Intended for

City of Port Phillip & City of Melbourne

Date

07 March 2018

Project Number

318000409

AMENDMENT GC 81 EXPERT WITNESS SERVICES

FISHERMANS BEND, VICTORIA

07 March 2018

Keldros Pty Limited c/o Nash Allen Williams & Wotton

Attn: Shelley Bennett
St Kilda Town Hall
99a Carlisle Street
St Kilda, Victoria 3182

By email: Shelley.Bennett@portphillip.vic.gov.au

Dear Shelley,

DRAFT - AMENDMENT GC 81 EXPERT WITNESS SERVICES

I have pleasure in submitting this expert report in relation to Fishermans Bend, located near the suburb of Port Melbourne, Victoria.

The report was commissioned by City of Port Phillip and the City of Melbourne to provide my opinion on flooding and drainage associated with the site.

Thank you for giving me the opportunity to conduct this review. Please call me on 02 9954 8100 if you have any questions.

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Yours faithfully
Ramboll Australia Pty Ltd

Tom Patterson
Managing Consultant, Environmental Engineer MIEAust

Ramboll Australia Pty Ltd
ACN 095 437 442
ABN 49 095 437 442

CONTENTS

APPENDICES

1. INTRODUCTION

1. I have been asked by City of Port Phillip and the City of Melbourne to provide my opinion (**this Report**) on flooding at Fishermans Bend, located near Port Melbourne, Victoria (**the Site**). I was engaged to commence my review in January 2018. A copy of my Letter of Instruction is included in Annexure 1.
2. This Report contains a summary of flooding at the site and my opinion on the best way to manage flooding at Fishermans Bend.
3. My opinion documented herein is informed by the following:
    4. The document Fishermans Bend Integrated and Innovative Water Management Report (Ramboll, 2018) of which I was the lead author. This can be found in Annexure 4.
    5. A site visit undertaken on the 30th of October 2017.
    6. Review of documents found in Section 3.
7. I have structured my opinion around the project tasks outlined in Section 3 in my Letter of Instruction.

2. QUALIFICATIONS AND EXPERT WITNESS CODE OF CONDUCT

8. A copy of my curriculum vitae is included in Annexure 2. This identifies my qualifications and summarises my experience in the assessment of and management of flood risk. In addition to extensive experience in flood management, I have worked on similar projects internationally through my current employer.
9. I confirm that I have read the "Guide to Expert Witness" produced by Planning Panels Victoria and dated April 2015 and agree to be bound by it. I acknowledge that I have made all the inquiries which I believe are desirable and appropriate and that no matters of significance which I regard as relevant have, to my knowledge, been withheld from the Panel.

3. DOCUMENTS REVIEWED

10. The key documents I have relied upon informing my understanding the flooding issues at the site are listed below.
    11. *Baseline Groundwater Quality Assessment* (AECOM for EPA, 2016)
    12. *The City of Copenhagen Cloudburst Management Plan* (The City of Copenhagen, 2012) http://en.klimatilpasning.dk/media/665626/cph_-_cloudburst_management_plan.pdf
    13. *Climate Change Adaptation Strategy* (City of Melbourne, 2009) https://www.melbourne.vic.gov.au/SiteCollectionDocuments/climate-change-adaptation-strategy.pdf.
    14. *Cloudburst Resiliency Planning Study Executive Summary* (New York City Environmental Protection Authority, 2017) http://www.nyc.gov/html/dep/pdf/climate/nyc-cloudburst-study.pdf
    15. *Desktop Study and Preliminary Regional Conceptual Site Model Fishermans Bend Urban Renewal Area* (AECOM for EPA, 2015)
    16. *Fishermans Bend Baseline Drainage Plan Options* (GHD for Melbourne Water, 2017)

17. *Final Report for Fishermans Bend Integrated Water Management Options Evaluation (GHD for Melbourne Water, 2015)*
18. *Fishermans Bend Baseline Utility Assessment Final Report (GHD for Department of Environment, Land, Water and Planning, 2016)*
19. *Fishermans Bend Buffer Assessment (GHD for Department of Environment, Land, Water and Planning, 2017)*
20. *Fishermans Bend Framework - Draft (Victoria State Government, 2017)*
21. *Fishermans Bend Integrated and Innovative Water Management Report* (Ramboll, 2018)
22. *Fishermans Bend Precinct Preliminary Land Contamination Study 1654703-002-L-Rev1. (Golder Associates, 2012)*
23. *Fishermans Bend Public Space Strategy (Planisphere for Fishermans Bend Taskforce, 2017)*
24. *Greening Port Phillip An Urban Forest Approach (City of Port Phillip, 2010)*
25. *Groundwater Monitoring Event Fishermans Bend Urban Renewal Area (AECOM for EPA, 2016)*
26. *Guide to Expert Witness (Planning Panels Victoria, April 2015)*
27. *High Level Geotechnical Input (Golder Associates for Places Victoria, 2012)*
28. *Melbourne Water Letter – Fishermans Bend Urban Renewal Area Recommended Floor Levels (Melbourne Water for City of Port Phillip, 2016)*
29. *Melbourne Water Letter – Recommended Floor Levels – Fishermans Bend (Melbourne Water, 10 April 2013)*
30. *Potential Contamination Cost Implications on Development, Employment Precinct, Fishermans Bend. 1654703-002-L-Rev1 (Golder Associates, 2016)*
31. *Preliminary Land Contamination Study. Employment Precinct, Fishermans Bend 1654703-001-R-Rev0 (Golder Associates, 2016)*
32. *Report on Pavement Design and Construction Geotechnical Advice Design and Technical Standards Fishermans Bend Urban Renewal Area (Douglas Partners for City of Port Phillip, 2017)*
33. *Resilient Melbourne (City of Melbourne, 2016) http://resilientmelbourne.com.au/wp-content/uploads/2016/05/COM_SERVICE_PROD-9860726-v1-Final_Resilient_Melbourne_strategy_for_web_180516.pdf.*
34. *Total Watermark: City as a Catchment (City of Port Phillip, 2014) http://www.melbourne.vic.gov.au/SiteCollectionDocuments/total-watermark-update-2014.pdf.*
35. *Water for Victoria Water Plan (Department of Environment, Land, Water and Planning, 2016) http://delwp.vic.gov.au/__data/assets/pdf_file/0007/371059/Water-Plan-strategy.pdf.*
36. *Water Plan: Towards a Water Sensitive (City of Port Phillip, 2010) http://www.portphillip.vic.gov.au/default/Water_Plan_Full_Version_FINAL_2010.pdf.*

4. SITE DETAILS

4.1 Site Identification and Description

37. Fishermans Bend lies between the lower reaches of the Yarra River and Port Philip Bay, it has an area of approximately 485 hectares. The site consists of five precincts across two local government areas including Montague, Sandridge and Wirraway in the City of Port Phillip; and Lorimer and the Employment Precinct in the City of Melbourne. The location of Fishermans Bend is shown in Figure 3 found in Annexure 3.
38. Planned future development will see the Fishermans Bend area transition from predominantly industrial land, into central city neighbourhoods. The area is expected accommodate approximately 80,000 residents and 80,000 workers by 2050 (being 40,000 workers in the Employment Precinct and 40,000 workers across the balance of the precincts).

