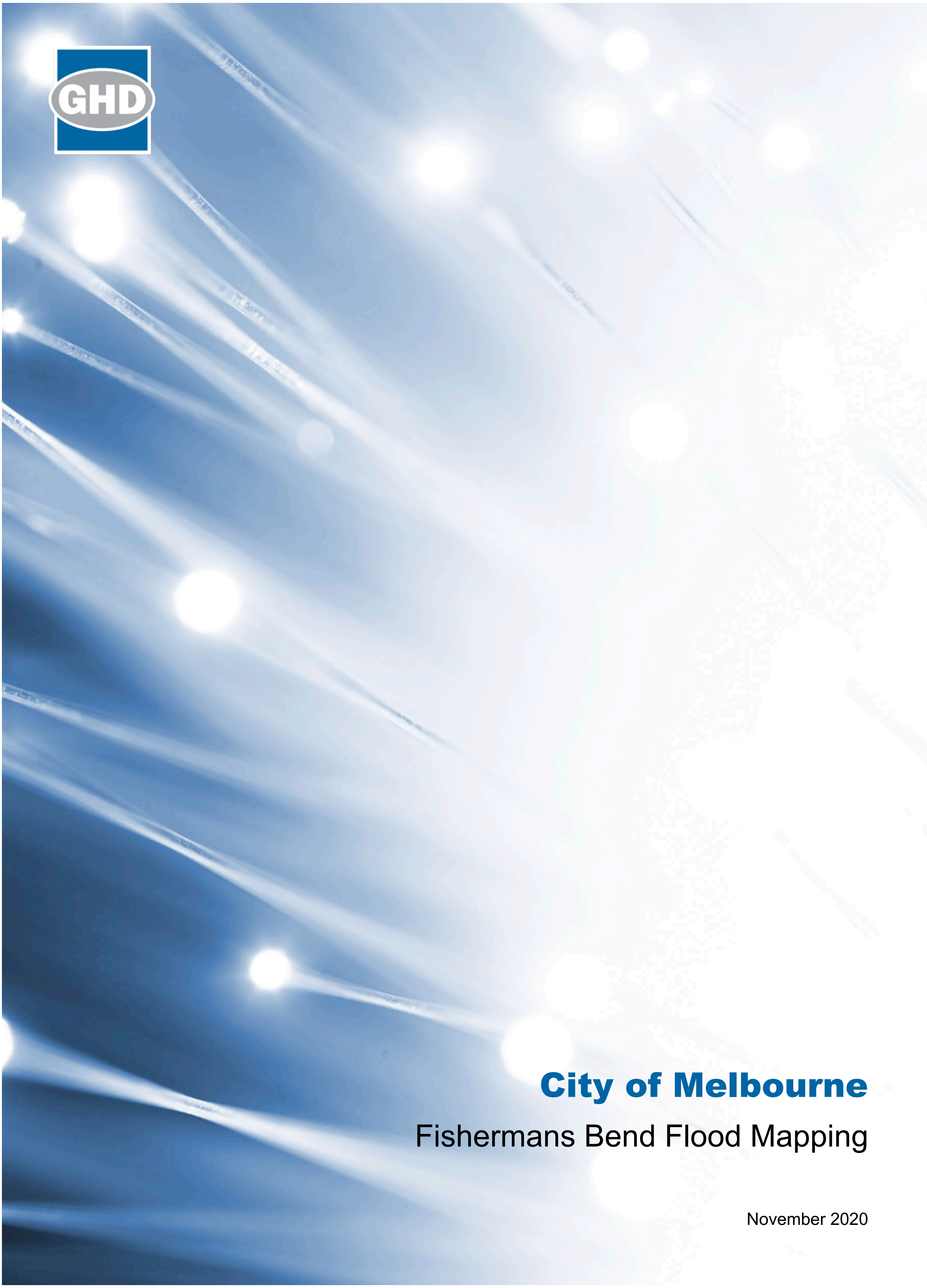

City of Melbourne

Fishermans Bend Flood Mapping

November 2020

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Appendices

Appendix A – Hydrological Modelling
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1. Introduction and background

1.1 Introduction

The City of Melbourne engaged GHD to update flood modelling for the areas within the Fishermans Bend urban renewal area that fall within the City of Melbourne municipal boundary for the purpose of flood mapping.

Fishermans Bend is an area located on a peninsula between the lower reaches of the Yarra River and Port Philip Bay and is currently built out with a mix of primarily commercial and industrial premises. The area has been rezoned as ‘Capital City Zone’, and is expected to transform over the next 40 years to become an extension of the CBD towards the Bay.

The area is relatively low lying with ground levels generally varying from 1.0 m AHD to 4.0 m AHD. Significant parts of Fishermans Bend are therefore potentially subject to inundation in tidal events, particularly towards the east within the Montague Precinct. The effects of climate change through sea level rise further exacerbate this.

The extent of Fishermans Bend that is covered in this flood mapping project is illustrated by the plan in Figure 1.

1.2 Purpose of this report

The purpose of this report is to document the methodology, underlying assumptions, and results of the updated modelling and flood mapping of the existing Melbourne Water and local council drainage system within the Fishermans Bend area in Melbourne.

The outputs of the project are raw flood extents that are intended for the City of Melbourne’s use in preparing flood plain maps. These maps will assist with planning approvals, determining flood risk within the catchment, and as a base case for comparing future mitigation options.

1.3 Background

In April 2019, a Water Sensitive Drainage and Flood Strategy for Fishermans Bend was completed by GHD. That strategy undertook flood modelling for Fishermans Bend using RORB and TUFLOW. These models form the basis of the flood modelling for this flood mapping project.

1.4 Scope

The City of Melbourne engaged GHD to undertake this current flood mapping study of Fishermans Bend to bring the mapping up to date and consistent with other recent flood mapping projects. In particular, the flood mapping was required for the areas of Fishermans Bend covered by the City of Melbourne (Lorimer and Employment precincts). The other areas of Fishermans Bend covered by the City of Port Phillip were not required to be flood mapped.

This study builds on the knowledge of the catchment and experience gained through undertaking previous projects within the catchment. The scope for this project was as follows:

- Adopt existing RORB and TUFLOW models that were prepared for the Fishermans Bend Water Sensitive Drainage & Flood Strategy, but with adjustments to the TUFLOW model.
- Adjustments to the TUFLOW model included:
  - Reduce grid size from 8m to 3m.
  - Reduce the extent of the model to primarily cover the parts of Fishermans Bend within the City of Melbourne, which is the focus of this project.
- Run the existing RORB model to obtain flow hydrographs for the scenarios outlined in Table 1
- Adopt and setup a TUFLOW (unsteady-state 1D/2D hydraulic) model with adjustments highlighted above.
- Run the TUFLOW model to obtain flows and flood levels under existing drainage conditions for the scenarios outlined in Table 1
- Process the TUFLOW results and produce GIS layers (in MapInfo format) similar to those produced for previous flood mapping projects for Council. GIS layers include raw flood extent results for each of the two scenarios listed in Table 1

Deliverables which are common to a flood mapping project but are outside of the scope of this project were:

- Setup a revised RORB (hydrologic) model based on current LiDAR information to refine the distribution of flow hydrographs.
- Process the TUFLOW results and produce flood mapping GIS layers for the two scenarios listed in Table 1

General project requirements were in accordance with Melbourne Water's Guidelines and Technical Specifications for Flood Mapping Projects (*MWC Nov, 2018*) – referred to herein as "the Guidelines".

Table 1 Scenarios Modelled and Mapped

Scenario Reference1	Impervious Fractions	Rainfall Intensities	Tailwater Levels2	Yarra Flood Levels	5 yr	10 yr	20 yr	50 yr	100 yr
A - Climate Change 1	Existing	18.5% increase in rainfall intensity	Increased by 0.8 m	10% AEP					✓
B - Climate Change 2	Existing	18.5% increase in rainfall intensity	Increased by 0.8 m	1% AEP					✓

1 The scenario references are taken from Melbourne Water's Guidelines and Technical Specifications for Flood Mapping Projects (MWC 2012)

2 For each of the above scenarios, it will be necessary to define whether the tidal condition from Port Phillip Bay is Highest Astronomical Tide of 1% AEP with 0.8m seal level rise to allow for climate change.

