investigated based on a review of data sourced from Transport for New South Wales (TfNSW), Sydney Water Corporation (SWC), City of Sydney Council (Council) and other publicly available sources. An overview of the information reviewed, and further details are provided in the CPRP Precinct Flood Model Report (Arcadis, 2021), attached as **Appendix C**.

The following describes the conditions of the existing environment which are relevant to the quality and conveyance of stormwater runoff. Potential constraints and opportunities of the existing environment, and key issues for future consideration are highlighted.

2.1 Land use

Central Precinct covers 24 hectares of government-owned land at the southern end of Central Sydney. The rail corridor servicing Central Station occupies the majority of Central Precinct along with the station terminal buildings and platforms in the north. Additional parcels of land surrounding the rail corridor to the west and east are also included in the Central Precinct extents which are occupied by commercial and various TfNSW premises.

The immediate area of Central Precinct contains high density, mixed-use and varied built form along with bus and light rail terminals. Nearby large public open spaces include Belmore Park to the north and Prince Alfred Park to the southeast. The larger catchment area is highly urbanised, and therefore highly imperious to stormwater infiltration.

Constraints, opportunities and key issues

The highly urbanised nature of Central Precinct and the upstream catchment area increases the pollutant load of stormwater runoff and the likelihood of flash flooding events when compared to a less populated, more vegetated pervious catchment. The presence of pollutants from the rail corridor further impacts the quality of stormwater runoff.

The quality of stormwater runoff from Central Precinct and upstream catchment areas may hinder the feasibility of stormwater reuse applications, and impact the quality of the downstream receiving waters. Within the rail corridor the restricted access, rail operations and infrastructure present constraint on the implementation of water quality treatment measures.

Future redevelopment of Central Precinct provides an opportunity to increase stormwater quality treatment, stormwater reuse applications, vegetation coverage and perviousness of Central Precinct. This may also aid in the mitigation of the urban heat island effect for Central Precinct.

The opportunity to improve the quality of stormwater leaving Central Precinct and the implementation of water reuse on-site is a key issue for consideration.

2.2 Topography

Central Precinct is located on the ridge of two main drainage catchments, the Darling Harbour catchment and Blackwattle Bay catchment. These catchment areas fall in a north-westerly direction towards Sydney Harbour.

The general topographical nature of Central Precinct is relatively flat with a slight fall towards the western boundary. Topographic features include:

- A steep drop in the terrain along the eastern boundary with Prince Alfred Park
- A trapped low point or sag beneath the rail flyovers along the Prince Alfred sidings
- The Goods Line rail track falling and creating a cutting as it departs from the main rail lines and crosses beneath George Street
- A trapped low point or sag at the eastern end of Ambulance Avenue
- An increase in elevation as the Lee Street / Pitt Street intersection ramps up the Railway Colonnade Drive to the Central Grand Concourse western pedestrian entry
- The reduced level of Henry Deane Plaza relative to Lee Street, which continues as a pedestrian tunnel beneath George Street to The Goods Line Walkway.

Constraints, opportunities and key issues

During large rainfall events, the topography results in the formation of concentrated overland flow paths crossing Central Precinct and ponding within the rail corridor, as mentioned in **Section 2.4.2**. Whilst this may present hazards and limitations within the rail corridor, it provides flood storage and conveyance for the larger catchment. Changes to the topography may adversely impact flood behaviour within and surrounding Central Precinct.

Recognising the flood behaviour within and surrounding Central Precinct, and the significance of the topography is a key issue for consideration to avoid flood impacts and mitigate flood risk.

2.3 Stormwater drainage network

In line with the topography and formal drainage network, stormwater runoff from the surrounding area approaches Central Precinct from the southeast and drains to the northwest via the pit and pipe drainage network and informal overland flow paths. Overland flow paths form predominantly along roadways during larger rainfall events.

From Central Precinct, stormwater runoff drains north to Sydney Harbour through either the Darling Harbour catchment in the north or Blackwattle Bay catchment in the south.

Figure 4 shows the locations of the existing stormwater and sewer trunk drainage lines crossing through Central Precinct. From consultation with SWC (**Section 4.2**) they believe that the sewer and stormwater drainage lines through Central Precinct are not interconnected, though historically they may have been.

Central Precinct incorporates the following formal drainage infrastructure:

- SWC trunk drainage lines – stormwater and sewer drainage lines servicing Central Precinct and upstream catchment areas. Assets drain north-west, apart from the Bondi Ocean Outfall Sewer (BOOS) which drains north-east
- Track drainage within the rail corridor – generally draining north or south parallel to the tracks and discharging to the SWC trunk lines within the rail corridor
- City of Sydney Council drainage – road drainage network along public roadways discharging to the SWC trunk lines
- Additional minor drainage networks are anticipated within the precinct
- A stormwater harvesting tank is located beneath the Pitt Street loading dock.

Figure 4: Existing Stormwater and Sewer Drainage Networks

From consultation with Sydney Water Corporation, Sydney Trains and the City of Sydney Council, a detailed analysis of the capacity of the drainage network is not available. Investigations from the recent Sydney Metro Central Station works have found the drainage network within the rail corridor to be in poor condition. Sydney Trains information suggests the track drainage is aged and limited in its coverage of the rail corridor. Detailed information from the construction of the Sydney Light Rail adjacent to the precinct was not available.

The CPRP Precinct Flood Model (**Section 2.4.2**) has illustrated the flood extent for the 10% AEP (10-year ARI) design rainfall event provided as **Figure 6**. The flood extent suggests the capacity of the drainage network along Eddy Ave is less than the 10% AEP design rainfall event. The remaining roadways surrounding the precinct appear to have a greater capacity.

The drainage network across Central Precinct is unlikely to meet current design standards given the age and condition of the network.

Whilst information of the existing drainage network across Central Precinct is available it is incomplete and often inconclusive, unconfirmed, or outdated. Our understanding of the drainage network has been based on sourcing and reviewing multiple sources of information and using engineering judgement to “gap fill’ required details. In some instances, this has involved making assumptions regarding the connectivity of drainage lines to the trunk outlets. As the design of the CPRP progresses, it is expected that additional data will be sourced to reduce assumptions. An overview of the available information reviewed including past studies is provided as **Chapter 3** of **Appendix C**.

Constraints, opportunities and key issues

The presence of several trunk stormwater drainage lines crossing Central Precinct may provide for alternative water reuse sources and alternative options for new discharge connections points.

The location, condition and capacity of the existing drainage networks (as well as the sewer network) within and surrounding Central Precinct may constrain the future design and construction of the built form, utility servicing, drainage network and flood mitigation options.

The sewer lines crossing Central Precinct may adversely impact stormwater quality in the event of leaks and overflows.

The CPRP instigates further investigation of the performance and condition of the existing drainage and sewer networks, and the opportunity for improvements to be made.

Recognising the constraint of the existing drainage and sewer networks, in particular the SWC trunk drainage lines is a key issue for consideration.

2.4 Flooding

2.4.1 CPRP Precinct Flood Model

The CPRP Precinct Flood Model Report (Arcadis, 2021) documents the significant flood modelling exercise that has been undertaken to improve our understanding of the existing and potential flooding regime of Central Precinct. The developed flood model strategy aims to provide a high quality, site-specific, fit-for-purpose flood model for Central Precinct.

The Precinct Flood Model has been developed utilising the Council flood models for the Darling Harbour and Blackwattle Bay catchments. These Council flood models were developed in response to the NSW Government's Flood Prone Land Policy, and developed in line with the NSW Floodplain Development Manual (see **Section 3.7**). Details of the Council flood models, along with the resulting description of the existing flood behaviour are outlined in the following flood studies:

- Blackwattle Bay Catchment Flood Study (WMA Water, 2015)
- Darling Harbour Catchment Flood Study (BMT WBM, 2014)

The subsequent floodplain risk management studies and plans have been documented as:

- Blackwattle Bay Catchment Floodplain Risk Management Study and Plan (WMA Water, 2015)
- Darling Harbour Catchment Floodplain Risk Management Study and Plan (WMA Water, 2016)

An overview of these studies is provided in **Section 3.2** of **Appendix C.** Whilst these flood models were available, they were not sufficiently schematised and detailed to adequately represent the existing conditions of the precinct. The Council flood models have been merged, with the model parameters realigned for a consistent modelling approach.

Flood models simulate design rainfall events and the resulting flood behaviour. The Average Recurrence Interval (ARI) and the Annual Exceedance Probability (AEP) are both a measure of the rarity of the rainfall event. The Precinct Flood Model has simulated flood behaviour for the critical 10% AEP (10 year ARI), 1% AEP (100 year ARI) and Probable Maximum Flood (PMF) design rainfall events for the base case existing and CPRP development. The Precinct Flood Model Report (**Appendix C**) illustrates flood results in a series of flood maps provided in the appendices, along with a comprehensive commentary.

The current flood modelling is considered fit-for-purpose considering the early stage of the Central Precinct Renewal Project (CPRP). It is expected that this flood model will evolve and become more detailed and accurate in its representation of the existing precinct and CPRP as the design progresses. The flood modelling has been undertaken utilising standard industry software and standard industry practice with respect to modelling approaches, selection of parameters and schematisation. The review and interpretation of flood modelling results has been undertaken by suitably qualified and experienced flood modelling specialists.

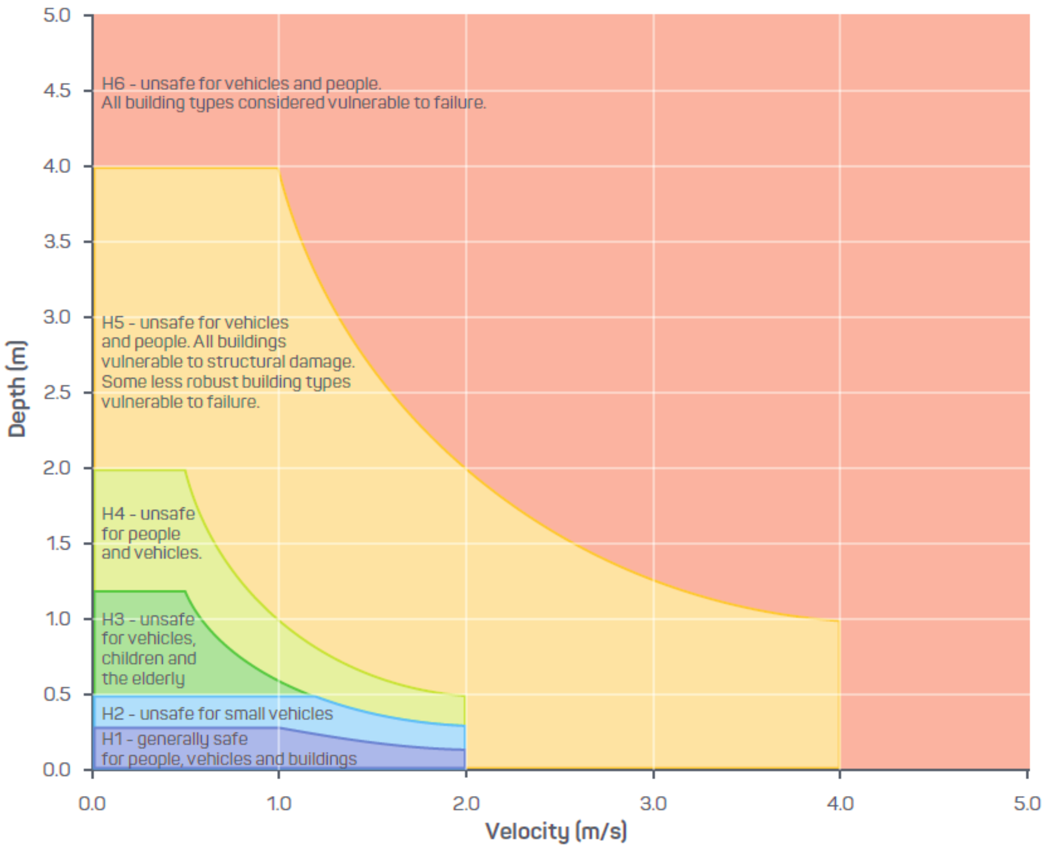
2.4.2 Existing flood regime

Flood mapping from the CPRP Precinct Flood Model has been provided for the 10% AEP (10-year ARI), 1% AEP (100 year ARI) and Probable Maximum Flood (PMF) design rainfall events as **Figure 6, Figure 7** and **Figure 8**. These maps show the extent and depth of flooding within and surrounding the precinct under existing conditions.

The legend at the top of the figures shows the peak depth of the flood event, with the flood contours showing the elevation of the peak flood level in metres to the Australian Height Datum (m AHD). As indicated in the legend at the bottom of the figures, the existing building footprints are shaded light grey.

Flood hazard mapping has also been provided for the 10% AEP, 1% AEP and Probable Maximum Flood (PMF) design rainfall events as **Figure 9, Figure 10** and **Figure 11** based on the Australian Institute of Disaster Resilience vulnerability curves illustrated in **Figure 5.** Depending on the combination of overland flow velocity and flood depth, an inundated area can be classified into 6 different hazard categories from H1 to H6, with category H6 being is the most hazardous.

Figure 5: Flood Hazard Vulnerability Curves



***Source**: Commonwealth of Australia (2017)*

Central Precinct is impacted by overland flows approaching the precinct from the east during large rainfall events. Significant overland flow paths occur through Prince Alfred Park and along Devonshire Street, Foveaux Street, Albion Street, Reservoir Street, Wentworth Avenue and Foy Lane.

Overland flows drain across Central Precinct in an east-west direction via Campbell Street, Hay Street and Eddy Avenue and the SWC trunk drainage systems under the rail corridor.

Ponding of stormwater within the precinct also occurs where the stormwater drainage network has insufficient capacity to drain the rainfall event, or where there is no drainage network present. The Precinct Flood Model results indicate a significant flood depth and extent of ponding within the rail corridor at the low point beneath the Bradfield flyovers along the Prince Alfred Sidings. Given the significant ponding volume, confirmation of the drainage network details at this location and seeking anecdotal evidence from Sydney Trains is to be pursued.

As shown in **Figure 6**, during the 10% AEP rainfall event, overland flows are evident along Eddy Ave travelling from east to west, generally less than 0.2 metres deep. Some flows along Devonshire St are also evident. The ponding depths at the Bradfield flyovers are greater than 1 metre in the 10% AEP design rainfall event.

As shown in **Figure 7**, during the rarer and larger 1% AEP rainfall event, the extent and depth of the overland flows along Eddy Ave and Devonshire St have increased. The ponding depths at the Bradfield flyovers are greater than 1.5 metres in the 1% AEP design rainfall event. Some ponding at low points in the roadways are also evident along Regent St and Chalmers St.

As shown in **Figure 8** during the rarest and largest PMF rainfall event, the depth of the overland flows along Eddy Ave and Devonshire St have increased to over 0.2 metres deep and extended along Chalmers St and Pitt St. The ponding depths at the Bradfield flyovers are greater than 2 metres in the PMF design rainfall event. The ponding within the rail corridor is extensive with flows draining through the goods line tunnel to the downstream. The ponding at low points in the roadways are over 0.5 metres deep.

A more detailed discussion of the existing flood behaviour for the precinct is provided in **Section 6.3** of **Appendix C**.

Climate change has the potential to impact flood behaviour due to increases in rainfall intensity and sea level rise. A climate change risk assessment and adaptation plan has been developed as part of the Central Precinct Climate Adaptation Plan (Atelier Ten & Integral Group, 2021) outlined in **Section 3.8.5**.

The potential impacts of climate change on increasing rainfall intensity and sea level rise have been assessed in the Council Darling Harbour and Blackwattle Bay flood studies (**Section 2.4.1**) which show:

- 2100 projected sea level increase of 0.9 metres did not impact flood levels within or adjacent to the precinct in the 1% AEP design rainfall event
- 30 percent increase in rainfall intensity resulted in flood level increases of less than 0.2 metres within or adjacent to the precinct in the 1% AEP design rainfall event

Constraints, opportunities and key issues

The flooding behaviour of Central Precinct must be well understood to ensure constraints are fully recognised, potential flood impacts are avoided, and flood risks are mitigated. The flood risk varies across Central Precinct, with areas of flood storage and overland flow paths being particular concerns.

Redevelopment of Central Precinct instigates further investigation of flood behaviour and provides the opportunity to reduce the existing flood risk to Central Precinct and surrounds. It can also facilitate climate adaptation measures to respond to expected increases in rainfall intensities. Recognising the constraint of the existing flood behaviour is a key issue for consideration.

Figure 6: Existing Flood Regime – 10% AEP Design Rainfall Event – Flood Depth

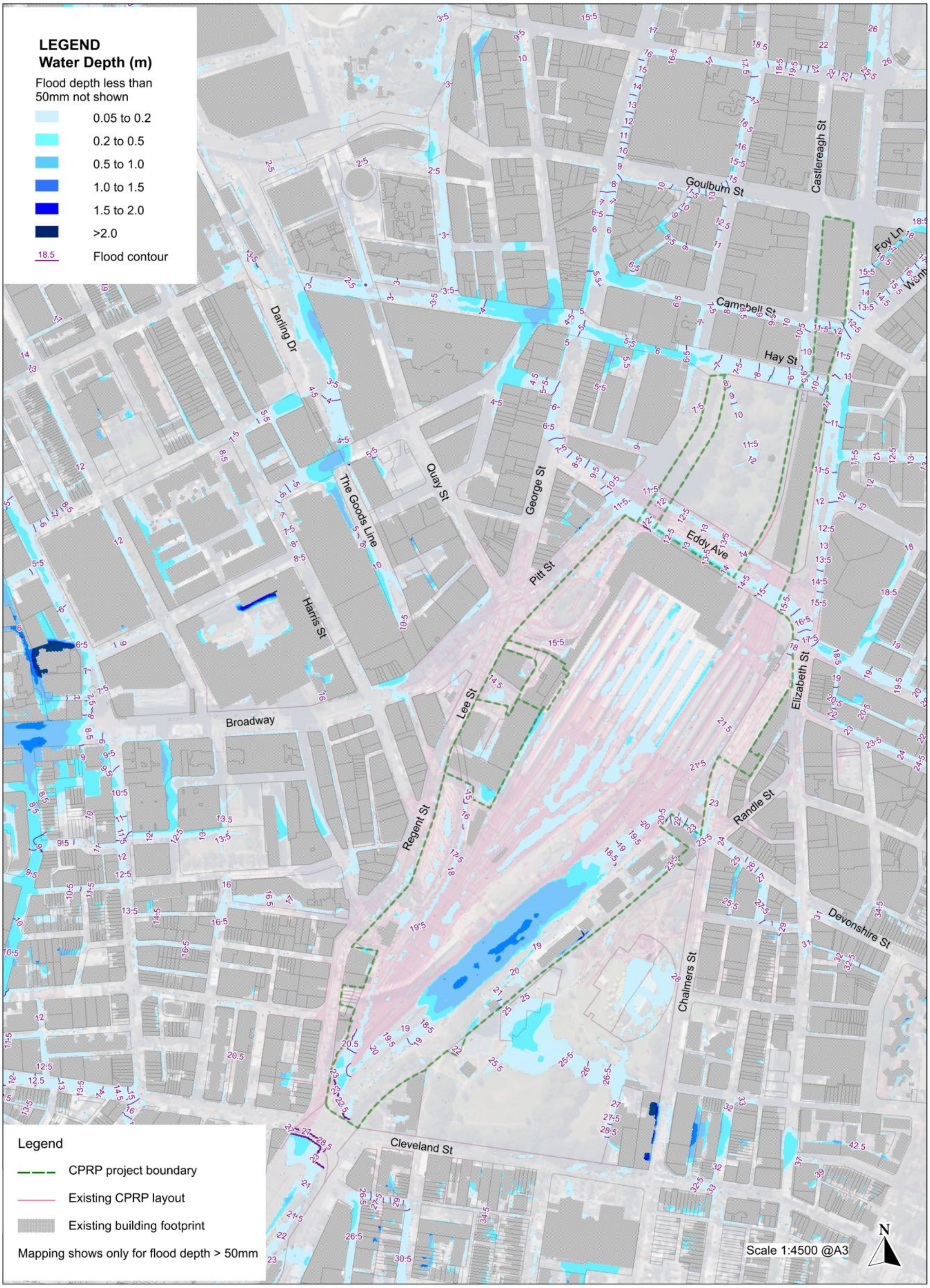


Figure 7: Existing Flood Regime - 1% AEP Design Rainfall Event – Flood Depth

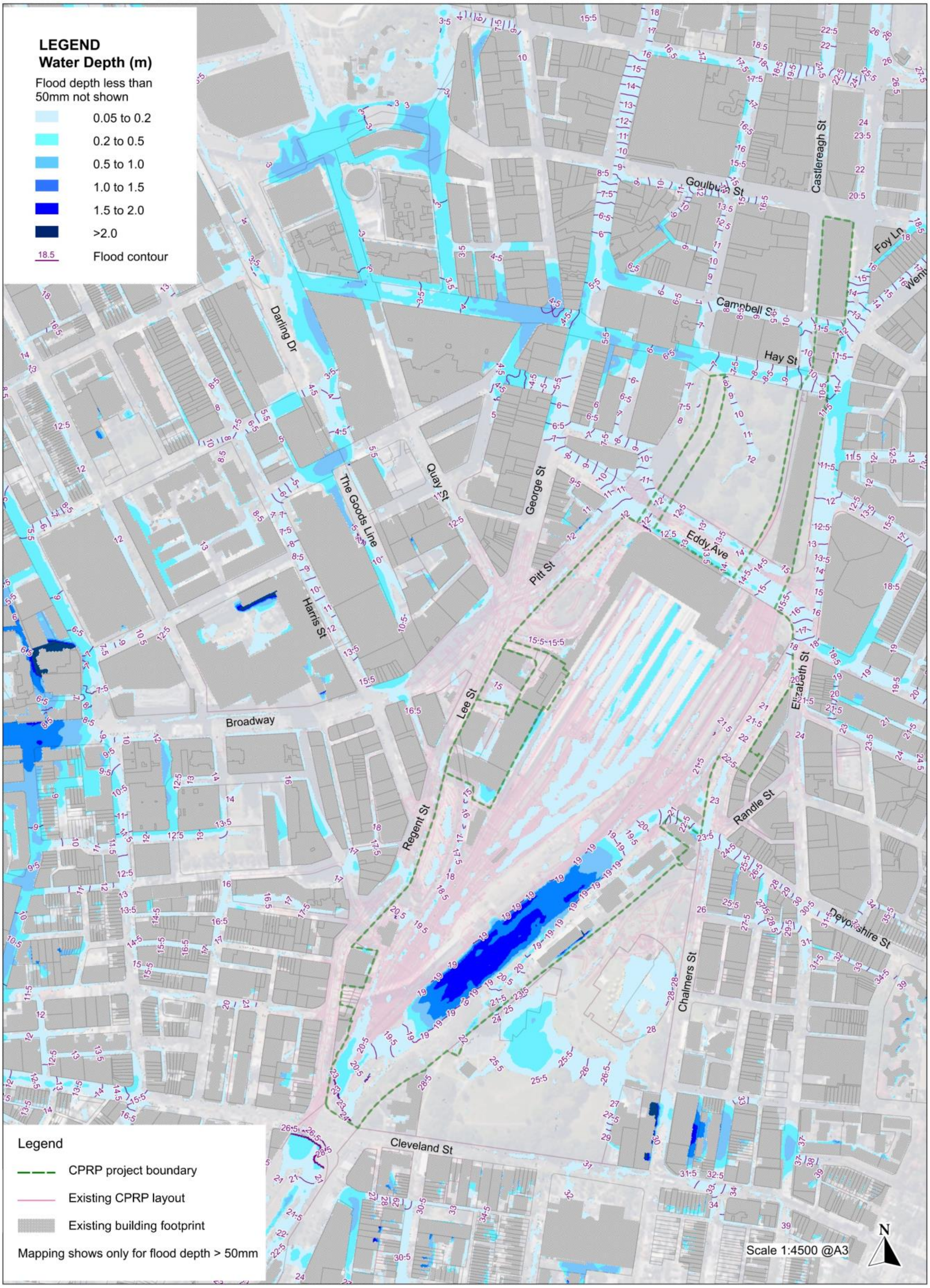


Figure 8: Existing Flood Regime - PMF Design Rainfall Event – Flood Depth

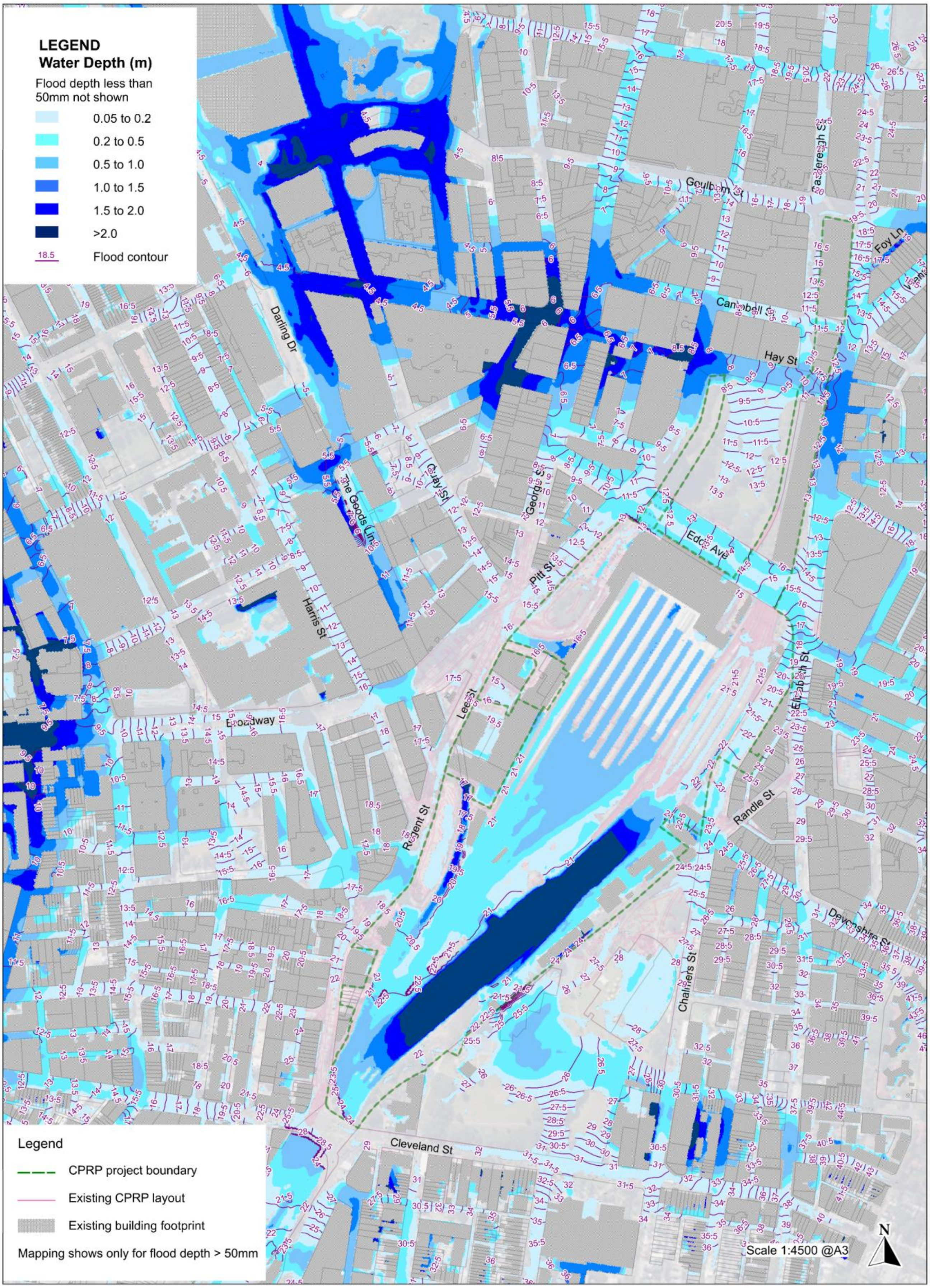


Figure 9: Existing Flood Regime – 10% AEP Design Rainfall Event – Flood Hazard

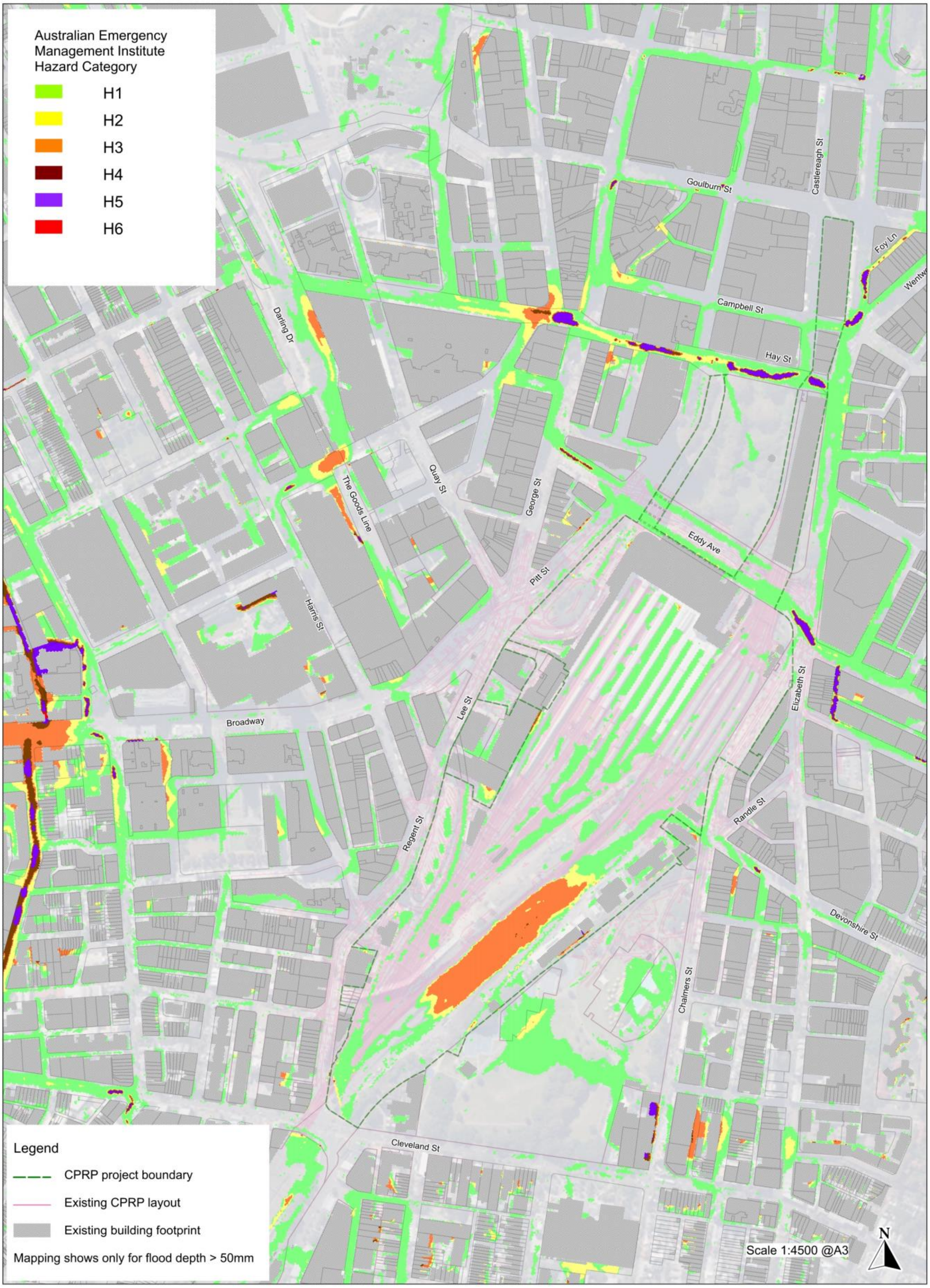


Figure 10: Existing Flood Regime – 1% AEP Design Rainfall Event – Flood Hazard

Figure 11: Existing Flood Regime – PMF Design Rainfall Event – Flood Hazard

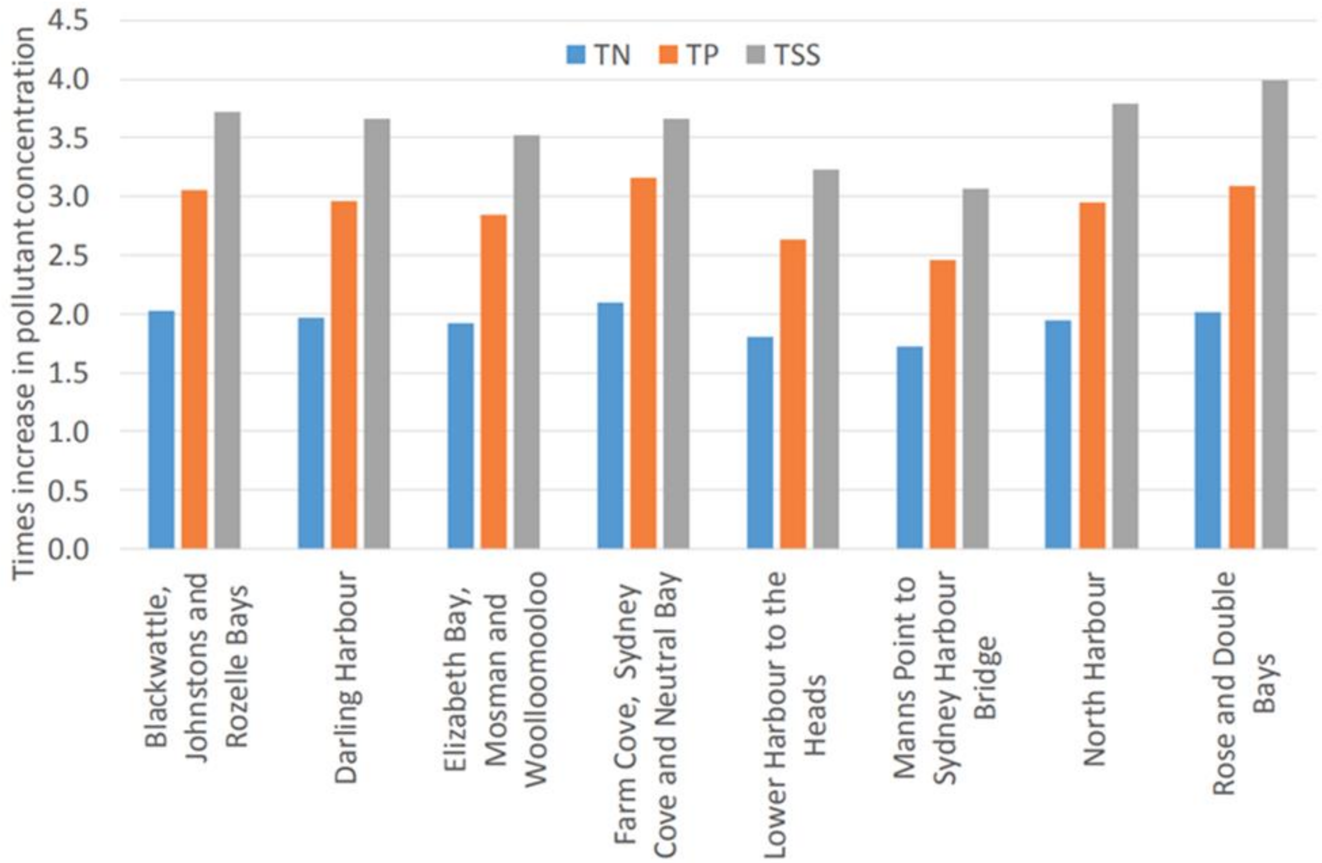
2.5 Water quality

As mentioned in **Section 2.1**, the highly urbanised nature of Central Precinct and the upstream catchment area increases the pollutant load of stormwater runoff when compared to a less populated, more vegetated pervious catchment. The presence of pollutants from the rail corridor further impacts the quality of stormwater runoff.

Within the rail corridor there is the potential for a range of pollutants to enter the stormwater system, with nutrients likely to be draining from railway ballast and other contaminants (such as diesel residue and brake dust) arising from train activity.

From Central Precinct, stormwater runoff drains north to Sydney Harbour through either the Darling Harbour catchment in the north or Blackwattle Bay catchment in the south. Local Land Services (2015) provides a general description of water quality in these two catchments, with nutrients and bacterial concentrations being somewhat consistent with other lower Sydney Harbour catchments, with nutrient and sediment concentrations being considerably higher than estimated pre-European levels (**Figure 12**).

Figure 12: Sydney Harbour increase in nutrient and sediment concentrations compared to estimated pre-European levels



***Source**: Local Land Services (2015)*

Bacteria levels in Blackwattle Bay have tended to be high, with the average enterococci count being around four times higher than the relevant ANZECC (2000) guideline value (Montoya 2015). Comparable data is not available for Darling Harbour.

Water quality in Blackwattle Bay and Darling Harbour will contribute to the broader water quality of Sydney Harbour, which in turn influences the health of the estuarine harbour's ecosystem and can in some situations influence that of recreational users of the harbour. The New South Wales Water Quality and River Flow Objectives recognises the range of different impacts associated with poor water quality.

Constraints, opportunities and key issues

The quality of stormwater runoff from Central Precinct and upstream catchment areas may hinder the feasibility of stormwater reuse applications, and impact the quality of the downstream receiving waters. Within the rail corridor the restricted access, rail operations and infrastructure present constraints on the implementation of water quality treatment measures.

Future redevelopment of Central Precinct provides an opportunity to increase stormwater quality treatment and stormwater reuse applications, which in turn improve the quality of stormwater leaving Central Precinct.

3. Policies and Plans

This chapter outlines the current policies and plans which apply to the precinct relating to stormwater, specifically stormwater quantity, quality and flooding. This information has been used to guide the development of the Central Precinct Renewal Project (CPRP) concept Stormwater Management Plan SMP (**Chapter 6**) and recommendations (**Chapter 7**) provided. Key extracts from the policies and plans below are provided as **Appendix D**.

3.1 Sydney Local Environmental Plan 2012

Flood planning is addressed under Section 5.21 of the Sydney Local Environmental Plan (LEP) 2012 which provides the following objectives:

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

b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change

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

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

3.2 Sydney Development Control Plan 2012

The Sydney Development Control Plan (DCP) 2012 supplements the LEP and provides more detailed provisions to guide development. Section 3.7 of the DCP addresses water and flood management with the following objectives:

a) Ensure an integrated approach to water management across the City through the use of water sensitive urban design principles

b) Encourage sustainable water use practices

c) Assist in the management of stormwater to minimise flooding and reduce the effects of stormwater pollution on receiving waterways

d) Ensure that development manages and mitigates flood risk, and does not exacerbate the potential for flood damage or hazard to existing development and to the public domain

e) Ensure that development above the flood planning level as defined in the Sydney LEP 2012 will minimise the impact of stormwater and flooding on other developments and the public domain both during the event and after the event

f) Ensure that flood risk management addresses public safety and protection from flooding.

In line with the DCP objectives, provisions are provided for:

- Site specific flood study
- Drainage and stormwater management
- Stormwater quality
- Additional provisions for commercial and industrial properties

From these provisions, key requirements include:

- A site-specific flood study is to be prepared (DCP Section 3.7.1)
- A local drainage management plan is to be prepared for sites greater than 1,800 square metres (DCP Section 3.7.2). Includes requirements to address:

- Any expected rise in groundwater
- How determinantal impacts on the existing natural hydrology and water quality are proposed to be minimised.
- A design capacity Average Recurrence Interval is specified of new stormwater drainage infrastructure
- For new drainage connections, the level of impact on existing stormwater infrastructure is limited and must be demonstrated
- A specified reduction in post-development average stormwater volumes generated
- For developments greater than 1,000 square metres, a stormwater quality assessment is to be undertaken to demonstrate specified pollutant reduction targets can be achieved
- For developments less than 1,000 square metres, to be designed to reduce the flow of pollutants from the site due to stormwater. Water re-use, recycling and harvesting

3.3 Interim Floodplain Management Policy 2014

The Interim Floodplain Management Policy provides controls to facilitate a consistent, technically sound and best practice approach for the management of flood risk. The policy offers direction with respect to how floodplains are managed and has been prepared in accordance with the guidelines provided in the NSW Government Floodplain Development Manual (2005). The policy offers the means for implementing Council's Floodplain Risk Management Plans.

Aims and objectives of the policy are:

- To inform the community of the City's Policy with regard to the use of flood prone land
- To establish guidelines for the development of flood prone land that are consistent with the NSW Flood Policy and NSW Floodplain Development Manual (2005) as updated by the Floodplain Management Guides
- To control development and activity within each of the individual floodplains within the City having regard to the characteristics and level of information available for each of the floodplains
- minimise the risk to human life and damage to property by controlling development on flood prone land
- To apply a merit based approach to all development decisions taking into account ecological, social and environmental considerations
- To ensure that the development or use of floodplains does not adversely impact upon the aesthetic, recreational and ecological values of the waterway corridors
- To ensure that all land uses and essential services are appropriately sited and designed in recognition of all potential floods
- To ensure that all development on the floodplain complies with Ecologically Sustainable Development (ESD) principles and guidelines
- To promote building design that considers requirements for the development of flood prone land and to ensure that the development of flood prone land does not have significant impacts upon the amenity of an area.

In addition to performance criteria and general requirements, the policy defines flood planning levels, meaning the permissible minimum building floor level. The policy describes a flood planning level as the combinations of flood levels and freeboards selected for floodplain risk management purposes, as determined in flood studies and floodplain risk management studies and plans.

The policy has defined different flood planning levels for different types of development and categories of flooding. The flood planning levels are typically specified relative to the 1% Annual Exceedance Probability (AEP) and/or the Probable Maximum Flood (PMF) flood level or the surrounding ground levels and apply to the following types of development:

- Residential, industrial and commercial development
- Above and below ground parking
- Critical facilities.

3.4 Sydney Streets Technical Specifications 2019

The Sydney Streets Technical Specifications set the guidelines for asset design, construction, handover, operation and maintenance. The specifications apply to assets that are under the Council's control and provide direction for private development that has implications on the public domain.

Within the specifications stormwater infrastructure is addressed in:

- Part A4: Stormwater Drainage Design
- Part B10: Stormwater Drainage Construction
- Part C3: Standard Drawings - Stormwater Assets

3.5 Environmental Strategy 2021-2025

Council's Environmental Strategy outlines the most important measures to help make Sydney a sustainable and resilient city. Council is continuing to work on initiatives that mitigate the urban heat island effect and contribute to a water-sensitive city that protects biodiversity, green space and waterways. Key actions of strategy related to stormwater include:

- Deliver energy, water and resilience outcomes through City asset design and management
- Keep City parks green with water efficiency and alternate water sources
- Drought-proof the city by facilitating water recycling
- Regenerate polluted waterways, air and land

The strategy also targets the following water quality reductions:

- 50 percent reduction in the annual solid pollution load discharged to waterways via stormwater by 2030
- 15 percent reduction in the annual nutrient load discharged to waterways via stormwater by 2030.

3.6 Central Sydney Planning Strategy 2016-2036

The Central Sydney Planning Strategy is a 20-year growth strategy that revises previous planning controls and delivers on Council's Sustainable Sydney 2030 program for a green, global and connected city.

Relevant to stormwater, the implementation component of the strategy, Section 26 - Energy and water efficiency, includes:

> *26.12 Ensure precincts are designed for the collection, treatment and reuse of locally generated wastewater, stormwater and rainwater for non-potable use including toilet flushing, laundry, cooling and irrigation.*

3.7 Flood Prone Land Policy and Food Development Manual 2005

The NSW Government's Flood Prone Land Policy, as set out in the NSW Floodplain Development Manual, supports the resilient development of flood prone land. The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods.

The policy highlights the primary responsibility for floodplain risk management rests with councils, who are provided financial and technical support by the state government.

The flood development manual guides councils in the development and implementation of detailed local floodplain risk management plans to produce robust and effective outcomes. Note the NSW Floodplain Development Manual is soon to be superseded by the Flood Risk Management Manual current under public exhibition.

3.8 Central Precinct studies and plans

3.8.1 Central Precinct Renewal Program Green Infrastructure Study 2022

The Central Precinct Renewal Program Green Infrastructure Study (TfNSW, 2022) illustrates how commitment through planning, design, implementation and the maintenance of green infrastructure can bring social, economic and environmental benefits to the precinct and the wider city. The development of the study has been undertaken in collaboration with the development of this report.

The green infrastructure strategy is guided by the following design principles:

- Improve and expand green open space with high environmental amenity and comfort
- Layer greening to create rich biodiversity and high quality habitat
- Design green landscape systems that strengthen resilience to climate change stresses
- Connect people and community through green open spaces that promote health, wellbeing and equality.

The strategy includes the following relevant performance outcome:

- Water Sensitive Urban Design (WSUD) strategies that offer environmentally sustainable management of onsite stormwater

3.8.2 Central Precinct Pollution Assessment 2022

The Central Precinct Pollution Assessment (TfNSW, 2022) identified and assessed the potential pollution impacts resulting from the CPRP in relation to water, light and noise. The assessment of stormwater pollution undertaken in the assessment has been based on the concept Stormwater Management Plan (SMP) outlined in this report (**Chapter 6**).

The pollution assessment addresses the policy framework of the New South Wales Water Quality and River Flow Objectives. The objectives provide guideline levels to help manage water quality for the lower estuary of the Sydney Harbour catchment which is the receiving environment for drainage from Central Precinct. These are however intended as a broader catchment management tool rather than targets that can be practically applied to individual developments.

The pollution assessment concluded that the CPRP represents a major opportunity to substantially reduce pollutant loads entering the stormwater system when compared with the existing situation. It also noted that the Central Precinct Environmental Sustainability Strategy (2021) objective to reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines was a realistic outcome with the appropriate design of Water Sensitive Urban Design (WSUD).

3.8.3 Central Precinct Sustainability Framework 2021

Transport for New South Wales (TfNSW) has developed a Sustainability Framework (2021) for the Central Precinct. The Sustainability Framework:

- Sets out the ambition for sustainability based on an analysis of the global sustainability context
- Synthesises the planning priorities to derive a series of sustainability themes specific to the project
- Provides context for the application of seven environmental sustainability themes, eight social sustainability themes and eight economic sustainability themes.

3.8.4 Central Precinct Environmental Sustainability Strategy 2021

The Central Precinct Environmental Sustainability Strategy (2021) builds upon this sustainability framework to identify the detailed objectives and opportunities for delivering world leading environmental sustainability outcomes at Central Precinct.

Of particular relevance to this report are the following environment sustainability themes and ambitions:

- Water – The ambition for water resource management at CPRP is to preserve non-renewable water resources and to provide a net improvement to environmental water quality as a result of development
- Climate Risk and Resilience – The ambition for resilience at CPRP is to effectively mitigate chronic stresses and insulate against acute shocks through design

The Environmental Sustainability Strategy identified Precinct Utility, Urban Forest and Green Infrastructure as opportunities for the precinct to deliver value in innovative ways.

3.8.5 Central Precinct Climate Adaptation Plan 2021

The Central Precinct Climate Adaptation Plan (Atelier Ten & Integral Group, 2021) has been developed for the Central Precinct. Related to stormwater, the Climate Adaptation Plan identifies extreme rainfall events, sea level rise and discharge runoff as climate change variables with potential impacts. A risk assessment has been documented for the various climate change variables identifying the potential impact and level of risk considering 2036, 2056 and 2090 horizons. An adaptation plan is presented specifying adaptation measures.

4. Consultation

Transport for New South Wales (TfNSW) has actively engaged with key stakeholders to share information, understand needs and aspirations for the precinct and seek feedback as the State Significant Precinct (SSP) study has developed.

The following summarises the stakeholder consultation activities which have been undertaken. This information has been used to inform the development of the Central Precinct Renewal Project (CPRP) concept Stormwater Management Plan (SMP) (**Chapter 6**) and recommendations (**Chapter 7**) provided. Stakeholder consultation records and key information received are provided as **Appendix E**.

4.1 City of Sydney Council

Arcadis has undertaken ongoing consultation activities for CPRP with the City of Sydney Council (Council) stormwater and flooding specialists. Key consultation activities are listed below in **Table 4**.

In addition to being a development consent authority, Council owns stormwater drainage in the vicinity of the precinct. For the larger catchment areas surrounding the precinct, Council has undertaken flood studies and developed floodplain risk management plans, as mentioned in **Section 2.4.1**. These flood studies and plans are used to apply flood-related development controls where applicable.

An initial consultation meeting was held with Council to provide an overview of the CPRP and seek information. Following this meeting, Arcadis requested documented feedback from Council on a number of technical issues, from which a formal response has been received. This response outlined the Council policies, guidelines, design requirements and development controls applicable to the precinct.

More recently additional consultation has been undertaken with Council to provide an update on the SSP study and seek feedback on this report.

Table 4: City of Sydney Council consultation activities

Date	Title	Description
24/10/2019	Flood Models	Council flood models and accompanying flood study and floodplain risk management study reporting were sourced for the Blackwattle Bay and Darling Harbour catchment areas.
10/06/2020	Consultation Meeting	Virtual meeting with TfNSW, Council and Arcadis providing an overview of the CPRP and current project status, investigations completed to date, requesting further information and feedback from Council.
18/06/2020	Request for Information Issued	Arcadis issued a request for information memo outlining various requests for Council information and seeking feedback on the application of Council development requirements.
13/07/2020	Request for Information Response	Council provided a formal response to the RFI raised along with survey files of nearby areas.
10/08/2021	Recycled Water Meeting	Meeting with Council and Sydney Water to discuss recycled water opportunities.
4/04/2022	CPRP SSP Update - Stormwater & Utilities	Ongoing consultation with Council in relation to the SSP, specifically the Utilities and Stormwater study requirements.

4.2 Sydney Water Corporation

Corporation (SWC) with regards to stormwater and flooding, potable water, wastewater and recycled water. Key consultation activities are listed in **Table 5**.

SWC owns a number of trunk stormwater and sewer drainage lines that cross Central Precinct. An initial consultation meeting was held with SWC to provide an overview of the CPRP and seek information. Following this meeting, Arcadis made a feasibility application to SWC who provided an advice letter offering guidance on the following stormwater related items:

- Investigation of existing assets
- Building over or adjacent to assets
- Connecting to existing assets
- Flood impact assessment requirements
- On-site stormwater detention requirements
- Discharged stormwater quality targets.

Further ongoing meetings have since occurred with SWC discussing the SSP study and in particular approvals for building over assets and opportunities for recycled water services.

Arcadis issued summary memos to SWC providing an overview of the concept stormwater management plan and the precinct flood modelling undertaken, along with the completed precinct flood model report (**Appendix C**). These memos requested formal documented feedback from SWC which was subsequently received.

Table 5: Sydney Water Corporation consultation activities

Date	Title	Description
4/10/2019	Initial Consultation Meeting	Overview of the CPRP and current project status, load demands and seeking a feasibility assessment.
5/11/2019	Feasibility Application	Feasibility application made (case number 181844) with SWC including information requests related to stormwater and flooding.
19/12/2019	Advice Letter	SWC provided an advice letter in response to the submitted feasibility application.
5/11/2020	Ongoing Consultation Meeting	General project status update. Discussion of requirements and approvals process related to building over assets and ongoing engagement.
25/05/2021	SSP Consultation Meeting	Overview of SSP study and general project update. Discussion of recycled water services.
30/06/2021	SSP Consultation Meeting	Ongoing consultation with SWC in relation to the SSP. Discussion of recycled water services. Further requests for information and feedback to be issued via memos.
19/07/2021	Stormwater Summary Memos	Memos issued to SWC providing an overview of the CPRP stormwater management strategy, precinct flood model report, and requesting documented feedback.
5/08/2021	SSP Consultation Meeting	Ongoing consultation with Sydney Water in relation to the SSP. Project update and discussion of recycled water services.
10/08/2021	Recycled Water Meeting	Meeting with Council and SWC to discuss recycled water opportunities.
19/01/2022	SWC Feedback	Documented feedback in relation to the stormwater management memo issued in July 2021.

5. Precinct assessment

An assessment of the potential impacts of the Central Precinct Renewal Project (CPRP) on stormwater quality and quantity during construction and at completion are discussed in this chapter. Potential impacts are identified for the precinct and the surrounding areas. A Hydrogeology Impact Assessment has also been provided as **Appendix B**. Further information on the potential flood impacts of the CPRP and flood modelling undertaken for the CPRP is also provided as **Appendix C**.

This impact assessment of the CPRP has been based on the SSP Reference Master Plan provided. The Reference Master Plan illustrates the potential redevelopment of Central Precinct and is considered representative of the scale and extent of the built form. Further detailed design of Central Precinct and description of works is not available at this early stage of the CPRP. This impact assessment is therefore high level in nature and intended to inform the preparation of the SSP planning framework.

In addition to the assessment below, the potential impacts on stormwater pollution are addressed further in the Central Precinct Pollution Assessment (Arcadis, 2022) outlined above in **Section 3.8.2**. Note the pollution assessment concluded that the CPRP represents a major opportunity to substantially reduce pollutant loads entering the stormwater system when compared with the existing situation. It also noted that the Central Precinct Environmental Sustainability Strategy (2021) objective to reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines was considered to be a realistic outcome with the appropriate design of Water Sensitive Urban Design (WSUD).

5.1 Potential impacts

Stormwater quality and quantity may be impacted where changes are made to land use, topography or drainage networks. If not adequately managed, construction activities and development have the potential to impact stormwater quality and quantity either directly or indirectly by providing contaminant sources, altering ground cover, concentrating flows, altering flow paths and reducing flood storage. This may result in increased surface runoff volumes, velocities and peak flows, scouring and mobilisation of pollutants. Ultimately this can lead to increased pollutant loads and flood impacts adversely impacting the surrounding environment.

5.1.1 Construction

Construction activities with the potential to impact the stormwater quality and quantity of the downstream environment include:

- Alteration of the topography and associated catchment areas
- Alteration or removal of drainage pathways across the construction area
- Removal or modification of existing drainage, retention or diversion structures
- The concentration of stormwater flows
- Use of water for construction activities such as dust suppression, commissioning of the pipelines and dewatering
- Vegetation clearing
- Demolition or removal of existing structures, infrastructure or materials

- Stockpiling of materials
- Spills or leaks of substances such as oil, hydraulic fluids and fuels
- Waste materials from construction activities
- Movement of vehicles and equipment.

The risk of construction activities impacting water quality or water quantity is increased in proximity to areas such as:

- The existing stormwater drainage lines
- Flood prone areas where ponding and overland flow paths form which may be impacted by flooding in a large event
- Construction compound areas where stockpiling occurs.

Mitigation measures can be implemented during construction to avoid, minimise, mitigate and/or manage the potential impacts of the CPRP. These include the staging and timing of works to limit the disturbance of areas and avoid wet weather periods, best practice erosion and sediment control procedures and undertaking ongoing inspection and monitoring of activities to identify and rectify issues.

5.1.2 Completion

Given the scale of the CPRP it has the potential to adversely impact stormwater quality and quantity by:

- Altering the sub-catchment divides across the precinct and imperviousness of the catchments
- Obstructing, narrowing or diverting overland flow paths
- Concentrating overland flows
- Reducing flood storage
- Altering the nature and mobilisation of pollutants.

The above may increase stormwater runoff volumes, peak flows, flood levels and pollutant loads within Central Precinct, impacting the surrounding environment. Through the design process, and in line with the concept stormwater management plan (**Chapter 6**), impacts can be further investigated with options available to avoid, minimise, mitigate and/or manage the potential impacts of the CPRP.

5.2 Master plan assessment

The CPRP represents a large-scale redevelopment of a highly urbanised precinct. Whilst the extent of potential development works area considerable, it is worth appreciating that the existing Central Precinct is highly modified and has been for a prolonged period.

The CPRP Over Station Development (OSD) represents a substantial portion of the overall development works and a significant change in conditions. The addition of the OSD will significantly alter the hydrological response of the sub catchment with regards to both quantity and quality.

In the existing condition, rainfall is falling onto a relatively flat ballasted rail corridor, with a track drainage network collecting and conveying stormwater flows. The quality of stormwater runoff from these areas is expected to be poor. Given the compacted nature of the ground surface the infiltration rate may be low, and further ponding on the ground surface may result from the poor condition and limited extent of the track drainage network.

With the addition of the over station deck, rainfall will be falling onto high rise rooftops, hard surfaces and landscaped areas. A drainage network will be incorporated into the deck to collect and convey flows to the downstream trunk drainage lines. The OSD will produce a different hydrological response to the existing conditions. The contaminants and pollutant loads from the over station development will also vary from those at the rail level beneath.

Other areas of the CPRP are more typical of high-rise redevelopments in the area and may be more predictable in their impacts and suitability of typical mitigation measures.

Given the complex nature of the existing precinct and the ultimate CPRP, detailed investigations are required in order to define the impacts of the CPRP and identify effective mitigation measures as outlined in **Section 5.3**.

5.3 Flood impact assessment

In order to assess the potential flood impact of the CPRP a significant flood modelling exercise has been undertaken as documented in **Appendix C**. A brief overview of the existing conditions flood modelling and behaviour is provided as **Section 2.4.2.**

An initial representation of the CPRP (see **Figure 13**) has been developed in the Precinct Flood Model based on the level of design available at the time, considering:

- Proposed building locations and developments surrounding the rail corridor including the Western Gateway, Regent Street Sidings and Prince Alfred Sidings
- Preliminary concept regrading of the Western Forecourt and pedestrian connection to Eddy Avenue
- Preliminary revised track drainage network and platform extents
- Simplistic representation and assumptions regarding the over station deck catchment areas and connections to the downstream trunk drainage lines.

The representation of the CPRP and assumptions made will be further refined as the design progresses.

Flood mapping from the CPRP Precinct Flood Model has been provided for the 10% AEP (10-year ARI), 1% AEP (100 year ARI) and Probable Maximum Flood (PMF) design rainfall events as **Figure 14, Figure 15** and **Figure 16**. The maps show the extent and depth of flooding within and surrounding the precinct under the proposed conditions.

The legend at the top of the figures shows the peak depth of the flood event, with the flood contours showing the elevation of the peak flood level in metres to the Australian Height Datum (m AHD). As indicated in the legend at the bottom of the figures, the existing building footprints are shaded light grey, with the proposed CPRP buildings shown in dark grey.

The flood impact mapping for the 1% AEP and PMF design rainfall events are also provided as **Figure 17, Figure 18** and **Figure 19**. The legend at the top of the figures shows the difference in metres between the existing and proposed peak flood level as a result of the CPRP development. These maps illustrate varying increases and decreases in the proposed flood level due to the CPRP development.

The CPRP flood model demonstrates potential flood level impacts at several locations within the precinct and surrounding areas including:

- Chalmers Street/Devonshire Street intersection
- Broadway, George Street and Pitt Street
- Regent Street sag north of Mortuary Station
- Prince Alfred Park boundary.

The flood levels impacts are in isolated locations and not widespread across the Central Precinct.

In general, the flood impacts of the CPRP are exacerbating existing flood issues at select locations. The magnitude of the impact on peak flood levels is generally less than 0.1 metres in the 1% AEP and less than 0.5 metres in the Probable Maximum Flood (PMF) at the vast majority of locations.

Flood hazard mapping has also been provided for the 10% AEP, 1% AEP and Probable Maximum Flood (PMF) design rainfall events as **Figure 20**, **Figure 21** and **Figure 22** based on the Australian Institute of Disaster Resilience vulnerability curves illustrated in **Figure 5**. These maps show the CPRP not having any significant impact on the flood hazard within and surrounding the precinct.

A more detailed discussion of the potential flood impacts of the CPRP is provided in **Section 8.3** of **Appendix C**.

As the design of the CPRP continues to be developed, it is recommended that the Precinct Flood Model is maintained with the latest design information to continue to inform the design as it progresses. The Precinct Flood Model is a valuable assessment tool for avoiding flood impacts and mitigating flood risk. Additional recommendations in relation to the ongoing utilisation of the CPRP Precinct Flood Model are provided as **Section 4.2** of **Appendix C**.

Figure 13: Precinct Flood Model - CPRP representation

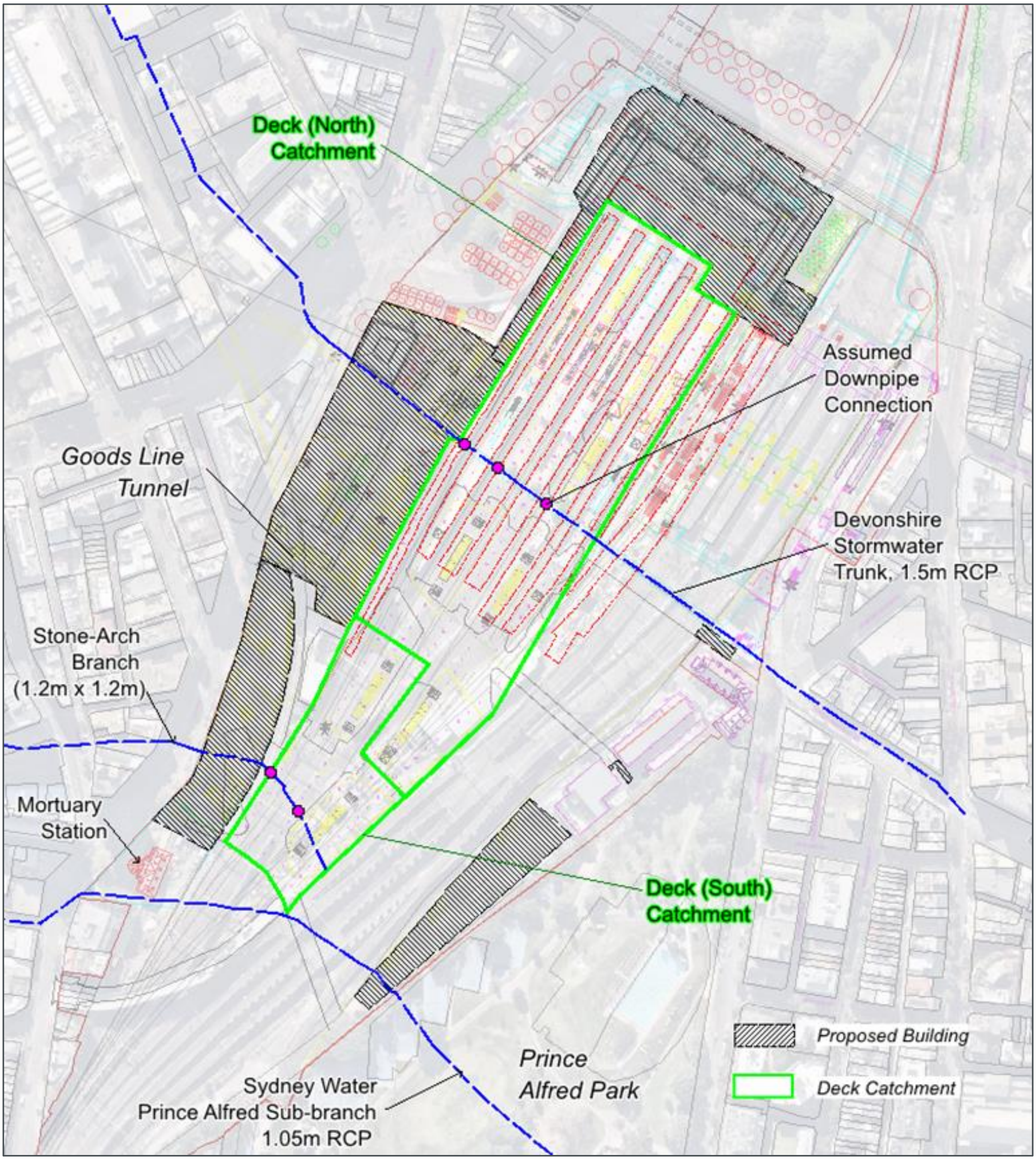


Figure 14: CPRP Flood Regime – 10% AEP Design Rainfall Event

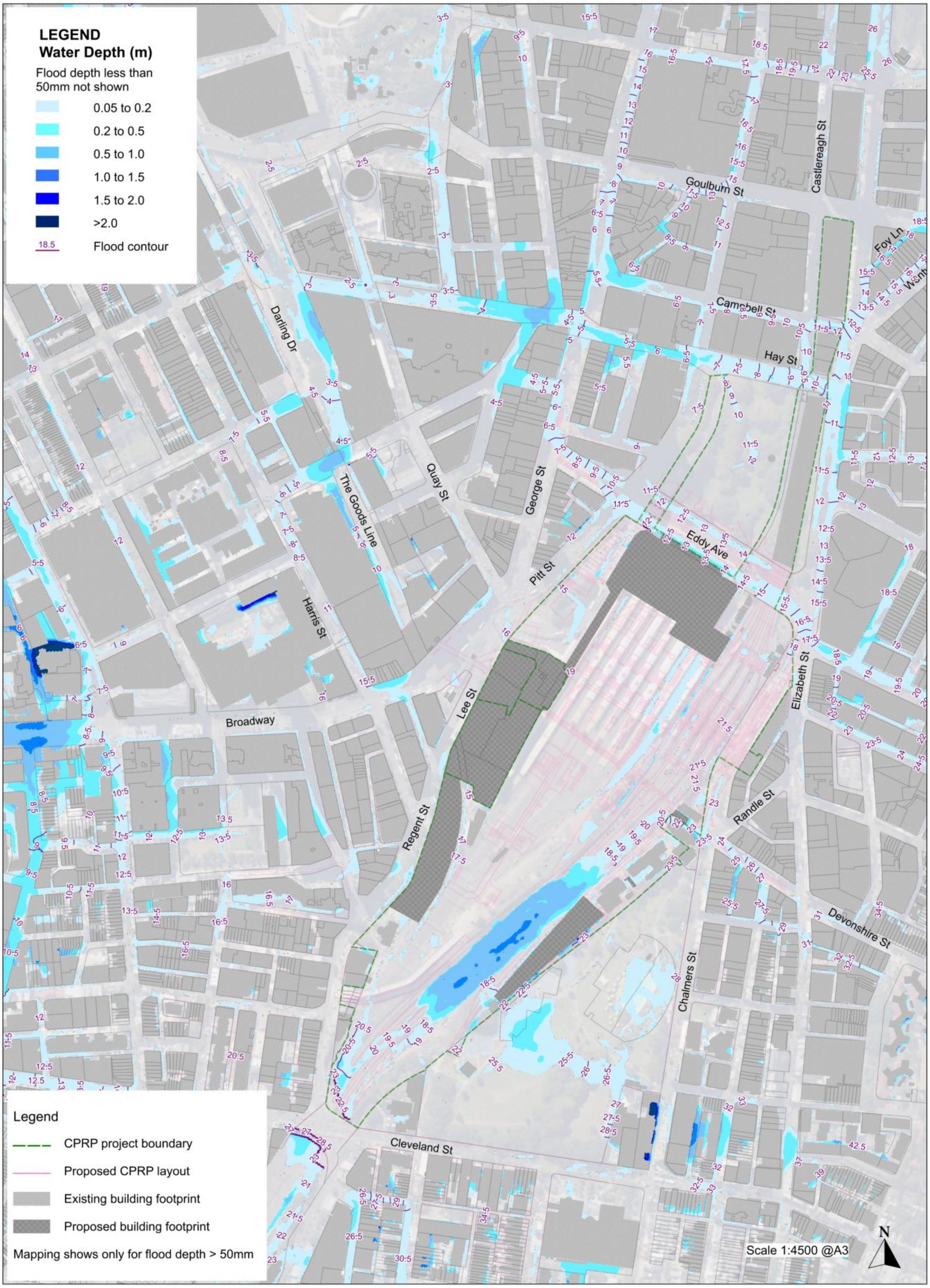


Figure 15: CPRP Flood Regime – 1% AEP Design Rainfall Event

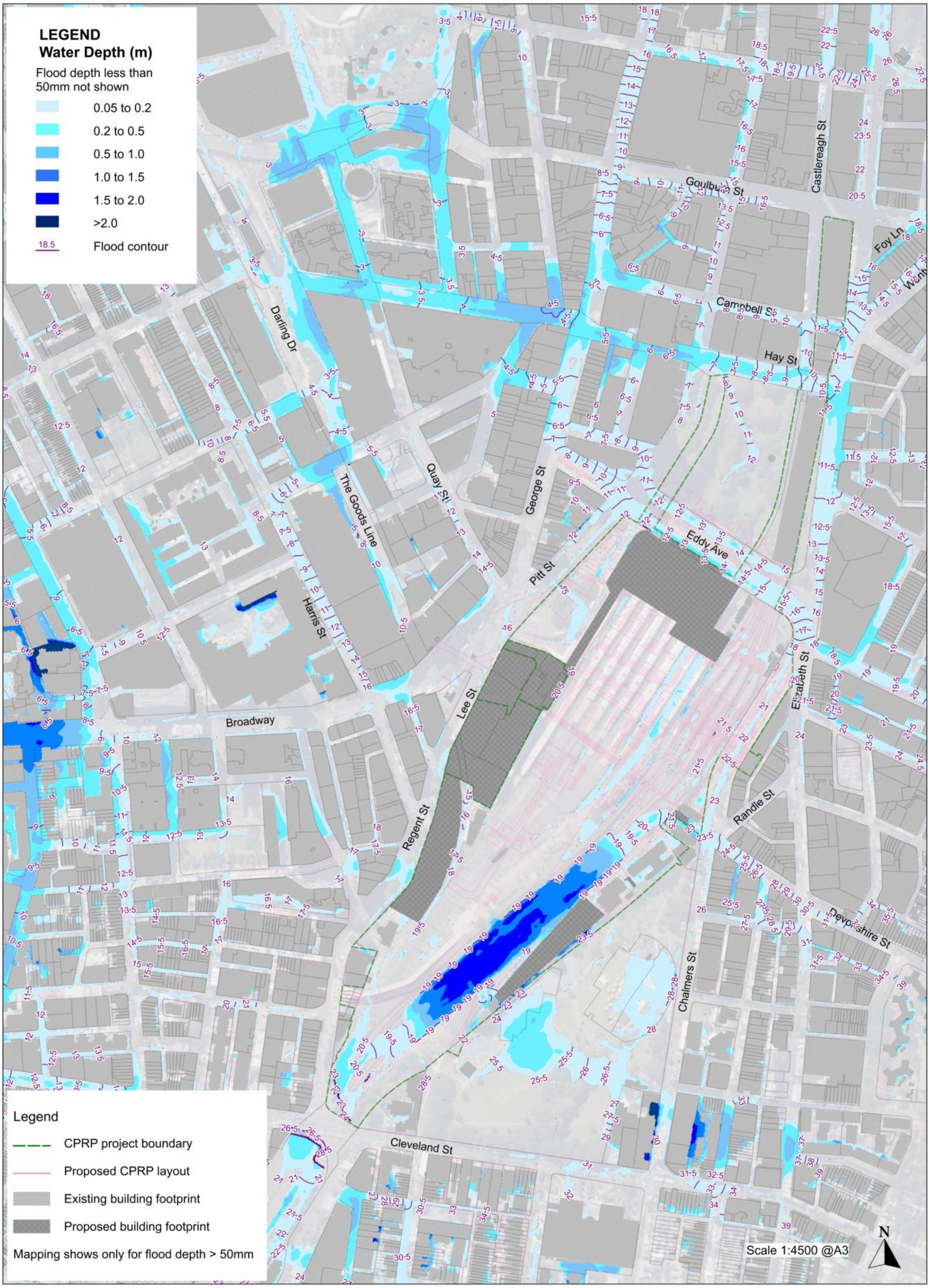


Figure 16: CPRP Flood Regime – PMF Design Rainfall Event

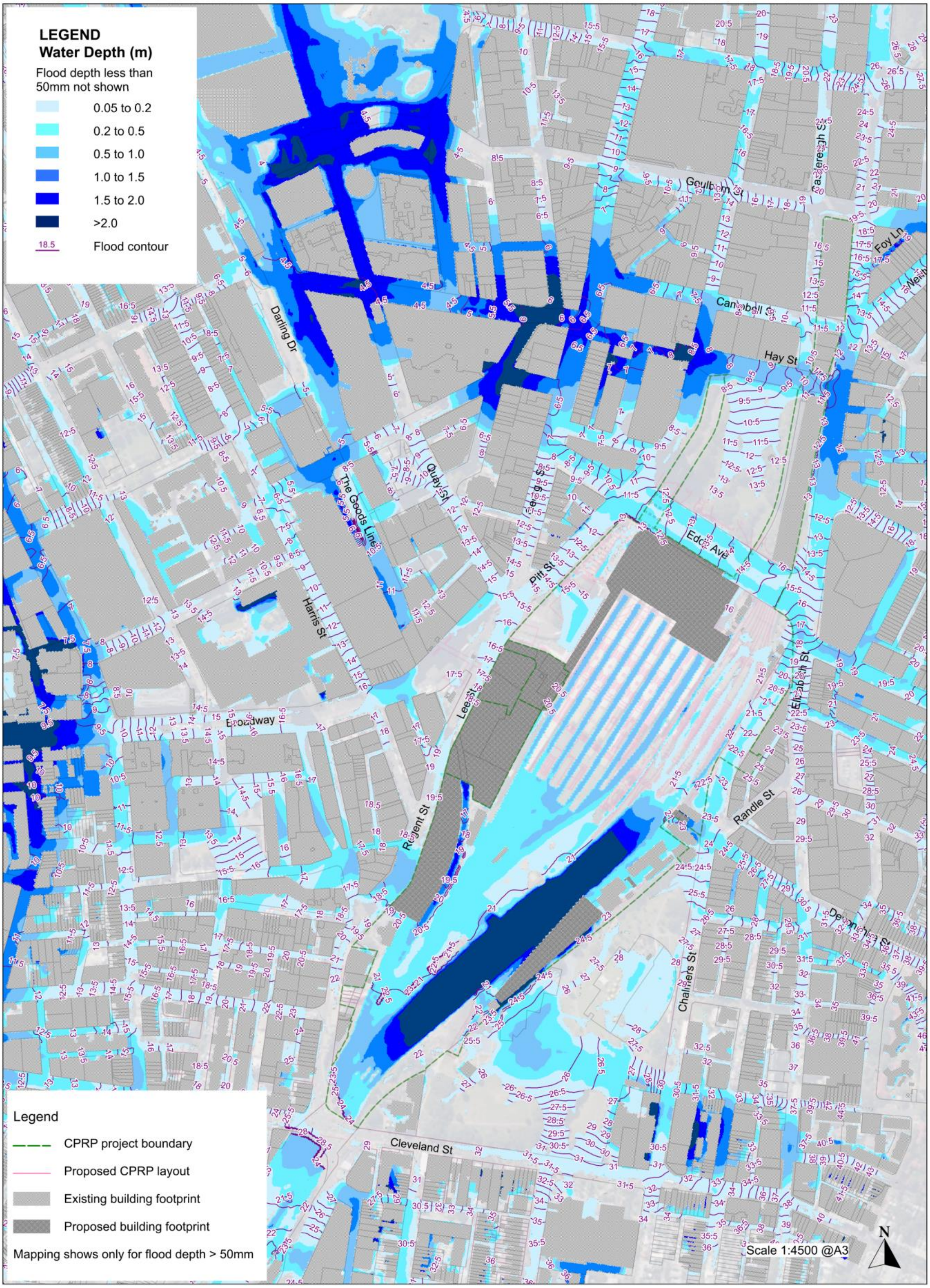


Figure 17: CPRP Flood Impact – 10% AEP Design Rainfall Event

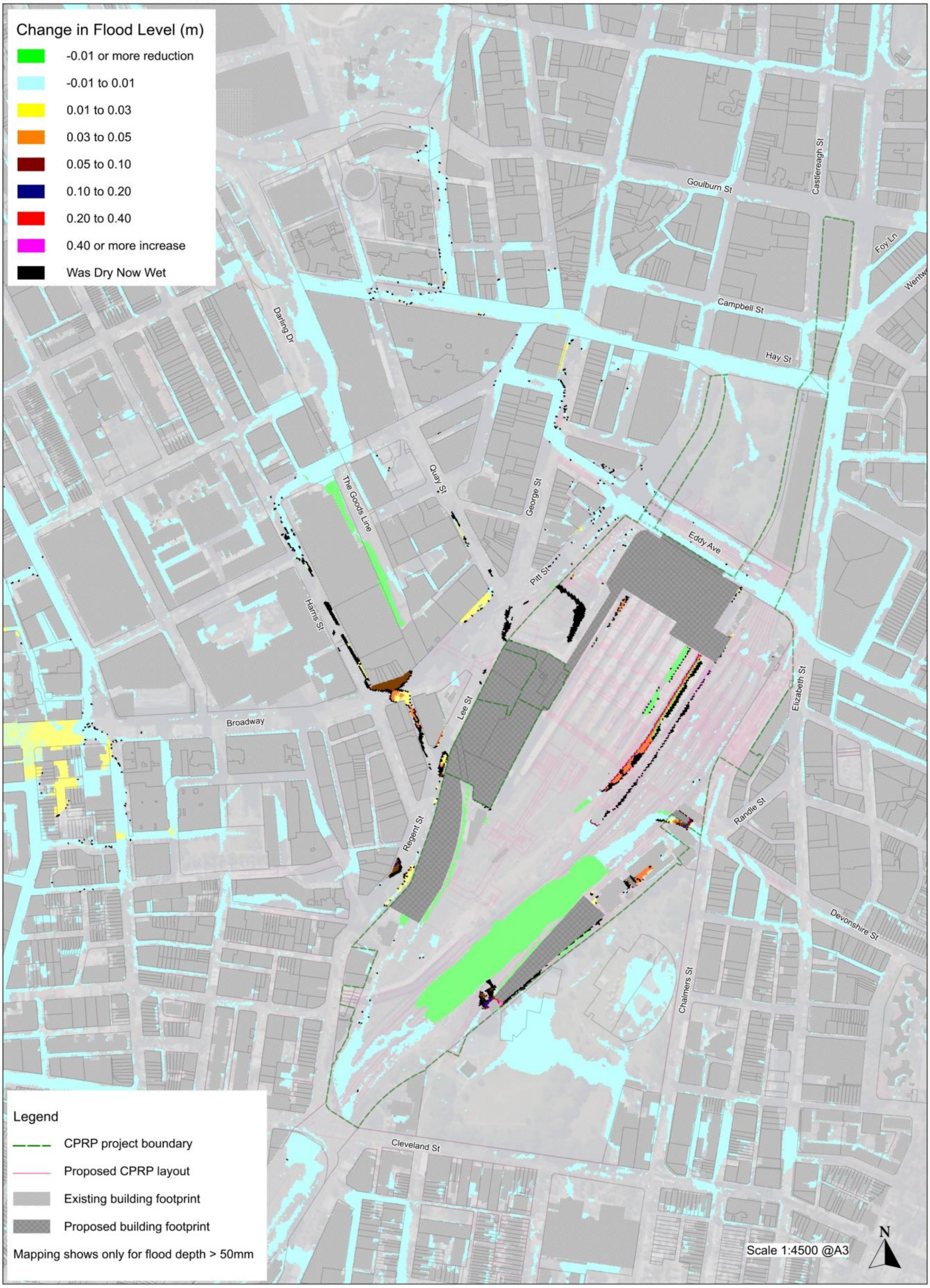
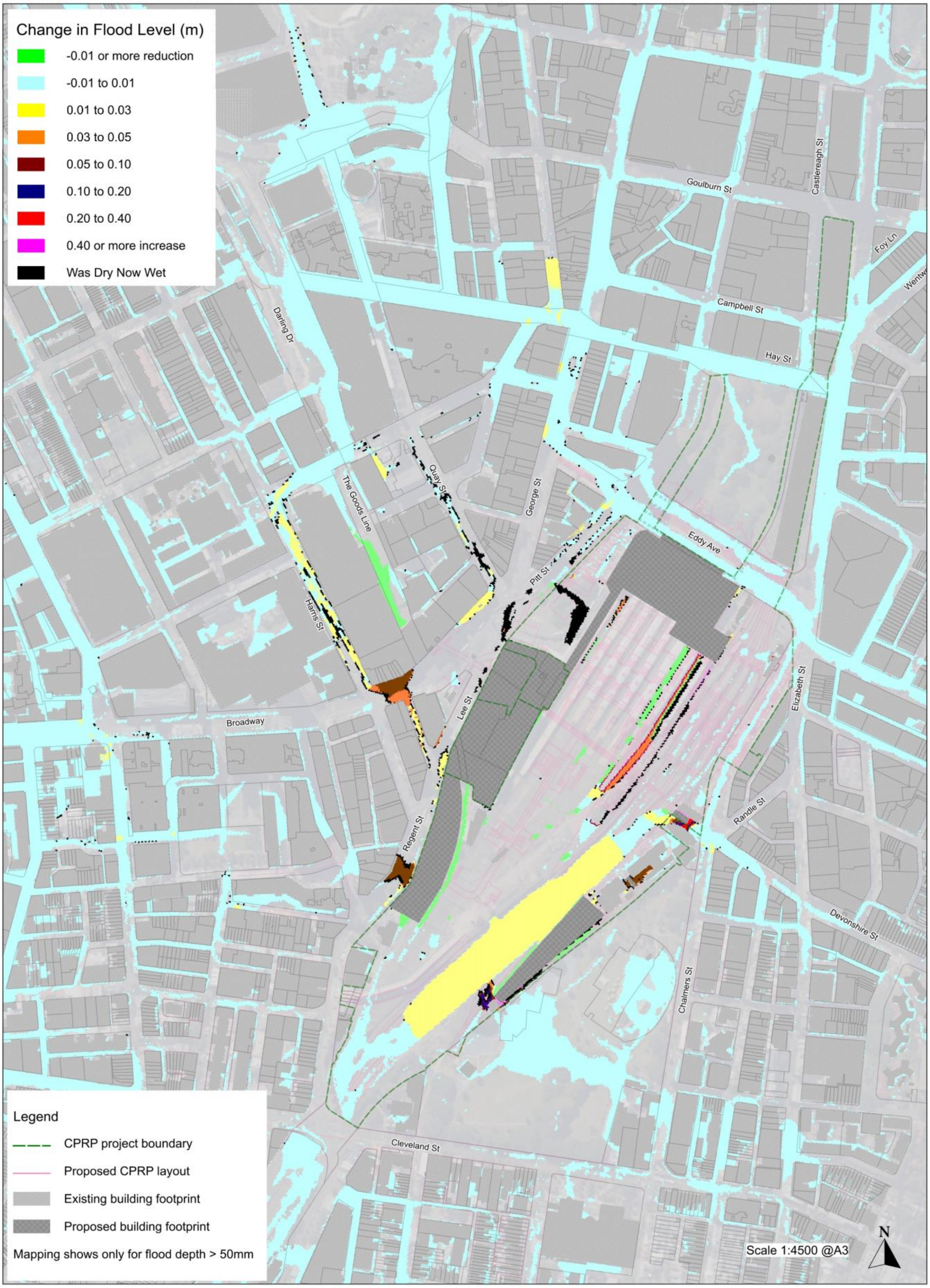


Figure 18: CPRP Flood Impact – 1% AEP Design Rainfall Event




Change in Flood Level (m)
-0.01 or more reduction
-0.01 to 0.01
0.01 to 0.03
0.03 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.40
0.40 or more increase
Was Dry Now Wet
Goulburn St
Castlereagh St
Foy Ln
Campbell St
Hay St
Darling Dr
Quay St
The Goods Line
George St
Eddy Ave
Pitt St
Harris St
Elizabeth St
Lee St
Broadway
Regent St
Randle St
Devonshire St
Chalmers St
Cleveland St
Legend
CPRP project boundary
Proposed CPRP layout
Existing building footprint
Proposed building footprint
Mapping shows only for flood depth > 50mm
Scale 1:4500 @A3
N

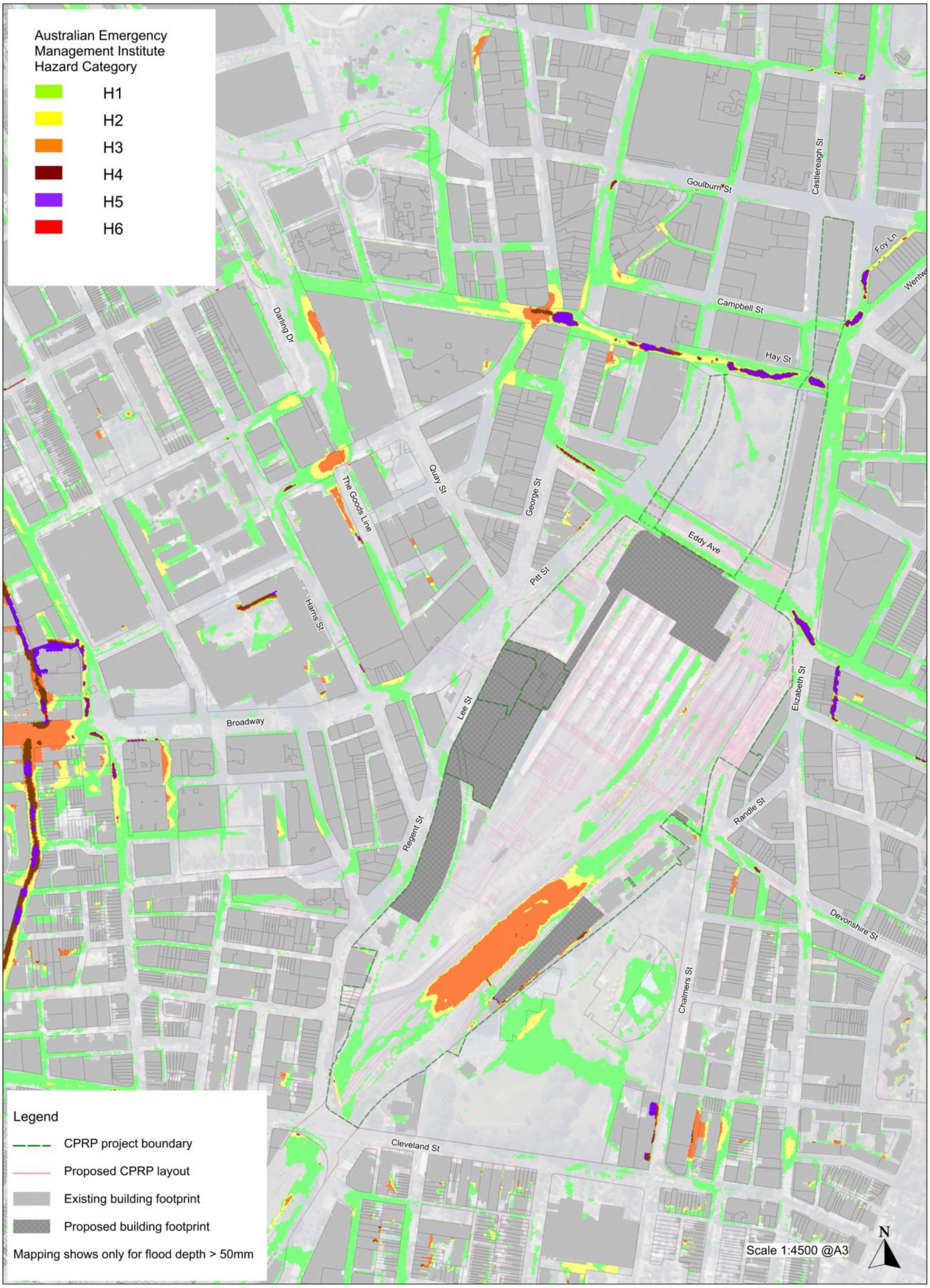

Australian Emergency
Management Institute
Hazard Category
H1
H2
H3
H4
H5
H6
Goulburn St
Castlereagh St
Foy Ln
Campbell St
Hay St
Darling Dr
Quay St
George St
The Goods Line
Eddy Ave
Pitt St
Harris St
Broadway
Lee St
Elizabeth St
Regent St
Randle St
Devonshire St
Chalmers St
Cleveland St
Legend
CPRP project boundary
Proposed CPRP layout
Existing building footprint
Proposed building footprint
Mapping shows only for flood depth > 50mm
Scale 1:4500 @A3
N

Figure 21: CPRP Flood Regime – 1% AEP Design Rainfall Event – Flood Hazard

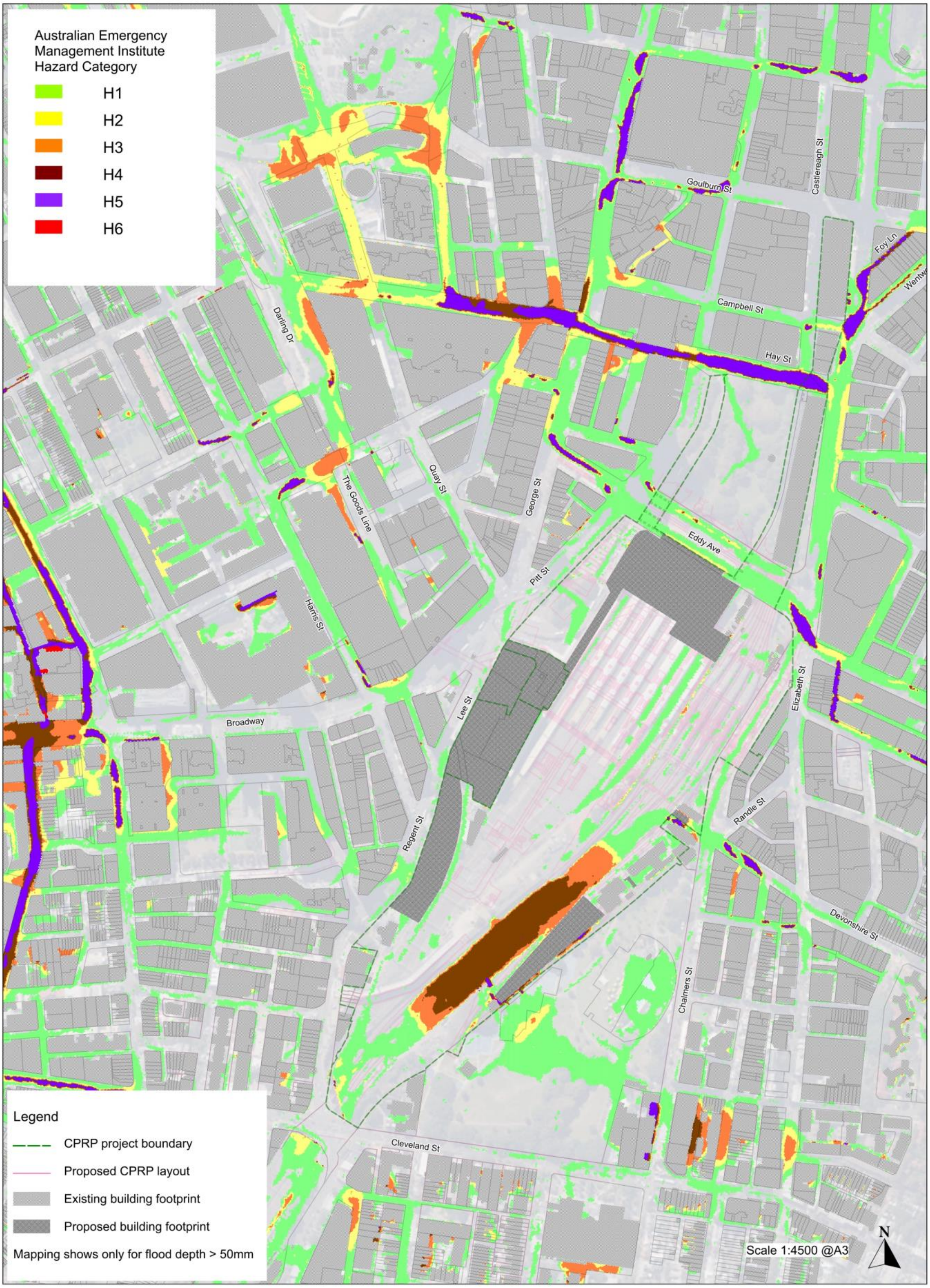


Figure 22: CPRP Flood Regime – PMF Design Rainfall Event – Flood Hazard

6. Concept Stormwater Management Plan

A concept Stormwater Management Plan (SMP) has been developed for the Central Precinct Renewal Project (CPRP) to convey the aspirations for stormwater management and provide supporting principles to guide the design development.