4.2 Background

39. Fishermans Bend is located within a relatively low-lying area, with ground levels generally varying from 1 metres Australian Height Datum (AHD) to 4 metres AHD. The Australian Height Datum is a geodetic datum for altitude measurement used in Australia, where 0.000 metres is the mean sea level measured between 1966 and 1968.
40. Long term changes in sea level do not change the Australian Height Datum.
41. Due to the effects of climate change, sea level rises are predicted. It is estimated that by the year 2100 mean sea level will rise to 0.8 metres AHD.
42. There are a number of ways to describe the probability of a flood event, the preferred method is the Annual Exceedance Probability (AEP). A flood with a 1% AEP has a one in a hundred chance of being exceeded in any year. Currently, the 1% AEP event is designated as having an 'acceptable' risk for planning purposes nearly everywhere in Australia, including Fishermans Bend.
43. The predicted 1% AEP flood level for the year 2100 is 2.4 metres AHD.
44. Melbourne Water recommend building floor levels should be at least 0.6 metres above the year 2100 1% flood in areas prone to tidal inundation.
45. Therefore, Melbourne Water are recommending that minimum floor levels are set at 3.0 metres AHD.
46. Significant parts of the renewal area are subject to inundation during tidal events, particularly towards the east within the Montague Precinct. This is further exacerbated by the effects of sea level rise and increased tidal range impact brought about by climate change.
47. A map showing flooding at the site under current 1% AEP without flood mitigation is shown in Annexure 7, Appendix B, Figure B1.
48. A map showing flooding at the site under the year 2100 1% AEP without flood mitigation is shown in Annexure 7, Appendix B, Figure B4. The depths of flooding across the site in a 1% AEP event for the year 2100 planning horizon would generally be less than 400 mm, but within the low-lying Montague Precinct, the depth of flooding would potentially exceed 1.5 m.

5. FLOOD MANAGEMENT OVERVIEW

49. Ramboll has prepared a report titled: *Fishermans Bend Integrated and Innovative Water Management Report* (Ramboll, 2018). Ramboll (2018) will form the analytical basis of flood management at Fishermans Bend for this expert witness statement.
50. The Report was compiled by the following authors,
    51. Tom Patterson. (Lead author).
    52. Neil Hugh McLean Goring. Chief Consultant, Climate adaptation and green infrastructure, Ramboll
    53. Heidi Caroline Sillanpää. Risk & Safety Consultant, Ramboll
    54. Tania Chrisafi, Associate Director Design, Ethos Urban
55. The Report found that there were two principal drivers of flooding at Fishermans Bend, flooding that originates from the Yarra River and Port Phillip Bay (fluvial flooding) and flooding caused by rainfall falling directly onto the site (pluvial flooding). A diagram explaining these two processes is shown in Figure 4 found in Annexure 3.
56. Flooding at the site is predicted to be exacerbated by climate change. Increased water levels in the Yarra River and Port Phillip Bay, more intense wind storms and increased rainfall intensity are predicted to increase the depth of inundation, time of inundation and velocity of water flowing on site.
57. Planned development at Fishermans Bend will increase the number of people living and working at the site. It will also increase the value of infrastructure such as buildings, roads and open space.
58. In simple terms flood risk is a function of the probability of flooding occurring and the expected losses caused by that flooding. As flooding at Fishermans Bend is predicted to increase and the number of people and value of infrastructure is also predicted to increase, it is predicted that flood risk will increase at the site. Flood risk at the site has not been quantified to my knowledge at this stage.
59. Melbourne Water is proposing to manage flood risk at Fishermans Bend through the increase of floor levels at the Site to 3 mAHD (Melbourne Water for City of Port Phillip, 2016). This corresponds to the year 2100 planning horizon and takes into account sea level rise caused by climate change.
60. It is my opinion that by only managing flooding through increasing floor levels in buildings, there will still be significant residual flood risk at the site. This flood risk will include:
    61. Damage to buildings from flooding
    62. Damage to roads
    63. Damage to property in the public realm such as cars
    64. Risk to life and safety to people who are in the public realm
65. GHD for Melbourne Water (2017) have prepared a plan to manage flooding at Fishermans Bend. This plan can be found in Annexure 7. A comparison of the different flood management techniques proposed by GHD for Melbourne Water (2017) and Ramboll (2018) is shown in Figure 1. Although GHD for Melbourne Water (2017) does not provide a discussion on floor levels, this is the current policy of Melbourne water and this requirement has been included to provide a more complete comparison of the two flood management approaches.

	Levee	Rainwater tanks	Pipe upgrades	Increased pump capacity	Raised floor levels	Blue laneways	Green streets	Cloudburst boulevards	Cloudburst detention
GHD for Melbourne Water (2017)	X	X	X	X	X				
Ramboll (2018)	X	X				X	X	X	X

Figure 1. Comparison of flood management techniques between GHD for Melbourne Water (2017) and Ramboll (2018)

66. The rainwater tanks proposed in GHD for Melbourne Water (2017) have been designed to capture 0.5 m^3 per 10 m^2 of roof or podium area. Ramboll (2018) are also proposing that 0.5 m^3 per 10 m^2 of roof or podium area is required.
67. I know of no existing plans for the reduction of the 3 mAHD floor level planning requirement if the levee proposed by Melbourne Water is built.
68. Ramboll (2018) proposed a flood management strategy termed a Cloudburst Masterplan. The Cloudburst Masterplan is a flood management technique that uses levees, detention and conveyance areas within a catchment to reduce flood heights and velocity and redirect water away from critical infrastructure such as roads and power transmission lines. Implementing a Cloudburst Masterplan is likely to reduce the degree of flood risk on site through the use of a set of flood management tools including:
    69. A levee
    70. Rainwater Tanks
    71. Blue Laneway
    72. Green Street
    73. Cloudburst Boulevard
    74. Cloudburst Detention
75. A levee is a continuous area of fill or a wall designed and constructed to a specified height sufficient to prevent the ingress of water from the Yarra River to Fishermans Bend. However, the levee will also act as a barrier to water trying to egress from the Fishermans Bend site. Therefore, detention areas to manage this water until the water levels in the Yarra River subside have been specified.
76. Rainwater Tanks are used to collect and store rain water runoff, typically from rooftops via pipes to a collection and storage point. The capacity of the rainwater tanks specified for the site is relative to the amount of roof and podium area on private property. These are explained in more detail on pages 23-24 of Ramboll (2018) found in Annexure 4.
77. Blue Laneways are similar to conventional laneways; however, they incorporate stormwater detention areas designed to store water as well as conveying stormwater. These are explained in more detail on pages 25-26 of Ramboll (2018) found in Annexure 4.
78. Green Streets are similar to conventional streets; however, they have detention areas located in the street corridor that allow water to be detained. These are explained in more detail on pages 27-30 of Ramboll (2018) found in Annexure 4.