The tidal conditions listed will be cyclical as was adopted for the Fishermans Bend Water Sensitive Drainage & Flood Strategy.

Both are Base Case scenarios where modelling is based on existing conditions impervious fractions, existing drainage infrastructure and "standard" Australian Rainfall and Runoff (AR&R) rainfall intensities (*IEAust 1997*). Both the downstream tail water level and rainfall intensities are increased by 0.8 m and 18.5% respectively to simulate Climate Change.

Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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LEGEND
- Model Boundary
- Mapping Limits
- Precinct Boundaries

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	19/09/2019

Catchment Locality

Figure 1

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

1.5 Limitations

This Report has been prepared by GHD for the City of Melbourne and may only be used and relied on by the City of Melbourne for the purpose agreed between GHD and the City of Melbourne as set out in Section 1.2 of this Report.

GHD otherwise disclaims responsibility to any person other than the City of Melbourne arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared. Once issued, this Report and associated modelling files are no longer subject to GHD's control and may include changes made by others. It is anticipated that Melbourne Water will update (Appendix D) of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD described in this Report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this Report on the basis of information provided by Melbourne Water, the City of Melbourne and the City of Port Phillip, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The precision (number of significant figures) of results and parameters documented in this Report should not be taken as an indication of their accuracy (level of uncertainty).

1.6 Available information

The following information was utilised in undertaking this flood mapping study:

- General information obtained from Melbourne Water and the City of Melbourne throughout the course of the project:
  - Cadastral boundaries (e.g. properties boundaries, easements, roads in MapInfo format)
  - Drainage layers (e.g. Melbourne Water underground, channel and natural drains, retarding basins, manholes, the City of Melbourne Council drains in MapInfo format)
  - Elevation information (e.g. 1 m contours, spot heights, natural surface contours in MapInfo format)
  - Planning information (e.g. planning scheme zones, LSIO, SBO, Urban Growth Boundaries in MapInfo format)
  - Aerial laser survey data (LiDAR – thinned ground points)
  - Design Drawings for many (not all) Melbourne Water drains within the catchment
  - Aerial ortho-photos (Dec, 2013)
  - Available field survey within the catchment
  - Melbourne Water default impervious fractions for Existing Conditions
  - Tailwater levels for Port Phillip Bay and the Yarra River

- General information obtained from the City of Port Phillip throughout the course of the project (directly or via Melbourne Water):
  - Drainage layers (pipes and pits) in MapInfo format
  - Design drawings of key drainage assets for inclusion in the modelling
  - Details and/or drawings of a number of significant developments within the Study Area
- Relevant information from the references listed in Chapter 7.

1.7 Assumptions

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing this Report ("Assumptions"), including (but not limited to):

- All data provided by Melbourne Water Corporation, the City of Melbourne and the City of Port Phillip is correct, unless explicitly noted.
- Selected design inputs such as rainfall losses, definition of the climate change rainfall scenario, downstream boundary conditions and the outer catchment boundary are in accordance with Melbourne Water Corporation requirements.
- The normal limitations of an investigation of an ungauged catchment, including (but not limited to) the inability to calibrate or verify either or both of the hydrologic and hydraulic models to a known situation or event.
- The qualifications outlined throughout the report, including Section 4.2

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the assumptions being incorrect.

2. Catchment and drainage description

2.1 Site Context

Fishermans Bend is currently predominantly privately owned light industrial and warehousing. Four precincts totalling 250 hectares were rezoned to Capital City Zone (Montague, Wirraway, Lorimer and Sandridge) enabling high density development. The 230 hectare Employment Precinct has industrial zoning and is one of Melbourne's seven National Economic and Innovation Clusters (NEIC). Fishermans Bend presents some relatively unusual challenges for planning drainage and flood management works, particularly when compared to a green field development or redevelopment of a single land parcel.

2.2 Existing Flood Risk

Some areas in Fishermans Bend are already subject to flooding today, and this may be a constraint for development in those areas without the provision of significant flood mitigation infrastructure in the short term.

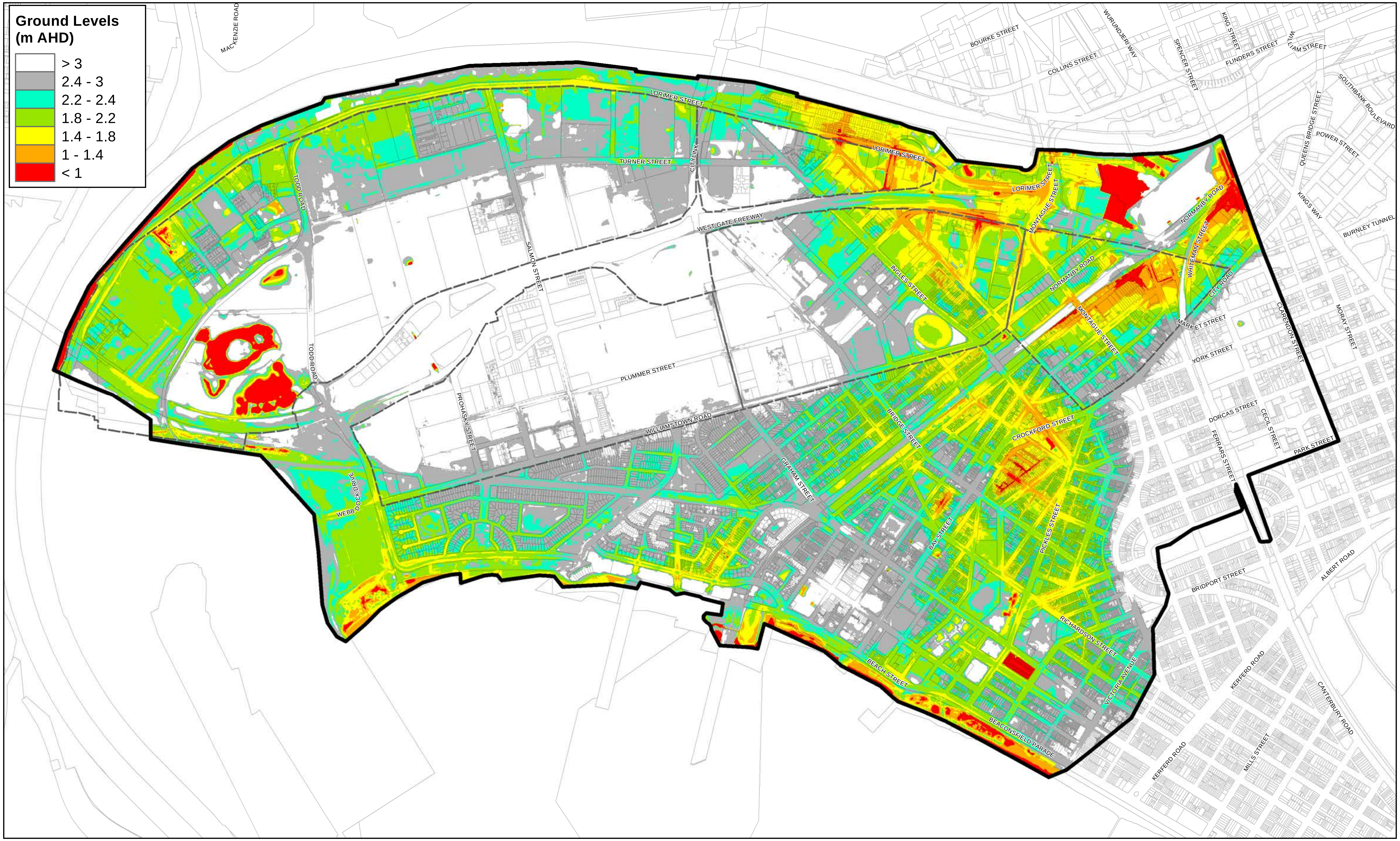
2.3 Imperviousness

Fishermans Bend is currently highly developed and impervious, with close to the maximum possible stormwater runoff being generated from rainfall today. The modelled imperviousness of the area is shown below in Figure 3.