The SMP has been informed by relevant policies and plans (**Chapter 3**), stakeholder consultation (**Chapter 4**) and the Central Precinct assessment (**Chapter 5**) undertaken. It aims to respond to the constraints and opportunities of the existing environment (**Chapter 2**), and the potential impacts of the CPRP. The SMP has been based on the SSP Reference Master Plan provided. The master plan illustrates the potential redevelopment of the precinct and is considered representative of the scale and extent of the built form.

6.1 Aspirations

In alignment with the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021), the CPRP aspires to achieve a resilient and sustainable stormwater management outcome. Looking beyond conventional pits and pipes, stormwater is treated as a valuable resource and suitably considered across the civil, rail, building and landscape design. Taking a precinct wide approach, the site constraints, potential development impacts and climate change risks will be intelligently responded to.

An integrated water cycle management approach adopting best practice water sensitive urban design measures is at the centre of the SMP. The SMP aims to reduce flood risk, maximise stormwater quality treatment and reuse and support enhanced greening and urban cooling. To maximise the potential for the precinct to achieve a sustainable and resilient outcome this integrated water cycle management approach will be considered, promoted and supported from the onset of the precinct master planning through to the detailed design stages. As a water sensitive precinct, CPRP would set a new benchmark in Sydney for precinct level redevelopment.

6.2 Guiding principles

At the foundation of the SMP the following core stormwater management principles have been employed:

- Maintaining existing sub-catchment areas
- Preserving existing and creating adequate overland flow paths to the downstream
- Maintaining flood storage
- Maximising pervious areas
- Provision for stormwater detention
- Provision for stormwater quality treatment measures
- Identification and reduction of flood risk through design
- Consideration of a changing climate and extreme events.

Through these core principles, the potential impacts of the proposed development can be minimised with sustainability and resilience embedded. An overview of the concept SMP is illustrated in **Figure 23**. In alignment with these principles, the SMP is outlined further in **Section 6.3** and **Section 6.4**. Further overarching elements of the SMP are summarised in the following sections.

Figure 23: Concept Stormwater Management Plan

6.2.1 Sub-precinct approach

The SMP proposes a sub-precinct approach to stormwater management given the varied nature of the precinct and potential staging of works. Whilst a holistic planning approach to the precinct is vital, independent developments need to achieve standalone performance targets and mitigate impacts, as well as contribute to the larger aspirations of Central Precinct.

Where feasible the discrete sub-precinct areas would independently manage and discharge stormwater to the downstream, whilst avoiding interdependencies. Appropriately tailored development controls would be applied to each sub-precinct to maximise the potential of each whilst remaining feasible. This approach would see all sub-precincts contribute and be capable of achieving a targeted outcome irrespective of the timing of works and technical complexities of the remaining sub-precincts. This approach also encourages a distributed and at source application of water sensitive urban design (WSUD) measures.

For example, a largely independent new building in the Prince Alfred Park Sidings sub-precinct is expected to offer different opportunities for sustainable water management and have different resilience challenges to overcome than the rail corridor at track level. Similarly, we would expect differences between the Western Forecourt public domain and the Grand Concourse Extension. The SMP acknowledges the different constraints and opportunities across Central Precinct and seeks to efficiently produce valued outcomes.

6.2.2 Over station development

The Over Station Development (OSD) portion of the CPRP presents unique challenges and opportunities in design development. Working with a team of architects, engineers, landscape designers and sustainability consultants, the CPRP has envisaged the concept SMP of the over station development. In balancing multiple criteria, opportunities and constraints a hierarchy of stormwater management priorities have emerged which vary across locations.

The stormwater management must balance the needs of conveyance, treatment, detention and harvesting.

For the OSD buildings, the priority is for integrated green roofs, which collect, treat, store and reuse rainfall for roof vegetation. This supports the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021) Strategic Initiative 26 – Landscape water treatment systems.

At the deck surface, the conveyance of stormwater takes priority to manage stormwater in large rainfall events. Providing for passive irrigation of landscaped areas is a secondary priority.

Within the deck structure, the conveyance of stormwater is the priority, followed by detention (if required), and subsequently water quality treatment measures. Stormwater harvesting is considered the final priority given the perceived feasibility, benefit and likelihood of an alternative recycled water resource being available.

Figure 23 illustrates the concept SMP overland flow directions for the over station development deck level.

6.3 Stormwater conveyance

6.3.1 Preservation of catchment areas

Several Sydney Water Corporation (SWC) sewer and stormwater trunk drainage lines cross the precinct. Where possible the catchment areas to these trunk lines will be maintained. Existing connections to the trunk lines will be utilised where suitable. Likewise, efforts will be taken to protect, preserve and avoid impacts to the existing SWC assets.

From consultation with SWC (**Section 4.2**) they believe that the sewer and stormwater drainage lines through Central Precinct are not interconnected, though historically they may have been. Should it be found that Central Precinct stormwater drains to a sewer network, works would be undertaken to redirect and maintain dedicated stormwater and sewer systems where possible. Should locations of sewer leaks or overflows be identified, works would be undertaken to minimise these occurrences.

With regards to the over station development above the rail corridor, the construction of this structure will allow for some flexibility in where the collected rainfall runoff will discharge to. The sub-catchment areas will align with the existing catchments where feasible. Where possible the over station deck drainage network will remain independent from the rail track drainage network. The Precinct Flood Model will be utilised to ensure any change in the catchment areas and the larger impact of the development on flooding is assessed.

6.3.2 Preservation of overland flow paths and flood storage

To avoid flood impacts on the surrounding areas, the existing overland flow paths through and from Central Precinct which form during large rainfall events will be maintained. This includes overland flow paths entering the precinct from Devonshire Street and Prince Alfred Park, and the flow path from the rail corridor exiting through the Goods Line tunnel.

The existing rail corridor provides informal flood storage during rainfall events. Care will be taken to ensure that any modification to the existing drainage network, or the addition of the over station deck drainage, does not adversely impact the drainage capacity of the downstream network.

The concept SMP overland flow directions and locations were where ponding of stormwater occur are illustrated in **Figure 23**.

6.3.3 Provision of on-site detention

Stormwater detention may be required to mitigate potential impacts on either the connecting underground drainage network or above ground flooding. On-site detention will also be considered should opportunities exist to mitigate the existing flood behaviour within or surrounding Central Precinct. Alternatively on-site detention may also be used to reduce the peak flows from frequent events to natural pre-development conditions.

The need for on-site detention, suitable locations and sizes will be determined as the detailed design of the precinct develops. On-site detention may potentially be located within underground basements, above and below landscaped areas and the public domain and within the over station deck structure.

Should detention be required, ideally this would be located external to the ground level rail corridor to provide greater access for maintenance and clearance from rail operations.

Other constraints on on-site detention locations that require early consideration include:

- Drainage network layout
- Location, level and capacity of downstream outlet connection points
- Presence of utilities and underground structures
- Maintenance access and safety requirements

For individual developments, the need for stormwater detention to be provided will be discussed with the downstream authority owner and individually assessed. The application of a basic site storage requirement and permissible site discharge rate are not advised.

Given the complex nature of the existing environment and the CPRP development, it is recommended that the Precinct Flood Model be utilised to ascertain if on site detention offers a benefit or detriment to the surrounding area. From a sustainability perspective, given the highly urbanised environment, water storage for reuse applications may provide a greater benefit over a detention function.

6.3.4 Consideration of climate change and extreme events

The impact of extreme rainfall events and climate change will be considered in the design of infrastructure and the built form. This responds to the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021) ambition for resilience at CPRP is to effectively mitigate chronic stresses and insulate against acute shocks through design, and Strategic Initiative 15 - Design for future climate. The CPRP Precinct Flood Model will be used to assess the impact of proposed developments and establish flood planning level requirements for buildings in line with the City of Sydney Council's Interim Floodplain Management Policy. Where possible the proposed development will not only avoid flood impacts but aim to mitigate existing flood behaviour.

Flood planning controls and the capacity of the stormwater drainage infrastructure will be designed to incorporate a designated future climate change scenario, not just assess its impact. This approach is in line with the adaptation measure for civil drainage identified in the Central Precinct Climate Adaption Plan (Atelier Ten & Integral Group, 2021) as well as the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021) Strategic Initiative 15 - Design for future climate.

Given the complex nature of hydraulics, should the consideration of climate change compromise the present-day hydraulic performance criteria, present day performance needs will be prioritised, with climate change adaptation measures planned for.

Surface stormwater runoff will be managed to support green infrastructure through passive irrigation to target the urban heat island effect and greener places policy. This supports the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021) Strategic Initiative 14 – Urban forest and green infrastructure.

6.4 Stormwater quality improvement and reuse

The design of the CPRP will aim to maximise the opportunity for Water Sensitive Urban Design (WSUD) measures to be incorporated. WSUD aims to minimise the impact of urbanisation on the receiving environment by mimicking the natural water cycle. This involves an integrated approach to capture, treat and reuse stormwater as a valued asset. WSUD can be applied a lot, street, precinct or catchment scale and is best applied in a treatment train approach.

Along with green infrastructure, the adoption of a WSUD approach is a key element of the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021), in particular the Strategic Initiative 14 – Urban forest and green infrastructure. WSUD is a performance outcome of the green infrastructure strategy with further detail of how WSUD can be incorporated into the landscape design of the precinct being provided in the Central Precinct Renewal Program Green Infrastructure Study (TfNSW, 2022).

A variety of WSUD measures aiming to improve the quality of stormwater discharge and reduce potable water demand will be implemented throughout Central Precinct. This includes within buildings, the OSD surface and deck structure and the surrounding public domain. It is envisaged that the CPRP may employ the following WSUD measures in particular:

- Green walls and green roofs
  - for the over station development buildings and the surrounding new sub-precinct buildings
- Stormwater harvesting
  - collected from and stored within building roofs
  - collected from the over station development surface and stored with the deck structure
- Passive irrigation systems for vegetation across the precinct
- Porous pavements at suitable locations across the precinct
- Gross pollutant traps at stormwater collection points and along drainage lines
- Biofiltration (e.g. raingardens, street tree pits) and vegetated swales within the public domain

An existing stormwater harvesting tank is located beneath the Pitt Street loading dock which will be utilised where feasible. As part of the ongoing design development of the precinct, the condition and performance of the existing stormwater harvesting tank will be assessed. Where possible the tank will be retrofitted to maximise its performance considering the CPRP development.

With regards to water quality treatment measures, given the additional benefits offered by vegetated systems, these will be preferred over proprietary below ground products. Catchment areas bypassing treatment measures will be minimised.

For both water quality and quantity treatment measures, a distributed approach will be preferred over end-of-line treatment options. Given that the rail corridor beneath the over station deck will remain dry during frequent rainfall events, water quality treatment at the rail level from the covered catchment area is not proposed given its expected challenges.

The CPRP will seek innovative solutions to manage the collection and conveyance of stormwater flows whilst supporting green infrastructure and providing for water quality treatment and reuse. Multi-functional infrastructure will be preferred such as integrated green roofs which collect, store and reuse rainfall in addition to providing green space. A variety of WSUD measures will be employed across Central Precinct in response to the unique constraints and opportunities present.

The Central Precinct Environmental Sustainability Strategy (2021) states an ambition for a net improvement to environmental water quality as a result of development, along with the objective to reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines. In response to this ambition and objective, the CPRP will investigate opportunities to provide water quality treatment to stormwater flows produced from the upstream catchment which pass through Central Precinct given the benefit provided to the downstream environment.

Water quality treatment targets will be developed and applied across all domains (public and private) of Central Precinct. The defined treatment targets may vary across sub-precincts based on the constraints and opportunities present.

7. Recommendations

The following recommendations are provided to support the advancement of the Central Precinct Renewal Project (CPRP). The recommendations align with the findings of the Central Precinct assessment (**Chapter 5**) and the developed concept Stormwater Management Plan (**Chapter 6**).

Recommendations are provided for the ongoing master plan and design development of the CPRP as **Section 7.1**. Recommendations targeted towards the development of planning controls are provided as **Section 7.2**. In addition to these recommendations, a line of sight table has also been provided as **Appendix A** which outlines stormwater management issues, aspirations and solutions.

7.1 Ongoing project development

- The CPRP concept SMP is to be considered, promoted, and supported throughout all stages from master planning to detailed design. This aims to maximise the potential for Central Precinct to achieve a sustainable and resilient outcome. This may be achieved by ensuring regular formal high-level design reviews are undertaken for this purpose. Similarly, the CPRP aspirations for green infrastructure, sustainability and resilience require consideration and commitment throughout the design process.
- A detailed integrated water cycle management (IWCM) plan is recommended to be developed for the CPRP. Servicing Central Precinct with recycled water is a key feature of the CPRP. Establishing the integrated water cycle management plan will determine how stormwater will contribute to water reuse at a precinct level. The IWCM plan responds to the Precinct Utility recommendations of the Central Precinct Environmental Sustainability Strategy (2021). It is anticipated that a strategic business case and procurement strategy would need to be developed before an Integrated Water Cycle Management Plan could be completed.
- It is recommended to investigate opportunities to provide water quality treatment, or reuse of stormwater flows produced from the upstream catchment as part of an IWCM plan. Through such opportunities, the Central Precinct Environmental Sustainability Strategy (2021) ambition for a net improvement to environmental water quality as a result of development, along with the objective to reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines can be achieved.
- As part of an IWCM plan, further analysis is recommended to identify how water sensitive urban design can be optimally integrated across the public and private domains and various sub-precincts. An analysis is to be undertaken to quantify distinctive water quality treatment targets for each of these regions in response to their unique constraints and opportunities. This analysis can utilise the Central Precinct Renewal Program Green Infrastructure Study (TfNSW, 2022) and translate objectives and opportunities from the Central Precinct Environmental Sustainability Strategy (2021) into quantified targets.
- Recommend the ongoing investigation of flood behaviour, assessment of potential impacts and opportunities to mitigate flood risk. Flood modelling to work iteratively with designers from the early stages to avoid and minimise flood impacts and flood risk. This responds to the Central Precinct Environmental Sustainability Strategy (TfNSW, 2021) ambition for resilience at CPRP is to effectively mitigate chronic stresses and insulate against acute shocks through design, and the Strategic Initiative 15 - Design for future climate.

- Recommend considering the staging of works in the design development process when assessing impacts and design performance. Whilst the ultimate stage of development needs to be considered, interim stages and individual developments need to equally deliver on outcomes. Reliance on other developments, stages or sub-precinct is to be avoided. Such interdependencies increase complexity and tend to erode performance outcomes at a precinct scale as the design develops. Developments need to be assessed to confirm they perform at both the stage of their construction and the ultimate state of the CPRP.
- Continuing engagement with stakeholders is strongly recommended for efficiency in the design process and achieving quality outcomes. It is recommended that the CPRP seek support from the City of Sydney Council and Sydney Water Corporation on all relevant precinct wide strategies and plans.

7.2 Planning controls

7.2.1 General

a) Planning controls to align with the Sydney Local Environment Plan 2012 Clause 5.21 Flood Planning. The LEP reflects the NSW Government Flood Prone Land Policy as set out in the NSW Floodplain Development Manual 2005 (Section 3.7). Note that the clause includes "taking into account projected changes as a result of climate change".

b) Planning controls to align with the objectives of the Sydney Development Control Plan 2012, Section 3.7 Water and Flood Management objectives.

c) Developments to demonstrate an assessment of:

- Options to reduce the existing flood risk
- Potential groundwater impacts
- Alternative Water Sensitive Urban Design measures for water quality treatment as well as stormwater reuse, for both site and offsite stormwater flows
- Green infrastructure feasibility.

d) Sustainability benchmarks – desirable credits to be identified and incorporated into the planning controls

7.2.2 Civil drainage

a) Stormwater design report to be developed addressing the stormwater drainage network design along with Water Sensitive Urban Design requirements.

b) The civil drainage design across the precinct is to comply with relevant Australian standards including 3500.3 (2021) Plumbing and Drainage – Part 3 Stormwater Drainage.

c) The civil drainage design across the precinct is to be carried out in accordance with the current version of the following guidelines:

- Australian Rainfall and Runoff
- NSW Floodplain Development Manual (soon to be superseded by the Flood Risk Management Manual current under public exhibition)
- Austroads Guide to Road Design
- Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Ed. 2004

d) Civil drainage is to be design for an RCP 8.5 climate change scenario.

e) Civil drainage systems are to be design for:

- Over Station development
    - Stormwater flows up to the 1% AEP event are to be conveyed by a minor drainage system
    - Stormwater flows above the 1% AEP event are to be conveyed by a major drainage system
    - Designed in accordance with applicable Asset Standards Authority (ASA) requirements, in particular T HR CI 12090 ST Airspace and External Developments
- Within the rail corridor
    - Stormwater flows up to the 2% AEP event are to be conveyed by a minor drainage system
    - Stormwater flows above the 2% AEP event are to be conveyed by a major drainage system
    - Designed in accordance with Asset Standards Authority (ASA) requirements, in particular T HR CI 12130 ST Track Drainage
- Remainder of the precinct
    - Stormwater flows up to the 5% AEP event are to be conveyed by a minor drainage system
    - Stormwater flows above the 5% AEP event are to be conveyed by a major drainage system
    - Public domain and roadway drainage designed to meet City of Sydney Council requirements: Sydney Streets Technical Specifications 2019 – A4 Stormwater Drainage Design

f) Water Sensitive Urban Design (WSUD)

- As part of the development of a detailed integrated water cycle management (IWCM) plan, stormwater quality treatment targets are defined for each sub precinct of the CPRP based on their unique opportunities and constraints.
- Developments demonstrate compliance with stormwater quality treatment targets using MUSIC software.
- The design of WSUD measures to be based on guidance from the following documentation:
    - City of Sydney Council - Sydney Streets Technical Specifications 2019 – A4 Stormwater Drainage Design
    - Transport for NSW – Water Sensitive Urban Design Guideline 2017
- Reporting to outline maintenance requirements
- MUSIC modelling to be undertaken by a suitably experienced and qualified professional engineer.

7.2.3 Flood planning

a) Site flood study to be developed addressing:

- On-site detention: the site flood study is to establish if on-site detention is required to avoid:
  - Peak flood level increases in the downstream network for the present day climate conditions 20% AEP, 5% AEP or 1% AEP design rainfall events. The full range of standard duration design rainfall events from 10 mins to 3 hours.
  - Where connected to the City of Sydney Council drainage network,– increases in the downstream peak flow rate of more than 10%.
- Flood impacts:
  - the site flood study is to determine under present day climate conditions, any change as a result of the development in:
    - peak flood levels (+/- 0.05 m)
    - flood extents
    - flood risk precincts
    - flood hazard categories
- The site flood study is to assess present day climate conditions 20% AEP, 5% AEP, 1% AEP and PMF design rainfall events for the full range of standard duration design rainfall events from 10 mins to 6 hours.
- An assessment of the impact of the proposed development with a RCP 8.5 climate change scenario is to be undertaken to inform flood planning levels.
- It is recommended that the CPRP Precinct Flood Model is to be used as the base assessment tool for all flood assessments, and maintained to reflect the latest approved developments. Technical guidance to be provide to applicants to ensure consistency in assessment methodology.
- The existing condition flood model is to be refined based on recent detailed ground survey that defines flow paths, storage areas and hydraulic controls.
- The site flood study to be prepared by a suitably qualified and experienced professional engineer. Verification of the flood modelling and assessment is to be undertaken by a suitably qualified and experienced chartered engineer.

b) Flood planning levels:

- The City of Sydney Council's Interim Floodplain Management Policy 2014 it to be used to determine appropriate flood planning levels across the precinct.
- Flood level data to be used for deriving flood planning levels it to be sourced from the CPRP Precinct Flood Model but a suitably qualified and experienced professional engineer. Flood planning levels are to be based on an RCP 8.5 climate change scenario.
- It is not considered appropriate to extract, assign and finalise specific flood planning levels at this early stage of the design. The flood level information will be updated as the design progresses to accurately determine the flood planning level requirements. The existing flood level information is currently used to identify where flood constraints apply and provide estimates of the flood planning levels in accordance with the City of Sydney Council's Interim Floodplain Management Policy (2014).

8. Conclusion

This Water Quality, Flooding and Stormwater Report has been prepared as part of the Central State Significant Precinct (SSP) Study, in response to the NSW Department of Planning, Infrastructure and Environment (the Department) issued study requirements.

Given the scale of the Central Precinct Renewal Project (CPRP) it has the potential to adversely impact the existing stormwater quantity and quality during both construction and at completion as outlined in **Section 5.1**.

A high-level assessment of the CPRP has been undertaken. The CPRP flood model demonstrates potential impacts at several locations within Central Precinct and surrounding areas. The flood level impacts are in isolated locations and not widespread across the Central Precinct. In general, the flood impacts are exacerbating existing flood issues with the magnitude of the impact on peak flood levels being less than 0.1 metres in the 1% AEP and 0.5 metres in the Probable Maximum Flood (PMF) at the vast majority of locations.

In response to the potential for adverse impacts, a concept Stormwater Management Plan (SMP) has been presented (**Chapter 6**). The SMP conveys the CPRP aspirations for stormwater management and provides supporting principles to guide the design development. By utilising the SMP the potential adverse impacts can be minimised or avoided, and the opportunities to reduce flood risk, provide water quality treatment and stormwater reuse maximised.

Additional recommendations to further inform the ongoing development of the Master Plan and design development, along with planning control recommendations have also been provided as outlined in **Chapter 7**.

9. References

- Arcadis (2021) *Central Precinct Renewal Project – Precinct Flood Model Report*
- Arcadis (2022) *Central Precinct Renewal Project – Pollution Assessment*
- Atelier Ten & Integral Group (2021) *Central Precinct Renewal Program – Climate Adaptation Plan*
- BMT WBM (2014) *The Darling Harbour Catchment Flood Study*
- City of Sydney Council (2012) *Sydney Development Control Plan*
- City of Sydney Council (2014) *Interim Floodplain Management Policy*
- City of Sydney Council (2019) *Sydney Streets – Technical Specifications*
- City of Sydney Council (2021) *Central Sydney Planning Strategy 2016-2036*
- Commonwealth of Australia (2017) *Australian Institute Disaster Resilience Guideline 7-3 Flood Hazard*
- Department of Infrastructure, Planning and Natural Resources (2005) *NSW Floodplain Development Manual*
- Transport for New South Wales (2021) *Central Precinct - Environmental Sustainability Strategy*
- Transport for New South Wales (2021) *Central Precinct - Sustainability Framework*
- Transport for New South Wales (2022) *Central Precinct Renewal Program - Green Infrastructure Study*
- WMA Water (2015) *Blackwattle Bay Catchment Floodplain Risk Management Study and Plan*
- WMA Water (2015) *Blackwattle Bay Catchment Flood Study*
- WMA Water (2016) *Darling Harbour Catchment Floodplain Risk Management Study and Plan*

Appendix A – Line of sight table

Issue	Aspirations	Solutions
Stormwater quality impacts and treatment performance	Avoid generating stormwater pollution Improve stormwater quality treatment for the precinct Provide water quality treatment of upstream catchment flows	• Maximise pervious surfaces and opportunities for green infrastructure. • Undertake works to prevent or minimise sewer network overflows and leaks. • Adopt innovative multi-functional designs and a variety of water sensitive urban design measures to maximise pollutant reduction and respond to the varied constraints and opportunities across the precinct. • Ensure stormwater treatment requirements are applied across all domains (public and private) of the precinct. Treatment targets may vary across individual regions in response to the constraints and opportunities present. • Investigate opportunities to further reduce pollutant loads by providing water quality treatment to upstream catchment runoff passing through the precinct.
Potential flood impacts	Avoid adverse impacts on flood behaviour	• Ongoing flood modelling to inform the master plan and design development. • CPRP concept stormwater management plan to be considered, promoted and supported throughout all stages from master planning to detailed design. • A site flood study is undertaken for individual developments considering the existing conditions, developed site conditions, and ultimate conditions of the precinct. Impacts need to be assessed to ensure individual and cumulative impacts are addressed. • CPRP Precinct Flood Model to be used as the base model to assess individual developments following its endorsement by stakeholders. The model will be used to determine flood impacts and any on-site detention requirements. CPRP Precinct Flood Model is to be maintained to reflect the latest designs across the precinct.
Consideration of flood risk	Ensure flood risk is sufficiently mitigated against	• Ensure flood risk is suitably assessed by undertaking a site flood study in line with the above. • Adoption of flood planning controls and flood planning levels in line with the City of Sydney Interim Floodplain Management Policy. In the selection of flood information for setting flood planning levels, consideration is to be given to the existing conditions, developed site conditions, and ultimate conditions of the CPRP. • Investigate opportunities to further reduce the existing flood risk for the precinct and surrounds.

Issue	Aspirations	Solutions
Consideration of climate change	Climate change is comprehensively accommodated in the design	• Stormwater drainage infrastructure and flood planning levels are to be based on a designated climate change scenario. Should the climate change scenario compromise the present-day performance, the present-day needs will be prioritised, with climate change adaptation measures planned for.
Impacts on existing stormwater trunk drainage infrastructure	Avoid impacts to existing stormwater trunk drainage infrastructure	• Ensure designs provide adequate clearance from existing stormwater trunk drainage infrastructure. Engage in early and ongoing consultation with asset owners for efficient and optimal planning and design outcomes.

Appendix B – Hydrogeology Impact Assessment

Transport for NSW

Central Precinct Renewal Program

Hydrogeology Impact Assessment

July 2022

transport.nsw.gov.au

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Acknowledgement of Country

We respectfully acknowledge the Traditional Custodians of the Central Precinct, the Gadigal and recognise the importance of place to Aboriginal people and their continuing connection to Country and culture. We pay our respect to Elders past, present and emerging.

Table of Contents

Document control

Authors	Arcadis Australia Pacific Pty Limited
Approved by	Transport for NSW
Branch	IP Development
Division	Infrastructure and Place (IP)

Versions

Version	Amendment notes
0.1	Final for CPRP Public Exhibition 2022

Abbreviations

Abbreviation	Definition
BOOS	Bondi Ocean Outfall Sewer
BTEXN	Referring to chemicals – benzene, toluene, ethylbenzene, xylene and naphthalene
CBD	Central Business District
CoS	City of Sydney Council
CPRP	Central Precinct Renewal Project
DCP	Development control plan
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
GANSW	Government Architect NSW
GFA	Gross floor area
LGA	The City of Sydney local government area
mAHD	Elevation in metres with respect to the Australian Height Datum
NSW EPA	New South Wales Environmental Protection Authority
OSD	Over-Station Development
QHA	Quaternary alluvial sand
QHD	Quaternary medium to fine marine sand
RL	Reduced level, measured in units of mAHD
SSP	State Significant Precinct
SVOC's	Semi-Volatile Compounds
TfNSW	Transport for NSW
TRH	Total Recoverable Hydrocarbons
VOC's	Volatile Organic Compounds

Definitions

Term	Definition
Amenity	The extent to which a place, experience or service is pleasant, attractive or comfortable. Improved features, facilities or services may contribute to increase amenity.
Aquifer	A body of rock and/or sediment that can contain or transmit groundwater
Borehole (BH)	Narrow shaft drilled into the ground to sample groundwater
Central Precinct	Central Precinct State Significant Precinct
Central Sydney	Land identified as Central Sydney under the Sydney Local Environmental Plan 2012 and represents the Metropolitan Centre of Sydney. Central Sydney includes Sydney's Central Business District
Character	The combination of the attributes, characteristics and qualities of a place (GANSW, 2021, Draft Urban Design Guide)
Community	Particular types of stakeholder and refers to groups of people in particular places who are both affected by our work and experience the outcomes and benefits of our activities
Control	A numerical standard that is applied in a prescriptive manner
Corridor	A broad, linear geographical area between places
Council	The City of Sydney Council
District Plan	means the Eastern City District Plan
Dyke	A sheet of rock formed in a fracture of pre-existing rock body
EV Loading Docks	Electric Vehicle loading docks located below the over station development to service the above buildings
Goods Line	The official name for the partly elevated walkway from Central Station to Darling Harbour following the route of a disused railway line
Groundwater Mounding	Pooling and rising of groundwater which can occur beneath stormwater management structures.
Groundwater Recharge	Surface water seeps into and replenishes the groundwater system
Hydrograph	Depicts the rate of water flow with respect to time
Hydraulic Conductivity	Measure of groundwater flows into subsurface structures, dependent on saturation, viscosity, temperature and density.
Interchange	A facility to transfer from one mode of transport or one transport service to another. For example, a station with an adjoining light rail stop
Lugeon Value	Used to estimate hydraulic conductivity (litres per minute per metre borehole at an overpressure of 1 megapascal)
Mobility	The ability to move or be moved easily and without constraints
Mortuary Station	The building formerly used as a railway station on the Rookwood Cemetery railway line, now disused
Over rail corridor development or Over Station Development	Development of air space over railway corridors

Term	Definition
Permeability	Measure of how easily water can pass through material, dependent on pore size, tortuosity and surface area.
Planning instrument	Means any of the following: • strategic plan (comprising regional strategic plans and district strategic plans) and local strategic planning statements • environmental planning instrument (comprising State environmental planning policies and local environmental plans) development control plan
Precinct	Geographical area with boundaries determined by land use and other unique characteristics. For example, an area where there is an agglomeration of warehouses may be termed a freight precinct
Proponent	Transport for NSW
Proposal	Proposed amendments to the planning framework
Public spaces	means areas that are publicly accessible where people can interact with each other and make social connections
Rail network	means the rail infrastructure in NSW
Railway corridor	The land within Central Precinct on which a railway is built; comprising all property between property fences, or if no fences, everywhere within 15m from the outermost rails. Under planning legislation rail corridor is defined as land: a) that is owned, leased, managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities: or b) that is zoned under an environmental planning instrument predominately or solely for development of the purpose of a railway or rail infrastructure facilities
Reference Master Plan	A non-statutory document that shows one way in which the precinct may develop in the future in accordance with the proposed amendments to the planning framework Note: Refer to the GANSW Advisory Note v2, dated 12/09/2018 for further guidance
Siding	A short stretch of rail track used to store rolling stock or enable trains on the same line to pass
State	The state of New South Wales
State Significant Precinct	The areas with state or regional planning significance because of their social, economic or environmental characteristics
Strategic Framework	The document prepared by Transport for NSW for Central Precinct in 2021 that addresses key matters including vision, priorities, public space, strategic connections, design excellence, identify sub-precincts for future detailed planning and also outlines the next steps in the State Significant Precinct process for Central Precinct
Strategic plan	The regional strategic plan, district strategic plan or a local strategic planning statement
Sub-precinct	The definable areas within Central Precinct SSP due to its unique local character, opportunities and constraints, either current or future. The Western Gateway is a sub-precinct
Sydney Metro	A fully-automated, high frequency rail network connecting Sydney
Tech Central	The State government initiative as set out in The Sydney Innovation and Technology Precinct Panel Report 2018. Previously known as the Sydney Innovation and Technology Precinct. Tech Central is located

Term	Definition
	south of the Sydney central business district, surrounded by the suburbs of Redfern, Ultimo, Haymarket, Camperdown, Chippendale, Darlington, Surry Hills and Eveleigh
Transport for NSW	The statutory authority of the New South Wales Government responsible for managing transport services in New South Wales.
Transport interchange	A facility designed for transitioning between different modes, such as a major bus stop or train station
Transport modes	The five public transport modes are metro, trains, buses, ferries and light rail. The two active transport modes are walking and cycling
Vibrant streets / places	Places that have a high demand for movement as well as place with a need to balance different demands within available road space

Executive summary

Arcadis has been engaged by Transport for NSW to prepare this Hydrogeology Impact Assessment as part of the Central State Significant Precinct (SSP) Study. This assessment addresses the study requirements issued by the NSW Department of Planning, Infrastructure and Environment (the Department) to guide preparation of the SSP study. Specifically this assessment addresses the hydrogeology requirements under Study Requirement 13.1 Water Quality, Flooding and Stormwater Report. The remainder of the 13.1 requirements are addressed in the Water Quality, Flooding and Stormwater Report.

This report provides a high-level assessment of the Central Precinct Renewal Project (CPRP) for potential impacts on the hydrogeology of the Central Precinct and adjoining areas. The understanding of the CPRP has been based on the provided Reference Master Plan. Three key groundwater related regulations have guided this assessment – the NSW Water Management Act, Water Sharing Plans and Aquifer Interference Policy.

Central Precinct is located in southern central Sydney and is primarily occupied by Central Railway Station, with a gross area of approximately 24 hectares. An assessment of its existing environment found:

- The location has a temperate climate with occasional intense rainfall events, which are a key cause of groundwater fluctuations in the Sydney Basin
- Regional hydrogeology units which underlie the precinct comprise largely of local or imported fill, alluvium, residual soils, Wianamatta group, Mittagong formation and Hawkesbury sandstone
- Key risks to groundwater quality include salinity, dissolved iron, turbidity and iron reducing bacteria. Treatment strategies for these risks have been outlined as reverse osmosis, oxidisation of ferric ions, settling and filtration, and biocide dosing, respectively.

An assessment of the CPRP focussed on subsurface design features and potential impacts to the groundwater environment. The following assumptions have been made regarding the CPRP:

- The proposed northern and southern basement loading docks along the western edge of the precinct are likely to adopt a drained solution based on the design currently proposed for the neighbouring Atlassian development
- All Electric Vehicle (EV) loading docks below the rail yard, which service the over station development buildings, will adopt a drained or partially drained solution, to be determined based on local geotechnical information still to be acquired
- The service tunnel running north to south below the rail yard is likely to be constructed as an undrained element and thus lined to meet waterproofing specifications.

A risk assessment of the potential impacts to groundwater concluded that designed excavations are likely to decrease local groundwater levels, particularly during construction phases of work. Any groundwater inflows into subgrade features are expected to be negligible due to the low permeability of the underlain units. Impacts to water quality are also expected to be low, however minor groundwater treatment may be required prior to discharge.

Potential impacts to precinct surrounds are considered low. It is recommended further hydrogeological studies be completed as the precinct designs and detailed construction plans progress to evaluate localised and project-specific risks and potential hydrogeological impacts to the precinct and surrounds in more detail. These hydrogeological studies and their scope should be evaluated at each stage of the design process and each time subsurface design features and subsurface drainage strategies change.

1. Introduction

Located within the heart of Eastern Harbour City, Central Precinct is Australia's busiest transport interchange. The precinct currently holds latent potential with all its inherent advantages of location and transport connections to revitalise Central Sydney. Capitalising on Central Precinct's prime location within Tech Central, a NSW Government commitment to create the biggest technology hub of its kind in Australia, Central Precinct presents the ultimate transformative opportunity to deliver a connected destination for living, creativity and jobs. The renewal of Central Precinct will provide a world-class transport interchange experience, important space for jobs of the future, improved connections with surrounding areas, new and improved public spaces and social infrastructure to support the community.

1.1 Tech Central

1.1.1 Overview

The NSW Government is committed to working with the local community to develop the biggest innovation district of its kind in Australia. Bringing together six neighbourhoods near the Sydney CBD (Haymarket, Ultimo, Surry Hills, Camperdown, Darlington North Eveleigh and South Eveleigh), Tech Central is a thriving innovation ecosystem that includes world-class universities, a world-leading research hospital, 100 + research institutions, investors and a wide range of tech and innovation companies. The vision for Tech Central is for it to be a place where universities, startups, scaleups, high-tech giants and the community collaborate to solve problems, socialise and spark ideas that change our world. It is also for it to be place where centring First Nations voices, low carbon living, green spaces, places for all people and easy transport and digital connections support resilience, amenity, inclusivity, vitality and growth.

Tech Central is an essential component of the Greater Sydney Region Plan's Eastern Harbour City Innovation Corridor. It aims to leverage the existing rich heritage, culture, activity, innovation and technology, education and health institutions within the precinct as well as the excellent transport links provided by the Central and Redfern Station transport interchanges.

The Central Precinct is located within the Haymarket neighbourhood of Tech Central. Planned to become the CBD for Sydney's 21st century, this neighbourhood is already home to The Quantum Terminal (affordable coworking space in the iconic Central Station Sydney Terminal Building) the Scaleup Hub (affordable and flexible workspace for high-growth technology scaleups) and is soon to be the home of Atlassian's headquarters. It is also in close proximity to a number of important education and research institutions.

The planned urban renewal of the Central Precinct has been identified as a key project to achieving the vision for Tech Central.

1.1.2 Background & Context

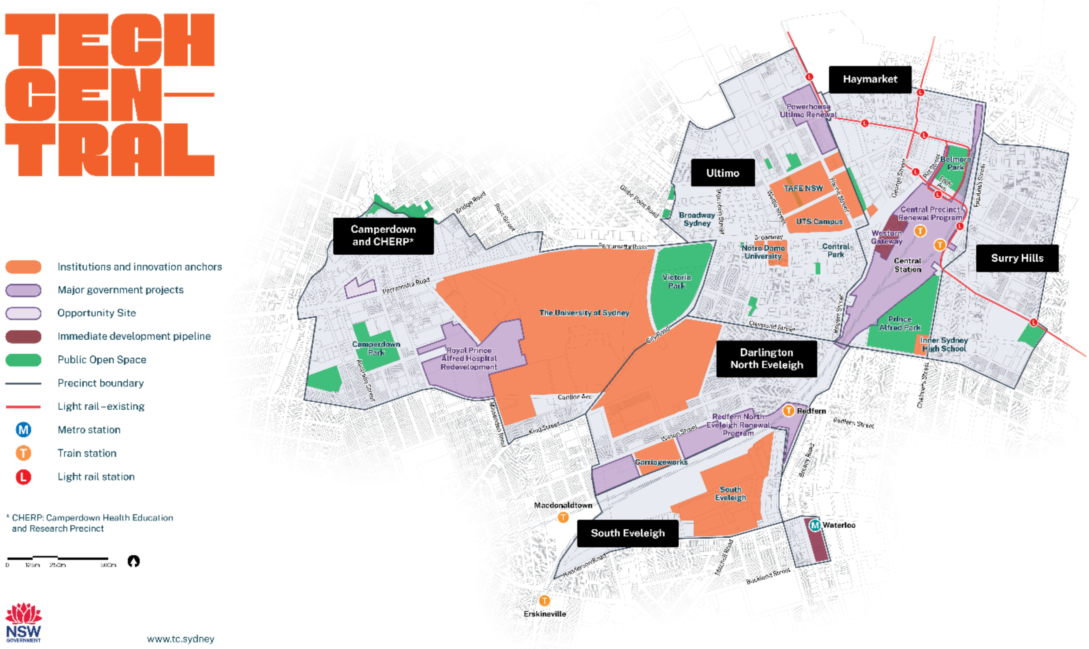
In August 2018, the NSW Government established the Sydney Innovation and Technology Precinct Panel (the Panel) comprising representatives from various industry, health, education, government agencies and key community members. In December 2018 'The Sydney Innovation and Technology Precinct Panel Report' was produced, setting out the Panel's recommendations for a pathway to delivering a successful innovation and technology district at Tech Central.

In February 2019, the NSW Government adopted the Panel's report and committed to delivering the following:

- 25,000 additional innovation jobs
- 25,000 new STEM and life sciences students
- 200,000 m² for technology companies, and
- 50,000 m² of affordable space for startups and scaleups

In February 2019, the Greater Sydney Commission released a Place Strategy for the area that is now known as Tech Central (Camperdown-Ultimo Collaboration Area Place Strategy, GSC). The Place Strategy, developed collaboratively by a range of stakeholders involved in planning for Tech Central's future, was prepared to inform public and private policy and investment decisions by identifying and recognising the complex, place-specific issues inhibiting growth and change. The strategy identifies shared objectives for the place and sets out priorities and actions to realise the vision for the area under the key themes of Connectivity, Liveability, Productivity, Sustainability and Governance.

Both the Panel Report and Place Strategy recognise the importance of the Central Precinct to Tech Central's future.



In July 2019, Central Precinct was declared a nominated State Significant Precinct (SSP) in recognition of its potential to boost investment and deliver new jobs. The SSP planning process for Central Precinct will identify a new statutory planning framework for Central Precinct. This involves two key stages:

- **Stage 1**: Development of a draft Strategic Vision which has since evolved into the Central Precinct Strategic Framework
- **Stage 2:** Preparation of an SSP study with associated technical analysis and community and stakeholder consultation.

In March 2021, the Central Precinct Strategic Framework was adopted representing the completion of Stage 1 of the planning process to develop a new planning framework for Central Precinct. The Strategic Framework outlines the vision, planning priorities, design principles, and the proposed future character of sub-precincts within Central Precinct. This is intended to inform and guide further detailed planning and design investigations as part of this SSP Study (Stage 2 of the SSP planning process).

This SSP Study intends to amend the planning controls applicable to Central Precinct under the SSP SEPP 2005 to reflect the vision and planning priorities set for the Precinct under the Strategic Framework. Study Requirements were issued in December 2020 to guide the investigations and the proposed new planning controls.

1.2 Central Precinct vision

Central Precinct will be a vibrant and exciting place that unites a world-class transport interchange with innovative and diverse businesses and high-quality public spaces. It will embrace design, sustainability and connectivity, celebrate its unique built form and social and cultural heritage and become a centre for the jobs of the future and economic growth.

1.3 Case for change

Over the coming years, Central Station will come under increasing pressure as technological innovations progress, investment in transport infrastructure increases and daily passenger movements increase.

Sydney Metro, Australia's biggest public transport project, will result in the delivery of a new generation of world-class, fast, safe, and reliable trains enabling faster services across Sydney's rail network. In 2024, Sydney Metro's Central Station will open with daily passenger movements forecast to increase from 270,000 persons to 450,000 persons over the next 30 years.

In its current state, Central Station is underperforming as Australia's major transport interchange – it's currently a hole in the heart of Sydney's CBD, lacking connectivity, activation and quality public spaces.

The renewal of Central Precinct will expand and revitalise Central Station, and transform this underutilised part of Sydney from a place that people simply move through to one where they want to visit, work, relax, connect and socialise. Its renewal also presents the potential to deliver on the strategic intent and key policies of regional, district and local strategic plans, providing for a city-shaping opportunity that can deliver economic, social and environmental benefit. Specifically, it will:

- make a substantial direct and indirect contribution to achieving the Premier's Priorities by facilitating upgrades to Sydney's largest and most significant public transport interchange, improving the level of service for users and visitors, and supporting the creation of new jobs and housing
- implement the recommendations of the NSW State Infrastructure Strategy 2018-2038, in particular the upgrading of the major transport interchange at Central to meet future customer growth
- contribute to key 'Directions' of the Greater Sydney Region Plan, to deliver 'a city supported by infrastructure', help create 'a city of great places', support 'a well connected city', deliver new 'jobs and skills for the city' and create 'an efficient city'

- implement the outcomes envisaged within the Eastern City District Plan including reinforcing the Harbour CBD's role as the national economic powerhouse of Australia and supporting its continued growth as a Global International City
- deliver on the shared objectives and priorities for Tech Central, the future focal point of Sydney's innovation and technology community, which aims to boost innovation, economic development and knowledge intensive jobs while creating an environment that foster collaboration and the exchanging of ideas
- deliver an outcome that responds to the overarching vision and objectives of the Central Sydney Planning Strategy. In particular it will assist with implementing a number of 'key moves' outlined in the strategy, including to 'ensure development responds to its context', 'ensure infrastructure keeps pace with growth', 'move people more easily', 'protect, enhance and expand Central Sydney's heritage, public places and spaces', and to 'reaffirm commitment to design excellence.'

1.4 About this report

The purpose of this report is to provide a high-level hydrogeology assessment of the proposed changes, and consider any potential impacts that may result within and surrounding the Central Precinct. This report addresses study requirement 13.1 Water Quality, Flooding and Stormwater items specifically related to hydrogeology. Note the remainder of the 13.1 Water Quality, Flooding and Stormwater requirements are addressed separately in the Water Quality, Flooding and Stormwater Report. The relevant study requirements, considerations and consultation requirements, and location of where these have been responded to is outlined in **Table 1** below.

1.4.1 SSP Study requirements

Table 1: Study requirements, considerations, and consultation requirements

Ref	Requirement or consideration	Summary response	Where addressed
Study requirement			
13.1_A	Identifies the existing situation, including constraints, opportunities, key issues and existing network capacity	This report addresses the study requirements in relation to hydrogeology. Stormwater hydrology is addressed separately in the Water Quality, Flooding and Stormwater Report.	Chapter 2: Existing Environment addresses these matters
13.1_B	Assesses the potential impacts of the proposal on the hydrology and hydrogeology of the precinct and adjoining areas	At a high-level this report assesses the potential impact of the precinct development on hydrogeology. Stormwater hydrology including flooding is addressed separately in the Water Quality, Flooding and Stormwater Report.	Chapter 3: Precinct Assessment addresses this matter
13.1_F	Informs and supports the preparation of the proposed planning framework including any recommended planning controls or DCP/Design Guideline	Based on the hydrogeology assessment undertaken, recommendations have been provided to inform the preparation of the proposed planning framework, planning controls/provisions.	Chapter 4: Conclusions and recommendations addresses this matter
Study consideration			
13.1	The Study is to demonstrate consideration of: • A particular focus on water quality, the extent to which proposed development protects, maintains or restores water health and the community's	These study considerations are appliable to the Water Quality, Flooding and Stormwater Report only which is documented separately.	Refer to the Water Quality, Flooding and Stormwater Report which addresses these matters

Ref	Requirement or consideration	Summary response	Where addressed
	environmental values and use of waterways for Sydney Harbour (also known as the NSW WQO); • No increase to existing flooding and that flooding is reduced where possible; • Flood risk impact across the catchment area and all adjoining land uses; • How the planning framework will address water quality targets in Sydney DCP 2012; and • WSUD options for the proposal.		
Consultation			
	The Study is to demonstrate that it has been undertaken in consultation with the City of Sydney's relevant specialists.	Consultation has been undertaken with the City of Sydney, Sydney Water and the NSW Environment Protection Authority as documented in the Water Quality, Flooding and Stormwater Report	Water Quality, Flooding and Stormwater Report – Chapter 4: Consultation Addresses this matter
Author			
13.1	The study is to be prepared by a suitably qualified professional(s) with the necessary experience and expertise to undertake the required works.	This Hydrogeology Impact Assessment has been undertaken by Jason Carr – Principal Hydrogeologist who is suitably qualified and experienced to undertake this assessment Jason Carr, Principal Hydrogeologist, MSc and Technology (Groundwater), UNSW, 2010, BSc (Marine Science, Hons) USYD, 2008, Chartered Geologist (CGeol)	
Guidance documents			
13.1	The following documents provide guidance for this Study: • The City's Interim Flood Policy; • NSW Environment Protection Authority's Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions; • Sydney DCP 2012; • Sydney Streets Technical Specifications; • the NSW State Government's Flood Prone Lands Policy and Floodplain Development Manual;	These guidance documents are appliable to the Water Quality, Flooding and Stormwater Report only which is documented separately	Refer to the Water Quality, Flooding and Stormwater Report which addresses this matter

Ref	Requirement or consideration	Summary response	Where addressed
	• Blackwattle Bay Flood Study and Floodplain Management Study; and • City of Sydney Central Sydney Planning Strategy.		

1.5 Study Area

Central Precinct is located at the south-east edge of Central Sydney (refer to **Figure 1**). Central Precinct is surrounded by a number of suburbs including, Haymarket to the north, Chippendale to the south and Surry Hills to the south-east. It is located within the City of Sydney local government area (LGA) with an approximate gross site area of 24 hectares of Government owned land. The precinct comprises land bounded by Pitt Street and Regent Street to the west, Cleveland Street to the south, Eddy Avenue, Hay Street and Goulburn Street to the north and Elizabeth Street and Chalmer Street to the east.

Central Precinct has been an important site for transport operations for over 150 years. Today, Central Station is Australia's busiest transport interchanges and is the anchor of New South Wales's (NSW) rail network. It provides 24 platforms for suburban and Intercity and Regional train connections as well as a direct link to Sydney Airport. The broader transport interchange also caters for light rail, bus, coach and point to point connections such as taxis. The transport interchange will also form part of the Sydney Metro network, with new underground platforms to be provided for Sydney Metro services under Platform 13, 15 and 16 at Central Station. Sydney Metro services will begin in 2024. The precinct also comprises several significant heritage items including the state-heritage listed Sydney Terminal Building and the Clock Tower.

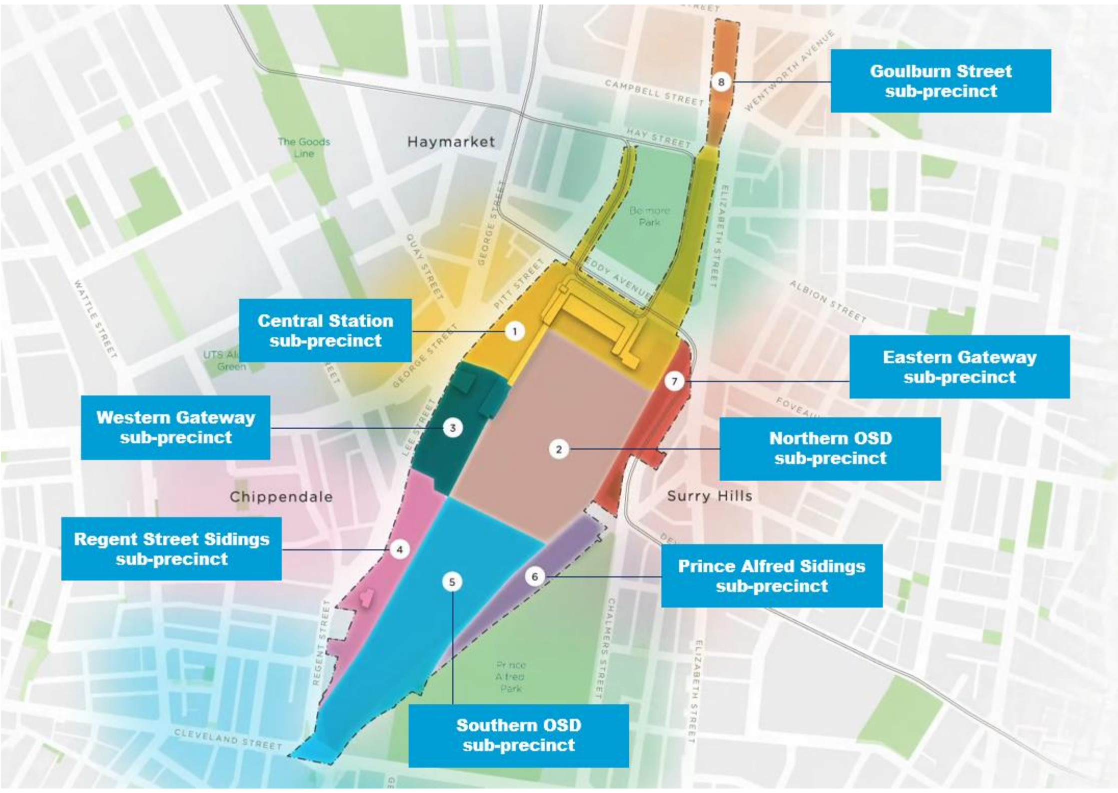
Figure 1: Location plan of Central Precinct

As part of the Strategic Framework, eight sub-precincts have been defined that reflect and positively respond to the varying character of the surrounding areas. These sub-precincts are:

- Central Station
- Northern Over Station Development
- Western Gateway
- Regent Street Sidings
- Southern Over Station Development
- Prince Alfred Sidings
- Eastern Gateway
- Goulburn Street.

The location of these sub-precincts and relevant boundaries is illustrated in **Figure 2**.

Figure 2: Central Precinct and sub-precincts



1.5.1 Planning priorities

To help realise the vision of Central Precinct and the desired local character of the sub-precincts, the following planning priorities have been developed and are grouped into five key themes as outlined in **Table 2** below.

Table 2: Central Precinct planning priorities

Theme	Planning priorities
Place and destination	• Unite the city by reconnecting with the surrounding suburbs • Shape a great place that is vibrant, diverse, active, inclusive and has a high level of amenity • Deliver a precinct which responds to its urban context and embeds design excellence Improve existing and providing additional connected public space in the precinct of high environmental amenity and comfort • Protect and celebrate the Precinct's heritage values • Create a people focussed precinct through a focus on public transport, cycling and walkability • Facilitate the precinct's focus on transport and economic diversity in tourism and across commercial sectors including office, business and retail.
People and community	• Design public spaces that promote health, equality and well-being • Promote social cohesion by providing spaces for gathering, connection, exchange, opportunity and cultural expression • Honour and celebrate the cultural heritage and identity of the Precinct's past and present Aboriginal community • Create a safe and intuitive precinct that promotes social access and inclusion • Support programs and initiatives that benefit communities and people

Theme	Planning priorities
	• Create a precinct that responds to the current and future needs of transport customers, workers, residents and visitors, including those of the broader local community.
Mobility and access	• Provide a world class, integrated and seamless transport interchange • Maintain the precinct's role as NSW's main transport interchange • Improve the transport customer experience, including wayfinding, pedestrian flows and interchange between different transport modes • Facilitate and enhancing connections within and towards key locations in southern Central Sydney • Deliver a people focussed precinct that is walkable, well connected, safe and puts people first • Design infrastructure that will adapt to future changes in transport and mobility.
Economy and innovation	• Advance Sydney's status as a global city • Support the creation of jobs and economic growth including new and emerging industries such as innovation and technology and explore the provision of space for cultural and creative uses and start-ups • Provide an active and diverse commercial hub with a rich network of complementary uses that nurture and support business • Support both the day and night economies of the precinct through diverse complementary uses, promoting liveability and productivity • Foster collaboration between major institutions in the precinct including transport, education, health and business • Create a smart precinct that incorporates digital infrastructure to support research and innovation.

1.5.2 Reference Master Plan

Architectus and Tyrrell Studio have prepared a Place Strategy, Urban Design Framework and a Public Domain Strategy which establishes the Reference Master Plan for Central Precinct. The Urban Design Framework and Public Domain Strategy provides a comprehensive urban design vision and strategy to guide future development of Central Precinct and has informed the proposed planning framework of the SSP Study.

The Reference Master Plan includes:

- Approximately 22,000 sqm of publicly accessible open space comprising:
  - Central Green – a 6,000 square metre publicly accessible park located in immediately south of the Sydney Terminal building
  - Central Square – 7,000 square metre publicly accessible square located at the George Street and Pitt Street junction
  - Mortuary Station Gardens – a 4,470 square metre publicly accessible park (excluding Mortuary Station building) located at Mortuary Station
  - Henry Deane Plaza – a publicly accessible plaza located in the Western Gateway sub-precinct
  - Eddy Avenue Plaza – a 1,680 square metre publicly accessible plaza located in the north-eastern portion of the Sydney Terminal building

  - Western Terminal Extension Building Rooftop - a 970sqm publicly accessible space above the Western Terminal Extension Building Rooftop.
- Approximately 269,500 square metres of office gross floor area (GFA)
- Approximately 22,850 square metres of retail GFA
- Approximately 53,600 square metres of hotel GFA
- Approximately 84,900 square metres of residential accommodation GFA, providing for approximately 850 dwellings (assuming 1 dwelling per 100sqm GFA). The Central Precinct SSP Study will include the commitment to deliver 15 per cent of any new residential floor space as affordable housing.
- Approximately 47,250 square metres of education/tech space GFA
- Approximately 22,500 square metres of student accommodation GFA
- Approximately 14,300 square metres of community/cultural space GFA.

The key features of the Indicative Reference Master Plan, include:

- A network of new and enhanced open spaces linked by green connections. This will include:
  - A Central Green (Dune Gardens) at the north of Central Precinct that will create a new civic public realm extension of the Sydney Terminal building and a new vantage point for Central Sydney
  - A new Central Square which will deliver on the vision for a new public square at Central Station, as one of three major public spaces within Central Sydney connected by a people-friendly spine along George Street
  - Mortuary Station Park at Mortuary Station that will be a key public domain interface between Chippendale and the over-station development. that will draw on the story of Rookwood Cemetery and the Victorian Garden context with the established rail heritage of the Goods Line and the rail lines
  - Henry Deane Plaza which will prioritise the pedestrian experience, improving connectivity and pedestrian legibility within the Western Gateway sub-precinct and provide clear direct links to and from the State heritage listed Central Station and its surrounds
  - Eddy Avenue Plaza – will transform into a high-amenity environment with significant greening and an enhanced interface with the Sydney Terminal building.
- A new network of circulation that will establish a clear layer of legibility and public use of the place. This will include:
  - A 15 - 24 metre wide Central Avenue that is laid out in the spirit of other street layouts within Central Sydney and which responds to the position of the Central clocktower, providing new key landmark views to the clocktower. Central Avenue will be a place for people to dwell and to move through quickly. It brings together the threads of character from the wider city and wraps them
  - Three over-rail connections to enhance access and circulation through Central Precinct, as well as provide pedestrian and bicycle cross connections through the precinct

- The extension of public access along the Goods Line from Mortuary Station Gardens, offering a new connection to Darling Harbour
- New vertical transportation locations throughout the precinct allowing for seamless vertical connections.
- An active recreation system supports health and well-being through its running and cycling loops, fitness stations, distributed play elements, informal sports provision, and additional formal recreation courts.
- a network of fine grain laneways that are open to the sky

The proposed land allocation for Central Precinct is described in **Table 3** below.

Table 3 Breakdown of allocation of land within Central Precinct (note: below figures, except for total Central SSP area, excludes WGP)

Land allocation	Proposed
Open-air rail corridor	101,755 sqm
Developable area	119,619 sqm
Public open space	19,185 sqm / 16% of Developable area
Other publicly accessible open space (Including movement zones, streets and links)	41,773 sqm / 35% of Developable area
Building area	58,661 sqm / 49% of Developable area
Central SSP total area (incl. WSP)	**23.8 ha**

* Note

The Indicative Reference Master Plan for Central Precinct is illustrated in **Figure 3** below.

Figure 3: Reference Master Plan

Sub-precinct		Total GFA per sub-precinct (sqm)*
(S)	Station (terminal building)	15,800
		15,800
(A)	OSD Block A	165,400
	A1	66,900
	A2	48,900
	A3	39,400
	A4	4,100
	A5	3,000
	A6	3,100
(B)	OSD Block B	88,900
	B1	42,700
	B2	37,200
	B3	4,000
	B4	5,000
(C)	OSD Block C	109,700
	C1	32,700
	C2	28,500
	C3	42,800
	C4	3,400
	C5	2,300
(D)	Regent Street Sidings Block D	65,000
	D1	33,300
	D2	31,700
(E)	Prince Alfred Sidings Block E	20,900
(F)	Goulburn St Car Park	49,200
Total GFA (excluding Western Gateway)		514,900
(WG)	Western Gateway	275,000

***Source**: Architectus and Tyrrell Studio*

2. Existing environment

2.1 Climate

The precinct is in the Sydney Basin which experiences a temperate climate and receives approximately 1200 millimetres of rainfall per year on average. The rainfall gauge at Observatory Hill has recorded measurements of daily rainfall since 1858. The highest rainfall by year was recorded in 1950 which received a maximum of 2194 mm. On average the highest rainfall is received between March and June where the average rainfall typically ranges between 120 and 135 millimetres per month. The highest monthly rainfall recorded at this station was 642.7 millimetres which occurred in June 1950.

Many of the intense rainfall events in Sydney are due to the formation of East Coast Lows which occur on average, several times each year off the east coast off Australia and are more common in Autumn and Winter months. They often intensify over a 12–24-hour period making them one of the more dangerous and intense weather systems to affect the eastern coast and can cause heavy widespread rainfall leading to flash and/or major river flooding. Major groundwater fluctuations in the Sydney Basin are often tied to these events which need to be considered when designing tunnel and basement drainage solutions.

2.2 Geology

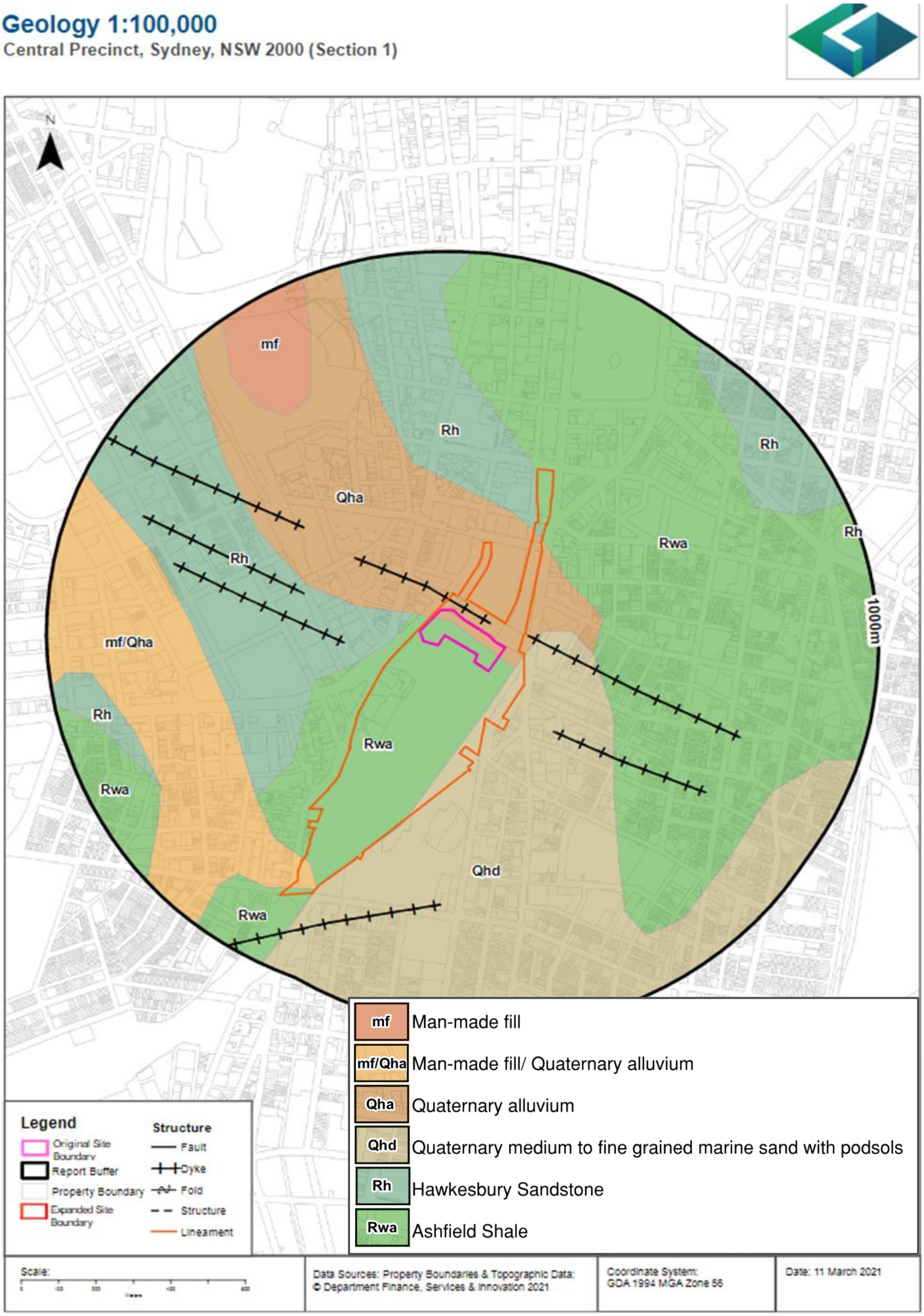
The precinct is located within the geological region known as the Sydney Basin, which is a thick sedimentary basin predominantly comprised of quaternary deposits as well as Triassic aged residual soils and sandstone, mudstone, and claystone units.

2.2.1 Regional hydrogeology

The regional geological units which underlie the precinct (as shown in **Figure 4**) include the following units:

- Fill: generally comprised of local or imported fill material which ranges in quality, composition, and compaction. Often the unit is comprised of dredged estuarine sand and mud, demolition rubble, industrial and household waste
- Alluvium (Qhd): This unit is generally comprised of medium to fine grained “marine” sand with podsols
- Wianamatta Group: The Wianamatta group is generally comprised of shale, carbonaceous shale, laminate and fine to medium grained lithic sandstone. Ashfield shale underlies the precinct and is generally comprised of black to dark grey shale and laminate
- Mittagong Formation. The Mittagong formation generally lies between the overlying Wianamatta Group and underlying Hawkesbury Sandstone Formation. The Mittagong formation is comprised of interbedded laminate, and medium grained quartz sandstone
- Hawkesbury Sandstone: The Hawkesbury Sandstone is a thick sandstone unit comprised of interbedded shale, and medium-grained quartz sandstone.

Figure 4: Sydney geological map



***Source**: after Herbert, 1983, modified by Och et al, 2009*
***Note**: all boundaries and buffers are drawn to an approximate extent, not to scale*

2.2.2 Geological structures

There are three sub-vertical structural lineaments that have been documented along the underground Sydney Metro corridor. These structures include the Martin Place Joint Swarm, GPO Fault Zone and Luna Park Fault Zone. These are persistent across the Sydney region with vertical continuity and joint spacing varying from 0.1 metres to 0.5 metres. It should be noted that the degree of weathering observed in these features varies spatially and whilst they are generally associated with lower strength than the surrounding rock, hydraulically these units need to show considerable connectivity to more extensive aquifers to pose a hydrogeological threat to subsurface developments.

There are numerous dykes that have been recorded across the Sydney Basin. These are generally basaltic and doleritic composition. They are generally less than 10 metres in width and generally intrude vertically through the surrounding Triassic units. Dykes tend to strike west-northwest sub-parallel to joint sets observed in sandstone and shale in Sydney. The formation is generally heavily weathered to a white and green kaolinite near the surface and can cause contact metamorphism of the host rock due to the high temperatures of the intruding material.

Because of the high degree of weathering of these units, the hydraulic conductivity and overall strength of the units tends to be quite low.

2.3 Hydrogeology

There have been numerous groundwater monitoring programmes that have been conducted in the Central Station footprint. The following recent investigations provide a good local summary of local geotechnical and hydrogeological conditions as well as provide a summary of the numerous geotechnical, hydrogeological, and contaminated land investigations that have been completed near the precinct.

- Dexus and Fraser Property, Central Place Sydney, Geotechnical Statement – DA Report (Arup, 2021). This report provides a summary of groundwater conditions that are relevant for the central and south-west portions of the precinct
- Report on Supplementary Geotechnical Investigation Proposed Commercial Development, 8-10 Lee Street, Haymarket (Douglas Partners, 2020). This report formed part of the EIS submission for the Atlassian development and contains a summary of groundwater levels which are useful for understanding groundwater conditions in the north-western portion of the precinct
- Sydney Metro – City and South West Technical Services Central Station (TfNSW, 2017). This investigation provides insight into the groundwater conditions along the eastern edge of the precinct.

2.3.1 Hydrogeological units

Groundwater within the precinct has previously been interpreted as either being:

- contained within porous geological units closer to the surface, such as in the mapped alluvial units, residual soil and fill units, or
- contained within geological discontinuities such as fractures, faults and joints within the Hawkesbury Sandstone, Mittagong Formation and Ashfield Shale Formation.

The same interpretation is used for this assessment with groundwater either being contained within the shallow or deep aquifers. It should be noted that aquifer is generally reserved as a term that means a geological structure or formation that is permeated with water and can yield productive volumes of water. In NSW, this term is extended to low yielding and saline systems so it can be used to describe the deeper aquifer system within the precinct whilst it may fail to yield productive water.

A conceptualisation of these units was completed as part of the latest Sydney Metro geotechnical investigation (TfNSW, 2017) and is presented in **Figure 5** and **Figure 6**. It should be noted that there are numerous existing tunnel structures that intersect the shallow unconsolidated units as well as the bedrock. Some of these mapped structures include the Devonshire Tunnel, EW Concourse, eastern suburbs rail line and the recently constructed Sydney Metro Station Box.

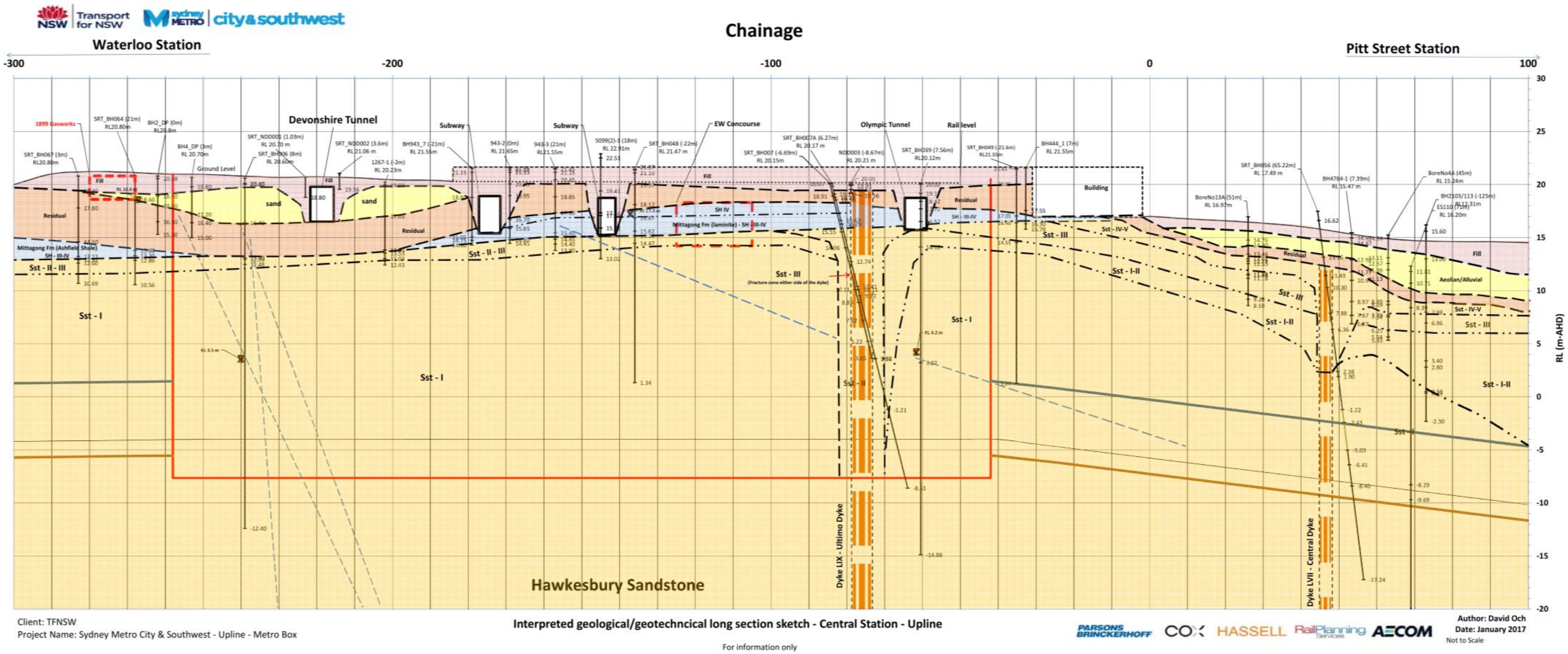
It is understood the eastern suburbs rail line and Sydney Metro Station Box were constructed as drained structures that allow groundwater to be intercepted and captured into the structure. As these are the lowest drained structures it is anticipated that groundwater will generally drain towards these features forming a cone of depression around the structures.

Other structures such as cross passages and underground walkways are generally designed as water-tight undrained structures. As such these structures can lead to local groundwater mounding depending on the orientation of the structure relative to groundwater flow. It is therefore anticipated the groundwater levels are not uniform across the precinct as the area is highly modified.

As per the geological map, there are three mapped quaternary alluvial and marine deposits. The Qha and Qhd units towards the northern, southern and western boundaries of the precinct boundary are expected to act as porous unconfined aquifers being comprised predominately of sand. Whilst there are no proposed basements planned directly in these units, they are near planned basements and may act as a groundwater source. Groundwater levels are expected to fluctuate substantially in these units (up to 2 metres) during heavy and prolonged rainfall events.

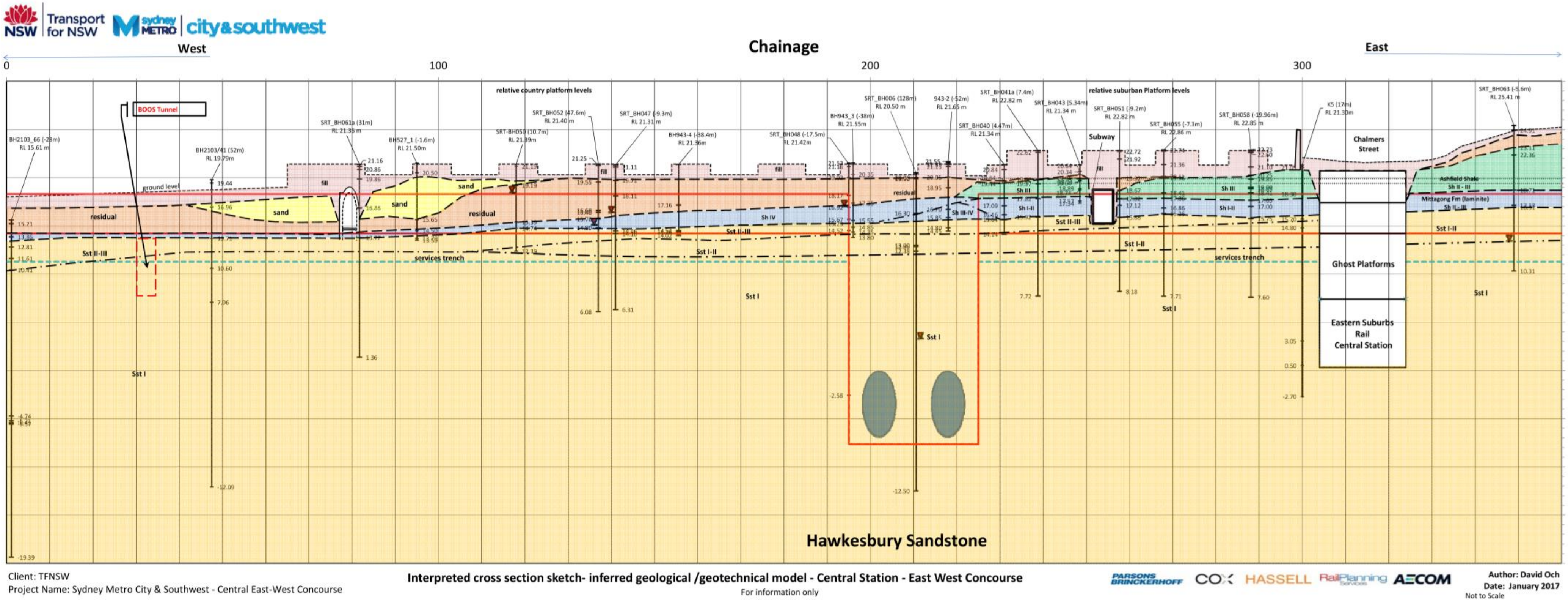
It should also be noted that in the latest Dexus Fraser geotechnical report (Arup, 2021) that there are some historic creeks (paleochannels) that are inferred to flow throughout the precinct, approximately in the north-west, which are not present on the regional 1:100,000k geological map of the area. Some sandy units were picked up in the latest ground investigation leading to an increased level of uncertainty about the extent of mapped alluvial which can act as significant sources for groundwater infiltration. Groundwater levels tend to fluctuate more in these aquifers than in underlying hard rock units and can lead to varying groundwater captured temporally from routine groundwater monitoring events.

Figure 5: South-North geological cross section



__Source__: TfNSW, 2017

Figure 6: West-East geological cross section



***Source**: TfNSW, 2017*

2.3.2 Groundwater monitoring

There have been numerous discrete groundwater monitoring investigations that have been completed across the precinct over numerous years. Historic investigations are not considered to be a reliable indication of recent conditions and only recent investigations have been used for this assessment, predominantly:

- Dexus and Fraser Property, Central Place Sydney, Geotechnical Statement – DA Report (Arup, 2021)
- Sydney Metro - City & Southwest - Technical Services, Central Station. Geotechnical Interpretive Report. Reference Design (TfNSW, 2017)
- Report on Supplementary Geotechnical Investigation Proposed Commercial Development. 8-10 Lee Street, Haymarket (Douglas Partners, 2020).

2.3.2.1 Atlassian development

Groundwater levels were recorded between July 2019 and June 2020 at the Atlassian Development from 10 boreholes. A snapshot of these results from the geotechnical investigation report (Douglas Partners, 2020) is presented in **Table 4** and **Table 5**.

Table 4: Groundwater Observations – Part A

Measurement Date	Standing Water Level Measurements in Boreholes									
	BH1		BH5		BH8		BH103		BH108	
	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]
23/07/2019	5.95	14.2	2.6	12.9	2.3	13.2	-	-	-	-
30/07/2019	6.1	14.0	2.4	13.1	2.3	13.2	-	-	-	-
31/07/2019	6.0	14.2	2.4	13.1	-	-	-	-	-	-
07/08/2019	6.2	14.0	-	-	-	-	-	-	-	-
14/08/2019	6.3 (dry)	<13.8 (dry)	2.4	13.1	2.3	13.2	-	-	-	-
02/09/2019	6.3 (dry)	<13.8 (dry)	-	-	-	-	-	-	-	-
26/11/2019	6.3 (dry)	<13.8 (dry)	2.4	13.1	2.3	13.2	-	-	-	-
19/02/2020	5.8	14.3	2.1	13.4	1.9	13.6	-	-	-	-
24/04/2020	6.3 (dry)	<13.8 (dry)	-	-	-	-	7.5	13.7	7.6	13.6
05/05/2020	6.3 (dry)	<13.8 (dry)	2.4	13.2	2.2	13.3	7.5	13.7	7.7	13.5
05/06/2020	6.3 (dry)	<13.8 (dry)	-	-	-	-	7.7	13.5	7.8	13.4

***Source**: Douglas Partners, 2020*
***Notes**: (1) *-* indicated not measured*
(2) Elevation (RL) in metres AHD

Table 5: Groundwater Observations – Part B

Measurement Date	Standing Water Level Measurements in Boreholes									
	BH107A		BH107B		BH109B		BH112A		BH112B	
	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]	Depth (m)	RL[2]
17/05/2020	3.2	12.3	1.8	13.7	-	-	-	-	-	-
21/05/2020	-	-	-	-	7.8[3]	7.5[3]	3.5	13.2	5.1	11.7
26/0/2020	2.1	13.4	2.6	12.9	8.2[3]	7.1[3]	3.1	13.6	5.2	11.6
05/06/2020	2.0	13.5	2.2	13.3	6.6[3]	8.7[3]	3.4	13.3	5.3	11.5

***Source**:* *Douglas Partners, 2020*
***Notes**:* *(1) *-* indicated not measured*
(2) Elevation (RL) in metres AHD
(3) Transient water level due to slow recharge rate

These results were taken from bores screened on both shallow and deep aquifers. Typical standing water levels within the sandstone on the eastern and central parts of the Atlassian development range between Reduced Level (RL) 11.5 metres and RL 13.6 metres. BH1 was screened in alluvial sand and groundwater was measured to rise 1.4 metres following heavy rainfall to an elevation of RL 15.2 metres. A hydrograph of this result is presented in **Figure 7**. A more typical response for monitoring wells screened in bedrock is presented in **Figure 8** where the groundwater level may only present minor fluctuations to rainfall. Similar groundwater monitoring results were observed at the Dexus Fraser development. (Arup, 2021) with levels generally being recorded between RL 11.9 metres and RL 13.86 metres.