79. Cloudburst Boulevards incorporate both detention and conveyance and are used to convey water during large storm events. These are explained in more detail on pages 31-32 of Ramboll (2018) found in Annexure 4.
80. Cloudburst Detention areas can be integrated into open space areas such as parks and plaza areas; and are designed to detain stormwater during flood events. It is proposed that these areas drain under gravity to the pipe network and Port Phillip Bay and the Yarra River. It is not anticipated that pumping will be required, however this will need to be confirmed by detailed modelling. These are explained in more detail on pages 33-34 of Ramboll (2018) found in Annexure 4.
81. The proposed Cloudburst Masterplan that integrates each of the tools described in Paragraph 75 to Paragraph 75 is shown in Figure 5 in Annexure 4.
82. The integration of flood management into the urban landscape conserves valuable land at the site. For example, the Cloudburst Detention areas are extensive areas that are designed to detain flood waters in a safe and controlled location. These areas can be designed in such a way that they can be used as parks or other public open spaces during times of no flood and therefore maximize the use of the land when compared to more traditional hard engineered flood management solutions such as concrete lined channels, which would need to be fenced and access excluded during no-flood conditions.
83. The Cloudburst flood management method also helps to increase both the quantity and quality of green areas, which has a flow on benefit of improving urban microclimate.
84. Urban areas usually have a distinct set of climatic characteristics that change according to local conditions. These are the result of inadvertent climate modification on a relatively small scale and includes the increase of concrete areas, decrease of water evaporation, decrease of shade and localized increase of wind. Through increased shade, green areas and water, the urban microclimate is returned to a more natural and comfortable state.
85. To maximize the multiple advantages of this type of flood planning to the site, a stakeholder engagement program was undertaken. Participants in these sessions included:
    86. City of Port Phillip
    87. City of Melbourne
    88. Fishermans Bend Taskforce
    89. Melbourne Water
    90. South East Water
    91. Victorian Department of Environment, Land Water and Planning
    92. Cooperative Research Centre for Water Sensitive Cities
93. The stakeholder engagement program allowed stakeholders to identify how the design should integrate with existing services, align with future works such as bike paths, help improve park areas; and improve urban microclimate.

5.1 Limitations

94. Ramboll (2018) has developed a conceptual plan for flood management at the site. Preliminary testing of available detention areas and levee heights has been undertaken only. The reason only preliminary testing was undertaken is that detailed modelled was beyond the scope of works for Ramboll (2018). The concept outlined in Ramboll (2018) will need to be modelled and refined before it can be implemented.
95. Further refinement of the concept presented in Ramboll (2018) concept will include two-dimensional flood modelling and a risk assessment.

5.2 Precedent

96. The management of flooding in the manner described in Paragraph 68 to Paragraph 81 is being undertaken in the city of Copenhagen, Denmark. This is summarized in The City of Copenhagen (2012). Significant parts of this plan have been implemented.
97. The management of flooding described in Paragraph 68 to Paragraph 81 is also being undertaken in the suburb of South East Queens, New York City, the United States of America. This project is summarized in New York City Environmental Protection Authority (2017). Currently this project is at the detailed design phase.

5.3 Risks

98. One of the main drivers of risk of flooding at the site from the plan put forward in The Report will be potential levee failure.
99. The management of risk of levee failure has been successfully undertaken in many cities, both in Australia, the Netherlands, the United States of America and Germany. The Report proposes using a methodology to assess and manage risk that has been used in Netherlands. This risk management methodology has been used successfully to protect high value assets and is considered to be suitable for the Fishermans Bend Site.

6. RAISING OF FLOOR LEVEL REQUIREMENT

100. The Report can make no definitive recommendation on raising floor levels.
101. However, the Report has found that as a concept, flooding could be managed using the methodology outlined from Paragraph 68 to Paragraph 81.
102. If the conceptual plan put forward in The Report shows that flooding has been successfully mitigated and there is a risk management procedure in place, then it is likely that raising floor levels will provide only a marginal additional protection against flooding.
103. A comparison of the difference in flood management options has been made and their associated benefits. The three options are:
    104. Raised floor levels only
    105. Raised floor level with levee
    106. Ramboll (2018)
107. These options have been assessed against the following criteria:
    108. Protection of people and property within buildings.
    109. Protection of building structure from flooding.
    110. Protection of roads.
    111. Protection of property in public realm. This includes cars, footpaths, sporting fields, *etc*.
    112. Decreased building costs. Raising the floor level and making a building structurally sound against flooding requires additional materials and labour.
    113. Increased land values. Improving protection against flooding and the public realm has a positive impact on land values.
    114. Increase retail rents. Raised floor levels make the building less attractive to retail sellers as it disrupts the connection of the street to the shop. In addition, an improved public realm increases the amount of people within the area.
    115. Improved urban microclimate. Increasing the amount of water and green areas in the public realm acts as a buffer to extreme temperatures.
    116. Improved public realm.

117. The results of this analysis are shown in Figure 2.

	Protection of people and property within buildings	Protection of building structures from flooding	Protection of roads	Protection of property in public realm. Ie cars.	Protection of people in public realm	Decreased building costs (Individual building flood protection)	Increased land values	Increased retail rents	Improved urban microclimate	Improved public realm
Raised floor levels	X									
Raised floor levels with levee	X	X	X	X	X					
Ramboll (2018)	X	X	X	X	X	X	X	X	X	X

Figure 2. Comparison of benefits for flood management options.

7. PLANNING DOCUMENTATION

118. Melbourne Water is a determining referral authority for any application for buildings and works within a Land Subject to Inundation Overlay (LSIO) or a Special Building Overlay (SBO) within the Melbourne and Port Phillip Planning Schemes (see pages 103-104 of Ramboll (2018) found in Annexure 4).

119. As the Determining Referral Authority, Melbourne Water has powers under Section 55 of the *Planning and Environment Act* 1987 to refuse to grant permits, it is also able to specify conditions on permits. For example, if Melbourne Water specifies finished floor levels of a building, the development can only be approved subject to this condition being met.

120. Alternatively, Melbourne Water can object to a development which means the determining authority for a development must refuse the application. This decision is not final and can be appealed through the Victorian Civil and Administrative Tribunal.

121. The distinction between the overlays is as follows:

    122. A SBO identifies areas prone to overland flooding. The purpose of this overlay is to set appropriate conditions and floor levels to address any flood risk to developments.

    123. A LSIO applies to land affected by flooding associated with waterways and open drainage systems, these areas are commonly known as floodplains.

124. In the City of Port Phillip planning scheme, the referral requirement under SBO1, SBO2 and SBO3 are different. SBO1 and SBO3 relate to the Melbourne Water Main Drains, whereas SBO2 relates to the Port Phillip City Council Local Drains. Under the SBO2, a referral to Melbourne Water is under clause 66 of the planning scheme.