2.4 Elevation

Fishermans Bend is low lying, with ground levels as low as 0.6 m AHD, as shown in Figure 2. This means that some areas are currently exposed to coastal flooding, which will increase over time due to sea level rise.

Approximately 25 ha (or 5%) of Fishermans Bend is below the current 1% AEP flood level (1.6 m AHD), and 166 ha (or 35%) of Fishermans Bend is below the predicted 2100 1% AEP flood level (2.4 m AHD). Noting both these numbers exclude the Westgate Lakes area.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary

Precinct Boundaries

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Ground levels

Job Number	12511721
Revision	A
Date	19/09/2019

Figure 2

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: sng

2.5 Climate Change

Rainfall Intensity

Climate change is predicted to increase the intensity of rainfall events (against a background of hotter and drier climate with fewer overall rainfall days). This will result in increased stormwater flooding over time. All future condition modelling has allowed for an increase in rainfall intensity (as per the City of Melbourne). The rainfall intensity was increase by 18.5% to model climate change conditions. It should be noted that the scaling factors provided in Australian Rainfall and Runoff 2019 results in a rainfall intensity increase by 18.4%.

Sea Level Rise

Global sea level rise (SLR) will increase the risk of coastal flooding at Fishermans Bend and result in higher tail-water levels for the underground drainage network. Current planning requirements and practice are to plan for a sea level rise of 0.8m by 2100. This is however only one scenario, and it is important to acknowledge that (i) 0.8m may be reached some time before or after 2100, and (ii) 0.8m is not an end point that sea levels will continue to rise beyond this. As discussed in Appendix G (Levee Discussion Memorandum), the latest science indicates 0.8m SLR could be reached as early as 2070 and that by 2100 SLR could be as high 1.8m. Refer to City of Melbourne's Planning for Sea Level Rise document regarding further discussion of sea level rise (Planning for Sea level Rise Guidelines, Melbourne Water 2017).

For the purpose of setting a tail-water level for future conditions flood modelling, a time varying tail-water level peaking at 2.25m AHD (from Water Technology for Melbourne Water, 2017) was used, which combines a 1% AEP extreme water level event in Port Phillip Bay of 1.45m AHD with 0.8m sea level rise.

Note that for the purpose of setting flood levels for development, Melbourne Water has adopted a 2100 1% AEP flood level of 2.4m AHD for Port Phillip Bay (Planning for Sea level Rise Guidelines, Melbourne Water 2017). Noting that this level makes some allowance for wave action, and for 0.8m of sea level rise.

2.6 Three Sources of Flooding

Flooding may arise from three separate sources: Coastal (or tidal) flooding from Port Phillip Bay and extending into the Lower Yarra River, Riverine (or fluvial) flooding from flows in the Yarra River, and Stormwater (or pluvial or surface) flooding from local rainfall events overwhelming the underground drainage network.

Upstream of Wurundjeri Way the Yarra River levels are flow-dominated during flood events and may be higher than peak Port Phillip Bay levels. Upon completion of the Yarra River Flood Mapping project, it was both concluded and advised that for the Fishermans Bend Precinct, Yarra River levels could be set to tidal levels from Port Phillip Bay.

Coastal and riverine flooding can increase the effect of stormwater flooding. This is because the ability of the stormwater drainage network to free drain under gravity is constrained if there is a high water level at the outlet of the network (e.g. in Port Phillip Bay or the Yarra River).

Catchment Context

Fishermans Bend's precinct boundaries do not align with stormwater catchment boundaries, meaning there are interdependencies between development conditions and management of stormwater outside of Fishermans Bend. In particular:

- Flooding in the Montague Precinct (and Wurundjeri Way PS catchment) is hydraulically connected to the adjacent Hannah St Main Drain catchment in South Melbourne. Flooding in that catchment impacts Fishermans Bend.

3. Modelling approach

3.1 Overview

Hydrologic modelling of the Fishermans Bend catchment was undertaken using RORB. An “undiverted” RORB model was initially created for “calibrating” to 100 year ARI Rational Method flow estimates. The “final” RORB model has been set up for the purposes of providing hydrographs for input into an unsteady hydraulic model only. With mainstream hydrograph routing being undertaken in the hydraulic model, the RORB model should not be directly used to provide total flow estimates along key flow paths. Hydrographs are printed for individual subareas along the drainage network, or for groups of subareas above hydraulically modelled drains. The final RORB model has been run for all standard storm durations (10 minutes to 72 hours) for the events and scenarios listed in Table 1.

For consistency with previous investigations, design storms were based on pre ARR 2019 design methodologies. On 13 May 2019, ARR 2019 was officially released and is no longer considered a draft document. The implications of any changes to ARR2019 with respect to this project have not been considered at this stage as all of the analysis was completed prior to its release despite its release predating the date of this report by about a few month. Original RORB modelling, which was conducted pre 2016, was undertaken with ARR1987 design methodologies. The current model was not updated for this flood mapping project in order to stay consistent with the mapping for the rest of the municipality, as well as acknowledging that there was no time or budget allocated to updating the model to ARR2019.

Hydraulic modelling of the Fishermans Bend catchments was undertaken using TUFLOW. TUFLOW is a hydrodynamic model used for simulating one-dimensional (1D) and two-dimensional (2D) flows. The TUFLOW model was created using drainage details and boundary conditions provided by Melbourne Water, LiDAR (and survey) based terrain data, drainage details provided by the City of Melbourne, and inflow hydrographs from RORB. The TUFLOW model was run to determine flood levels for the events listed in Table 1.The results of the TUFLOW runs were post-processed to create GIS layers.

3.2 Digital Terrain Model

A Digital Terrain Model (DTM) was created for the catchment, based on LiDAR information provided by Melbourne Water. This DTM was used to assist in the development of the hydrologic and hydraulic models for this investigation. Survey information was used in preference of the LiDAR information where there was overlap due to the age of the LiDAR and higher claimed accuracy of the field survey. A field survey completed in May 2017 called the Port Philip Sea Wall Survey undertaken for Melbourne Water was used to manipulate data in the DTM for levels along the Yarra River and Port Phillip Sea Wall. Checking the accuracy of the supplied terrain data is beyond the scope of this project and was not undertaken by GHD.

Creation of the DTM was undertaken using 12D and formed the basis of RORB catchment and subarea delineation, and of the two dimensional grid for use in the TUFLOW model. The DTM was also used in the post-processing of TUFLOW results to generate flood extents and depths.

The 2d model is based on a 3 m grid, with elevations assigned from the 2008 LiDAR data set. Changing the underlying terrain was necessary as the URS models did not provide the full extent required, and were on different orientations from model to model.

3.3 Hydrology

3.3.1 Introduction

RORB (*Laurenson et al 2010*) is a non-linear rainfall runoff and streamflow routing model for calculation of flow hydrographs in drainage and stream networks.

The model requires catchments to be subdivided into subareas, connected by a series of conceptual reach storages. Design storm rainfall is input to the centroid of each subarea. Design losses are then deducted, and the excess routed through the reach network.

Each reach is assumed to have storage characteristics as follows:

$$S = 3600 \times k \times Q^m$$

where *S* is storage (m^3);
Q is outflow discharge (m^3/s); and
k and *m* are dimensionless parameters.

The coefficient k is the product of two factors:

$$k = k_c \times k_r$$

where k_c is an empirical coefficient applicable to the entire catchment, and
k_r is the relative delay time applicable to each reach.