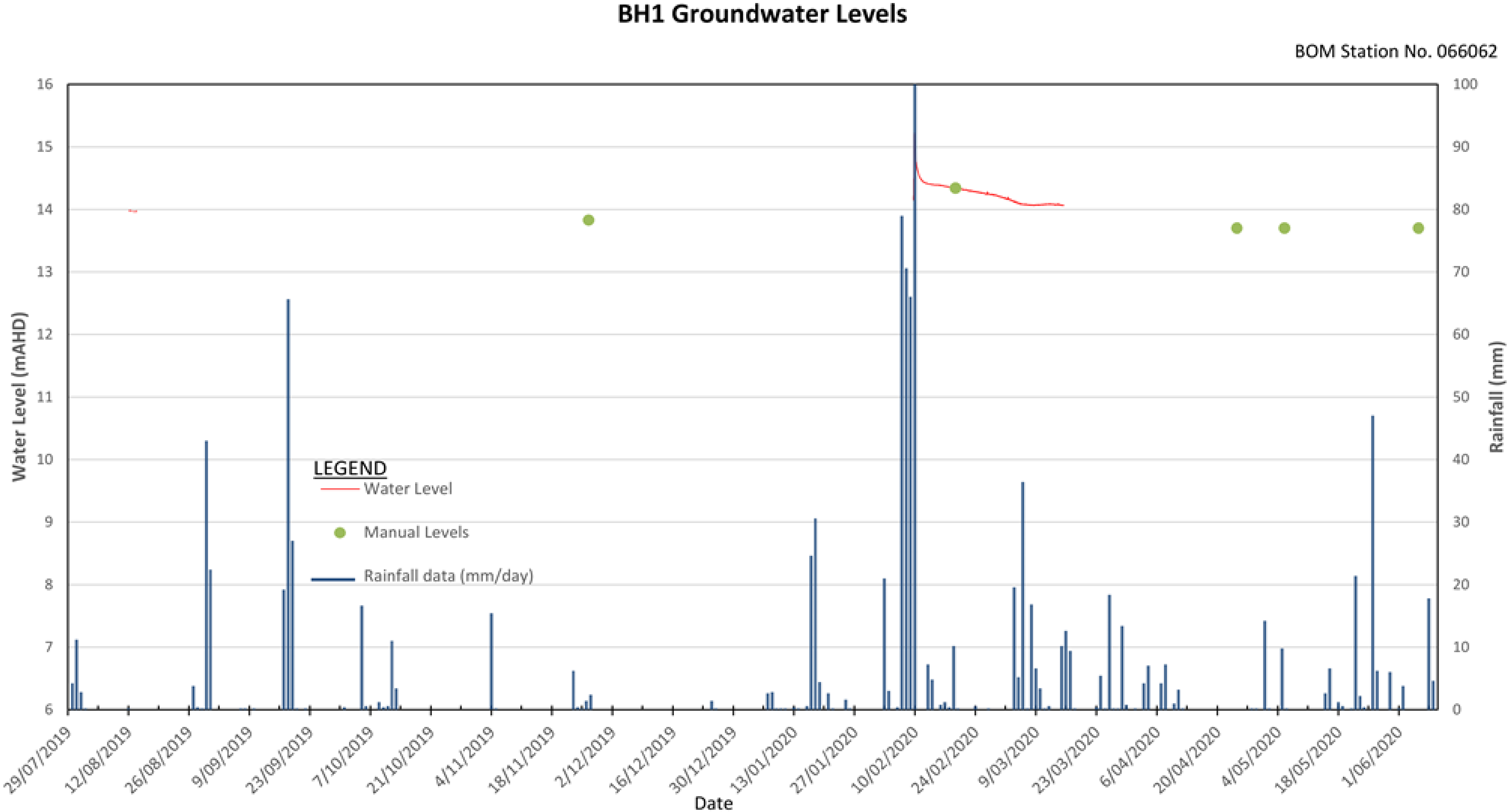
2.3.2.2 Sydney Metro City and Southwest

There were 14 groundwater monitoring wells used as part of the Sydney Metro City and Southwest groundwater investigation. A snapshot of these results is presented in **Table 6**.

In general, the groundwater levels observed ranged from RL 15 metres to RL 19.8 metres with the exception of SRT_039. Most of these results were from shallow standpipes less than three metres, below the fill/residual layer, and may represent perched groundwater. SRT_039 was installed 20 metres below the ground surface to RL -5 metres. The borehole recorded a groundwater level of 4.5 metres which may be considered representative of the deeper hardrock aquifer. As such the design groundwater levels provided in **Table 7** were recommended during the reference design for the station box.

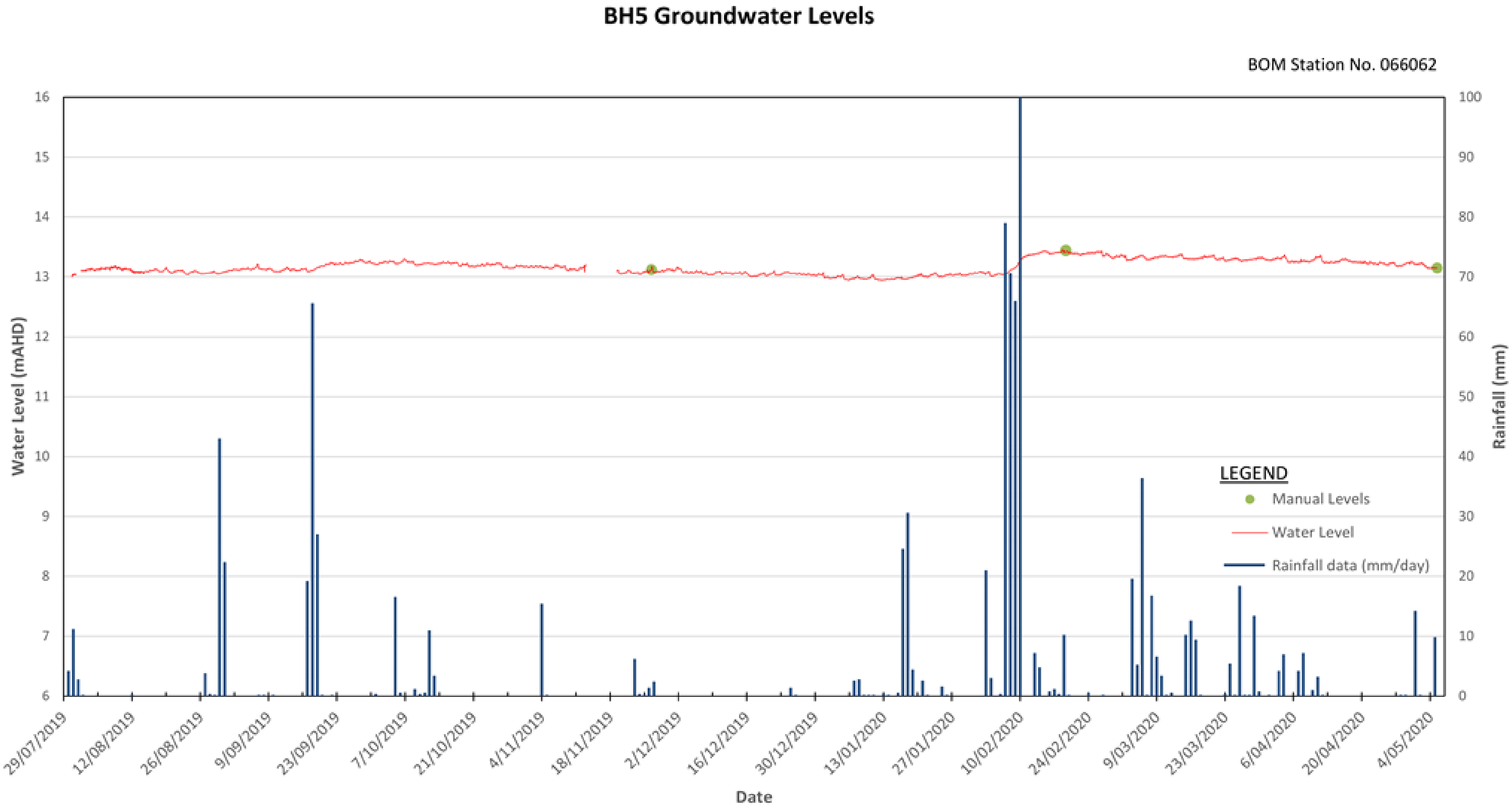
A hydrograph of SRT_BH039 has been presented in **Figure 9**. A hydrograph of BH052 has also been included for reference as **Figure 10** which is considered representative of a shallow groundwater level closer to the centre of the precinct in close proximity to Platform 6. It should be noted a test was completed on SRT_BH039 and the graph shows the groundwater level returning to the representative standing water level and holding stable despite rainfall events.

Figure 7: BH1 Hydrograph



***Source**: Douglas Partners, 2020*

Figure 8: BH5 Hydrograph



Source: *Douglas Partners, 2020*

There appears to be a discrepancy between the RL of the deeper aquifer between the west and east of the Central Station terminal building. Although the shallow aquifer water level RL is similar on both sides, the RL of the deeper aquifer is considerably deeper in the east and may be due to subsurface drainage associated with the eastern suburbs rail line tunnel.

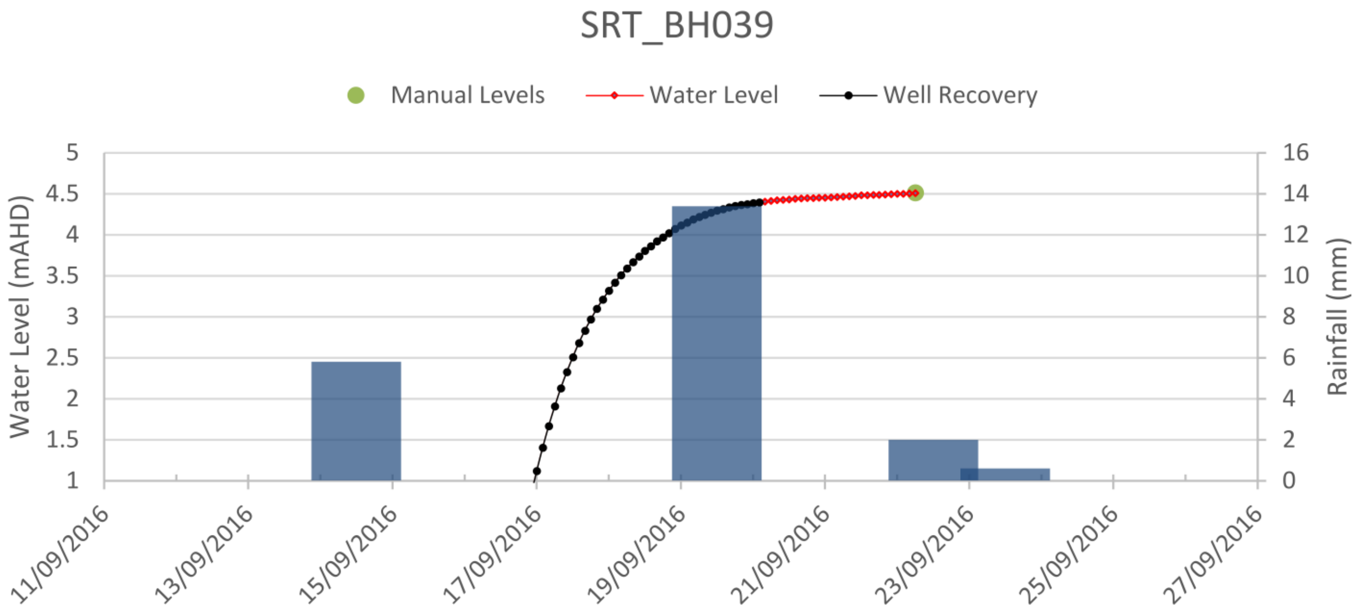
It should be noted that groundwater levels may have become more depressed as the Metro station box and running tunnels were excavated between the time the Sydney Metro report was published and this assessment.

Table 6: Sydney Metro groundwater monitoring wells and reported groundwater observations

Borehole Name	Location	Observed Trend in Water Level
SRT_BH006 (2015 SI)	South of Platform 15	Decreasing from 6.6 mAHD in September to 4.3 mAHD in June 2016 with some increases apparently due to rainfall. Lack of equilibrium could be due to incomplete purging of the wells.
SRT_BH039	Platform 15 Road	Quickly rising from 3 mAHD on 17 September to about 4.5 mAHD then oscillating within a range of 4.4 mAHD to 4.6 mAHD.
SRT_BH045	Station Yard (near flyover)	Slightly decreasing from 13.9 mAHD to 13.6 mAHD
SRT_BH047	Platform 7	Fluctuation between 17 mAHD and 16.2 mAHD, influenced by rainfall events.
SRT_BH048	Platform 12	Gradually drop down from 17.5 mAHD to 17.0 mAHD then back to 17.3 mAHD due to rainfall events during 15 – 17 December.
SRT_BH050	Platform 4-5	Minor fluctuation between 18.8 mAHD and 18.6 mAHD, influenced by rainfall events.
SRT_BH052	Platform 6	Gradually drop down from 15.5 mAHD to 15.2 mAHD then minor fluctuation around 15.2 mAHD.
SRT_BH053	Platform 12	Gradually drop down from 16.6 mAHD to 16.3 mAHD
SRT_BH055	Platform 20-21	Fluctuation between RL 19.8 mAHD and RL 18.9 mAHD approximately, the up and down is influenced by rainfall events.
SRT_BH059	Platform 19	Up and down between RL 19.6 mAHD and RL 18.2 mAHD approximately, appeared to be influenced by rainfall events.
SRT_BH060	Platform 16-17	Steady at 18.5 mAHD since 16/11.
SRT_BH061	Platform 1	Dry
SRT_BH063	Randle Lane	Gradually rising up (with fluctuation) from 15.7 mAHD to 16.2 mAHD then almost kept steady (17/09 to 16/11). Around 16/11 water level of 16.3 mAHD then gradually down to 15.9 mAHD on 16/12.
SRT_BH064	Guard Station Building	Fluctuation between 18.4 mAHD and 18.9 mAHD approximately, appears to be influenced by rainfall events.

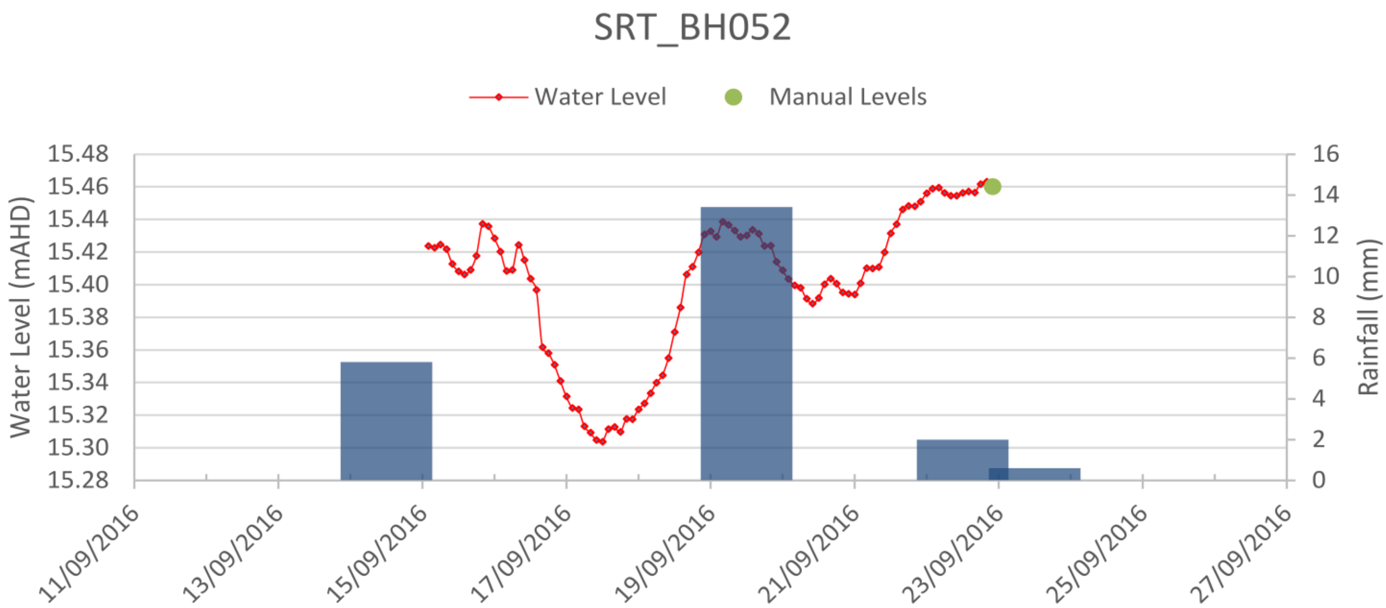
Source*: TfNSW, 2017*

Figure 9: SRT_BH039 Hydrograph



***Source**: TfNSW, 2017*

Figure 10: SRT_BH052 Hydrograph



***Source**: TfNSW, 2017*

2.3.3 Water levels

The water table within two bores (SRT_039 and SRT_006) was recorded at an RL of approximately 4.5 mAHD. **Table 7** shows the groundwater levels that were recommended during the Sydney Metro reference design.

Table 7: Reference design groundwater levels

Structure	Depth (m)	Elevation (mAHD)
Central Station Box	16.0	4.5
East West Concourse	5.0	17.5 (Perched)

2.3.4 Water quality

Risks associated with groundwater quality into subsurface excavations are summarised in **Table 8.** The purpose of this section is not to provide a detailed analysis of contaminants across the precinct as further detailed contamination investigations will be undertaken as the planning and design of the precinct develops. Rather an overview of general parameters of concern related to groundwater associated with the CPRP are highlighted based on previous assessments. **Table 8** provides an overview of groundwater parameters that given the hydrogeological units that are present and from what is known from other Sydney Metro projects across the Sydney Region are likely to pose a groundwater quality risk to the CPRP. The following groundwater risks were highlighted in the Sydney Metro EIS (Chatswood to Sydenham (Jacobs, 2016).

Table 8: Groundwater quality risks

Issue	Comment	Treatment Strategy	Sandstone Risk	Risk Shale
Salinity	Groundwater salinity can have an impact on durability and groundwater discharge to local watercourses or water treatment plants	Reverse Osmosis	No	Unknown
Dissolved Iron	Oxidisation can lead to the accumulation of precipitants. This can lead to pipe clogging and iron staining	Typically removed by oxidising ferric ion to ferrous which enables precipitation and physical removal.	Yes	Yes (minor)
Turbidity	Water can be too turbid for discharge to local watercourses	Settling and filtering	Yes	Yes (minor)
Iron reducing bacteria	Can combine with oxidised iron at drainage points to produce iron ochre sludge. This can lead to clogging and durability issues.	Biocide dosing	Yes	No.

Contaminant screening testing was completed for the Sydney Metro City and Southwest project. The contamination assessment noted the following results.

- TRH and BTEXN was detected in several wells however no criteria were exceeded
- Dissolved metals were detected in all samples, however most concentrations were low and likely to be representative of background levels. Exceedances of ANZECC freshwater protection criteria were exceeded for arsenic, chromium, copper, nickel, and zinc. It should be noted that these analytes are typically detected in Hawkesbury Sandstone in the Sydney Metropolitan Area
- VOC's were detected in well SRT-BH064, detections were of benzene, toluene and 1,1-docholoethene. No criteria were exceeded and SVOC's were not detected.

These results indicate some minor hydrocarbon impact across the precinct, although no health exceedances were noted.

2.3.5 Hydraulic conductivity and groundwater inflow

Hydraulic conductivity (often used interchangeably with permeability) is a measure used in the assessment of groundwater flows into subsurface structures. In hard rock formations in situ packer testing is the primary methodology used to assess hydraulic conductivity. The outcome of this testing is the derivation of a Lugeon Value which can be converted to hydraulic conductivity as an indication of the condition of rock mass discontinuities. **Table 9** provides an overview of the condition of rock mass discontinuities associated with different Lugeon Values.

Previous packer testing programmes completed as part of the Epping to Chatswood Rail Line report an unscaled geometric mean of hydraulic conductivity varying from about 0.1 m/day (10 Lu or 1 x 10-6m/s) near the surface to about 0.002 m/day (0.2 Lu or 2 x 10-8m/s at 50 metres depth. Generally, the hydraulic conductivity of the Hawkesbury Sandstone decreases with depth, due to mainly decreasing sub-horizontal defect aperture (from overburden pressure) with increasing depth. This would need to be confirmed locally.

Table 9: Condition of rock mass discontinuities

Hydraulic Conductivity	Lugeon Value (uL)	Condition of Rock Mass Discontinuities
Very low to low	< 1	Tight joint
Low to moderate	1 – 15	Small joint openings
Moderate to high	15-50	Some joint openings
High	50-100	Many joint openings
Very high	> 100	Open closely spaced joints or voids

Historic results show that packer testing suggests generally a low to moderate hydraulic conductivity across the precinct. Potential rock mass risks which may be attributed to higher inflows include two mapped igneous dykes (Pittman Dyke LIX and Pittman Dyke LVII) which are inferred to cut through the Central Station area. Previous packer test data from the CBD Metro site investigation boreholes BH23103/64 and BH2103/65 indicate high hydraulic conductivity around the interface of these dykes with Lugeon values of > 100 being recorded at depth. The local extent of these dykes would need to be confirmed, and the source and extent of any connected aquifer units would need to be confirmed to close out potential risks.

Packer testing results from the Atlassian development are provided in **Table 10**. The results are considered typical permeability results recorded elsewhere in the CBD, with results recorded in the Hawkesbury Sandstone of approximately 1 x 10-7 m/s. Competent unfractured Hawkesbury Sandstone does not typically transmit significant quantities of groundwater.

Eleven boreholes were selected for packer testing during the Sydney Metro investigation (TfNSW, 2017). Most of the results were similar to the Atlassian investigation with some exceptions. Some discrete intervals tested high Lugeon values. However, all results were noted in intervals that are deeper than the proposed basement of the CPRP Reference Master Plan.

Table 10: Atlassian development permeability results

Borehole ID	Material Types within Screened Interval	Calculated Permeability (m/sec)
BH1 [1]	Sand	6.5×10^{-7} to 4.5×10^{-7}
BH5	Sandstone: fine and medium grained with clay seams in upper metre of screened interval	2.7×10^{-9}
BH8 [2]		4.5×10^{-7}
BH103 [1]	Sandstone: fine grained with extremely weathered bands, fractured	1.2×10^{-6} to 1.4×10^{-6}
BH104 [1]	Sandstone: fine to medium grained, slightly fractured then unbroken	1.2×10^{-7} to 3.5×10^{-7}
BH107A [1]	Sandstone: fine to medium grained, high strength with very low strength bands, fractured	1.4×10^{-7} to 2.0×10^{-7}
BH107B [1]	Sandstone: fine to medium grained, slightly fractured then unbroken	5.0×10^{-8} to 7.7×10^{-8}
BH109B	Sandstone: fine to medium grained, slightly fractured then unbroken	4.7×10^{-8}
BH112A [2]	Sandstone: fine grained with very low strength bands (core loss)	4.8×10^{-7}
BH112B [1]	Sandstone: medium grained, slightly fractured then unbroken	2.4×10^{-7} to 3.9×10^{-7}

Note: *(1) Two tests were carried out.*
(2) Well screen includes an interval of core loss and clay seams, below the top of rock

2.4 Groundwater users

All registered groundwater bores within one kilometre of the precinct are registered as monitoring bores only and are not used for any extractive purpose. Locations of groundwater bores are shown in **Figure 11**. There are no registered groundwater dependent ecosystems within a one kilometre radius of the precinct.

2.5 Water restrictions

To the south-east of the precinct a Temporary Water Restriction current applies to the Botany Sands Groundwater Source as shown in **Figure 12**. The temporary restrictions state that groundwater cannot be used for:

- Human consumption or consumption by animals
- Domestic purposes
- Any other purpose, except if the water is fit for purpose, or it is for remediation, temporary construction dewatering, testing or monitoring purposes.

Figure 11: Groundwater bore locations

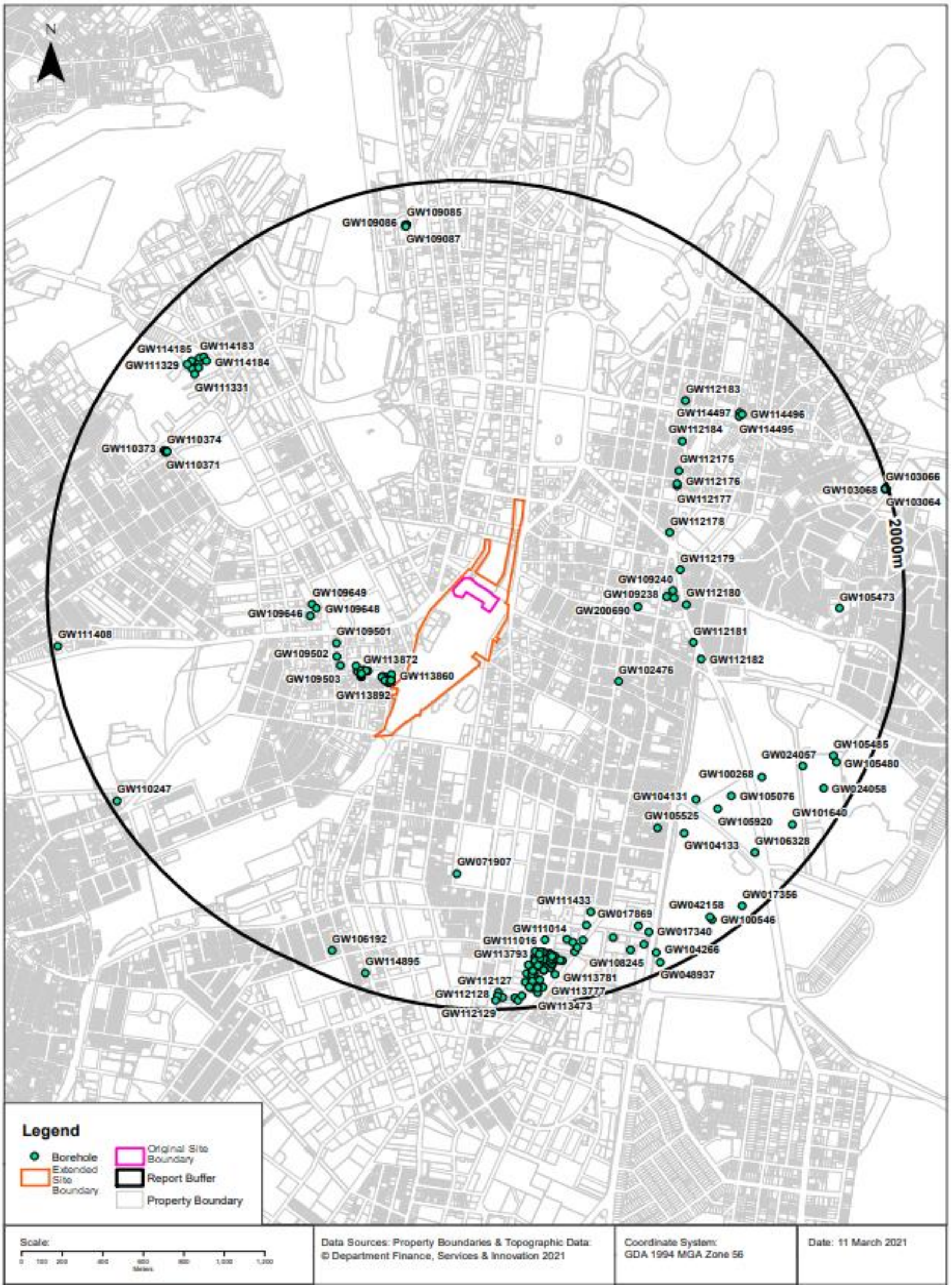
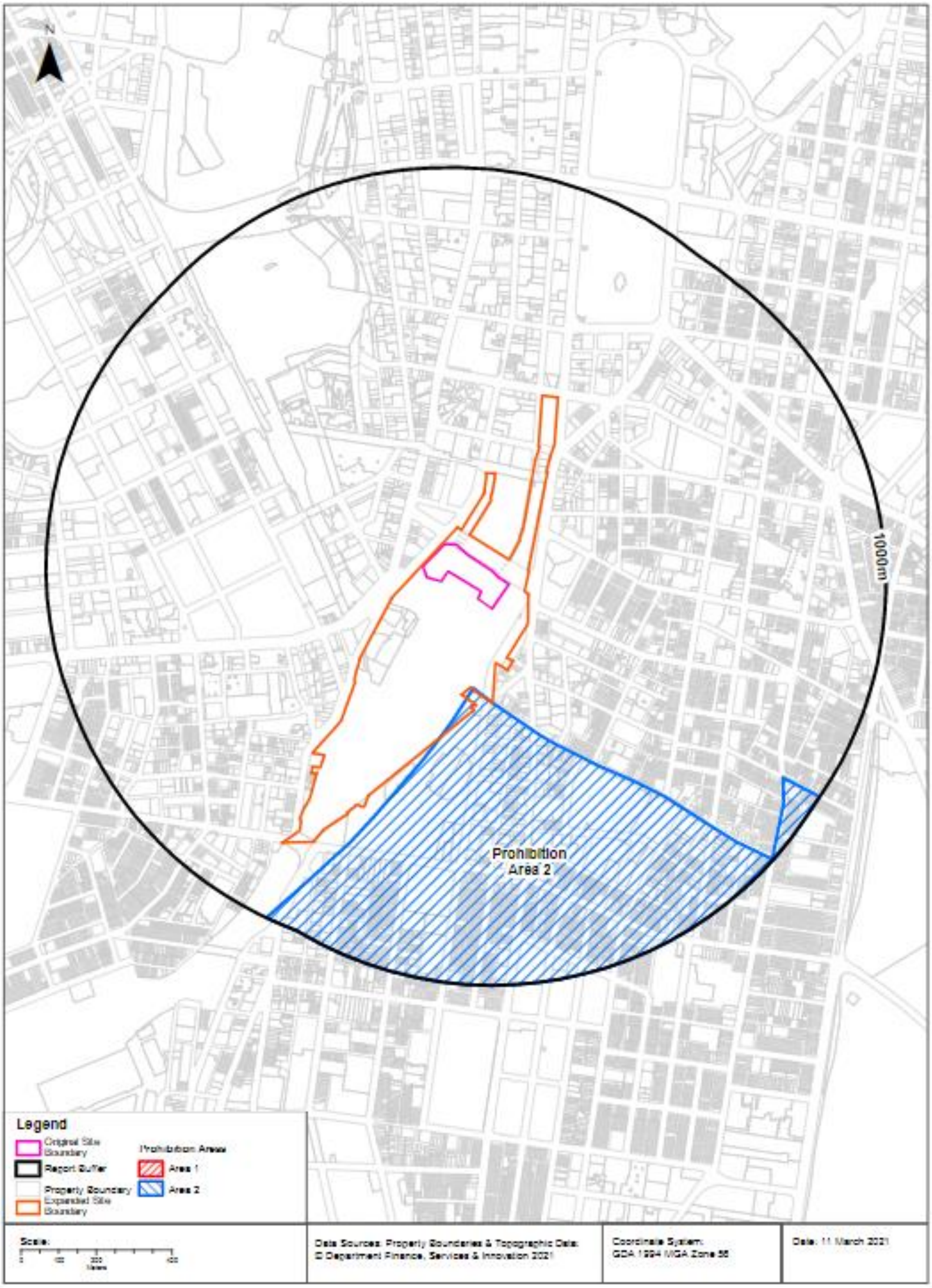


Figure 12: Temporary Water Restrictions boundary



3. Precinct assessment

A hydrogeology impact assessment is required to inform the State Significant Precinct (SSP) Study Requirements. In the absence of any prescribed assessment criteria it has been assumed that typical criteria for a groundwater assessment apply such as that which would be required for an Environmental Impact Assessment for a NSW state significant development.

An outcome of the SSP study is to identify groundwater risks of the Central Precinct Renewal Project (CPRP) noting that there are already multiple groundwater investigations and construction activities ongoing within the precinct. Because multiple projects are at different stages of approvals, design development and construction within the precinct, baseline conditions and the overall precinct Reference Master Plan are subject to change. The approach to this groundwater impact assessment is to identify current major elements of the CPRP that are likely to impact on groundwater across the precinct and surrounds. This assessment has been undertaken based on the CPRP Reference Master Plan provided.

3.1 Assessment criteria

It is expected that groundwater risks of the CPRP will be assessed against similar criteria that would be used for an Environmental Impact Statement (EIS) groundwater assessment prepared in the Sydney Metropolitan Area. These assessments generally require an assessment of potential impacts to groundwater levels, groundwater inflows, groundwater flow paths and groundwater quality. There are multiple subsurface design features which are likely to impact on the existing groundwater environment that will ultimately need to be assessed against the Aquifer Interference Policy. Detailed groundwater modelling is not part of the scope of this assessment, however, this groundwater assessment will be used to target areas that may warrant further investigation during the design development and prior to construction.

3.2 Subsurface design features

There are multiple subsurface design features which are likely to impact on the groundwater environment during the construction and operational phases of the CPRP. These features include tunnels, cross passages, and mined/excavated basements. A summary of the existing and proposed basements is provided in **Table 11**. This includes details of the expected floor Reduced Level (RL) (some have been estimated in the absence of design information), recorded and anticipated shallow and deep standing groundwater levels. Based on the baseline information these values have been kept constant across the CPRP and are considered a conservative estimate that should be further refined during the design development.

All proposed subsurface design features are expected to be constructed beneath the standing shallow groundwater level based on an analysis of the existing available groundwater level information.

Table 11: Summary of existing and proposed basements

Existing / Proposed Basement Structures	RL (floor)	Shallow Water Level (RL)	Deep Water Level (RL)
Existing Basements			
Atlassian Basement	5.6	15.2	13
Dexus Fraser Basement	6	16	13
Central Station Metro Box	~- 8	17.5	4.5
Other Existing Subsurface Elements			
Devonshire Street Tunnel	~16	17	13
ESL Station Tunnels (platform 24 and 25)	~- 5	17	13
BOOS Tunnel	~7	17	13
Master Plan Design Features			
Northern Loading Dock	9	17	13
Southern Loading Dock	13	17	13
EV Loading Docks servicing the OSD	5.7	17	13
Service Tunnel (northern end)	14	17	13
Service Tunnel (southern end)	13	17	13
Prince Alfred Siding Basement	17	17	13
Cross Passages - Central Walk	14.2	17	13

Based on the current design strategy adopted for the Sydney Metro station box and the proposed Atlassian basement the following assumptions have been made regarding the assumed subsurface drainage strategy for the CPRP. This strategy will be further investigated and refined as the design progress.

- The northern and southern loading docks are likely to adopt a drained solution based upon the current design approach for the adjacent Atlassian development. This may require further consideration following local ground investigations. A partially drained solution may also be adopted to seal off drainage surficial sediments given the nearby presence of alluvial aquifers
- All EV loading docks located below the over station buildings will adopt a drained or partially drained solution, similar to the northern and southern loading docks. This will be based on local geotechnical information to be acquired
- The service tunnel will be lined. Typically running tunnels and cross passages for metro projects are required to meet strict waterproofing specifications so it has been assumed that the service tunnel will be constructed as an undrained element. This is yet to be confirmed
- The Prince Alfred Siding basement is yet to be determined, however the planned basement may require minor cuttings. It is considered unlikely that an undrained solution would be adopted. The only potential caveat being the Prince Alfred Siding is adjacent to the Botany Sands Aquifer. Further local information will be required to determine the depth to water table relative to any finalised cutting plans.

3.3 Groundwater risk assessment

Table 12 contains a high-level summary of anticipated groundwater impacts associated with the construction of subsurface design features. The following impacts to groundwater are anticipated.

- All excavations that are likely to be designed as drained or undrained features are likely to decrease the local groundwater level. This is especially true during the construction phase. During the operational phase, and dependent on the final retention design strategy, groundwater impacts can be minimized.
- The northern and southern loading docks are in relatively close proximity to mapped alluvial groundwater sources which may act as a source for groundwater inflows. Further localised ground investigation will likely be required to determine the risk of heightened inflows both during construction and operation.
- Groundwater inflows into the EV loading docks are expected to be low as the docks are underlain by residual soils and Ashfield Shale and Hawkesbury Sandstone which all typically have low hydraulic conductivity /permeability. These units are not in close proximity to any mapped alluvial units, however this should be confirmed with local geotechnical investigations.
- No impact to groundwater levels is anticipated because of the installation of the service tunnel as this feature is expected to be constructed as undrained, however this will require confirmation further into detailed design.
- Impacts to water quality are expected to be low. The precinct already contains evidence of minor hydrocarbon and metals contamination. Some of the metal contamination may be attributed to the host rock (Hawkesbury Sandstone and Ashfield Shale). It is expected that minor groundwater treatment may be required prior to offsite discharge.

As outlined in the baseline assessment no groundwater users or groundwater dependent ecosystems were identified. As such the CPRP is not expected to impact on these users. Groundwater recharge is not expected to be impacted as drainage at Central Station is already highly managed.

Groundwater mounding associated with the installation of the service tunnel and other long linear features is not expected to lead to an increase in localised groundwater levels as these features are expected to be installed in the Hawkesbury Sandstone which does not readily transmit groundwater flow except through secondary porosity. Examples of continuous fracturing across the precinct has not yet been identified.

Table 12: Anticipated groundwater impacts

Design Features	Drained (D)/ Undrained (U)/ Partially Drained (PD)	Water Level Impact	Groundwater Inflows	Water Quality
Northern Loading Dock	D	Decrease	Low/Moderate	Low
Southern Loading Dock	D	Decrease	Low/Moderate	Low
EV Loading Docks	P/D	Decrease	Low	Low
Service Tunnel (Northern End)	U	No Impact	Low	Low
Service Tunnel (Southern End)	U	No Impact	Low	Low
Prince Alfred Siding Basement	D	No Impact	Low	Low
Cross Passages and Central Walk	U	No Impact	Low	Low

4. Conclusions and recommendations

This Hydrogeological Impact Assessment documents the potential effects of the Central Precinct Renewal Project (CPRP) on the groundwater within the Central Precinct and adjoining areas. A high-level assessment of potential impacts has indicated that risks to groundwater level and quality are anticipated to be minor due to the hydrogeology of the location and expected subsurface drainage solutions. The anticipated impacts may include:

- Groundwater levels within the precinct and to a lesser degree in surrounding areas, are likely to fluctuate, particularly in the construction phases due to excavations, dewatering activities that may be required, removal of impermeable surface material and changes to surface infiltration to groundwater
- Impacts on groundwater level in the operational phase will be dependent on the final retention design strategy
- Groundwater inflow to the Electric Vehicle (EV) loading docks is anticipated to be negligible due to the low hydraulic conductivity of residual soils and rock below the docks
- Evidence of minor metal and hydrocarbon contamination is already present in the precinct groundwater, however additional groundwater quality impacts associated with the CPRP are expected to be minimal
- Minor groundwater treatment may be required prior to offsite disposal in select areas where dewatering occurs, depending on the concentrations of compounds in extracted groundwater
- Changes to groundwater levels as a result of the CPRP should be restricted to the precinct and immediate vicinity of development operations, and are likely to vary with the construction phase.

Based on these predicted impacts, a line-of-sight table has been included as **Appendix A**, which outlines recommendations and solutions for the key potential issues determined in this assessment. The following recommendations have been suggested for further development of the CPRP:

- All plans and drainage strategies for subsurface design features should be confirmed before progressing to more detailed risk analyses
- A more detailed hydrogeological study should be completed as the CPRP progresses, evaluating localised and project specific risks as well as sources and magnitude of any potential hydrogeological impacts to the precinct or surrounds
- A groundwater monitoring program should be prepared for both the construction and operational phases of projects to ensure groundwater quality is maintained. This program would specify locations and number of groundwater aquifers as well as the frequency of monitoring
- A groundwater treatment plan is proposed, subject to the outcomes of regular groundwater monitoring, and the extent of contamination.

5. References

- Arup (2021) *Dexus and Fraser Property, Central Place Sydney, Geotechnical Statement DA Report*
- Douglas Partners (2020) *Report on Supplementary Geotechnical Investigation Proposed Commercial Development 8-10 Lee St, Haymarket*.
- Jacobs (2016) *Chatswood to Sydenham Environmental Impact Statement*
- Transport for New South Wales (2017) *Sydney Metro - City & Southwest - Technical Services. Central Station. Geotechnical Interpretive Report. Reference Design*
- Transport for New South Wales (2018) *Central Precinct, Geotech, Contamination and Drainage TA Geotechnical and Contamination Desktop Study and GIS Database.*
- Transport for New South Wales (2022) *Central Precinct Renewal Program – Water Quality, Flooding and Stormwater Report*

Appendix A – Line of sight

Issue	Aspirations	Solutions
Unexpected changes in groundwater levels within the precinct or at neighbouring properties.	Potential groundwater and hydrogeological changes are well defined and included in the planning and evaluation stages.	Including a provision in the planning framework to ensure proposed developers demonstrate they have adequately considered and addressed groundwater as part of their design to minimise the risk of impacts during construction or operation. A groundwater assessment is to be completed, undertaken by a suitable qualified and endorsed specialist, prior to the approval of any proposed works which include underground excavation of permanent structures or modification to existing structures.
Excessive inflow to the CPRP subsurface design features resulting in the need for design changes or additional infrastructure to manage inflows.	Ensure subsurface drainage is sufficient for all possible inflows.	Consider the sources and volumes of all possible inflows, assess subsurface drainage requirements, and implement additional drainage solutions where required. Incorporate the results of additional hydrogeological studies and continued evaluation of potential groundwater flow changes at each stage of the precinct design and implementation.
Negative impacts to groundwater level of the precinct and surrounds during construction and longer-term. Potential issues may include changes in inflows to neighbouring subsurface structures or the potential need to change precinct design parameters.	Elimination or minimisation of negative groundwater impacts.	Further specify the volume of anticipated groundwater level impacts and refine the subsurface drainage strategy accordingly. Use the results of additional hydrogeological evaluations to inform the subsurface drainage design and construction plans. Manage potential changes to hydrogeological regimes through subsurface drainage design updates as new data becomes available.
Negative impacts to groundwater quality of the Precinct and surrounds	Elimination or minimisation of negative impacts.	Complete a detailed groundwater risk assessment, and ensure measures are taken to reduce the risk to as low as reasonably practicable. Prepare a groundwater monitoring program and groundwater treatment if deemed necessary. Verify construction management plans include measures for containment of accidental spills and releases to the subsurface.

Appendix C – Precinct Flood Model Report

CENTRAL PRECINCT RENEWAL PROJECT

Precinct Flood Model Report

26 FEBRUARY 2021

TRANSPORT FOR NEW SOUTH WALES

CENTRAL PRECINCT RENEWAL PROJECT

Precinct Flood Model Report

Issue for TfNSW

Author Vincent Ng / Melanie Gostelow

Checker Ian Rath / Greg Ives / John Merrick

Approver Jonathan Davies

Report No CPRP025-ADAP-CEN-CV-RPT-00001

Date 26/02/2021

Revision Text 01

This report has been prepared for Transport NSW in accordance with the terms and conditions of appointment for Central Precinct Renewal Project dated 11th July 2019. Arcadis Australia Pacific Pty Limited (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

REVISIONS

Revision	Date	Description	Prepared by	Approved by
00	22/12/2020	For TfNSW review and comment	VN	JD
01	26/02/2021	Completed report with executive summary added	MG	JD

CONTENTS

Appendices

EXECUTIVE SUMMARY

Arcadis Australia Pacific Pty Ltd has been engaged by TfNSW to develop a Precinct Flood Model for the Central Precinct Renewal Project (CPRP). This report provides an overview of the flood modelling undertaken to date, a summary of predicted flood behaviour and an indication of potential flood impacts. Recommendations to ensure that flooding is adequately considered throughout the design process are also provided.

The Precinct Flood Model has simulated flood behaviour for the critical 10% AEP (10-year ARI), 1% AEP (100-year ARI) and PMF design flood events for the base case existing and proposed CPRP development. Results have been illustrated in a series of flood maps provided in the appendices, along with a comprehensive commentary in this report.

Background

The Central Precinct Renewal Project (CPRP) is investigating the renewal of 24 hectares of government owned land within and surrounding the Central Station rail yard. The potential scope of the CPRP includes development above the rail yard, redevelopment surrounding the rail yard and modifications to existing rail assets across 10 sub-precincts.

Given the significant scale of the CPRP it has the potential to adversely impact flooding within and surrounding the site. The design of the CPRP will aim to avoid worsening flood conditions in the surrounding area, whilst ensuring the proposed developments suitably consider the flood conditions. To inform the design of the CPRP, the complex flood behaviour of the existing and proposed site needs to be well understood.

Base Case Flood Model Development

A Precinct Flood Model has been developed to predict flood behaviour for the site and surrounding catchment area. The developed flood model strategy aims to provide a high quality, site specific, fit-for-purpose flood model for the CPRP.

The Precinct Flood Model has been informed by a large volume of information sources obtained from TfNSW, Sydney Water, City of Sydney Council and other publicly available sources. The quality of the topographic and drainage network information is critical to the accuracy of the flood model results. The data review process has found the current information is often incomplete, inconclusive, unconfirmed, or outdated. It is recommended that additional topographic survey of the existing ground surface, obstructions (building extents) and underground drainage network be carried out to improve the accuracy of the flood model prior to detailed design.

The Precinct Flood Model has been developed utilising the City of Sydney Council flood models for the Darling Harbour and Blackwattle Bay catchments. Whilst these flood models were available, they were not sufficiently schematised and detailed to adequately represent the existing conditions of the CPRP. The Council flood models have been merged with the model parameters realigned for a consistent modelling approach.

Based on the data sources reviewed, the Precinct Flood Model has been further updated and refined. This has included incorporating the Sydney International Convention Exhibition and Entertainment Precinct downstream of the site and Sydney Light Rail in the vicinity of the site. The Sydney Metro works at Central Station are proposed to be incorporated into the flood model upon completion of construction. For technical comprehensiveness, a comparison of the Precinct Flood Model results compared to the City of Sydney flood models has been provided.

Proposed Flood Model Development

The Precinct Flood Model has considered the proposed CPRP based on the current level of design undertaken. This has largely been informed by the Central Precinct Structure Plan & Urban Design Report (Architectus, 2020). Key features of the proposed development of interest for a flooding perspective have been identified.

An initial representation of the proposed CPRP has been developed in the Precinct Flood Model considering:

- Proposed building locations and developments surrounding the rail yard including the Western Gateway, Regent Street Sidings and Prince Alfred Sidings;
- Preliminary regrading of the Western Forecourt and pedestrian connection to Eddy Avenue;
- Preliminary revised track drainage network and platform extents; and
- Simplistic representation and assumptions regarding the deck drainage network catchment areas and connections to the downstream trunk drainage lines.

The representation of the proposed CPRP and assumptions made will be further refined as the design progresses.

Existing Flood Conditions

The CPRP is impacted by informal overland flow paths approaching the site from the east during significant rainfall events. Significant overland flow paths occur through Prince Alfred Park and along Devonshire Street, Foveaux Street, Albion Street, Reservoir Street, Wentworth Avenue and Foy Lane. Flow depths along roadways are typically less than 0.5m in the 1% AEP design storm event.

Overland flows drain across the CPRP site in an east-west direction via Campbell Street, Hay Street and Eddy Avenue and via the Sydney Water trunk drainage systems under the rail yard.

Ponding of stormwater within the site also occurs due to a lack of sufficient capacity and extent of the existing drainage network. The Precinct Flood Model results indicate a significant flood depth (>1m in the 10% AEP) and extent of ponding in the low point beneath the flyovers along the Prince Alfred Sidings. Given the significant ponding volume, confirmation of the drainage network details at this location and seeking anecdotal evidence from Sydney Trains is strongly recommended.

Proposed Flood Conditions

The proposed CPRP has the potential to impact flooding by altering the ground surface, concentrating stormwater runoff, altering flow paths and reducing flood storage. The current CPRP flood model demonstrates potential impacts at several locations within the site and surrounding areas including:

- Chalmers Street/Devonshire Street intersection
- Broadway, George Street and Pitt Street
- Regent Street sag north of Mortuary Station
- Prince Alfred Park boundary

In general, the flood impacts of the proposed CPRP are exacerbating existing flood issues with the magnitude of the impact on peak flood levels being less than 0.5m in the PMF at the vast majority of locations. Ongoing flood modelling is recommended to maintain and improve the accuracy of the flood modelling results as the design progresses.

Conclusions

The Precinct Flood Model provides predicted flood behaviour for the site and surrounds along with indicating potential impacts of the CPRP. With potential flood constraints and flood impacts identified, the CPRP design can aim to further investigate and mitigate these issues through the design process.

The current flood modelling is considered fit-for-purpose considering the early stage of the project and the initial objectives of this scope. This report demonstrates the commitment of the CPRP to understand and mitigate flood risk throughout the design process. It is sufficiently detailed for the purpose of stakeholder engagement and to support the ongoing CPRP approvals process.

Recommendations

The investigation of flood behaviour and potential flood impacts is anticipated to be ongoing and involves working iteratively with others through the design development to avoid and minimise flood impacts and constraints. It is expected that the Precinct Flood Model will evolve and become more detailed and accurate in its representation of the existing site and proposed development as the design progresses and further information becomes available. Ongoing flood modelling is recommended to be undertaken as the design of the CPRP develops with the following recommendations:

- Flood model updates to be undertaken selectively on an as needs basis to adopt an efficient approach.
- Consideration of the staging of works of the CPRP may be required to ensure flood impacts are suitably considered.
- Engaging early with stakeholders is strongly recommended. In particular with Sydney Water and the City of Sydney Council to gain support for the CPRP design, and Sydney Trains to seek anecdotal evidence to verify the flood model results.
- Ensuring suitable quality and quantity of data is available and incorporated in the flood model for the detailed design phase. We recommend a survey program and survey brief be developed to ensure the collection of survey information is undertaken in a cost-efficient and timely manner.

1 INTRODUCTION

1.1 Project Overview

Through the Central Precinct Renewal Project (CPRP) the NSW Government plans to renew the land in and around the Central Station transport interchange known as Central Precinct. The Central Precinct Draft Strategic Vision (TfNSW, 2019) provides an overview of the vision for the Central Precinct and its various sub-precincts. The CPRP extent and its various sub-precincts are illustrated in **Figure 1-1**.

As a nominated State Significant Precinct, the CPRP is currently undertaking a detailed planning and investigation process. The potential scope of the CPRP being investigated includes:

- Development over the rail yard
- Redevelopment surrounding the rail yard
- Modifications to the rail assets within the rail yard

Arcadis Australia Pacific Pty Ltd (Arcadis) has been engaged by TfNSW to provide technical advisory services for the CPRP. As part of the current engagement Arcadis has developed a Precinct Flood Model for the CPRP as outlined in the following report.

1.2 Precinct Flood Model Objectives

A flood model is an essential tool used to predict flood behaviour. By creating a detailed representation of the existing terrain and drainage network, design rainfall events are simulated to produce stormwater runoff and provide details of resulting flood conditions.

By understanding the existing and proposed flood behaviour of a development, we can attempt to alleviate flood impacts and mitigate flood risks.

Whilst existing Council flood models exist, these were not sufficiently schematised and detailed to adequately represent the existing conditions of the CPRP.

The CPRP flood model ultimately aims to provide a high quality, site specific, fit-for-purpose flood model which can:

- Provide accurate flood predictions for the existing site area and proposed CPRP
- Assess potential flood impacts of the CPRP and potential flood mitigation options
- Provide required flood outputs to inform flood development controls
- Provide ongoing inputs for the design, stakeholder consultation and approvals processes

It is expected that this flood model will evolve and become more detailed and accurate in its representation of the existing site and proposed development as additional information becomes available.

This report documents the initial CPRP flood model development based on the currently available information, the strategy for which is outlined in **Section 4**.

Figure 1-1: CPRP Extent & Sub-precincts

(Source: TfNSW, 2019)

1.3 Purpose of this Report

The purpose of this report is to provide an overview of the CPRP flood modelling undertaken for the CPRP. It offers a summary of the predicted flood behaviour within and surrounding the existing site, as well as providing an indication of the potential flood impacts of the proposed development.

In addition, this report provides recommendations for ongoing enhancements to the flood model to improve its quality, suitability and robustness as the CPRP design progresses. It is expected that this report will be updated and expanded as the flood model evolves.

This report demonstrates the commitment of the CPRP to understand and mitigate flood risk throughout the design process.

1.4 Report Structure

This report provides an overview of the CPRP flood modelling undertaken and includes:

- A site description (**Section 2**).
- A summary of the available information used to inform the flood modelling (**Section 3**).
- An overview of the flood model strategy adopted for the CPRP (**Section 4**).
- Details of the development of the base case flood model (**Section 5**) and simulated flood conditions (**Section 6**).
- Details of the development of the proposed flood model (**Section 7**) and simulated flood conditions and flood impacts (**Section 8**).
- An overview of outstanding issues in relation to the flood modelling and recommendation for the ongoing design development of the CPRP (**Section 9**).
- An overall conclusion of the report (**Section 10**).

Flooding mapping for the base case (**Appendix A**) and proposed flood conditions and flood impacts (**Appendix B**) have also been provided.

1.5 Key Terms & Abbreviations

With respect to describing the probabilities of design flood events, this report utilises the Australian Rainfall and Runoff preferred terminology of AEP, expressed as a percentage, for the frequency of events considered, defined as:

- *Annual Exceedance Probability (AEP)* - the probability of an event being equalled or exceeded within a year.

For those more familiar with the ARI terminology, an approximate conversion table is provided in **Table 1-1** below.

Table 1-1: AEP / ARI Conversion Table

AEP	ARI
10 %	10 year
2 %	50 year
1 %	100 year

The key terms and abbreviations used in this report are outlined in **Table 1-2** below.

Table 1-2: Terminology

Term	Definition
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR1987	Australian Rainfall Runoff 1987
ARR2019	Australian Rainfall Runoff 2019
BoM	Bureau of Meteorology
BBFS	Blackwattle Bay Catchment Flood Study
BB - FRMS	Blackwattle Bay Catchment Floodplain Risk Management Study
Council	City of Sydney Council
CoS	City of Sydney Council
CPRP	Central Precinct Renewal Project
DCP	Development Control Plan
DEM	Digital Elevation Model
DHFS	Darling Harbour Catchment Flood Study
DH - FRMS	Darling Harbour Catchment Floodplain Risk Management Study
FPL	Flood Planning Level
FPA	Flood Planning Area
FRMS	Floodplain Risk Management Study
IFD	Rainfall Intensity-Frequency-Duration
IFD 1987	BoM 1987 Rainfall Intensity-Frequency-Duration data
IFD 2019	BoM 2019 Rainfall Intensity-Frequency-Duration data
LiDAR	Light Detection and Ranging
m^3/s	Volumetric flow rate in cubic metre per second
mAHD	Meters to Australian Height Datum
OSD	On-site Detention
PMP	Probable Maximum Precipitation
PMF	Probable Maximum Flood
SQID	Stormwater Quality Improvement Device
SICEEP	Sydney International Convention Exhibition and Entertainment Precinct
SM C&S	Sydney Metro – City & Southwest
SLR	Sydney Light Rail
SWC	Sydney Water Corporation
SYAB	Sydney Yard Access Bridge
TfNSW	Transport for New South Wales
WSUD	Water Sensitive Urban Design

2 SITE DESCRIPTION

2.1 Location

The CPRP site covers 24 hectares of government owned land at the southern end of Central Sydney. The site is located within the City of Sydney local government area and extends across the suburbs of Haymarket and Chippendale. The site is roughly bounded by Eddy Avenue to the north, Elizabeth Street and Chalmers Street to the east, Cleveland Street to the south and Regent Street, Lee Street and Pitt Street to the west. The CPRP extent and its various sub-precincts are illustrated in **Figure 1-1**.

The rail yard servicing Central Station occupies the majority of the CPRP site along with the station terminal buildings and platforms in the north. Additional parcels of land surrounding the rail yard to the west and east are also included in the CPRP extent which are occupied by commercial and various TfNSW premises.

The immediate area of the CPRP contains high density, mixed use and varied built form along with bus and light rail terminals. Nearby large public open spaces include Belmore Park to the north and Prince Alfred Park to the southeast. The larger catchment area is highly urbanised.

2.2 Topography

The CPRP is located on the ridge of two main drainage catchments, the Darling Harbour catchment and Blackwattle Bay catchment. These catchment areas fall in a roughly north-westerly direction towards Sydney Harbour.

The general topographical nature of the CPRP site area is relatively flat with a slight fall towards the western boundary. Topographic features include:

- A steep drop in the terrain along the eastern boundary with Prince Alfred Park.
- A trapped low point or sag beneath the rail flyovers along the Prince Alfred sidings relatively to the surrounding ground surface.
- The Goods Line rail track falling and creating a cutting as it departs from the main rail lines and crosses beneath George Street.
- A trapped low point or sag at the eastern end of Ambulance Avenue.
- An increase in elevation as the Lee Street / Pitt Street Intersection ramps up the Railway Colonnade Drive to the Central Grand Concourse western pedestrian entry.
- The reduced level of Henry Deane Plaza relative to Lee Street, which continues as a pedestrian tunnel beneath George Street to The Goods Like Walkway.

2.3 Drainage Network

In line with the topography and formal drainage network, stormwater runoff from the surrounding area approaches the CPRP from the south-east and drains to the north-west via the pit and pipe drainage network and informal overland flow paths. Overland flow paths form predominantly along roadways during larger rainfall events.

From the CPRP stormwater runoff drains north to Sydney Harbour through either the Darling Harbour catchment in the north, or Blackwattle Bay catchment in the south.

The existing drainage network within and immediately surrounding the CPRP is illustrated in **Figure 5-5**.

The CPRP site incorporates the following formal drainage infrastructure:

- Sydney Water trunk drainage lines – stormwater and sewer servicing the site and upstream catchment areas. Assets drain north-west, apart from the Bondi Ocean Outfall Sewer (BOOS) which drains north-east.
- Track drainage within the rail yard – generally draining north or south parallel to the tracks and discharging to the Sydney Water trunk lines within the rail yard.
- Additional minor drainage networks anticipated in the surrounding areas.
- A stormwater harvesting tank located beneath the Pitt Street loading dock (future Western Forecourt sub-precinct).

Whilst the capacity of the drainage network across the CPRP site is unlikely to have been assessed in recent history it is unlikely to meet current design standards based on the age and condition of the network.

Whilst information of the existing drainage network across the CPRP is available it is incomplete and often inconclusive, unconfirmed, or outdated. The currently available drainage information is further discussed in **Section 3**, and its incorporation into the flood model is outlined in **Section 5.4.**

Our understanding of the drainage network has been based on sourcing and reviewing multiple sources of information and using engineering judgement to “gap fill’ required details. In some instances, this has involved making assumptions regarding the connectively of drainage lines to the trunk outlets. As the design of the CPRP progresses, we expect to source additional data to reduce our assumptions.

3 AVAILABLE INFORMATION

To inform the flood modelling, information was sourced from TfNSW, Sydney Water, City of Sydney Council and other publicly available sources. A comprehensive list of the information reviewed has been complied as the Reliance Information List included in **Appendix E**. **Section 3.1** below highlights the digital information that were directly relevant to the current flood assessment.

3.1 GIS and Digital Stormwater Information

GIS Information that directly related to the CPRP flood modelling is summarised in **Table 3-1** below.

Table 3-1: GIS and Stormwater Information

Item	Descriptions	Remarks
Aerial Photography	Nearmap imagery	2019
Cadastre	Sourced from SIX maps on-line	Lot boundary
Lidar Data	Laser/Light Detection and Ranging survey sourced from ELVIS on-line	2013 data for comparison with 2008/2009 data embedded in CoS flood models
Sydney Water GIS	GIS information including land, sewer, stormwater, and potable water within the study area	Provided asset location information, however details such as inverts and pit type are not complete
Sydney Water Hydra Information	Historical drawings of Sydney Water assets	Used to confirm and update stormwater network information, in particular inverts, sizes, materials.
City of Sydney	Stormwater Asset GIS database provided indirectly by Sydney Metro	Information such as inverts and pit type are not complete. Coverage only around CPRP. Used to confirm/cross-check CoS flood model configuration.
Dial-Before-You-Dig	Stormwater and other utilities information	2019 information, used to confirm/cross-check CoS flood model configuration.
DSS Sydney Trains Survey Information	Numerous existing Sydney Rail Yard topographic survey	Inform existing track drainage network layout, asset details not provided.
LTS Topographic Survey	Land survey of the existing Western Gateway area	Provided by Atlassian, issued date April 2020.
Existing Survey External to Rail Yard	Topographic survey of Central Station	Survey dated Sept 2016. Use to define building footprints and train station entrance arrangement in the flood model.
VFT Survey	Rail Yard Survey July 2017	Platform 1 to Platform 9
Historical Drawings	Various historical drawings of the drainage network within and surrounding the rail corridor.	Various design drawings of the Stormwater Harvesting Tank along Pitt St utilised.

3.2 Past Studies and Relevant Design Documents

3.2.1 Blackwattle Bay Catchment Flood Study

Blackwattle Bay Catchment Flood Study, WMA Water, 2015

The Blackwattle Bay Catchment Flood Study (BBFS) was undertaken for the City of Sydney (CoS) and involved the development of a TUFLOW flood model for the catchment area. The report provides information regarding the modelling approach and assumptions made. The study defined the flood conditions on the regional level and highlights areas that are susceptible to flooding. The CoS has made available their current TUFLOW flood model for this catchment area (provided October 2019), noting that since the flood study some updates may have been made as part of the subsequent floodplain risk management study mentioned below.

3.2.2 Blackwattle Bay Catchment Floodplain Risk Management Study & Plan

Blackwattle Bay Catchment Floodplain Risk Management Study and Plan, WMA Water, 2015

The Floodplain Risk Management Study and Plan investigates potential flood mitigation options for the Blackwattle Bay Catchment. One of the proposed mitigation options is the construction of additional drainage and detention basin in Prince Alfred Park located immediately upstream of the Central station site. Ongoing consultation with CoS is recommended. The CPRP should keep abreast of proposed works within Prince Alfred Park given the potential impacts on CPRP works and flood conditions.

3.2.3 Darling Harbour Catchment Flood Study

The Darling Harbour Catchment Flood Study, BMT WBM, 2014

The Darling Harbour Flood Study (DHFS) was undertaken for the City of Sydney (CoS) and involved the development of a TUFLOW flood model for the catchment area. The report provides information regarding the modelling approach and assumptions made. The study defined the flood conditions on the regional level and highlights areas that are susceptible to flooding. The CoS has made available their current TUFLOW flood model for this catchment area (provided October 2019), noting that since the flood study some updates may have been made as part of the subsequent floodplain risk management study mentioned below.

3.2.4 Darling Harbour Catchment Floodplain Risk Management Study & Plan

Darling Harbour Catchment Floodplain Risk Management Study and Plan, WMA Water, 2016

The Floodplain Risk Management Study and Plan investigated seven flood mitigation options to address the existing flood-affected areas within the Darling Harbour Catchment. Some of these mitigation options may also be beneficial to the CPRP development to reduce flood impacts that may arise from the CPRP. The options of increasing flood storage within Belmore Park and the Elizabeth Street Outlet Drainage may be of particular interest to the CPRP. The CPRP should keep abreast of proposed works within the vicinity of the site given the potential impacts on CPRP works and flood conditions.

3.2.5 SICEEP Flood Model

SICEEP flood model by Lendlease Development

The Sydney International Convention Exhibition and Entertainment Precinct (SICEEP) development involved the redevelopment of the convention, exhibition and entertainment centre and the Darling Square residential/commercial area. The SICEEP site is located directly downstream of the CPRP. The SICEEP project construction was completed in 2019. It involved the diversion of the existing stormwater trunk system, modifications to the ground surface and the building arrangement within the precinct relative to the pre-development conditions.

Arcadis previously undertook the final flood modelling for the SICEEP project. Lendlease has provided consent (6/7/2020) for Arcadis to use the SICEEP TUFLOW flood model to inform the CPRP flood model. The flood model includes the details of the reconfigured stormwater system and the design ground surface. The information represents the latest stormwater design information for the area prior to the completion of the project in 2019.

3.2.6 Sydney Light Rail

Flood Immunity and Flood Mitigation Report, City South, Sydney Light Rail – Detailed Design, Acciona Infrastructure Australia, October 2017

The Sydney Light Rail (SLR) project involved the design and construction of the CBD & South East Light Rail network comprised of:

- L2 Randwick Line running in both directions between Circular Quay and Randwick via Central Station; and
- L3 Kingsford Line operating in both directions between Circular Quay and Juniors Kingsford via Central Station.

Both L2 and L3 shares the same alignment from Circular Quay to Anzac Parade at Moore Park. The alignment follows George Street from the north and turns east into Rawson Place. It then crosses the CPRP project area at Eddy Avenue between Pitt Street and Elizabeth Street. The alignment continues south along Chalmers Street and east along Devonshire Street. Sydney Light Rail L2 and L3 commenced full operation in April 2020.

The SLR construction works involved laying 12km of track along the alignment. It also required modification of existing underground utilities including stormwater drainage and resurfacing of road pavement.

Acciona has conducted a flood assessment to investigate the flood issues within Zone C (South) and Zone S of the SLR. Zone C (South) is located between Bathurst Street in the north and the Pitt Street/Eddy Avenue intersection in the south. Zone S is between the Pitt Street/Eddy Avenue intersection in the west and Anzac Parade/Lang Road in the east. Part of the Zone C (South) and Zone S are located within the Darling Harbour catchment area. The flood modelling aimed to demonstrate the proposed flood mitigations works achieved the design criteria.

A TUFLOW flood model developed by SLR DJV for Acciona and accompanying design report (Oct 2017) were made available for the CPRP. Note however the design tin inputs were missing from the TUFLOW model. The status of the flood model was for Design Stage 3 (*SLR_DH_Des_45.tcf*), which was likely the final design stage according to the methodology described in the report. Complete final design information and work-as-executed information of the SLR has not been made available at this time.

3.2.7 Sydney Metro - Central

Sydney Metro – City & Southwest – Civil, Structures, Utilities, Drainage, Geotechnics and Constructability – Volume 4, Reference Design, Transport for NSW, February 2017

Sydney Metro commenced the construction of the Chatswood to Sydenham line in early 2017, due for completion around 2025. According to the reference design, the proposal includes the following works around Central Station:

- New underground Sydney Metro platforms at Central Station beneath platforms 13, 14 and 15.
- Escalator access to suburban platforms 12 to 23.
- An upgraded northern concourse with transformed pedestrian thoroughfares.
- A 19-metre wide tunnel (Central Walk) from Chalmers Street linking to the new Sydney Metro platforms.

In relation to stormwater and flooding, the document presents the following information:

- Existing conditions of the stormwater system prior to Sydney Metro works
- Stormwater reference design of Sydney Metro Central
- Flood risk assessment and mitigation at entrances

The reference design documentation indicated that no designated flood model has been developed for the flood assessment purpose. The flood risk assessment has been carried out through interpretation of the existing CoS Blackwattle Bay and Darling Harbour Catchment flood modelling results.

The original proposal of the Central Walk consists of the provision of a new western entry at Ambulance Avenue directly connecting to the Sydney Metro platforms. It is understood that the works have been removed from the current Sydney Metro construction contract. The Central Walk western entry design is expected to be included in the CPRP scope to allow for better integration with the Western Forecourt and Western Gateway sub-precincts.

Whilst some design information for Sydney Metro (Central Station) has been made available, TfNSW has been unable to confirm the elements that would be constructed at this stage.

3.3 Information Reliance

The flood model has been informed by a variety of information sources. A comprehensive list of the sources has been compiled as the Reliance Information List and included in **Appendix E**.

In some instances, this information has been directly relied upon by the flood model. For example, where the CoS flood model representation of the catchment has been utilised. Other sources, such as the Sydney Metro reference design report, have been used to improve our understanding of the existing conditions. The reliance information list attempts to list the information sources we have reviewed and provide commentary on the information utilised.

To improve the accuracy of the flood modelling, the quality of the topographic and drainage network information is particularly key. Whilst information is available, it is often incomplete, inconclusive, unconfirmed, or outdated. In some instances, such as the existing track drainage information (**Section 5.4.8**), information has been pieced together from various sources and assumption made to “gap fill” required details.

As the CPRP design progresses it is expected that additional information will become available which can be incorporated to reduce assumptions, provide missing information, replace poor data, and improve the accuracy of the flood model. Obtaining quality topographic survey of the existing ground surface and obstructions (building extents) and detailed underground drainage network information is essential. Beyond the flood model, this information will also be required by other design disciplines. To specifically address this information need, we suggest a survey program and survey brief be developed to ensure the collection of survey information is undertaken in a cost-efficient and timely manner.

4 PRECINCT FLOOD MODEL STRATEGY

As outlined in **Section 1.2**, the CPRP flood model ultimately aims to provide a high quality, site specific, fit-for-purpose flood model. The flood model is an essential tool used throughout the design development to predict flood behaviour.

With regards to flood constraints for the CPRP, the investigation process is inherently complex as:

- Part of the CPRP site is subject to regular flooding such as the Sydney Rail Yard area, trapped sag locations, roadways and areas that their flood hazards are sensitive to proposed development changes such as underground subway entrance and basement car park entrances.
- The project scale is large consisting of 10 sub-precincts and multiple levels of proposed development.
- The CPRP requires consultation with a number of key stakeholders.

The investigation process will need to be undertaken in an iterative manner. Flood modelling is first conducted based on a set of development assumptions. Through analysis of the results, flood constraints are then identified and used to inform the future development configuration. The investigation process will repeat until the final development layout can be satisfactorily determined. The current flood modelling is considered to be the “first cut” of the investigation process.

4.1 Initial Flood Model Development

This report documents the initial CPRP flood model development, the primary aims are:

- Creation of a site-specific precinct wide flood model to be used as a starting point for further model refinement.
- Initial identification of potential flood constraints.
- Documentation to support the development approvals process and stakeholder consultation.

The initial CPRP flood model development has been undertaken based on the information currently available for both the existing site and proposed CPRP. The proposed CPRP architectural concept is preliminary in nature. Through the design process, the development layout will evolve and provide greater detail as constraints and opportunities are identified and investigated. It is also expected that additional information regarding the existing site conditions will become available as the design progresses.

The initial CPRP flood model development has been conducted in accordance with the following steps:

1. Development of a suitable base case scenario model
    - Detailed review of available information
    - Development of an appropriate flood modelling approach
    - Utilising existing CoS, merging models and aligning model step
    - Undertake flood model updates and refinements
2. Establishment of the base case flood conditions
    - Simulating design storm events
    - Reviewing and interpreting flood results

3. Development of the conceptual proposed scenario model
    - Reviewing the proposed development
    - Development of an appropriate flood modelling approach
    - Undertake flood model updates on the base case flood model
4. Establishment of the proposed flood conditions and determine flood impact relative to the base case conditions
    - Simulating design storm events
    - Reviewing and interpreting flood results
    - Assessing flood impacts relative to base case scenario results
5. Investigation of the causes of flood impacts and identify potential mitigation measures.
6. Identifying development constraints and providing recommendations.

The current flood modelling is considered fit-for-purpose considering the early stage of the project and the initial objectives of this scope as mentioned above. It is expected that this flood model will evolve and become more detailed and accurate in its representation of the existing site and proposed development as the design progresses. The flood modelling has been undertaken utilising standard industry software and standard industry practice with respect to modelling approaches, selection of parameters and schematisation. The review and interpretation of flood modelling results has been undertaken by suitably qualified and experienced flood modelling specialists. Assumptions made with regards to the current flood modelling are described in **Appendix E**.

4.2 Ongoing Flood Model Development

The investigation of flood conditions and potential impacts is anticipated to be ongoing and involves working iteratively with others through the design development. As the design progresses additional information will become available for both the existing site conditions as well as the proposed development. Stakeholder consultation will also be required.

For the ongoing flood model development, we recommend:

1. Flood model updates be undertaken selectively on an as needs basis. Not all information will be of suitable quality, sufficient detail or reasonably current to warrant inclusion in the flood model. It is recommended that information be provided to the flood modeller who can provide recommendations for when flood model updates are required.
2. Consideration of the staging of works. A review of the CPRP program and works across the sub-precincts is recommended. Additional modelling of interim stages may be required where additional flood impacts and flood risks may occur.
3. Engaging early with stakeholders. This recommendation aims to avoid delays in the program and potential rework as stakeholders may request further flood model investigations or impose additional flood constraints.
4. Ensuring suitable quality and quantity of data is available and incorporating in the flood model for the detailed design phase. Whilst not required initially, suitability detailed information (particularly ground topography and drainage network details), is required to ensure the flood model accuracy at final design.

In addition, we recommend that the outstanding issues and recommendations summarised in **Section 9** are also addressed through future flood model updates.

5 BASE CASE FLOOD MODEL DEVELOPMENT

5.1 Base Case Definition

Prior to a flood impact assessment, a base-line or base case conditions flood model has to be established. The conditions should ideally represent the site conditions before the commencement of the construction of the CPRP.

After the completion of the CoS Darling Harbour Flood Study (DHFS) and Blackwattle Bay Flood Study (BBFS) around 2015 to 2016, there were several major developments within the CPRP and surrounding catchment areas. SICEEP and Sydney Light Rail were completed respectively in 2019 and 2020. As of 2020 Sydney Metro Central Station construction has commenced and is on-going, scheduled for completion in 2025. These are large-scale projects and may alter the regional flood regime. These projects are expected to be completed before the commencement of CPRP works and therefore need to be included in the base case flood model configuration.

For the purpose of the current flood modelling, it has been assumed that the base case conditions flood model would be based on the DHFS and the BBFS flood models, modified to include:

- SICEEP – based on the provided TUFLOW model
- Sydney Light Rail – based on the provided TUFLOW model

Future updates of the base case flood model are anticipated to also include:

- Sydney Metro (Central Station) – not currently included given that the design has not been finalised.
- Track drainage modifications – several packages of work are in various design development stages. Propose only to include works that have been constructed and are of sufficient scope to warrant inclusion.

The omission of the Sydney Metro design may not have significant implications on the predicted flood conditions for large flood events. As the Sydney Metro works are mostly underground, anticipated stormwater modifications would have relatively small effects on overland flows within the Sydney Rail Yard.

Additional updates and refinements for the base case flood modelling are outlined in the following sections.

5.2 Review of CoS Flood Modelling Approach

The floodplain risk management study and plan for the Blackwattle Bay Catchment and Darling Harbour Catchment were completed respectively in 2015 and 2016. As part of the development process of the floodplain risk management plan, flood studies were undertaken to define the flood conditions at the time. A two-dimensional TUFLOW flood model has been developed each catchment.

Review of the Blackwattle Bay and Darling Catchment flood models indicates that there are similarities and differences in the modelling approach and model parameters used. **Table 5-1** summarises the modelling approach, model parameters and assumptions adopted in the two studies. Additional flood model details are also provided in **Table 5-2** to **Table 5-6**.

Table 5-1: Comparison of CoS Key Flood Model Parameters and Assumptions

Parameter/Assumption	DHFS	BBFS	Remarks
BoM IFD	Refer to IFD parameter Table 6	Refer to IFD parameter Table 6	Different in IFD, but the difference is relatively small
Hydrology	Direct rainfall on grid to active cells, supplementary Surface Area (SA) catchment to account for building footprints.	Direct rainfall within SA confined polygons not evenly applied over the model footprint, also no rainfall applied within rail corridor	The location of SA polygon can appear arbitrary.
Impervious Area Initial / Continuing Losses	1.0mm / 0.0mm/hr	1.5mm / 0.0mm/hr	-
Pervious Area Initial / Continuing Losses	10.0mm / 2.5mm/hr	10.0mm / 2.5mm/hr	Use of Soil file in DHFS.
2D Time Step (s)	0.25	0.20	-
2D Cell Size (m)	2	2	-
Hydraulic roughness Manning's n	8 categories (based on Landuse) Refer to Table 5-3	6 categories (based on Aerial photos)	-
Underground Conduit Roughness (Concrete assumed)	0.015	0.013	-
Building Representation	Fully blocked (null code)	Fully blocked (null code)	
Darling Harbour Tailwater Conditions	Static tailwater level varies with design event. Refer to **Table 5-4** and **Table 5-5** for details	Static tailwater level of 1.38 mAHD adopted for all design events	
Minimum Stormwater Conduit Dimension	All assets within source data included	<0.45m RCP ignored	
Inlet Assumption	Lintel and grate sizes based on source data	Generic 1.5m x 0.15m lintel	
Blockage Assumption	Pit inlet blockage varies with ARI, refer to **Table 5-6**	25% pipe blockage	Blockage of pits is the more commonly adopted approach

Table 5-2: BoM Rainfall IFD

IFD Parameter	DHFS	BBFS
$^{2}I_{1}$ (mm/h)	41.00	40.84
$^{2}I_{12}$ (mm/h)	8.63	8.20
$^{2}I_{72}$ (mm/h)	2.71	2.55
$^{50}I_{1}$ (mm/h)	84.00	82.87
$^{50}I_{12}$ (mm/h)	18.10	16.75
$^{50}I_{72}$ (mm/h)	5.98	5.22
G (skewness)	0.00	0.00
F2	4.29	4.29
F50	15.86	15.86

Table 5-3: DHFS Land Use Parameters

Land Use Category	Manning's n	Fraction Impervious	Initial Loss (mm)	Pervious Area Infiltration Loss (mm/h)
Road	0.02	100%	1.0	0.0
Building	NA	100%	1.0	0.0
Public Recreation	0.05	10%	10.0	2.5
Metro Centre	0.04	90%	1.0	2.5
Rail Corridor	0.04	90%	1.0	2.5
General Residential	0.04	90%	1.0	2.5
Mixed Use	0.04	90%	1.0	2.5
Commercial Core	0.04	90%	1.0	2.5
Darling Harbour (water body)	0.03	90%	1.0	2.5

Table 5-4: DHFS Local Catchment Flood/Tailwater Combination

Design Event	Local Catchment Flood	Tailwater
2-year ARI	2-year ARI	1-year ARI
5-year ARI	5-year ARI	2-year ARI
10% AEP (10-year ARI)	10% AEP (10-year ARI)	2-year ARI
5% AEP (20-year ARI)	5% AEP (20-year ARI)	5-year ARI
2% AEP (50-year ARI)	2% AEP (50-year ARI)	10% AEP (10-year ARI)
1% AEP (100-year ARI)	1% AEP (100-year ARI)	5% AEP (20-year ARI)
0.2% AEP (500-year ARI)	0.2% AEP (500-year ARI)	1% AEP (100-year ARI)
PMF	PMF	1% AEP (100-year ARI)

Table 5-5: DHFS Darling Harbour Design Tailwater Levels

Frequency	Maximum Water Level (mAHD)
0.02-year ARI	0.965
0.05-year ARI	1.045
0.1-year ARI	1.095
1-year ARI	1.235
2-year ARI	1.275
5-year ARI	1.315
10% AEP	1.345
5% AEP	1.375
2% AEP	1.415
1% AEP	1.435
0.5% AEP	1.455

Table 5-6: DHFS Pit Blockage Assumptions

Event	Blockage Specification
5-Year ARI more frequent	• Kerb inlet (on-grade) pits are assumed to be 20% blocked • Sag pits are assumed to be 50% blocked
Rarer than 5-Year ARI	• Kerb inlet (on-grade) pits are assumed to be 50% blocked • Sag pits are assumed to be 100% blocked

5.3 Adopted Flood Modelling Approach

5.3.1 Combining Council Flood Models

The CPRP footprint stretches across the DHFS and BBFS catchments as seen in **Figure 5-1**. The study catchment areas overlap in several places. The catchment boundary crossing the Sydney Rail Yard is somewhat arbitrary and was possibly based on the suburb boundary. Inspection of the terrain indicates the boundary through the Sydney Rail Yard is incorrect and cross catchment flows would occur between the two catchments in the flood events simulated.

Both models adopted simplified outflow boundary assumptions along the arbitrary boundary within the Sydney Rail Yard to ignore the inter-catchment flows. With the model configuration, stormwater runoff entered the rail yard area would disappear from the system at this boundary like draining out of a sink. The assumption was arbitrary and the modelled flood levels within the rail yard area were misleading as a result.

The development of the CPRP flood model utilises the CoS flood models as a base and combines the two adjacent catchments in a single flood model. This combining of flood models eliminates the need for the arbitrary boundaries within the rail yard, and allows proper overland flow transfer between the two catchments. The combined model would produce more reliable flood predictions inside the Sydney Rail Yard and the downstream areas.

Combining the DHFS and BBFS flood model involved the following main steps:

- Removal of the BBFS component whenever overlapping with the DHFS model layers, for example DEM, stormwater network, building footprint layers etc.
- Conversion of the BBFS model layers to be consistent with the adopted DHFS approach, such as material layers, removing pipe blockage, assigning pit types, and inclusion of conduits smaller than 0.45m RCP and associated stormwater pits.

Details of the flood model combining process are provided in **Appendix F** for reference.

As shown in **Figure 5-1** that the CPRP flood model has extended in the southwest to include the Carriageworks and part of the North Everleigh track areas which may contribute runoff to the Sydney Rail Yard in large events. Details of the extension are discussed in **Section 5.4.2**.

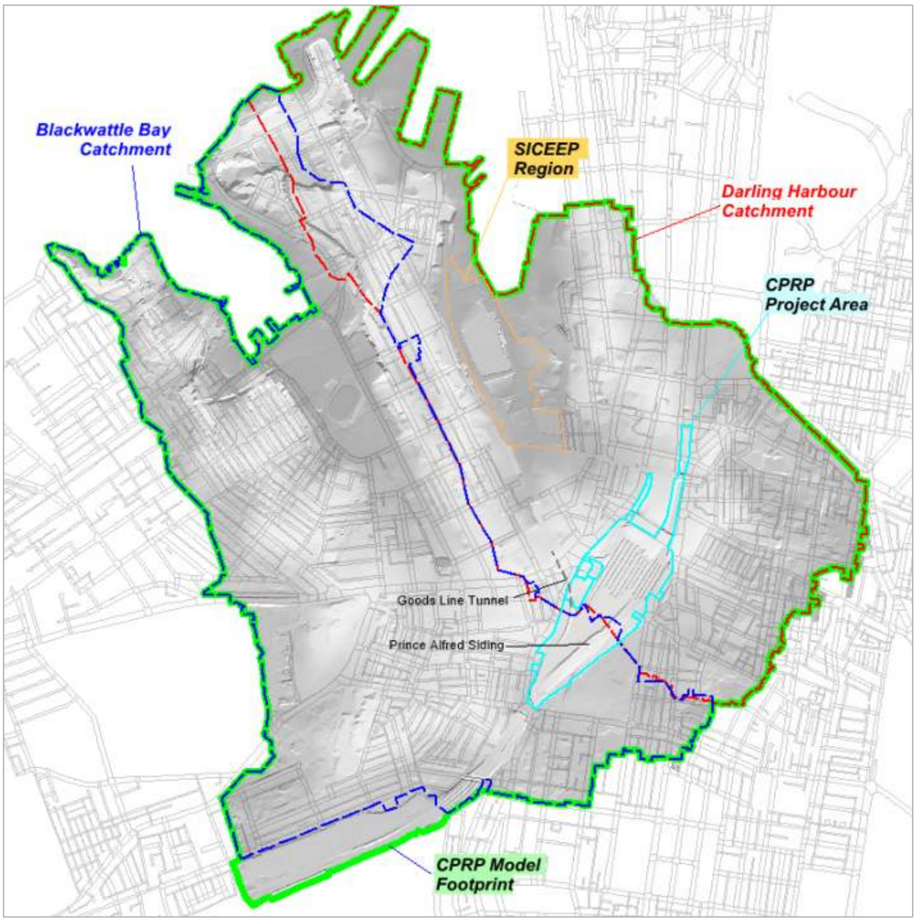


Figure 5-1: Proposed CPRP Flood Model

5.3.2 Adoption of Darling Harbour Flood Modelling Approach

The CPRP flood model has adopted an approach mostly in line with the DHFS. The DHFS has taken preference to the BBFS for the following reasons:

1. The majority of the CPRP site is within the DHFS catchment boundary. Adopting the DHFS approach would tend to produce theoretically a closer comparison to the Council adopted DHFS flood levels if further updates to the flood model were not made.
2. The proposed CPRP will likely impact more of the downstream area within the DHFS catchment as most of the major overland flow paths interacting with the CPRP site drains towards the Darling Harbour catchment. For instance, the Goods Line tunnel, Chalmers Street, Elizabeth Street, Eddy Avenue, Hay Street, and Campbell Street are overland flow paths draining to the Darling Harbour catchment.
3. The DHFS approach is the relatively more commonly adopted approach concerning the rainfall application and stormwater network blockage applied.

The DHFS approach and parameters adopted are summarised in **Table 5-1** to **Table 5-5** presented in **Section 5.2**. **Table 5-6** for pit blockage approach has been adopted but with modification as outlined in **Section 5.3.3** below.

5.3.3 Pit Blockage Assumption

The CPRP flood model has adopted a pit blockage assumption of the following for all design storm events:

- Kerb inlet (on-grade) pits - assumed to be 20% blocked
- Sag pits - assumed to be 50% blocked

For ease of reference, this assumption is herein referred to as the 20/50 blockage rule.

The CPRP assumption has deviated from the DHFS blockage adopted for events bigger than the 20% AEP. The DHFS has followed the CoS's DCP 2012, Section 3.7.1 Site Specific Flood Study guidelines, which assumes the 'worst case scenario' conditions for blockages to pipes that kerb inlets are 50% blocked and sag pits are 100% blocked (herein referred to as the 50/100 rule) for rarer events larger than the 20% AEP.