125. In *Planning for Sea Level Rise Guidelines*. Port Phillip and Westernport Region (Melbourne Water, 2017) it states that the freeboard requirements for new dwellings is 3.0 m AHD.

126. For planning permits, areas marked with the SBO (identified as the land within the Lorimer precinct and over a limited proportion of land in Wirraway which is generally bound by Williamstown Road, Plummer Street and Salmon Street), a permit application must be referred to Melbourne Water for comment.

127. For building permits, surveyors must consult with Melbourne Water prior to issuing a building permit to ensure that the proposed development design has considered the impacts of flooding and assets such as waterways or drains;

128. A building permit application is referred if the proposed site is land liable to flooding and the land abuts a waterway or is within 20 metres of an asset or waterway (Regulation 806). There are no LSIO areas within the Fishermans Bend Site.
129. Council or building surveyors are required to consult with Melbourne Water to obtain flood level information. This information will assist in the setting of floor levels to protect against flooding (Regulation 802).
130. Melbourne Water will provide written approval that a project is flood protected or meets Melbourne Water conditions to proceed with building permit application.

8. ABBREVIATIONS

131. Abbreviations used in this report are summarised below:

AEP	Annual Exceedance Probability
LSIO	Land Subject to Inundation Overlay
m	Metre
mm	Millimetre
SBO	Special Building Overlay

ANNEXURE 1
LETTER OF INSTRUCTION

Project Brief
Amendment GC81 Expert Witness services

1. Amendment GC81

Fishermans Bend is one of several priority precincts identified in Plan Melbourne and plays a central role in accommodating significant growth. Plan Melbourne designates Lorimer, Wirraway, Sandridge and Montague precincts within Fishermans Bend as priority major urban renewal precincts (mixed use precincts) comprising more than 250 hectares of land.

The draft Fishermans Bend Framework has been created to provide direction for development and establishes benchmarks for high quality design and development outcomes.

To support the implementation of the draft Framework, a suite of planning controls has been prepared to provide detailed planning guidance for new development. These controls once introduced into the City of Melbourne and City of Port Phillip Planning Schemes, will replace the current interim planning measures.

Amendment GC81 to the Port Phillip Planning Scheme proposes to translate elements in the draft Fishermans Bend Framework into planning terms and address the following key issues for Fiserhmans Bend:

- Identifies the preferred land use, form and intensity of urban development in each of the four mixed use precincts, including new floor area ratios and maximum height controls.
- Identifies and safeguards potential key transport alignments and services and the preferred locations for public open space and community infrastructure.

In summary, the Amendment implements the built form and land use elements of the draft Fishermans Bend Framework (October 2017) as follows:

- Amending Clauses 21.1, 21.02, 21.03, 21.04, 21.05 and 21.06 of the Municipal Strategic Statement
- Replacing Clause 22.15 of the Local Planning Policy Framework with a new Clause 22.15 to guidance on how to evaluate and exercise discretion in the assessment of planning permit applications. This includes; employment, dwelling densities, community and diversity, design excellence, active street frontages, energy, urban heat island, water management, waste management, public open space, new streets and laneways, smart cities, sustainable transport and floor area uplift.
- Replacing the Capital City Zone – Schedule 1 with a new Schedule 1 which outlines land use and development outcomes.
- Replacing Design and Development Overlay – Schedule 30 with a new Schedule 30 which outlines built form controls. This includes; building heights, setbacks and separation, overshadowing, wind, site coverage, active street frontages, adaptable buildings, building finishes and landscaping.
- Replacing Schedule 1 to the Parking Overlay with a new Schedule 1 to set maximum car parking rates to foster sustainable transport outcomes.
- Introducing a new Schedule 2 to the Development Plan Overlay to protect areas of strategic importance to ensure development achieves defined outcomes.
- Amending schedules to clauses 61.03 and 81.01.
- Introducing new Planning Scheme Map Nos. 2DPO, 3DPO, 1EAO, 2EAO, 3EAO, 1ESO

Amendment GC81 was out for public comment between 31 October and 15 December 2017, to which both Councils have made a submission.

A planning review panel has been appointed to consider the submissions and a four week public hearing will be held starting on the 19th February 2018.

ANNEXURE 2
T PATTERSON CURRICULUM VITAE

TOM PATTERSON

Senior Engineer

Tom is a Senior Engineer with Ramboll Environ with over 9 years' experience in water consulting. Tom has a thorough knowledge of surface water management that includes waterway engineering, hydraulic modelling, research and stormwater quality modelling. His experience also includes three years working in Studio Dreiseitl, Germany.

Tom has experience across a range of engineering functions from concept design, detailed design and project management.

CAREER

2015->>>
Senior Engineer, Ramboll - Environ
Sydney, Australia

2013-2015
Environmental Engineer, Ramboll - Studio Dreiseitl
Überlingen, Germany

2008-2012
Environmental Engineer, BMT WBM
Sydney, Australia

2005-2006
Environmental Engineer, Sinclair Knight Merz
Melbourne, Australia

EDUCATION

2000-2004
B Engineering (Environmental)
University of Newcastle, Newcastle, Australia

2000-2004
B Natural Resources
University of New England, Armidale, Australia

CONTACT INFORMATION

Tom Patterson

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PROJECTS

2017-2018

City of Melbourne, Innovative Flood Managment and Liveability Solutions fo Arden Macaulay
City of Melbourne, Australia
The objective of this project is to develop innovative flood management solutions in / near the Arden Macaulay area. Solutions should address flood mitigation and other ideas to embrace water within the precinct. Solutions should build on the ideas that were co-created in the City Solution Platform workshop but can also include other ideas that have the potential to have significant flood mitigation benefits.

2017-2018

Wellscape, Parramatta Light Rail - Peer review of Flood Models
Wellscape Consulting, Australia
Transport for NSW (TfNSW) is developing the Parramatta Light Rail (PLR) which is proposed to run from Westmead to Carlingford via Parramatta CBD, Camellia and Sydney Olympic Park.

2017

Port Phillip City Council, Fishermans Bend
Port Phillip City Council, Australia
Innovative water management for Fishermans Bend.

2017

Westconnex M4-M5 Link
Sydney Motor Corporation
Technical peer review of the surface water, flooding and drainage report to meet the SEARs issued by the DPE.
The Westconnex M4-M5 Link is a major road and tunneling project in the inner city suburbs of Sydney.

2016-2017

Carina Bay Reserve Drainage Design
Sutherland Shire Council, Australia
Project Manager
Management of odour concerns among residents adjacent to the tidal inlet at Carina Bay Reserve, Sydney, New South Wales. The project considered tidal inflows, stormwater runoff, sediment and acid sulphate soil issues affecting the site. The project included hydraulic modelling and detailed design.

2016-2017

Bellerive Howrah Beach Stormwater System Management Plan
Clarence City Council, Australia
Project Manager
Stormwater system management plan (SSMP) for the Bellerive-Howrah Beach stormwater catchment in Hobart, Tasmania. The report assisted with meeting requirements legislated in the Urban Drainage Act 2013. This stormwater system management plan will be used as the basis for land use planning, emergency management, community consultation/education and capital expenditure planning.