The relative delay time for each reach, k_{ri}, is determined as follows:

$$k_{ri} = F_i \times \left(\frac{L_i}{d_{av}}\right)$$

where L_i is the reach length (km),
d_{av} is the average distance along the reach network from each subareas' centroid to the catchment outlet (km), and
F_i is an empirical factor, and a function of reach type as follows (where S_c is the reach slope as a percentage):

- for natural reaches $F_i = 1.0$
- for excavated but unlined reaches $F_i = \frac{1}{(3 \times S_c{}^{0.25})}$
- for lined or piped reaches $F_i = \frac{1}{(9 \times S_c{}^{0.5})}$
- for drowned reaches $F_i = 0.0$

The model is also able to simulate:

- Lakes, retarding basins and similar storages.
- Concentrated and distributed inflows and outflows.

3.3.2 History of RORB modelling in the catchment

GHD did not create the RORB model. Much of the modelling approach (e.g. use of rain on grid) was continued from the TUFLOW model URS prepared for the City of Port Phillip in 2011, which GHD was asked to adopt and make only necessary adjustments to. Key changes were generally made only where key shortcomings were found, this included:

- Modelling additional durations to the two durations (45 minute and 1.5 hour) modelled by URS.
- Further dividing land use categories into 10% impervious fraction ranges to represent differing losses.
- Changing a single rainfall polygon to multiple rainfall polygons based on impervious fractions with appropriate factors to replicate the RORB runoff co-efficients prescribed by Melbourne Water.

3.3.3 RORB model layout

In this investigation, all inflows were routed overland from the centroid of their subcatchment to the drainage network. For the purpose of determining routing, each reach was assigned a type and for this study we generally applied the following rules:

- Overland flow along roads was generally assumed to be “lined or piped” (reach type 3).
- Overland flow through properties, or grassed surfaces, was generally classed as “Excavated, but unlined” (reach type 2).
- Overland flow through golf courses or densely vegetated areas was generally classed as “Natural” (reach type 1).
- Overland flow through lakes or waterbodies was generally classed as “Drowned” (reach type 4).

A GIS representation of the RORB model can be found in Appendix A

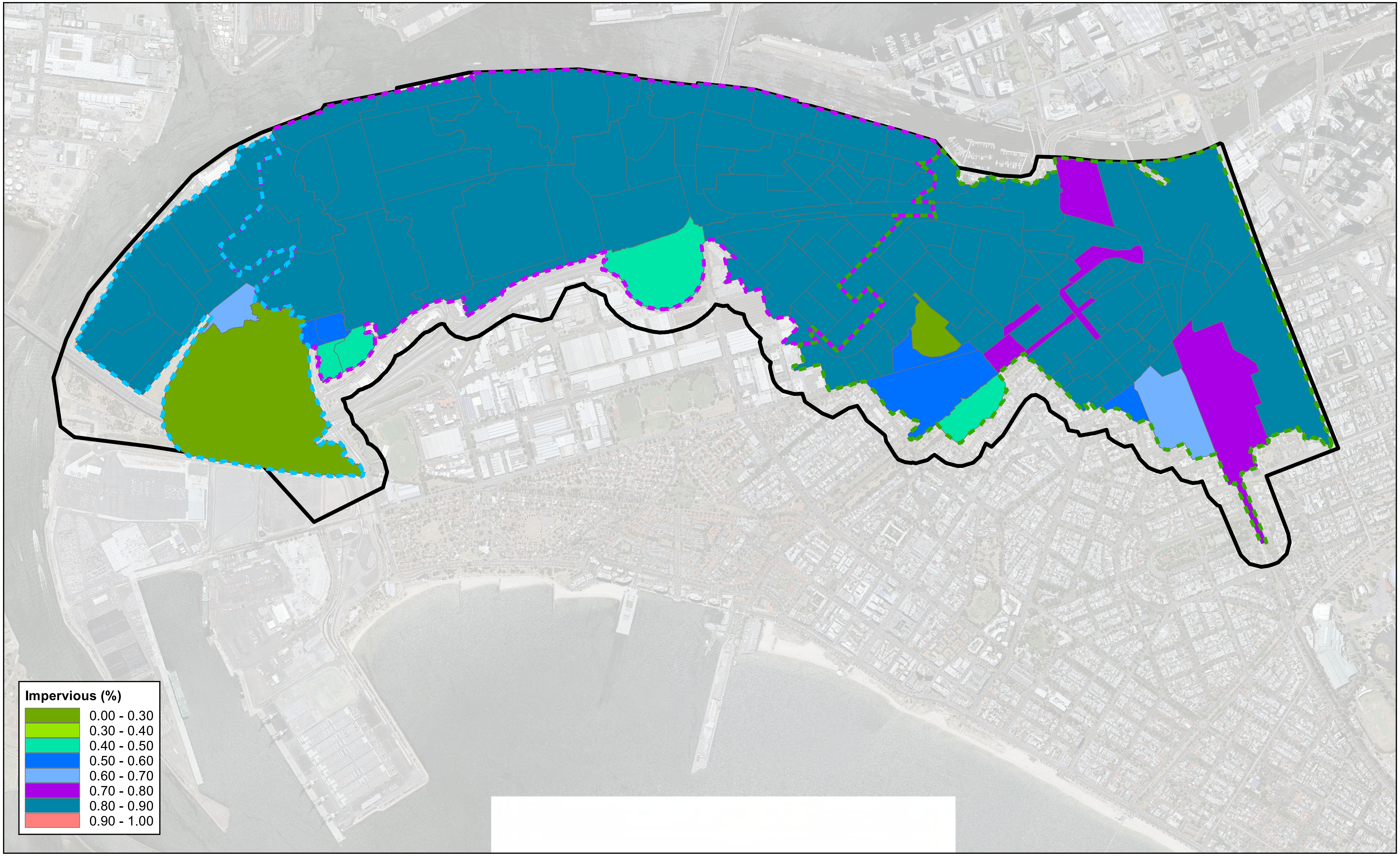
3.3.4 Impervious fractions

Impervious fractions for each subarea were determined based on default impervious fraction values assigned to each Planning Scheme Zone type. This approach was adopted to bring this study in line with the Guidelines (*MWC 2018*) and replaces the previous approach that utilised default impervious fractions from the Planning Model. In some locations the default impervious fraction values were adjusted based on visual inspection of aerial photography and/or known development details. The default impervious fractions adopted for each zone type are listed in below.

Table 2 Adopted Default Impervious Fractions

Planning Scheme Zone Type	Impervious Fraction
Residential Zone (R1Z)	0.6
Residential Zone (R2Z)	0.75
Business Zones (B1Z, B2Z, B4Z, B5Z)	0.9
Business Zone (B5Z)	0.8
Comercial Zone (C1Z, C2Z)	0.9
Industrial Zone (IN1Z)	0.9
Mixed Use Zone (MUZ)	0.7
Public Use Zone – Service and Utility (PUZ1)	0.05
Public Use Zone – Education (PUZ2)	0.7
Public Use Zone – Health and Community (PUZ3)	0.8
Public Use Zone – Transport (PUZ4)	0.75
Public Use Zone – Cemetery/Crematorium (PUZ5)	0.7
Public Use Zone – Local Government (PUZ6)	0.7
Public Park and Recreational Zone (PPRZ)	0.1
Road Zone – Category 1 (Major roads and freeways) (RDZ1)	0.8
Road Zone – Category 2 (Secondary and local roads) (RDZ2)	0.7
Capital City Zone (CCZ1, CCZ3, CCZ4)	0.9
Docklands Zone (DZ1, DZ7)	0.9
Special Use Zone (SUZ3)	0.5

The adopted impervious fractions were used to determine weighted impervious fractions for each subarea, as shown in Figure 3. A table showing the area and impervious fraction of each subarea and a breakdown of the zones in each subarea is shown in Appendix A



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary

RORB NE Catchment Boundary

RORB Wst Catchment Boundary

RORB NW Catchment Boundary

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number 12511721
Revision A
Date 30/09/2019

Impervious Fraction Distribution by Subarea

Figure 3

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

3.3.5 Design rainfall intensities

Design rainfall intensities were determined based on the methods prescribed in Book 2 of the 1997 Edition of Australian Rainfall and Runoff (*IEAust 1997*). The IFD parameters adopted for the Fisherman's Bend catchments were obtained from the Bureau of Meteorology's webpage for creating IFD data (*BOM 2013*) and are presented in Table 3 and Table 4 below. The full IFD table is presented in Appendix A in A.4 IFD Table.