It is noted that there is no specific guideline for stormwater pit blockages in the latest Australian Rainfall and Runoff research. The intention of the Council guideline would likely be to produce the most conservative design flood level for setting the flood planning level in the local area. However, there are few drawbacks associated with such an approach:

1. The flood level at trapped sag locations may be extremely sensitive to the blockage assumption depending on the elevation of the overland flow relief.
2. The approach may distort the local flood regime as it may produce a higher flood level at the sag, but a reduced flood level in the downstream. The water level downstream may not necessarily be conservative.
3. The availability of debris that causes the inlet pit blockage in a fully urbanised catchment may be limited. The degree of blockage is not necessarily higher in a smaller event than a larger event, beyond a certain storm severity.

The 20/50 rule on the other hand is a more commonly used approach amongst local councils in the greater Sydney region.

Comparative tests of adopting the 50/100 blockage rule have been conducted to determine the sensitivity on the flood level due to the assumption, as discussed in **Section 6.4**.

5.3.4 Pit Stage-Discharge Scale Factor

The drainage inlets in the DHFS model have included a pit inlet capacity ratio of 1.5. The use of the factor would increase the inlet capacity value by a factor of 50%. It appears that this was an unintentional error, a "leftover" of the superseded inlet pit generic setup of a 1.5m wide by 0.15m high lintel adopted in an earlier stage of the model development.

For the CPRP the pit inlet capacity ratio has been set to 1.0 (that is no scale factor). This change would reduce the inlet capacity which would lead to a reduction of conduit flows. However, the overall effect on the flood regime for the 1% AEP or larger events may be minor as most of the stormwater pipeline would be at capacity and full in large flood events.

5.3.5 TUFLOW Build Version

The CPRP flood model has adopted the latest TUFLOW 2020-01-AB version in place of TUFLOW 2011-09-AF-w64 used in BBFS and TUFLOW 2013-12-AA-w64 used in the DHFS. The latest TUFLOW version has significant improvements in numerical stability and has enhanced features over the older versions of the software. The latest version uses the HPC solver which significantly reduces the model run time. This reduced run time has facilitated the merging the DHFS and BBFS flood models whilst maintaining the use of a 2m fine model grid resolution.

The latest TUFLOW version provides quadtree mesh and sub-grid sample computation options. The quadtree mesh allows reduction of computation time by increasing the cell grid size for the model areas in which accuracy of flood regime is less important. The sub-grid sampling (SGS) technique is used to improve the accuracy of results by maintaining the same cell grid size, SGS technique is particularly relevant to vertically variable terrain like a steep sided channel.

The current study has attempted the use of quadtree approach with the use of a 2m grid cell for the area of interest (CPRP and the immediate surrounding area) and the remaining model area employing a larger 4m grid cell. It was found that the saving on the computation time was not significant, but the quadtree approach did require a different building blockage approach than that adopted by the DHFS and the model setup process is more involved. For these reasons, the quadtree approach has not been adopted for the CPRP flood model. The CPRP flood model employs the standard HPC approach.

5.4 Base Case Flood Model Updates

5.4.1 LiDAR Survey

The BBFS report documented that the project DEM was derived from the LiDAR survey undertaken between 2007 and 2008. The DHFS report did not document the date of the LiDAR used. Since both flood studies were commenced around the same time, the same LiDAR set was likely used in both of the CoS flood studies.

The NSW Spatial Services LiDAR information is publicly available through ELVIS under National Elevation Data Framework. The latest LiDAR information available for the Sydney area is 2013. DEM of a 1m grid spacing is currently available.

Figure 5-2 shows a comparison between the 2008 and 2013 LiDAR DEM. It indicates that the 2013 LiDAR is about 70mm (in median terms) lower than 2008 LiDAR level within the combined catchment area of the CPRP flood model.

Arcadis has previously undertaken a ground truthing exercise as part of another project located within the DHFS catchment using topographic survey data collected prior to 2013. A sample of 64 surveyed spot levels located within an open area, at which the accuracy of LiDAR is expected to be highest, were selected for comparison with the 2008 LiDAR and the 2013 LiDAR datasets. **Table 5-7** shows the statistical difference between the topographic surveyed level with the LiDAR levels.

Although 2013 LiDAR is more recent than the 2008 data set, the comparison indicates that the 2008 LiDAR on average is closer to the surveyed spot levels, however the 2008 LiDAR is more variable than the 2013 LiDAR set. Accuracy of the LiDAR generally depends on parameters such as flying elevation, density of the data collection points and filtering algorithm. Based on the simple statistical analysis, it can be concluded that the 2013 LiDAR does not necessarily have better accuracy than the 2008 LiDAR in some locations within the DHFS catchment.

Table 5-7: LiDAR to Topographic Survey Level Comparison

LiDAR Source	Mean (m)	Standard Deviation
2008 LiDAR	0.005	0.121
2013 LiDAR	-0.079	0.108

From the CPRP flood model perspective, should the 2008 DEM from the CoS flood models, be replaced with the 2013 LiDAR, potentially a large number of 1D-2D interface boundary condition settings within the model would need to be updated, the process could be time consuming. Moreover, the process would also need to be repeated if more recent LiDAR data is available in the future as the CPRP progresses.

Given the above, the CPRP flood model has continued to adopt the 2008 LiDAR data at the present time.

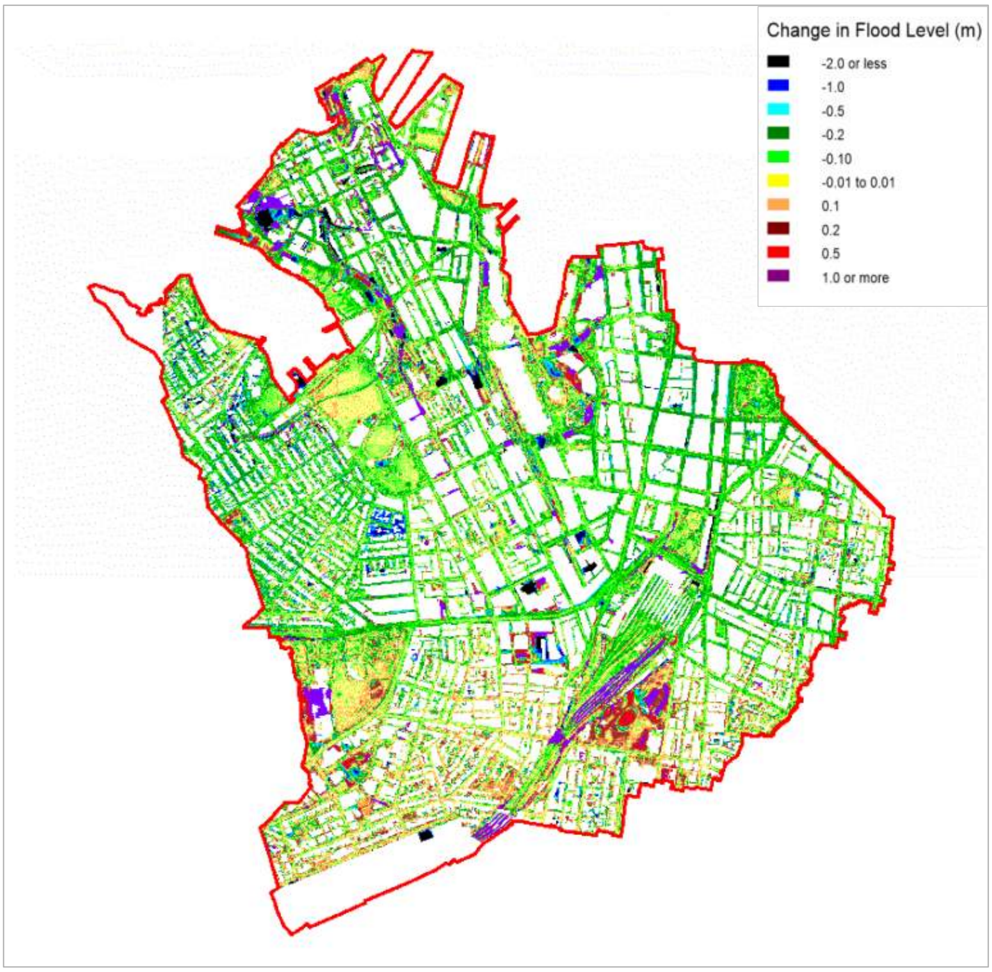


Figure 5-2: LiDAR Survey Level Comparison

5.4.2 Topographic Survey

Topographic survey information employed in this study are listed in **Section 3.1** and the Reliance Information List included in **Appendix E**. This information was likely collected over a period of time before the construction of the SLR and the Sydney Metro construction works. The information would represent the existing ground level if no works were carried in the surveyed area recently. Topographic survey is however considered more reliable information than the LiDAR survey.

The survey information has been used to refine the topographic features in the flood model in the following ways:

1. Rectify the local LiDAR DEM - for example, creating local tins for Ambulance Avenue and the Henry Deane Plaza walkway within the flood model.
2. Incorporate solid walls - for instances, solid boundary walls around the Mortuary Station and the adjacent bus layover area, Adina Hotel driveway and Railway Colonnade Drive. These walls would influence the overland flow patterns in the vicinity of the CPRP.
3. Refine building footprints within the CPRP and surrounding areas.
4. Define the model extent - for instance, extending the model coverage to the North Everleigh rail yard, using available survey information to determine the approximate model boundary.

Model refinements were confirmed with site observations and photos wherever possible.

5.4.3 Sydney Yard Access Bridge

The Sydney Yard access bridge (SYAB) project forms part of the Sydney Metro City & Southwest project. The SYAB is understood to be a relatively new permanent road bridge that provides a connection from Regent Street into the Sydney Rail Yard. The SYAB extends from Regent Street over several rail tracks as it enters the Sydney Rail Yard. The design drawings of the bridge have been provided for the CPRP.

The SYAB bridge structure is supported by abutment structures at the ends and two piers as interim supports. The eastern abutment and one of the piers are located immediately adjacent to the Flyovers area and obstructions the overland flow path in large floods. **Figure 5-3** presents the layout SYAB.

5.4.4 Flood Model Extent Adjustment

The BBFS flood model assumed no rail yard catchment contributes to the Sydney Rail Yard catchment beyond the Redfern station platform. According to the LIDAR 2013 information, the Carriageworks track area is generally sloping northeast towards the Sydney Rail Yard. The track is slightly elevated just south of the Redfern station platforms by about 0.2 to 0.3m forming a small “ridge” which separates the Carriageworks/North Everleigh catchment from Sydney Rail Yard catchment.

In larger events, runoff from the Carriageway rail yard area could potentially breach the ridge high point and aggravate flooding in the CPRP Sydney Rail Yard area. The CPRP flood model footprint has been extended southwest to include the Carriageworks rail yard area catchment, as shown in **Figure 5-4**. Underpass/tunnel configuration such as dimensions, invert levels have been based on LiDAR survey and the North Everleigh track survey information available from TfNSW.

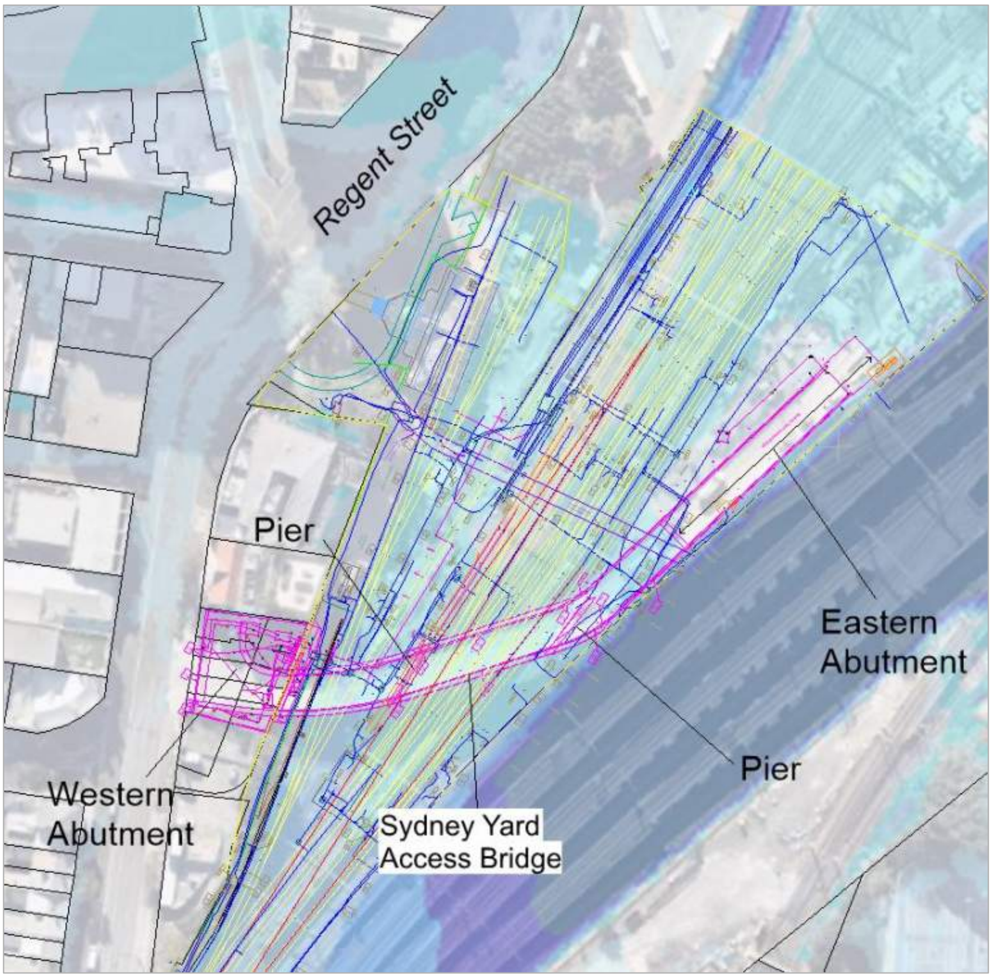


Figure 5-3: Sydney Yard Access Bridge

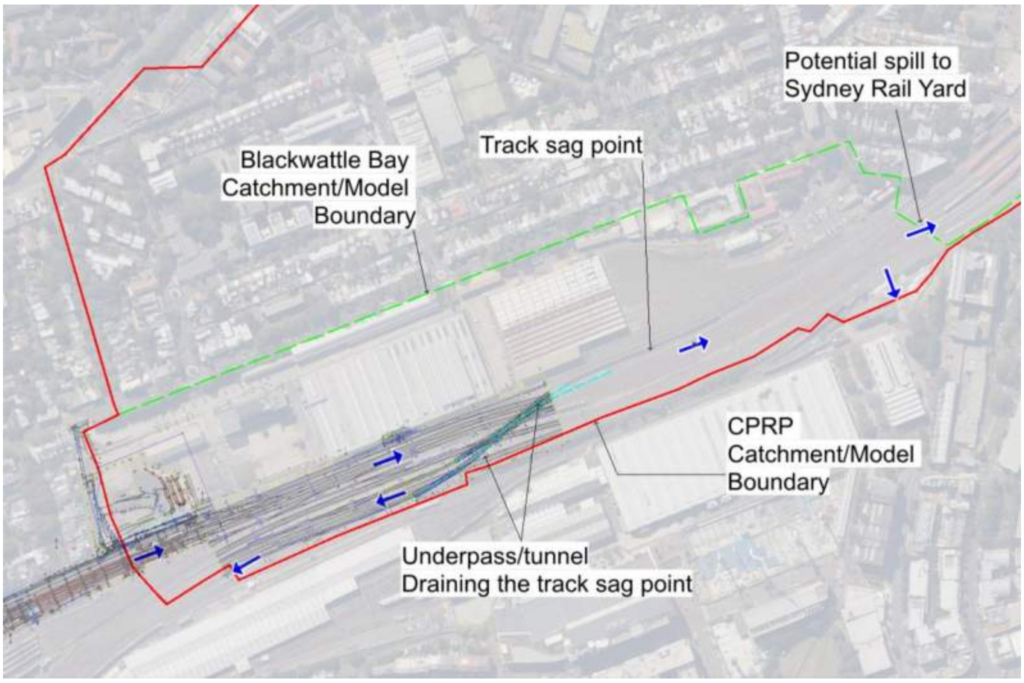


Figure 5-4: Carriageworks Rail Yard

5.4.5 Goods Line Representation

The Goods Line track is the westernmost track within the Sydney Rail Yard. The Goods Line tunnel connects the rail yard to The Goods Line Urban Walk. It is a major overland flow path draining the Sydney Rail Yard in large storm events. In the PMF event, the CPRP flood modelling shows that the Goods Line tunnel transfers a flow of 30m^3/s out of the Sydney Rail Yard to the downstream area. Neither the DHFS and or BBFS has adequately considered The Goods Line tunnel.

The CPRP flood model has incorporated a connection to adequately represent the passage of flows from the rail yard along the Goods Line to downstream.

5.4.6 Sydney Light Rail

TfNSW has provided the SLR flood assessment report for the detailed design of the City South area, together with the design TUFLOW flood model. Complete final design information and work-as-executed information of the SLR has not been made available.

Without the as-executed information, the information embedded in the SLR flood model would represent the best indicative stormwater design for the SLR works. The proposed stormwater drainage information from the SLR flood model has been extracted and transferred to the CPRP flood model. However, the SLR design surface has been missing from the flood model information provided. Although the SLR works in general may not significantly modify the pre-SLR ground surface along the routes, adoption of the pre-SLR ground surface still likely distorts the modelling results. The associated uncertainties need to be reviewed in the next phase of the CPRP when the work-as-executed information is available.

5.4.7 SICEEP

Downstream of the CPRP project area (**Figure 5-1**), Darling Harbour was redeveloped from 2013 to 2019. The SICEEP development involved diversions and augmentations of the underground stormwater trunk system, and modifications of overland flow paths associated with the arrangement of precinct layout.

Lendlease has provided Arcadis permission to use the SICEEP TUFLOW flood model to inform the CPRP flood model. The CPRP flood model has adopted the SICEEP stormwater design and the design ground shaping information within the project area to replace the original CoS flood model setup.

5.4.8 Stormwater Asset Information

Section 3.1 and the Reliance Information List included in **Appendix E** list the sources of stormwater information available. When considering several information sources, the assumed hierarchy is indicated below. Where stormwater details are not available, assumptions have been made and survey will be required to confirm if the assumption has a considerable impact on the flood model results.

The current CPRP flood model drainage network is illustrated in **Figure 5-5**. The drainage network lines (red) are shown connecting to the Sydney Water trunk stormwater lines (blue) crossing the rail yard, with the external drainage network also shown (green). For the purpose of this report the Sydney Water trunk drainage lines have been labelled and referred to based on size. However, note that the size and material of the trunk drainage lines vary as they pass through the rail yard.

External to the Rail Yard

Where available data has been used to confirm and update the stormwater network configurations from the DHFS and BBFS within the area of interest. The stormwater asset information has mainly be used for cross-checking and update of the stormwater system.

The information has been employed in accordance with the following hierarchy.

1. Site Survey
2. Sydney Water Hydra (work-as-executed)
3. Sydney Water Stormwater GIS
4. City of Sydney GIS
5. Dial Before You Dig
6. Darling Harbour flood model network
7. Blackwattle Bay flood model network

Site survey information is considered to be the most reliable and to be adopted where available. SWC stormwater information would be adopted where both SWC Stormwater and CoS stormwater information are available as the trunk drainage within the Sydney area are SWC assets. DHFS information is adopted in preference to information from the BBFS for overlapping areas.

Rail Yard Drainage

Both the DHFS and BBFS have ignored the rail yard track drainage network and considered no local runoff entering the trunk systems from the rail yard. Only the Sydney Water stormwater trunk lines crossing the rail yard were included in the CoS flood models. The inclusion of the track drainage is particularly important as the drainage network controls how stormwater runoff enters the trunk drainage systems within the rail yard. Correct representation of the drainage network would minimise the uncertainty of flood predictions for the Sydney Rail Yard area.

For the CPRP flood model the Sydney Water stormwater trunk assets crossing the rail yard have been detailed based on the Sydney Water GIS location information, and the Sydney Water Hydra invert levels and conduit sizes. In some instances, this has involved converting data from very old datums and assuming details when absent.

With regards to the track drainage network, the majority of the rail yard has been developed based on various Sydney Trains DSS survey information. This information contains only the approximate locations of assets. All pipe inverts, flow directions and diameters have been assumed, and in some instances the connection points to the trunk drainage lines.

For the track drainage network north of the Devonshire Tunnel to Central Station, this network has been based on a converted 3D model of the existing drainage network sourced from the Sydney Metro project.

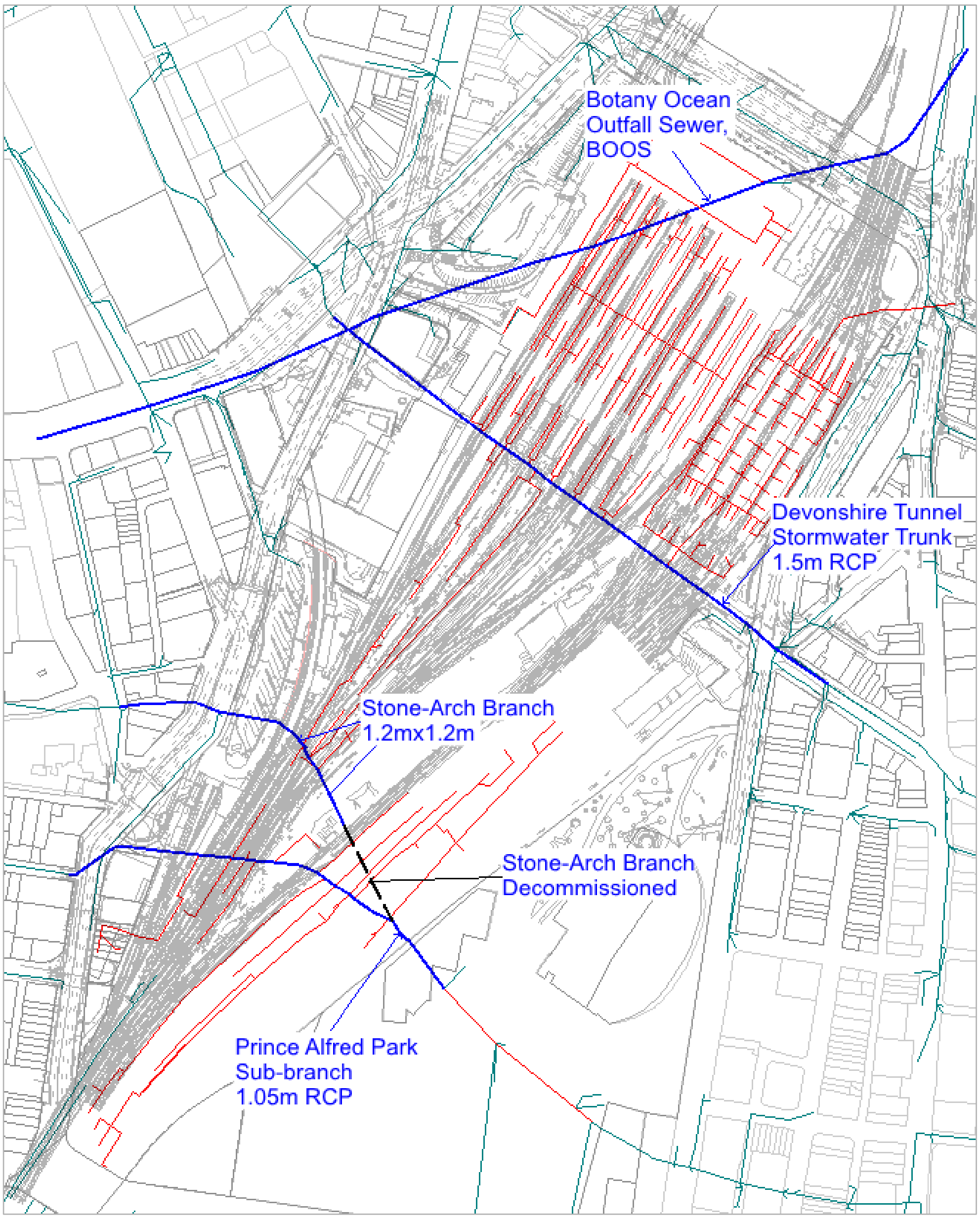


Figure 5-5: Stormwater Drainage Network

5.4.9 Sydney Water BOOS

The Bondi Ocean Outfall Sewer (BOOS) line runs across the north-western part of the CPRP crossing beneath the Western Forecourt, platforms and the main Central Station building. The system was constructed some 80 years ago. The Sydney Metro reference design indicates that the northern portion of the track and platform drainage network connects into the BOOS. According to the SWC asset database, this section of the BOOS is an oviform with a nominal dimension of 1.68 m(H) x 1.37 m(W), with an estimated flow area of 2.3 m^2.

The CPRP flood model has included a short section of the sewer in the vicinity of the rail yard. **Figure 5-6** illustrates the section of BOOS included in the CPRP flood model.

As there is no design flow information available for the section of the sewer at this stage, the following simplified assumptions have been adopted in the flood hydraulic simulation.

- a constant sewage inflow to the section of 7m^3/s, that is equivalent to a flow velocity of 3m/s.
- tailwater level of 9.46 mAHD, which is equivalent to around 70% of the conduit depth.

The assumptions needed to be verified with detailed hydraulic sewer modelling in the next project stage.

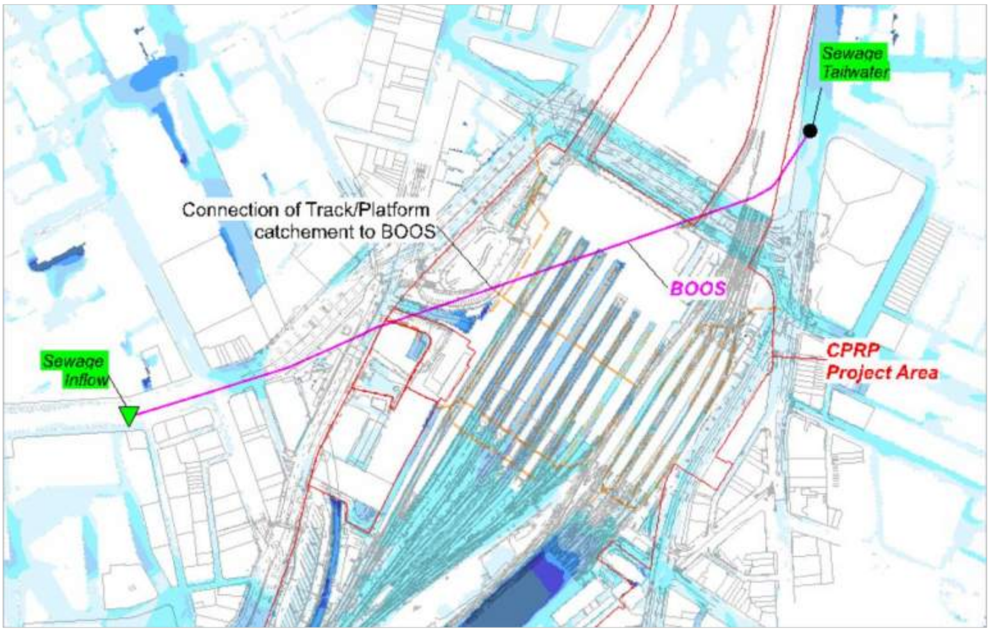


Figure 5-6: BOOS Hydraulic Boundary Assumption

5.4.10 Sydney Terminal Stormwater Harvesting Tank

A stormwater harvesting/retention tank is located below the Pitt Street loading dock. Based on various historical design drawings, the design volume is about 1,350m^3. The original design intent was to collect station building roof runoff supplemented with track and platform roof runoff. The collected water would then be treated and reused for toilet flushing. The stormwater tank is connected to the Pitt Street CoS drainage system. In large storm events, tank surcharges are expected to surcharge overland to Pitt Street through the existing loading dock entrances.

The Sydney Metro C&M reference design report indicated the stormwater harvesting is currently not reusing collected stormwater given poor water quality. Should the stormwater harvesting tank be full of water, any attenuation function is compromised. The stormwater tank would likely behave hydraulically as an ordinary stormwater pit

The CPRP flood model has included the stormwater tank as a normal pit connecting to the Pitt Street stormwater network. The configuration of the tank assumes a nominal inlet capacity to accept stormwater runoff from approximately half of the main station terminal roof via the upper-level Railway Colonnade Drive area above the tank. It is recommended that the representation of the stormwater harvesting tank be refined further once an investigation of the building roof drainage network is undertaken.

5.5 Design Rainfall Data

5.5.1 Intensity Frequency Duration Data

Adoption of ARR1987 approach

ARR2019 is the new national guideline to replace the older ARR1987 guideline. ARR2019 represents the latest engineering best practices for hydrologic analysis and investigation. In response to the updated guideline, the NSW Office of Environment and Heritage has issued a floodplain risk management guide "Incorporating 2016 Australian Rainfall and Runoff in studies" providing advice to assist in the transition of engineering projects to adopt the new national guideline. The general directive is that an on-going project may continue with the ARR1987, but there is an expectation that ARR2019 guidelines will gradually be adopted for the future stages of the project whenever possible.

The CPRP flood modelling has been undertaken utilising ARR1987 methodology as used in the CoS flood models. The use of ARR1987 involves a simpler analysis process and requires relatively less simulation effort.

Given the main objectives of the current CPRP flood modelling are exploratory in nature, the continued use of ARR1987 is reasonable. The adoption of ARR2019 will need to be undertaken at a future stage of the project, preferably prior to the development approval.

Comparison of IFD 1987 and IFD 2019

One of the main differences between ARR1987 and ARR2019 is the use of updated IFD information. **Figure 5-7** compares the 5%, 10% and 1% AEP rainfall depths for Sydney IFD 1987 and IFD 2019, as extracted from BoM website.

Preliminary flood modelling has indicated that the critical storm duration for the CPRP project area would be no greater than 3-hour. It can be seen from the figure that for the critical duration range, rainfall depths are higher for the IFD 1987 than for the IFD 2019. This suggests the use of ARR1987 using IFD 1987 rainfall data will likely produce more conservative flood depth compared to ARR2019. The exact flood impact magnitude however would depend on other factors such as the storm temporal patterns and rainfall losses, for which the two ARR approaches follow very different procedures.

Experiences from other projects in the Sydney region seem to indicate that the use of the ARR2019 approach would produce lower flood levels. This can be confirmed with further flood modelling in future stages of the CPRP project.

5.5.2 Probable Maximum Precipitation Estimates

The CPRP project area has an upstream catchment about 1.3 km^2. Following the BoM Generalized Short-Duration Method (GSDM) procedure and assuming point rainfall, PMP depths has been estimated and summarised in **Table 5-8** below. The CPRP estimates are higher than the DHFS estimates for the same storm duration. The difference would be due to the areal reduction effect considered in the regional flood study for a larger catchment (3.0 km^2). Due to the use of slightly larger PMP estimates in the CPRP flood modelling we expect slightly higher PMF flows and flood levels.

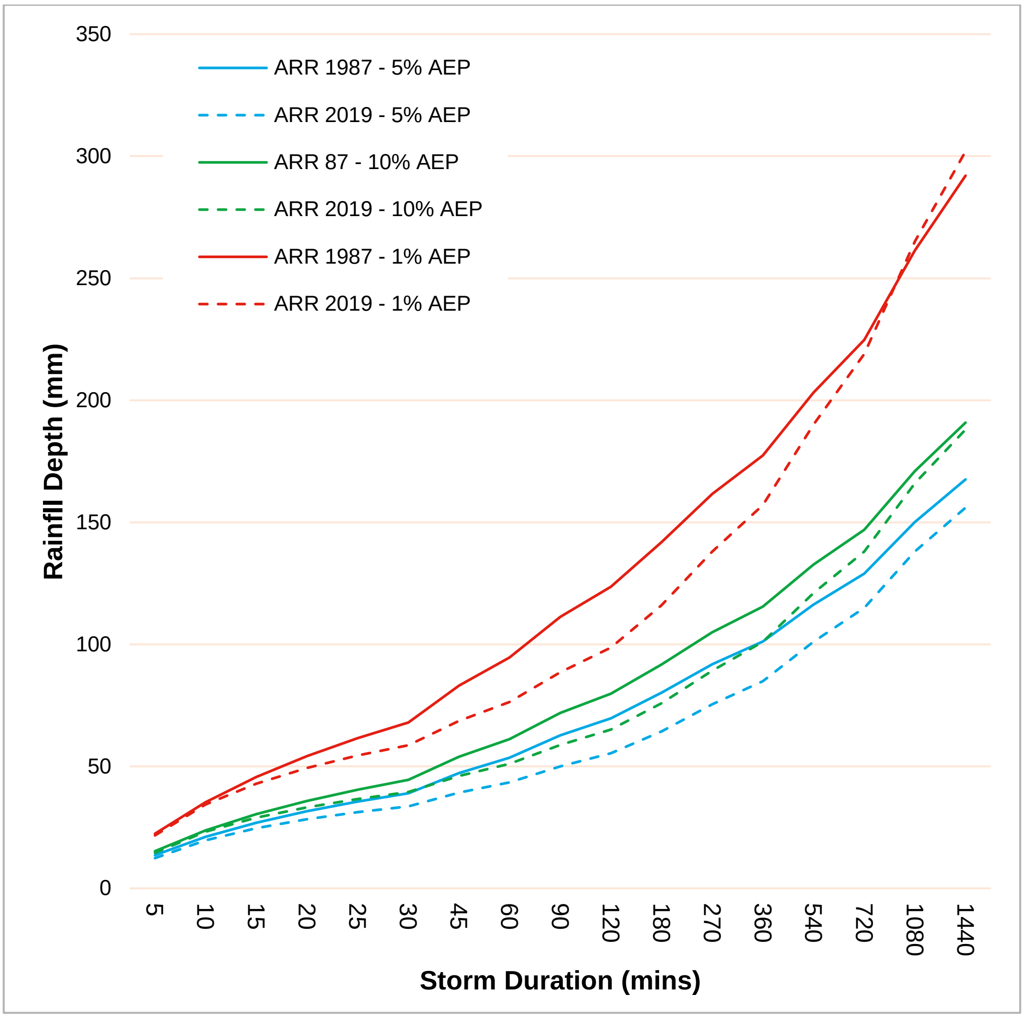


Figure 5-7: IFD Comparison - ARR1987 & ARR2019

Table 5-8: PMP Depth Estimates

Duration (hr)	CPRP (mm)	DHFS (mm)
0.25	170	160
0.50	240	230
0.75	310	300
1.00	350	340
1.50	460	440
2.00	530	520
2.50	590	570
3.00	650	630
4.00	740	720
5.00	820	790
6.00	860	830

Note: - DHFS has a regional catchment of 3.0 km^2.

6 BASE CASE FLOOD CONDITIONS

6.1 Critical Storm Durations

The critical duration which produces the peak flood level result generally varies across the CPRP catchment. The base case flood model has been run for the following design rainfall events:

- 1% AEP: 10-minute, 25-minute, 45-minute, 1-hour, 1.5-hour, 2-hour, 3-hour, 4.5-hour, 6-hour, 9-hour and 12-hour events.
- PMF: 15-minute, 30-minute, 45-minute, 1-hour, 1.5-hour, 2-hour and 2.5-hour and 3-hour events.

Analysis of the spatial mapping for the critical duration found that the following storm durations are generally representative of the CPRP and the immediate surrounding areas.

Table 6-1: 1% AEP and PMF Critical Duration

Design Rainfall Event	Critical Storm Durations
1% AEP	25-minute, 1-hour, and 2-hour
PMF	15-minute, 45-minute, and 1.5-hour

Subsequent flood model simulations have only considered the identified critical duration storm events instead of the full range of storm durations. It has been assumed that the 10% AEP critical storm durations are equivalent to the 1% AEP critical storm durations. Details of the selection of the critical storm durations for the 1% AEP and PMF events are included in **Appendix C** for reference.

6.2 Base Case Flood Mapping

Figure 6-1 illustrates the overland flow patterns approaching the CPRP project area.

Figures A.1 to A.3 in **Appendix A** present the peak flood depths and levels for the base case conditions of the 10%, 1% AEP and PMF design storm events. The flood mapping is for the enveloped results of the selected critical duration events. The flood mapping extents are limited to depths exceeding 50 mm.

Figures A.4 to **A.6** present velocity distribution and **Figures A.7** to **A.9** show the Australian Emergency Management Institution (AEMI) flood hazard for the 10%, 1% AEP and PMF design storm events. Under the AEMI hazard framework, depending on the combination of overland flow velocity and flood depth, an inundated area can be classified into 6 different hazard categories from H1 to H6, with category H6 being is the most hazardous. The AEMI flood hazard vulnerability category curves are illustrated in **Figure 6-2**.

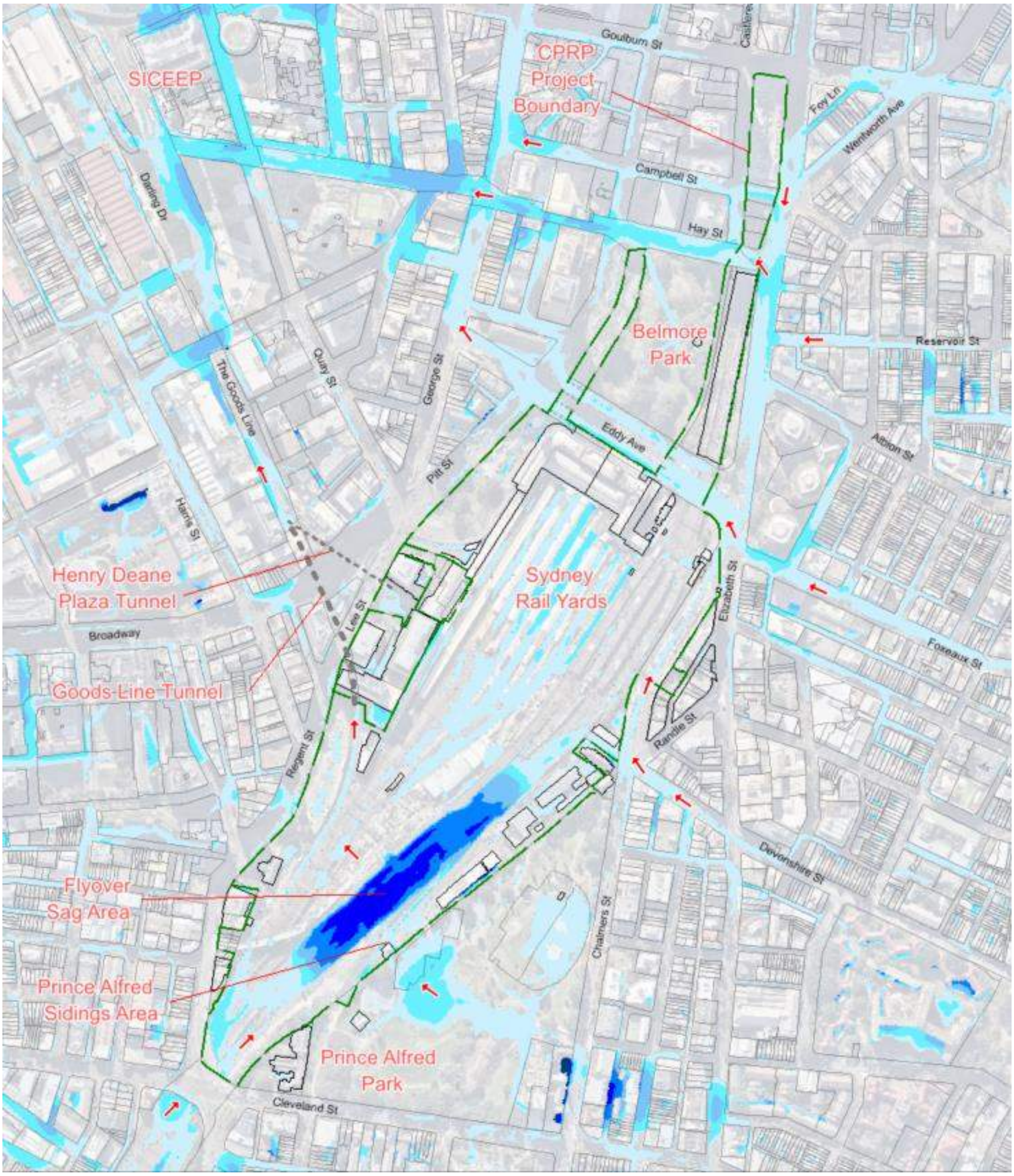


Figure 6-1: Flood Regime - Base Case Conditions (1% AEP)

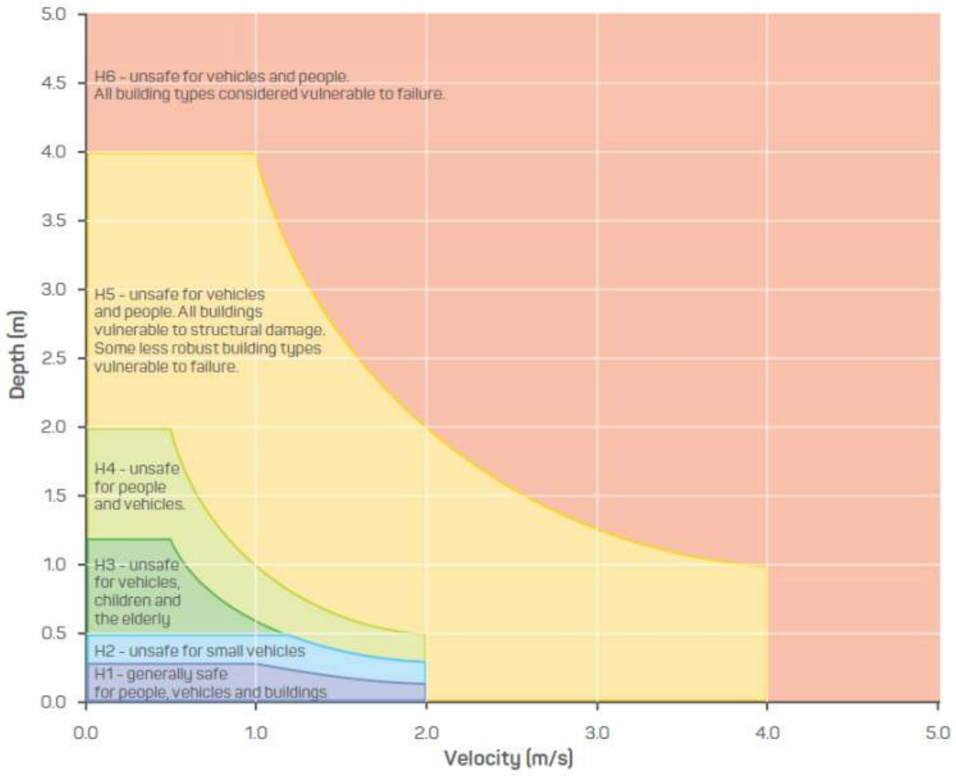


Figure 6-2: Flood Hazard Vulnerability Curves (Australian Disaster Resilience Handbook Collection, 2017)

6.3 Design Flood Conditions

The overland flow approaches the CPRP project area following broadly the Prince Alfred Park overland flow path, Devonshire Street, Foveaux Street, Albion Street, Reservoir Street, Wentworth Avenue and Foy Lane overland flow paths. Overland flows cross the CPRP project site in an east-west direction via Campbell Street, Hay Street and Eddy Avenue and via the trunk drainage systems under the Sydney Rail Yard.

6.3.1 Sydney Rail Yard and Rail Corridor

The Sydney Rail Yard flood regime is controlled by the stormwater trunk system running underneath the rail yard area. The southern section of the rail yard is drained to the Prince Alfred Branch, the northern section, the intercity track/platform areas are drained to Devonshire stormwater trunk line and the BOOS. A relatively small system (0.4m pipe) drains the city service track/platforms (Platform 16 to 25) to the Elizabeth Street stormwater line at the Eddy Avenue intersection.

Apart from the stormwater pipelines, the rail yard receives local rainfall, as well as overland flow entering the rail yard from the east boundary. Overland flows enter the site through Prince Alfred Sidings access road, across the Prince Alfred Park western boundary, and also overland flows following the tracks from Redfern Station under the Cleveland Road bridge.

Figure A.1 to **Figure A.3** present the flood regime within the rail yard for the 10%, 1% and PMF events. It notes that for the 10% AEP and 1% AEP events, the ponding within the rail yard is localised, for instance, track/platform flooding and Flyovers sag flooding are separated.

In the PMF events, almost all ponded areas in the rail yard are connected. Flood modelling predicts that the intercity train track line next to Platform 15 is subject to deepest inundation (apart from the Flyovers Sag). The predicted flood depths are 0.23m, 0.28m and 0.79m respectively for the 10%, 1% AEP and PMF events.

6.3.2 Prince Alfred Park Overland Flow Path

Prince Alfred Park

Prince Alfred Park has a total catchment area of about 35 hectares. The catchment is drained by the SWC Prince Alfred sub-branch as shown in **Figure 6-3**. The central green area (oval) of the Prince Alfred Park is a low-lying area with a drainage outlet. The basin outlet is assumed to be connected to the nearby SWC stormwater oviform conduit, which has an approximate dimension of 0.61m x 0.91 m. **Photo 6-1** shows the basin outlet. In larger storm events, the open green area appears to be functioning as a de facto flood storage area providing flow attenuation. **Table 6-2** shows that the area has an estimated flood storage between 1,300 to 5,500m^3. When the available flood storage is filled, overland flow continues to drain in a westerly direction across the tennis court area and into the Prince Alfred Sidings area.

Table 6-2 provides a flood summary of the Prince Alfred Park overland flow path. The overland flows crossing into the Prince Alfred Sidings along the eastern boundary is 4.2m^3/s in 1% AEP event and is about 23.9m^3/s in the PMF. The trunk drainage system of the 1.05m RCP is full in the 10% AEP event carrying about 2m^3/s.

Refer to **Figure A.7** to **Figure A.8**, for the flood hazard results in the Prince Alfred Park. For the 1% AEP, the area immediately east of the CPRP project site is of low categories H1 and H2. Under the PMF conditions the oval area is subject to hazard category H3 (unsafe for vehicles, children and early) as flood level rises. The flood hazard is associated with the significant depth of flooding within the central green area.

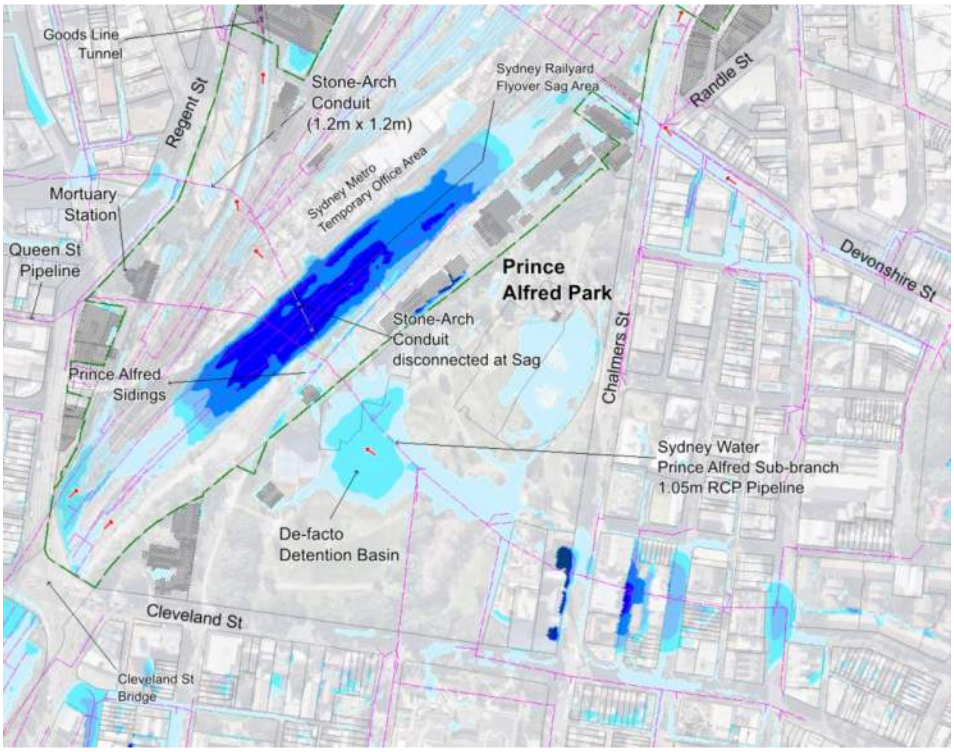


Figure 6-3: Flood Regime - Prince Alfred Park - Base Case Conditions (1% AEP)

Photo 6-1: Prince Alfred Park Basin Outlet

Table 6-2: Flood Summary - Prince Alfred Park - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Prince Alfred Park Green (Oval)	Flood Level (mAHD)	25.3	25.3	25.6
Prince Alfred Park Green (Oval)	Flood Storage (m^3)	1,320	1,870	5,540
Prince Alfred Sidings Eastern Boundary 1.05m RCP	Conduit Flow (m^3/s)	2.0	2.1	2.3
Prince Alfred Sidings Eastern Boundary	Overland Flow (m^3/s)	1.9	4.2	23.9
Flyovers Sag	Flood Level (mAHD)	18.2	18.9	21.0
Flyovers Sag	Flood Depth (m)	1.15	1.88	3.98
Flyovers Sag	Flood Storage (m^3)	8,960	20,380	69,720
Regent St, Western Boundary, 1.05m RCP	Conduit Flow (m^3/s)	1.8	1.8	1.9
Regent St, Western Boundary, Stone-Arch 1.2m x 1.2m	Conduit Flow (m^3/s)	0.2	0.4	4.2
Goods Line Tunnel	Overland Flow (m^3/s)	0.3	0.5	31.77
Spill at Mortuary Station North	Overland Flow (m^3/s)	0.02	0.03	0.11
Regent St Road Say	Flood Level (mAHD)	17.8	17.8	18.3
Regent St Road Sag	Flood Depth (m)	0.28	0.43	0.88
Cleveland St Bridge	Flow (m^3/s)	0.9	1.9	12.0

Prince Alfred Sidings & Flyover Area Sag

The SWC Prince Alfred sub-branch (1.05m RCP) continues from Prince Alfred Park under the Prince Alfred Sidings area, the Flyovers area, the Sydney Rail Yard, and the Regent Street Sidings area to join the drainage network along Queen Street to the west of Regent Street.

The Prince Alfred Sidings area consists of several existing buildings including the Rail Institute building, Prince Alfred substation and Chalmers Street substation.

The Flyovers area is a rail grade separated intersection with a distinct local track sag. The sag has a lowest invert level of about 17.04 mAHD, which is considerably lower than the upstream Prince Alfred Sidings (level over 21.0 mAHD) and the downstream Sydney Metro temporary site office area (level 20.5 mAHD). Track drainage record indicated that the Flyovers sag is drained by the track drainage connecting to the 1.05m RCP stormwater trunk line. Refer to **Figure 5-5** for the stormwater drainage layout.

Table 6-2 shows that the 1% AEP peak conduit flow of the 1.05m RCP has reduced across the Flyovers sag from 2.0m^3/s to 1.8m^3/s. The flow pattern is similar for the 10% AEP and PMF events. The flow difference would likely be due to the storage effect of the sag area. The predicted modelled flood depth at the sag is 1.88m for 1% AEP event and almost 4.0m for the PMF event. It has an estimated flood storage volume of 20,000m^3 and 68,000m^3 respectively in the 1% AEP and PMF events.

It is noted that in the 10% AEP event the modelled flood depth at the sag is 1.1 m. With such a flood depth the train service (including the airport service) would have been interrupted on average 1 in 10 years which is surprisingly high. It is recommended that anecdotal flooding information for the Flyovers area to be sought from Sydney Rail to check if the flood model is overpredicting flood levels at the sag.

Referring to **Figures A.7** to **A.9** for the flood hazard results, there is high flood hazard associated with Flyovers sag due to the depth of ponding. For the Prince Alfred Sidings area, the area is generally above the 10% AEP and 1% AEP flood event ponding at the Flyovers sag. For the Prince Alfred Sidings area, the general ground level is more than a metre above the Flyovers flood level in the 1% AEP flood event. Flooding within the Sidings area is limited to some local areas such as the car park area. The predicted flood hazard category is H1 for most of the Prince Alfred Sidings area including the access road. For the PMF event, the Sidings access road is subject to about a 0.5m inundation depth and has flood hazard categories of H2 and H3. Flood hazard is as high as H5 (unsafe for vehicles and people, all building types considered vulnerable to failure), across the informal overland flow path from the Prince Alfred Park due to the velocities of the flow.

Sydney Rail Yard (south) & Regent Street Sidings

The Sydney Rail Yard (south) and Regent Street Sidings (Mortuary Station and existing bus layover) are drained by the SWC 1.05m RCP pipeline and the SWC Stone-Arch conduit.

The Sydney Rail Yard and the Regent Street Sidings areas are “bounded” by the Mortuary Station building and platform, and the boundary solid walls along Regent Street. As the capacity of the trunk drainage system reaches its full capacity, the majority of the overland flows would escape the Sydney Rail Yard through The Goods Line tunnel under Lee Street and George Street to The Goods Line Urban Walkway north of Broadway. Minor spills to Regent Street may occur immediately to the north of Mortuary Station in larger rainfall events.

Table 6-2 shows the flow distributions across the areas. In the PMF events, the model predicts The Goods Line tunnel conveying a flow of 30.2m^3/s. This indicates that The

Goods Line tunnel is an important overland flow path in the PMF event, and this highlights the magnitude of flow being incorrectly excluded from the CoS flood model.

The Stone-Arch Branch has a sizable capacity with a nominal dimension of about 1.2mx1.2m. The rail yard track drainage model indicated that the section of the conduit has a relatively small catchment relative to the capacity of Stone-Arch Branch. As indicated in **Table 6-2,** the Stone-Arch Branch carries a relatively small flow in the 10% and 1% AEP design events, equivalent to approximately 10% and 14% of the full capacity respectively.

Sydney water records show that the existing Stone-Arch Branch was historically extended to the Prince Alfred Sidings connecting to the main branch. The section across the Flyovers sag has been decommissioned. No inflow is expected from the sag to Stone-Arch Branch. However, given that the predicted Flyovers sag depth also seems unexpectedly high for the 10% AEP event, the assumption of no inflow from the sag area to the Stone-Arch Branch is questionable.

The Regent Street road sag is subject to a flood depth of 0.3m in 10% AEP and 0.45m in 1% AEP. The flood level at the sag would be particularly sensitive to the local inlet configuration and changes of the Stone-Arch Branch hydraulic.

It is recommended that ground survey be undertaken for the section of the Stone-Arch Branch within the CPRP site including the Regent Street sag to confirm if there are live inlet connections from the flyovers sag area and all existing inlets and pipe connections to the conduit.

6.3.3 Devonshire St Overland Flow Path

Devonshire Street slopes from east to west towards the Chalmers Street intersection. The flood modelling shows that the approaching overland flows would split at the intersection. The majority of the Devonshire overland flow would continue its way across Chalmers Street towards the Prince Alfred Sidings access road, with the flow eventually draining to the Flyovers area sag within the Sydney Rail Yard. The remaining overland flow would follow Chalmers Street to Darling Harbour via Eddy Avenue and Hay Street. **Figure 6-4** shows the flow pattern at Devonshire Street and Chalmers Street intersection. **Table 6-3** summarises the key flow characteristics at the intersection.

The Devonshire stormwater trunk is full for the length within the CPRP site for the 10% AEP design event. The 1.5m RCP pipeline would carry 10% to 25% more flow when pressurised in the 1% AEP and PMF design events. The additional inflows from the Sydney Rail Yard would be about 0.7m^3/s by comparing the upstream and downstream conduit flow rate.

It is noted that the Prince Alfred Sidings access road has an overland flow of 2.4m^3/s in the 1% AEP and the road area currently has a low H1 hazard category. **Photo 6-2** shows the access road adjacent to Central Station Chalmers Street pedestrian exit/entry.

Available survey information indicates that the Chalmers Street pedestrian exit/entry (**Photo 6-3**) has an entrance level of 23.509 mAHD, which is below the predicted PMF level of 23.76 mAHD. Floodwater may enter the Central Station underground concourse area and this result is consistent with the comments documented in Sydney Metro C&S reference design report, Section 4.6.2.

It worth noting that Devonshire Street and Chalmers Street are part of the recently completed SLR alignment. The flood levels along the route may be influenced by the SLR design. The modelled flood regimes along the Devonshire flow path need to include the SLR work-as-executed information in future refinements of the flood modelling to reduce the flood level uncertainty.

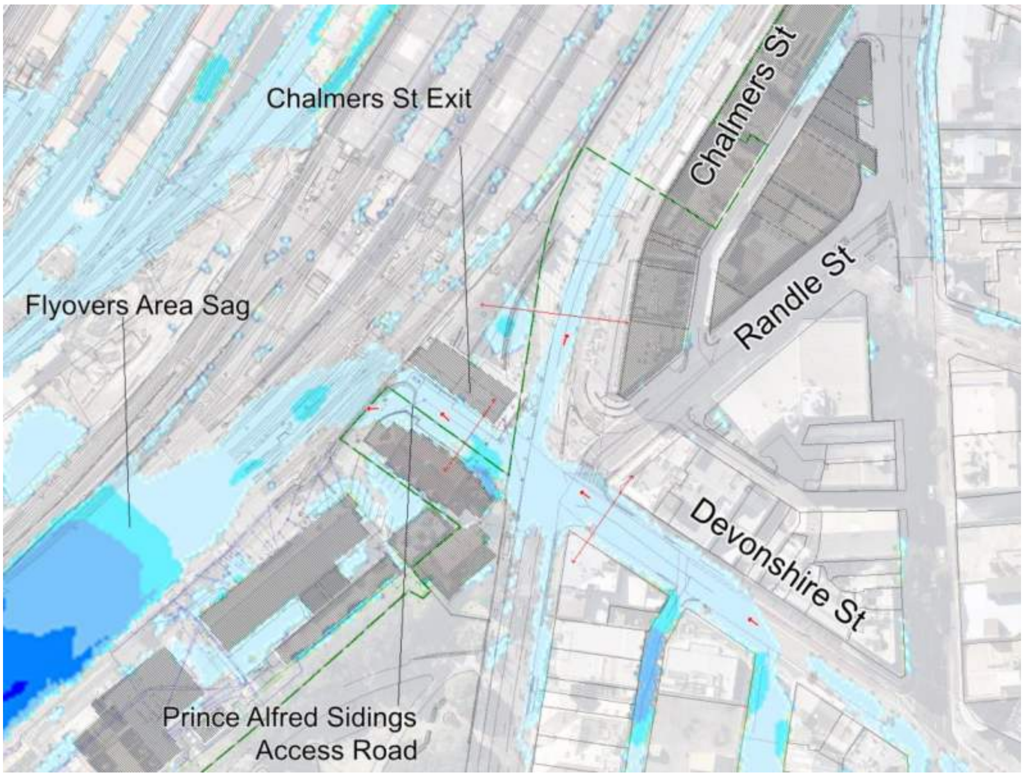


Figure 6-4: Flood Regime - Devonshire St/Chalmers St Intersection - Base Case Conditions (1% AEP)

Table 6-3: Flood Summary - Devonshire St/Chalmers St Intersection - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Devonshire St Intersection U/S	Overland Flow (m^3/s)	0.9	2.2	14.1
Chalmers St Intersection D/S	Overland Flow (m^3/s)	0.3	0.7	6.2
Prince Alfred Sidings Access Road	Overland Flow (m^3/s)	1.0	2.4	15.2
Devonshire Tunnel Stormwater Trunk 1.5m RCP under Chalmers St Exit Structure, U/S Rail Yard	Conduit Flow (m^3/s)	3.8	4.5	5.2
Devonshire Tunnel Stormwater Trunk 1.5m RCP under Henry Deane Plaza, D/S Rail Yard	Conduit Flow (m^3/s)	4.4	5.2	5.8
Chalmers St Exit	Flood Level (mAHD)	N/A	23.34	23.76

Note: N/A represents no flood level. For flow locations refer to **Figure 6-4**.

Photo 6-2: Sydney Trains Access Road from Devonshire St/Chalmers St Intersection

Photo 6-3: Chalmers St Pedestrian Entry

6.3.4 Foveaux St Overland Flow Path

Foveaux Street slopes from east to west towards the Elizabeth Street and Eddy Avenue intersection. It has an approximate upslope catchment of 19.5 hectares. Overland flows from Foveaux Street join Chalmers Street flows as they approach the intersection. With the flow split at the intersection, the majority of the flows would follow Eddy Avenue with the remainder of the flows continuing along Elizabeth Street. **Figure 6-5** illustrates the flow patterns at the intersection. It is expected that the flow split would be sensitive to the local road level at the intersection. Inclusion of the work-as-executed ground surface for the SLR works in the future flood modelling will be necessary for a more reliable flow prediction for this location.

Elizabeth Street Exit and Eastern Stairs Exit of Central Station are located in proximity to the Foveaux Street/Elizabeth Street intersection. The entrance level of the Elizabeth Street Exit estimated from LiDAR survey is 18.45 mAHD and the Eastern Staircase Exit is 20.33 mAHD. The predicted flood level at the exits presented in **Table 6-4** are higher than the estimated entrance levels suggesting that overland flows could possibly enter both station exits in the PMF flood event. The flood model prediction is similar to that documented in Sydney Metro City and Southwest Reference design report, Section 4.6.2. Site survey of the entrances is recommended to confirm the flood immunity.

The intersection of Elizabeth Street and Eddy Avenue is subject to a high flood hazard of H5 in 10% AEP and 1% AEP event shown in **Figure A.7** and **Figure A.8**. The high flood hazard is likely related to high flow velocity due to steep road grade across Elizabeth Street from Foveaux Street to Eddy Avenue which exceeds 2m/s as indicated in **Figure A.4** and **Figure A.5**. In the PMF event, the Foveaux Street, Elizabeth Street intersection and Eddy Avenue flow path is highly hazardous as shown in **Figure A.9**.

Table 6-4: Flood Summary - Elizabeth St/Eddy Ave Intersection - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Foveaux St U/S	Overland Flow (m^3/s)	2.8	4.9	20.4
Elizabeth St U/S	Overland Flow (m^3/s)	3.7	6.4	36.3
Eddy Ave D/S	Overland Flow (m^3/s)	2.3	4.2	20.6
Elizabeth St D/S	Overland Flow (m^3/s)	1.4	2.3	17.3
Elizabeth St Exit	Flood Level (mAHD)	N/A	N/A	18.96
Eastern Stairs Exit	Flood Level (mAHD)	20.28	20.30	20.69
Sydney Rail Yard Platform/Track to Elizabeth St	Conduit Flow (m^3/s)	0.2	0.2	0.4

Note: N/A represents no flood level. For flow locations refer to **Figure 6-5**.

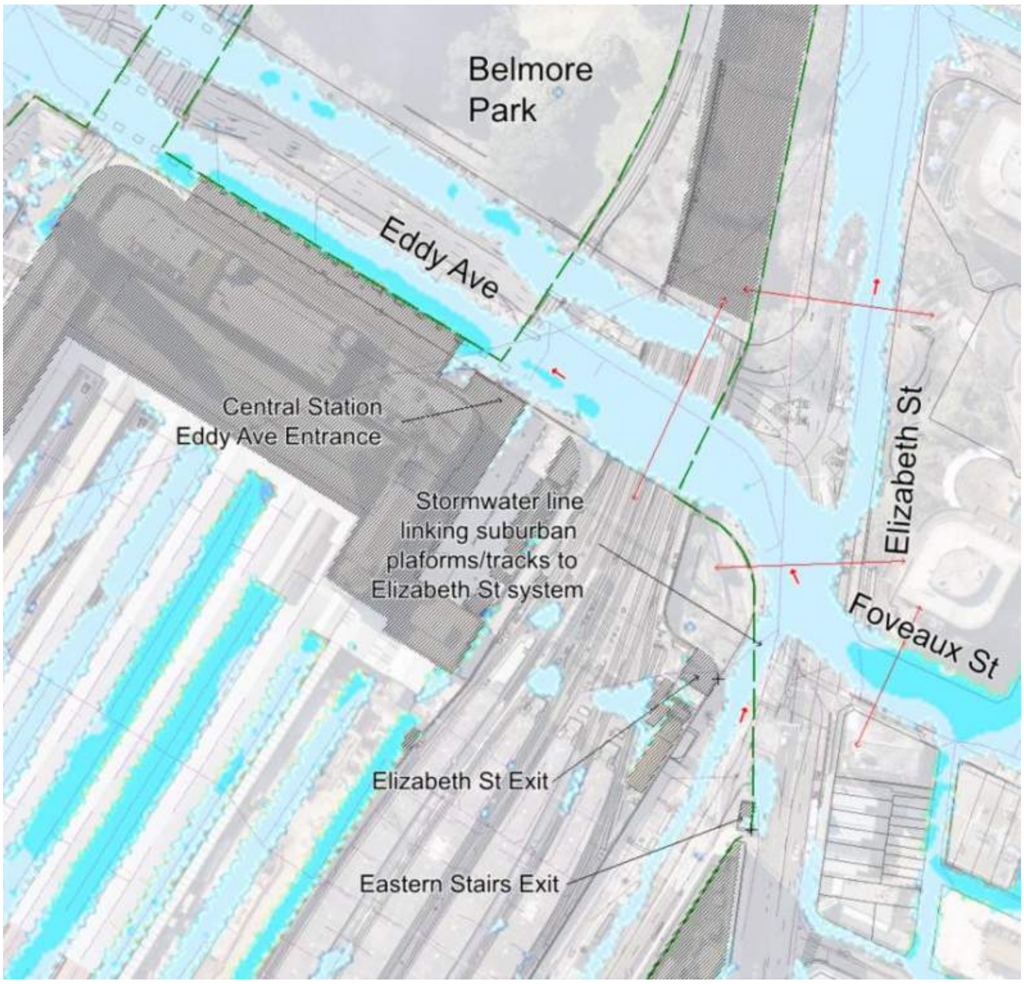


Figure 6-5: Flood Regime - Elizabeth St/Eddy Ave Intersection - Base Case Conditions (1% AEP)

6.3.5 Hay St & Campbell St Overland Flow Paths

Campbell Street – Elizabeth Intersection

Foy Lane and Wentworth Avenue convey overland flow towards the Campbell Street/Elizabeth Street intersection. **Figure 6-6** shows the overland flow split at the intersection with a minor part of the flow turning west to Campbell Street and the majority of the flow continuing on Elizabeth Street to the Hay Street intersection. **Table 6-5** summarises the distribution of overland and conduit flows at the road intersection.

Table 6-5: Flood Summary - Campbell St/Elizabeth St Intersection - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Elizabeth St, North	Overland Flow (m^3/s)	3.7	7.1	36.8
Elizabeth St, South	Overland Flow (m^3/s)	1.9	4.5	33.5
Campbell St, East	Overland Flow (m^3/s)	1.9	3.0	4.9

Note: N/A represents no flood level. For flow locations refer to **Figure 6-6**.

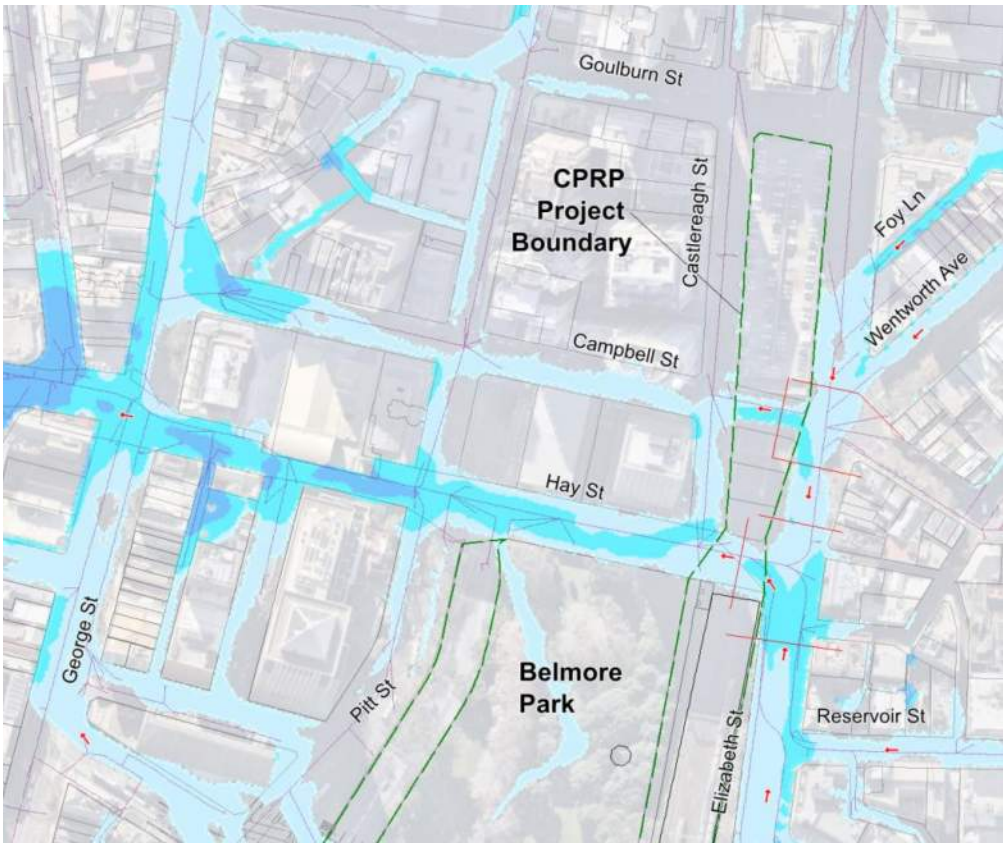


Figure 6-6: Flood Regime - Hay St/Elizabeth St Intersection - Base Case Conditions (1% AEP)

Hay Street – Elizabeth Intersection

The Hay Street overland flow path crosses the CPRP project area under the existing elevated rail structure and is the main overland flow path to Darling Harbour via the SICEEP area. The Hay Street/Elizabeth Street intersection is a pronounced sag. Overland flows are converging at the intersection from the north and south. Apart from the overland flows, underneath Hay Street is a SWC heritage oviform trunk stormwater system which has an approximate dimension of 3.0mx2.0m carrying a considerable amount of stormwater to Darling Harbour. **Table 6-6** summarises the overland and trunk drainage flows at the road intersection. The intersection is subject to a high flood hazard (H5 category) in the 1% AEP event and significant inundation of over 1m in the PMF event.

Table 6-6: Flood Summary - Hay St/Elizabeth St Intersection - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Elizabeth St, North	Overland Flow (m^3/s)	2.0	4.5	32.9
Elizabeth St, South	Overland Flow (m^3/s)	2.4	4.9	50.2
Hay St	Overland Flow (m^3/s)	3.6	8.8	82.6
Elizabeth St, North Oviform	Conduit Flow (m^3/s)	5.7	6.5	7.5
Elizabeth St, South Oviform	Conduit Flow (m^3/s)	4.2	5.7	6.8
Elizabeth St, South RCBC	Conduit Flow (m^3/s)	6.7	7.7	10.1
Hay St, RCBC	Conduit Flow (m^3/s)	17.5	20.8	26.2
Hay St Intersection	Flood Depth (m)	0.15	0.27	1.24

Note: N/A represents no flood level. For flow locations refer to **Figure 6-6.**

6.3.6 Ambulance Ave & Henry Deane Plaza

Ambulance Avenue

Ambulance Avenue is located within the future Western Forecourt sub-precinct of the CPRP. The proposed western entry to the Sydney Metro is proposed at the eastern end of the existing Ambulance Avenue. Ambulance Avenue currently operates as car parking area and serves accesses to the Central Station Building. The roadway is graded from Lee Street towards the Central Terminal Building forming a local trap sag at the eastern end. The sag is drained by a grated drain connecting to a pipeline (375mm RCP) linking to the Stormwater Harvest Tank located beneath the Pitt Street loading dock. According to the survey record, the Ambulance Avenue grate has a surveyed level of 14.38 mAHD. **Photo 6-4** shows the grated drain at the end of Ambulance Avenue.

The local catchment of Ambulance Avenue is limited to the roadway area itself. Modelling shows that overland flows from Lee Street could spill into Ambulance Avenue when the gutter reaches its flow capacity. **Figure 6-7** shows the overland flow pattern around Ambulance Avenue.

Table 6-7 summarises predicted flow characteristics from the CPRP flood modelling. There would be a minor inundation for the Ambulance Avenue sag up to the 1% AEP flood event. With the PMF event, a maximum ponding depth of 1.66m is predicted over the grated drain. As the location is a trapped sag, the local flood level is sensitive to the pit blockage assumption. The design condition has assumed 50% blockage for sag pits, sensitivity testing of a full pit blockage indicates the flood level will be increased by about 0.57m, for more details refer to **Section 6.4**.

Photo 6-4: Ambulance Ave Grated Drain

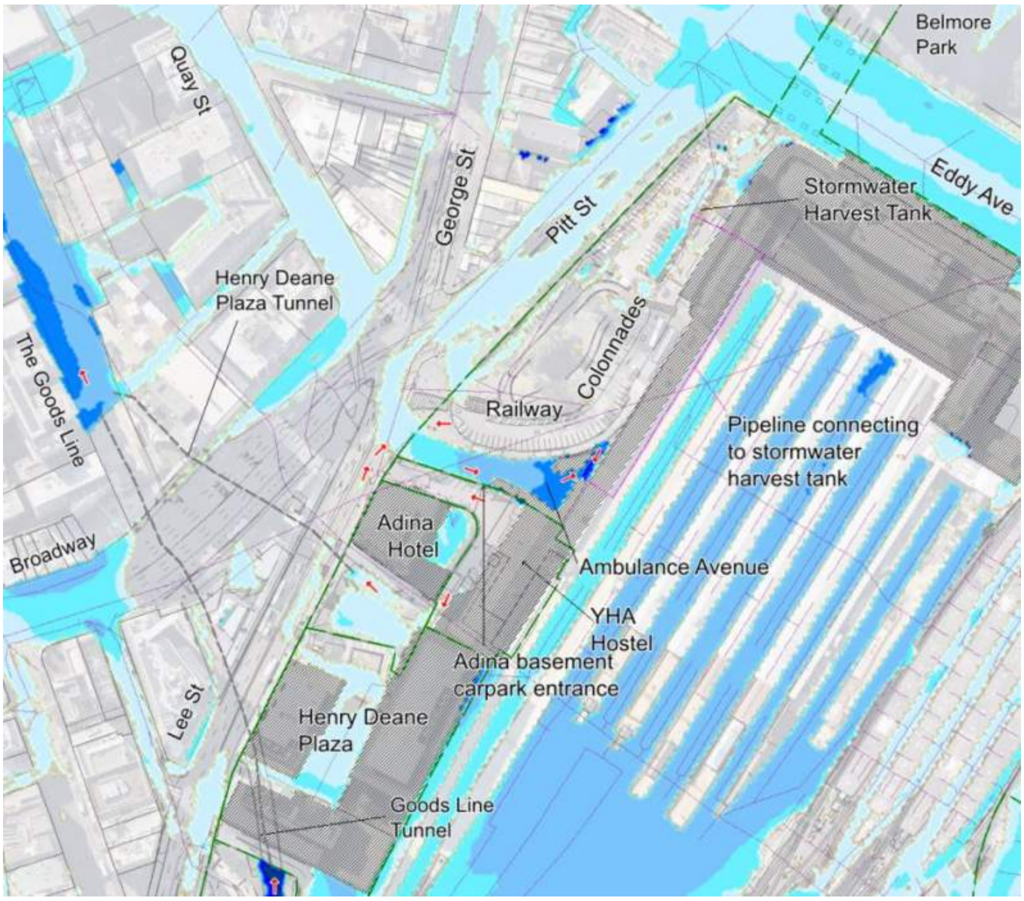


Figure 6-7: Flood Regime - Ambulance Ave & Western Forecourt (PMF) - Base Case Conditions (1% AEP)

Henry Deane Plaza

The Henry Deane Plaza tunnel is a pedestrian walkway under Lee Street and George Street connecting Henry Deane Plaza, Railway Square and The Goods Line Urban Walkway. Flood modelling shows that the Henry Deane Plaza tunnel flows are quite small as the local catchment is confined to local property lots, Henry Deane Plaza and the neighbouring Adina Hotel and YHA Hostel. The predicted 1% AEP and PMF tunnel flows are $0.35m^3/s$ and $1.2m^3/s$ respectively.

It is noted that Henry Deane Plaza pedestrian tunnel was not modelled in the DHFS, the omission would slightly underestimate the overland flow along The Goods Line Urban Walkway.

Table 6-7: Flood Summary - Ambulance Ave & Henry Deane Plaza - Base Case Conditions

Location	Flood Characteristic	10% AEP	1% AEP	PMF
Ambulance Ave at Lee St intersection	Overland Flow (m^3/s)	0.1	0.1	0.4
Flow to Stormwater Harvest Tank	Conduit Flow (m^3/s)	0.2	0.3	0.3
Ambulance Ave Sag	Flood Level (mAHD)	14.93	14.97	16.03
Ambulance Ave Sag	Flood Depth (m)	0.6	0.6	1.7
Henry Deane Plaza Walkway	Overland Flow (m^3/s)	0.2	0.3	1.1

Note: N/A represents no flood level. For flow locations refer to **Figure 6-7.**

6.4 Pit Blockage Sensitivity

As discussed in **Section 5.3.1**, a 20/50 pit blockage rule has been applied for the CPRP flood modelling. A sensitivity analysis has been undertaken where a 50/100 blockage has been applied and flood results simulated for the critical duration events (**Section 6.1**) 1% AEP and PMF events. The difference in results between the 20/50 and 50/100 blockages has been mapped as **Figure A10** and **Figure A11** of **Appendix A.** The key observations from the flood mapping are:

1. The Prince Alfred sub-branch is located along a distinct depression. There is a minor increase in flood levels along the Prince Alfred Park in the 1% AEP event relative to the base case. However, there is no significant flood level difference for the PMF event for adopting the higher blockage ratio.
2. For the 1% AEP at the sag locations where the Stone-Arch branch crosses Regent Street and Kensington Street, increases in the flood level of 0.24m and 0.060m are apparent. However, for the PMF, the peak flood level increased by 0.05m and decreased by 0.02m respectively for the Regent Street and Kensington Street sags.
3. Flood depth increases of up to 0.06m are evident along the overland flow path from Reservoir Street via Elizabeth Street and Hay Street to the SICEEP area for the PMF event. For the 1% AEP design storm event the maximum flood level increase is about 0.26m. The location of the maximum increase is at the SICEEP Boulevard under the Pier Street structure which has the lowest sag invert for the entire SICEEP precinct. Analysis of the stormwater system hydraulics revealed that certain sections of the underground conduit along the overland flow path is flowing part full due to inadequate inlet capacity. Flood level changes are therefore particularly sensitive to the inlet capacity assumptions.
4. For Ambulance Avenue the flood level has increased by 0.57m for 1% AEP design event, with no change for the PMF event. In the PMF event the flood level is a level pool condition controlled by the Pitt Street flood level both for the 20/50 and the 50/100 blockage scenarios.

6.5 Comparison with CoS Flood Model Results

The modelled CPRP flood regimes are considerably different from that predicted by CoS DHFS and BBFS. The main reasons for the discrepancies are list below. Each factor contributes to the various degrees of deviation from the CoS flood regimes at different parts of the model, as discussed in the following sections.

a. Merging of the adjacent CoS DHFS and BBFS flood models which eliminated the arbitrary boundary conditions within the Sydney Rail Yard area.
b. The CPRP model adopts a unified model approach for the merged flood model that leads to significant model regime changes in particular to the BBFS catchment area.
c. Incorporation of the existing Goods Line tunnel and Henry Plaza pedestrian tunnel linking the CPRP area to the downstream Darling Harbour.
d. Inclusion of updated details for recent developments including the SICEEP and SLR.
e. Inclusion of the track drainage network and other survey information.
f. The use of higher PMP rainfall estimates specifically derived for the CPRP.
g. The use of updated TUFLOW software suite.

6.5.1 Darling Harbour Flood Study Area

Figure D.1 and **Figure D.2** included in **Appendix D** show the comparisons of the CPRP and the CoS DHFS peak flood level results for the 1% AEP and PMF events. **Table 6-8** presents the flood regime comparisons at selected key locations.

In addition, the original CoS DHFS flood model has been rerun with the CPRP TUFLOW version. The peak flood level impact of the change in TUFLOW version for the 1% AEP and PMF events is illustrated in **Figure D.5** & **Figure D.6.**

Observations for the 1% AEP event are:

a. With the 1% AEP there are increases and decreases in flood level in the order of less than 50mm for the eastern flow paths (Devonshire Street, Kippax Street, Foveaux Street, Reservoir Street, Wentworth Avenue and Foy Lane) approaching the CPRP. Analysis shows that the changes in flood level are likely due to the update of the TUFLOW software. Refer to **Figure D.5** for the resulting changes with the use of the latest TUFLOW software on the rerun of the DHFS model.

b. There are minor reductions (less than 50mm) in flood level along Chalmers Street, Elizabeth Street and Eddy Avenue.

c. There are minor increases (less than 50mm) in flood level along Hay Street and Campbell Street

d. On the western CPRP site, flood levels along Regent Street, Lee Street and Pitt Street have relatively small changes from the CoS flood levels.

e. Flood level changes within the Sydney Rail Yard is expected as the CPRP flood model has incorporated The Goods Line tunnel, replaced the arbitrary model boundary assumptions in DHFS model and included the track drainage network.

f. The flood level increases in The Goods Line Urban Walkway due to the inclusion of The Goods Line Tunnel and Henry Deane Plaza pedestrian tunnel in CPRPs model.

g. The changes in flood level for the SICEEP area would be largely associated with incorporation of the SICEEP design.

Observations for the PMF event are:

a. There are increases in the order of 50mm to 100mm for flood levels along Chalmer Street, Elizabeth Street, Eddy Avenue. The increases in flood level along Hay Street, Campbell Street and George Street intersections is more than 200mm. The increase is likely due to the adoption of the higher rainfall estimate for the PMP event.

b. On the western CPRP site, flood levels along Regent Street, Lee Street, Pitt Street have negligible changes relative to the CoS flood levels.

c. The flood level increases in The Goods Line Urban Walkway due to the inclusion of The Goods Line Tunnel and Henry Deane Plaza pedestrian tunnel in the CPRP flood model.

d. The flood level changes in the SICEEP area would be largely due to the incorporation of the SICEEP development.

6.5.2 Blackwattle Bay Flood Study Area

Figure D.3 and **Figure D.4** included in **Appendix D** show the comparisons of the CPRP and the CoS BBFS peak flood level results for the 1% AEP and PMF events.

a. The CPRP flood model broadly adopted the DHFS flood model approach which in some instances is considerably different from the BBFS approach. The CPRP flood levels therefore are expected to be significantly different from the BBFS flood levels. It can be seen in both figures that the flood level differences are generally over 50mm for the majority of the map coverage.

b. For the 1% AEP event, there are general reductions in flood level across the BBFS area. There are reduced flood levels between 50mm to 100mm for the Prince Alfred Park area and a reduction of more than 200mm at the Regent Sag. There are 100mm to 200mm increases in the flood level for the Flyovers Area sag.

c. For the PMF event, the patterns of reduction and increases are similar to the 1% AEP event for the Prince Alfred Park, Regent Street sag and the Flyovers Area sag.

Table 6-8: CPRP & CoS Flood Regime Comparison

Key Locations	CoS	CPRP	Remarks
Ponding Depth Between Platforms	0.4m 1% AEP 0.6m PMF	0.25m 1% AEP 0.7m PMF	Reduction of flood depth in 1% AEP due to inclusion of track drainage. DHFS PMF results are unreliable given the arbitrary flood model boundary.
Flyovers Ponding Depth	1.7m 1% AEP 2.3m PMF	1.9m 1% AEP 4.0m PMF	BBFS flood level adopted an arbitrarily flood model boundary and didn’t consider the full upstream catchment area.
Devonshire St Overland Flow Path	High flood hazard	PMF level increased by 0.25m relative to CoS model at Devonshire St Exit	CPRP adopted a shorter duration PMP/PMF which has higher flood peaks.
Regent Street Sag Ponding Depth	0.9m 1% AEP 1.2m PMF High flood hazard	0.3m 1% AEP 0.7m PMF High flood hazard	CPRP flood model included the Goods Line rail tunnel and solid wall structures within the CPRP. The wall structure stops overland flow from CPRP reaching Regent St.
Ambulance Ave Trapped Low Point Flood Level	19.20 mAHD 1% AEP 19.23 mAHD PMF	14.93 mAHD 1% AEP 16.03 mAHD PMF	CPRP flood model updated the ground level, incorporated stormwater pits to represent grated drain draining the Ambulance Ave sag and solid walls structures along Adina Hotel boundary.
Eddy Ave Overland Flow Path Depth	0.27m 1% AEP 0.32m PMF	0.26m 1% AEP 0.38m PMF	CPRP adopted a shorter duration PMF which has higher flood peaks
Hay St Overland Flow Path Depth	0.3m 1% AEP 0.7m PMF	0.3m 1% AEP 1.2m PMF	CPRP adopted a shorter duration PMF which has higher flood peaks

7 PROPOSED FLOOD MODEL DEVELOPMENT

7.1 Proposed Development Flood Review

The CPRP has initially been reviewed from a flooding perspective based on the Central Precinct Structure Plan & Urban Design Report (Architectus, 2020). The architectural plans and sections from this report illustrate the proposed building locations and ground levels across the site based on the level of design undertaken to date.

The CPRP involves development over, within and surrounding the rail yard across 10 sub-precincts as described and illustrated in **Figure 1-1**. Key features of the proposed development of interest for a flooding perspective across these sub-precincts include:

Central Station

- Sydney Terminal Building will be extended. The roof drainage will be modified which may have an impact on the local stormwater drainage network capacity and flooding.

  Refer to **Section 7.2.1** for details of flood modelling considerations and results.