2015-2016

Financing Low-Carbon, Climate-Resilient Urban Infrastructure in Asia and the Pacific (ADB TA-8865 REG)
Asian Development Bank (ADB), Australia
Ramboll has been engaged by the ADB to assess the potential for financing low-carbon, climate-resilient urban infrastructure across the Asia-Pacific region. This assessment will include a rapid appraisal of the infrastructure needs, emissions profile and climate vulnerability of the 6 pilot cities, with cost benefit analysis of selected options and identification of appropriate financing mechanisms. City-level investment needs will then be scaled up to a regional-level overview of investment potential in over 100 cities across the Asia-Pacific.

2015-2016
Leighton SJH WestConnex CL
CPB Samsung John Holland JV, Australia
Support for delivery of Contaminated Land Reporting and Validation for the WestConnex M4 East Project.
Work also involved extensive use of Arc GIS software packages and delivery of complex graphical representations for contaminated land site assessment purposes.

2015-2016
Burrabogie Island Flood Mitigation Options
East Gippsland Shire Council, Australia
Flood mitigation options for Burrabogie Island in the Gippsland Region of Victoria. The report included a summary of current flooding conditions at the site, outcomes from stakeholder engagement and options for future management.
Project Engineer
Technical Review

2014-2015
Masdar City
Abu Dhabi Future Energy Company PJSC - Masdar, United Arab Emirates
Water Specialist
The project's goal is to deliver an overall landscape plan and conceptual landscape design for Masdar City's public realm, and establish a city-wide guidance for the design, selection and assessment of landscape elements. The Masdar City Landscape Plan aims to meet our client's vision to "build the world's most sustainable city".

2014-2015
JTC CleanTech Park
Jurong Town Council, Singapore
Project Engineer - Flooding analysis
Envisioned to be the first business park set in a tropical rainforest, the JTC Clean Tech Park plays an important role in spear-heading Singapore's efforts to become a leader in the global thrust, towards sustainability. It spans over a 50 hectares site, with a 5 hectares green core situated at its heart.

2013
Nusajaya Stormwater and Natural Cleansing Biotope Design
Tradewinds Corp Bhd, Malaysia
Project Manager
This project provided a conceptual stormwater design for the Nusajaya development in Malaysia. The design also incorporated a stormwater collection and reticulation system for an artificial lake located on site. A water treatment system utilizing a natural cleansing biotope type was also specified in the design.

2013-2014
Xiawangang River Realignment Study
City of Zhuzhou, China
Project Engineer - Flood Analysis
A river realignment and flood estimation study was undertaken for a 4 km section of the Xiawangang river near Zhuzhou, China. The estimation included a HEC-RAS model of the river to assess flooding.

2013-2015
San Francisco Civic Centre Stormwater Concept
San Francisco Public Utilities Commission, United States
Project Engineer
A total watercycle concept design for Civic Centre in San Francisco incorporating potable water, stormwater, wastewater and landscape design. Emergency management systems for extreme weather events was also incorporated in the design. The site aims to act as a centre of education for the broader San Francisco area.

2013-2014
Detailed plan and approaching cloudbursts in Copenhagen and Frederiksberg East
Frederiksberg Kommune, Denmark, Denmark
Project Engineer
Rambøll's team with Atelier Dreiseitl has done a detailed plan of approaching cloudbursts in Copenhagen and Frederiksberg. The plan included hydraulic flooding calculations of Copenhagen and Frederiksberg, risk mapping, sketch design of solutions, investment planning, socio-economic calculations etc. The plan is innovative and paves the way for implementation of the new infrastructure grid for Copenhagen to protect the city against extreme rainfalls.

2013
Fast Track Malaysia Stormwater Feasibility Design
Iskandar Malaysia, Malaysia
Project Engineer
A stormwater and drainage design for a racetrack in Malaysia. Novel stormwater detention elements were incorporated into the track design and surrounding landscape areas.

2013
Bratislava Science Centre Stormwater Design
Bratislava Science Centre, Slovakia
Project Engineer
A stormwater management plan for the new Bratislava Science Centre. The plan included flood protection from a nearby river.

2012
Perth Office Buildings Efficiency Report
Water Corporation Perth, Australia
Project Engineer
A survey of water use efficiency within office buildings in the Perth CBD. As a part of the study various office buildings were assessed and benchmarking for future efficiency work was undertaken.

2011
Gladstone Surface Water Flow Estimation
Queensland Energy Resources, Australia
Project Engineer
Assessment of hydraulic flows in watercourses using HEC-RAS.

2011
The Parade, Dulwich Hill Raingarden Design
Marrickville Council, Australia
Project Manager
The detailed design of a raingarden in Dulwich Hill, Sydney.

2011
Elizabeth St, Waterloo, Raingarden Design
Sydney Water, Australia
Project Manager
The detailed design and construction supervision of a raingarden in Sydney.

2010-2012
Residential Water Monitoring Project
Commonwealth Science and Industrial Research Organisation (CSIRO), Australia
Project Manager
Data collection for an assessment of the water saving capabilities rainwater tanks in the Brisbane region. Collection was undertaken using remote telemetry and involved 20 sites around Brisbane.

2010-2011
Net Zero House
Clarendon Homes, Australia
Project Manager
The design of an ultra low water use house in Western Sydney.

2009-2010
Residential Water Monitoring Project
Sydney Water, Australia
Project Manager
Data collection for an assessment of the water saving capabilities of the BASIX system. Collection was undertaken using remote telemetry and involved 50 sites around Sydney. A further 1000 sites were surveyed for water use characteristics.

2009
Picken Oval Stormwater Harvesting Concept
Sydney Water, Australia
Project Engineer
A water harvesting and reuse design for a football ground in Western Sydney.

2009
Bankstown Civic Centre Stormwater Harvesting Concept Design
Bankstown Council, Australia
Project Manager
A conceptual design for water savings and reuse at the Bankstown Civic Centre.

2008
WIN Stadium Stormwater Reuse Concept
Sydney Water, Australia
Project Engineer
A water harvesting and reuse design for a football ground in Wollongong.

2008
Water Balance and Irrigation Efficiency Study, North Murray Darling Basin
Queensland Murray Darling Basin Committee, Australia
Project Engineer
An desktop assessment of total flows within the North Murray Darling basin to assess water availability and potential for efficiency improvements in irrigation systems.

PUBLICATIONS

2017
Copenhagen, New York, Paynesville. Economic Assessment of Flood Mitigation.
Flood Management Association, Newcastle, Australia
Authors: Patterson, T.

2017
Poster Presentation: Bellerive Howrah Beach Stormwater System Management Plan
Flood Management Association, Newcastle, Australia
Authors: Kovacevic, S. Patterson, T. & Popowski, G.

2005
Laboratory Experiments On Vertical Slot Fishways With Added Roughness
Proceedings of XXXI IAHR Congress, Seoul, Korea
Authors: Patterson, T. & Rodriguez, J.