Table 3 IFD Parameters for Fishermans Bend Catchments*- Normal Intensities

Parameter	Rainfall Intensities
${}^{2}i_{1}$ (1 hr duration, 2 yr ARI)	18.77 mm/hr
${}^{2}i_{12}$ (12 hr duration, 2 yr ARI)	3.62 mm/hr
${}^{2}i_{72}$ (72 hr duration, 2 yr ARI)	1.08 mm/hr
${}^{50}i_{1}$ (1 hr duration, 50 yr ARI)	39.07 mm/hr
${}^{50}i_{12}$ (12 hr duration, 50 yr ARI)	7.08 mm/hr
${}^{50}i_{72}$ (72 hr duration, 50 yr ARI)	2.20 mm/hr
G (skewness)	0.36
F2 (2 yr ARI geographical factor)	4.29
F50 (50 yr ARI geographical factor)	14.94

*(Location: 144.925°E, 37.825°S)

Table 4 IFD Parameters for Fishermans Bend Catchments*- 18.5% Higher Intensities

Parameter	Rainfall Intensities
${}^{2}i_{1}$ (1 hr duration, 2 yr ARI)	22.24 mm/hr
${}^{2}i_{12}$ (12 hr duration, 2 yr ARI)	4.29 mm/hr
${}^{2}i_{72}$ (72 hr duration, 2 yr ARI)	1.28 mm/hr
${}^{50}i_{1}$ (1 hr duration, 50 yr ARI)	46.30 mm/hr
${}^{50}i_{12}$ (12 hr duration, 50 yr ARI)	8.39 mm/hr
${}^{50}i_{72}$ (72 hr duration, 50 yr ARI)	2.61 mm/hr
G (skewness)	0.36
F2 (2 yr ARI geographical factor)	4.36
F50 (50 yr ARI geographical factor)	15.99

*(Location: 144.925°E, 37.825°S)

3.3.6 RORB loss parameters

RORB's initial loss/runoff coefficient model was used for the 100 year to 5 year ARI design runs. Adopted parameters for *pervious* areas were as follows:

- Initial loss = 10 mm
- 100 year ARI Runoff coefficient = 0.6

The model automatically sets the loss parameters for *impervious* areas as follows:

- Initial loss = 0 mm
- Runoff coefficient = 0.9

A value of 0.8 was adopted for the model exponent, m, throughout.

The design storms used in the modelling were based on point storms, fully filtered temporal patterns and the IFD parameters described in Section 1.1.

3.3.7 Determination of k_c value

In RORB, the kc value is used as a method of calibrating the storage and attenuation that's modelled within the RORB model. The exercise of defining a kc values depends on the knowledge of the catchment and some known data to calibrate to or validate the model against. Unfortunately no historical streamflow or flood level information was available within the Study Area, so the value of kc had to be determined using empirically derived formulas.

A kc value, based on the RORB equation (kc $=2.2 \times A^{0.5}$), was adopted for the Fishermans Bend model. This can be seen in Table 5. Due to the unique nature of the Fishermans Bend Catchments, it is important to keep in mind the following points when considering a kc value:

- Could not compare kc flows to rational method flows due to the imbedded storage that is within the Fishermans Bend model.
- Fishermans Bend has a relatively flat topography. In this situation, the kc value plays a smaller role in characterising flows. Due to the flat topography, inflows were routed in the TUFLOW model rather than RORB model.
- The importance of the kc parameter diminishes as the amount of routing done within the RORB model is insignificant compared to the routing in the hydraulic model.

As most of the routing will be in the hydraulic model, the final results are relatively insensitive to k_c, which arguably becomes less important than the adopted loss model parameters (which will affect the volume of runoff).

Table 5 Kc values calculated for Fishermans Bend Catchments.

Fishermans Bend Catchment	Catchment Area (km^2)	Kc
North East Catchment	1.927	3.05
North West Catchment	2.554	4.04
West Catchment	0.813	1.91

3.4 Hydraulic modelling

3.4.1 Introduction

The model extends from the top of the Fishermans Bend catchments which drain north to the Yarra River, and broadly from the end of Lorimer Street in the west to Clarendon Street in the East. A plan showing the layout of the TUFLOW model for the Fishermans Bend catchments, as described below, is included in Appendix B.

Hydraulic modelling was undertaken using TUFLOW version 2018-AE-iDP-w64. TUFLOW (*WBM 2018)* is a hydrodynamic model used for simulating one-dimensional (1D) and two-dimensional (2D) flows.

The model is based on the solution to the free-surface flow equations. The TUFLOW model consists of a 2D domain (TUFLOW) representing the catchment terrain, a 1D network (ESTRY) representing the pipe systems and a set of boundary conditions comprising the calculated RORB hydrograph inflows and the downstream water levels.

TUFLOW modelling was undertaken to determine the peak water levels throughout Fishermans Bend; Lorimer and Employment precincts for the events listed in Table 1 Scenarios Modelled and Mapped. The model was initially run for 16 different 100 year ARI storm durations ranging from 10 minutes to 30 hours in order to determine the critical peak flood levels (i.e. 16 runs in total for each scenario). The longest storm duration run was later revised to 30 hours after a review of an initial set of results showed that running longer storms was unnecessary for the current design storms and model configuration (i.e. longer duration events did not result in peak flood levels).

3.4.2 History of TUFLOW modelling in the catchment

GHD did not create the TUFLOW model. Much of the modelling approach (e.g. use of rain on grid) was continued from the TUFLOW model URS prepared for the City of Port Phillip in 2011, which GHD was asked to adopt and make only necessary adjustments to. Key changes were generally made only where substantial errors were found.

Key changes made included:

- Mannng's "n" values were adopted from the previous model, checked and adjusted where necessary.
- Changing inverts on pipes which had negative slopes or were above the inverts of incoming pipes, except where these are at bifurcation locations where they are likely to form a high level relief system, or where Melbourne Water GIS layer inverts indicated that slopes were negative, or there was a step up.
- Changing pipes from circular to rectangular where Melbourne Water GIS layers indicated these were not circular.
- Changing inverts on pipes which had no cover (were effectively sticking out of the ground).
- Increasing the tail water levels to those provided by Melbourne Water.
- Adding additional City of Port Phillip pipes and pits from Council's GIS layers that were located within or close to the precincts and not present in the URS model.
- Adding City of Melbourne pits and pipes in areas the model was extended and connecting the City of Port Phillip network to these as appropriate.
- Added Melbourne Water pits and pipes were development had caused realignments to Melbourne Water drainage infrastructure.
- The fixed water level that was used for the downstream boundary conditions in the previous TUFLOW modelling was replaced with a tidal cycle boundary condition.
- The terrain data within the TUFLOW model was updated with data from the Port Phillip Sea Wall Survey (Port Melbourne to Williamstown) (May 2017) undertaken for Melbourne Water.
- The pipe drainage under the West Gate Fwy and through the site of the Melbourne Convention Centre had not been represented correctly within the hydraulic model used previously for the drainage plan options. This had likely occurred as a result of the recent redevelopment of the site and the changes that were understood to have been made then to the drainage. The pipe drainage has been updated for the modelling undertaken for this baseline drainage plan.

Where elaboration is required these changes are further described in the following sections.

3.4.3 2D domain

The 2D domain represents the ground surface and hence the overland flow paths within the model. A DTM was created to represent the catchment topography, as described above in Section 1.1. Using this terrain model, grids comprising 3 metre square cells were formed, covering an area of 5400 m by 3680 m. Each cell is made up of nine points, with the elevation for each point based on the DTM. Given there was no obviously dominant street direction, the grid was rotated to minimise the size of the 2D domain. The 2D domain was used to model all overland flow paths.