Sydney Rail Yards

- The proposed construction will effectively create a significantly large deck over the rail yard with public open space and high-rise buildings above. This deck would intercept local rainfall which currently falls on the tracks. Along with potential stormwater harvesting and reuse schemes, the presence of this deck will significantly alter the local hydrology.
- The drainage strategy to collect and convey rainfall runoff from the deck to the surrounding trunk systems will have potential impacts on the stormwater drainage network and flooding in the adjoining areas.
- There will be associated track level and platform modifications which may have an influence on flooding within the rail yard.

  Refer to **Section 7.2.3, Section 7.2.4** and **Section 8.2** for details of flood modelling considerations and results.

Prince Alfred Sidings

- There are several structures along the eastern edge of the development to provide access to elevated walkways connecting the eastern edge to the main over rail deck. One of the structures is currently located along the sidings access road narrowing the overland flow path from Devonshire Street. The arrangement would potentially lead to significant local flood impacts both within the immediate area of the station exit/entry as well as further downstream.
- The Prince Alfred Park Sidings sub-precinct development proposes a building along the boundary with Prince Alfred Park. The proposed building is located across the existing overland flow path from the park and will have implications on local flooding.

  Refer to **Section 7.2.1** and **Section 8.3.1** for details of flood modelling considerations and results.

Western Forecourt

- The Western Forecourt area will be reshaped to form an open community area along Pitt Street. Part of Railway Colonnade Drive will be removed and lowered to form the open area. The community area may be impacted by overland flows from Lee Street similar to the existing Ambulance Avenue and subject to flooding.
- Flood immunity of the Central Walk entrance.
- Flood immunity and flood hazard associated with the proposed pedestrian corridor through the retail space linking the Western Forecourt north to Eddy Avenue.
- Flood immunity of the proposed basement car park entrance at Pitt Street.

Refer to **Section 7.2.2** and **Section 8.3.5** for details of flood modelling considerations and results.

Regent Street Sidings

- The proposed redevelopment will build over the existing bus overlay area, which will alter the existing local overland flow paths. Potentially overflows from the Sydney Rail Yard across the Regent Street Sidings and neighbouring Cleveland Precinct may also be impacted.
- The proposed redevelopment will redistribute the local rainfall runoff, the disposal strategy of the roof runoff will affect the local flow pattern and may influence flooding at the Regent Street sag and Goods Line tunnel.
- North of the Mortuary Station building is current a low-lying area, rearrange the layout of the area including the removal of the existing workshop buildings and wall structures north of the Mortuary building may affect the local overland flow.

The current CPRP flood modelling has not considered flood risks associated with flood emergency and evacuation strategy associated with the layout of emergency travel routes and increased dwelling population within the precinct. Analysis of these factors would be considered at a later stage of the project.

Refer to **Section 7.2.1** and **Section 8.3.1** for details of flood modelling considerations and results.

7.2 Proposed Development Modelling Approach

7.2.1 Proposed Buildings

The flood model approach adopts full flow blockage to building structures. As the detailed layout of the individual CPRP sub-precincts is not known at this stage, a building blockage has been applied to the entire Western Gateway and Regent Street Sidings sub-precincts.

Blockage for the Sydney Terminal building extension has been applied based on the building footprint indicated in the current CPRP architectural layout.

For the Prince Alfred Sidings sub-precinct, there are only a few building structures proposed between the existing buildings. The proposed building footprint has been based on the current CPRP architectural layout.

Runoff from the building footprints is generally assumed to be evenly distributed around the building perimeter. This is the general approach applying to all buildings in the flood model. However, the distribution assumption on some occasions may need adjustment to suit the specific site conditions and requirements.

For the Western Gateway and Regent Street sub-precinct developments, the CPRP flood model has assumed that the roof runoff drains to Lee Street and Regent Street only to avoid runoff being applied to Sydney Rail Yard area.

As the CPRP design develops, the representations of the buildings and their drainage networks can be further refined.

Also note that with the approach of blocking out buildings, the impacts of flow entering basement car parks or other building entrances is not considered, unless otherwise specifically noted in this report.

The extents of the blocked buildings are illustrated in **Figure 7-1**.

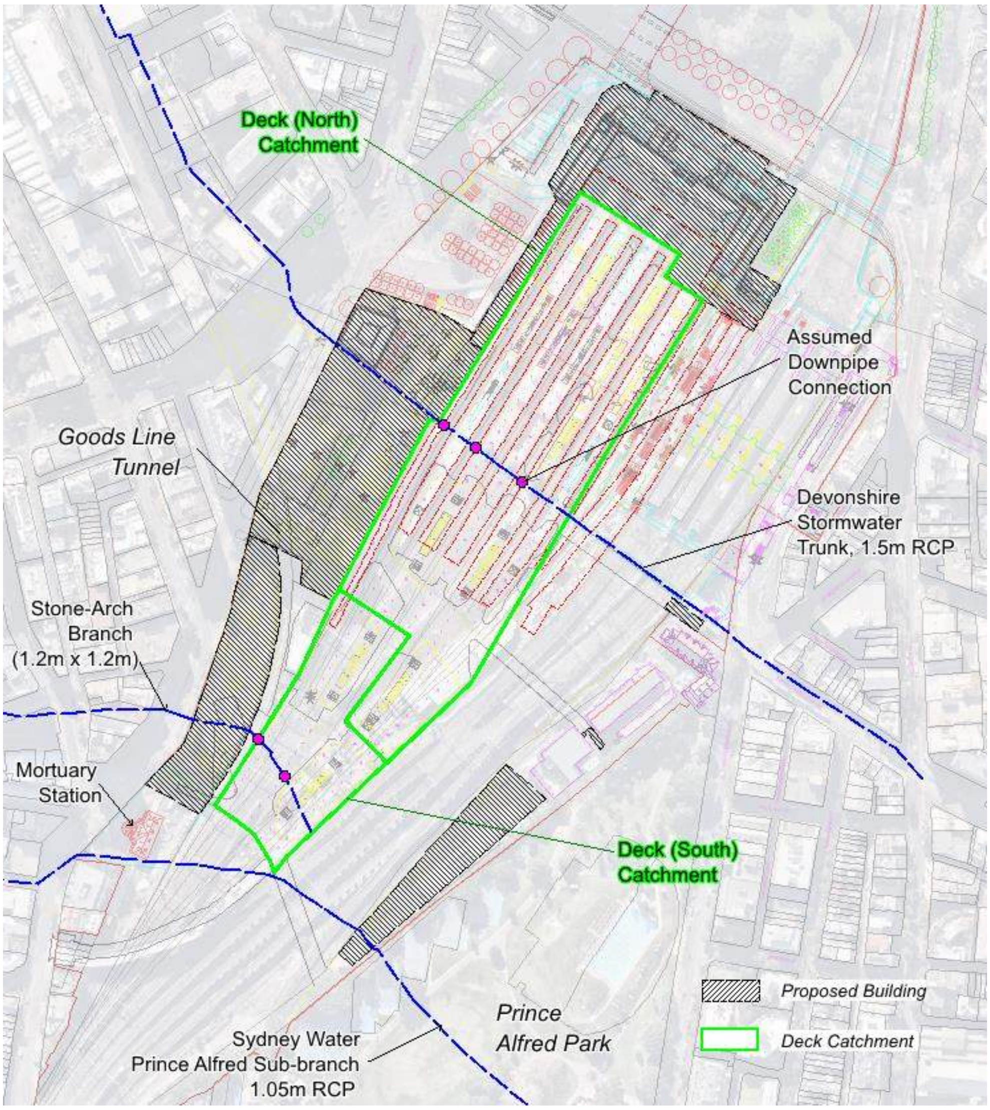


Figure 7-1: CPRP Deck Catchment and Proposed Building Footprints

7.2.2 Western Forecourt

The CPRP proposes to reshape and lower the Western Forecourt area to form an open community area along Pitt Street. A preliminary ground surface model has been developed based on the current CPRP architectural layout which has been incorporated into the proposed conditions flood model.

The CPRP flood model also assumed a 0.375m RCP stormwater pipeline will collect surface runoff and drain the local area directly to Pitt Street.

7.2.3 Rail Yard

Revised platform extents have been incorporated into the CPRP flood model based on the current CPRP architectural layout. The platform modifications involve extending the platforms further south. The extents of the proposed platforms are illustrated in **Figure 7-1**.

A preliminary revised track drainage network has been developed for the purpose of the proposed CPRP flood modelling.

Whilst modifications to the track alignment within the rail yard are proposed, no ground surface model is currently available. The CPRP flood model therefore assumed that the rail yard is unchanged from the LiDAR representation. The existing and CPRP track surface may be updated in the model once further information is available.

Additional structural columns will be required within the rail yard to support the deck structure of the over rail development. Given the preliminary nature of the current flood modelling such structures have not been included in the CPRP flood model at this time.

7.2.4 Over Rail Deck

General Considerations

The proposed construction will effectively create a significantly large deck over the rail yard with public open space and high-rise buildings above. The current CPRP architectural layout assumes the deck level is at 30 mAHD which is about 10m above the existing rail yard level. The proposed deck structure extends from the Grand Concourse Terminal down to Mortuary Station for the western half of the rail yard. **Figure 7-1** presents the approximate extent of the structural deck over the sub-precincts.

The deck arrangement will significantly alter the local hydrology. Rainfall which currently falls on the existing open track area will be intercepted by the deck. Stormwater runoff will then be collected and drain to designated outlet locations at the deck level. The collected deck runoff will then be transferred to the ground level through downpipe systems or other means and then discharged to the existing stormwater network.

The design of the deck drainage system will require consideration of, but not limited to the following factors as in **Table 8-1**. Some of these factors are interrelated and reflect the complexity of the drainage requirements.

Table 7-1: Deck Drainage Considerations

Factor to be Considered	Remarks
Water Quality Requirements	• CoS and SW Stormwater quality policy, WSUD guidelines • number, location, and type of SQID units etc
On-Site-Detention Requirements	• SW and CoS OSD requirement and policy • permissible discharge rate, size, and location & OSD configurations.
Deck Catchment Delineation	• depends on downpipe, SQID and OSD requirements • Structural constraints
Downpipe System	• Interface issue • Determine the connections to rail yard drainage, SW / CoS stormwater system • Surcharge locations etc • Siphonic breaker pit requirements, locations within rail yard
Hydraulic Impact on Existing Stormwater Systems	• Proportionate flows to different existing systems, control of sub-catchment or OSD. • No adverse impact to existing system including pipe hydraulic and flooding to adjoining properties. • Satisfy track drainage and rail yard flooding criteria • Alternative criterion not to worsen existing conditions
Hydraulic Issues	• Erosion caused by downpipe surcharge. • Protection works within rail yard • Siphonic breaker pit requirements, locations within rail yard • Spill from the deck
Legal Discharge Point	• Agreement with the involved owners • Sydney Rail, CoS and SWC requirements
Maintenance Issues	• Locations of downpipe system and other drainage elements • Ownership • Maintenance schedule and requirements, access etc
Structural Issues	• Layout and loading from deck • Spacing of column grid, column dimensions • Dimension of drainage system such downpipe
Safety Issues	• Runoff spilling from the deck • Rail safety, such as overhead electrical lines • Maintenance safety

Deck Catchment Assumption

For the current CPRP flood model, the deck footprint has been assumed to be divided into two catchment areas, namely the Deck (north) and Deck (south). **Figure 7-1** shows the proposed deck extent and the catchment delineation assumed in the current CPRP flood model.

The Deck (north) area is assumed to drain directly to the Devonshire stormwater trunk line and has a catchment area of 40,180 m^2. The Deck (south) is discharged to the Stone-Arch branch and has a catchment of 11,360 m^2. The catchment delineation reflects approximately the same contributing catchment areas to the corresponding trunk lines under the pre-development scenario with the exception of the BOOS catchment. It has been assumed that maintaining any stormwater drainage connection to the BOOS will not be desired by Sydney Water moving forward. The approximate catchment area of the current track drainage network discharging to the BOOS has alternatively been directed to the Devonshire trunk stormwater line for the proposed CPRP flood model.

Note that the deck footprint considered in the CPRP flood model only considers the main deck structure over the rail yard, no pedestrian walkways connecting to the eastern edge have been included.

The deck footprint is assumed to be fully paved which assumes an initial loss (IL) 1.0mm and continuing loss (CL) 0.0mm/h, consistent to the “Building” landuse category assumption listed in **Table 5-3** of the DHFS flood model. This assumption would slightly increase the local runoff from the area as compared with the base case conditions, which assumes approximately 90% paved and 10% pervious area losses of 1mm IL and 2.5mm/hr CL.

The runoff generation assumed for the deck footprint is in line with the adopted building runoff approach. Stormwater runoff is generated based on a rainfall hyetograph equivalent to the deck catchment area, taking out the IL and CL directly and the resultant rain excess hyetograph is directly added to the trunk drainage network through nominated pits. The generated flow considers no flood routing across the deck catchment, no storage on top of or within the deck or buildings for stormwater detention or reuse.

Direct rainfall has been removed for the deck area to account for the direct application of hydrographs for the deck catchment to ensure the conservation of rainfall volume in the flood model.

Drainage Network Assumption

The flood model assumed the following configurations:

a. Deck runoff is drained by downpipe systems directly connected to the trunk system.

b. Downpipe system is assumed to have a PMF capacity. All the deck stormwater runoff would directly discharge to the trunk system underneath the track level. No spill would occur from the deck to rail yard level in any event.

c. Downpipe surcharge may occur when the trunk line HGL level exceeds 0.3m above the local rail yard ground surface level.

Figure 7-2 illustrates the downpipe surcharge concept adopted in the model.

The flood model setup has assumed:

- 3 connection points of 6 x 0.6m RCPs downpipes directly connected to the Devonshire trunk line
- 2 connection points of 3 x 0.6m RCPs downpipes to Stone-Arch Branch.

Figure 7-1 shows the locations of the downpipe connection points to the trunk line in the CPRP flood model.

It is noted that this assumption is a simplistic representation of the stormwater transfer system from the deck level to the underground drainage network. In the reality the connection details could be considerably more complex when all required factors are taken into consideration in the detailed design process. Nevertheless, simulation results for the simplified configuration would provide insights to the downpipe system design at a later stage of the CPRP design.

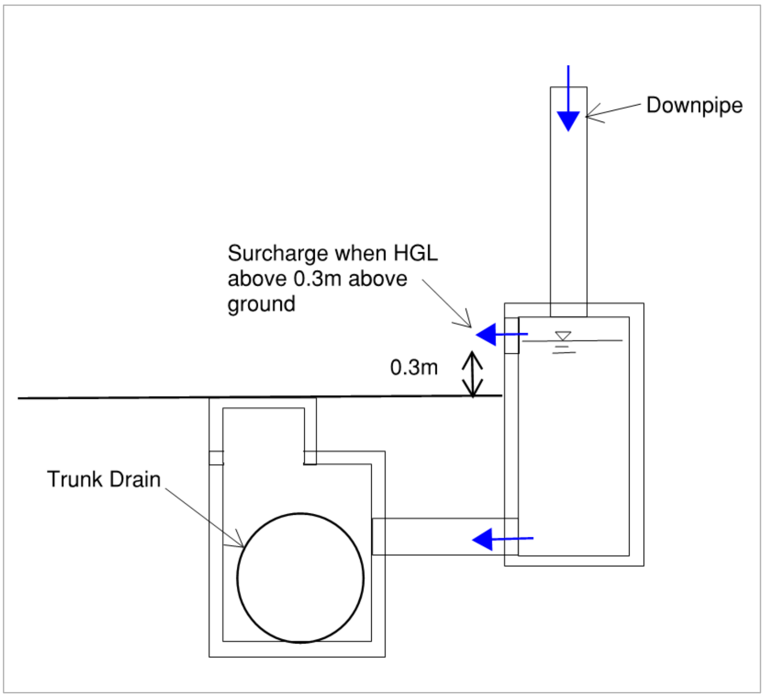


Figure 7-2: Assumed Deck Downpipe Arrangement

8 PROPOSED FLOOD CONDITIONS

The base case conditions flood modelling has established the existing flood regimes of the CPRP project area for the 10% AEP, 1% AEP and PMF events. To reflect the proposed development, the base case model has been modified as outlined in **Section 7**.

The proposed CPRP flood model has been simulated for the critical design events outlined in **Section 6.1**. The peak flood results have then been compared to the base case results to assess how the flood regimes have been impacted by the proposed development.

The proposed CPRP flood modelling aims to understand the uncertainties of the modelling results, to determine future model improvement needs, and to provide insights to the development layout that may avoid or minimise adverse flood impacts. The proposed conditions flood results are discussed in the following sections.

8.1 Proposed Conditions Flood Maps

The proposed conditions flood modelling results are presented in a series of flood maps included in **Appendix B**.

Figure B.1, **Figure B.2** and **Figure B.3** are peak flood depth and level maps for the proposed conditions of the 10%, 1% AEP and PMF design storm events.

Figure B.4, **Figure B.5** and **Figure B.6** present the peak flood level increase relative to the base case conditions for the of 10%, 1% AEP and PMF design storm events.

Figure B.7, **Figure B.8** and **Figure B.9** present the flood velocity for the proposed conditions of 10%, 1% AEP and PMF design storm events.

Figure B.10, **Figure B.11** and **Figure B.12** present the flood hazard for the proposed conditions of 10%, 1% AEP and PMF design storm events.

The following sections provide comments to the modelling results specific to different areas within the CPRP.

8.2 Deck Flows Simulation

The over rail deck catchment has been divided into two areas as outlined in **Section 7.2.4**. The Deck (north) catchment is assumed to discharge to the Devonshire stormwater line and the Deck (south) catchment is drained to the Stone-Arch trunk line. **Table 8-1** summarises the simulated peak runoff from the deck catchments for the 10%, 1% AEP, and PMF events.

Table 8-1: Peak Runoff from Deck Catchments

Location	Catchment Area (m^2)	10% AEP	1% AEP	PMF
Deck (north)	40,180	2.2	3.0	11.1
Deck (south)	11,360	0.6	0.9	3.1

Note: Peak duration 25-minute event for the 10% and 1% AEP and 15-minute for PMF.

8.3 Design Flood Conditions

8.3.1 Prince Alfred Park Overland Flow Path

Prince Alfred Park overland flow path traverses across the Prince Alfred Park, Prince Alfred Sidings precinct, Flyovers Area, Sydney Rail Yard and Regent Street Sidings sub-precincts. **Figure 8-1** illustrates the proposed development elements and its interaction with the overland flow path.

Four development components would affect the Prince Alfred Park overland flow path:

1. Proposed buildings in Prince Alfred Sidings sub-precinct along the northern boundary Prince Alfred Park obstructing the overland flow path
2. Decking of Sydney rail yards (south) redirects the runoff from the deck to the Stone-Arch stormwater branch
3. Proposed buildings in Regent Street Sidings sub-precinct.
4. Removal of the workshop building and masonry walls north of Mortuary Station building

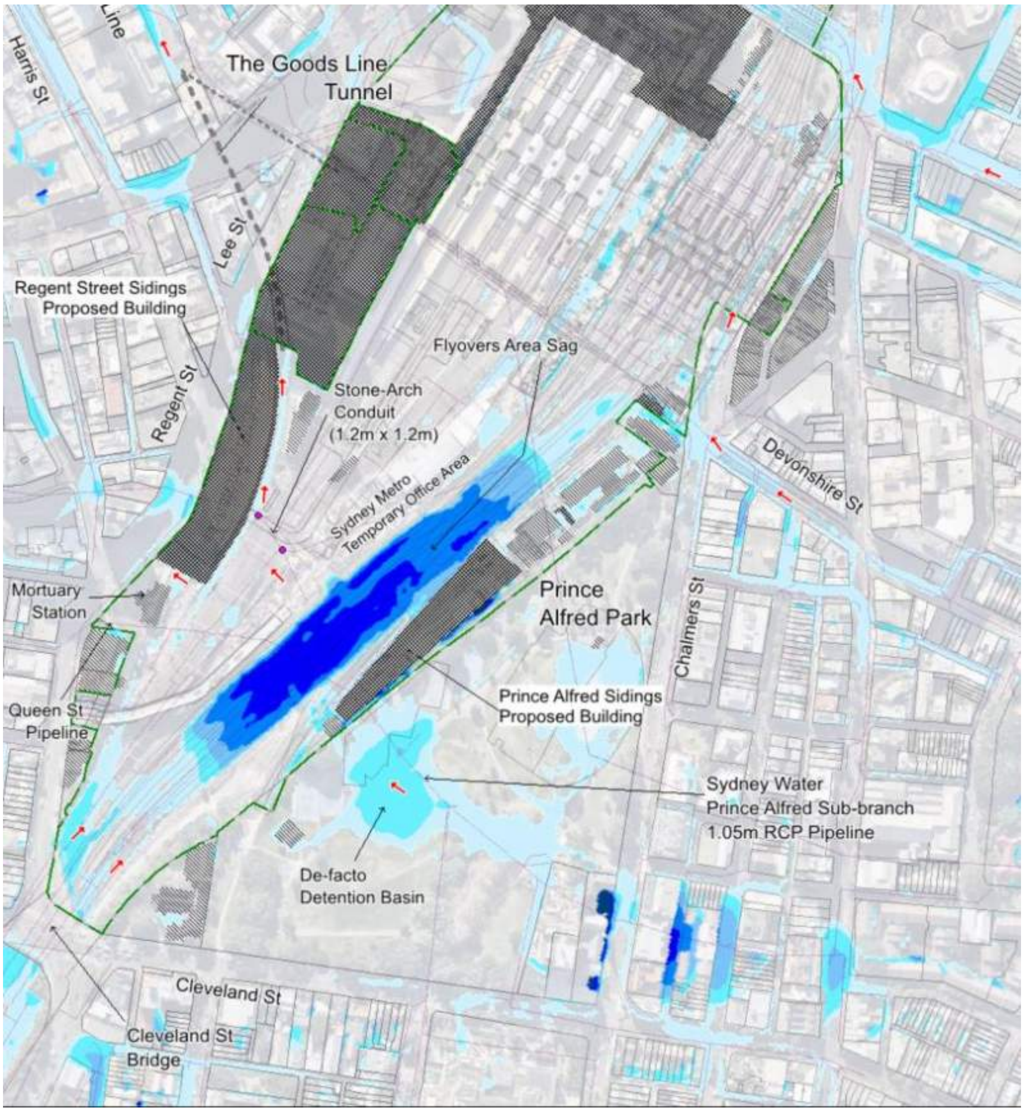


Figure 8-1: Flood Regime - Prince Alfred Park - Proposed Conditions (1% AEP)

Figure 8-2 presents the flood level changes for the Prince Alfred Park overland flow path in the 1% AEP event. summarised the changes in flood characteristics relative to the base case conditions. For detailed flood depth, flood impact, flood hazard and flood velocity maps, readers for other modelled events can refer to flood maps in **Appendix B**.

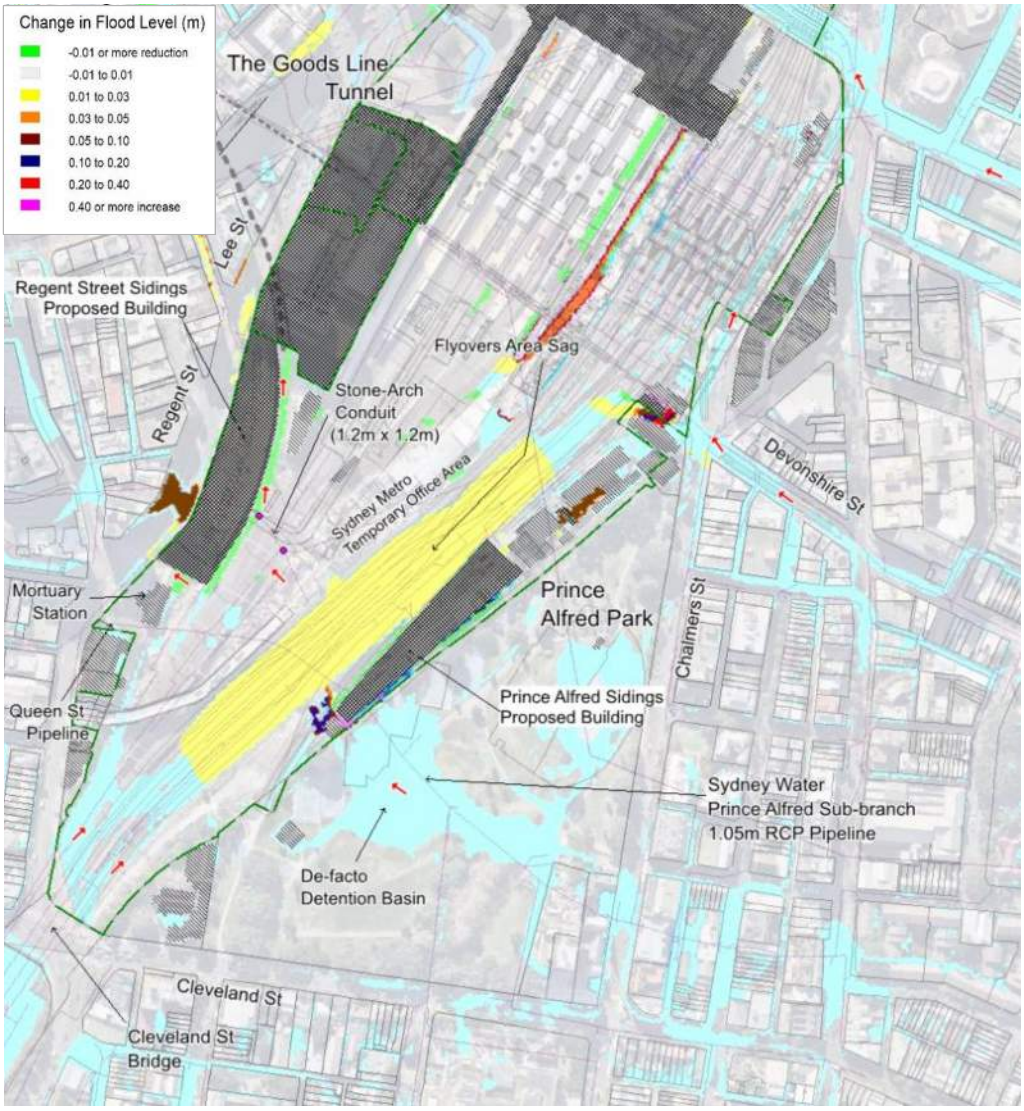


Figure 8-2: Flood Level Impact - Prince Alfred Park - Proposed Conditions (1% AEP Event)

Following comments are made:

a. Refer to **Figure 8-2**, the flood modelling predicted an increase in flood level of about 0.6m at the western end of the proposed building footprint in Prince Alfred Sidings in the 1% AEP event. The flood level impact exceeds 2.0m in the PMF event. The flood impact results from an insufficient gap between the proposed building footprint and the nearby existing building. The 2m wide gap does not allow sufficient overland flow to pass efficiently. The flood modelling indicates that the proposed layout has to provide an adequate overland flow path to prevent flood impacts on the existing buildings. In addition to this, table drains should be installed along the boundary with Prince Alfred Park to collect flows from the park and direct them to the designated overland flow path.

b. There is a small change relative to the base case for the conduit flow of the 1.05m RCP stormwater trunk line for the 10% and 1% AEP and the PMF event, as the pipeline is full in the base case for all three simulated events.

c. There are significant flow increases for the Stone-Arch branch. The increases are due to the deck flow entering the trunk line from the assumed downpipe system. For instance, the 1% AEP conduit flow is 0.36m^3/s in the base case, the flows are coming from the rail yard area. In the proposed conditions, the conduit is 0.86m^3/s are entirely originated from the downpipe flows, no flows are from the rail yard as it has been decked over. The conduit flow slightly less than Deck (south) peak flow (0.9m^3/s) is likely due to the pipe routing effect.

d. The modelling has assumed that the Stone-Arch branch received no inflow from the Flyovers sag. Should the assumption changed, the Stone-Arch could be full before it received the deck flow, hydraulic performance of the conduit could be different.

e. There is a slight variation of flood depth at the Flyovers sag ranging from a 24mm decrease to 13mm increase for the 10%, 1% AEP and PMF events. These variations are relatively small compared to the predicted flood depth which is over a meter. The overall effect on the flood storage at the sag would be insignificant.

Table 8-2: Flood Summary - Prince Alfred Park - Proposed Conditions

Location	Flood Characteristics	10% AEP	Diff	1% AEP	Diff	PMF	Diff
Prince Alfred Park Green/Oval	Flood Level (mAHD)	25.27	0.00	25.33	0.00	25.57	0.00
Prince Alfred Sidings Eastern Boundary 1.05m RCP	Conduit Flow (m^3/s)	2.0	-0.04	2.0	-0.07	2.1	-0.12
Prince Alfred Sidings Eastern Boundary	Overland Flow (m^3/s)	1.9	-0.01	4.1	-0.11	23.3	-0.59
Flyovers Sag	Flood Level (mAHD)	18.16	-0.02	18.93	0.01	21.04	0.01
Flyovers Sag	Flood Depth (m)	1.1	-0.02	1.9	0.01	4.0	0.01
Regent St, Western Boundary, 1.05m RCP	Conduit Flow (m^3/s)	1.8	-0.01	1.8	0.02	1.9	0.02
Sydney Rail Yards West StoneArch 1.2 mx1.2 m,	Conduit Flow, (m3/s)	0.6	0.38	0.9	0.50	3.8	-0.40
The Goods Line Tunnel	Overland Flow (m^3/s)	0.2	-0.16	0.3	-0.25	26.5	-5.30
Spill at Mortuary Station North	Overland Flow (m^3/s)	0.2	0.20	0.3	0.31	3.9	3.75
Regent St, Road Sag	Flood Level (mAHD)	17.80	0.04	17.90	0.08	18.49	0.19
Regent St, Road Sag	Flood Depth (m)	0.38	0.10	0.50	0.07	1.08	0.09
Cleveland St Bridge	Overland Flow (m^3/s)	0.9	-0.01	1.9	0.00	11.9	0.01

Note: For flow locations refer to **Figure 8-1.**

8.3.2 Devonshire St Overland Flow Path

For the Devonshire/Chalmers Street intersection, the proposed development components that would influence the local flood regimes are:

a. Inclusion of the stair/elevator support structures of the access bridges linking the decked area to Prince Alfred Sidings area. Stair/elevator structure, SE-1 is located adjacent to the existing Central Station Chalmers Street Exit. Stair/elevator structure, SE-2 is located amongst the existing buildings within Prince Alfred Sidings Area. For locations refer to **Figure 8-3**.

b. Deck (north) flows from the decked level piped to Devonshire stormwater trunk line.

Figure 8-3 shows the 1% AEP flood regime and **Figure 8-4** presents the 1% AEP flood level changes. **Table 8-3** summarises the flood characteristics in the vicinity of Chalmers Street Exit. Comprehensive flood maps for the proposed conditions can be found in **Appendix B**.

Following comments are made to the flood results:

a. It can be seen that the Devonshire stormwater trunk flow has increased by 1.78m^3/s in 1% AEP due to the assumed downpipe flows from the deck. The increase is less than the Deck (north) peak flow 3.0m^3/s (refer to **Table 8-1**), this is largely due to the difference in time of flow peak between the trunk and pipe systems, and to a minor extent the storage effect in the pipeline.

b. There are negligible changes to the rail yard flood level for the 1% AEP case. For the PMF event there are about 40 to 50mm decreases in flood level for the Track/Platform 1 to 15 underneath the deck and the 30mm to 50mm increases for the Track/Platform 16 to 23. The reduction of flood level is likely due to the local rainfall runoff to the Track/Platform 1 to 15 intercepted by the deck. The increases in flood level from Track/Platform 16 to 23, could be related to the rises of pipeline HGL upstream of the decked area associated with the deck runoff directly entering the stormwater trunk line.

c. The ponding extent reduced for the 10% AEP and 1% AEP events for the covered portion of the country train rail yard. There are negligible flood level changes to the suburban train track/platform for the 10% and 1% AEP cases. For the PMF event there are about 40 to 50mm decreases in flood level for the country train track/platform underneath the deck. The reduction of flood level is likely due to the local rainfall intercepted by the deck. There are 30mm to 50mm increases in flood level for the suburban train track/platform. The increases could be related to the rises of pipeline HGL upstream of the decked area associated with the deck runoff directly entering the stormwater trunk line.

d. Refer to **Figure 8-4** and flood impact maps **Figures B5 and B6** in **Appendix B**, the proposed SE-1 structure would significantly impact the local flood level in the 1% AEP event. The predicted flood level increase upstream of SE-1 is about 0.3 m. For ES-2, the modelled local flood level increase is about 0.8 m. The magnitude of increase deems to be unacceptable. In the PMF event, SE-1 with the assumed footprint would cause considerable obstruction to the Prince Alfred Sidings access road flow path, as the result, there is about 3.2m^3/s of overland flow diverted to Chalmers Street. Flood level at the entrance of the Chalmers Street Exit has increased by 0.17m compared to the base case conditions, this would further reduce the flood immunity of the entrance structure.

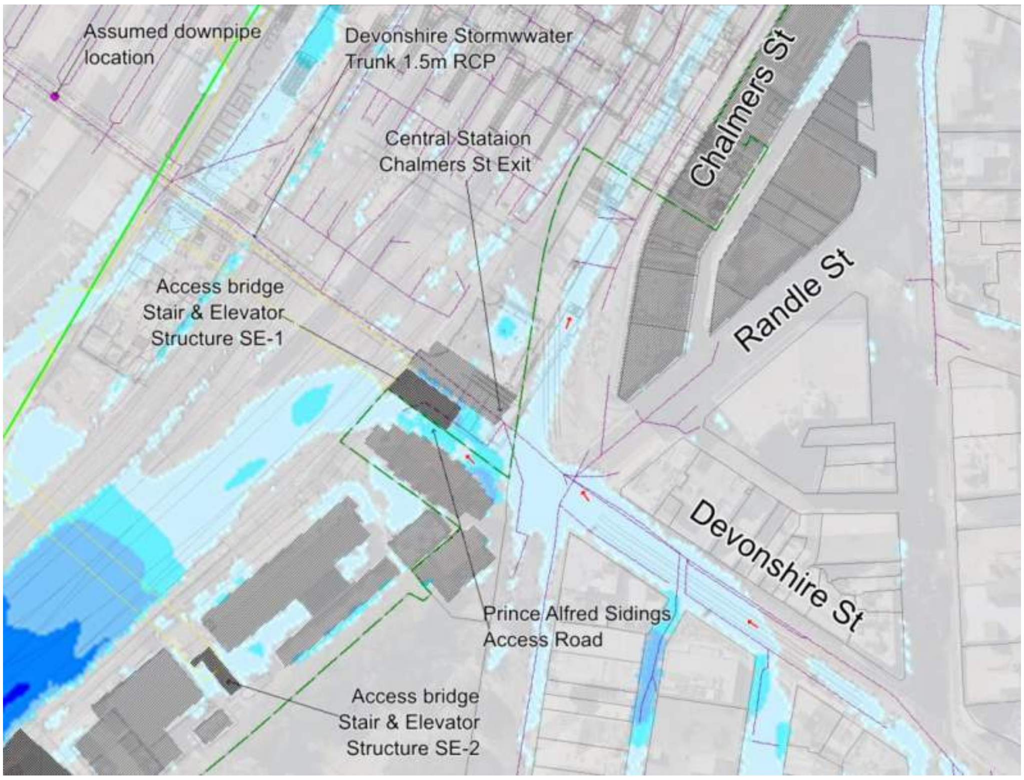


Figure 8-3: Flood Regime - Devonshire St/Chalmers St Intersection - Proposed Conditions (1% AEP)

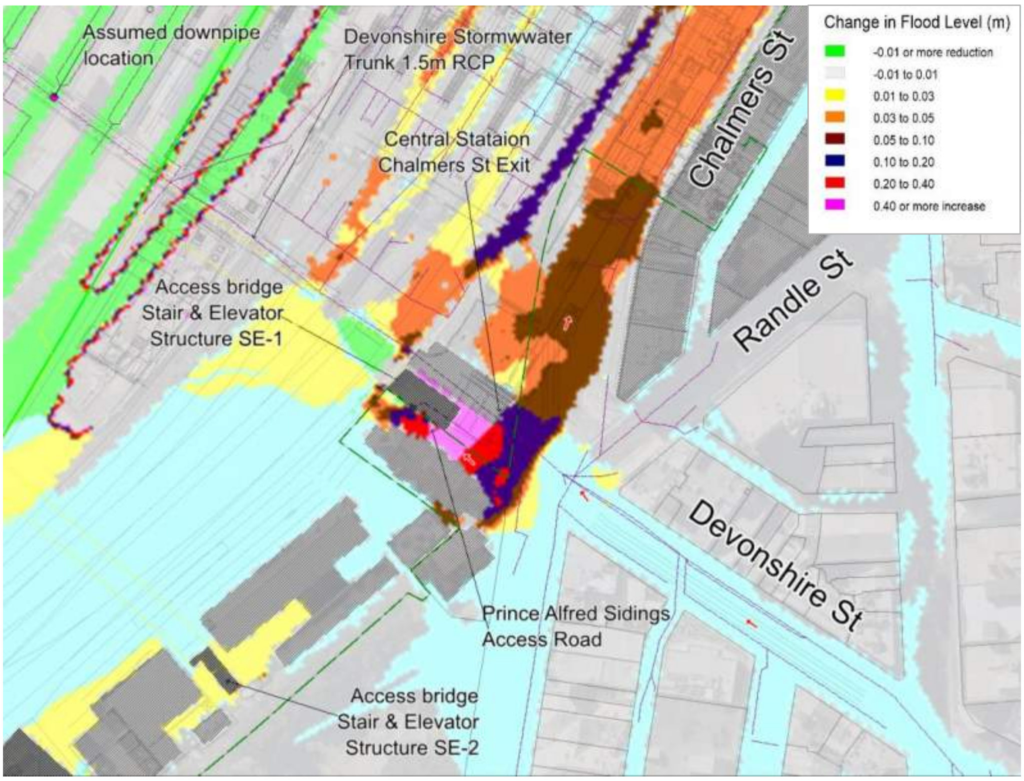


Figure 8-4: Flood Level Impact - Devonshire St/Chalmers St Intersection - Proposed Conditions (1% AEP)

e. Comparing the flood hazard maps of the base case and the proposed conditions indicates that there are no hazard category changes along the Devonshire Street flow path in the 10% AEP event. For 1% AEP event, the Prince Alfred Sidings access road next to the proposed SE-1 structure is high hazard H5 as opposed to a H1 hazard category in the base case. The increase in hazard is due to high flow velocity resulting from a reduction in the overland flow path width. For the PMF event, the flood hazard of Chalmers Street increases as significant flow diverted from the sidings access road flow path to Chalmers Street.

f. Following mitigation options may be considered for the Devonshire overland flow path:

   – Relocation of the stair/elevator support structures away from the existing overland flow path, such as Prince Alfred Sidings access road.

   – Reduction of obstruction to the overland flow by minimising the structure footprint or use of flow permeable structures such as plank staircase.

   – Integrate the proposed structure with the existing building structure. For instance, the SE-1 may be integrated with the existing Chalmer Street Exit structure.

   – Improve inlet capacity to convey overland flow to the stormwater trunk line.

Table 8-3: Flood Summary - Devonshire St Overland Flow Path - Proposed Conditions

Location	Flood Characteristic	10% AEP	Diff	1% AEP	Diff	PMF	Diff
Devonshire St Intersection U/S	Overland Flow (m^3/s)	0.9	0.00	2.3	0.09	14.5	0.32
Chalmers St Intersection D/S	Overland Flow (m^3/s)	0.3	0.00	0.7	0.02	9.9	3.68
Prince Alfred Sidings Access Road	Overland Flow (m^3/s)	1.0	0.00	2.6	0.15	12.0	-3.19
Devonshire Tunnel Stormwater Trunk 1.5m RCP, under Chalmers St Exit Structure	Conduit Flow (m^3/s)	3.8	0.02	4.2	-0.30	4.3	-0.91
Devonshire Tunnel Stormwater Trunk 1.5m RCP, under Henry Deane Plaza	Conduit Flow (m^3/s)	5.1	0.69	5.9	0.71	8.1	2.28
Devonshire Stormwater Trunk U/S of the Station Exit	HGL (mAHD)	19.53	0.82	22.00	1.77	22.95	0.53
Chalmers St Exit	Flood Level (mAHD)	N/A	N/A	23.35	0.01	23.90	0.14

Note: N/A represents no flood level. For flow locations refer to **Figure 8-3.**

8.3.3 Elizabeth St-Eddy Ave Intersection

Under the developed scenario, CPRP proposes the restoration and modification of the existing Sydney Terminal Building, the building footprint will be extended to the south and the roof drainage will need to be modified. As the details of the modification are not available at this stage, it is assumed that the no roof runoff will drain to the Sydney Rail Yard area and the additional roof runoff will be distributed to the surrounding roadway and public area.

Figure 8-5 shows the 1% AEP flood regime in the vicinity of Foveaux-Elizabeth-Eddy Avenue intersection. **Figure 8-6** presents the flood level changes in the 1% AEP event. Comprehensive flood maps for the proposed conditions are included in **Appendix B**. **Table 8-4** summarises flood characteristics at the intersection.

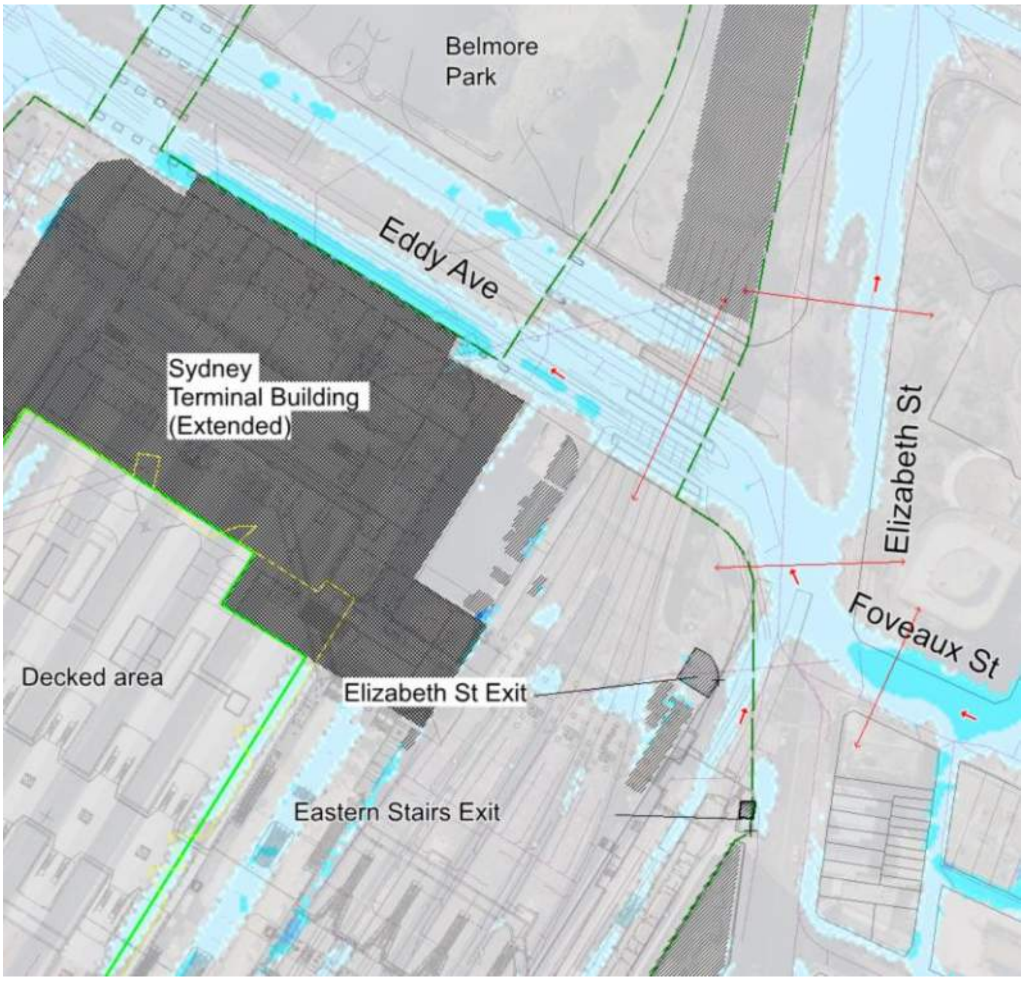


Figure 8-5: Flood Regime - Elizabeth St/Eddy Ave Intersection - Proposed Conditions (1% AEP)

Comments on the flood modelling results are as follows:

a. There is no significant change in the flood regime for the 10% AEP and 1% AEP events. Refer to **Table 8-4**, it shows no flood level impact along Elizabeth St and the Elizabeth Street/Eddy Avenue intersection.

b. With the PMF, refer to **Figure B6 (Appendix B)**, there is about maximum 0.18m flood level increase along Elizabeth Street due to the increase in Chalmers St flows, which is caused by the SE-1 structure blocking the access road overland flow path. Refer to discussion in **Section 8.3.2**.

c. Regarding the flood hazard, there are minimal changes to flood hazard category at Elizabeth Street-Eddy Avenue intersection for the 10%, 1% AEP and PMF events. The intersection is subject to high flood hazard of category H5 in all modelled events.

d. Refer to **Table 8-4**, PMF flood level at the entrance of the Central Station Elizabeth Street Exit has increased by 0.03m and no increase in PMF flood level for the Eastern Stairs Exit was predicted. The flood immunity of the Elizabeth Exit would be reduced under the proposed conditions. As no survey spot levels are available for the entrances, a more definitive statement regarding flood immunity cannot be made.

e. In the next project stage, more accurate flood modelling should employ survey ground surface model for the CPRP project area, together with the SLR work-as-executed information, to minimise the uncertainty with the PMF flood level for flood immunity determination.

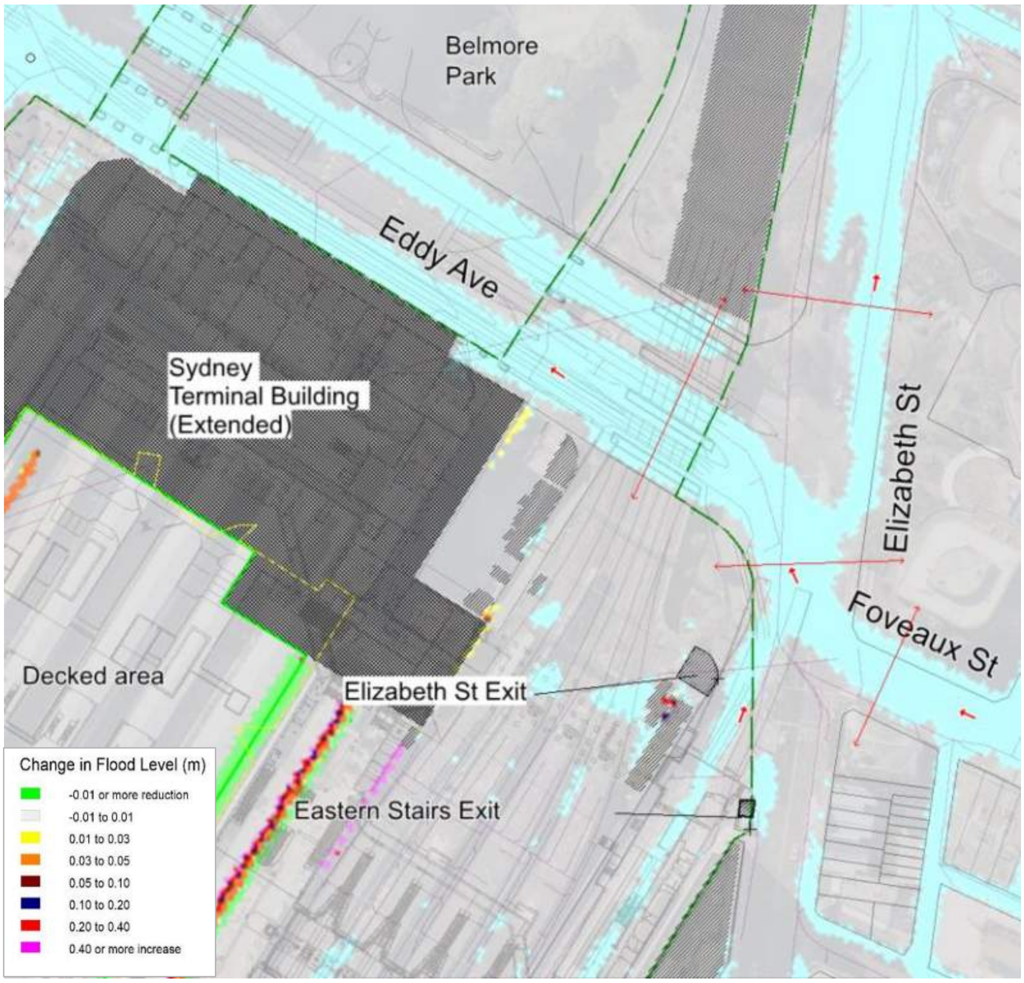


Figure 8-6: Flood Level Impact - Elizabeth St/Eddy Ave Intersection - Proposed Conditions (1% AEP)

Table 8-4: Flood Summary - Elizabeth St/Eddy Ave Intersection - Proposed Conditions

Location	Flood Characteristic	10% AEP	Diff	1% AEP	Diff	PMF	Diff
Foveaux St	Overland Flow (m^3/s)	2.8	0.00	4.9	0.00	20.4	0.00
Elizabeth St	Overland Flow (m^3/s) ^	3.7	0.00	6.4	0.00	38.1	1.75
Eddy Ave	Overland Flow (m^3/s)	2.3	0.00	4.2	0.00	20.8	0.28
Elizabeth St	Overland Flow (m^3/s)	1.4	0.00	2.3	0.00	18.8	1.48
Elizabeth St Exit	Flood Level (mAHD)	N/A	N/A	N/A	N/A	18.99	0.04
Eastern Stairs Exit	Flood Level (mAHD)	20.28	0.00	20.30	0.00	20.69	0.00

Note: N/A represents no flood level. For flow locations refer to **Figure 8-5.**

^ Elizabeth St flow location locates downstream of Foveaux St flow location

8.3.4 Hay St & Campbell St Overland Flow Paths

Hay Street and Campbell Street overland flow paths are located amid the fully developed urbanised area, following generally the existing roadways. No major changes to building footprints or rail structures would be anticipated along the flow paths under the proposed conditions. Hydraulic conditions of the existing flood flow paths are assumed to be unchanged. However, flowrate would be different depending on the proposed changes made to the upstream areas. It is predicted that there will be increases in the overland flow along Chalmers Street and Elizabeth Street due to the proposed SE-1 structure next to Devonshire Street exit. The impact could possibly extend to the Hay Street-Elizabeth Street intersection.

Table 8-5 and **Table 8-6** present respectively the flood characteristics at the Hay Street/Elizabeth Street intersection and Campbell Street/Elizabeth Street Intersection. **Figure 8-7** shows the flood level changes from the intersection and along the Hay Street in PMF event. For more detailed flood mapping refer to **Appendix B**.

Comments on the flood modelling results are as follows:

a. Refer to **Table 8-5,** there are relatively small changes in overland and conduit flows at the Hay Street-Elizabeth Street intersection as the results of the flow diversion at Devonshire intersection. Only in the PMF event, the flood model predicted an overland flow increase of 2m^3/s (~4%) on Elizabeth Street.

b. Refer to **Table 8-6** and **Table 8-5**, there are no or minimal changes in the overland flows at Campbell Street-Elizabeth Street intersection. Flood regime is not affected by the flow changes at Devonshire intersection.

c. In terms of flood level, there is almost no impact on the 1% AEP event. For the PMF flood level increase is generally about 20mm at the Hay Street and Campbell Street intersections with Elizabeth Street. The effect of flow increases from the Devonshire Street intersection has diminished to a minimal level.

d. **Figure 8-7** shows there are larger flood level increases predicted along George Street extending to SICEEP area, the impacts are more likely related to the proposed development changes of the western precincts and will be discussed in the later sections.

e. There are minimal flood hazard changes relative to the base case conditions at both intersections for all three modelled events.

Table 8-5: Flood Summary - Hay St/Elizabeth St Intersection - Proposed Conditions

Location	Flood Characteristic	10% AEP	Diff	1% AEP	Diff	PMF	Diff
Elizabeth St, North	Overland Flow (m^3/s)	2.0	0.00	4.5	0.00	32.8	-0.09
Elizabeth St, South	Overland Flow (m^3/s)	2.4	0.00	4.9	0.00	52.1	1.98
Hay St, East	Overland Flow (m^3/s)	3.6	0.00	8.8	0.00	84.3	1.69
Elizabeth St, North - Oviform	Conduit Flow (m^3/s)	5.7	0.00	6.5	0.00	7.5	0.00
Elizabeth St, South - Oviform	Conduit Flow (m^3/s)	4.2	0.00	5.7	0.00	6.8	0.00
Elizabeth St, South - RCBC	Conduit Flow (m^3/s)	6.7	0.00	7.7	0.00	10.1	0.01
Hay St - RCBC	Conduit Flow (m^3/s)	17.5	0.00	20.8	0.00	26.1	-0.05
Elizabeth St/ Hay St Intersection	Flood Depth (m)	0.15	0.00	0.27	0.00	1.26	0.02

Note: For flow locations refer to **Figure 8-7.**

Table 8-6: Flood Summary - Campbell St/ Elizabeth St Intersection - Proposed Conditions

Location	Flood Characteristic	10% AEP	Diff	1% AEP	Diff	PMF	Diff
Elizabeth St, North	Overland Flow (m^3/s)	3.72	0.00	7.13	0.00	36.80	0.00
Elizabeth St, South	Overland Flow (m^3/s)	1.93	0.00	4.50	0.00	33.52	0.00
Campbell St, East	Overland Flow (m3/s)	1.94	0.00	2.99	0.00	4.88	0.00

Note: For flow locations refer to **Figure 8-7.**

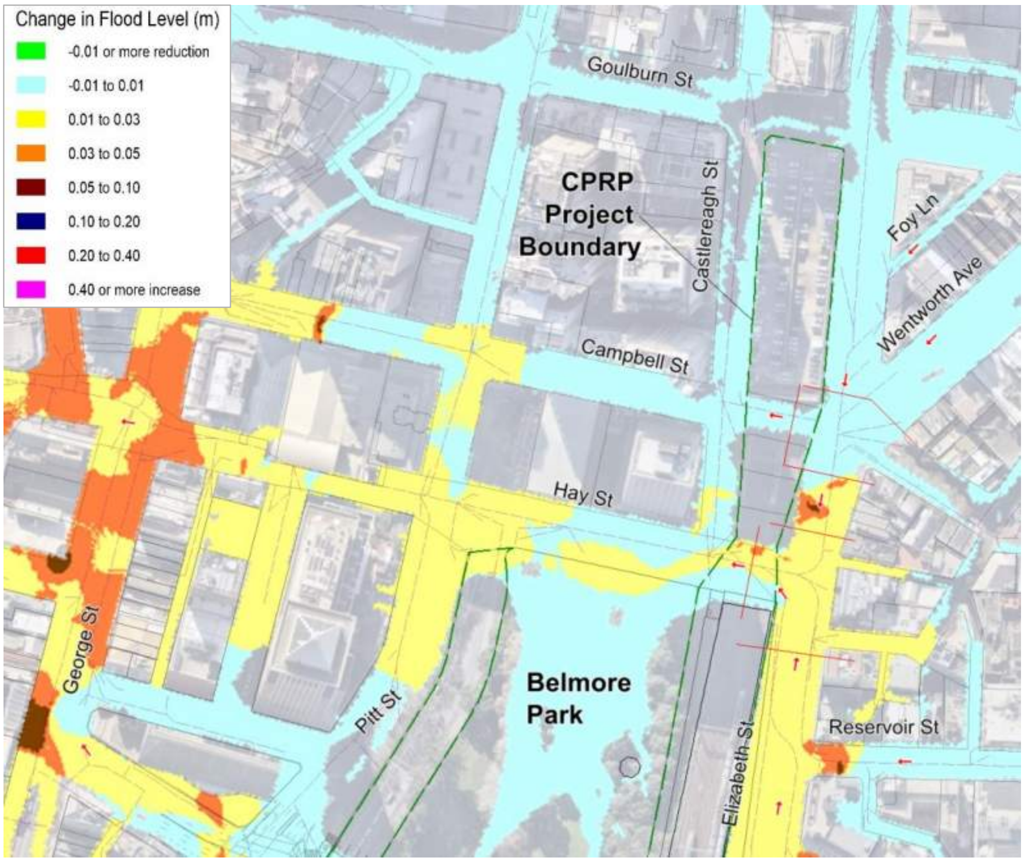


Figure 8-7: PMF Flood Impact - Elizabeth St/Hay St Intersection, Proposed Conditions

8.3.5 Western Forecourt & Western Gateway

Western Forecourt

A community public area is proposed at the western entrance of the Metro Sydney Central walk connecting Chalmers Street to Pitt Street. The proposal also includes a pedestrian corridor at street level linking Eddy Avenue to the community area via the existing Western Forecourt building and a vehicle entrance at Pitt Street to the proposed basement car park underneath the community area.

The flood level at the area is critical as it determines the flood immunity of the underground passages to Sydney Metro Station and the basement car park, and the flood hazard conditions of the corridor to Eddy Avenue. These are important elements from the flood immunity and design perspectives.

Western Gateway

According to the architectural Structure Plan, the existing YHA Hostel, Adina Hotel and Henry Deane Plaza area will be redeveloped. As the development layout is not definitive at this stage, for the current flood modelling, it is assumed the entire precinct will be represented by a single solid block.

The Structure Plan also indicates that the Henry Deane Plaza tunnel walkway entrance will be covered. Under the existing conditions, the tunnel is a minor overland flow path, it is assumed that no local runoff will be blocked from the tunnel walkway entrance, no flow is expected in the tunnel under the developed scenario.

Modelling Results

Figure 8-8 shows the 1% AEP flood regime and **Figure 8-9** presents the 1% AEP flood level changes in the Western Forecourt and Western Gateway Sub-precincts. **Table 8-7, Table 8-8, Table 8-9** show the summary flow and flood characteristics in the precincts.

Following observations and comments can be made to the area:

a. Refer to **Table 8-7.** The modelling predicted that there would have minimal flood issue for the pedestrian corridor to Eddy Avenue. The predicted flow in 1% AEP is about 0.04m3/s and in the PMF event is about 0.16m^3/s, originated from the local catchment draining from the Public community area to Eddy Avenue. The anticipated flood depth would be limited to about 0.2m in the extreme event and would have little flood hazard concern.

b. Refer to **Table 8-7.** The predicted PMF flood level at the entrance of the Sydney Metro Central walk is 14.86 mAHD. This is about 60mm above the design ground level of 14.80 mAHD indicated in the Structure Plan. To ensure PMF flood immunity of the linking to the underground Sydney Metro Central station, the following mitigation may be considered:

   - review ground shaping of the public community area to encourage local runoff draining to Pitt Street
   - provide additional stormwater inlet and conveyance to remove the local catchment runoff.
   - provide stormwater inlet and conveyance to divert external flow away from the local catchment area.
   - raise the entrance highest point to be above the predicted flood level.

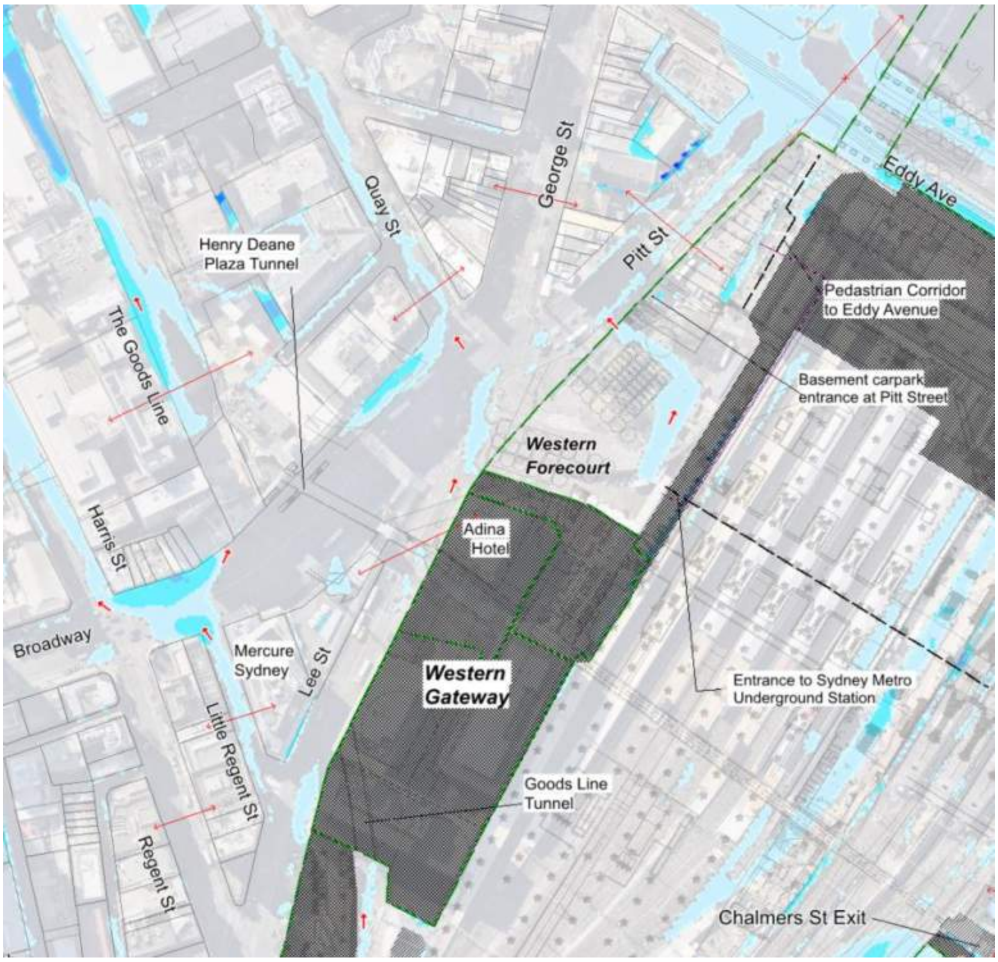


Figure 8-8: Flood Regime - Western Forecourt - Proposed Conditions (1% AEP event)

Table 8-7: Flood Summary - Western Forecourt - Proposed Conditions

Location	Flood Characteristic	Critical Ground Level*	10% AEP	1% AEP	PMF
Eddy Ave Corridor	Overland Flow (m^3/s)	N/A	0.03	0.04	0.16
Eddy Ave Corridor - Eddy Ave Entrance	Flood Level (mAHD)	N/A	11.78	11.81	12.00
Eddy Ave Corridor - Western Forecourt Entrance	Flood Level (mAHD)	14.80	N/A	N/A	14.83
Western Forecourt - Sydney Metro Entrance	Flood Level (mAHD)	14.80	N/A	N/A	14.86
Pitt St - Basement Car Park Entrance	Flood Level (mAHD)	13.62	13.71	13.73	13.80

Note: N/A represents not applicable or no flood level. For flow locations refer to **Figure 8-8.**
(*) - Existing survey ground level at the location of the proposed basement entrance.

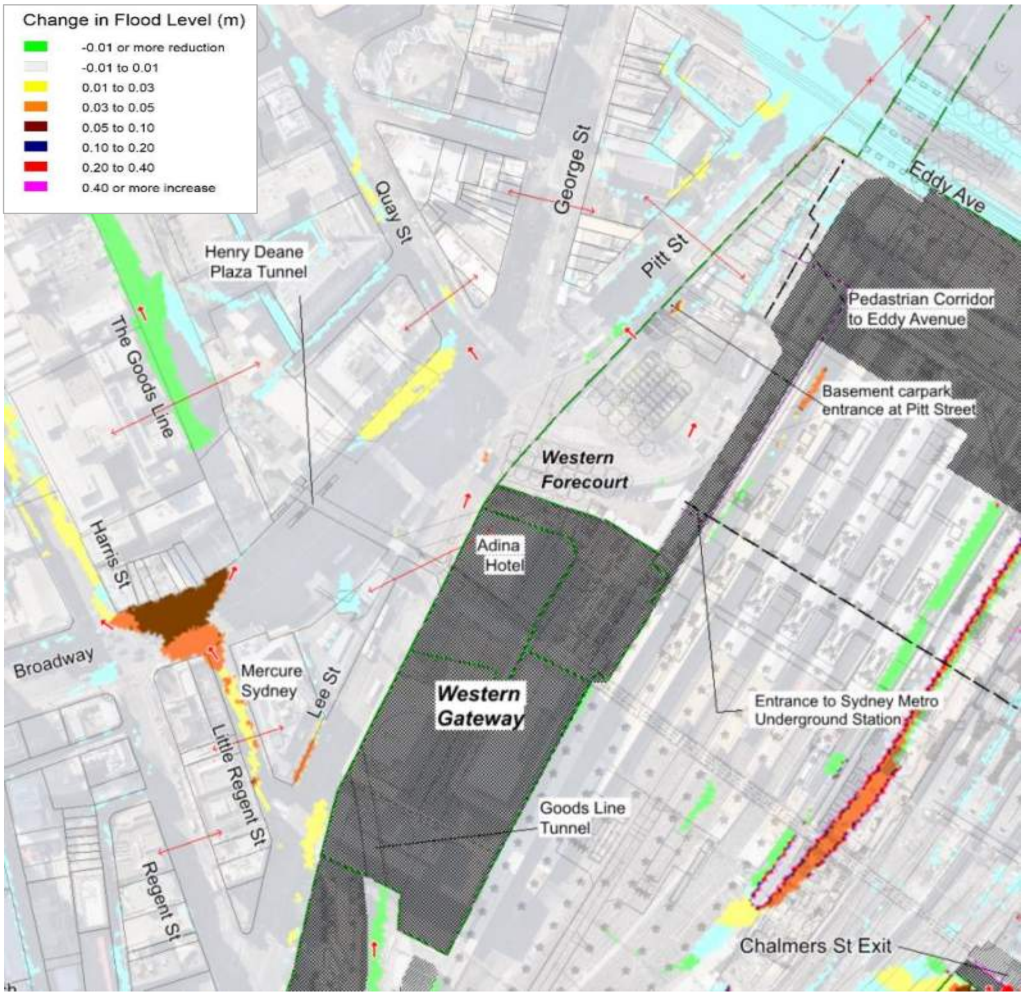


Figure 8-9: Flood Level Impact - Western Forecourt - Proposed Conditions (1% AEP event)

Table 8-8: Flow Summary - Western CPRP Precincts - Proposed vs Base Case Conditions

Flow (m3/s)	Base Case			Proposed			Difference		
	10% AEP	1% AEP	PMF	10% AEP	1% AEP	PMF	10% AEP	1% AEP	PMF
Little Regent St	0.2	0.4	1.7	0.5	0.8	2.9	0.32	0.35	1.16
Lee St (north towards George St)	0.1	0.2	0.6	0.3	0.5	3.6	0.22	0.30	3.07
Quay St (towards SICEEP)	0.4	0.6	2.2	0.5	0.8	3.7	0.12	0.18	1.43
George St (towards SICEEP)	0.2	0.2	1.0	0.2	0.3	1.9	0.03	0.05	0.91
Pitt St (towards SICEEP)	0.6	0.9	3.0	0.7	1.1	4.0	0.08	0.19	1.05
Eddy Ave (south side)	1.6	2.7	14.2	1.7	2.7	14.6	0.05	0.07	0.46
Eddy Ave (north side)	1.0	2.4	11.6	1.0	2.5	11.8	0.01	0.03	0.15

Note: N/A represents no flood level. For flow locations refer to **Figure 8-8.**

c. Refer to **Table 8-7, t**he predicted PMF flood level at the proposed Forecourt basement car park entrance is 13.80 mAHD, which is about 0.1 to 0.2m above the road kerb level (based on survey data), the design of the basement access ramp should be raised above the higher of PMF flood level and 0.5m plus 1% AEP flood level to comply CoS flood policy.

d. Refer to **Figure B.12** in **Appendix B**, the Western Forecourt public area has flood hazard categories H1 and H2, which is considered to be safe for pedestrian/light vehicle movement under the PMF scenario.

e. Refer to **Figure 8-9**, with the 1% AEP event the flood impacts are observed for Lee Street, Little Regent Street, Broadway, Harris Street, George Street, Quay Street and Pitt Street. The modelled maximum flood level increase at the Broadway road sag near Harris Street is about 53 mm. Flood increase would reduce the number of carriageways with flood depth less than 200mm from 4 to 2 in the proposed scenario that would have implications to the local traffic. Refer to **Figure B.6** in **Appendix B**, it shows that there are significant flood level increases in the PMF event for the Lee Street, Pitt Street, Little Regent Street, Broadway, Harris Street, George Street and Quay Street. The predicted level increases are larger than in the 1% AEP case. **Table 8-8** shows the difference in the flow rate are positive representing increases in overland flows for the roadways under consideration.

f. For both the 1% AEP and the PMF events, there is corresponding flood level reduction along The Goods Line Urban Walkway. **Table 8-9** summarises the flows across Goods Line Urban Walk immediately downstream of Goods Line tunnel and Henry Deane Plaza tunnel. The reduction in flowrates for the proposed conditions are 0.46m^3/s and 5.8m^3/s respectively in 1% AEP and PMF events. This would be directly related to the development assumption that the Regent Street Sidings precincts has assumed no runoff would be diverted to the Goods Line tunnel under the proposed conditions and the Henry Deane Plaza walkway would no longer receive local catchment flows.

   Table 8-9 also compares with the total estimated overland flow to Darling Harbour and The Goods Line Urban Walkway flows. The total diversion to Darling Harbour is estimated by adding up increases in the overland flows for the local streets in **Table 8-8**. In the PMF event, the estimated total diversion to Darling Harbour is about 5.2m^3/s, which is comparable to 5.8m^3/s for The Goods Line Walkway flow. This indicates that the importance of preserving The Goods Line flow rate to the pre-development level to minimise the impact to downstream SICEEP areas and the need for flood mitigation works.

g. The increase in roadway overland flows can also be related to the fact that the deck runoff has been directly input to the Devonshire stormwater trunk line. The Devonshire stormwater carries about 0.7m^3/s and 2.3m^3/s more flow than the base case flows for the 1% AEP and PMF events, equivalent to about 15% and 37% increase in flowrates. As the conduit flow increases, the HGL of the pipeline also increases, the conduit may surcharge at downstream sag locations and road runoff will also find it harder to enter the system. In any case, this will result in increases in overland flows and flood levels.

h. The flood level increase in the PMF may also affect the flood immunity of existing basement car parks in the vicinity. For instance, car park entrance for the Mercure Sydney at Little Regent Street would be affected by the higher PMF level. Refer to **Photo 8-1** for the Mercure basement entrance.

i. To mitigate the flow and flood level increases to the surrounding roadways, the following measures may be considered:
   - Divert part of the Western Gateway and Regent Street Sidings Sub-precincts runoff to The Goods Line track and tunnel to match flow levels as in the base case scenarios.
   - Inclusion of on-site-detention to reduce the deck runoff flow rates
   - Inclusion of on-site-detention to Western Gateway and Regent Street Sidings precincts to reduce peak flow rates to the adjoining roadways
   - Maintain the rail yard flood storage to a similar level as in the base case scenario by adjusting the surcharge setting from the deck downpipe system.

Table 8-9: Flow Summary – Goods Line & Henry Deane Plaza - Proposed vs Base Case Conditions

Flow (m3/s)	Base Case			Proposed			Difference		
	10% AEP	1% AEP	PMF	10% AEP	1% AEP	PMF	10% AEP	1% AEP	PMF
Henry Deane Plaza Tunnel	0.2	0.3	1.1	0.0	0.0	0.0	-0.21	-0.31	-1.13
Goods Line Tunnel	0.3	0.5	31.8	0.2	0.3	26.5	-0.16	-0.25	-5.30
Goods Line Urban Walk	0.7	1.0	30.9	0.4	0.6	26.8	-0.31	-0.46	-5.77
Total Flow Moving Downstream to Darling Harbour ^	4.0	7.2	33.7	4.6	8.1	38.8	0.61	0.86	5.17

Note: N/A represents no flood level. For flow locations refer to **Figure 8-8.**

^ estimated by adding Little Regent St, Quay St, George St, Pitt St, Eddy Ave flows from **Table 8-8.**

Photo 8-1: Mercure Sydney Basement Car Park Entrance of Little Regent St

9 OUTSTANDING ISSUES & RECOMMENDATIONS

Table 9-1: Outstanding Issues & Recommendations

Outstanding Issue	Description	Effect on Flood Modelling Result	Recommendation
Survey of rail yard Drainage (general)	Flyovers area is a prominent sag area. Flood modelling shows that the area has a substantial flood storage volume (80,000m^3 in PMF). Flood regime of the upstream and downstream of Prince Alfred Sidings area could be significantly influenced by the storage effect of the sag. The sag is drained by the rail yard drainage which controls the flood storage hydraulic.	Uncertainty of Flyovers area flood level that may influence the flood regime downstream, in particular at the Regent Street sag. The Prince Alfred Sidings area is slightly elevated above the sag PMF level, the area and the upstream park area is less sensitive to any rail yard drainage uncertainty.	Detailed survey of the rail yard drainage to confirm the modelled configuration is recommended to reduce flood regime uncertainty in the next project stage.
Sydney Rail Yard Flood Record	Flood modelling results show that the Flyovers area sag is subject to more than 1m of ponding in the 10% AEP event. This implies the City Circle services including the airport line would be interrupted in 1 in 10 year on average. The predicted frequency seems high. Anecdotal evidence from Sydney Rail can confirm if the predicted frequency of interruption is consistent with the observations.	As above	To obtain the rail yard flood records for the Flyovers sag and the related service interruption records for model validation.
Survey of Decommissioned Stone-Arch Branch Across Flyovers Area Sag	Flood modelling indicated that Stone-Arch branch north of Flyovers area sag to Regent Street road sag is only 10% full in 10 % AEP and 14% full in 1% AEP. The Stone-Arch conduit has a nominal dimension of 1.2mx1.2m. Sydney water records show that the existing Stone-Arch branch was originally connected to the Prince Alfred Park Sub-branch and the section across the Flyovers sag was decommissioned some time ago. It is a concern that if the Flyovers area is still connected to the Stone-Arch branch it may explain why the high modelled flood depth and the Stone-Arch branch could be "fuller" than the current flood model results indicate.	If the live connection to Stone-Arch branch exists, the Stone-Arch branch would be "fuller" than the model currently suggests. The Regent Street flood sag flood level will be higher than currently predicted. This will affect the flood planning level for the Regent Street Sidings Precinct. Moreover, in the proposed conditions, the runoff from the deck (south) catchment has been discharged to the Stone-Arch branch, surpassingly, taking advantage of its 'spare' capacity. The current prediction of the flood impact may be distorted.	Rail yard survey at Flyovers area sag to confirm if the decommissioned line has any live inlet connection to the Stone-Arch branch downstream.
Survey of Stone-Arch Branch at Regent Street Sag	Flood level at the Regent Street road sag is sensitive to the hydraulic regime of Stone-Arch Branch which are controlled by the inlet connection and configuration of Regent Street and Flyovers sag.	As above	Survey to confirm the inlet system to the section of pipeline including inlets at the Regent Street sag.
Post-Sydney Metro Rail Yard Drainage	The post-Sydney Metro drainage information is not available at this stage. The current Base Case flood modelling has been	The uncertainty of the Sydney Metro drainage likely affects the flood prediction for the smaller	Update the CPRP flood model with information when available.

Outstanding Issue	Description	Effect on Flood Modelling Result	Recommendation
	based on the best available rail yard track drainage information of the pre-Sydney Metro conditions. The discrepancy may lead to certain uncertainty to modelled results.	events. As the stormwater trunk system is expected to be full in the larger storm events, the effect of the uncertainty on flooding would be diminished. It is anticipated that flood prediction for the 1% AEP or larger event would be reasonable representations.	
Proposed CPRP Drainage and Deck Drainage Systems	The current proposed conditions flood modelling has been based on the best available rail yard track drainage information for the pre-Sydney Metro conditions and quite arbitrary deck drainage assumptions. This would lead to uncertainty to the modelled proposed conditions results.	The concept of the interface of deck drainage to the rail yard level is yet to be developed. The deck drainage system configuration can vary as constraints identified. The effect of the uncertainty of CPRP on flooding is not known at this stage. This uncertainty may have an effect on the flood mitigation measures adopted for Western Forecourt, Regent Street Sidings sub-precincts.	Proceed the stormwater masterplan and concept design of CPRP/Deck drainage in the next stage. Update CPRP flood model with a more “realistic” deck drainage design to reduce uncertainty.
Sydney Light Rail Work as Executed Information	The CPRP flood model has adopted partial information available from SLR as the provided SLR flood model is incomplete. The CPRP flood modelling has been based on LiDAR ground surface adopted in CoS flood models in place of the SLR design surface. The resulting flood level along the SLR route could be subject to uncertainty due to the difference of the design SLR and the LiDAR surface.	As Central station has several entrances/exits to the underground concourse area (Elizabeth Street exit, Eastern Stairs exit and Devonshire Street exit) which are located along the SLR, the predicted flood results may change if the as-built SLR road level is used and this would affect the assessment of the flood immunity of the station exits.	Update the CPRP flood model with the SLR WAE information when available. Alternatively, undertake a topographic survey along the SLR route in the proximity of the CPRP project to incorporate into the flood model.
Topographic Surface Information in the CPRP Site	The CPRP flood model has adopted LiDAR ground surface from the CoS flood models. LiDAR is typically subject to vertical error of 0.15m and horizontal error of 0.45m. The flood model accuracy would also be expected to be affected by a similar order of magnitude. For this reason, it is a common practice for the flood model used for design work using the local ground surface information developed from topographic survey in the vicinity of the project site, in place of LiDAR data.	This is essential that the proposed design be based on topographic survey information. Flood assessments compare the flood regime changes purely due to the design changes, otherwise some changes could be due to changes in ground level reference sources. In addition the modelled flood surface would be more accurate for flood immunity assessment when using topographic survey information.	Update the CPRP flood model with local ground surface model derived from topographic survey information.
Survey of Existing Central Station Entrance/Exit Level	The survey level information is not available for the Elizabeth Street exit and Eastern Stairs exit.	Flood immunity for these exits cannot be assessed.	Undertake topographic survey for all existing Central station entrances/exits.

Outstanding Issue	Description	Effect on Flood Modelling Result	Recommendation
BOOS Design Flow Information	The BOOS is sewerage constructed in 1880's to carry sewage to the ocean. The discussion of Sydney Rail Yards drainage connection to the BOOS has been documented by Sydney Metro C&S referenced design report. The rail yard area is partly drained to BOOS located underneath the Rail Track 1 and 2. In the current flood modelling, the BOOS design flow and tailwater level have been based on somewhat arbitrary assumptions.	The flood characteristic of the rail yard will therefore be influenced by the hydraulic assumptions of BOOS. The stormwater capacity of the BOOS for the rail yard drainage relative to the other existing trunk drainage systems draining the rail yard. It is expected that the effect of the assumptions diminishes with the magnitude of flood events.	It is recommended that • the connection of the rail yard to the BOOS is to be confirmed by the detailed survey. • Undertaking detailed sewage hydraulic modelling to inform the design sewage flow and tailwater level assumption in the next stage of flood modelling.
ARR2019	ARR2019 is the national guidelines on hydrologic investigation and it represents the latest engineering best practices. There is an expectation that all future projects would be adopting the ARR2019 standard. The current flood modelling has been based on ARR1987 methodology used in the CoS flood models. The use of ARR1987 is in general less involved and requires relatively less simulation effort. This benefits the current commission of work in terms of project cost and time requirements. The main objectives of the current flood modelling are exploratory in nature, to investigate the existing flood issues in the vicinity of the project area and to identify the potential flood impacts of the future development. Whilst the use of ARR1987 at this stage is considered to be adequate to provide the insights to these issues, the ARR2019 is to be adopted at a later stage of the CPRP development.	Experience from other projects indicates the flood level predicted with the use of the ARR2019 approach tends to be lower. This impact however would need to be confirmed for the CPRP with additional flood modelling.	It is recommended that consideration the use of ARR2019 approach in the next flood modelling stage
Consultation of Stakeholders	Consultation of CoS, SW and other parties in particular current flood modelling results, future flood modelling requirements and design criteria for each development precincts.	To minimise the risk of the disagreement in flood results. Agree on the responsibility of flood mitigation measures with stakeholders.	Consult the stakeholders
Climate Change	Climatic change has not been considered in the current flood assessment.	Consideration of climate change may have an influence on the design of the CPRP.	Include an assessment of climate change in the next stage of the CPRP flood modelling.

10 CONCLUSION

A significant flood modelling exercise has been undertaken to further improve our understanding of the existing and potential flooding regime of the CPRP. This has involved a comprehensive review of previous investigations and a large volume of additional information sources. Results of the flood modelling simulations have been illustrated in a series of flood maps provided in the appendices, along with a comprehensive commentary in this report.

The CPRP is impacted by informal overland flow paths approaching the site during significant rainfall events. Ponding of stormwater within the site also occurs due to a lack of sufficient capacity and extent of the existing drainage network.

The proposed CPRP has the potential to impact flooding by altering the ground surface, concentrating stormwater runoff, altering flow paths and reducing flood storage. The current CPRP flood model demonstrates potential impacts at several locations within the site and surrounding areas. In general, the flood impacts of the proposed CPRP are exacerbating existing flood issues with the magnitude of the impact on peak flood levels being less than 0.5m in the vast majority of locations. With potential flood impacts being identified, the CPRP design can aim to further investigate and mitigate these issues through the design process.

In addition to providing an overview of the current flood investigation undertaken, this report provides recommendations for ongoing enhancements to the flood model to improve its quality, suitability and robustness as the CPRP design progresses. The current flood modelling is considered fit-for-purpose considering the early stage of the project and the initial objectives of this scope. It is expected that this CPRP flood model will evolve and become more detailed and accurate in its representation of the existing site and proposed development as the design progresses. The investigation of flood conditions and potential impacts is anticipated to be ongoing and involves working iteratively with others through the design development, including key stakeholders.

In documenting the work undertaken to date, this report demonstrates the commitment of the CPRP to understand and mitigate flood risk throughout the design process.