ANNEXURE 3

FIGURES

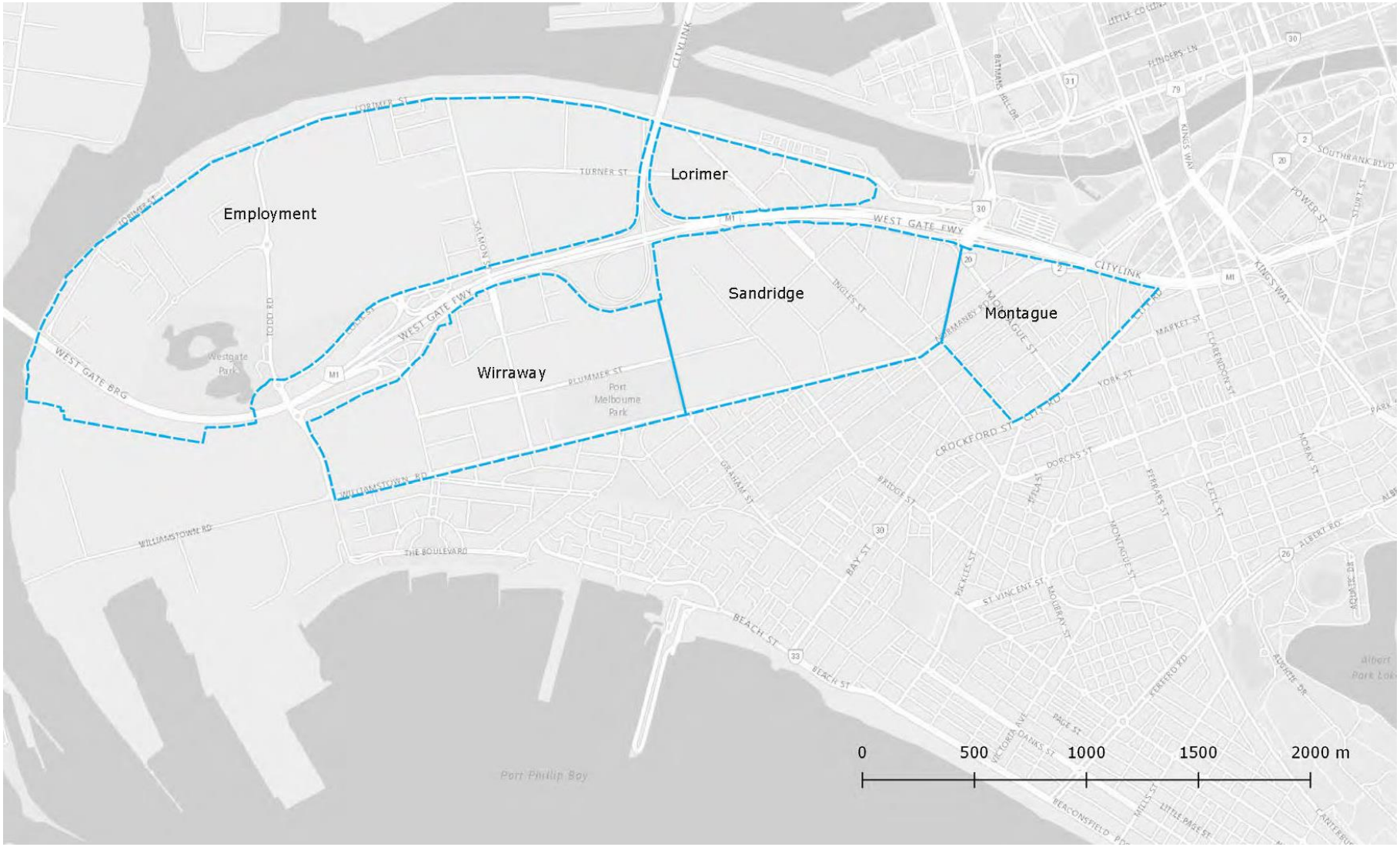

Figure 3. Fishermans Bend Location showing precincts

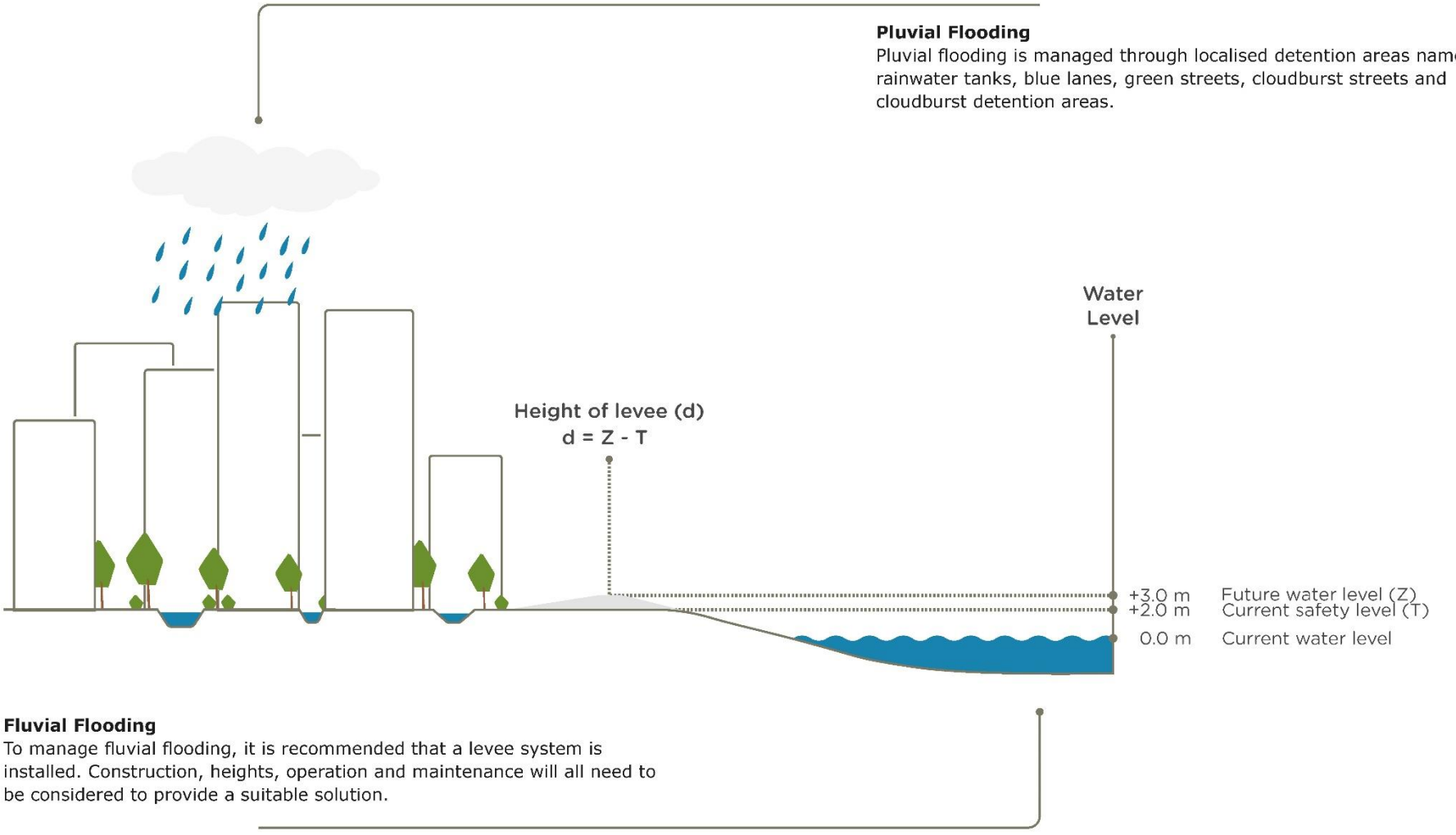

Figure 4. Description of flooding at Fishermans Bend

Figure 5. Location of Cloudburst Elements

ANNEXURE 4

FISHERMANS BEND INTEGRATED AND INNOVATIVE WATER MANAGEMENT REPORT (RAMBOLL, 2018)

ANNEXURE 5

MELBOURNE WATER LETTER – FISHERMANS BEND URBAN RENEWAL AREA RECOMMENDED FLOOR LEVELS (MELBOURNE WATER FOR CITY OF PORT PHILLIP, 2016)

Melbourne Water

15 August 2016

Ms Helen Pritchard
Fishermans Bend Urban Renewal Area Planner
City of Port Phillip
Private Bag No 3
ST KILDA VICTORIA 3182

Dear Helen

Fishermans Bend Urban Renewal Area Recommended Floor Levels

Thank you for your letter dated 3 August 2016 seeking to clarify floor level requirements for development within the Fishermans Bend Urban Renewal Area.

As the floodplain management authority for the Port Phillip and Westernport region we can confirm that the current adopted 1% Annual Exceedance Probability (AEP) flood level for Port Phillip Bay is 1.6 metres AHD.

For the Fishermans Bend Urban Renewal Area Melbourne Water recommends adopting a long term planning approach by planning for sea level rise of not less than 0.8 metres by 2100. On this basis, it is recommended that floor levels be raised above the predicted 1% AEP flood level in 2100, which is 2.4 metres AHD.

In areas prone to tidal inundation, building floor levels should be at least 600 millimetres above the relevant predicted future 1% AEP flood level, which in this case is 2.4 metres AHD. That is, minimum floor levels should be 3.0 metres AHD.

Similarly, entry to basements with finished floor levels below 3.0 metres AHD must incorporate a continuous apex of any entry or exit ramp that is at least 3.0 metres AHD.