2d Domain Corrections

Some major flow control features critical in determining overland flow distribution and/or levels of ponding were included in the 2D domain by modifying the elevations of cell points (through the use of additional z-shapes and/or z-lines). “Z shapes” have been used to alter the terrain in the model where anomalies were observed in key areas (such as holes where large buildings were under construction and significant excavation was seen in the data set within or upstream of the precincts), or in areas where bridges had caused obstructions to flow in the DEM.

The 2D domain was compared to current day images (both aerial and street view) to highlight areas of development and the appropriate use of terrain manipulation was used to produce flood extents that better replicate expected flooding. In areas where there is a noticeable change to terrain since LiDAR data was gathered, i.e. the development of buildings, “z shapes” and/or “z lines” were used to adjust terrain to more appropriate levels. Along with “Z shapes”, “Z lines” have been used to alter the terrain in the model in areas where flow paths should not exist because a structure is now preventing water from flowing in that direction. “Z lines” create a hypothetical wall by modifying the elevations of cell points, redirecting flow paths. “Z lines” were used to incorporate the Port Philip Sea Wall Survey manipulating data in the DTM for levels along the Yarra River and Port Phillip Sea Wall. This enabled a better representation of ground levels along the Yarra River to be represented in the model.

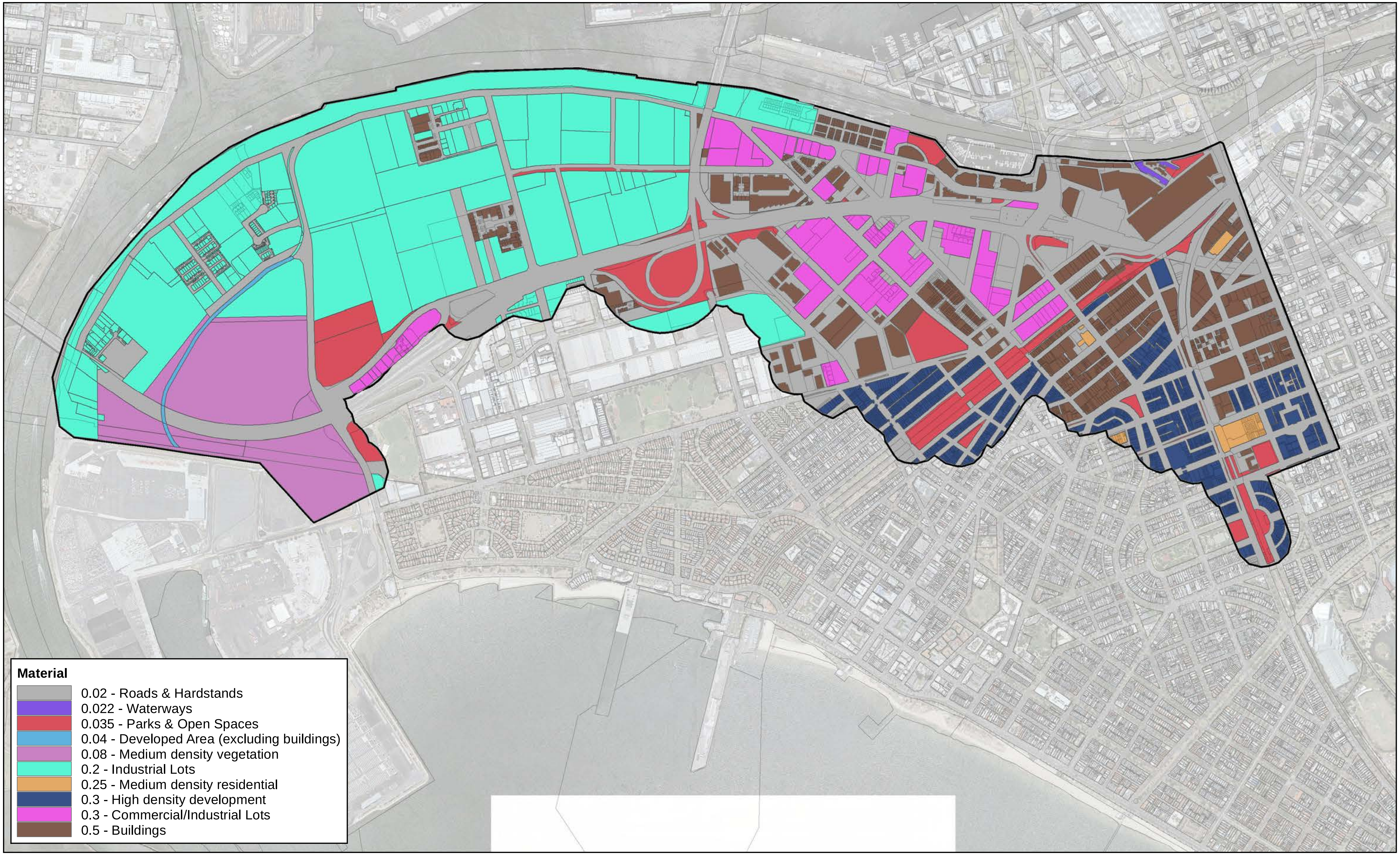
Bed Resistance

The bed resistance was allocated to each cell as a Manning’s n value based on land use type and aerial photography. Adopted Manning’s n values are displayed in Table 6 below. Figure 4

shows the distribution of Manning’s n values throughout the 2D domain.

Table 6 Bed Resistance Values for 2D Domain

Material Number	Land Use	Manning's n
1	Roads and Hardstands	0.02
2	Parks and Open Space (well maintained grass/lawn)	0.035
3	Medium density residential, buildings not separated	0.25
4	High density development, buildings not separated	0.3
5	Buildings	0.5
6	Waterways	0.022
7	Commercial/industrial lots, buildings not separated	0.3
8	Developed areas excluding buildings	0.04
9	Medium density vegetation	0.08
10	Industrial lots, buildings not separated	0.2



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary

Parcels

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number 12511721
Revision A
Date 13/09/2019

Manning's 'n' Distribution

Figure 4

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

3.4.4 1D network

The one-dimensional network comprises all Melbourne Water and City of Melbourne, as well as a number of City of Port Phillip, underground pipes. The existing underground drainage network was mostly sourced from the original modelling and supplemented with information from MW provided GIS data.

Pipe networks

The pipe networks include underground pipes and connections to the surface (pits). Pipes were mostly modelled as circular (“C”) or rectangular (“R”) channels.

Modelled inlet pits have typically been generously sized to enable the pipes to be more easily filled in recognition of the fact that other directly connected drainage systems are not explicitly modelled. Inlet losses were generally based on typical design values. These values were sometimes reduced using engineering judgement where they were considered too conservative (large).

Manning’s n pipe roughness values of 0.015 were adopted for all concrete pipes for consistency with the URS base model.

Details of the Melbourne Water pipes (i.e. dimensions, invert levels and location) were generally adopted from Melbourne Water’s GIS layers and/or design drawings of the drains. Details of Council pipes were based on GIS layers of Council drainage received from City of Melbourne and the City of Port Phillip.

Although many of the underground assets are reasonably well documented, a number of assumptions have been made in building and or updating the model, these typically include assumptions regarding invert levels and sometime even connectivity. These assumptions and others, which may remain from the original URS source model, are not considered sufficiently representative for the current modelling purposes however they may not be appropriate for other objectives. It is recommended that any future modelling considers the potential significance of these assumptions and refers to the original drawings, GIS databases and survey to confirm key characteristics.

Pits

‘Pits’ are defined in TUFLOW as being locations where flow can interchange between pipes and the surface (excluding pipe inlets/outlets at headwalls). While Council provided a GIS layer of all pits identifying different pit types (e.g. junction pits, side entry pits, grated pits, etc.), it was agreed with Council to model all Council pits as model ‘pits’. The exception to this was where there was no physical evidence on site of a pit of any kind existing. In those instances, the GIS pit was modelled as a ‘Node’ and did not provide connectivity to the surface. This general pit modelling assumption recognises that pit lids could blow off during a flood event regardless of the pit type and that other inlets may exist which are not explicitly included in the model.