11 REFERENCES

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APPENDIX A – BASE CASE FLOOD MAPS

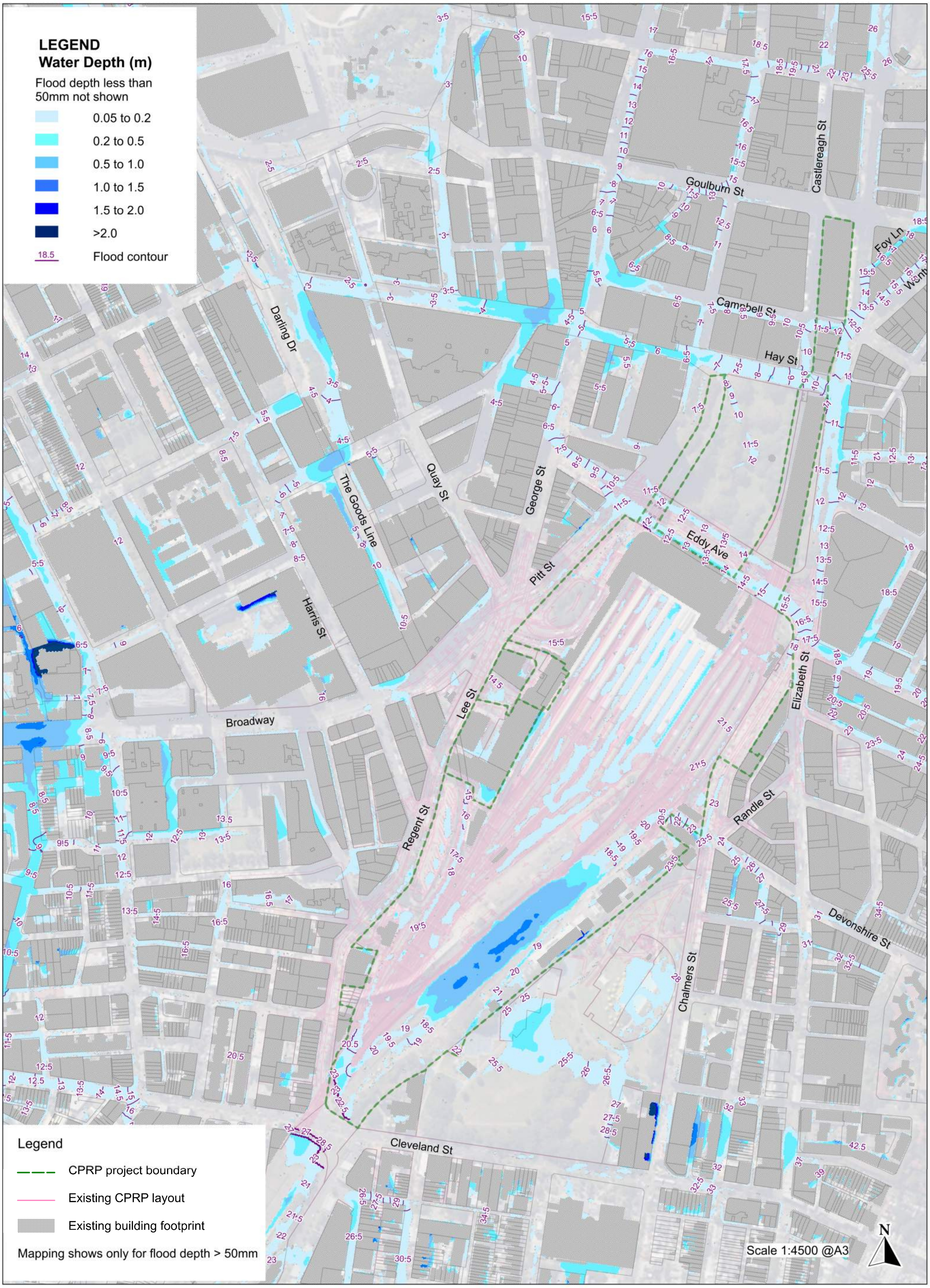

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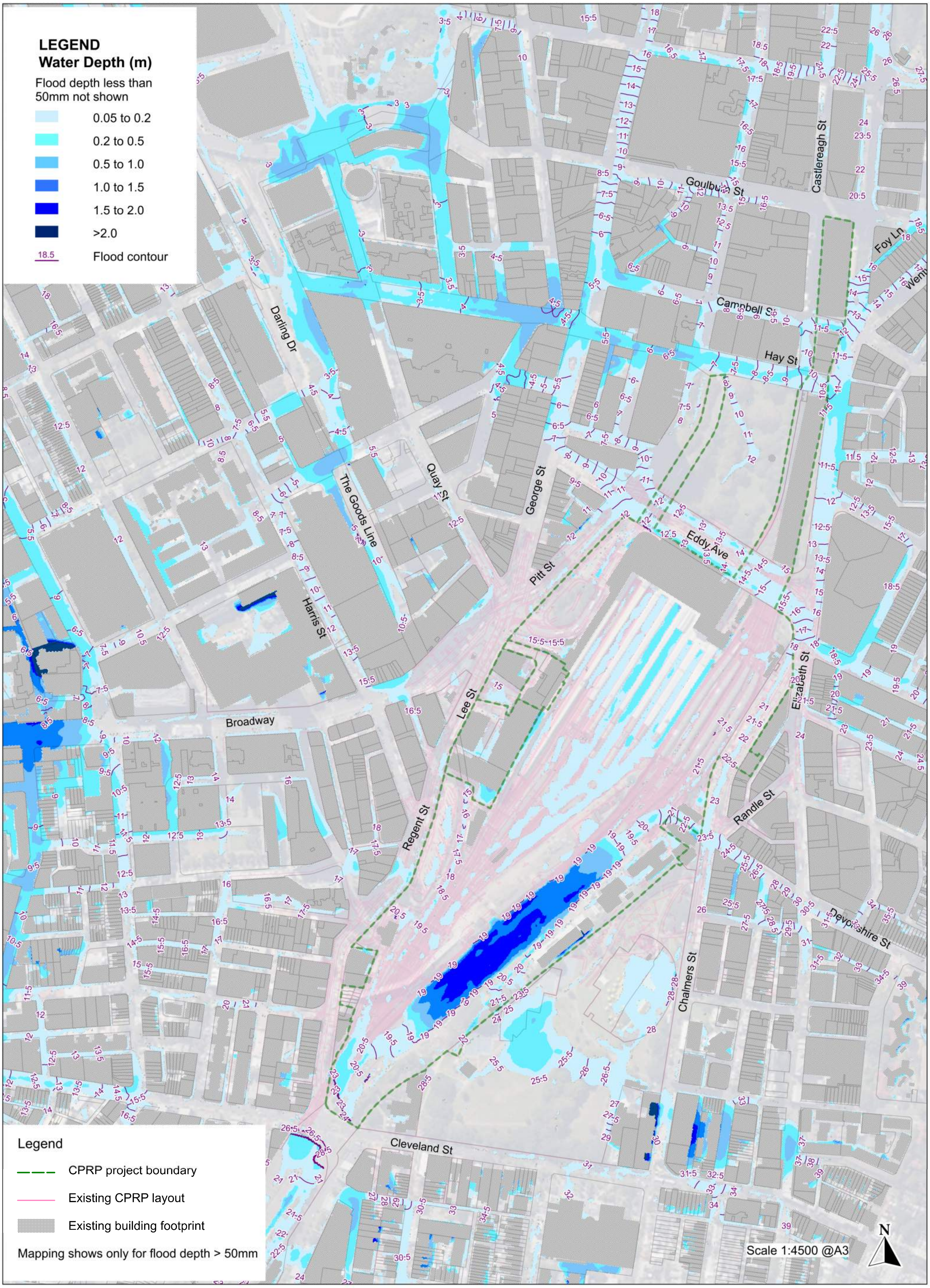
Figure A.1
Flood Depth and Level 10% AEP
Base Case Conditions



Central Precinct Renewal Program

Figure A.2
Flood Depth and Level 1% AEP
Base Case Conditions

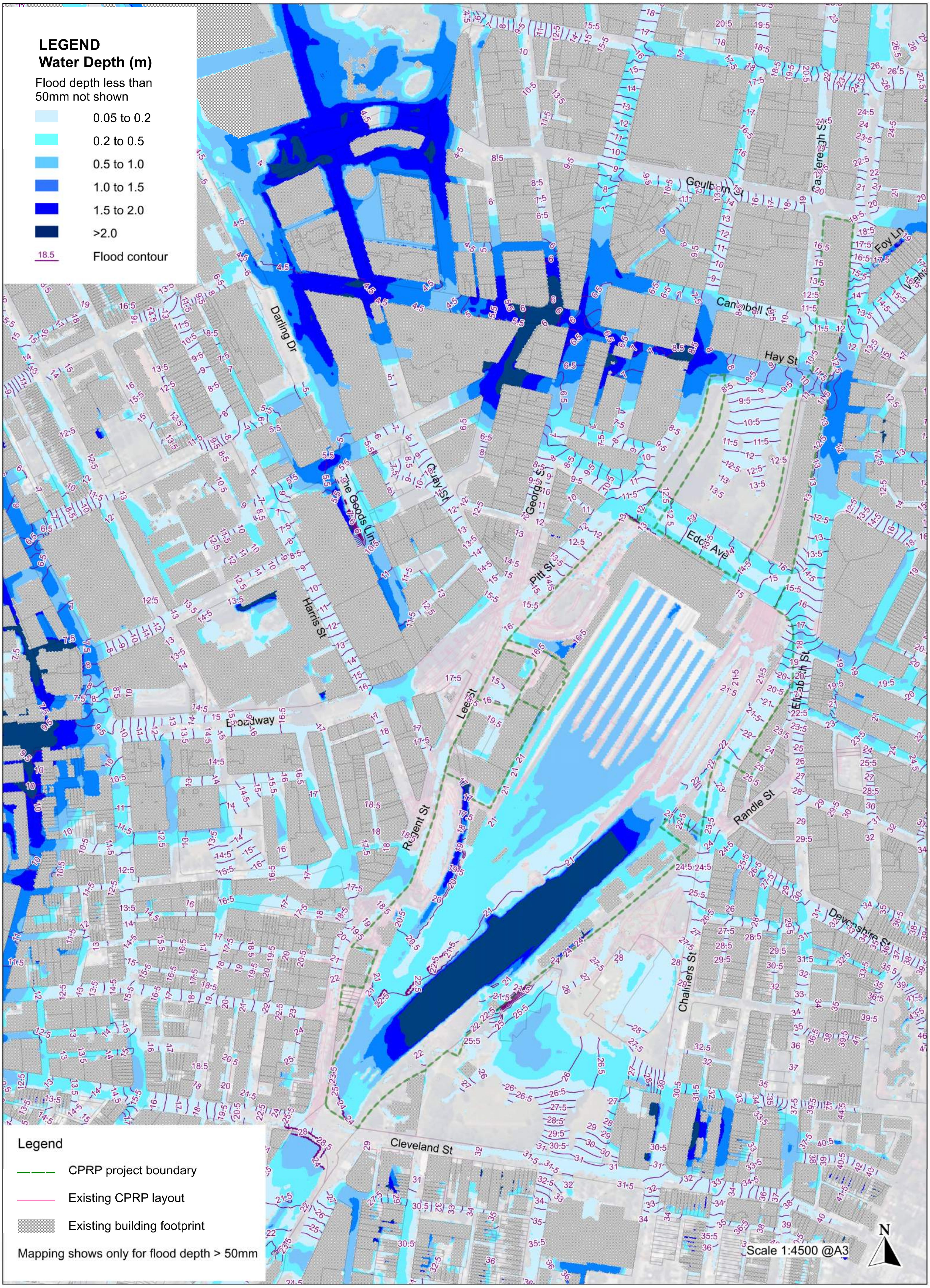


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Figure A.3
Flood Depth and Level PMF
Base Case Conditions

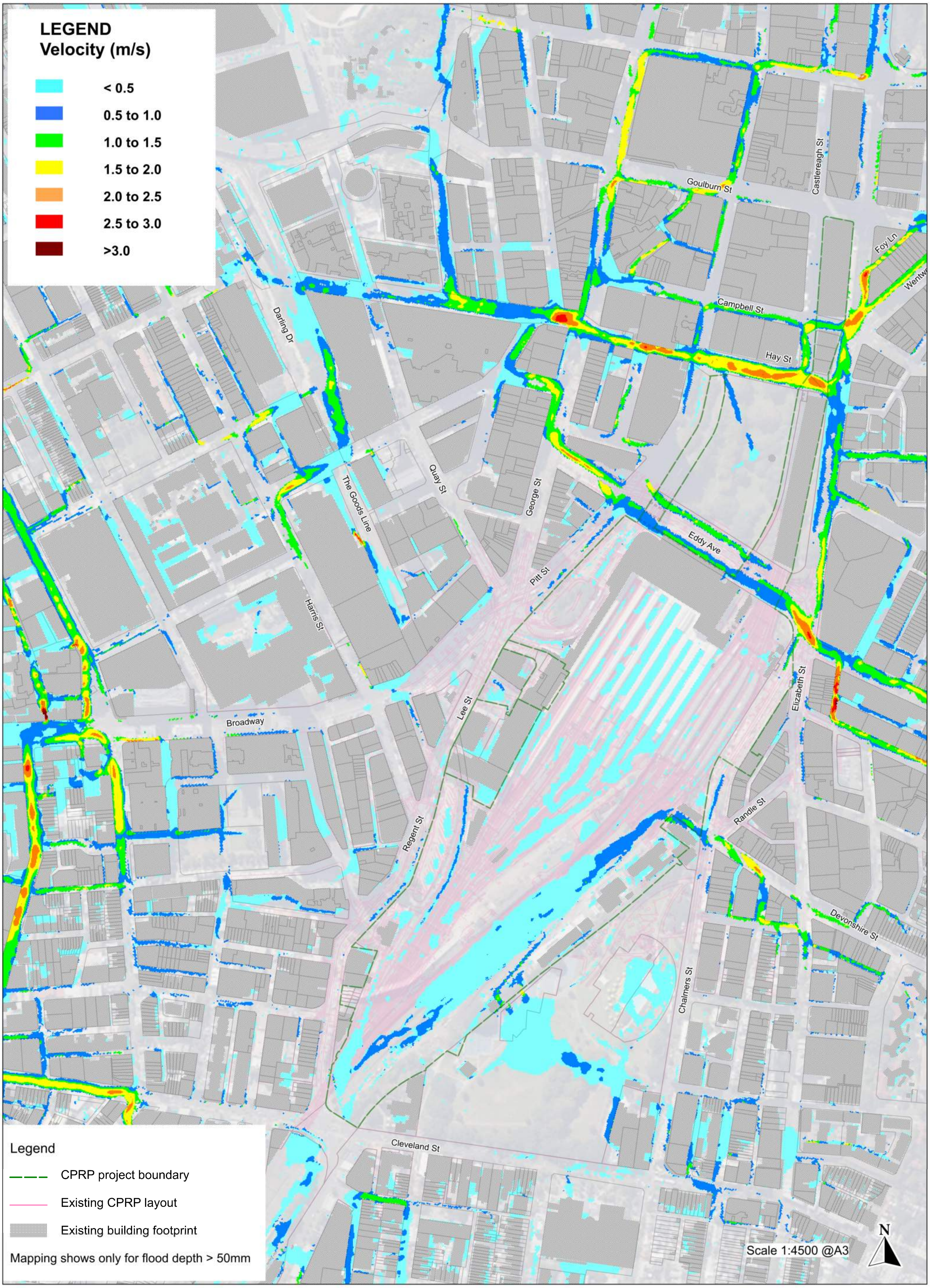

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Figure A.4
Flood Velocity 10% AEP
Base Case Condtions

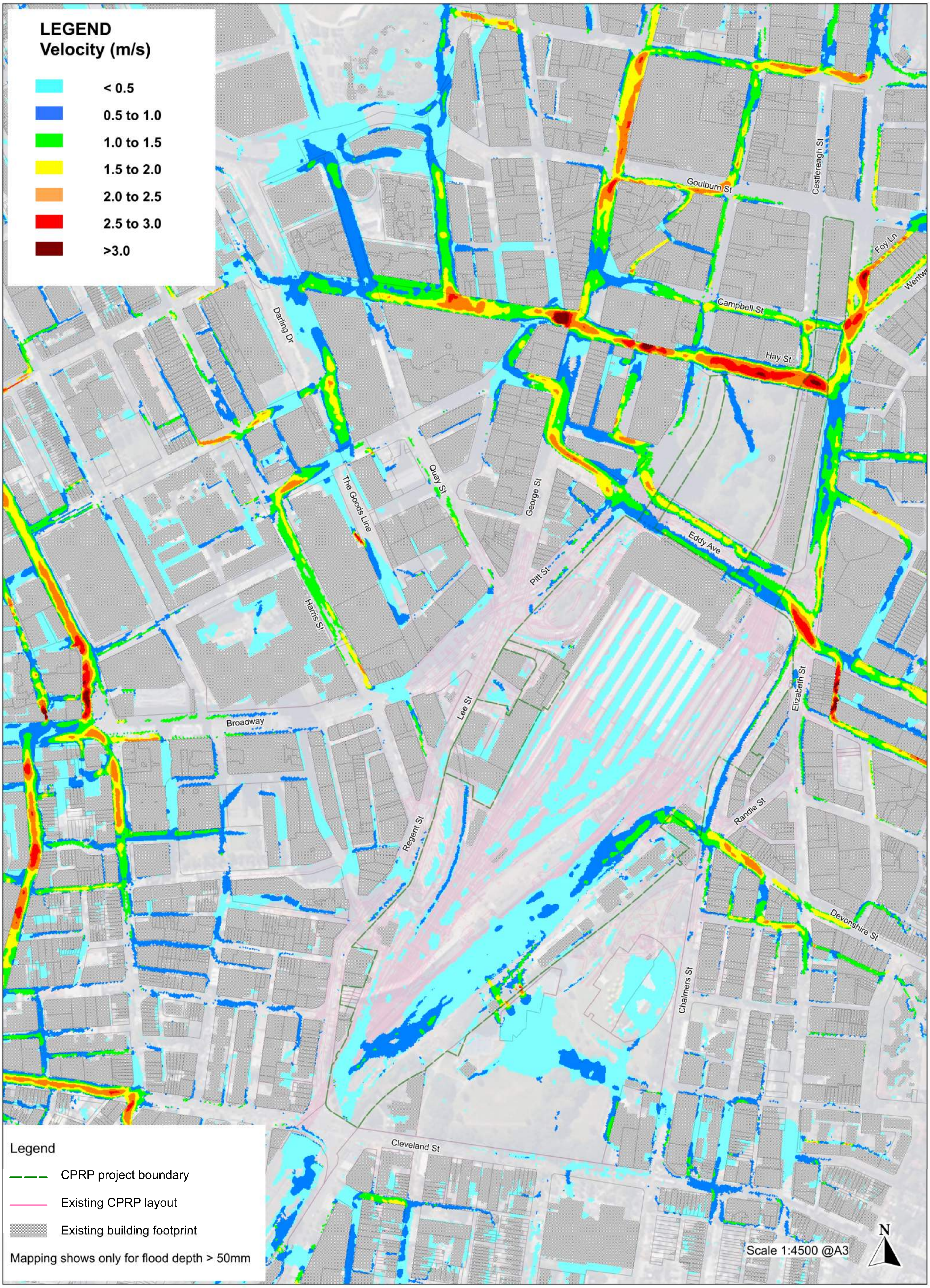

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Figure A.5
Flood Velocity 1% AEP
Base Case Condtions

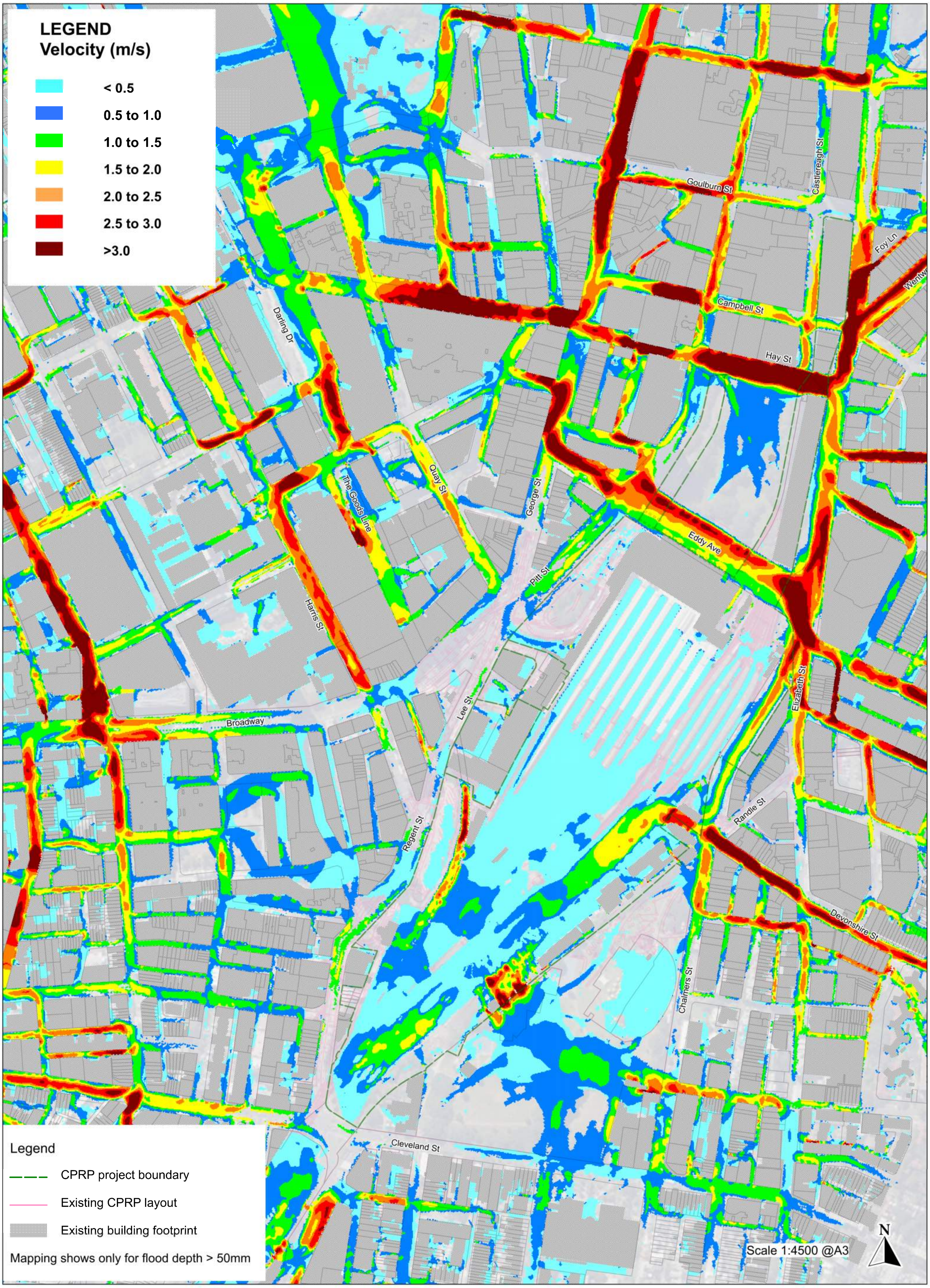

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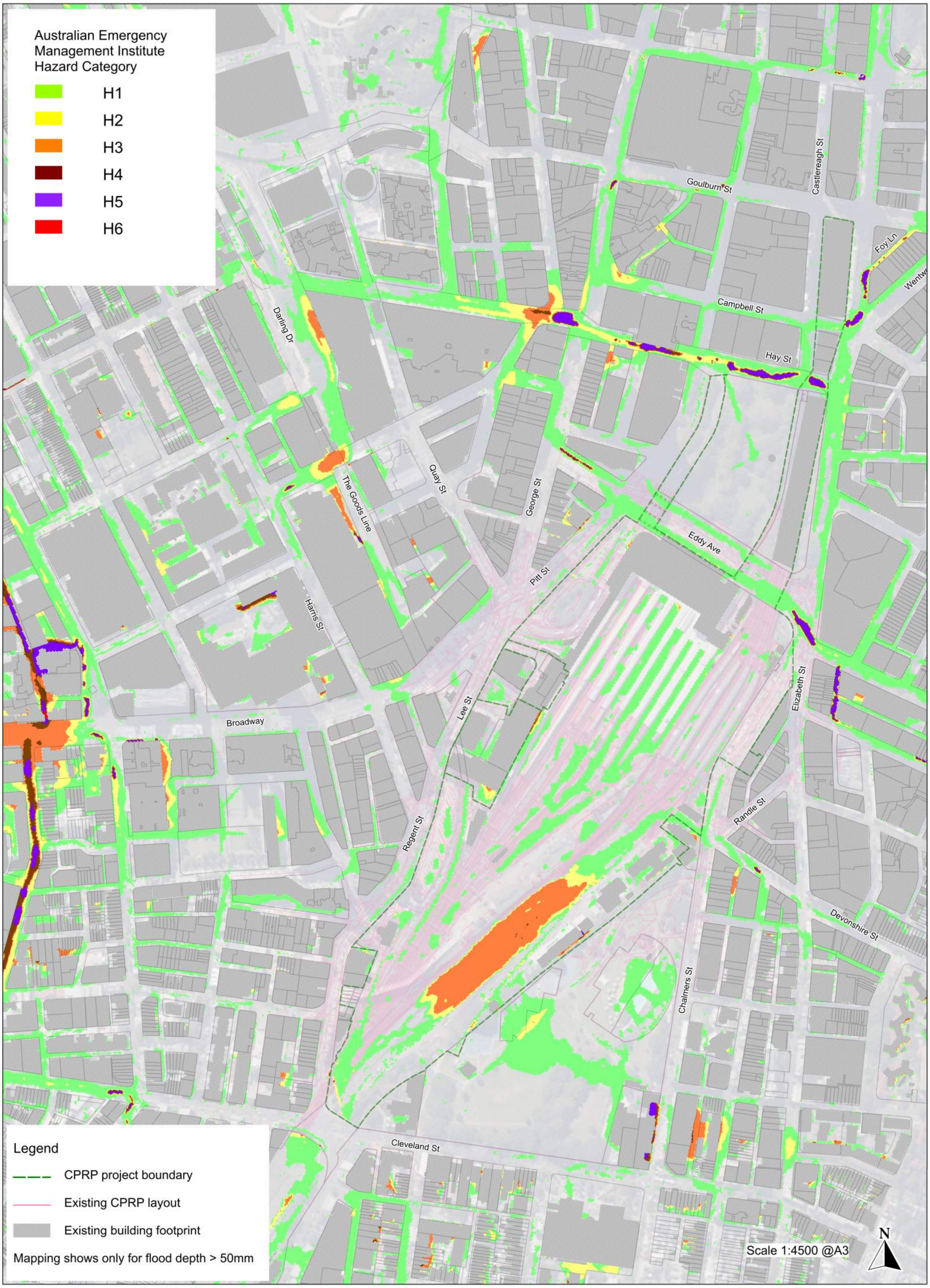
Figure A.6
Flood Velocity PMF
Base Case Condtions



Central Precinct Renewal Program

Figure A.7
Flood AEMI Hazard 10% AEP
Base Case Conditions

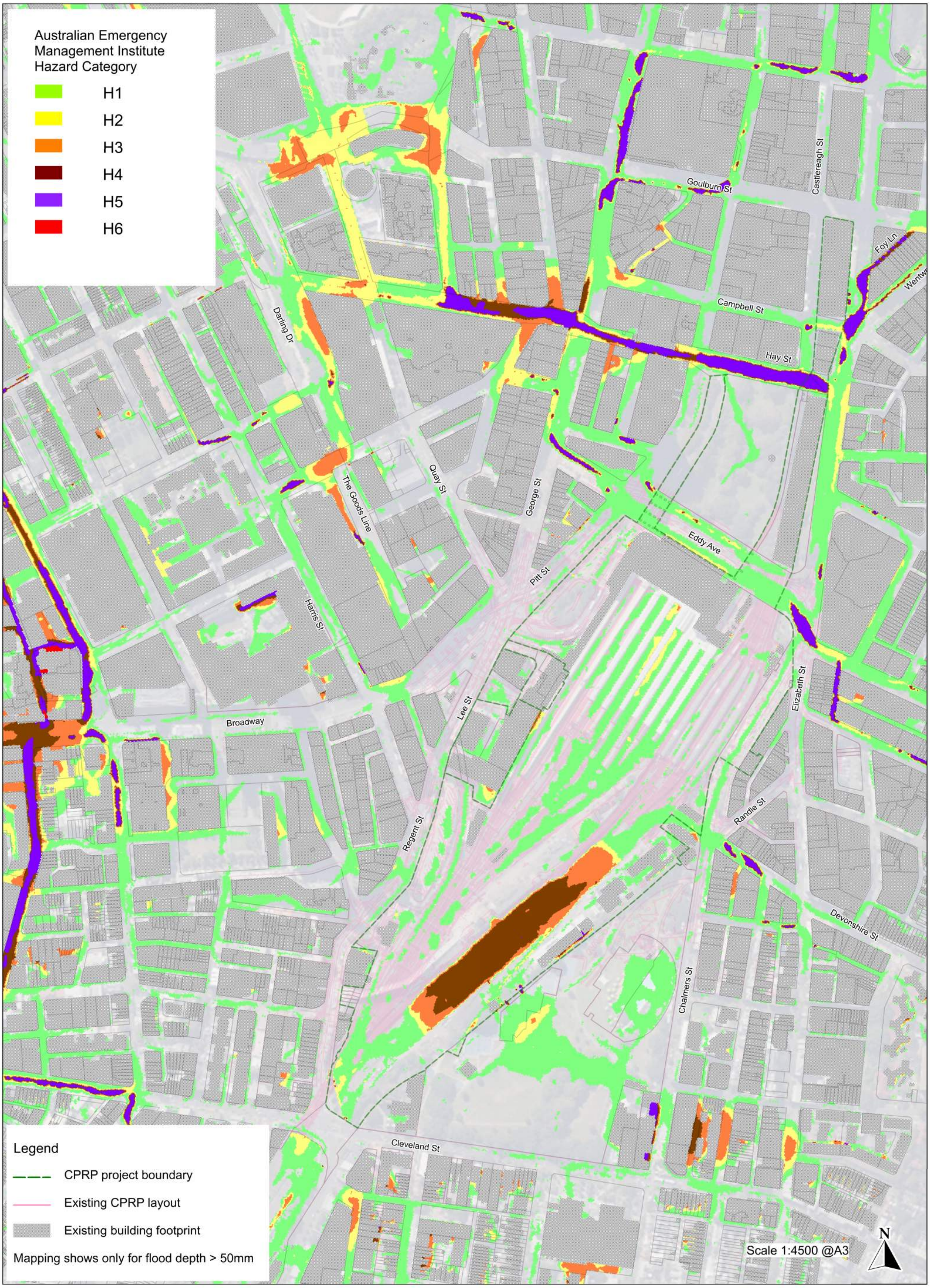


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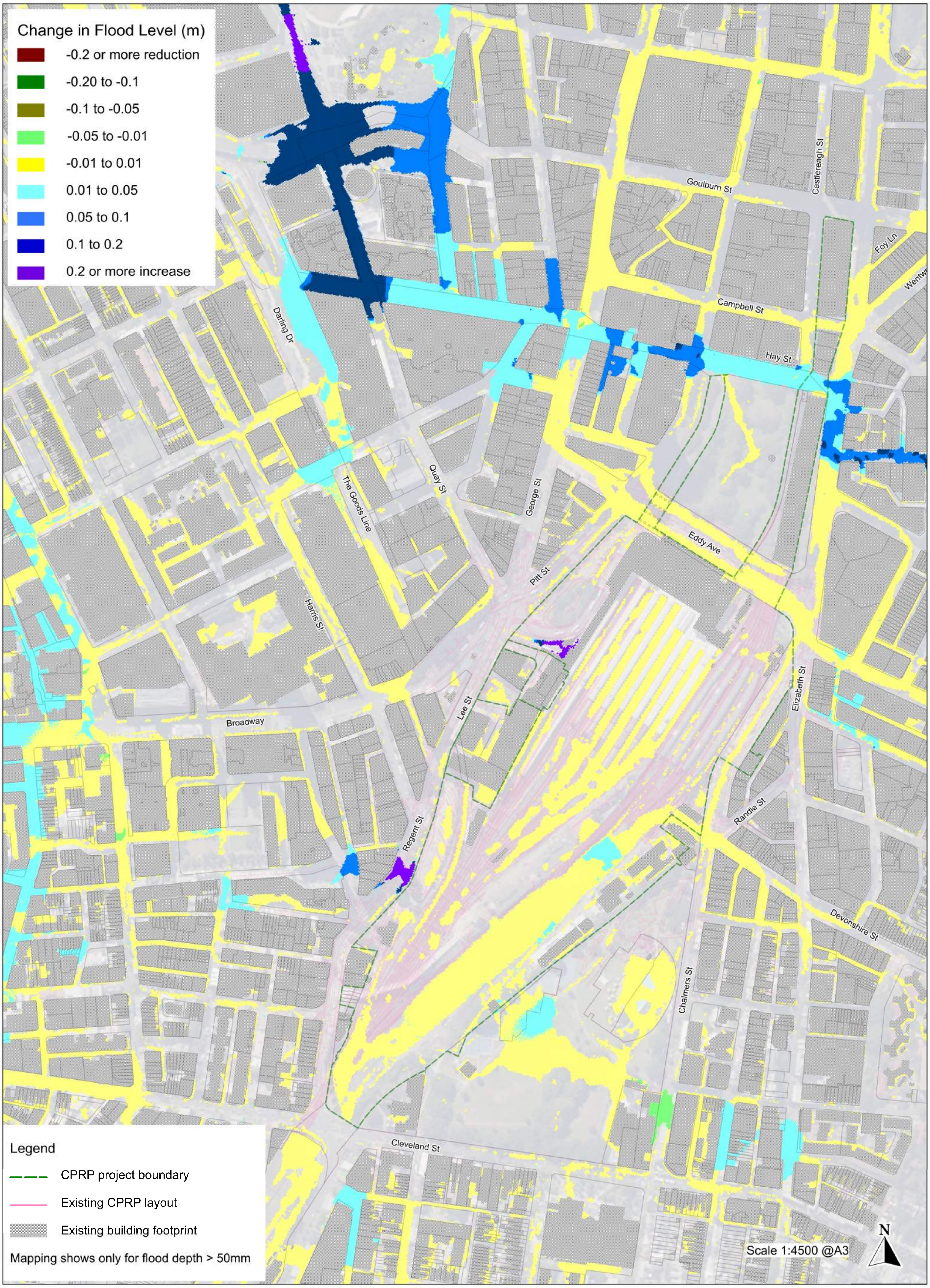
Figure A.8
Flood AEMI Hazard 1% AEP
Base Case Conditions

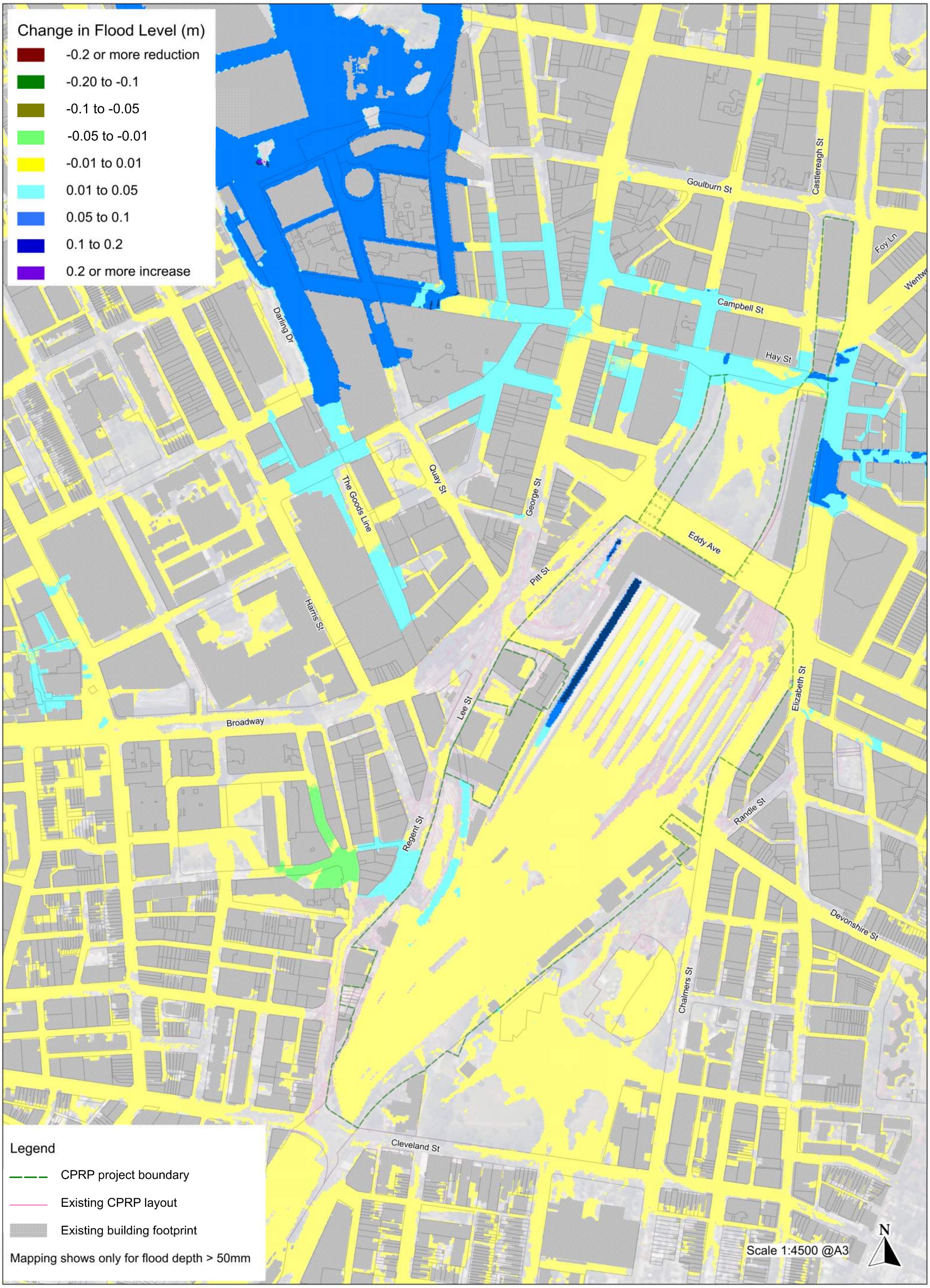
Central Precinct Renewal Program

Figure A.9
Flood AEMI Hazard PMF
Base Case Conditions



Central Precinct Renewal Program

Figure A.10
Flood Level Change 1% AEP
Ongrade 50% & Sag 100% Pit Blockage
Base Case Condtions



Central Precinct Renewal Program

Figure A.11
Flood Level Change PMF
Ongrade 50% & Sag 100% Pit Blockage
Base Case Condtions

APPENDIX B – PROPOSED CONDITIONS FLOOD MAPS

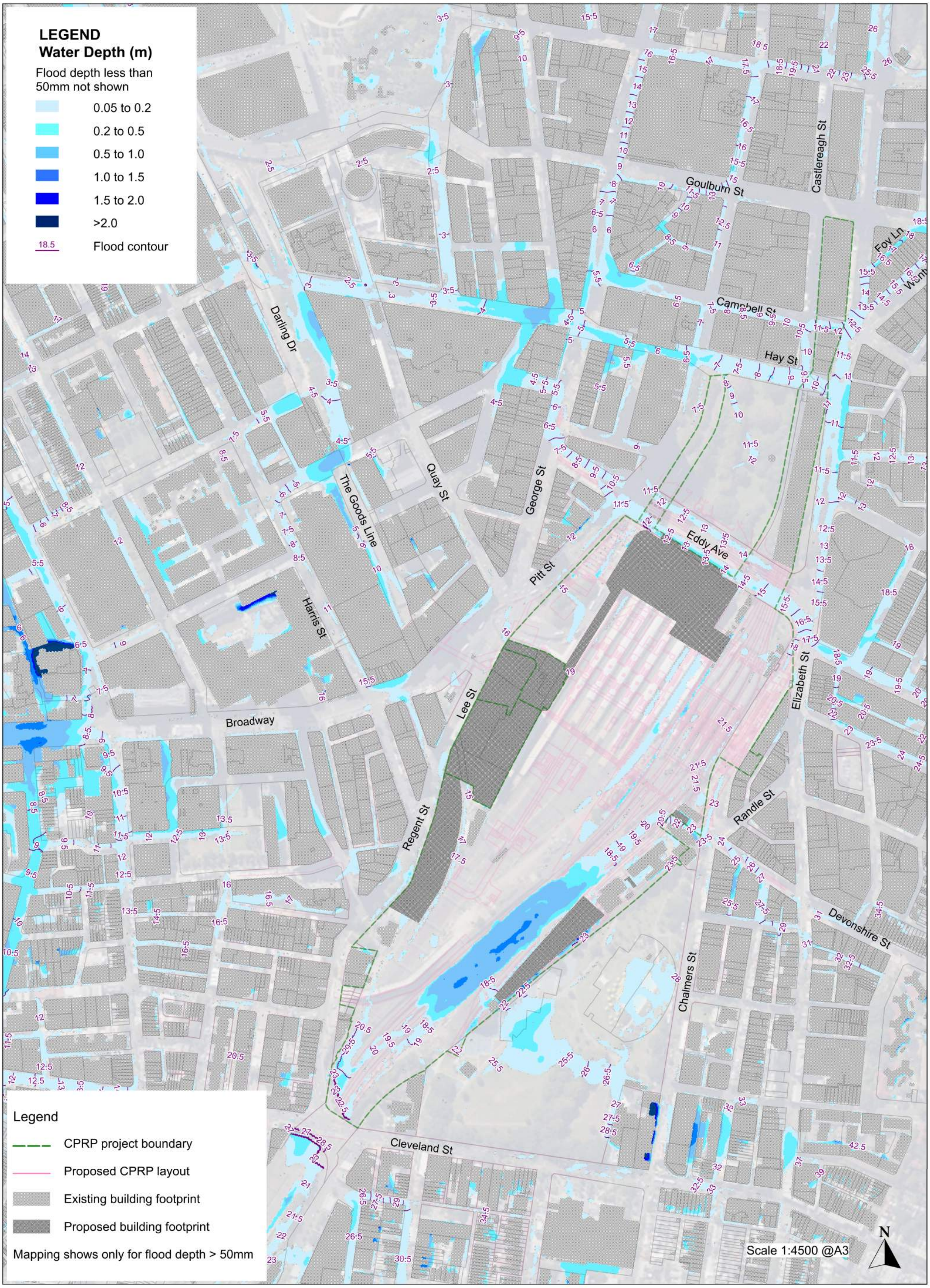


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Figure B.1
Flood Depth and Level 10% AEP
Proposed Conditions

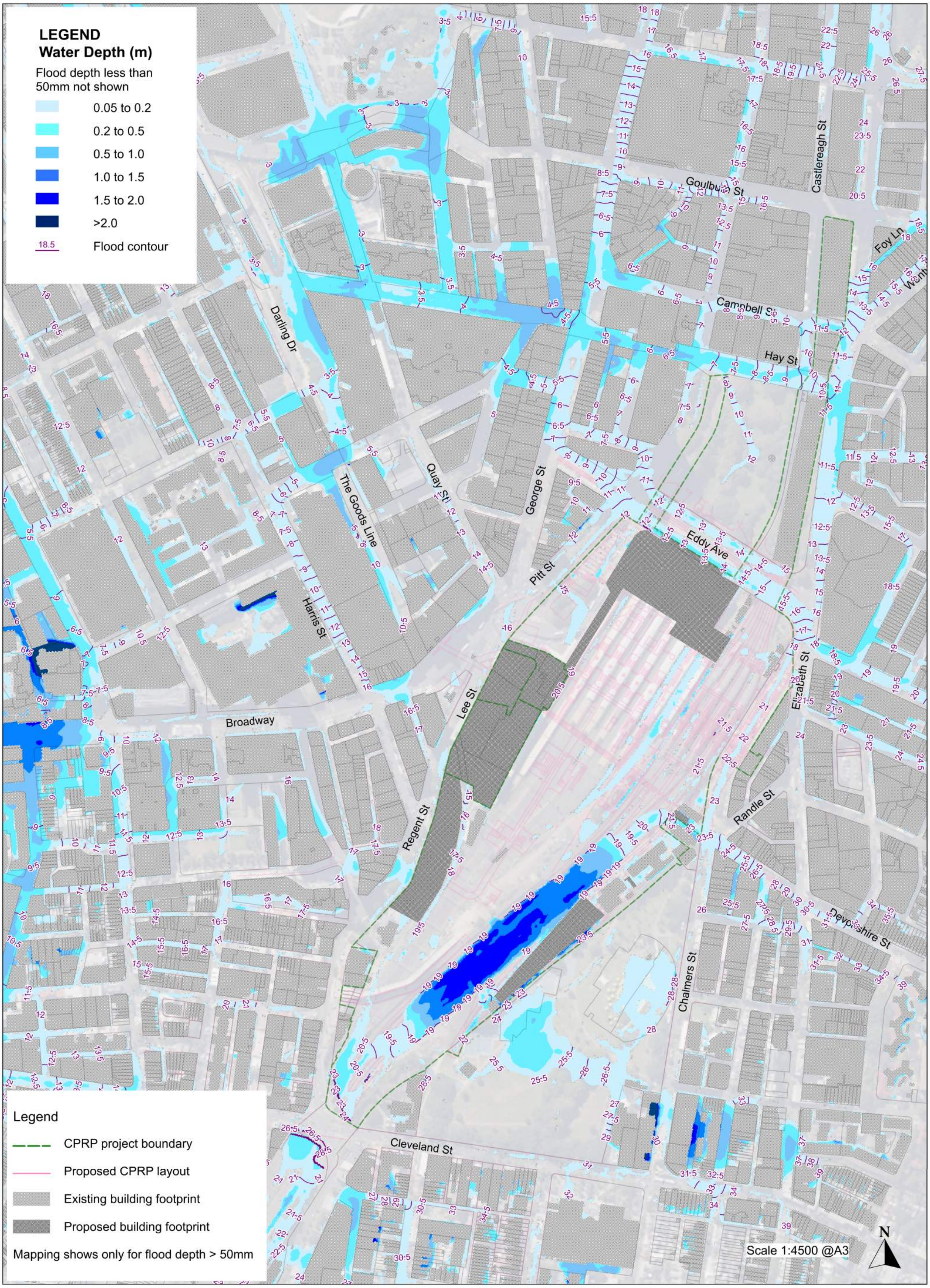

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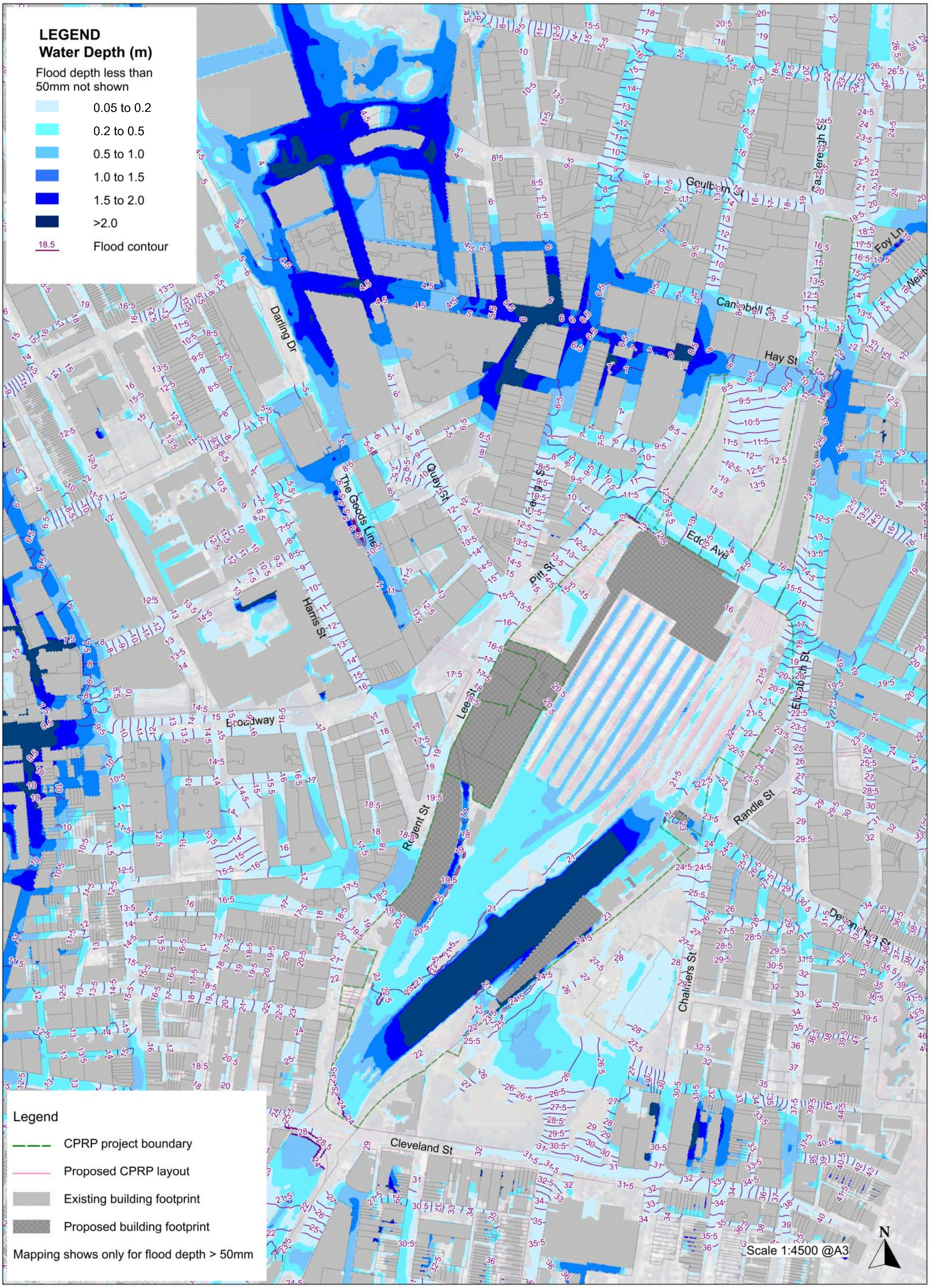
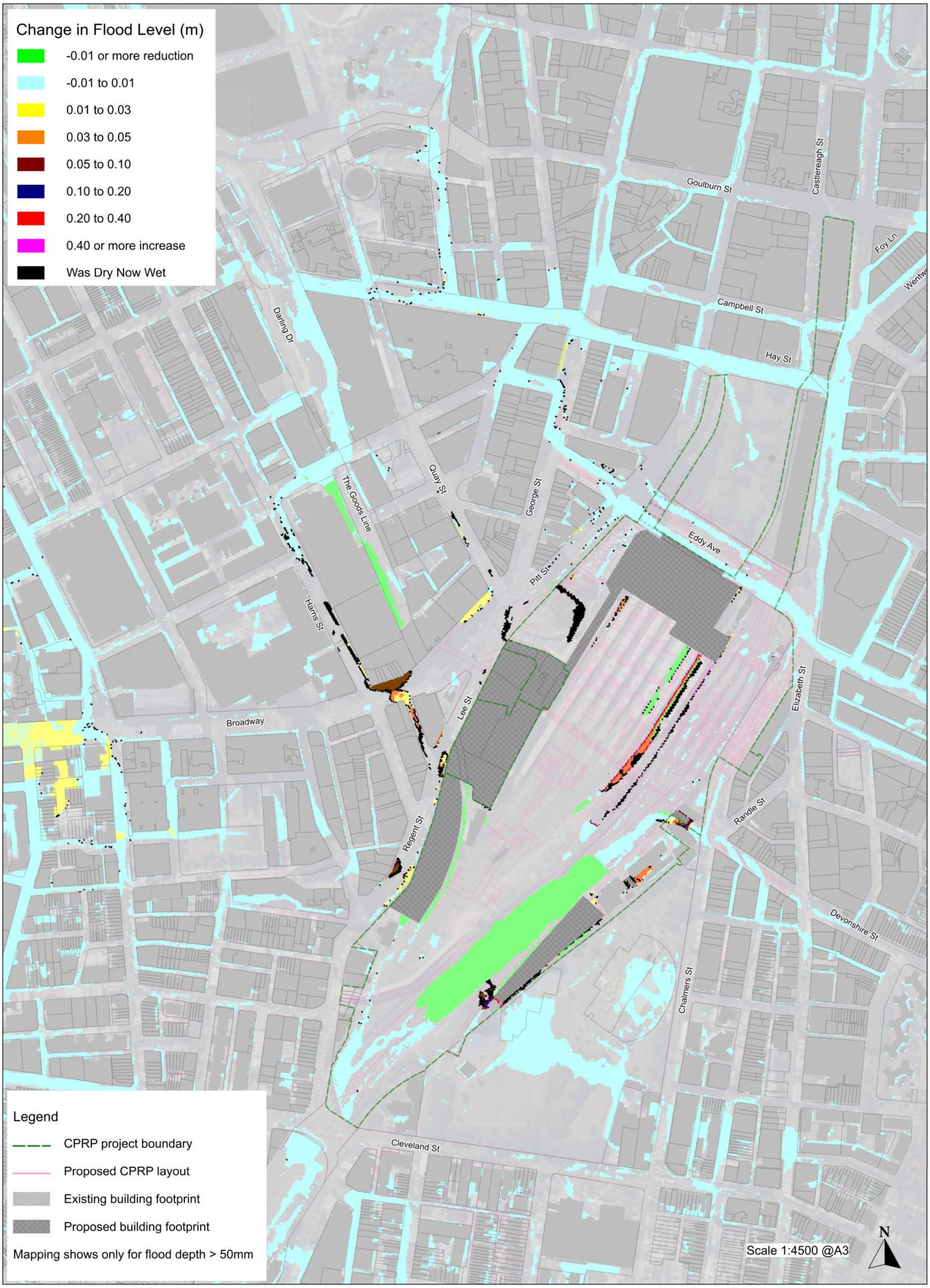
Figure B.2
Flood Depth and Level 1% AEP
Proposed Conditions



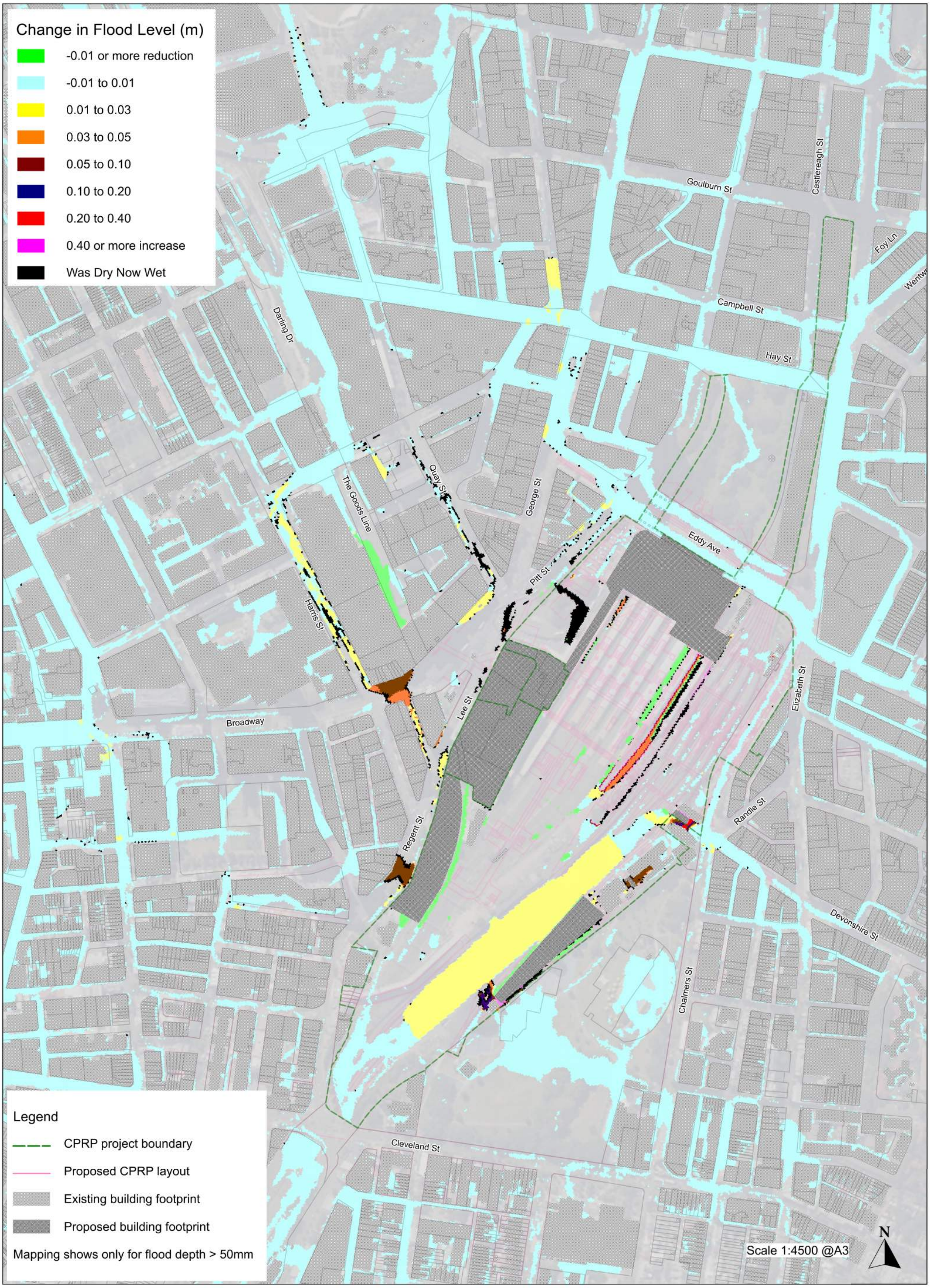
Central Precinct Renewal Program

Figure B.3
Flood Depth and Level PMF
Proposed Conditions



Central Precinct Renewal Program

Figure B.4
Flood Level Change 10% AEP
Proposed Conditions



Central Precinct Renewal Program

Figure B.5
Flood Level Change 1% AEP
Proposed Conditions

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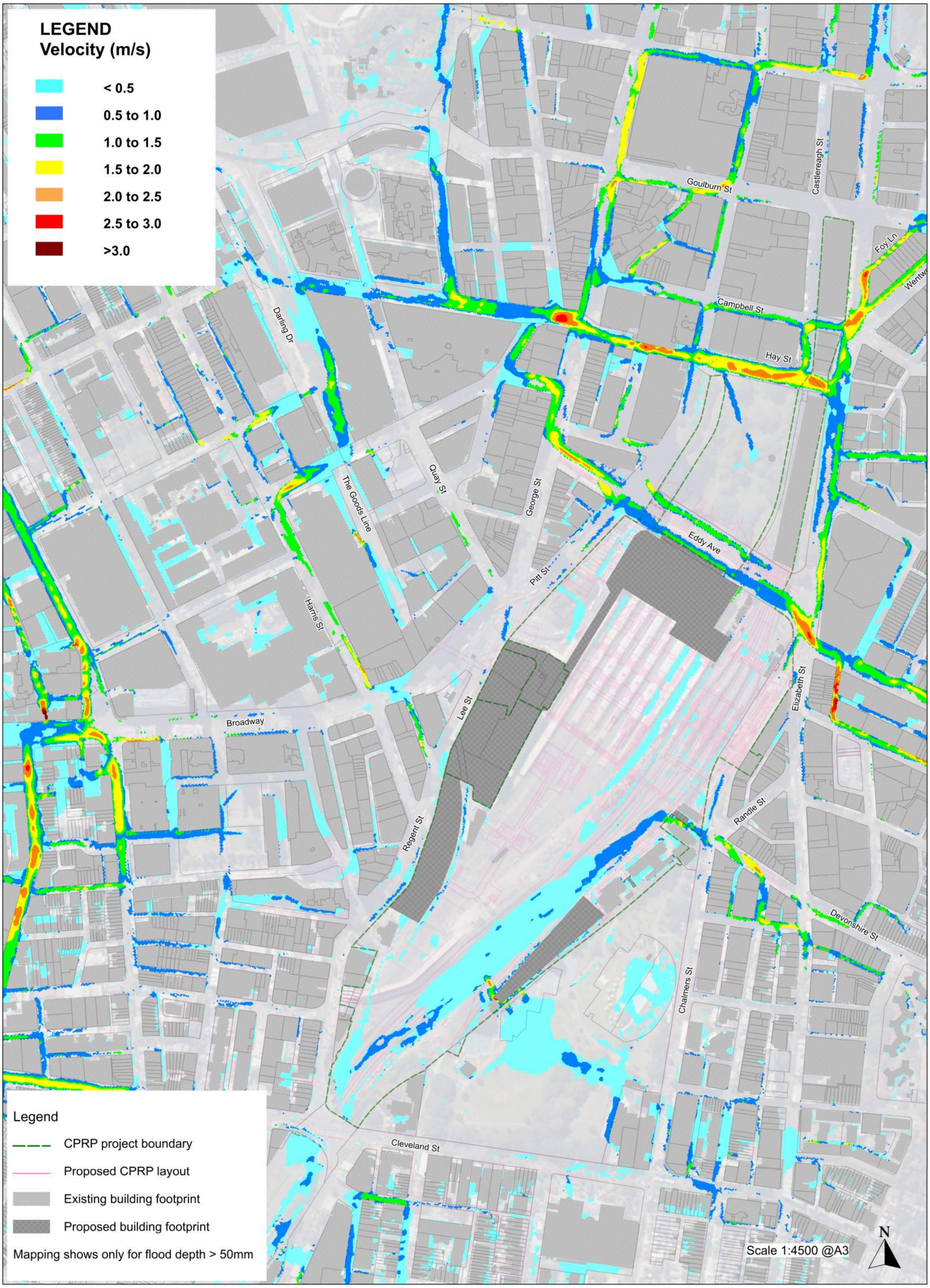
Central Precinct Renewal Program

Figure B.6
Flood Level Change PMF
Proposed Conditions

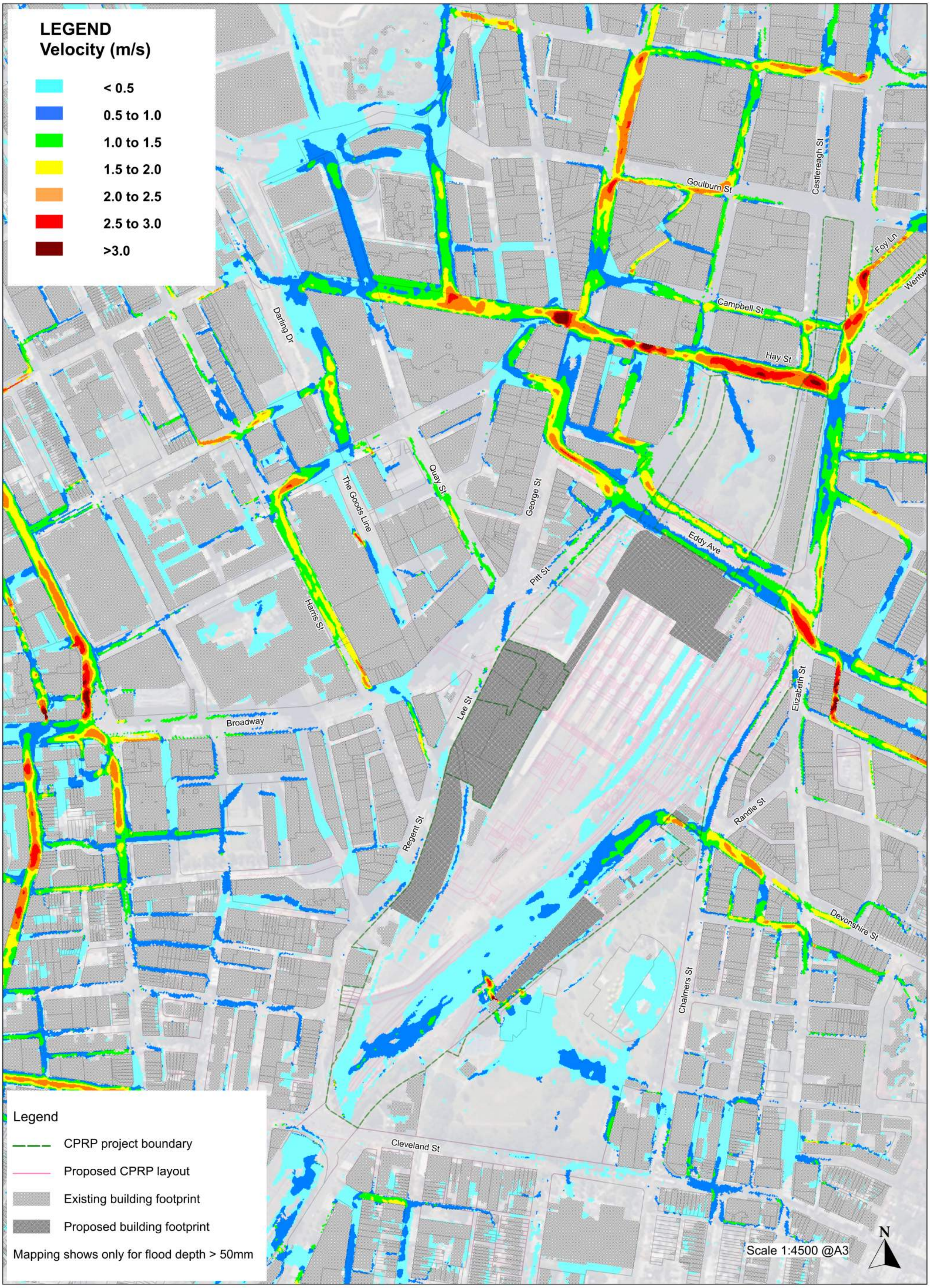


Transport for NSW

ARCADIS

Central Precinct Renewal Program

Figure B.7
Flood Velocity 10% AEP
Proposed Conditions

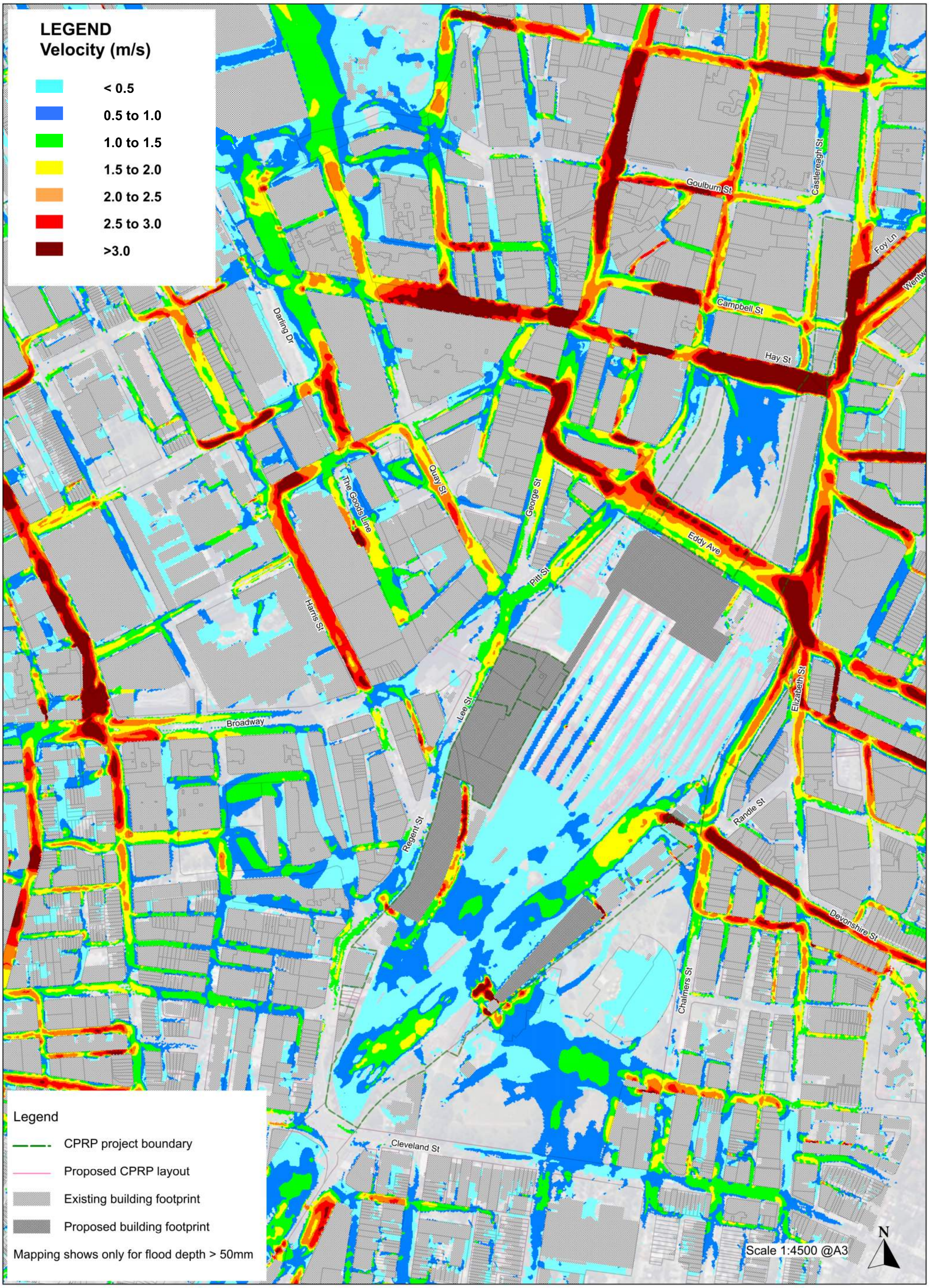


Transport for NSW

ARCADIS

Central Precinct Renewal Program

Figure B.8
Flood Velocity 1% AEP
Proposed Conditions



Transport for NSW

ARCADIS

Central Precinct Renewal Program

Figure B.9
Flood Velocity PMF
Proposed Conditions

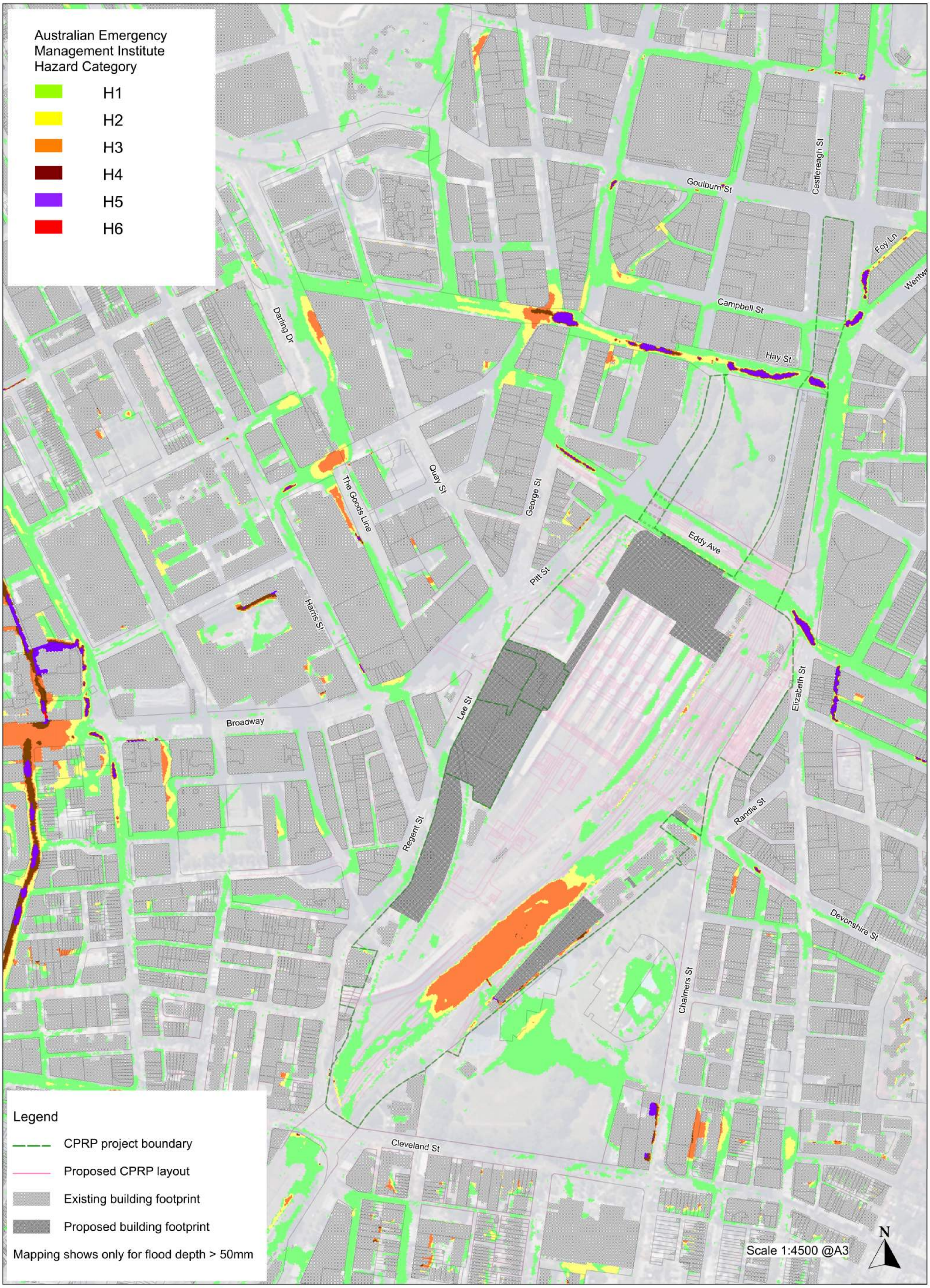


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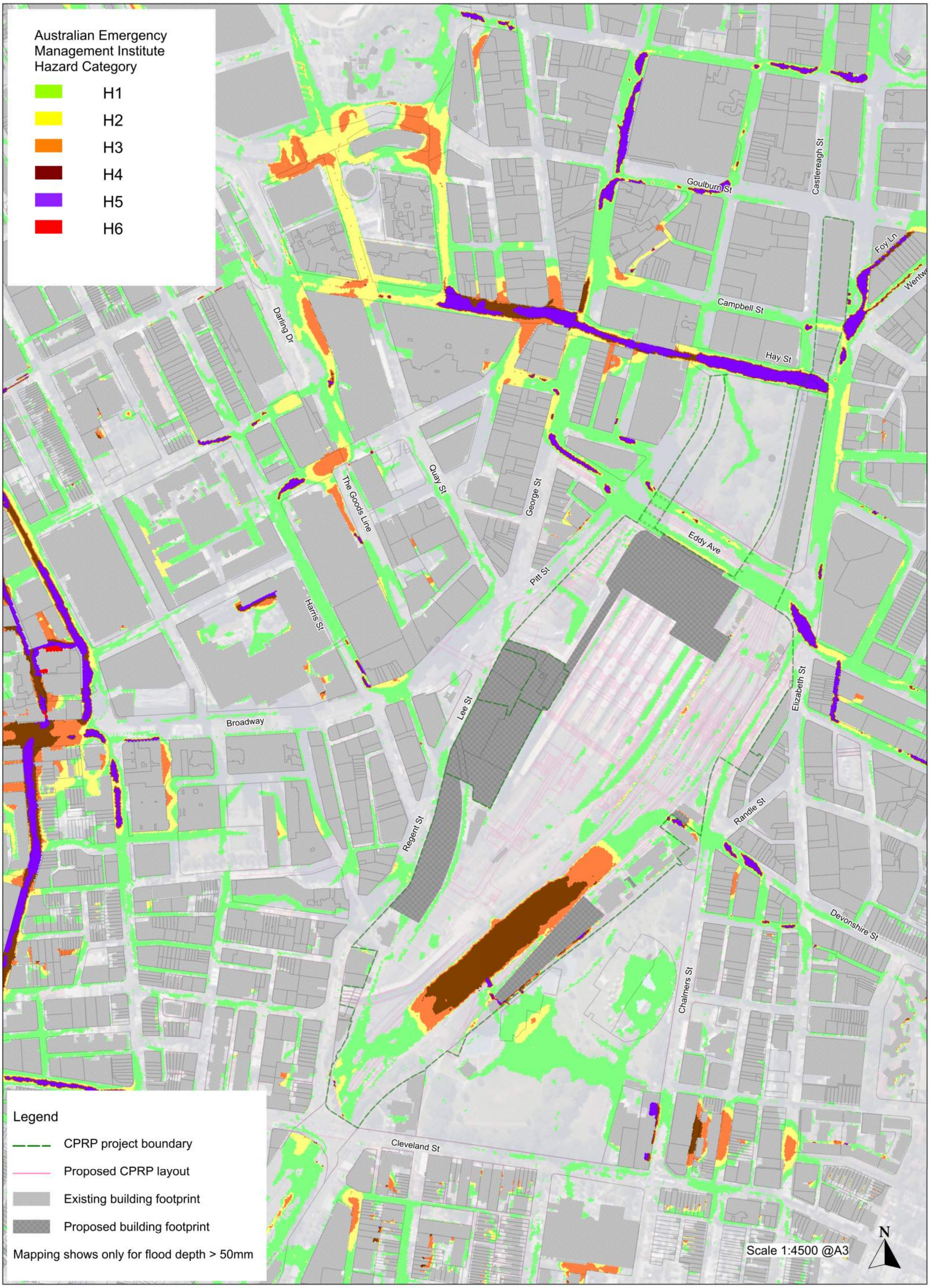
Figure B.10
Flood Hazard AEMI 10% AEP
Proposed Conditions



Central Precinct Renewal Program

Figure B.11
Flood Hazard AEMI 1% AEP
Proposed Conditions

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Central Precinct Renewal Program

Figure B.12
Flood Hazard AEMI PMF
Proposed Conditions

APPENDIX C – CRITICAL STORM DURATION ASSESSMENT

Critical Storm Duration Assessment

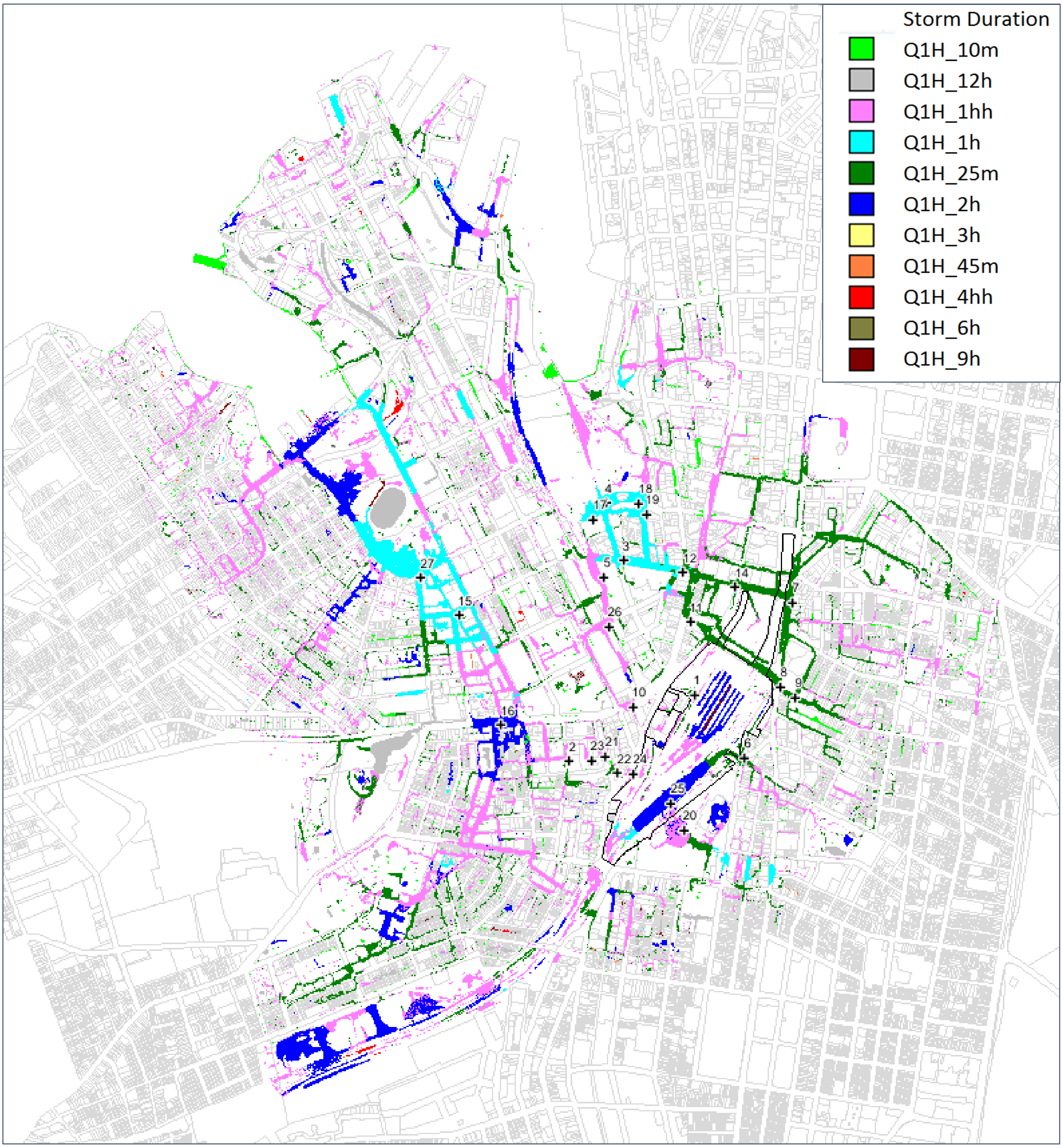


Figure 1 - CPRP Critical Storm Duration – 1% AEP

Table 1 – Selection of Critical Events, 1% AEP

Label	ID	Critical	T5_HEB11J2H	Q1H_10m	Q1H_12h	Q1H_1hh	Q1H_1h	Q1H_25m	Q1H_2h	Q1H_3h	Q1H_45m	Q1H_4hh	Q1H_6h	Q1H_9h	Max
P_AmbuAve_1	1	-9999	5.00	0.06	-9999.00	0.07	0.06	0.07	0.06	-9999.00	0.06	-9999.00	-9999.00	-9999.00	0.07
P_BalfourSt	2	0	3.00	0.14	0.09	0.18	0.16	0.16	0.16	0.13	0.14	0.12	0.10	0.09	0.18
P_Boulevard_1	3	0	4.00	0.11	0.06	0.41	0.44	0.40	0.42	0.17	0.36	0.11	0.07	0.06	0.44
P_Boulevard_2	4	-9999	4.00	-9999.00	-9999.00	0.14	0.20	-9999.00	0.14	-9999.00	0.07	-9999.00	-9999.00	-9999.00	0.20
P_DarlingDr	5	0	3.00	0.53	0.49	0.70	0.70	0.69	0.70	0.60	0.67	0.55	0.50	0.49	0.70
P_DevStEntry_1	6	-9999	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00
P_ElizabethSt_1	7	-9999	5.00	0.13	-9999.00	0.20	0.19	0.23	0.19	0.09	0.18	-9999.00	-9999.00	-9999.00	0.23
P_ElizabethSt_2	8	-9999	5.00	0.10	-9999.00	0.13	0.13	0.14	0.12	0.07	0.12	0.05	-9999.00	-9999.00	0.14
P_FoveauxSt	9	0	5.00	0.26	0.09	0.30	0.30	0.32	0.29	0.19	0.29	0.16	0.11	0.09	0.32
P_GeorgeSt_1	10	0	3.00	0.34	0.11	0.40	0.39	0.39	0.38	0.32	0.36	0.27	0.18	0.11	0.40
P_GeorgeSt_2	11	-9999	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00	-9999.00
P_HaySt_1	12	0	4.00	0.56	0.28	0.79	0.81	0.81	0.81	0.61	0.79	0.50	0.36	0.29	0.81
P_HaySt_2	13	0	5.00	0.40	0.14	0.56	0.57	0.62	0.58	0.33	0.56	0.26	0.17	0.15	0.62
P_MountainSt	14	1	4.00	0.36	0.73	1.06	1.07	0.90	1.06	0.93	1.02	0.92	0.82	0.77	1.07
P_ParramattaRd	15	1	6.00	0.70	0.65	1.18	1.18	1.06	1.18	1.00	1.10	0.91	0.76	0.65	1.18
P_PierSt_1	16	-9999	4.00	-9999.00	-9999.00	0.53	0.58	0.43	0.52	-9999.00	0.46	-9999.00	-9999.00	-9999.00	0.58
P_PierSt_2	17	-9999	4.00	-9999.00	-9999.00	0.59	0.61	0.55	0.59	0.28	0.56	-9999.00	-9999.00	-9999.00	0.61
P_PierSt_3	18	-9999	4.00	0.18	-9999.00	0.66	0.68	0.62	0.66	0.35	0.64	0.24	-9999.00		0.68
P_PrinceAlfredPk	19	0	3.00	0.46	0.44	0.53	0.53	0.52	0.53	0.49	0.52	0.47	0.45	0.43	0.53
P_Regent_St_1	20	0	3.00	0.29	0.28	0.34	0.33	0.33	0.33	0.31	0.32	0.30	0.29	0.28	0.34
P_Regent_St_1a	21	-9999	5.00	0.12	-9999.00	0.14	0.14	0.16	0.13	-9999.00	0.13	-9999.00	-9999.00	-9999.00	0.16
P_Regent_St_2	22	0	3.00	0.36	0.40	0.45	0.44	0.42	0.45	0.43	0.42	0.42	0.41	0.40	0.45
P_Regent_St_2a	23	0	3.00	0.22	0.15	0.29	0.28	0.29	0.28	0.18	0.25	0.17	0.15	0.15	0.29
P_SRY_Sag	24	1	6.00	0.59	1.22	1.61	1.51	1.07	1.66	1.61	1.34	1.52	1.43	1.32	1.66
P_UltimoRd	25	1	3.00	0.64	0.58	0.75	0.74	0.74	0.74	0.66	0.71	0.62	0.59	0.58	0.75
P_WentworthPkRd	26	1	4.00	0.46	0.52	0.86	0.86	0.62	0.85	0.72	0.81	0.72	0.60	0.56	0.86

Notes:

1. Sample points represent locations that could potentially be affected by CPRP development
2. Highlighted (red) cell indicates the critical duration for the sample point location
3. Based on the selected sample points, the selected critical storm durations for the 1% AEP are the 25 minute, 1 hour, and 2 hour.