We recognise that some parts of Fishermans Bend are low-lying and it may be difficult to achieve an apex at 3.0 metres AHD, such as where access is constrained or required via a laneway. In these instances, Melbourne Water would allow the use of a continuous apex at 2.4 metres AHD, with the 600 millimetres freeboard achieved through the use of a mechanical mechanism such as a flood gate. In addition, Melbourne Water would require a section 173 agreement to be put in place to require preparation of a flood response plan and maintenance plan to reduce the risk of failure of the flood gate in future.

If you have any further queries, please feel free to contact me on 9679 7016.

Yours sincerely

Nicki Granek
Senior Land Use Planner

Melbourne Water ABN 81 945 386 953
990 La Trobe Street Docklands VIC 3008
PO Box 4342 Melbourne VIC 3001 Australia
T 131 722 F +61 3 9679 7099
melbournewater.com.au

VICTORIA State Government

ANNEXURE 6

MELBOURNE WATER LETTER – RECOMMENDED FLOOR LEVELS – FISHERMANS BEND (MELBOURNE WATER, 10 APRIL 2013)

Melbourne Water

10 April 2013

Mr Adrian Salmon
Assistant Director Statutory Approvals
Department of Planning and Community Development
GPO Box 2392
MELBOURNE VIC 3000

Dear Adrian

Recommended floor levels - Fishermans Bend

I refer to your letter dated12 March regarding recommended floor levels for the Fishermans Bend area.

As discussed in our meeting, the current 100 year flood level for the Fishermans Bend Area is 1.6m AHD. Therefore based on the climate change predictions reflected in Clause 13.01, the adopted flood level for 2040 is 1.8m AHD (200mm rise above existing level) and the adopted 2100 level is 2.4m AHD (800mm above the existing level)

On this basis we recommend the following floor levels:

Land Use	Floor Level metres AHD
Habitable Residential and Office	3.0
External entry to individual dwellings	1.9 to 2.1
Commercial Lobbies/Retail	2.4
Lifts/Services	3.0
Garage/Car Parking entry	2.4 plus 600mm mechanical freeboard
On street parking spaces	1.9 to 2.1

Melbourne Water is willing to continue providing advice to applicants.
Should you wish to discuss the above matters further, please call me on 9679 6846

Yours sincerely

Bruce Rush

Bruce Rush
Team Leader Town Planning
Waterways Group.