For modelling purposes, pits have generally been modelled as 3 m wide weirs, unless real pits were actually larger than this. This approach partially allows for additional inlet capacity to the drainage system not otherwise explicitly included in the model (such as private property connections, etc.). The resultant flood characteristics are therefore mostly influenced by the capacity of the modelled pipes and less by inlet capacity.

Losses

Form loss coefficients were determined throughout the pipe network based on standard pit loss tables (*MWC 2018*). Pit loss values were generally assigned to the downstream pipe as a form loss, rather than in the pits themselves. A typical entrance loss of 0.5 and exit loss of 1.0 was applied to culverts and to the ends of pipes. While the loss coefficients are generally conservative, no allowance has been made for blockage due to debris.

In order to apply this method of form loss application, the command "Manholes at All Culvert Junctions == OFF" was added to the model ECF files. By adding this command, TUFLOW's default approach of applying Engelund loss values is deactivtated.

3.4.5 Boundary conditions

Boundary conditions in the TUFLOW model include inflow hydrographs and downstream tailwater conditions.

Inflows

Inflow hydrographs for the events listed in Table 1 were generated using the RORB models and adopted as the flow boundary conditions ("QT" – flow versus time). Hydrographs were input to the TUFLOW model by applying the hydrograph in one of the following ways:

- As a point on a single node on the 1D network (via a 1d_bc layer).
- As a polygon distributing a hydrograph evenly between a number of nodes on the 1D network (via a 1d_bc layer); or

The vast majority of these boundaries are however applied directly to the 1D network to encourage the pipes to flow full before surface flow occurs.

Inflow hydrographs were created from four RORB catchment models; North-Eastern, North-Western, Western and Southern catchments. The NE, NW and Wst catchment inflows are included in the RORB model used for this flood mapping project. Southern catchment inflows were applied from Fishermans bend existing southern catchment model (external from this current flood mapping project). Southern Catchment inflows were required and applied at the Salmon Street and Rocklea Drive intersection, where a two way drain is located. The pipe network along Salmon street heads both north underneath the West Gate Freeway and south down Salmon Street, outside of the hydraulic model boundary. Creating a boundary condition for this particular drain is described below. The RORB catchment boundaries can be seen in Appendix A.

Downstream boundaries

Following consultation with Melbourne Water, cyclical Port Phillip Bay tidal levels were adopted as tail water levels for the Melbourne Water and council pipes discharging to the Yarra River. These levels were applied in the TUFLOW model as head versus time boundary conditions ("HT" boundary with head remaining constant) at the ends of the pipe networks (via a 1d_bc layer).

A 1D boundary condition was applied to a pipe exiting the model to the south along Salmon Street. A level of 2.541 m AHD was nominated which represents the obvert of the pipe outlet closest to the hydraulic model boundary. This level was applied in the TUFLOW model as a "HT" boundary conditions (via a 1d_bc layer).

2D boundary conditions were also included at multiple locations along the edge of the model. A 2D boundary condition along the Yarra River was applied as a "HT" boundary (via a 2d_bc layer) representing the Yarra River Levels and Sea Levels.

To allow overland flow that reaches the southern boundary to exit the model, multiple “HQ” boundaries (via a 2d_bc layer) are at locations identified from previous flood modelling results.

Tidal cycle boundary

Based on discussions with Melbourne Water, it was decided that tide cycle data from Port Phillip Bay should be used for the downstream boundary condition of the Fishermans Bend model instead of flood levels from the recently completed Yarra River flood modelling project. The decision was made in light of the fact that the critical storm event for the Yarra River is much longer than what is critical for Fishermans Bend and therefore the two events would likely not coincide. A comparison of the Yarra River Flood Model results with Port Phillip Tide Cycle Levels results found that there was less than 50mm difference in water levels.

Tide cycle data was supplied by Melbourne Water from a tidal model of Port Phillip and consisted of 500, 100, 20 and 5 year ARI time series results for both current conditions and 2100 climate change conditions. Tide data from Cowderoy Road in St Kilda was used for the Fishermans Bend flood modelling. Based on this data, the peak tide level for the 100-year ARI event, including the effects of climate change, was 2.25 mAHD, The 10-yr and 100-yr ARI tidal cycles from the tidal model for existing conditions and 2100 are shown in Figure 5 below. The 10 year ARI data was interpolated from the 20 and 5 year ARI time series results.

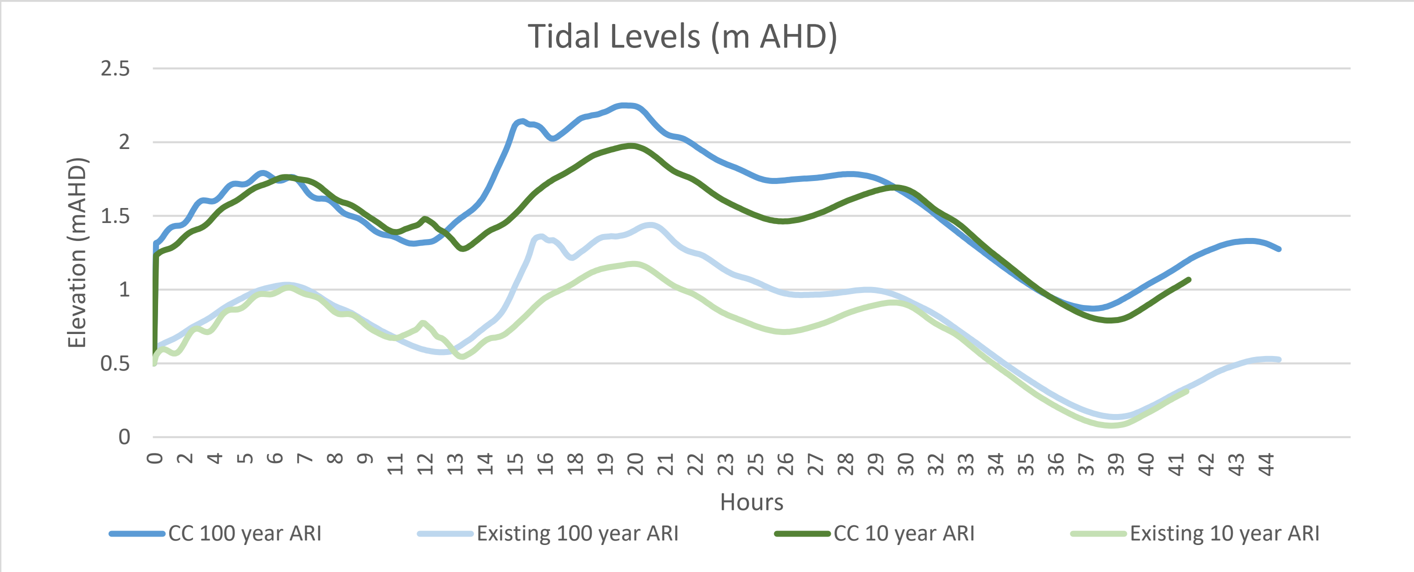


Figure 5 Adopted tidal cycle data

Table 7 Adopted Tailwater Levels

Scenario	Event	Yarra Flood Levels	1D Boundary Condition Tailwater Levels (m AHD)		2D Boundary Condition Tailwater Levels (m AHD)		
			Yarra River	Salmon Street*	Yarra River	Southern Boundary^	Salmon St
A - Climate Change 1	100 year ARI	10% AEP	#	2.541	#	1 in 500 slope	1 in 100 slope
B - Climate Change 2	100 year ARI	1% AEP	#	2.541	#	1 in 500 slope	1 in 100 slope

Note:

refer to Tidal Cycle data shown in Table 7.

* indicates that this level represents the obvert of the pipe outlet closest to the hydraulic model boundary.

^ includes all 2D boundary conditions along the southern boundary of the model except for Salmon Street (15 in total).