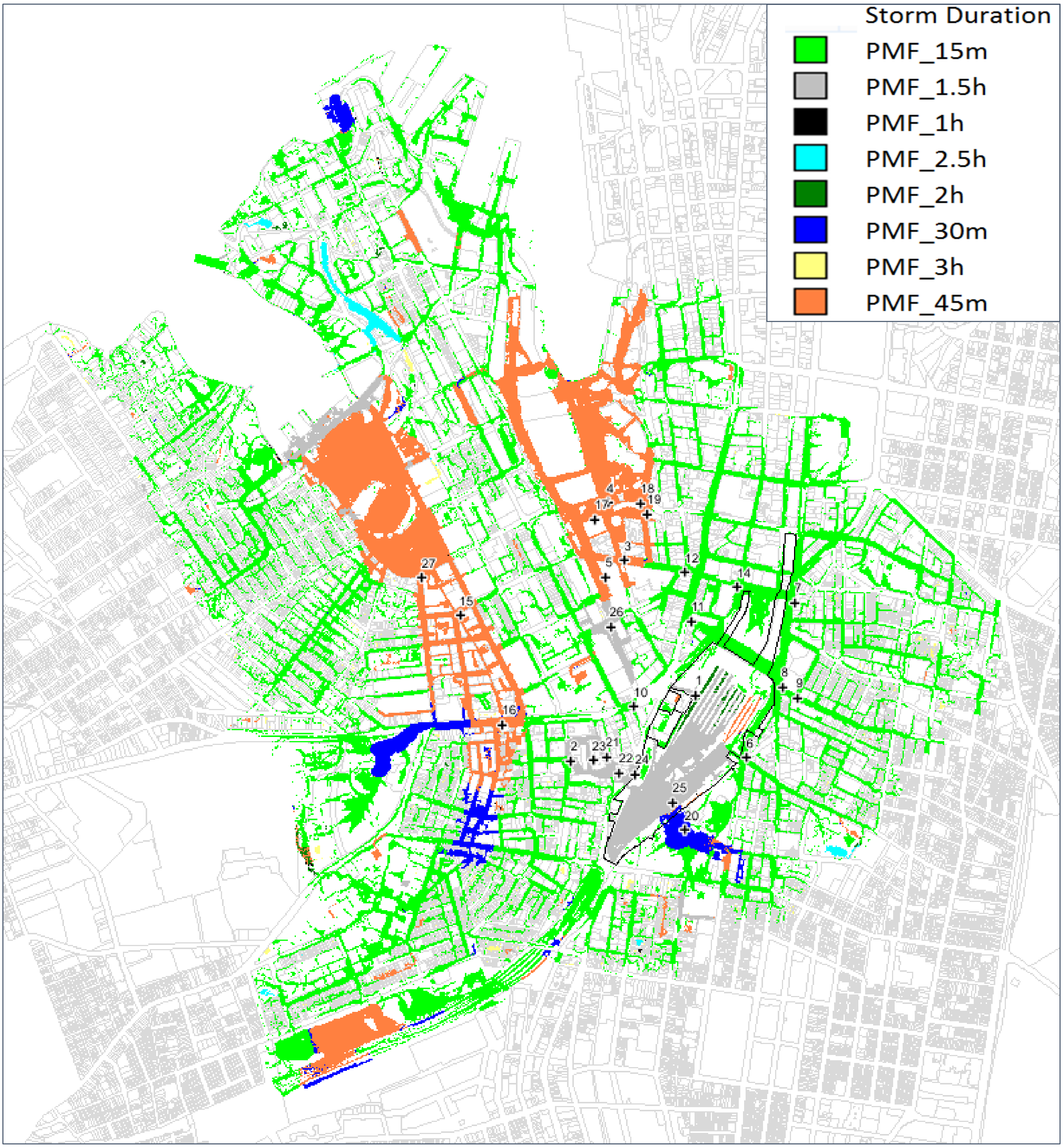


Figure 2 - CPRP Critical Storm Duration – PMF

Table 2 – Selection of Critical Events, PMF

Label	ID	Critical	PMF_15m	PMF_1.5h	PMF_1h	PMF_2.5h	PMF_2h	PMF_30m	PMF_3h	PMF_45m	Max
P_AmbuAve_1	1	2	0.723	1.103	1.082	1.065	1.096	0.926	1.011	1.072	1.103
P_BalfourSt	2	1	0.531	0.511	0.457	0.474	0.511	0.510	0.478	0.504	0.531
P_Boulevard_1	3	8	1.750	1.709	1.764	1.574	1.664	1.856	1.522	1.872	1.872
P_Boulevard_2	4	8	1.568	1.582	1.634	1.451	1.537	1.691	1.409	1.719	1.719
P_DarlingDr	5	8	1.777	1.710	1.756	1.567	1.660	1.859	1.520	1.872	1.872
P_DevStEntry_1	6	1	0.406	0.178	0.211	0.125	0.156	0.313	0.108	0.269	0.406
P_ElizabethSt_1	7	1	1.125	0.649	0.730	0.525	0.592	0.944	0.484	0.850	1.125
P_ElizabethSt_2	8	1	0.527	0.315	0.348	0.254	0.289	0.440	0.234	0.400	0.527
P_FoveauxSt	9	1	0.702	0.496	0.525	0.437	0.468	0.609	0.411	0.567	0.702
P_GeorgeSt_1	10	1	0.685	0.551	0.577	0.516	0.536	0.636	0.501	0.612	0.685
P_GeorgeSt_2	11	1	0.271	0.117	0.147	0.072	0.094	0.214	0.060	0.186	0.271
P_HaySt_1	12	1	2.410	1.800	1.979	1.501	1.636	2.286	1.425	2.196	2.410
P_HaySt_2	13	1	2.204	1.581	1.728	1.322	1.465	2.007	1.231	1.902	2.204
P_MountainSt	14	8	1.867	1.992	2.044	1.811	1.910	2.061	1.751	2.133	2.133
P_ParramattaRd	15	8	2.010	1.968	2.029	1.807	1.899	2.101	1.751	2.108	2.108
P_PierSt_1	16	8	1.983	1.996	2.049	1.861	1.951	2.109	1.820	2.136	2.136
P_PierSt_2	17	8	1.766	1.775	1.829	1.640	1.725	1.886	1.596	1.913	1.913
P_PierSt_3	18	8	1.829	1.843	1.893	1.704	1.791	1.952	1.657	1.980	1.980
P_PrinceAlfredPk	19	6	0.751	0.721	0.738	0.687	0.708	0.760	0.672	0.759	0.760
P_Regent_St_1	20	2	0.603	0.654	0.615	0.622	0.653	0.590	0.623	0.587	0.654
P_Regent_St_1	21	2	0.516	0.572	0.546	0.550	0.569	0.496	0.544	0.522	0.572
P_Regent_St_2	22	2	0.646	0.705	0.660	0.672	0.702	0.636	0.671	0.632	0.705
P_Regent_St_2	23	2	0.719	0.862	0.822	0.819	0.850	0.690	0.808	0.781	0.862
P_SRY_Sag	24	2	3.647	3.827	3.822	3.807	3.822	3.690	3.796	3.812	3.827
P_UltimoRd	25	2	1.264	1.509	1.404	1.422	1.490	1.205	1.415	1.317	1.509
P_WentworthPkRd	26	8	1.488	1.705	1.725	1.589	1.662	1.649	1.544	1.755	1.755

Notes:

1. Sample points represent locations that could potentially be affected by CPRP development
2. Highlighted (red) cell indicates the critical duration for the sample point location
3. Based on the selected sample points, the selected critical storm durations for PMF are the 15 minute, 45 minute, and 1.5 hour.

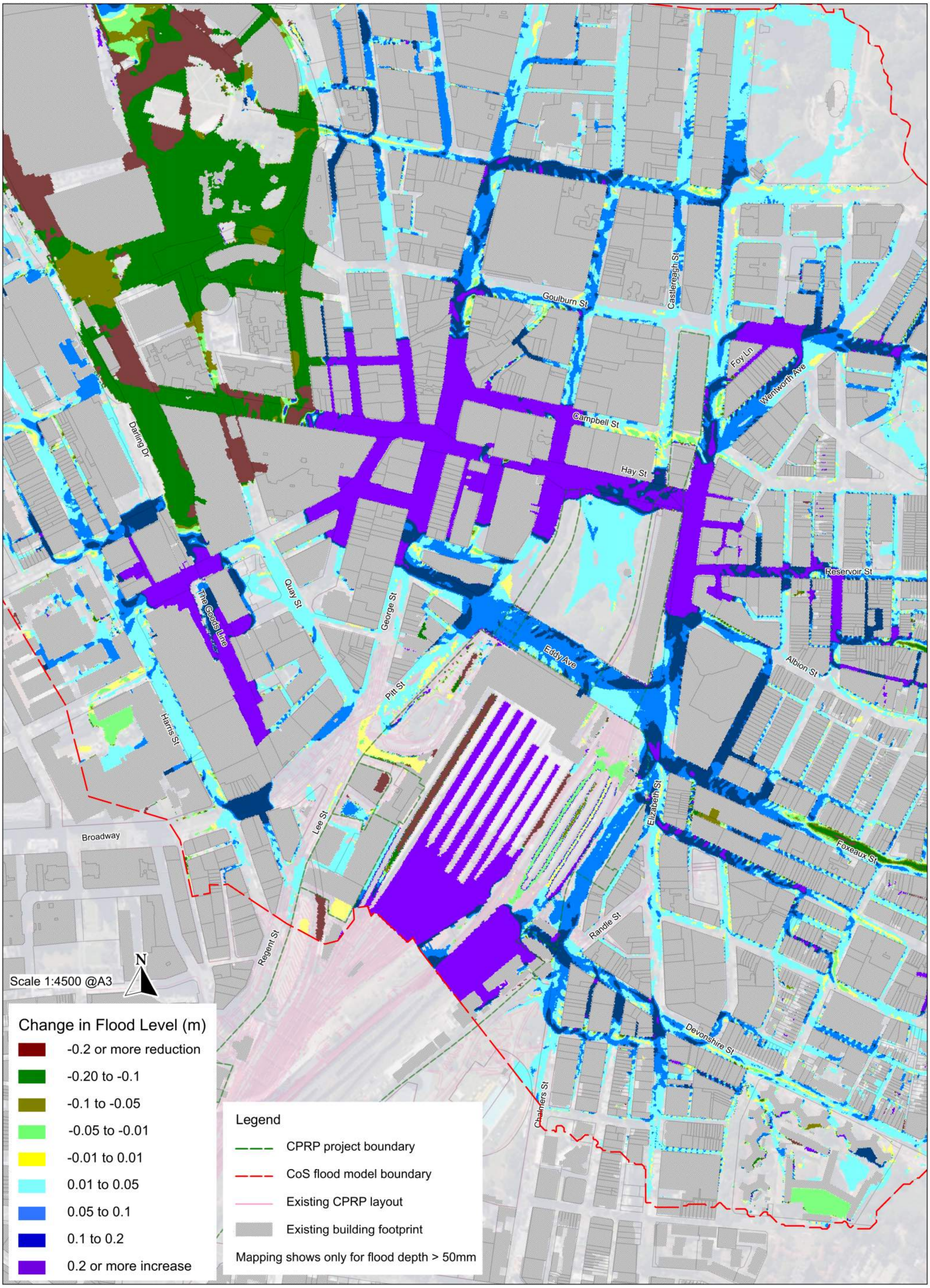
APPENDIX D – COMPARISON WITH COUNCIL FLOOD STUDIES

Transport for NSW

ARCADIS

Central Precinct Renewal Program

Figure D.1
Flood Level Change 1% AEP
Relative to DHFS Flood Level
Base Case Conditions
TUFLOW HPC

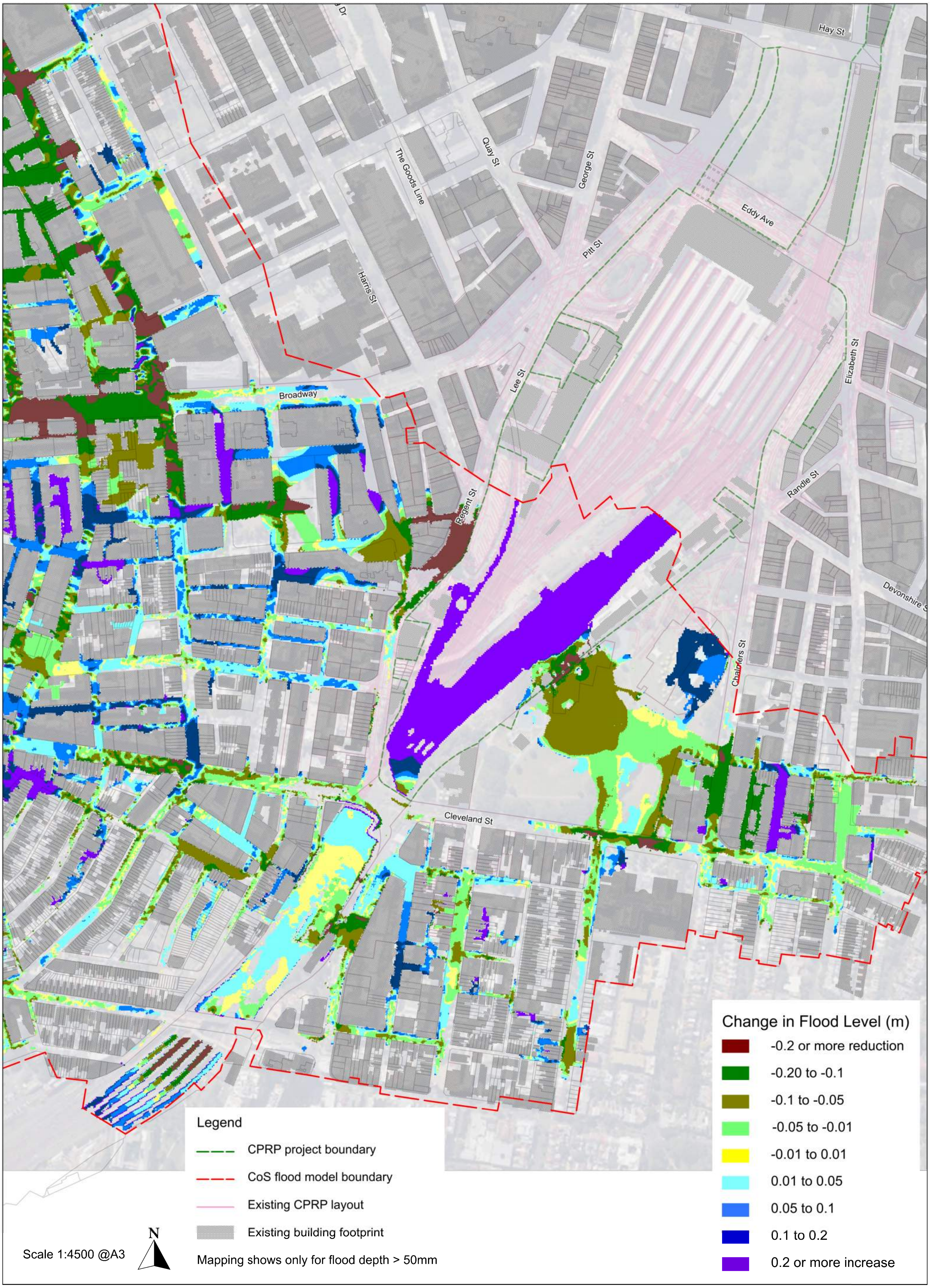


Central Precinct Renewal Program

Figure D.2
Flood Level Change PMF
Relative to DHFS Flood Level
Base Case Conditions
TUFLOW HPC

Central Precinct Renewal Program

Figure D.3
Flood Level Change 1% AEP
Relative to BBFS Flood Level
Base Case Conditions
TUFLOW HPC



Central Precinct Renewal Program

Figure D.4
Flood Level Change PMF
Relative to BBFS Flood Level
Base Case Conditions
TUFLOW HPC

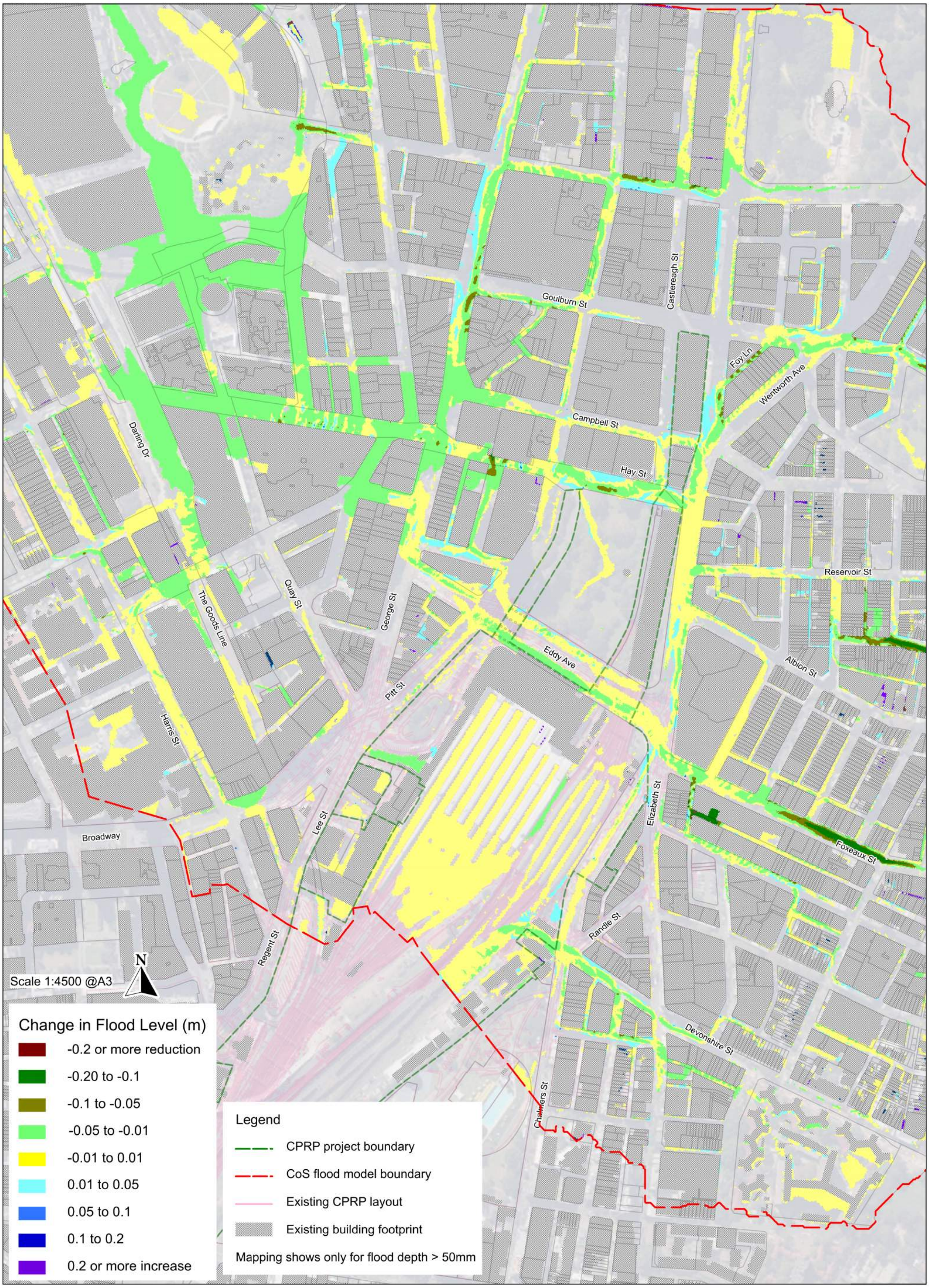


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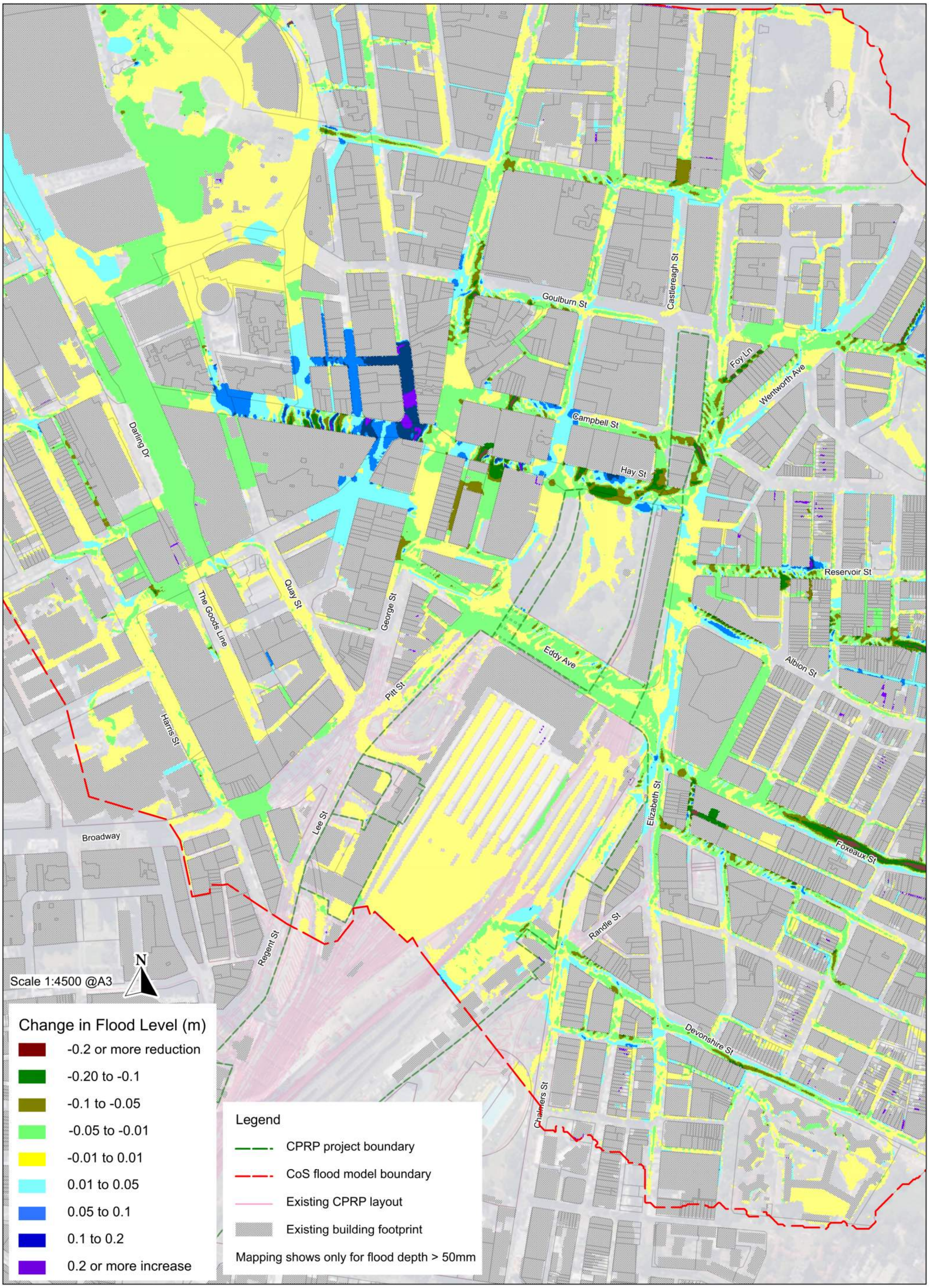
Figure D.5
Flood Level Change 1% AEP
Relative to DHFS Flood Level
Base Case Conditions
TUFLOW HPC - Rerun CoS Model



Transport for NSW

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Central Precinct Renewal Program

Figure D.6
Flood Level Change PMF
Relative to DHFS Flood Level
Base Case Conditions
TUFLOW HPC - Rerun CoS Model

APPENDIX E – RELIANCE INFORMATION LIST & ASSUMPTIONS REGISTER

Item Number	Scope	Document Number	Document Revision	Document Description	File Type	SharePoint Source File	Information Received From	Information Relied On	Reliance Remarks
SURVEY									
1	FLOODING & TRACK DRAINAGE	RFI-R-CPRP000-TFNSW-SYDT-RFI-000002.07-SW0+894 F2012-13954 FINAL 14.02.2020_CD-SS-20222.dwg	-	DSS Track Survey - Cleveland St to Redfern	PDF/DWG/TIF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=8cPRqK&cid=9cd45cc9%2Db190%2D4378%2Db1eb%2Da554270a0132&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200721%20%2D%20DSS%20%28Cleveland%20St%20to%20Redfern%29	TfNSW	Existing drainage network	
2	FLOODING & TRACK DRAINAGE	SW1+803 F2013-14192 FINAL_25.02.2019_CD-SS-20254.dwg	2014	DSS Track Survey - Redfern to Macdonaldtown	PDF/DWG/TIF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=GfbFOz&cid=5d821868%2Dd80c%2D4fbe%2Db7f6%2Dd6156a654d2d&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200825%20%2D%20DSS%20Redfern%20to%20MacDonaldtown	TfNSW	Existing drainage network	
3	FLOODING & TRACK DRAINAGE	SMCSWCSM-VFT-UT-00-DWG-SR-SR0375_1_M_Con Survey Section 1	Revision M (19/06/2020)	Existing rail survey - intercity platforms	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=D2jtCG&cid=d24c534a%2Dc487%2D4153%2Dab29%2D9d6db5a25698&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200630%20%2D%20DSS%20%28Sydney%20Yard%20to%20Cleveland%20St%20Bridge%29	TfNSW	Existing drainage network	
4	FLOODING & TRACK DRAINAGE	SMCSWCSM-VFT-UT-00-DWG-SR-SR0375_2_N_Con Survey Section 2	Revision N (19/06/2020)	Existing rail survey - Platforms 9 to 15	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=D2jtCG&cid=d24c534a%2Dc487%2D4153%2Dab29%2D9d6db5a25698&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200630%20%2D%20DSS%20%28Sydney%20Yard%20to%20Cleveland%20St%20Bridge%29	TfNSW	Existing drainage network	
5	FLOODING & TRACK DRAINAGE	SMCSWCSM-VFT-UT-00-DWG-SR-SR0375_3_M_Con Survey Section 3	Revision M (19/06/2020)	Existing rail survey - Mortuary approaching Redfern	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=D2jtCG&cid=d24c534a%2Dc487%2D4153%2Dab29%2D9d6db5a25698&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200630%20%2D%20DSS%20%28Sydney%20Yard%20to%20Cleveland%20St%20Bridge%29	TfNSW	Existing drainage network	
6	FLOODING & TRACK DRAINAGE	SMCSWCSM-VFT-UT-00-DWG-SR-SR0375_4_K_Con Survey Section 4	Revision K (19/06/2020)	Existing rail survey - City Platforms 16 to 23	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=D2jtCG&cid=d24c534a%2Dc487%2D4153%2Dab29%2D9d6db5a25698&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200630%20%2D%20DSS%20%28Sydney%20Yard%20to%20Cleveland%20St%20Bridge%29	TfNSW	Existing drainage network	
7	FLOODING & TRACK DRAINAGE	SW0+167 F2014-15466 FINAL 15.01.18_CD-SS-20186	26/06/2020	Existing rail survey - flyovers - ground level	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=D2jtCG&cid=d24c534a%2Dc487%2D4153%2Dab29%2D9d6db5a25698&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200630%20%2D%20DSS%20%28Sydney%20Yard%20to%20Cleveland%20St%20Bridge%29	TfNSW	Existing drainage network	
8	FLOODING & TRACK DRAINAGE & WESTERN FORECOURT	PR124856-34-002A-Central Station Regent Street.dwg	Dated 13/9/2016	Existing Survey - External to Rail YardTitled: Sydney Metro City and South West Topographical Detail Survey- Central Station (RPS)	DWG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?q=C02%20Central%20Topographical%20Survey%2Ezip&csf=1&web=1&e=JI4ENU&cid=5d914cc7-123c-4310-bc05-faaa9f927939&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&id=%2Fsites%2FAUS-PS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E05%20Central%20Station%20Main%20Works%20Information%20Documents%2F03%2E05%2E03%20RPS%20Survey%20Information%20%28C%29%2F	TfNSW	Existing ground level survey information, drainage network and building extents.	
9	FLOODING & TRACK DRAINAGE	mx-srt-pba-38_scs-sr-rps-combined-dss.dwg	-	Existing Survey - Rail Yard	DWG	TfNSW External Hard Drive 03 - Metro\02 Navisworks existing & design\ ModelInputs\Existing\	TfNSW	Existing ground level survey information, drainage network and building extents.	
10	FLOODING & TRACK DRAINAGE	SMCSWCSM-VFT-UT-00-DWG-SR-SR0375_1_C_Con Survey Section 1	Rev C (12/10/2019)	VFT 2019 Track Survey	PDF/DWG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?RootFolder=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F06%20Goods%20Line&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749	TfNSW	Existing stormwater drainage network detail	
11	FLOODING & TRACK DRAINAGE & WESTERN FORECOURT	50176 001DT [CPRP-TFNSW-CEN-SU-M3D-000030]	Revision E (9/4/2020)	Atlassian LTS Western Gateway Existing Survey	DWG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=JI4ENU&cid=5d914cc7%2D123c%2D4310%2Dbc05%2Dfaaa9f927939&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200617%20%2D%20Western%20Gateway%20LTS%20Survey%20Files%2FAtlassian	Atlassian	Existing ground levels, building extents and other ground structures and drainage network. Atlassian LTS survey has been selected over the Dexus Fraser LTS survey as it has been updated more recently and contains additional survey information. This recent survey information will take precedence over other survey information sources for the area.	
12	FLOODING & TRACK DRAINAGE	Various	-	LiDAR Digital Elevation Model	ASC	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=mdlgOx&cid=6152415d%2D531d%2D4893%2D9b63%2D1cb5d0c55ca4&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Arcadis%2FWorking%20Folder%2FBackground%20Data%2F20130413%5FLiDAR%5FDEM	NSW Spatial Services	Ground surface levels in the absence of any 3D survey tin information. May also be used for estimating existing stormwater pit grate levels, pipe levels, pipe flow directions and defining catchment areas.	
13	FLOODING & TRACK DRAINAGE	Various	1/09/2019	2019 Aerial Imagery	JPG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=mdlgOx&cid=6152415d%2D531d%2D4893%2D9b63%2D1cb5d0c55ca4&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Arcadis%2FWorking%20Folder%2FBackground%20Data%2F20190901%5FNearmap%5FAerials	Nearmap	Estimation of existing surface conditions for hydrological and hydraulic modelling.	Used for Information Only
EXISTING DRAINAGE INFORMATION									
14	FLOODING & TRACK DRAINAGE	Various	As provided 10/09/2019	Sydney Water GIS Database	GIS	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=mdlgOx&cid=6152415d%2D531d%2D4893%2D9b63%2D1cb5d0c55ca4&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Sydney%20Water	Sydney Water	Existing stormwater drainage network details	
15	FLOODING & TRACK DRAINAGE	-	-	City of Sydney GIS Pit and Pipe Database	GIS	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Arcadis%2FWorking%20Folder%2FBackground%20Data%2F20200611%5FCoS%5FDrainage%5FDatabase	Sydney Metro	Existing stormwater drainage network. This information has been sourced from Sydney Metro (WSP) and is to be used in the absence of City of Sydney Council providing their database information as requested.	
16	FLOODING & TRACK DRAINAGE	Various	-	Sydney Water "Tap In" Work as Constructed Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Sydney%20Water%2F20200724%5FTapIn%5FWAC	Sydney Water	Existing stormwater drainage network details	
17	FLOODING & TRACK DRAINAGE	CPR Drainage and Flooding TA.pdf	October 2018	GHD 2018 CPRP Geotechnical, Contamination and Drainage Technical Advisor: Stormwater Drainage Desktop Study	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F05%20Previous%20Studies%2F05%2E03%20GHD%20Technical%20Reports	TfNSW	Existing stormwater drainage network detail and catchment areas.	Used for Information Only
18	FLOODING & TRACK DRAINAGE	Various	Unknown	Various historical track drainage drawings	TIF/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200605%20%2D%20Flood%20Info%2FSydney%20Trains%20%2D%20Drainage%20Drawings%20%28VPR%29	TfNSW	Existing stormwater drainage network details	Used for Information Only
19	FLOODING & TRACK DRAINAGE	Various	Unknown	Various historical onsite detention tank drawings from GW Engineers (2006) & Acor (2008)	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200605%20%2D%20Flood%20Info%2FSydney%20Trains%20Stormwater%20Tank	TfNSW	Existing stormwater drainage network details, the particular the existing stormwater tank discharging to Pitt St.	
20	WESTERN FORECOURT & TRACK DRAINAGE	mx-srt-pba-30_shc-sr-existing-utilities	Unknown	Existing utilities	NWC	BIM360: CPRP-TFNSW-CEN-SU-M3D-00002 TfNSW External Hard Drive provided 2019: 03 - Metro\02 Navisworks existing & design\ ModelInputs\Existing	TfNSW	Existing Bondi Ocean Outfall Sewer (BOOS) location and dimensions. Note that the native data has not been provided for this model.	
FLOOD MODELS									
21	FLOODING	Various	As provided by Council 2019	City of Sydney Flood Models for Blackwattle Bay and Darling Habour Catchments	Various	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=mdlgOx&cid=6152415d%2D531d%2D4893%2D9b63%2D1cb5d0c55ca4&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20City%20of%20Sydney%2F20191024%20%2D%20CoS%20Flood%20Models&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565	City of Sydney Council	Base TUFLOW flood models used for the existing site conditions. Council flood models used to represent the upstream and downstream areas surrounding the site. Flood models combined, modelling assumptions coordinated and model refined to improve representation of existing conditions based on available information.	
22	FLOODING	Various	SLR_DH_Des_45.tcf	Sydney Light Rail - TUFLOW Model	Various	https://arcadiso365.sharepoint.com/:f:/r/sites/AUS-PS10/CPRP/Transfer/From%20TfNSW/16%20Request%20For%20Information/20200501%20-%20SLR%20Flood%20Model?csf=1&web=1&e=I2TRhQ	TfNSW	Information will be used to represent the stormwater design along the route of SLR. Note the full TUFLOW model has not been provided (ground surface information is missing), but selected model information has been incorporated into the Existing Case Flood Model.	
23	FLOODING	Various	-	Sydney International Convention Exhibition and Entertainment Precinct (SICEEP) TUFLOW Modelling	Various	-	Arcadis	The SICEEP TUFLOW model representation of the proposed SICEEP design (which has since been constructed) will be used for the SICEEP area located downstream of the CPRP site. Arcadis have formally received permission from Lend Lease (6/7/2020) to utilise this flood model information from the SICEEP project which Arcadis previously completed.	

Item Number	Scope	Document Number	Document Revision	Document Description	File Type	SharePoint Source File	Information Received From	Information Relied On	Reliance Remarks
						DESIGN INFORMATION			
24	FLOODING & TRACK DRAINAGE	SMCSWCSM-LOR-SMC-EN-REP-008438.A.RVW.A.01.pdf	-	Sydney Metro City & Southwest, Central Station Main Works, Metro Box Package 7 Remaining Structures - Stage 3 Design Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200605%20%2D%20Flood%20Info%2FSydney%20Metro%20%2D%20OSD%20Tank%20Drawings	TfNSW	Sydney Metro City & Southwest - Stage 3 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
25	FLOODING & TRACK DRAINAGE	SMCSWCSM-DJV-NC-20-REP-EN-000007 (SMCSWCSM-LOR-SMC-EN-REP-005703.F.RVW.F.01.pdf)	Rev F (24/04/2020)	Sydney Metro City & Southwest, Central Station Main Works, Metro Box Package 7 Remaining Structures - Stage 3 Design Report	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200605%20%2D%20Flood%20Info%2FSydney%20Metro%20%2D%20OSD%20Tank%20Drawings	TfNSW	Sydney Metro City & Southwest - Stage 3 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
26	FLOODING & TRACK DRAINAGE	CSM - Detailed Design - Platform Modification Works Reinstatement tracks of Platforms 13 & 14 BS Design Drawings - Stage 3.pdf	-	Sydney Metro City & Southwest, Central Station Main Works, Platform Modification Works Package 2, Reinstatement tracks of platforms 13 & 14 - Stage 3 Design Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E03%20Central%20Station%20Main%20Works%20Detailed%20Design%2FPlatform%20Modification%20Works	TfNSW	Sydney Metro City & Southwest - Stage 3 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
27	FLOODING & TRACK DRAINAGE	SMCSWCSM-DJV-NC-00-REP-EN-000113 (CSM - Detailed Design - Platform Modification Works Reinstatement tracks of Platforms 13 & 14 Design Report - Stage 3.pdf)	Rev C (18/04/2019)	Sydney Metro City & Southwest, Central Station Main Works, Platform Modification Works Package 2, Reinstatement tracks of platforms 13 & 14 - Stage 3 Design Report	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E03%20Central%20Station%20Main%20Works%20Detailed%20Design%2FPlatform%20Modification%20Works	TfNSW	Sydney Metro City & Southwest - Stage 3 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
28	FLOODING & TRACK DRAINAGE	SMCSWCSM-DJV-NC-30-REP-EN-000006 (Pages from CSM - Detailed Design - CWE - Track Slab, Portal Structures and Demolition of Existing Baggage Tunnel Design Report - Stage 2.pdf)	Rev A (30/08/2019)	Sydney Metro City & Southwest, Central Station Main Works, Central Walk East Package 2A, Track Slab, Portal Structures and Demolition of Existing Baggage Tunnel - Stage 2 Design Report	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E03%20Central%20Station%20Main%20Works%20Detailed%20Design%2FCentral%20Walk%20East	TfNSW	Sydney Metro City & Southwest - Stage 2 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
29	FLOODING & TRACK DRAINAGE	Existing Baggage Tunnel Design Drawings - Stage 2.pdf	Rev A (30/08/2019)	Sydney Metro City & Southwest, Central Station Main Works, Civil Drainage - Stage 2 Design Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E03%20Central%20Station%20Main%20Works%20Detailed%20Design%2FCentral%20Walk%20East	TfNSW	Sydney Metro City & Southwest - Stage 2 Proposed Drainage Details. Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling.	Used for Information Only
30	FLOODING & TRACK DRAINAGE	NWRLSRT-PBA-SCS-CE-DWG-338105 to NWRLSRT-PBA-SCS-CE-DWG-338187	-	Sydney Metro City & Southwest - Concept Design Drawings (24/02/2019)	DWG/PDF	DWGs provided on external hard drive by TfNSW. Report: https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E02%20Central%20Station%20Main%20Works%20Reference%20Design	TfNSW	Existing track drainage layout and details, noting that this is stated to be assumed based on a variety of sources and requires further survey to confirm accuracy.	Used for Information Only
31	FLOODING & TRACK DRAINAGE	NWRLSRT-PBA-SCS-EN-REP-000024 (Report - Civil - Volume 4.pdf)	Rev B	Sydney Metro City & Southwest - Civil, Structures, Utilities, Drainage, Geotechnics and Constructability - Volume 4, Reference Design 24/2/2019	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?RootFolder=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200605%20%2D%20Flood%20Info%2FSydney%20Metro%20%2D%20Reference%20Design&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749	TfNSW	Existing stormwater drainage network details and catchment areas.	Used for Information Only
32	FLOODING & TRACK DRAINAGE	Sections 2 and 3 track drainage from ST_combined	Rev A (19/12/2014)	GHD Sydney Yard Track Drainage Design Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/From%20TfNSW/05%20Previous%20Studies/05.08%20Flood%20and%20Drainage%20Reports/Sections%202%20and%203%20track%20drainage%20from%20ST_combined.pdf?csf=1&e=37kpa9&cid=f236b884-05b1-4e3e-8b45-f435a5a6aecb	TfNSW	Proposed design is not believed to have been constructed. Information of what is presented as existing to be used to understanding the existing drainage network.	Used for Information Only
33	FLOODING & TRACK DRAINAGE	21-20426-G001-RA to 21-20426-G005-RA	Jun-11	GHD Existing Track Drainage Drawings	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F05%20Previous%20Studies%2F05%2E08%20Flood%20and%20Drainage%20Reports	TfNSW	Existing stormwater drainage network details and catchment areas.	Used for Information Only
34	FLOODING & TRACK DRAINAGE	PS111185-DRN-REP-001 RevC.PDF	Rev C (20/11/2019)	Sydney Trains Bradfield Flyover Drainage	PDF/TIF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=VaZB7a&cid=00161610%2D714b%2D4684%2D8b2d%2Dc80e3184330b&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F01%20Interfaces%2F01%2E08%20Sydney%20Trains%20Bradfield%20Flyover%20Drainage	TfNSW	Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling. The design information will be used to improve our understanding of the existing drainage network within the rail yard.	Used for Information Only
35	FLOODING & TRACK DRAINAGE	Various	-	Sydney Terminal Area Reconfiguration (STAR)	PDF/DWG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=gFPcoq&cid=45e16211%2D8789%2D4db5%2Db31c%2Da3b33b45cdb4&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F01%20Interfaces%2F01%2E01%20MTMS%20%26%20STAR	TfNSW	We are not proposing to consider the STAR works in either the concept track drainage design or the flood modelling exercise given the scale of these works. The design information will be used to improve our understanding of the existing drainage network within the rail yard.	Used for Information Only
36	FLOODING	Various	As Built	Sydney Light Rail Design Information	PDF/DWG	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=I2TRhQ&cid=78060244%2D9081%2D4312%2Da91b%2Dadb6efeb6bf6&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F16%20Request%20For%20Information%2F20200714%20%2D%20SLR%20CADs	TfNSW	Existing stormwater drainage network details. SLR Tuflow Model is to be used as reference for SLR drainage.	Used for Information Only
37	FLOODING	Various	Rev A	Architectus Structural Plan & Urban Design Report - May 2020	DWG/PDF	https://arcadiso365.sharepoint.com/:f:/r/sites/AUS-PS10/CPRP/Transfer/From%20Architectus/2020-06-09%20Final%20Structure%20Plan%20DWG%20files%20+%20Rhino%20model?csf=1&web=1&e=fqxPFU	Architectus	Representation of Proposed Development used to inform flood modelling assumptions of the Preliminary Developed Case Flood Model. Floor levels of internal building entrances for proposed ground level interfacing.	
38	FLOODING	Various	-	Atlassian Proposed Ambulance Ave Pipeline	PDF/IFC	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=LLgjGb&cid=9d6a8159-ae68-42bf-b566-8485b7bb3d0c&RootFolder=%2fsites%2fAUS%2dPS10%2fCPRP%2fTransfer%2fFrom%20TfNSW%2f02%20Third%20Party%20Development%20Proposals%2f02%2e01%20Atlassian%2f20200729%20%2d%20Atlassian%20Proposed%20Drainage%20Line&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749	Architectus	Given that this design is work in progress, it will not be considered as part of the Existing or Preliminary Developed Case Flood Modelling. The Architectus Structural Plan from May 2020 will be used to inform the Preliminary Developed Case Flood Modelling.	Used for Information Only
39	FLOODING	CPRP025-CEN-CV-EW-SKE-000001	2	Western Forecourt Proposed Ground Levels	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=9QObl6&cid=67070e0e%2D7d0f%2D478d%2D937b%2D2e19d4dc5a13&RootFolder=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20Arcadis%2FWorking%20Folder%2FWestern%20Forecourt%2FPreliminary%20Sketches%2F20200804%5FWestern%5FForecourt%5FGrading&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749	Arcadis	Proposed ground surface for the Western Forecourt/Central Square. Note no proposed drainage network has been developed at this stage of the project.	
40	TRACK DRAINAGE	610076.000 CSRP Sustainability Strategy - Final DRAFT Report	0.2	Central Precinct Renewal Program Environmental Sustainability Strategy - Final Draft	PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/From%20Integral%20(Sustainability)/2020-06-29%20Draft%20Sustainability%20Strategy/610076.000%20CSRP%20Sustainability%20Strategy%20-%20Final%20DRAFT%20Report.pdf?CT=1594625170675&OR=ItemsView	IGAT	Nil. To be provided for information only. Not proposed to be considered in current scope.	Used for Information Only
41	FLOODING	SYDNEY YARD ACCESS BRIDGE PROJECT	DDS Rev 2	Transport for NSW	DWG/PDF	https://arcadiso365.sharepoint.com/sites/AUS-PS10/CPRP/Transfer/Forms/AllItems.aspx?csf=1&web=1&e=kMQkta&cid=776812cf%2D7ffa%2D4087%2Dac3a%2D25d95634866f&FolderCTID=0x0120000970D42AD6F00A4CB8672BD953840749&id=%2Fsites%2FAUS%2DPS10%2FCPRP%2FTransfer%2FFrom%20TfNSW%2F03%20Sydney%20Metro%2F03%2E06%20SYAB&viewid=2d51f7a4%2D6994%2D4d91%2D8089%2Db8bc74f78565	Laing O'Rourke	Representation of existing conditions of the rail yard. The bridge structure will have a influence on overland flow across railyard.	Used for Information Only

ASSUMPTION REGISTER

Project Scope: Central Precinct Renewal Project

Contributors: Arcadis

	ASSUMPTION DESCRIPTION			FUTURE WORK	
Ref #	**Category/ Discipline**	**Title**	**Description**	**Future work options (to clarify opportunity)**	**Recommendations**
1	Precinct Flood Modelling	Sufficiency of Existing Drainage Details	Existing drainage network details have been obtained from a variety of sources with low reliance. Assumptions have been made in the absence of complete drainage details. In some instances this has included assumptions regarding outlet connections as well as diameters and invert levels. The flood model assumes the incorporated drainage details are reflective of the existing drainage network. Should the data and assumptions used be inaccurate, identified and unidentified flood risks may be unreliable. Potential inaccuracy of drainage details may primarily impact the suitability of proposed drainage network designs, flood immunity and flood mitigation works.	Undertake quality topographical surveys to confirm and complete the drainage network data. Undertaking surveys sooner in the project program will reduce the likelihood of design and construction rework. Revise flood model based on obtained data. Seek anecdotal evidence from Sydney Trains & City of Sydney Council to validate flood results. Discrepancies in flood behaviour can then be further investigated. This may involve review of the flood model setup, collecting and incorporating additional data. Consider the potential for inaccuracies in the flood model results when developing designs impacted by flood constraints. This may involve providing additional stormwater detention capacity and freeboard to flood levels.	Undertake topographical site surveys to confirm drainage and surface topographical details. Develop a survey program to undertake these works in an efficient manner.
2	Precinct Flood Modelling	Accuracy of Existing Terrain Information	The flood model creates a representation of the ground surface terrain over which the conveyance of flood flows are simulated. The current model uses a combination of Lidar and various topographical survey to define the existing surface and flow obstructions (such as buildings and walls). The flood model assumes the data sources are an accurate reflection of the existing terrain. Should the accuracy of these sources be incorrect, the simulated flood results would contain this error. Errors in vertical information are of particular concern given that little freeboard is often provided to floor levels driven by flood controls.	Undertake a ground truthing exercise to determine the accuracy of the existing data sources. More recent data sources may be obtained and validated. This data can then be incorporated into the flood model to improve reliance. This may include Lidar as well as topographical survey. Revise flood model based on obtained data. Consider the potential for inaccuracies in the flood model results when developing designs impacted by flood constraints. This may involve providing additional stormwater detention capacity and freeboard to flood levels.	Undertake topographical site surveys to confirm surface topographical details. This survey information will also be required by various other disciplines in developing the CPRP design. Develop a survey program to undertake these works in an efficient manner.
3	Precinct Flood Modelling	Suitability of Council Flood Models	Council flood models have been used as the base models upon which updates, refinements and improvements have been made around the CPRP area as outlined in the Precinct Flood Model Report. It has been assumed that these models are an accurate and suitable reflection of the upstream and downstream catchment area under present and future conditions. Should inaccuracies be present in these Council flood models, it has the potential to alter the simulated flood behaviour surrounding and through the site. Identified and unidentified flood risks may be unreliable. This may primarily impact the suitability of proposed drainage network designs, flood immunity and flood mitigation works.	Ongoing Council engagement may be undertaken to identify changes to the flood model catchment area. Where required the flood model can be updated to reflect these changes. This may require sourcing of design details and/or survey information from others. Consider the potential for inaccuracies in the flood model results when developing designs impacted by flood constraints. This may involve providing additional stormwater detention capacity and freeboard to flood levels.	Continue to engage with Council to ensure changes in catchment conditions are identified, understood and considered in future flood model updates.
4	Precinct Flood Modelling	Suitability of Adopted Flood Model Parameters	The Darling Harbour Flood Study has been a primary source of flood model parameters. These flood model parameters are considered typical of the those adopted throughout metropolitan Sydney. It has been assumed that the flood model parameters adopted are reasonable and suitable for the catchment area. It has also been assumed that stakeholders (in particular City of Sydney Council and Sydney Water) will be accepting of the model parameters and methodology of the flood modelling undertaken. Should the flood model parameters or methodology be adjusted this would impact the simulated flood results, in particular design flood levels, velocities and hazard. Adjustments to the flood model may be requested by stakeholders, or the need may become apparent on review of additional data.	Ongoing consultation with stakeholders is recommended to ensure any issues with the flood model are identified early in the design process. Additional sensitivity testing of parameters may be undertaken to determine the impact of various assumptions on the produced results.	Present flood modelling to stakeholders and seek review early in the design process.
5	Precinct Flood Modelling	Suitability of Proposed Development Conditions	A variety of assumptions regarding the extent of the proposed CPRP works and nature of the ultimate design are required to inform the flood model. Unique modelling approaches have also been employed to represent the proposed development within the flood model. This work has been undertaken based on our understanding of the current level of design development for the CPRP. It has been assumed that these assumptions are a reasonable reflection of the ultimate CPRP development, and that the flood modelling approach is suitable. Should the assumptions be inaccurate, identified and unidentified flood risks may be unreliable. This may primarily impact the suitability of proposed drainage network designs, flood immunity and flood mitigation works.	The flood model can be updated as the CPRP design develops. The assumptions and modelling approaches will be reviewed and revised as required.	Revise the representation of the proposed CPRP throughout the design process.
6	Precinct Flood Modelling	Consideration of Staging	The flood model does not make any allowance for the consideration of staged development of the CPRP. It is expected that identified and unidentified flood risks will vary from those presented throughout the construction process.	Revise the proposed flood modelling throughout the design process to ensure the flood assessment remains current. Assess the flood risk at interim development stages to avoid unknown and possibly increased flood risk during the construction period.	Assess the flood risk at interim development stages to avoid unknown and possibly increased flood risk during the construction period.
7	Precinct Flood Modelling	BOOS Stormwater Connection & Base Flow Conditions	A portion of the existing track drainage is believed to discharge to the Bondi Ocean Outfall Sewer (BOOS) along track 1. A section of the BOOS has been included in the flood model. A base flow condition of the sewer has been assumed to provide a tailwater condition for the track drainage connection. Should the sewer base flow assumption be inaccurate, this would impact the existing flood results for the track drainage in the vicinity of the Country platforms. Flood impact results for the CPRP are expected to be impacted if the track drainage connection to the BOOS is incorrect.	Undertaking quality topographical survey to confirm the track drainage connection to the BOOS. It is expected that sewer load modelling of the BOOS will be conducted during the design of the CPRP. The BOOS base flow assumption can be refined based on the findings of this modelling work.	Undertake survey to confirm track drainage connection to the BOOS. Review BOOS assumption based on sewer modelling if required.
8	Precinct Flood Modelling	Outdated SLR Ground Surface Information	The Sydney Light Rail (SLR) project has been incorporated into the CPRP flood model based on the SLR flood model information provided. However the SLR ground surface information is missing in the flood model provided. The ground surface information for the extent of the SLR is therefore outdated in the flood model. This may result in inaccuracies in the simulated flood results and consequently identified and unidentified flood risks may be unreliable.	Obtain final design ground surface information for the SLR. Alternatively undertake topographical ground survey of the area to ensure the ground surface information is current.	Undertake topographical survey to establish existing ground surface information.
9	Precinct Flood Modelling	Sydney Metro Excluded	The Sydney Metro works within the CPRP are currently being constructed across several different packages of work. The Sydney Metro works have not currently been considered in the flood model as the final design information is not yet available. The flood modelling therefore assumes that the Sydney Metro works will not have significant impacts on flood model results. Should this assumption be incorrect, flood results in the vicinity of the Sydney Metro works (Platforms 13/14 and Central Walk East in particular) may be inaccurate.	A representation of the Sydney Metro works could be incorporated based on the information currently available and adopting assumptions where required. However we envisage this work would then need to be repeated once the final design information is obtained. Comprehensive final design information (models, drawings and reports) are ideal for our purposes. Alternatively sufficiently detailed WAE information may be suitable.	Incorporate the final design information for Sydney Metro into the flood model once the majority of the works have been constructed to avoid rework in the flood modelling.
10	Precinct Flood Modelling	Ongoing Track Modifications Excluded	Ongoing track modification works are scheduled within the rail corridor, including the STAR project and works near the flyovers. In some instances these involve modifications to the track drainage network. Given that these works are at various design stages, and that they are relatively minor, they have not currently be incorporated into the CPRP flood model. It has been assumed that these work do not significantly impact the drainage network performance within the rail corridor. Should this assumption be inaccurate, this would impact the existing flood results for the track drainage in the vicinity of the track modification works.	Planned works within the rail corridor will need to be considered in the flood modelling and CPRP design as the design develops. However, we propose only to incorporate track drainage modifications for completed works deemed significant in the context of the CPRP flood model.	Incorporate final design information for constructed track modifications on an as needs basis.

APPENDIX F – BASE CASE FLOOD MODEL DEVELOPMENT

Base Case Flood Model Development

The CPRP flood model was formed by merging the City of Sydney DHFS and the BBFS flood models. The flood model development process is complex and has involved many tasks as summarised in the table below.

Task	Detail of Modelling Task
Review of Available Data	• Review of background information e.g. CPRP project scope, project concept, strategic vision, previous CRPR technical desktop study. • Review of GIS information e.g. aerial photos, cadastre, Lidar survey information. • Review of stormwater information e.g., Sydney Water assets, City of Sydney assets, DBYD. • Review of survey data e.g. ground survey around CPRP. • Review of as-built design information e.g. Central Station layout. • Review of site photos and google street-view photos. • Review of interfacing project data e.g. Sydney Metro Reference design, Railyard track drainage improvement works.
Development of CPRP Existing Flood Model (Base Model)	• Review of Council Darling Harbour and Blackwattle Bay catchment flood study and flood models. • Comparison of flood modelling adopted parameters, assumptions and modelling approaches e.g. hydrological losses, material roughness, boundary conditions, inlet and pipe blockages, rainfall input method, cell size. • Selection of DHFS flood modelling approach and adoption across the flood model. • Removal of the scaling factor of 1.5 to all inlet pits for DHFS model setup (it is believed to be an inherited error in the model setup). • Alignment of BBFS model components to DHFS standard e.g. inclusion of pipe sizes < 0.45m, inlet pit configuration, removal of stormwater system overlapd between flood models. • Conversion of flood model GIS layers to satisfy latest TUFLOW version requirements. e.g. SA inflow, material, building code polygons. • Assembly of CPRP flood model, testing and comparison with City of Sydney flood model results.
Refinement of Modelling Approach	• Review of cell size considering run time. • TUFLOW Classic solver updated to HPC solver (reduction of run time). • Consideration of Quadtree option.
Update of Existing Conditions (Base) Model – Topographic Information	• Comparison of 2008 and 2013 Lidar data. • Refinement of Henry Deane Plaza area and inclusion of pedestrian tunnel to the Goods Line walkway. • Inclusion of the Goods Line tunnel from the rail corridor to the Goods Line walkway. • Refinement of Ambulance Ave area based on topographic survey. • Refinement of building footprints within the CPRP site. • Inclusion of solid wall structures that may influence local flow patterns, e.g., walls along Pitt St and Ambulance Ave. • Inclusion of Sydney Metro Sydney Yard Access Bridge.
Update of Existing Conditions (Base) Model – Stormwater Information	• Update of stormwater system in proximity of the CPRP based on: - DBYD information - City of Sydney pit and pipe database - Sydney Water GIS database and WAE drawings - Topographical survey information

Task	Detail of Modelling Task
Update of Existing Conditions (Base) Model – SICEEP Area	• Review of SICEEP flood model. • Replacement of stormwater system within SICEEP area. • Replacement of ground surface with SICEEP design surface.
Update of Existing Conditions (Base) Model – SLR Area	• Review of SLR flood model. • Replacement with stormwater system along SLR route.
Update of Existing Conditions (Base) Model – Track Drainage	• Development existing track drainage network complied from multiple sources and incorporated into the flood model.
Update of Modelling Extent – Carriageworks Area	• Extension of flood model to include the Carriageworks rail yard area. This area may form part of catchment draining north towards the CPRP rail corridor in large storm events.

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CENTRAL, BUILDING A CONNECTED PLACE.

Appendix D – Policy and plan extracts

(iii) whether the music played or performed is original music, or

(iv) the number of musicians or live entertainment acts playing or performing, or

(v) the type of instruments played,

(b) whether dancing occurs,

(c) the presence or use of a dance floor or another area ordinarily used for dancing,

(d) the direction in which a stage for players or performers faces,

(e) the decorations to be used, including, for example, mirror balls, or lighting used by players or performers.

(2) The consent authority must not refuse consent to development in relation to licensed premises on the grounds of noise caused by the playing or performance of music, if the consent authority is satisfied the noise may be managed and minimised to an acceptable level.

(3) In this clause—

licensed premises has the same meaning as in the *Liquor Act 2007*.

5.21 Flood planning

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

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

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(5) In this clause—

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

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

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

5.22 Special flood considerations

[Not adopted]

3.7

Water and Flood Management

Terms used in this section are consistent with the NSW Floodplain Development Manual 2005.

Objectives

(a) Ensure an integrated approach to water management across the City through the use of water sensitive urban design principles.

(b) Encourage sustainable water use practices.

(c) Assist in the management of stormwater to minimise flooding and reduce the effects of stormwater pollution on receiving waterways.

(d) Ensure that development manages and mitigates flood risk, and does not exacerbate the potential for flood damage or hazard to existing development and to the public domain.

(e) Ensure that development above the flood planning level as defined in the Sydney LEP 2012 will minimise the impact of stormwater and flooding on other developments and the public domain both during the event and after the event.

(f) Ensure that flood risk management addresses public safety and protection from flooding.

Note: A number of flood studies are currently underway. New development will be required to conform to the flood studies once endorsed by Council.

Provisions

3.7.1 Site specific flood study

(1) When required by Clause 7.15 of Sydney LEP 2012, a site-specific flood study is to be prepared by a suitably qualified and experienced hydrologist 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.

(2) The site-specific flood study is to include, but not be limited to:

  (a) a detailed topographical survey that defines flow paths, storage areas and hydraulic controls; and

  (b) flood modelling that uses appropriate hydrological and hydraulic techniques and incorporates boundary conditions.

(3) The site-specific flood study is to show pre-development and post-development scenarios, and at a minimum is to include the following information:

  (a) water surface contours;

  (b) velocity vectors;

  (c) velocity and depth product contours;

  (d) delineation of flood risk precincts; and

  (e) flood profiles for the full range of events for total development including all structures and works (such as revegetation and physical enhancements).

(4) The site-specific flood study is to assume the 'worst case scenario' conditions for blockages to pipes, culverts and other infrastructure, such that:

(a) kerb inlets are assumed to be 50% blocked;

(b) sag pits are assumed to be 100% blocked; and

(c) culverts and bridges with an open area less than six metres, measured on the diagonal, are assumed to be 50% blocked.

3.7.2 Drainage and stormwater management

These provisions are supported by the *Stormwater management map*. The map identifies the catchments with specific stormwater management requirements and also those areas where stormwater is required to be integrated with open space.

(1) A local drainage management plan is required for development on sites of:

(a) 1,000sqm or more in the Fowler's Creek catchment area and drains to Johnston's Creek as shown on the *Stormwater management map*; or

(b) 1,800sqm or more in other catchments.

(2) The Local Drainage Management Plan is to address:

(a) the hydrology of the locality and its relationship to the drainage system;

(b) the distribution of soil types and the scope for on-site infiltration;

(c) any expected rise in ground water level due to development;

(d) the role of the principal landscape components on the site for water conservation and on-site detention;

(e) the scope for on-site stormwater detention and retention, including collection of water for re-use;

(f) how any detrimental impacts on the existing natural hydrology and water quality are proposed to be minimised;

(g) how pedestrian safety is to be ensured; and

(h) integration of drainage management responses and open space areas.

(3) A suitably qualified engineer with experience in drainage design is to assess the site drainage requirements for the proposed development, and prepare the required local drainage management plan in accordance with the provisions of this DCP.

(4) Development on sites identified in the *Stormwater management map*, are to provide on-site stormwater detention within open space areas.

(5) Drainage systems are to be designed so that:

(a) on a site with an area less than or equal to 1,000sqm:

(i) stormwater flows up to the 20% annual exceedance probability event are conveyed by a minor drainage system; and

(ii) stormwater flows above the 20% annual exceedance probability event are conveyed by a major drainage system;

(b) on a site with an area greater than 1,000sqm:

(i) stormwater flows up to the 5% annual exceedance probability event are conveyed by a minor drainage system; and

(ii) stormwater flows above the 5% annual exceedance probability event are conveyed by a major drainage system.

(6) The development proposal must demonstrate how the major drainage system addresses any site-specific conditions and connects to the downstream drainage system.

(7) Major drainage systems are to be designed so that ensures that public safety is not compromised.

(8) Minor flows from a development site are not to be discharged to the kerb if direct connection to an existing stormwater pipe is available, unless it can be demonstrated there is sufficient capacity within the existing gutter and the flow velocity and depth within the gutter will remain below 400mm.

(9) Where the proposed development is located on a floodplain, high level overflows are permitted for roof drainage systems where the overflow is set above the 1% annual exceedance probability level.

(10) Connection to existing stormwater infrastructure are not to reduce the capacity of that infrastructure by more than 10%. The development proposal is to show the level of impact on the existing stormwater infrastructure as a result of the proposed new connection.

(11) The post development run-off from impermeable surfaces (such as roofs, driveways and paved areas) is to be managed by stormwater source measures that:

(a) contain frequent low-magnitude flows;

(b) maintain the natural balance between run-off and infiltration;

(c) remove some pollutants prior to discharge into receiving waters;

(d) prevent nuisance flows from affecting adjacent properties; and

(e) enable appropriate use of rainwater and stormwater.

(12) Post-development stormwater volumes during an average rainfall year are to be:

(a) 70% of the volume if no measures were applied to reduce stormwater volume; or

(b) the equivalent volume generated if the site were 50% pervious, whichever results in the greater volume of detention required.

(13) Stormwater detention devices are to be designed to ensure that the overflow and flowpath have sufficient capacity during all design rainfall events, discharge to the public stormwater system without affecting adjoining properties, and are free of obstructions, such as fences.

(14) Where filtration and bio-retention devices are proposed, they are to be designed to capture and provide temporary storage for stormwater.

(15) Car parking areas and access aisles are to be designed, surfaced and graded to reduce run-off, allow stormwater to be controlled within the site, and provide for natural infiltration of stormwater runoff through landscaping.

3.7.3 Stormwater quality

(1) Development of a site greater than 1,000sqm must undertake a stormwater quality assessment to demonstrate that the development will achieve the post-development pollutant load standards indicated below:

(a) reduce the baseline annual pollutant load for litter and vegetation larger than 5mm by 90%;

(b) reduce the baseline annual pollutant load for total suspended solids by 85%;

(c) reduce the baseline annual pollutant load for total phosphorous by 65%; and

(d) reduce the baseline annual pollutant load for total nitrogen by 45%.

(2) The stormwater quality assessment is to be prepared by a suitably qualified engineer with experience in water sensitive urban design (WSUD) and include:

(a) modelling of pollutant load standards with an industry standard water quality model;

(b) the design of WSUD measures used to achieve the post-development pollutant load standards; and

(c) maintenance schedules of any proposed WSUD measure that requires maintenance or full replacement including the likely recycling or disposal location of any wastes that may be generated.

(3) Development on a site with an area less than 1,000sqm is to be designed so that the flow of pollutants from the site due to stormwater is reduced.

3.7.4 Additional provisions for commercial and industrial properties

(1) Development proposals for service stations, motor showrooms, vehicle repair stations and vehicle body repair workshops are to capture all stormwater up to the 3 month average recurrence interval event within the site to reduce the risk of stormwater pollution caused by spilled contaminants. The critical duration storm for the property and the 24 hour duration storm should be analysed.

(2) Drainage and waste disposal is to be conducted to the levels specified by the NSW Environmental Protection Authority.

3.7.5 Water re-use, recycling and harvesting

(1) Development proposals that seek to re-use water runoff from paved surfaces for irrigation and wash down purposes are to incorporate measures into the design of the development that will treat the water to ensure that it is fit for this purpose. These measures are to clean the water to exclude contaminants such as litter, sediment and oil.

Interim Floodplain Management Policy

Purpose

The Floodplain Management Policy provides direction with respect to how floodplains are managed within the Local Government Area (LGA) of the City of Sydney Council (the City).

The City has a responsibility to manage floodplains to ensure that any:

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

The Policy provides controls to facilitate a consistent, technically sound and best practice approach for the management of flood risk within the City's LGA. In forthcoming years the City will complete Floodplain Risk Management Plans and then integrate outcomes from these plans into planning controls. Once this process is completed this interim policy will be withdrawn.

Scope

This Policy applies to all new developments within the City of Sydney.

Definitions

Term	Meaning
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. 1% AEP flood is approximately equal to 1 in 100 year Average Recurrent Interval (ARI) flood event (or simply 100 year flood). It has 1% chance to occur in a given year.
Australian Height Datum (AHD)	A common national plan of level corresponding approximately to mean sea level.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event may occur on average once every 20 years.

Term	Meaning
Basement Car Parking or Below-Ground Car Parking	The car parking area generally below ground level where inundation of the surrounding areas may raise water levels above the entry level to the basement, resulting in inundation. Basement car parks are areas where the means of drainage of accumulated water in the car park has an outflow discharge capacity significantly less than the potential inflow capacity.
Below-Ground Garage/Car park	Applies where the floor of the parking and/or access surface is more than 1 m below the surrounding natural ground.)
Carport	A structure used to house motor vehicles, which has a minimum of two sides "open" and not less than one third of its perimeter "open".
Critical Facilities	Includes hospitals and ancillary services, communication centres, police, fire SES, major transport facilities, sewerage and electricity plants; any installations containing critical infrastructure control equipment and any operational centres for use in a flood.
Effective Warning Time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to raise furniture, evacuate people and transport their possessions.
Evacuation	The transfer of people and or stock from areas where flooding is likely, either close to, or during a flood event. It is affected not only by warning time available, but also the suitability of the road network, available infrastructure, and the number of people that have to evacuate during floods.
Extreme Flood	An estimate of the probable maximum flood (PMF), which is the largest flood that could conceivably occur at a particular location, generally estimated from the probable maximum precipitation (PMP). Generally it is not physically or economically possible to provide complete protection against this event.
Flood	A relatively high stream flow that overtops the natural or artificial banks in any part of a stream, channel, river, estuary, lake or dam, and/or local overland flooding associated with major drainage as defined by the NSW Floodplain Development Manual (FDM) before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood Compatible Materials	Those materials used in building which are resistant to damage when inundated. A list of flood compatible materials is attached.
Flood Evacuation Strategy	The proposed strategy for the evacuation of areas with effective warning time during periods of flood as specified within any policy of Council, the floodplain risk management plan (FRMP), the relevant state government disaster plan, by advices received from the State Emergency Services (SES) or as determined in the assessment of individual proposals.
Floodplain	The area of land which is subject to inundation by floods up to and including the probable maximum flood (PMF) event.

Term	Meaning
Floodplain Development Manual (FDM)	The document dated April 2005, published by the New South Wales Government and entitled 'Floodplain Development Manual: the management of flood liable land'.
Flood Planning Area	The area of land below the FPL and thus subject to flood related development controls.
Flood Planning Level (FPL)	The combinations of flood levels and freeboards selected for floodplain risk management purposes, as determined in flood studies and floodplain risk management studies and plans.
Floodplain Risk Management Plan (FRMP)	A plan prepared for one or more floodplains in accordance with the requirements of the FDM or its predecessor.
Floodplain Risk Management Study (FRMS)	A study prepared for one or more floodplains in accordance with the requirements of the FDM or its predecessor.
Flood Storage	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
Floodway	Those areas, often aligned with obvious naturally defined channels, where a significant discharge of water occurs during floods. They are also areas where, if only partially blocked, will cause a significant redistribution of flood flow or significant increase in flood levels, which many impact on other properties.
Freeboard	A factor of safety expressed as the height above the design flood level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action; localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement; cumulative impacts of fill in floodplains and other effects such as changes in rainfall patterns as a result of climate change.
Garage	A private building or part of a building used to park or keep a motor vehicle and that is not defined as a carport.
Habitable Floor Area	• in a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom; • in an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Hazardous Materials	Solids, liquids, or gases that can harm people, other living organisms, property, or the environment. These may include materials that are radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, bio-hazardous, toxic, pathogenic, or allergenic. Also included are physical conditions such as compressed gases and liquids or hot materials, including all goods containing such materials or chemicals, or may have other characteristics that render them hazardous in specific circumstances.
Large Scale Development	For the purposes of this document refers to a proposal that involves site disturbance 1000m2 of land or greater.
Local Overland Flow Path	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.

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Term	Meaning
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.
Probable Maximum Precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.
Reliable Access During A Flood	The ability for people to safely evacuate an area subject to imminent flooding within effective warning time, having regard to the depth and velocity of flood waters, the suitability of the evacuation route, and without a need to travel through areas where flood hazard increases
Section 149 Planning Certificate	Information, including the statutory planning controls that apply to a parcel of land on the date the certificate is issued.
Shed	Includes machinery sheds, garden and storage sheds but does not include a garage or car park.
Suitably Qualified Engineer	An engineer who is included in the National Professional Engineers Register, administered by the Institution of Engineers Australia.
Survey plan	A plan prepared by a Registered Surveyor which shows the information required for the assessment of an application in accordance with the provisions of this Policy.

Policy statement

1 Introduction

The Policy has been prepared in accordance with the guidelines provided in the NSW Government Floodplain Development Manual (2005) (FDM). This manual guides Council in the development and implementation of local Floodplain Risk Management Plans to produce robust and effective floodplain risk management outcomes.

In accordance with the FDM, the Flood Risk Management Process entails four sequential stages:

- Stage 1:Flood Study
- Stage 2:Floodplain Risk Management Study
- Stage 3:Floodplain Risk Management Plan
- Stage 4:Implementation of the Plan

The City is progressively producing Floodplain Risk Management Plans for each of the individual drainage catchments within the City's LGA. Floodplain Risk Management Plans consider the existing flood environment and recommend specific measures to manage the impact of flooding. In assessing the flood environment, elements such as known flood behaviour, evacuation issues, site access and the potential impact of sea level rise are taken into consideration. This information is used to create floodplain risk mapping for each catchment.

Floodplain Risk Management Plans provide a range of measures that can be used to mitigate the impact of flooding. Invariably one of the most successful measures is the implementation of effective land use planning. This document provides the means for implementing the Floodplain Risk Management Plans and associated mapping for the control of development on the floodplain within the City.

1.1 Aims and Objectives of the Policy

- To inform the community of the City's Policy with regard to the use of flood prone land;
- To establish guidelines for the development of flood prone land that are consistent with the NSW Flood Policy and NSW Floodplain Development Manual (2005) as updated by the Floodplain Management Guides;
- To control development and activity within each of the individual floodplains within the City having regard to the characteristics and level of information available for each of the floodplains;
- To minimise the risk to human life and damage to property by controlling development on flood prone land;
- To apply a merit based approach to all development decisions taking into account ecological, social and environmental considerations;
- To ensure that the development or use of floodplains does not adversely impact upon the aesthetic, recreational and ecological values of the waterway corridors;
- To ensure that all land uses and essential services are appropriately sited and designed in recognition of all potential floods;
- To ensure that all development on the floodplain complies with Ecologically Sustainable Development (ESD) principles and guidelines; and
- To promote building design that considers requirements for the development of flood prone land and to ensure that the development of flood prone land does not have significant impacts upon the amenity of an area.

1.2 Background

This Policy has been prepared having regard to the provisions of the NSW Flood Policy and NSW Floodplain Development Manual (2005).

Sydney Local Environmental Plan 2012 (Sydney LEP 2012) requires the consent authority to be satisfied that all new development adequately protects the safety of property and life, and avoid significant adverse impacts on flood behaviour and the environment. Specified flood planning controls apply to all land which is at or below the flood planning level. The requirements set out in Sydney LEP 2012 must be met before development consent is granted.

This Policy is to be read in conjunction with the provisions of Sydney LEP 2012 and Sydney DCP 2012.

1.3 Relationship to other Policies

This Policy is to be read in conjunction with Sydney LEP 2012 and Sydney DCP 2012. It includes but is not limited to the development types listed below:

- Single dwellings, terraces, and dual occupancy buildings;
- Residential flat, commercial and mixed use developments;
- Industrial developments; and
- Other development types and uses, as detailed in the Sydney DCP 2012.

In conjunction with the development type requirements, the Sydney LEP 2012 and Sydney DCP 2012 also require:

- Sustainable water use practices;
- The reduction of stormwater pollution on receiving waterways; and
- That development does not exacerbate the potential for flood damage or hazard for existing development or public domain.

1.4 Application of Policy

The policy is written in an objectives/requirements format. Where an applicant seeks variation from the requirements, appropriate written justification indicating how the proposal meets the relevant objectives, must be provided for the consideration of Council.

2 Application Requirements

2.1 Required Information

Applications must include information that addresses all relevant controls listed within this document and the following matters as applicable:

a Development applications affected by this Policy shall be accompanied by a survey plan showing:
- i the position of the existing building/s or proposed building/s;
- ii the existing ground levels and features to Australian Height Datum around the perimeter of the site and contours of the site; and
- iii the existing or proposed floor levels to Australian Height Datum.

b Applications for earthworks, filling of land, infrastructure and subdivision shall be accompanied by a survey plan (with a minimum contour interval of 0.25m) showing relative levels to Australian Height Datum.

c For large scale developments, or developments that in the opinion of the City are in critical situations, where an existing catchment based flood study is not available, a flood assessment report prepared by a suitably qualified engineer using a hydrologic and hydraulic dynamic one or two dimensional computer model.

d Where the controls for a particular development proposal require an assessment of structural soundness during potential floods, the following impacts must be addressed:
- iv hydrostatic pressure;
- v hydrodynamic pressure;
- vi impact of debris; and
- vii buoyancy forces.

Foundations need to be included in the structural analysis. Scour protection may be required at foundations.

3 Development Provisions

The Department of Planning and Infrastructure has produced a group of Model Local Provisions for inclusion in Local Environmental Plans. The Model Local Provisions have been produced to address common topics raised by Councils in Local Environmental Plan preparation and provide them with guidance in what is to be considered in the assessment of development proposals. The Model Clause for Flood Planning has been adopted as clause 7.15 in Sydney LEP 2012. The Performance Criteria listed under Section 3.2 below reflects the considerations specified in Sydney LEP 2012.

Sydney DCP 2012 provides prescriptive planning controls in Section 3.7. The objectives of these planning controls are to:

- Ensure an integrated approach to water management across the City through the use of water sensitive urban design principles.
- Encourage sustainable water use practices.
- Assist in the management of stormwater to minimise flooding and reduce the effects of stormwater pollution on receiving waterways.
- Ensure that development manages and mitigates flood risk, and does not exacerbate the potential for flood damage or hazard to existing development and to the public domain.
- Ensure that development above the flood planning level as defined in the Sydney LEP 2012 will minimise the impact of stormwater and flooding on other developments and the public domain both during the event and after the event.

Note: A number of flood studies and associated flood risk management plans are currently under development. New development will be required to conform to the requirements of these flood studies and associated flood risk management plans once endorsed by Council.

3.1 Performance Criteria

If a proposal does not meet the requirements of the relevant Prescriptive Provisions, consent must not be granted to development unless the consent authority is satisfied with the following the provision and assessment of information relating to the development. The development:

a is compatible with the established flood hazard of the land. In areas where flood hazard has not been established through previous studies or reports, the flood hazard must be established in accordance with the Floodplain Development Manual considering the following:

- i Impact of flooding and flood liability is to be managed ensuring the development does not divert floodwaters or interfere with flood storage or the natural function of the waterway;
- ii Flood behaviour (for example, flood depths reached, flood flow velocities, flood hazard, rate of rise of floodwater);
- iii Duration of flooding for a full range of events;
- iv Appropriate flood mitigation works;
- v Freeboard;
- vi Council's duty of care – Proposals to address or limit; and
- vii Depth and velocity of flood waters for relevant flood events.

b will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties;

c incorporates appropriate measures to manage risk to life from flood considering the followings:

- i The proposed development should not result in any increased risk to human life
- ii Controls for risk to life for floods up to the Flood Planning Level
- iii Controls for risk to life for floods greater than the Flood Planning Level

- iv Existing floor levels of development in relation to the Flood Planning Level and floods greater than the Flood Planning level
- v Council's duty of care – Proposals to address and limit
- vi What level of flooding should apply to the development e.g. 1 in 100 year, etc
- vii Effective flood access and evacuation issues
- viii Flood readiness – Methods to ensure relative flood information is available to current and future occupants and visitors;

d will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of creek or channel banks or watercourses;

e is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding;

f is consistent with the principles of Ecologically Sustainable Development; and

g adequately considers the impact of climate change.

It is to be noted that with regard to climate change, appropriate benchmarks based on the best available current information have been used in producing the flood risk management plans that inform this document.

Some prescriptive requirements such as flood planning level requirements may be relaxed if Council can be satisfied that the projected life of the proposed development is for a relatively short-term and therefore does not warrant the imposition of controls that consider impacts beyond the cessation of the proposed development. This will only be considered for uses where the residual risk to the occupation of the development is considered to be low. This may include certain temporary or demountable structures but would not include residential developments.

3.2 Concessional Development – Minor Additions

a. The City acknowledges that in some instances, relatively minor building additions will have minimal impact on the floodplain and will not present an unmanageable risk to life. Council will give consideration for the following forms of development on suitable sites:
   - i attached dwelling additions of up to 40m^2 of habitable floor area at or above the same level as the existing adjoining approved floor level for habitable floor area. The allowance for additions shall be made no more than once for any given development;
   - ii additions to Commercial and Industrial Uses of up to an additional 100 m^2 or 20% (whichever the less) of the Gross Floor Area of the existing building at no less than the same level as the existing adjoining approved floor level. The allowance for additions shall be made no more than once for any given development.

b. As part of any consent issued pursuant to this section Council will require:
   - i a restriction on the property title requiring compliance with the flood studies and associated flood risk management plans.
   - ii the existing development is to be suitably upgraded to address the potential impacts of flooding.

3.3 Heritage Considerations

The City acknowledges that certain buildings or structures require preservation due to their heritage significance. Developments with heritage significance can be assessed on a merit based approach provided the following requirements are satisfied:

i. Expert assessment has identified the structure or development as having heritage conservation value;

ii. Planning instruments have specifically identified the existing developmentas having heritage conservation value and provide the appropriate level of statutory protection;
iii. The highest practical level of flood protection is provided while maintaining an appropriate balance with heritage conservation;
iv. The proposed development will not be subject to frequent flooding risk that may jeopardise the long term viability or heritage conservation of the development. Comprehensive assessment would be required where the development is subject to flooding in storms more frequent than the 5% AEP flood;
v. A restriction shall be placed on the property title, identifying the flooding risk and requiring conservation of heritage values.

4 General Requirements

The following ancillary development issues are to be considered in the assessment of proposed development of flood prone land.

Development Type/ Aspect	Objective	Requirement
Fencing	• To ensure that fencing does not result in any significant obstruction to the free flow of floodwaters; and • To ensure that fencing will remain safe during floods and not become moving debris that potentially threatens the security of structures or the safety of people.	Fencing is to be designed and constructed in such a manner that it will not modify the flow of floodwaters and cause damage to surrounding land.
Residential Properties	• To minimise the damage to residential properties from flooding; and • To minimise risk to human life from the inundation of residential properties and to minimise economic cost to the community resulting from flooding.	• 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 detailed in Section 5; and • The proposed residential building or dwelling should not increase the likelihood of flooding on other developments, properties or infrastructure.
Industrial and Commercial Properties	• To minimise the damage to industrial and commercial properties from flooding; and • 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.	• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements detailed in Section 5; and • The proposed industrial or commercial development should not increase the likelihood of flooding on other developments, properties or infrastructure.

Development Type/ Aspect	Objective	Requirement
Car Parking	• To minimise the damage to motor vehicles from flooding; • To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures or the safety of people, or damage other property; and • To minimise risk to human life from the inundation of basement and other car park or driveway areas.	• The proposed car park should not increase the risk of vehicle damage by flooding inundation; • The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure; • The proposed garage or car park must meet the Flood Planning Level Requirements detailed in *Section 5*; and • 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 demonstrated how the objectives will be met.
Filling of Flood Prone Land	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.	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 filling must be supported by a flood assessment report from a suitably qualified engineer which certifies that the filling will not increase flood affectation elsewhere.
On-Site Sewer Management (Sewer mining)	• To prevent the spread of pollution from on-site sewer management systems during periods of flood; and • To assist in the ongoing operation of on-site sewer management systems during periods of flood.	The treatment facility must be located above the 1% AEP flood level and must comply with Flood Planning Level requirements, or are otherwise protected and may function if below this level.
Storage of Hazardous Substances	To prevent the potential spread of pollution from hazardous substances.	The storage of products which, in the opinion of the City, may be hazardous or pollute floodwaters, must be placed above the 1% AEP flood level or placed within an area protected by bunds or levels such that no flood waters can enter the bunded area and must comply with the Flood Planning Level requirement for such a facility.

Development Type/ Aspect	Objective	Requirement
Consideration of the Impact of Climate Change	To prevent the potential impact of climate change.	• For those developments which have a lifespan of more than fifty years the impact due to sea level rise and impacts due to increased rainfall intensities shall be considered. • Meet the allowances for sea level rise as recommended in the NSW Government Coastal Planning Guideline: Adopting Sea Level Rise 2010 (recently withdrawn from publication). Specifically, this shall include and allowance of 40cm by 2050 and a 90cm by 2100 from the 2009 Mean Sea Level. • Where in the opinion of the City the proposed development is of reasonable impact to regional or catchment trunk drainage, the drainage system design shall allow for a minimum of 10% increased rainfall.

5 Flood Planning Levels

A Flood Planning Level refers to the permissible minimum building floor levels. For below-ground parking or other forms of below-ground development, the Flood Planning Level refers to the minimum level at each access point. Where more than one flood planning level is applicable the higher of the applicable Flood Planning Levels shall prevail.

Development		Type of flooding	Flood Planning Level
Residential	Habitable rooms	Mainstream flooding	1% AEP flood level + 0.5 m
		Local drainage flooding (Refer to Note 2)	1% AEP flood level + 0.5 m or Two times the depth of flow with a minimum of 0.3 m above the surrounding surface if the depth of flow in the 1% AEP flood is less than 0.25 m
		Outside floodplain	0.3 m above surrounding ground
	Non-habitable rooms such as a laundry or garage (excluding below-ground car parks)	Mainstream or local drainage flooding	1% AEP flood level
Industrial or Commercial	Business	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level
	Schools and child care facilities	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level + 0.5m
	Residential floors within tourist establishments	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m
	Housing for older people or people with disabilities	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m or a the PMF, whichever is the higher
	On-site sewer management (sewer mining)	Mainstream or local drainage flooding	1% AEP flood level
	Retail Floor Levels	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Below-ground garage/ car park	Single property owner with not more than 2 car spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m

Development		Type of flooding	Flood Planning Level
	All other below-ground car parks	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m or the PMF (whichever is the higher) See Note 1
	Below-ground car park outside floodplain	Outside floodplain	0.3 m above the surrounding surface
Above ground car park	Enclosed car parks	Mainstream or local drainage flooding	1% AEP flood level
	Open car parks	Mainstream or local drainage	5% AEP flood level
Critical Facilities	Floor level	Mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is higher)
	Access to and from critical facility within development site	Mainstream or local drainage flooding	1% AEP flood level

Notes

1) The below ground garage/car park level applies to all possible ingress points to the car park such as vehicle entrances and exits, ventilation ducts, windows, light wells, lift shaft openings, risers and stairwells.

2) Local drainage flooding occurs where:

- The maximum cross sectional depth of flooding in the local overland flow path through and upstream of the site is less than 0.25m for the 1% AEP flood; and
- The development is at least 0.5m above the 1% AEP flood level at the nearest downstream trapped low point; and
- The development does not adjoin the nearest upstream trapped low point; and
- Blockage of an upstream trapped low point is unlikely to increase the depth of flow past the property to greater than 0.25m in the 1% AEP flood.

3) Mainstream flooding occurs where the local drainage flooding criteria cannot be satisfied.

4) A property is considered to be outside the floodplain where it is above the mainstream and local drainage flood planning levels including freeboard.

6 Flood Compatible Materials

Where required for development, the following materials are to be applied. Materials not listed may be accepted by Council subject to certification of the suitability of the material of the manufacturer.

Component	Flood Compatible Material
Flooring and Sub-floor	▪ Concrete slab-on-ground monolith construction ▪ Suspended reinforced concrete slab
Wall Structure	▪ Solid brickwork, blockwork, reinforced concrete or mass concrete
Wall and Ceiling Linings	▪ Fibro-cement board ▪ Brick, face or glazed ▪ Clay tile glazed in waterproof mortar ▪ Concrete ▪ Concrete block ▪ Steel with waterproof applications ▪ Stone, natural solid or veneer, waterproof grout ▪ Glass blocks ▪ Glass ▪ Plastic sheeting or wall with waterproof adhesive
Roof Structure	▪ Reinforced concrete construction ▪ Galvanised metal construction
Doors	▪ Solid panel with water proof adhesives ▪ Flush door with marine ply filled with closed cell foam ▪ Painted metal construction ▪ Aluminium or galvanised steel frame
Insulation	▪ Closed cell solid insulation ▪ Plastic/polystyrene boards
Windows	▪ Aluminium frame with stainless steel rollers or similar corrosion and water resistant material.
Nails, Bolts, Hinges and Fittings	▪ Brass, nylon or stainless steel ▪ Removable pin hinges ▪ Hot dipped galvanised steel wire nails or similar
Main Power Supply	▪ Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the designated flood planning level. Means shall be available to easily disconnect the dwelling from the main power supply.
Wiring	▪ All wiring, power outlets, switches, etc., should be located above the designated flood planning level. All electrical wiring installed below this level should be suitable for continuous underwater immersion and should contain no fibrous components. This will not be applicable for below-ground car parks where the car park complies with flood planning level requirements. ▪ Earth leakage circuit-breakers (core balance relays) or Residual Current Devices (RCD) must be installed. ▪ Only submersible type splices should be used below maximum flood level. ▪ All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.
Electrical Equipment	▪ All equipment installed below or partially below the designated flood planning level should be capable of disconnection by a single plug and socket assembly.

Component	Flood Compatible Material
Heating and Air Conditioning Systems	▪ Heating and air conditioning systems should be installed in areas and spaces of the house above the designated flood planning level.
Fuel storage for heating purposes	▪ Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off. ▪ The heating equipment and related fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. The tanks should be vented above the flood planning level.
Ducting for heating/cooling purposes	▪ All ductwork located below the relevant flood level should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, a closure assembly operated from above relevant flood level should protect the ductwork.

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Responsibilities

The Technical Services Manager is responsible for the development and revision of the policy. The City's Planning team together with the Public Domain team are responsible for communicating the policy and ensuring systems are in place to validate its compliance.

Consultation

The initial draft edition of the Interim Floodplain Management Policy was first reviewed by internal stakeholders of the City including City Operations and City Planning divisions. The Policy was then revised to take account of this input.

The City's Floodplain Risk Management Committee was initially informed regarding the need for the interim policy in December 2012. During the March 2013 Floodplain Risk Management Committee meeting a presentation was made by City staff regarding the draft policy. Copies of the policy were then provided to all Committee members for comment. Some minor changes were then made to the draft policy following feedback from committee members.

References

Laws and standards	• Local Government Act 1993, Section 733 • Environment Planning and Assessment Act 1979
Policies and procedures	• *Floodplain Development Manual: the management of flood liable land*, New South Wales Government, Published April 2005 • Sydney LEP 2012 • Sydney DCP 2012 • South Sydney DCP 1997, Green Square precinct amended 2006

Approval

Council approved this policy on 12 May 2014.

Review

Review period	Next review date	TRIM reference
City Operations will review this policy every 2 years	May 2016	2014/216277

26 | Energy and water efficency

The Strategy is in alignment with and seeks to support the City's other sustainability strategies including the Climate Adaption Strategy, the Residential Apartments Sustainability Plan and the Energy Efficiency Master Plan.