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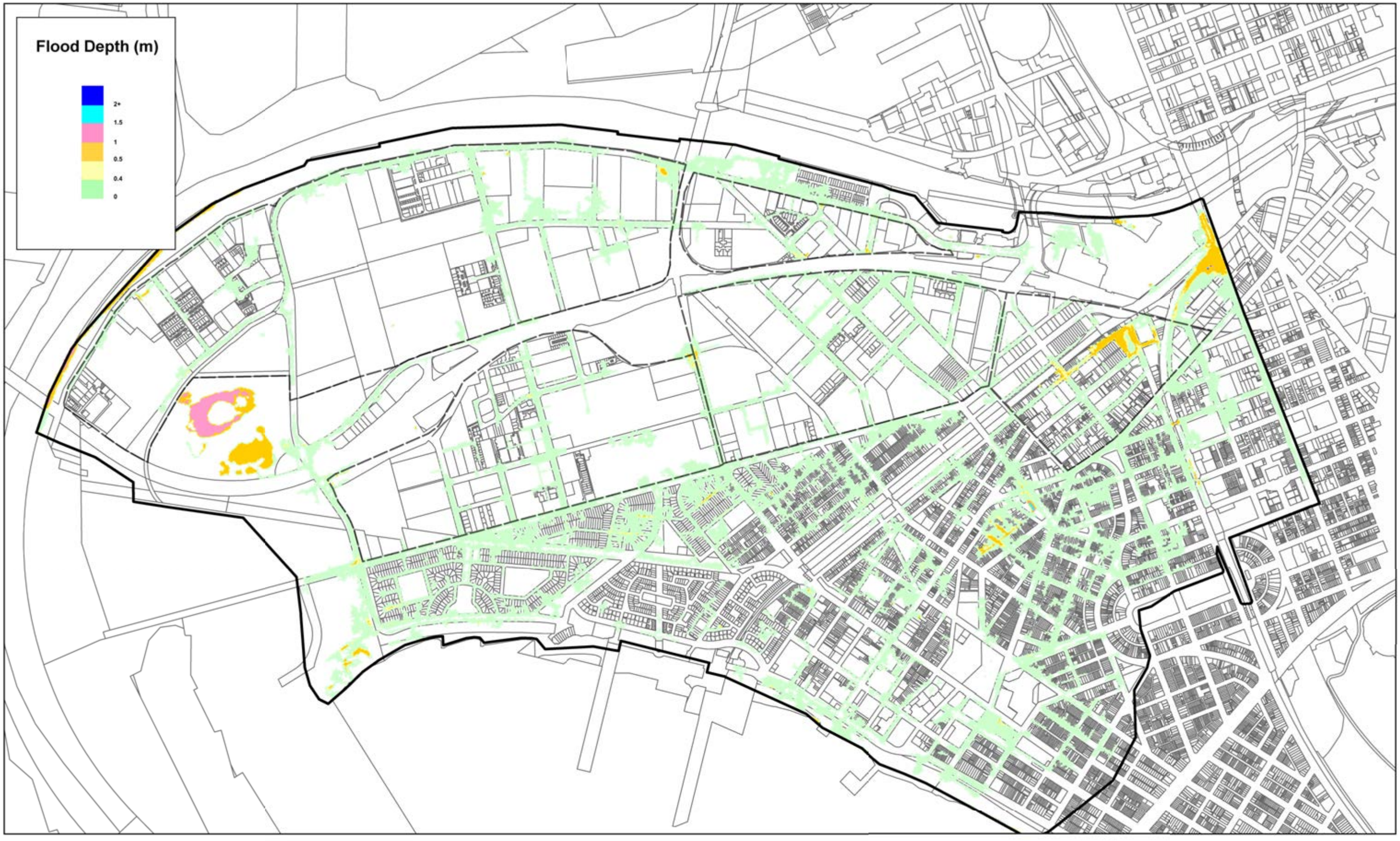
State Government Victoria

ANNEXURE 7

FISHERMANS BEND BASELINE DRAINAGE PLAN OPTIONS (GHD FOR MELBOURNE WATER, 2017)



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N

LEGEND

Precinct Boundaries

Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Developed conditions without mitigation
100 year ARI Rainfall - 0.52 mAHD Tailwater

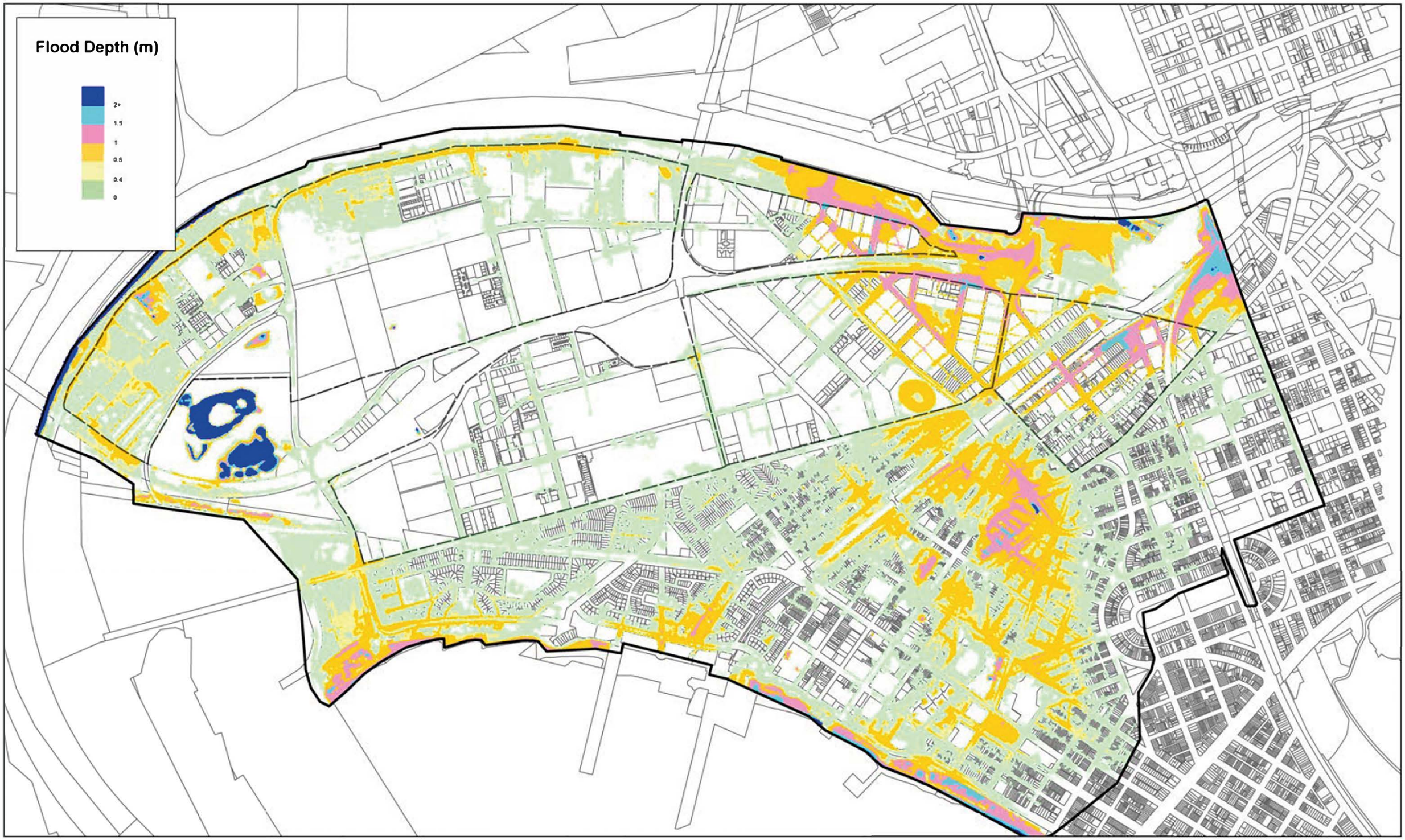
Job Number | 31-34157
Revision | 0
Date | 17 02 2017

Figure B1

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - DEV.WOR

Data Source: MW - Aerial Imagery (2013), Existing Drainage (2014); GHD - Flooding Extents (2016); VicMap - Parcel, Roads (2016), CoPP - Existing Drainage (2014); MCC - Existing Drainage (2014). Created by: hihartenthaler

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:15,000 (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N

LEGEND

Precinct Boundaries

Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Developed conditions without mitigation
100 year ARI Rainfall - 2.4 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure B4

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - DEV.WOR

Data Source: MW - Aerial Imagery (2013), Existing Drainage (2014); GHD - Flooding Extents (2016); VicMap - Parcel, Roads (2016), CoPP - Existing Drainage (2014), MCC - Existing Drainage (2014) . Created by: hharter\hatter

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 6000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au