Objectives

- To improve the energy efficiency of buildings by reducing energy intensity per square metre
- To move towards a zero-net carbon precinct
- To reduce potable water consumption through water efficiency and connection to recycled water
- To assist in reducing future infrastructure costs

Priority action

26.1 Require all new tower development to meet BASIX+ targets and minimum 5 star NABERS ratings

Actions

26.2 Use the City of Sydney's strategic partnerships to advocate for higher energy targets in BASIX and the energy efficiency provisions in the National Construction Code

26.3 Achieve best-practice energy intensity targets in new buildings and major refurbishments

26.4 Ensure major new development areas commit to be zero-net energy or climate-positive

26.5 Ensure buildings are designed to achieve the highest possible thermal comfort levels and performance criteria through passive means to avoid artificial energy demand and consumption

26.6 Ensure mechanical heating and cooling services are avoided or where applied use best-in-class energy-efficient technologies

26.7 Ensure individual buildings and large-scale developments are designed to maximise the generation and use of local renewable energy

26.8 Investigate City of Sydney provision of zero or low-carbon precinct-scale services where demonstrated to be most efficient and feasible

26.9 Specify optimal lighting levels in buildings and the public domain and use the most energy-efficient technologies

26.10 Ensure all new major developments include the capacity to generate 10 per cent of their total energy onsite using renewable energy sources

26.11 Require best-practice water efficiency design, for example efficient fixtures and fittings, and dual-plumbing to enable connection to recycled water

26.12 Ensure precincts are designed for the collection, treatment and reuse of locally generated wastewater, stormwater and rainwater for non-potable use including toilet flushing, laundry, cooling and irrigation

26.13 Maintain green space using locally sourced, independent water supplies

Appendix E – Evidence of consultation

MINUTES

Issue date	Thursday, 18 June 2020
Issue to	Shah Alam (City of Sydney Council), Steven La (TfNSW), Lindsay Baker (TfNSW)
Issued by	Melanie Gostelow (Arcadis)
Subject	City of Sydney Consultation – Stormwater & Flooding
Reference	CPRP-ADAP-CEN-CV-MIN-000005
Client	TfNSW
Meeting date	Wednesday, 10 June 2020
Time	04:00 PM
Location	Online Teams Meeting
Present	Shah Alam (City of Sydney Council), Steven La (TfNSW), Greg Ives (Arcadis), Melanie Gostelow (Arcadis)
Copy to	John Merrick (Arcadis), Greg Ives (Arcadis)

ITEM	COMMENTS	ACTION
1	**Open & Introductions** GI – CPRP is investigating the potential for significant development around Central Station. Looking at stormwater and flooding, meeting aim is to start getting input from Council early in the project, and to request further information from Council. A major component of the project is looking at building a new deck over the country platforms with a series of mixed-use buildings of significant height above the deck. The footprint of the project is around the same as the Barangaroo development.	Note
2	**Flood Modelling** GI – Intend on developing a flood study of the area, look at potential impacts and connections to the Sydney Water and Council drainage networks. Attempting to use Council flood models as the basis for the flood model. Existing track area is possibly not well defined in the existing models. SA – Council does not want any worsening of flooding due to development and cumulative impact of future development needs to be considered. Council is happy to share flood models for assessment of flooding but appreciate the models were developed for catchment scale and should not be used to define lot scale flood levels. Flood models need to be reviewed to determine the appropriateness of the model and updated as needed. GI – Confirming this is our intent. The models have been shared and we are adding more detail to these models to get the best possible representation of the existing case in the model.	Note

3	**Information Requests** GI - Question, does Council have pit and pipe drainage networks in the area that can be incorporated into the model? SA – Yes, and models provided do have some information available. If requested Council can provide information on the pit and pipe drainage network. Note that Council cannot guarantee the accuracy of the information and this will need to be confirm on site. GI – Arcadis to request via email any information requests as mentioned in this meeting. For areas around the site, does Council have any survey information in the surrounding areas, such as Belmore Park and Prince Alfred Park? SA – Council might have some information, but again it may not be reliable. GI – Acknowledge that any information we would have to use with care. We are requesting additional survey be collected for the site and surrounds as part of the project and would update the model when available. SA – Will pass on any request to Council's survey team. MG – In relation to Council's Floodplain Risk Management Plans, these do recommend some upgrades to the drainage network around Belmore Park and Prince Alfred Park. Has Council committed any capital or scheduled in any of these works? SA – The adopted Floodplain Risk Management Plans are in the implementation plan but it's unlikely any of these works would be undertaken in the next 5 years. Other higher priority works are underway around the Alexandria Canal area. Council's interim floodplain management policy needs to be adhered to also. MG – In relation to Council's floodplain management policy, DCP, Engineering Guidelines etc, are any of these proposed to be updated anytime soon? SA – The DCP is in the process of being revised, unsure of timeline but can find out. The interim floodplain policy may get reviewed, but the basis should remain unchanged, highly unlikely that the requirements would change.	MG
4	**Stormwater Requirements** GI – There are significant Sydney Water assets that we would be connecting into directly or close by. Does Council have OSD or water quality requirements in these instances or are the requirements referred to Sydney Water. SA – The primary imposer for OSD requirements is Sydney Water as they are the owner of the trunk drain. If connected to the Council network, Council has conditions to maintain existing capacity of the network. As per the DCP, any existing network capacity can't be worsened by more than 10% of the existing flow rate. GI – Given that the rail yards are largely impervious, and we are not proposing significant changes, possibly reshaping but will generally remain the same footprint. SA – May not be changing the footprint but also need to look at whether you are concentrating or redirecting the flow. Council looking to make sure they are not overly burdened by the concentrating of flow.	Note

	GI – Our staring point is to maintain catchments as much as possible. Water quality is this similar? SA – Water quality is not with Sydney Water. City of Sydney has an overall 2030 target for suspended solids and nutrients. To achieve this, Council require all the developments to reduce their pollutant loads. GI – Confirming this applies when connecting to Sydney Water assets. SA – Correct. Sydney Water also has similar water quality reduction targets. GI – Note we have had similar conversation with Sydney Water, and will continue these conversations. MG – In terms of water quality treatment, does council have any general preferences in relation to measures or devices? SA – Where ownership transfers to City of Sydney, there is preferences for GPTs based on maintenance requirements. Council can provide when the project gets to that point, but this is also in Council's Street Technical Specifications.	
5	**Additional Information Requests** MG – Recent major projects have been constructed in the area including the Sydney Light Rail (SLR), Sydney International Convention, Exhibition and Entertainment Precinct and Central Park. Have any of these works been incorporated into Council's flood models? SA – Sydney Light SLR is the biggest in the area. The SLR did update Council's flood models but Council is waiting to receive the completed models. MG – Are there any other major projects proposed in the area we should be aware of? SA – No, but if you send through a catchment area this can be reviewed. MG – Does Council have any initial concerns or thoughts regarding the project in relation to stormwater or flooding? SA – Lesson learnt from SLR is to look at flood impacts beyond the project boundary. When looking at stormwater management look at the whole network. Look at impacts on the capacity of the stormwater network. MG – The flood modelling will extent into the surrounding area based on the level of detail in Council flood model to look at potential flood impacts in the surrounding area.	Note
6	**Conclusion** GI – If Council has any related questions, we are happy to discuss further. Arcadis will send through a follow up email with our information requests.	MG

ARCADIS Design & Consultancy for natural and built assets

MEMO

Date	18/06/2020
To	Shah Alam (City of Sydney Council)
From	Melanie Gostelow (Arcadis)
Copy to	Lindsay Baker (TfNSW), Steven La (TfNSW), John Merrick (Arcadis), Greg Ives (Arcadis)
Subject	CPRP – Stormwater & Flooding Information Request

Introduction

Following our recent meeting on the 10th June 2020 we would like to request the following information to inform the Central Precinct Renewal Program (CPRP).

1) Stormwater Design Requirements

a. Confirmation of the City of Sydney water quality treatment and water quantity (on-site detention) requirements for stormwater discharge.

b. Confirmation if any of these requirements vary depending on the ownership of the downstream asset (Sydney Water or City of Sydney).

c. Confirmation if design requirements vary for the rail track areas, over station development or surrounding public open spaces.

d. Where design requirements apply, can City of Sydney confirm which specific design requirement guidelines apply.

e. DCP – We understand Council's DCP is undergoing revision. Can Council please advise on the expected timing for this revision.

2) Information Requests

a. City of Sydney Pit and Pipe GIS Database

Whilst information existing in Council's flood models, there is issues with using the flood model drainage information with the latest version of TUFLOW. We would also like to standardise some of the modelling approaches and assumptions between the two flood models which cover the site. Council's GIS database would assist with this work.

b. Council Survey Information

Does Council have any available survey information that can be provided for the areas surrounding Central Station as shown below.

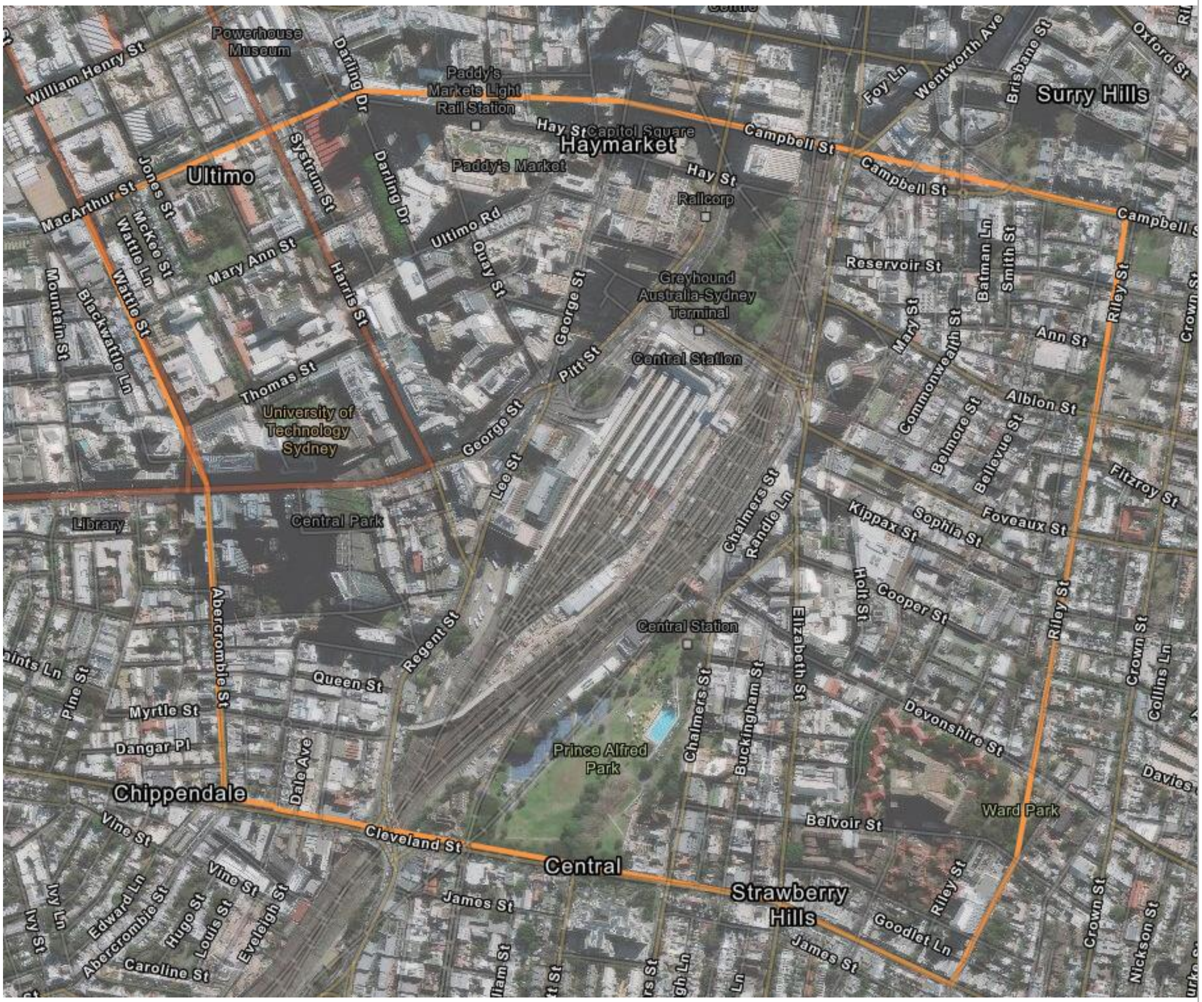
c. Regarding the Darling Harbour and Blackwattle Bay Flood Model

i. Have the Sydney International Convention, Exhibition and Entertainment Precinct, the Sydney Light Rail or Central Park development been included?

ii. Are any updates to council's flood modelling planned?

d. Major Projects Planned

Are they any major works (by Council or others) in the immediate area of Central Station that we should be aware of (drainage network upgrades or otherwise)?



<table>
<tr><th>Question</th><th>Response</th></tr>
<tr><td>1. Stormwater Design Requirements
a. Confirmation of the City of Sydney water quality treatment and water quantity (on-site detention) requirements for stormwater discharge.</td><td>The City’s water quality treatment and water quantity guidelines can be found in the City of Sydney DCP 2012, Section 3, General Provisions - 3.7 Water and Flood Management.
https://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0005/314429/Section3_DCP2012_170619.pdf</td></tr>
<tr><td>b. Confirmation if any of these requirements vary depending on the ownership of the downstream asset (Sydney Water or City of Sydney).</td><td>Stormwater quality targets vary between Sydney Water and the City of Sydney as per Table 1 below.

<table>
<tr><th>Water quality parameter</th><th>City of Sydney*</th><th>Sydney Water**</th></tr>
<tr><td>Gross Pollutants</td><td>90</td><td>90</td></tr>
<tr><td>Total Suspended Solids</td><td>85</td><td>85</td></tr>
<tr><td>Total Phosphorus</td><td>65</td><td>60</td></tr>
<tr><td>Total Nitrogen</td><td>45</td><td>45</td></tr>
</table>
Table 1: Stormwater quality targets between City of Sydney and Sydney Water

*Taken from the City’s Development Control Plan 2012, section 3.7.3 Stormwater quality.
https://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0005/314429/Section3_DCP2012_170619.pdf
**Sydney Water Stormwater quality targets
https://alternate.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdgz/~edisp/dd_083352.pdf

Where stormwater enters the City’s drainage assets, the City of Sydney water quality targets must be followed.

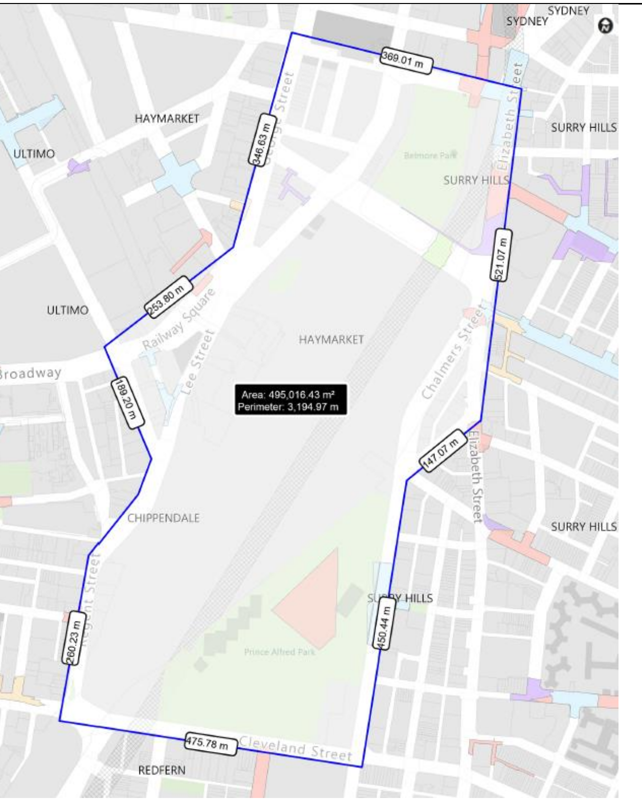
Where connecting to a downstream asset owned by Sydney Water, at the connection point, a Water Servicing Coordinator must be engaged. Upstream assets are to be designed in accordance the City of Sydney’s stormwater design standards.</td></tr>
<tr><td>c. Confirmation if design requirements vary for the rail track areas, over station development or surrounding public open spaces.</td><td>For stormwater, design requirements do not vary for rail track areas, over station development or surrounding public open spaces. The Sydney streets technical specifications apply for design and construction. https://www.cityofsydney.nsw.gov.au/development/public-domain-works/da-associated-works/sydney-streets-technical-specifications</td></tr>
</table>

	Where deviating from the City's specifications, it is up to the designer/s to ensure their proposed methodology or design is safe and fit for use. Consult with a certified Structural Engineer as required.
d. Where design requirements apply, can City of Sydney confirm which specific design requirement guidelines apply.	For stormwater design refer to: • A4 Drainage design • Attachment A: Drainage design checklist • Attachment B: Drainage variation approval summary sheet • Attachment C: Hydraulic design sheet • Attachment D: Raingarden asset datasheet • Attachment E: Kerb inlet capacities • Attachment F: Raingarden design checklist For the City of Sydney's standard drawings, refer to C7.1 Pits and pipes and C7.2 Raingardens:

	Standard drawings: Stormwater drainage - Pits and pipes C7.1 Pits and pipes 7.1.1 Standard gully pit with extended kerb inlet 7.1.2 Standard gully pit with stone inlet 7.1.3 Double grate/lintel pit with stone inlet 7.1.4 Standard extended gully pit 7.1.5 Trapped gully pit with extended kerb inlet 7.1.6 Trapped gully pit with stone inlet 7.1.7 Standard junction pit 7.1.8 Bandage joint 7.1.9 Typical pipe trench backfill 7.1.10 Typical culvert trench backfill 7.1.11 Junction pit with infill lid 7.1.12 High flow CBD inlet pit (stone kerb) 7.1.13 Standard surcharge pit (stone kerb) 7.1.14 Standard kerb inlet pit at station 7.1.15 Slotted inlet drain under seat 7.1.16 Slotted inlet drain under bicycle parking layout 7.1.17 Slotted inlet drain under bicycle parking reinforcement 7.1.18 Boundary downpipe rodding pit 7.1.19 Standard step irons

	Standard drawings: Stormwater drainage - Raingardens C7.2 Raingardens 7.2.1 Set out plan - Example 7.2.2 Lined 7.2.3 Lined: submerged zone 7.2.4 Unlined 7.2.5 Terrace raingarden 7.2.6 Raingarden direct inflow weir and calming basin 7.2.7 Standard surcharge pit 7.2.8 Gutter bridge 7.2.9 Dissipation rocks - small kerb outlets 7.2.10 Subsoil drains and high end riser 7.2.11 Inlet pit with steel tray, pit perpendicular to the road 7.2.12 Inlet pit, pit parallel to the road 7.2.13 Raingarden with kerb drain and standard drainage pit as outlet 7.2.14 Raingarden with direct side inlet - setout plan 7.2.15 Swale system - general arrangement - no drainage in the vicinity These attachments can be found within the Sydney streets technical specification. https://www.cityofsydney.nsw.gov.au/development/public-domain-works/da-associated-works/sydney-streets-technical-specifications During construction please refer to the City of Sydney B10 Stormwater Drainage Construction. https://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0004/142591/B10-19_01-COS-SS-TS.pdf

e. DCP – We understand Council's DCP is undergoing revision. Can Council please advise on the expected timing for this revision.	There are changes proposed to the DCP which have just come off public exhibition, and we will be working towards finalising the DCP early-mid next year. These relate to Central Sydney, here's a link to the proposed changes, including the DCP. https://www.cityofsydney.nsw.gov.au/council/your-say/central-sydney-planning-framework There is also work being done on changes to the broader DCP, noting the below map includes areas outside Central Sydney. The City is working on these and is aiming to report to Council later this year to commence the process.
2. Information Requests a. City of Sydney Pit and Pipe GIS Database Whilst information existing in Council's flood models, there is issues with using the flood model drainage information with the latest version of TUFLOW. We would also like to standardise some of the modelling approaches and assumptions between the two flood models which cover the site. Council's GIS database would assist with this work.	The City's representative Shah Alam would be best placed to provide this. Shah will be returning on the 23rd July, 2020.
b. Council Survey Information Does Council have any available survey information that can be provided for the areas surrounding Central Station as shown below.	Council has various surveys completed from 2003 – 2019. The coloured polygons show areas which have been surveyed. The list of projects which are within the requested project area can be found in the attached spreadsheet *Central Planning Precinct – Surveys - Arcadis RFI.xlsx.*



c. Regarding the Darling Harbour and Blackwattle Bay Flood Model i. Have the Sydney International Convention, Exhibition and Entertainment Precinct, the Sydney Light Rail or Central Park development been included? ii. Are any updates to council's flood modelling planned?	i. For the Darling Harbour and Blackwatte Bay catchment, the latest flood study was completed in 2016 by WMA Water. The Sydney International Convention, Exhibition and Entertainment Precinct, the Sydney Light Rail or Central Park development would not have been included in the 2016 flood model. ii. Yes, the Blackwattle Bay Flood Study Report 2019 is currently being reviewed by the City. There are more flood studies being planned. The City's representative Shah Alam would be best placed to provide this information. Shah will be returning on the 23rd July, 2020.

<table>
<tr><td></td><td></td></tr>
<tr><td>d. Major Projects Planned
Are they any major works (by Council or others) in the immediate area of Central Station that we should be aware of (drainage network upgrades or otherwise)?

</td><td>Water Assets is not aware of any major drainage network upgrades within the immediate area of Central Station.</td></tr>
</table>

Date: 13/07/2020

MINUTES

Issue date	Tuesday, 19 April 2022
Issue to	Attendees
Issued by	Melanie Gostelow
Subject	Central Precinct SSP – City of Sydney Consultation – Stormwater & Utilities
Reference	CPRP-ADAP-CEN-CV-MIN-000009
Client	TfNSW
Meeting date	Monday, 4 April 2022
Time	02:00 PM
Location	Online
Present	David Andersen (CoS), Steve Audet (CoS), James Dirickx-Jones (CoS), Stuart McTaggart (CoS), Hugh Thornton (TfNSW), Melanie Gostelow (Arcadis), Rhys Harvey (Arcadis), Greg Ives (Arcadis).
Copy to	Colin Sargent (TfNSW), John Merrick (Arcadis) + Attendees

ITEM	COMMENTS	ACTION
1	**Introductions** MG - Meeting to discuss Central Precinct Renewal currently at the State Significant Precinct (SSP) Study phase, specifically stormwater, flooding and utilities. Introductions, Melanie Gostelow, Stormwater and Flooding lead and overseeing other Arcadis disciplines. GI – Greg Ives, Senior Technical Director in Urban Development at Arcadis. Civil lead for the project. RH – Principal Civil Engineer assisting Greg and Mel on SSP.	Note
2	**Central Precinct Overview** MG – Consultation objectives, Arcadis has spoken with Council earlier in 2019 and 2020 in relation to Stormwater and Flooding with Shah Alam (CoS), keen to give an update on where the project is at with the SSP, seek feedback and any updates from Council. Brief overview of the Central Precinct with masterplan images. Scale, large extent from Goulburn to Cleveland Street with several sub-precincts. Masterplan has been developed to show a vision of what is possible. SSP is part of the planning approval process, we are not seeking approval of the masterplan or a specific design. Providing input into the planning framework to ensure future developments meet the aspirations of the precinct. Over-station deck is a key feature of the development. Looking at over-station development with high rises above a portion of the rail corridor as well as parcels of land surrounding the rail corridor.	Note

ITEM	COMMENTS	ACTION
3	**Stormwater** MG – Significant amount of flood modelling work has been completed to date, seeking feedback on. Stitched together two Council flood models, refined and updated details to better understanding existing flood behaviour around the site, to avoid future flood impacts. Developed a high-level stormwater management strategy for the precinct. Aims to maintain the integrity of the stormwater design moving forward to ensure the best practice principles are included. Also driving for an aspirational precinct capitalising on opportunities given the scale of the precinct, issues such as water quality treatment to benefit the downstream. Have consulted with Sydney Water. Large trunk stormwater and sewer lines cross the site. Generally stormwater flows east to north-west. Flood modelling report provides technical detail for Council and future flood modellers, including comparisons with Council flood maps. Flood mapping provided, ponding in the rail corridor and overland flow along road ways as expected. As Central Precinct is building above the rail corridor, this flood storage is maintained. Example of refinement, the Goods Line Tunnel draining overland flows wasn't identified in Council flood studies. Flood modelling for the existing conditions but also a representation of the proposed design. Aim for the flood model to continue being refined and used as a tool as the design progresses, not as an end of line assessment. Impact mapping of proposed development, not showing broad scale major impacts, instead looking at worsening of existing flooding. Through the design process further refinements can be made to reduce and mitigate these impacts. The stormwater strategy for the site aims to maintain the overland flow paths entering the existing site to avoid flood impacts. Continue working with Council and Sydney Water to ensure assets aren't impacted and any required mitigation measures are identified early in the design process. GI – Principals of water quality aim to exceed normal practice. Will be looking at passive irrigation and treating prior to discharge. Detention and reuse will be looked at. SM – Stuart is Shah's replacement, Principal Engineer for Water and Environment, floodplain management and stormwater asset management responsibilities. Flood impacts have been shown in the current mapping. Masterplan building footprints impact flows. Report doesn't comment on how impacts may be resolved. Comment on what sort of options could be considered to manage impacts would be useful. MG – A lot of detail is buried in the flood model report. We can pull some of the conversation from the flood report into the main body of the SSP report to convey what those potential options are.	Note

ITEM	COMMENTS	ACTION
4	**Utilities** GI – Previous Sydney Water discussion with Council (David Andersen) regarding recycled water. The SSP report will recommend continued discussions with Council and Sydney Water on the status and feasibility of the George Street recycled water pipeline. ‘ RH – Project has a strong focus on sustainability and resilience. Consultation with Sydney Water, Ausgrid, NBN and Jemena has occurred. We have confirmed connections to all networks and working through details of demand impacts and strategies for connections. Gas is being eliminated. Investigating all opportunities including the recycled water main. Seek confirmation on the current status of the George St recycled water main. DA – Correct, it is constructed but not active. RH – SSP study requirement in relation to guidance documents. Do any documents exist for the recycled water main? DA – Not currently, work in progress. MG – Any other utility providers that Council is having discussions with in terms of big scale opportunities? DA – In the water space this is under a market process at the moment so we can’t comment. Onsite electrical generation being looked at? GI – Total demand calculations have been taken to Ausgrid, who have confirmed they can service the site subject to ongoing negotiations with several options to investigate. RH – Onsite electrical generation, solar generally limited to roof area. For Central Precinct we are looking at new technologies such as on the façade. HT – At this stage covering sustainability objectives with green star commitments rather than more detailed commitments. GI – May struggle to find enough space for solar to provide a significant generation.	Note
5	**Additional Stormwater Questions** SM – Provided information suggested the concept drainage plan was still to come. Is there intent for additional detail to be provided in the final version of the reporting? MG – As the drainage design progresses further, more information will become available. At this stage for the SSP submission it will remain at a high level. HT – Masterplan being included is indicative only. Showing the planning rules being proposed can met certain objectives. Further design work at this stage would be redundant. SM – Intent is to meet and exceed water quality targets. What work has been done to confirm spatially the targets can be met given the constraints of the masterplan. Is green space sufficient? GI – In addition to the green space we would look at proprietary products. MG – Recommending a detailed study is done upfront to identify what constraints and opportunities there are across the different sub-precinct. Some sub-precincts may be able to over deliver, others may struggle to deliver. Report also discusses priorities for stormwater management which vary.	Note

ITEM	COMMENTS	ACTION
	SM – Understand that is the Integrated Water Cycle Management Plan. How does this fit into the overall planning controls. MG – Working on this with the planners who are working on ensuring the discipline recommendations are adequately reflected in the design guide and planning framework. GI – Flood model, does Council have a process for reviewing the flood model? SM – Reviewed the flood model report and the refinements seem to make sense. At this stage we may not get more involved in check it, may need to engage someone to do this. GI – Sydney Water we expect to also be interested in this. SA – The flood model needs to be adopted and prepared without agenda. Not aiming for a certain outcome. MG – When it comes to reviewing the model in the future, if Council has checklist items they would like provided, more than happy to include those in our work sooner rather than later. Meeting Council expectations, efficiency and consistency. Keen to support Councils review and assessment process. HT – Consultation presentation not available to be shared currently. GI – Appreciate meeting, happy to answer questions and keen to keep the conversation going. HT – Further questions please email Hugh Thornton direct.	

MINUTES

Issue date	Friday, 18 October 2019
Issue to	Dean Dalawitz (TfNSW), Peter Jansen (Sydney Water)
Issued by	Melanie Gostelow
Subject	Sydney Water Initial Consultation
Reference	CPRP-ADAP-CEN-CV-MIN-000001
Client	TfNSW
Meeting date	Friday, 4 October 2019
Time	1:30 PM
Location	580 George Street, Sydney NSW 2000
Present	Peter Jansen (Sydney Water), Dean Dalawitz (TfNSW), Greg Ives (Arcadis), Mai Lam (Arcadis), Melanie Gostelow (Arcadis), Max Hough (Arcadis)
Copy to	John Merrick + Attendees

ITEM	COMMENTS	ACTION
1	**Open & Introductions** GI – Overview of CPRP. CPRP is to provide stakeholder engagement with Sydney Water. Aim of the meeting is to confirm how best to engage with Sydney Water moving forward. DD – Currently CPRP is at a planning pathway stage as a state significant project. Confidentially regarding the project applies. For the western precinct Dexus/Fraser is submitting a planning application, Atlassian a design competition, strategic vision to go on public exhibition – all expected to be public knowledge by 14th October. End of the first quarter of 2020 the CPRP aims to establish what is feasible to build.	Note
2	**Load Demands** GI – Currently DBYD has been reviewed and demand loads estimated based on GFA. CPRP proposes to provide demand loads as a Feasibility Assessment for Sydney Water to provide advice on. PJ – For demand loads Sydney Water requests worst cast / highest demand possible as well as most likely estimate. Modelling will be needed at some point to provide assessment to Sydney Water strategic planners to provide support, guidance, requirements. The more information upfront the better (e.g. staging, timeframes). GI – CPRP can provide high level, broad estimate of load over time based on assumed building developments for the project. PJ – Recommend that for any Feasibility Assessment the CPRP doesn't involve other developments in the areas as the project programmes are unlikely to be aligned. PJ – Feasibility Assessment can be reassessed overtime as details of the project are refined. Requesting worst case / highest demand loads initially. Water reuse is of interested as it impacts demand, but not required at a high level initially.	Note

ITEM	COMMENTS	ACTION
3	**Feasibility Assessment** MH – Centralised fire protection system is something we are looking into. Can the feasibility assessment look at parameters for dual supply for firewater? PJ – Feasibility Assessments will look into bulk supply but not detail. Modelling required can be discussed separate to the feasibility assessment. PJ – Stormwater can be included in the Feasibility Assessment if requested. Regarding the stormwater network it is dual ownership, the trunk drainage lines tend to be owned by Sydney Water with the remainder of the drainage network being owned by the City of Sydney. In general stormwater impacted by the Sydney Light Rail Project was mostly relocated, some updates may be reflected in Sydney Water's GIS. Crossing the Light Rail Slab not recommended as it is over a meter thick.	Note
4	PJ – Confirmed Sydney Water does not guarantee fire pressure and flows.	Note
5	GI – CPRP will prepare a Feasibility Application and send through once further information is public knowledge (target date 14th October).	Action
6	PJ – Likely Sydney Water will respond with a request for modelling to be undertaken as part of the response to the Feasibility Application. Sydney Water may provide a general high-level comment on the system capacity but no specifics regarding impacted assets or connection points.	Note

MEMO

ARCADIS Design & Consultancy for natural and built assets

Date 24/10/2019
To Sydney Water Corporation
From Mai Lam
Copy to
Subject Central Precinct Renewal Project

STORMWATER

The project involves potential development over the existing Central Station rail lines from Cleveland Street north to Eddy Ave. Our area of interest stretches from Prince Alfred Park in the south to Belmore Park in the north, as shown below with stormwater lines in blue, sewer in orange and stormwater lines of interest shown in red.

1) Understanding Sydney Water's Network
   a. In some instance the sewer lines and stormwater lines appear to intersect. Can Sydney Water confirm if these locations are connected, the purpose of these connections and the operational preference into the future.
   b. It is understood that the area falls within the SWC 17 & 30 catchment areas. Can Sydney Water provide any reporting regarding the details or capacity of these drainage networks?
   c. For the stormwater lines shown in red can Sydney Water provide WAE, survey or design drawings detailing these pipelines.
   d. The BOOS (Bondi Ocean Outfall Sewer) runs through the site. Can Sydney Water provide WAE or survey information for this line?

2) Water Quality Design Requirements
   a. Confirm any water treatment requirements for stormwater runoff which may ultimately drain into Sydney Water's network.
      i. If water treatment varies depending on land use (e.g. rail yard, buildings, over station development open spaces, and surrounding open space areas).
      ii. If water treatment varies depending on the connection location to Sydney Water's network.
   b. Where water quality treatment is required can Sydney Water confirm design guidelines which apply.
   c. Does Sydney Water have any preference for stormwater quality treatment devices or measures.

3) Onsite Detention Design Requirements
   a. Confirm if onsite detention requirements apply.

b. Confirm if the requirements vary depending on the connection location to Sydney Water's network.
c. Where onsite detention is required can Sydney Water confirm design guidelines which apply (including any requirements regarding AR&R and climate change).

4) Flooding
   a. Provide any flooding or hydraulic assessments of Sydney Water assets in the area.
   b. Confirmation of any flood impact assessment or design requirements apply to Sydney Water assets.

5) Recent Developments & Planned Upgrades – Indicate if Sydney Water is aware of any recent/planned upgrades in the vicinity of the site which may impact the capacity of the drainage network.

6) Other constraints – please advise is Sydney Water is aware of any known constraints or issues with the stormwater drainage in the area and any preferences with regards to stormwater drainage connection points.

Case Number: 181844

19 December 2019

ARCADIS
c/- MGP BUILDING & INFRASTRUCTURE SERVICE PL

FEASIBILITY LETTER

Developer:	**ARCADIS**
Your reference:	**2019-0422**
Development:	**Lot 2 DP819366 RAILWAY SQ, Haymarket**
Development Description:	**Potential retail/commercial development over the existing Central Station rail lines from Cleveland Street north to Eddy Ave**
Your application date:	**5 November 2019**

Note: **Level 2 water restrictions are in place from December 10**, which limits how and when water can be used outdoors. This can impact you and your contractors in the activities they need to undertake for this proposal.

Using water to suppress dust is only permitted via a permit when no other water source is available.

You/your contractors will need to apply for an exemption permit to use water for most outdoor uses including:

- Cleaning equipment and the exterior of **new** buildings
- Drilling and boring, and
- Batching concrete on-site

Fines for deliberate breaches of restriction rules are in place.

For more information on the restrictions and for applying for an exemption, visit our web site at https://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/water-restrictions/level-2-water-restrictions/index.htm

The more water everyone saves, the longer we can stave off the progression to stricter restrictions or emergency measures.

Please provide this information to your contractors and delivery partners to inform them of their obligations and check our web site for up to date restriction information.

Dear Applicant

This Feasibility Letter (Letter) is a guide only. It provides general information about what Sydney Water's requirements could be if you applied to us for a Section 73 Certificate (Certificate) for your proposed development. **The information is accurate at today's date only.**

If you obtain development consent for that development from your consent authority (this is usually your local Council) they will require you to apply to us for a Section 73 Certificate. You will need to submit a new application (and pay another application fee) to us for that Certificate by using your current or another Water Servicing Coordinator (Coordinator).

Sydney Water will then send you either a:

- Notice of Requirements (Notice) and Developer Works Deed (Deed) or
- Certificate.

These documents will be the definitive statement of Sydney Water's requirements.

There may be changes in Sydney Water's requirements between the issue dates of this Letter and the Notice or Certificate. The changes may be:

- if you change your proposed development eg the development description or the plan/ site layout, after today, the requirements in this Letter could change when you submit your new application; and

- if you decide to do your development in stages then you must submit a new application (and pay another application fee) for each stage.

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

What You Must Do To Get A Section 73 Certificate In The Future.

To get a Section 73 Certificate you must do the following things. You can also find out about this process by visiting www.sydneywater.com.au > Plumbing, building & developing > Developing > Land development.

1. Obtain Development Consent from the consent authority for your development proposal.

2. Engage a Water Servicing Coordinator (Coordinator).

You must engage your current or another authorised Coordinator to manage the design and construction of works that you must provide, at your cost, to service your development. If you wish to engage another Coordinator (at any point in this process) you must write and tell Sydney Water.

For a list of authorised Coordinators, either visit www.sydneywater.com.au > Plumbing, building & developing > Developing > Providers > Lists or call **13 20 92.**

The Coordinator will be your point of contact with Sydney Water. They can answer most questions that you might have about the process and developer charges and can give you a quote or information about costs for services/works (including Sydney Water costs).

3. **Developer Works Deed**

It would appear that your feasibility application is served from existing mains and does not require any works to be constructed at this time. Sydney Water will confirm this with you after you have received Development Approval from Council and your Coordinator has submitted a new Development application and Sydney Water has issued you with a formal Notice of Requirements.

4. Water and Sewer Works

4.1 **Water**

Your development must have a frontage to a water main that is the right size and can be used for connection.

Sydney Water has assessed your application and found that:

The proposed development is within the Centennial Park Water Supply Zone and represents a significant increase in demand within the system. The developer must engage a hydraulic engineer and conduct a detailed planning study to determine required augmentations and proposed connection points. This needs to be provided to Sydney Water for review.
Service location and potholing of existing water mains to be undertaken accurately identify the location of existing assets.

4.2 Sewer

Your development must have a sewer main that is the right size and can be used for connection. That sewer must also have a connection point within your development's boundaries.

Sydney Water has assessed your application and found that:

The proposed development is within the Sydney West SCAMP which is a part of the Bondi Wastewater System and represents a significant increase in demand within the system.
The proposed development sits above three trunk sewer mains, DN450 gravity main, a DN400 gravity main and a 1371x1676 gravity main. Sydney Water does not support connections to trunk mains.

The developer must engage a hydraulic engineer and conduct a detailed planning study (including a wastewater catchment plan and flow schedule) to determine required augmentations and proposed connection points. This will need to be submitted to Sydney Water for review.
Service location and potholing of existing sewer mains to be undertaken accurately identify the location of existing assets.

4.3 Stormwater

Building over or adjacent to stormwater assets

The proposed development has impact on Sydney Water's major stormwater pipe/ channels which are draining through the proposed development site.

Without precisely knowing the exact position of the Sydney Water's stormwater pipe/ channel and its relation to the proposed building and permanent structures, Sydney Water is not in a position to provide firm requirements for the proposed development. However, the following can be used as general Sydney Water's requirements for building over and adjacent to Sydney Water's stormwater assets:

No building or permanent structure is to be proposed over the stormwater channel / pipe or within **1m** from the outside wall of the stormwater asset or within Sydney Water easement whichever is larger. Permanent structures include (but are not limited to) basement car park, hanging balcony, roof eves, hanging stairs, stormwater pits, stormwater pipes, elevated driveway, basement access or similar structures. This clearance requirements would apply for unlimited depth and height.

The applicant is required to submit the elevation drawings with the stormwater channel/ pipe, to ensure that the proposed buildings and permanent structures are 1m away from the outside face of the stormwater channel and away from the Sydney Water easement.

Locating the Exact Position of the Stormwater Channel

Exact position of the stormwater pipe/ channel is to be identified using the pot holes or any other acceptable survey method. Location of the easement position should not be used as location of the stormwater channel.

Dilapidation Survey Report

The proponent is required to undertake a dilapidation survey report / CCTV report of the Sydney Water's stormwater channel/ pipe prior to commencement of any work on the site. This report should extent at least 10m upstream and downstream from the property boundary. A copy of this dilapidation report is to be provided to Sydney Water.

This dilapidation survey report/ CCTV Report is to be carried out again upon completion of the all construction work and need to provide an assessment report, confirming that no damage has occurred to Sydney Water's stormwater assets during construction.

Stormwater connections to Sydney Water's Stormwater Channel

Design of the stormwater work on Sydney Water's stormwater assets are to be carried out by Sydney Water accredited providers for stormwater design. Construction of the stormwater work is to be carried out by Sydney Water accredited providers for construction for sewer and water and based on their capability { S1 (up to 300mm connection), W1 (up to 375mm connection), S2, W2 & W3 for any size of connection}.

If you have intention to make direct stormwater connections to Sydney Water's stormwater system, then the connection is to be carried out according to the Asset Adjustment and Protection Manual. Further details regarding this process can be obtained from your Water Servicing Coordinator. The applicant is advised of the following:

- For pipes with a diameter 300mm or more the connection angle is to be no greater than 30 degrees in the direction of the channel flow.
- Proposed connections that are 300mm or more in diameter require a qualified structural engineer to design the connection. A structural engineer's certificate is to be attached with the design drawings.
- Proposed connections that are less than 300mm in diameter can use Sydney Water's standard drawings to design the connection drawings.

It is your stormwater designer's responsibility to determine the location of the connection point. Sydney Water will not nominate any preferred point of connection.

Flood impact assessment (FIA)

The applicant is required to submit a Flood Impact Assessment report based on a current flood model for the proposed development and identify flood hazards. The FIA must:

- demonstrate that there are no potential adverse flood impacts offsite due to the development; and

- evaluate the impacts of flooding on the proposed development.

On-site Stormwater Detention (OSD)

On Site Detention is not required for any catchment which drains to Sydney Water's stormwater pipe which is located under the Devonshire Street Pedestrian Subway.

On Site Detention is required for all other areas, except the area which drains to Sydney Water's stormwater pipe under Devonshire Street Pedestrian Subway. To determine the required On Site Detention and Permissible Site Discharge (PSD), the following site specific information is required to be submitted:

- Total site area (m^2)
- Existing pre-development impervious area (m^2)
- Proposed post-development impervious area (m^2)

If a percentage of the site area does not drain into the OSD system, the rate of discharge from the OSD storage must be restricted so that the total flow from the site (from the OSD storage and free runoff) does not exceed the specified PSD.

On Site Detention is to be designed according to the Sydney Water's values and the details of the On Site Detention are to be submitted to Sydney Water for review and approval.

The following details are to be included in your submission for On Site Detention approval:

- Location of the On Site Detention in relation to the development
- Location of the On Site Detention in relation to overall stormwater network of the property
- Plan and Elevation of the On Site Detention tank with all dimensions
- Orifice plate calculation

Positive Covenant for On-site Stormwater detention

You are required to create a Positive Covenant over the On-site Stormwater Detention. The Positive Covenant must follow the rules laid out in Sydney Water's Policy and Guidelines on the "Documentation Standards for On-site stormwater detention guide".

You should contact Sydney Water's Group Property to get the specific details via email acquisitions@sydneywater.com.au or Ph: 02 8849 6223 or 02 8849 4532

Discharged Stormwater Quality Targets

Stormwater run-off from the site should be of appropriate quality before discharged into a Sydney Water asset or system. Developments must demonstrate stormwater quality improvement measures that meet the following specified stormwater pollutant reductions:

Pollutant	Pollutant load reduction objective (%)
Gross Pollutants (>5mm)	90
Total Suspended Solids	85
Total Phosphorus	65
Total Nitrogen	45

You may use our tool, through the website below, to determine whether your development is Deemed to Comply. In some cases though, we may request an eWater MUSIC model before approving your connection.

https://stormwater.flowmatters.com.au/_/#/

Flood Study

City of Sydney has carried out flood studies for these area and copies of these flood studies are available on their website.

Sydney Water's Stormwater and Sewer

All stormwater and sewer mains owned by Sydney Water are not interconnected at the vicinity of this area. They are dedicated stormwater line and dedicated sewer line.

Service location and potholing of existing storm water and sewer mains to be undertaken accurately identify the location of existing assets.

Work As Constructed Drawings

You need to make a formal application through "Sydney Water Tap-In" in order to obtain Work As Constructed drawings for Sydney Water assets. If these drawings are available, you will be advised accordingly and the required fees that need to be paid prior to issue the Work As Constructed drawings.

5. Ancillary Matters

5.1 Asset adjustments

After Sydney Water issues this Notice (and more detailed designs are available), Sydney Water may require that the water main/sewer main/stormwater located in the footway/your property needs to be adjusted/deviated. If this happens, you will need to do this work as well as the extension we have detailed above at your cost. The work must meet the conditions of this Notice and you will need to complete it **before we can issue the Certificate**. Sydney Water will need to see the completed designs for the work and we will require you to lodge a security. The security will be refunded once the work is completed.

5.2 Entry onto neighbouring property

If you need to enter a neighbouring property, you must have the written permission of the relevant property owners and tenants. You must use Sydney Water's **Permission to Enter** form(s) for this. You can get copies of these forms from your Coordinator or the Sydney Water website. Your Coordinator can also negotiate on your behalf. Please make sure that you address all the items on the form(s) including payment of compensation and whether there are other ways of designing and constructing that could avoid or reduce their impacts. You will be responsible for all costs of mediation involved in resolving any disputes. Please allow enough time for entry issues to be resolved.

6. Approval of your Building Plans

You must have your building plans approved **before the Certificate can be issued. Building construction work MUST NOT commence until Sydney Water has granted approval.** Approval is needed because construction/building works may affect Sydney Water's assets (e.g. water and sewer mains).

Your Coordinator can tell you about the approval process including:

- Your provision, if required, of a "Services Protection Report" (also known as a "pegout"). This is needed to check whether the building and engineering plans show accurately where Sydney Water's assets are located in relation to your proposed building work. Your Coordinator will then either approve the plans or make requirements to protect those assets before approving the plans;
- Possible requirements;
- Costs; and
- Timeframes.

You can also find information about this process (including technical specifications) if you either:

- visit www.sydneywater.com.au > Plumbing, building & developing > Building > Building over or next to assets. Here you can find Sydney Water's *Technical guidelines - Building over and adjacent to pipe assets*; or
- call 13 20 92.

Notes:

- **The Certificate will not be issued until the plans have been approved and, if required, Sydney Water's assets are altered or deviated;**
- **You can only remove, deviate or replace any of Sydney Water's pipes using temporary pipework if you have written approval from Sydney Water's Urban Growth Business. You must engage your Coordinator to arrange this approval; and**
- **You must obtain our written approval before you do any work on Sydney Water's systems. Sydney Water will take action to have work stopped on the site if you do not have that approval. We will apply Section 44 of the *Sydney Water Act 1994*.**
- **Separate out of scope applications are to be submit for water, waste water and stormwater assets.**

7. Special Requirements

OTHER THINGS YOU MAY NEED TO DO
Shown below are other things you need to do that are NOT a requirement for the Certificate. They may well be a requirement of Sydney Water in the future because of the impact of your development on our assets. You must read them before you go any further.

Disused Sewerage Service Sealing

Please do not forget that you must pay to disconnect all disused private sewerage services and seal them at the point of connection to a Sydney Water sewer main. This work must meet Sydney Water's standards in the Plumbing Code of Australia (the Code) and be done by a licensed drainer. The licensed drainer must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Soffit Requirements

Please be aware that floor levels must be able to meet Sydney Water's soffit requirements for property connection and drainage.

Requirements for Business Customers for Commercial and Industrial Property Developments

If this property is to be developed for Industrial or Commercial operations, it may need to meet the following requirements:

Trade Wastewater Requirements

If this development is going to generate trade wastewater, the property owner must submit an application requesting permission to discharge trade wastewater to Sydney Water's sewerage system. You must wait for approval of this permit before any business activities can commence.

The permit application should be emailed to Sydney Water's Business Customer Services at businesscustomers@sydneywater.com.au

It is illegal to discharge Trade Wastewater into the Sydney Water sewerage system without permission.

A **Boundary Trap** is required for all developments that discharge trade wastewater where arrestors and special units are installed for trade wastewater pre-treatment.

If the property development is for Industrial operations, the wastewater may discharge into a sewerage area that is subject to wastewater reuse. Find out from Business Customer Services if this is applicable to your development.

Backflow Prevention Requirements

Backflow is when there is unintentional flow of water in the wrong direction from a potentially polluted source into the drinking water supply.

All properties connected to Sydney Water's supply must install a testable **Backflow Prevention Containment Device** appropriate to the property's hazard rating. Property with a high or medium hazard rating must have the backflow prevention containment device tested annually. Properties identified as having a low hazard rating must install a non-testable device, as a minimum.

Separate hydrant and sprinkler fire services on non-residential properties, require the installation of a testable double check detector assembly. The device is to be located at the boundary of the property.

Before you install a backflow prevention device:

1. Get your hydraulic consultant or plumber to check the available water pressure versus the property’s required pressure and flow requirements.
2. Conduct a site assessment to confirm the hazard rating of the property and its services. Contact PIAS at NSW Fair Trading on **1300 889 099**.

For installation you will need to engage a licensed plumber with backflow accreditation who can be found on the Sydney Water website:
http://www.sydneywater.com.au/Plumbing/BackflowPrevention/

Water Efficiency Recommendations

Water is our most precious resource and every customer can play a role in its conservation. By working together with Sydney Water, business customers are able to reduce their water consumption. This will help your business save money, improve productivity and protect the environment.

Some water efficiency measures that can be easily implemented in your business are:

- Install water efficiency fixtures to help increase your water efficiency, refer to WELS (Water Efficiency Labelling and Standards (WELS) Scheme, http://www.waterrating.gov.au/
- Consider installing rainwater tanks to capture rainwater runoff, and reusing it, where cost effective. Refer to http://www.sydneywater.com.au/Water4Life/InYourBusiness/RWTCalculator.cfm
- Install water-monitoring devices on your meter to identify water usage patterns and leaks.
- Develop a water efficiency plan for your business.

It is cheaper to install water efficiency appliances while you are developing than retrofitting them later.

Contingency Plan Recommendations

Under Sydney Water's customer contract Sydney Water aims to provide Business Customers with a continuous supply of clean water at a minimum pressure of 15meters head at the main tap. This is equivalent to 146.8kpa or 21.29psi to meet reasonable business usage needs.

Sometimes Sydney Water may need to interrupt, postpone or limit the supply of water services to your property for maintenance or other reasons. These interruptions can be planned or unplanned.

Water supply is critical to some businesses and Sydney Water will treat vulnerable customers, such as hospitals, as a high priority.

Have you thought about a **contingency plan** for your business? Your Business Customer Representative will help you to develop a plan that is tailored to your business and minimises productivity losses in the event of a water service disruption.

For further information please visit the Sydney Water website at: http://www.sydneywater.com.au/OurSystemsandOperations/TradeWaste/ or contact Business Customer Services on **1300 985 227** or businesscustomers@sydneywater.com.au

Fire Fighting

Definition of firefighting systems is the responsibility of the developer and is not part of the Section 73 process. It is recommended that a consultant should advise the developer regarding the firefighting flow of the development and the ability of Sydney Water's system to provide that flow in an emergency. Sydney Water's Operating Licence directs that Sydney Water's mains are only required to provide domestic supply at a minimum pressure of 15 m head.

A report supplying modelled pressures called the Statement of Available pressure can be purchased through Sydney Water Tap in™ and may be of some assistance when defining the firefighting system. The Statement of Available pressure, may advise flow limits that relate to system capacity or diameter of the main and pressure limits according to pressure management initiatives. If mains are required for firefighting purposes, the mains shall be arranged through the water main extension process and not the Section 73 process.

Large Water Service Connection

A water main are available to provide your development with a domestic supply. The size of your development means that you will need a connection larger than the standard domestic 20 mm size.

To get approval for your connection, you will need to lodge an application with Sydney Water Tap in™. You, or your hydraulic consultant, may need to supply the following:

- A plan of the hydraulic layout;
- A list of all the fixtures/fittings within the property;
- A copy of the fireflow pressure inquiry issued by Sydney Water;
- A pump application form (if a pump is required);
- All pump details (if a pump is required).

You will have to pay an application fee.

Sydney Water does not consider whether a water main is adequate for fire fighting purposes for your development. We cannot guarantee that this water supply will meet your Council's fire fighting requirements. The Council and your hydraulic consultant can help.

Disused Water Service Sealing

You must pay to disconnect all disused private water services and seal them at the point of connection to a Sydney Water water main. This work must meet Sydney Water's standards in the Plumbing Code of Australia (the Code) and be done by a licensed plumber. The licensed plumber must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Other fees and requirements

The requirements in this Notice relate to your Certificate application only. Sydney Water may be involved with other aspects of your development and there may be other fees or requirements. These include:

- plumbing and drainage inspection costs;
- the installation of backflow prevention devices;
- trade waste requirements;
- large water connections and
- council firefighting requirements. (It will help you to know what the firefighting requirements are for your development as soon as possible. Your hydraulic consultant can help you here.)

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

END

MINUTES

Issue date	Wednesday, 25 November 2020
Issue to	Steven La (TfNSW)
Issued by	Melanie Gostelow
Subject	Sydney Water Ongoing Consultation
Reference	CPRP-ADAP-CEN-CV-MIN-000006
Client	TfNSW
Meeting date	Thursday, 5 November 2020
Time	12:30 PM
Location	Online
Present	Peter Jansen (Sydney Water), Willy Ramlie (Sydney Water), Cassie Perente (Sydney Water) Steven La (TfNSW), Greg Ives (Arcadis), Jordan Scott (Arcadis), Melanie Gostelow (Arcadis), Joe Heydon (Arcadis), Max Hough (Arcadis)
Copy to	Lindsay Baker (TfNSW), John Merrick (Arcadis) + Attendees

ITEM	COMMENTS	ACTION
1	**Open & Introductions** GI – Aim for this meeting is to establish regular contact with Sydney Water for consultation throughout the CPRP. To date we have received an initial feasibility letter for the CPRP from Sydney Water (dated 5/11/2019). Our current focus is investigating how CPRP can build around existing Sydney Water assets. PJ – Be aware that Sydney Water accreditation will require structures to be independently verified by approved consultants outside of Arcadis. GI – Provided overview of the extent of the CPRP. Proposed development includes works near Prince Alfred Park, Mortuary Station, Western Gateway (development proposed by Atlassian, TOGA and Dexus Fraser), Western Forecourt ("Sydney's third square"). Central Walk to provide pedestrian access to the Central Station platforms and Sydney Metro station. Large deck to be built over the railyard with a series of mixed-use buildings.	Note
2	**BOOS Clearances** GI – To service the buildings, loading dock access will be required (as well as some technical access above). Buildings generally serviced by basement loading docks. Note location of the BOOS crossing the north-west corner of the CPRP. The proposed Western Forecourt basement is accessed from Pitt St and runs alongside the BOOS. Currently we have the basement shoring with a 3m clearance from the outside of the BOOS and extending further down.	Note

ITEM	COMMENTS	ACTION
	We are also providing vehicle access over the BOOS near the terminal building and allowing a 1m clearance below our structure to the top of the BOOS. Some refitting of the terminal building in the area will also be undertaken. How do we engage with Sydney Water in regard to the 3m clearance from the BOOS? WR – 3m is close. Sydney Water isn't in a position to inform you what clearance distance is adequate. Arcadis needs to undertake an engineering assessment to justify what distance will not impact the asset. Sydney Water has a Specialised Engineering Assessment Procedure for this purpose. This outlines what checks, calculations and documents which need to be prepared and submitted to Sydney Water. Sydney Water will forward the Specialised Engineering Assessment Procedure to TfNSW. (Note this has since been received 12/11/2020). GI – The development of Central Park may have involved construction near the BOOS. Can some initial advice be provided based on Central Park? PJ – An independent review will still be required. Sydney Water cannot provide any clearance advice. WR – The BOOS is critical infrastructure and the concern is the construction impacts of the excavation, vibrations etc. PJ – Anchors, shoring etc may impact clearance also which needs to be considered. Construction methodology to outline risk mitigation strategies. GI – We can illustrate the intent of the proposed works and review the geology.	Action
3	**Sydney Water Assessment Timing** GI – Can Sydney Water provide an indicative timeframe for approval with the Specialised Engineering Assessment Procedure? Also noting that Atlassian in the Western Gateway has a proposed vehicle ramp crossing the BOOS. PJ – If Atlassian is only proposing a ramp, Sydney Water may not have provided comment as yet. Atlassian would be required to have the same level of rigour around the BOOS. WR – For timing, on some other projects it's taken 1.5 years and still ongoing.	Note
4	**Devonshire Tunnel Assets** GI – The Devonshire Tunnel has trunk stormwater and sewer lines beneath. We are proposing a vehicle tunnel which crosses perpendicular beneath these assets. WR – Any pipe size 600 or larger is of major concern and considered a significant interest to Sydney Water. The Specialised Engineering Assessment Procedure specifies a threshold procedure. PJ – Suggest obtaining the WAE from Sydney Water TapIn. These assets look to have been constructed in 1970 so they may be less of a concern then the older oviforms. GI – Expect these works will fall into Specialised Engineering Assessment Procedure process. Expect we would need to pull together some details. The proposed tunnel may be about 8m wide by 5m high below the Devonshire Tunnel. WR – Be mindful of access to the assets also for repairs/maintenance. GI – Is the benchmark to maintain the existing level of access for these assets given that it is currently limited?	Note

ITEM	COMMENTS	ACTION
	WR – Correct. PJ – Sydney Water also look at the space required for equipment to replace the asset. GI – We may not be able to provide more than the current situation.	
5	**Stormwater Requirements** MG – In regard to the stormwater water quality and on-site detention requirements, we would be looking to approach these on a sub-precinct scale. We will be requesting confirmation from Sydney Water on what requirements apply to the different areas of the site. We may also seek advice about potential changes to the catchment areas draining to different trunk lines as well as modifications, realignments or decommissioning of assets. Arcadis to send through a separate request to seek further feedback and in principal support for proposed requirements.	Action
6	**Sydney Water Engagement** PJ – Sydney Water is fine to review the extent of the CPRP works. Sydney Water is open to moving or realigning assets. Appreciate a coordination role is needed and there may be opportunities for augmentation. GI – On other major projects such as Sydney Metro, we've had a Sydney Water case officer to regularly engage with the project. Is such an opportunity available for this project? WR – Yes. Sydney Metro has an interface agreement between TfNSW and Sydney Water. TfNSW and Sydney Water need to discuss the commercial agreement for providing support moving forward. Usually for a big project, there would be a lot of exchange of information (some confidential), a mutual confidentiality agreement would be required. CP to send through an MCA template as a start. CP to send through a cost recovery agreement template which can be used prior to another agreement being made. SL – Agree, the interface agreement is key. WR – Establishing an agreement does take time, but Sydney Water can look at the project while arranging the agreement with TfNSW. Usually a WSC is involved from the beginning, CP will also be able to talk through the WSC agreement. WR – Note Willy's team is also managing the "More Trains More Services" project. GI – Arcadis to send through more information on the proposed works for Sydney Water to review. WR – Request a separate meeting request be made to discuss the recycled water line. Sydney Water has been working with City of Sydney on this asset.	Action

MINUTES

Issue date	Wednesday, 26 May 2021
Issue to	TfNSW, Sydney Water
Issued by	Jordan Scott, CPRP Design Manager - Arcadis
Subject	Central Precinct Renewal Program – Sydney Water Consultation
Reference	CPRP025-ADAP-CEN-CV-MIN-000001
Meeting date	Tuesday, 25 May 2021
Time	13:30-14:15
Present	Cassie Perente (Sydney Water), Grant MacDonnell (Sydney Water), Edbie Villanueva (Sydney Water), Steven La (TfNSW), Hugh Thornton (TfNSW), Glenn Egan (TfNSW), Thanh Ha (TfNSW), Bryce McCarthy (TfNSW), Greg Ives (Arcadis), Jordan Scott (Arcadis)

ITEM	COMMENTS	ACTION
1	**CPRP Overall State Significant Precinct Work**	
1.1	TfNSW looking to re-commence dialogue with Sydney Water regarding the SSP, to resolve issues early and collaboratively and to inform the planning process. Project not yet at the level of detail requiring engagement with a Sydney Water Asset Coordinator	**Sydney Water** to confirm who the key contacts are, including involvement from their planning team
1.2	Sydney Water looking to review CPRP plans and the interface with Sydney Water assets	**Arcadis** to share outcomes from former correspondence
1.3		**TfNSW & Arcadis** to present CPRP plans to the Sydney Water team
2	**CPRP Priority Works**	
2.1	TfNSW & Arcadis shared the Priority Works concept plans with Sydney Water, including structural accommodation of the BOOS	**Sydney Water** to share the latest critical asset procedure with TfNSW and Arcadis
2.2		**Sydney Water** to provide former condition audits, reports, reviews and surveys of the BOOS in and around the CPRP boundaries
2.3	Recycled water services	**Arcadis** to share our understanding of the City of Sydney recycled water main and the interface potential with CPRP
2.4		**Sydney Water** to address recycled water services at the next session
3	**Way of working between Sydney Water and TfNSW**	
3.1	Discussed after Arcadis left the meeting	

ARCADIS Design & Consultancy for natural and built assets

MEMO

Date	16/07/2021
To	Hugh Thornton (TfNSW)
From	Melanie Gostelow (Arcadis)
Copy to	Greg Ives (Arcadis)
Subject	CPRP Stormwater Management Strategy Overview

Introduction

The following provides a brief overview of the current stormwater management strategy being developed for the Central Precinct Renewal Project (CPRP). An integrated water management approach adopting best practice water sensitive urban design measures is at the centre of the strategy. Looking beyond conventional pits and pipes, stormwater is treated as a valuable resource and suitably considered across the civil, rail, building and landscape design. The impacts of the development on the water cycle are mitigated by employing a range of appropriate water sensitive urban design measures.

Where feasible the development will aim to go beyond minimum development control requirements to sustainably reduce flood risk, maximise water quality treatment and water reuse.

To maximise the potential for the development to achieve a sustainable and resilient outcome this integrated water management approach will be considered, promoted and supported from the onset of the precinct master planning through to the detailed design.

In addition to the summary below, the attached figures illustrate:

- the existing drainage network within and immediately surrounding the CPRP with the Sydney Water trunk infrastructure labelled.
- the existing catchment split within the rail yard
- key sub-precincts of the CPRP

Existing Site Conditions

In line with the topography and formal drainage network, stormwater runoff from the surrounding area approaches the CPRP from the southeast and drains to the northwest via the pit and pipe drainage network and informal overland flow paths. Overland flow paths form predominantly along roadways during larger rainfall events.

From the CPRP stormwater runoff drains north to Sydney Harbour through either the Darling Harbour catchment in the north or Blackwattle Bay catchment in the south.

The Precinct Flood Model Report provides an overview of the existing site flood conditions along with an initial assessment of potential flood impacts of the proposed development.

The CPRP site incorporates the following formal drainage infrastructure:

- Sydney Water trunk drainage lines – stormwater and sewer servicing the precinct and upstream catchment areas. Assets drain northwest, apart from the Bondi Ocean Outfall Sewer (BOOS) which drains northeast.
- Track drainage within the rail yard – generally draining north or south parallel to the tracks and discharges to the Sydney Water trunk lines at multiple locations within the rail yard.
- Additional minor drainage networks are anticipated in the surrounding areas.
- A stormwater harvesting tank is located beneath the Pitt Street loading dock (future Western Forecourt sub-precinct) discharging to the Council drainage network.

Our understanding of the drainage network has been based on sourcing and reviewing multiple sources of information and using engineering judgement to "gap fill' required details. In some instances, this has involved making assumptions regarding the connectivity of drainage lines to the trunk outlets. As the design of the CPRP progresses, we expect to source additional data to reduce our assumptions.

Stormwater Management Strategy

The following general stormwater management principles have been considered in the development of the stormwater management strategy:

- Maintaining existing sub-catchment areas
- Preserving existing and creating adequate overland flow paths to the downstream
- Maximising pervious areas
- Provision for stormwater quality treatment measures
- Provision for stormwater detention
- Maintaining flood storage
- Identification and reduction of flood risk through design

Through these principles the potential impacts of the proposed development can be minimised.

In addition, the role of stormwater management in responding to sustainability and resilience drivers will also be fundamental to the strategy. The impact of extreme rainfall events and climate change will be considered in the design of infrastructure and the built form. Stormwater will be managed to support vegetated landscapes through passive irrigation to target the urban heat island effect and greener places policy.

The key elements of the stormwater management strategy are summarised below:

1) Sub-Precinct Approach
   We propose adopting a sub-precinct approach to stormwater management given the varied nature of the development and potential staging implications. The discrete sub-precinct areas would independently manage and discharge stormwater to the downstream, whilst avoiding interdependencies. Appropriately tailored development controls would be applied to each sub-precinct to maximise the potential of each whilst remaining feasible. This approach would see all sub-precincts contribute and be capable of achieving a targeted outcome irrespective of the timing of works and technical complexities of the remaining sub-precincts.

   For example, a largely independent new building in the Prince Alfred Park Sidings is expected to offer different opportunities for sustainable water management and have different resilience challenges to overcome than the rail yard at track level. Similarly, we would expect differences between the Western Forecourt public domain and the Grand Concourse Extension.

2) Preservation of Catchment Areas
Several Sydney Water sewer and stormwater trunk drainage lines cross the precinct. Where possible the catchment areas to these trunk lines will be maintained. Existing connections to the trunk lines will be utilised where feasible. Likewise, efforts will be taken to protect, preserve and avoid impacts to the existing Sydney Water assets where feasible.

As mentioned, the connectivity of the existing drainage network to the trunk drainage lines may need to be confirmed. It is worth highlighting that some of the existing track drainage may currently drain to the BOOS.

With regards to the over rail deck, the construction of this structure will allow for some flexibility in where the collected rainfall runoff will discharge to. The sub-catchment areas will align with the existing catchments where feasible. Where possible the deck drainage network will remain independent from the rail track drainage network.

3) Preservation of Overland Flow Paths and Flood Storage
The avoid flood impacts on the surrounding areas, the existing overland flow paths through and from the precinct will be maintained. This includes overland flow paths entering the precinct from Devonshire Street and Prince Alfred Park, and the flow path from the rail yard exiting through the Goods Line tunnel which are expected to form during extreme rainfall events.

The existing rail yard provides for some informal flood storage during rainfall events. Care will be taken to ensure that any modification to the existing drainage network, or the addition of the over rail deck drainage, does not adversely impact the drainage capacity of the downstream network.

Stormwater detention may be required to mitigate potential impacts. Should detention be required, ideally this would be located beyond the ground level rail corridor to provide greater access for maintenance and clearance from rail operations.

4) Maximise Opportunities for Water Sensitive Design Measures
The design of the precinct will aim to maximise the opportunity for a range of Water Sensitive Urban Design (WSUD) measures to be incorporated. A variety of WSUD measures aiming to improve the quality of stormwater discharge and reduce potable water demand will be implemented throughout the precinct. This includes within buildings, the over rail deck and surrounding public domain.

With regards to water quality treatment measures, given the additional benefits offered by vegetated systems, these will be preferred over proprietary below ground products. Areas bypassing treatment measures will be minimised.

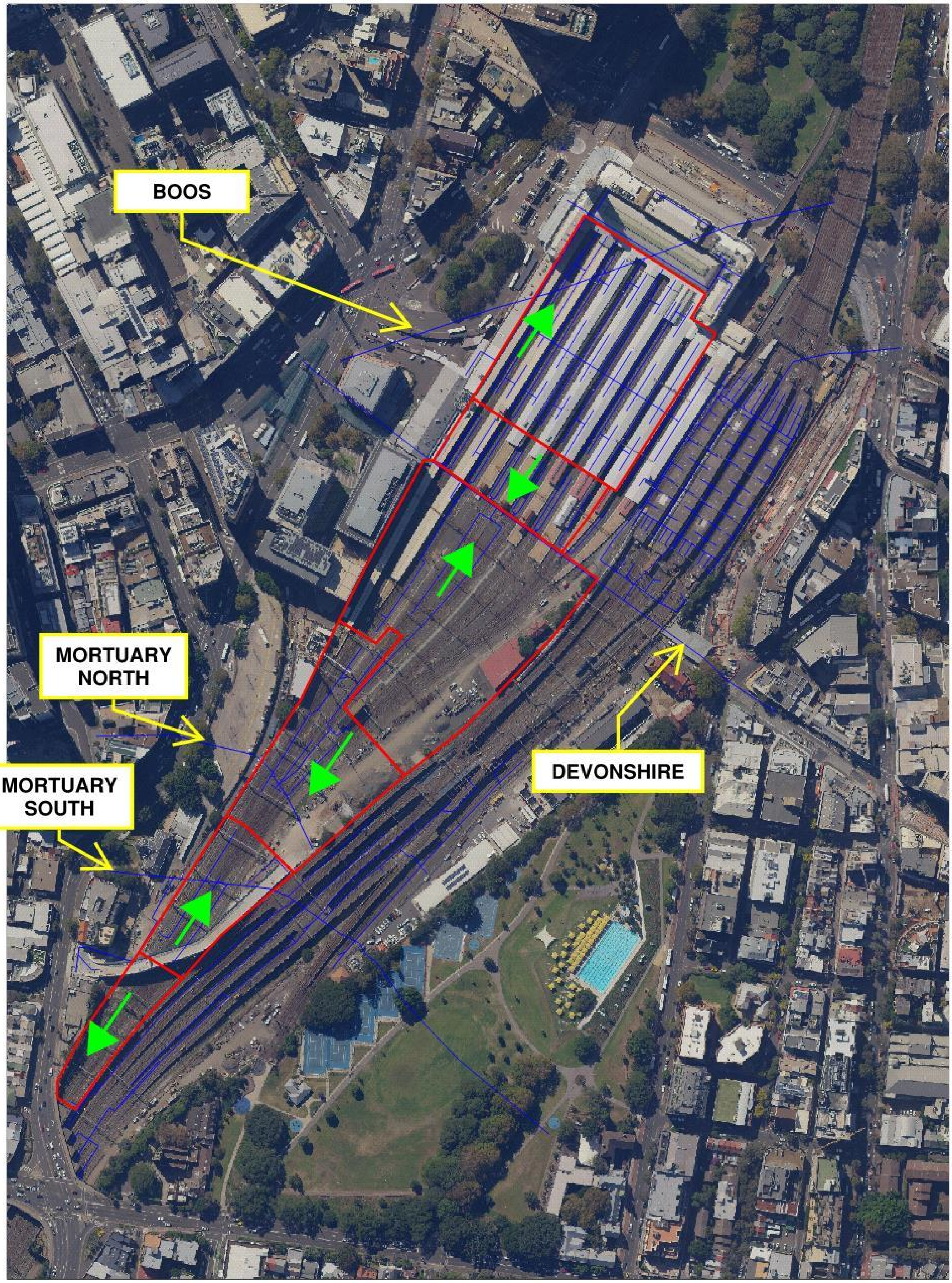
With regards to both water quality and quantity treatment measures, a distributed approach will be preferred over end of line treatment options. Given that the rail beneath the deck will remain dry during frequent rainfall events, water quality treatment at the rail level is not proposed.

Request for Stakeholder Feedback

As part of the State Significant Precinct planning process, TfNSW would like to engage with stakeholders to share information, understand needs and seek feedback. In presenting this stormwater management strategy, TfNSW requests feedback from stakeholders. Early identification of any potential issues or concerns is highly appreciated.

EXISTING DRAINAGE NETWORK

EXISTING CATCHMENTS



CONCEPT STORMWATER STRATEGY

MEMO

Date	16/07/2021
To	Hugh Thornton (TfNSW)
From	Melanie Gostelow (Arcadis)
Copy to	Greg Ives (Arcadis)
Subject	Sydney Water – CPRP Precinct Flood Model Report

Background

Given the significant scale of the Central Precinct Renewal Project (CPRP) it has the potential to adversely impact flooding within and surrounding the site. To inform the design of the CPRP, the complex flood behaviour of the existing and proposed site needs to be well understood. In response to this need, TfNSW engaged Arcadis to undertake a significant flood modelling exercise.

The Precinct Flood Model Report provides an overview of the flood modelling undertaken to date, a summary of predicted flood behaviour and an indication of potential flood impacts. Recommendations to ensure that flooding is adequately considered throughout the design process are also provided.

Request for Stakeholder Feedback

As part of the State Significant Precinct planning process, TfNSW would like to engage with Sydney Water to share information, understand needs and seek feedback. In presenting the Precinct Flood Model Report, TfNSW requests feedback on the technical approach and recommendations provided. Early identification of any potential issues or concerns is highly appreciated.

TfNSW seeks to obtain in-principle support for the current Precinct Flood Model Report, whilst appreciating the project is in the early stages of design development. The Flood Model will evolve and become more detailed and accurate in its representation of the existing site and proposed development as the design progresses and further information becomes available. Along with the design development of the precinct, future revisions of the Flood Model provide the opportunity to address any concerns raised.

Key Sections of Interest

To aid in Sydney Water's review of the Precinct Flood Model Report, key sections of the report which may be of particular interest include:

- *Section 5.4.8 Stormwater Asset Information & Figure 5-5: Stormwater Drainage Network -*
  - illustrates the various Sydney Water trunk assets crossing the precinct.
- *Section 5.4.9 Sydney Water BOOS & Figure 5-6: BOOS Hydraulic Boundary Assumptions*
  - describes and illustrates the Bondi Ocean Outfall Sewer crossing the precinct and provides the hydraulic assumptions incorporated into the Flood Model.
- *Section 9 Outstanding Issues and Recommendations*

Minutes and actions

Project Name **Central Precinct**	**Subject:** **Meeting on servicing & RW opportunity**
Chair:	Grant Macdonnell (meeting 5/8/21)
Attendees:	Cassie Perente. Sydney Water Grant Macdonnell. Sydney Water Raju Mangalam. Sydney Water Subha Balasubramanian. Sydney Water (Planning Partner) Lisa Curry. Sydney Water (Planning Partner) Ray Parcel. Sydney Water Hugh Thornton. TFNSW Michael Bigen. TFNSW Bryce McCarthy. TFNSW Melanie Gostelow. Arcadis Gregory Ives. Arcadis Paul Stroller. Atelienten
Apologies/absent:	Ira Williams
Distribution date:	16/8/21
Distribution list:	All attendees
Next meeting date:	TBC

Minutes (if required):

- Loading calculations in Arcadis reports to be reviewed again as job progresses
- The demands in the feasibility calculations after review remain the same at this current stage

- Flooding reports completed after review of Councils hydraulic flood models
- Arcadis requested how would mitigation tactics as part of the development be adopted to mitigate flooding impacts
- Keen to get a capacity check on the existing Storm Water Infrastructure
- Early indication of the Storm Water requiring upsizing to cater for current known demand
- TFNSW provided clarity around scope of development. Development currently under consideration in discussion will cantilever over country rail link via a slab and build vertically from this point.
- The proposed development over the station is an un-solicited proposal by TfNSW. TfNSW is currently preparing an SSD application to DPIE requesting to alter the current planning instruments to progress the development.
- Block C currently being rezoned by TFNSW and is not a part of this conversation
- Discussion around if RW plant possible at Central Station
- Discussion around the space allowance in development to enable RW distribution centre
- Oviform Trunk sewer reports to be supplied if available
- Question raised to adjust 1371 trunk asset. This would not be considered.

Action items:

No	Action item(s)	Responsibility	Due date
1	TFNSW to consider commercial agreements with Sydney Water to provide service checks, system capacity's, and further collaboration commitments. SW to provide more information on this	Sydney Water	TBC
2	SW to investigate servicing options for the Central precinct development with particular consideration to current servicing capacity in the context of adjacent developments in the sub region, i.e Block A, B & C, Pyrmont and the Bays.	Sydney Water	TBC
4	Supply conditions assessment reports around current Oviform 1371mm trunk asset if available	Sydney Water	TBC
5	TFNSW to provide details around suitable space for RW distribution centre	TFNSW	TBC
6	TfNSW to confirm utility loads, considering recycled water and stormwater harvesting	TFNSW	TBC

Minutes and actions

Project Name **Central Precinct**	**Subject: Meeting on servicing options & Recycled Water opportunity with City Of Sydney**
Chair:	Chris Gantt (Meeting date 10/08/21)
Attendees:	Ira Williams. Sydney Water Grant Macdonnell. Sydney Water Chris Gantt. Sydney Water Hugh Thornton. TfNSW Melanie Gostelow. Arcadis Gregory Ives. Arcadis David Andersen. City of Sydney
Apologies/absent:	N/A
Distribution date:	19/8/21
Distribution list:	All attendees
Next meeting date:	TBC

Minutes (if required):

- Transport for NSW (TfNSW) is halfway through the SSP study for the site in question
- TfNSW Aspiration for the development is to not be dependent on Fossil Fuels. Recycled Water (RW) forms part of this aspiration through a circular water economy
- City of Sydney (COS) will take RW from the George Street Pipeline to the parks within their portfolio first
- At this current stage the RW pipeline in George Street is not operational and is yet to be commissioned
- No current facility asset has been identified to supply the RW pipeline in George Street
- COS & Sydney Water are currently investigating options to supply RW to the George Street pipeline in line with the collaboration commitment under the signed MOU
- Sydney Water cannot forward fund Infrastructure and cannot take development risk.
- TfNSW may investigate supply of RW via a plant within their proposed development. This will dependent on the size allocation in the subsequent development

- At this current stage TfNSW is not in a position to negotiate commercial terms around RW
- TfNSW may state that they do not wish to supply RW water. COS & Sydney Water will investigate alternative supply options in this instance
- Confidentiality deeds may be required moving forward

Action items:

No	Action item(s)	Responsibility	Due date
1	TfNSW to continue engagement with Sydney Water over availability of space for a RW distribution unit within proposed development	TfNSW/Sydney Water	TBC
2	COS & Sydney Water to further investigate the supply of RW to the George Street Pipeline	COS/Sydney Water	TBC
3	Confidentiality deeds may be required as the collaboration increases	Sydney Water/TfNSW	TBC

Central Precinct - Stormwater management

- Sydney Water supports an integrated water management approach by adopting best practice water sensitive urban design measures for the Central Precinct development.
- The stormwater management strategy needs to be in the context of overall water needs for the precinct and the place making opportunities including mitigation of flood impacts due to the development.
- Sydney Water would like to collaborate with TfNSW and Sydney City Council to identify issues, opportunities and develop a range of appropriate water sensitive design solutions for the precinct.

- Based on a preliminary review of the CPRP stormwater management strategy overview documents provided by TfNSW, we have identified some high-level strategic constraints and opportunities for an integrated water cycle management outcome for the Central Precinct. This is outlined in the following page for your consideration.

Label	Constraints to Overcome	Suggested Design Approach	Integrated Water Cycle Management Opportunities	TfNSW Objective / Design Requirement Addressed
1	Remove existing flood risk without exacerbating downstream flooding	Preserve flood storage volumes (eg flyover sag, ambulance avenue sag along western precinct, areas beneath Northern Deck)	Incorprate stormwater storages that can provide both conveyance (overflow), flood storage/detention, water reuse and pollution reduction opportunities within the same drainage element. These could be within the deck or at the connection to the deck downpipe connection (eg Figure 7-2 in Arcadis flood report)	Development is to manage and mitigate flood risk and must not exacerbate the potential for flood damage or hazard to development and to the public domain (including publicly accessible managed space).
2	Drainage of the southern will be critical to flooding in the Little Regent St sag	Cause no change on culvert performance or flooding along Sydney Water assets (eg sag at little regent street)		
3	Northern Deck is 500m long posing longitudinal grading challenges once disconnected from BOOS			
4	Severing the BOOS will increase stormwater volumes to downstream areas that are already affected by flooding and pollutant loads. This additional water would be managed within the Northern Deck which is significant given its size and length	Disconnect stormwater from BOOS and cause no further overflows of stormwater to the BOOS	Utilise stormwater harvesting within new residential appartments (notionally 4000 new dwellings). Stormwater reuse would need to be prioritised over recycled wastewater.	Reduce the effects of stormwater pollution on receiving waterways.
5	Distributed approach requires WSUD measures to be located within building and on decks adding to structural loads	At-source WSUD design approach over more simplistic end-of-pipe stormwater treatments	Incorporate lightweight green roof/wall matrices (eg. 'purple roof' / rock wool) that increase the 'initial losses' of stormwater from impervious surfaces	Include Water Sensitive Urban Design (WSUD) measures to improve stormwater quality

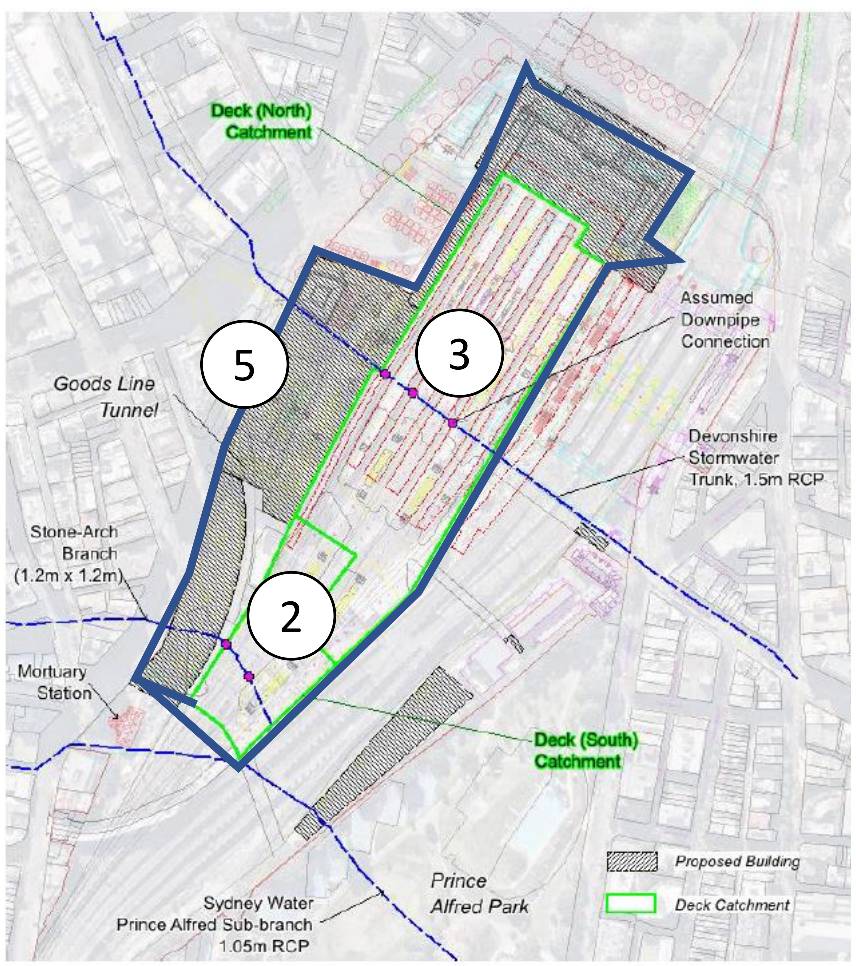


Figure 7-1: CPRP Deck Catchment and Proposed Building Footprints

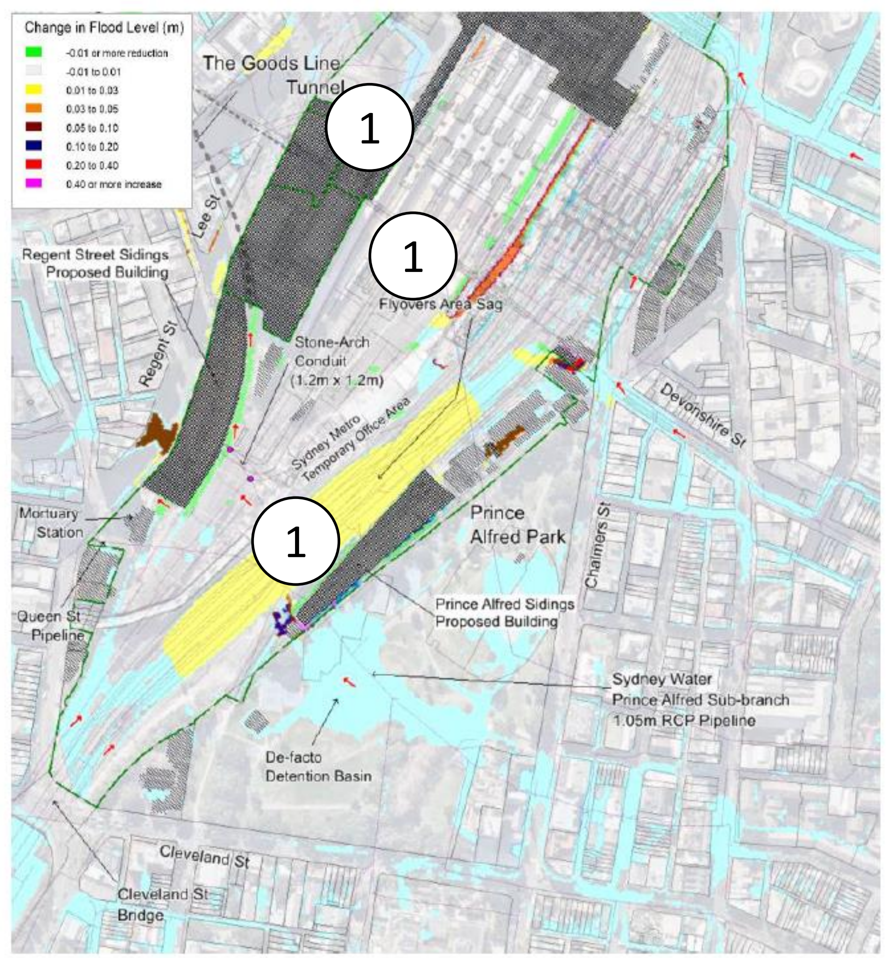


Figure 8-2: Flood Level Impact - Prince Alfred Park - Proposed Conditions (1% AEP Event)

NSW GOVERNMENT