Initial water level

The tailwater levels listed above were also applied as initial water levels to the entire respective models (in both the 1D network and 2D domain) to improve stability at the start of a simulation. These global 1D and 2D initial water level boundary conditions were overridden at the following permanent water bodies:

- West Gate Park: Fresh and Salt Water Lakes – an initial water level of 0.5 m was set for the two lakes.

Clarendon Street boundary/ Hanna Street Main Drain catchment approach

A "glass wall" boundary was modelled at the Clarendon Street boundary in areas below 2.22 m AHD. The limitation of this approach is that it does not account for the additional flood storage or pipe capacity which may be available in the large depressed area on the eastern side of the road, or conversely any flows which may be crossing the road from east to west from the Hanna St drain catchment if this is experiencing greater surcharging. Overcoming this limitation would involve extensive model extension. The Hanna St Drain has a catchment area of 421 ha according to the 'DR_MW_Catchment tab', the Crown Casino Pumping Station is also located at the end of the Hanna St main drain.

Only between half and two thirds of the Hanna St Main Drain catchment is shown in the DR_MW_Catchment tab which was included in the URS Catchment 4 model, stopping at the CoPP boundary. The pipe continues to the Yarra in the 1d only without further inflows and the Crown Casino Pump Station is not included.

An additional pump station at Clarendon Street was sized to limit flooding originating from the system on the western side of the road for all scenarios except Scenario 0 (Conventional servicing with rainwater tanks as per SFP and no precinct based drainage) so that ponding on Whiteman Street does not drive flow into the 525 mm Council drain southwest into the Montague precinct (somewhere between approximately 0.8m and 0.95 m AHD). There is potential to provide additional capacity for the Hanna St catchment if desired, subject to detailed investigation in the future.

3.4.6 Model run parameters

Following several test runs trialling various parameters, the following parameters were found to achieve the most stable model runs across a wide range of storm durations, and have been adopted for all runs (unless otherwise specified):

- Cell size – 3m
- 2D domain size – 5400 m x 3680 m.
- A time step of 1 seconds for the 2D domain and 0.25 seconds for the 1D network.
- Maximum Velocity Cutoff Depth == 0.05 (default is 0.1) – this allows maximum velocities to be recorded once depth is above 0.05m.
- Cell Wet/Dry Depth == 0.0002 (default is 0.002)
- Initial water levels in the 1D and 2D domains as described above in Section 1.1.
- "Manholes at All Culvert Junctions == OFF" command has been used to override the automatic calculation of losses and apply the parameters determined in accordance with Melbourne Water's standard pit loss tables (see discussion in Section 1.1).
- Minimum NA == 2 (used to increase nodal storage slightly at 'nodes' in the 1D network where pits are not digitised).

- “Weir Flow == METHOD B” (default approach for weirs prior to 2013 versions of TUFLOW – necessary to improve the stability of the “W” pits and reduce total cumulative mass error).
- Model run times long enough for peak flood levels to occur throughout the drainage system for each storm duration.
- For each duration the starting time of the rainfall event was set such that the peak tide cycle level coincided with the end of the rainfall event. For the purpose of this flood mapping project, this approach was deemed acceptable by Melbourne Water. Although the joint probability of the peak of a 1% AEO tidal event coinciding with the end of a 1% AEP rainfall event is probably less than 1%, this approach provides a more conservative result.

3.4.7 Final TUFLOW Model Input Layers

A list of description of the layers read into the TUFLOW model are presented in Appendix B – Table B16.

4. Mapping output

4.1 Raw flood extent results

The raw results of the TUFLOW modelling were post-processed to produce raw flood extent layers as outlined in Melbourne Water's Guidelines and Technical Specifications for Flood Mapping Projects (*MWC Nov, 2018*). The model results produced for the selected storms, envelopes of maximum values were produced for each AEP and for each of the key output parameters (i.e. flood level, depth, velocity, velocity-depth) using the "DAT to DAT" utility. Further details of the mapping output is described in the following sections.

4.2 Qualifications relating to flood mapping output

The hydraulic model and its results extend beyond the region being mapped for to achieve a number of objectives, including:

- To improve the distribution of model inflows.
- To reduce the significance of downstream boundary conditions.
- To facilitate flow diversions.

Therefore, the flood mapping outputs described in the following sections, and provided to the City of Melbourne as 3 m grid points in accordance with the Guidelines and Technical Specifications for Flood Mapping Projects (*MWC Nov, 2018*) are for the entire model and extend beyond the "Mapping Limit" line. This line designated the extent of meaningful results. Outside of the "Mapping Limit" the results shown may be misleading due to a number of reasons, including:

- Boundary conditions
- Incomplete representation of drainage assets
- Detail to which the 2d surface is presented

The accuracy of the final results is in part a function of the resolution of the TUFLOW model (which uses a 3 m cell size).

4.3 GIS output

The MapInfo layers listed below were provided to City of Melbourne as a primary output of this flood mapping project. This report describes the methodology and steps taken to arrive at these layers. The layers listed in Table 8, Table 9 and Table 10 conform to Melbourne Water's supplied metadata standards and naming conventions, as outlined in the Guidelines and Technical Specifications for Flood Mapping Projects (*MWC, 2018)*. The projection of all layers is Map Grid of Australia Zone 55 (GDA94).

4.3.1 Flood Extents

Table 8 Deliverables – GIS Layers

Layer name	Description
Mapping_Limits.TAB	Extent of meaningful results.

Table 9 Deliverables - Flood Extent Results

Name	Units	Comment
FB_Base_10yTide_100y_Water_Level.flt	m AHD	Maximum water level for 10y ARI Tide and 100y ARI Rainfall
FB_Base_100yTide_100y_Water_Level.flt	m AHD	Maximum water level for 100y ARI Tide and 100y ARI Rainfall
FB_Base_10yTide_100y_Water_Depth.flt	m	Maximum depth for 10y ARI Tide and 100y ARI Rainfall
FB_Base_100yTide_100y_Water_Depth.flt	m	Maximum depth for 100y ARI Tide and 100y ARI Rainfall
FB_Base_10yTide_100y_Velocity.flt	m/s	Maximum velocity for 10y ARI Tide and 100y ARI Rainfall
FB_Base_100yTide_100y_Velocity.flt	m/s	Maximum velocity for 100y ARI Tide and 100y ARI Rainfall
FB_Base_10yTide_100y_Velocity_x_Depth.flt	m^2/s	Maximum velocity-depth product for 10y ARI Tide and 100y ARI Rainfall
FB_Base_100yTide_100y_Velocity_x_Depth.flt	m^2/s	Maximum velocity-depth product for 100y ARI Tide and 100y ARI Rainfall

Table 10 Deliverables - RORB Model Layers

Layer name	Description
RORB MapInfo Layers	
FB_NE_catch_region.TAB	North East Catchment Boundary
FB_NE_subarea_region. TAB	North East Sub area boundaries
FB_NE_node_point. TAB	North East Nodes
FB_NE_reach_polyline. TAB	North East reaches
FB_NW_catch_region. TAB	North West and West Catchment Boundary
FB_NW_subarea_region. TAB	North West and West Sub area boundaries
FB_NW_node_point. TAB	North West and West Nodes
FB_NW_reach_polyline. TAB	North West and West reaches
Imp_Fracs_region. TAB	Sub Area Impervious Factions

5. Recommendations

It is recommended that:

- The City of Melbourne adopts the outcomes of this investigation to assist in the classification of the catchment in terms of severity of flooding.
- The City of Melbourne adopts the outcomes of this investigation for future planning purposes and assessment of potential future mitigation options.
- Any future mitigation option assessment makes allowance for the impact of future development within the catchment.
- The planning assumptions used in this modelling are reviewed periodically and updated as required.

Improvements to the modelling for future flood mapping projects:

- Update LiDAR to current data
- Update the RORB model with ARR2019 design methodologies.
- Complete a Monte Carlo simulation on the joint starting times of the tide cycle and the rainfall event to correctly identify probability events.
- Update 1D network with current asset data;.

6. References

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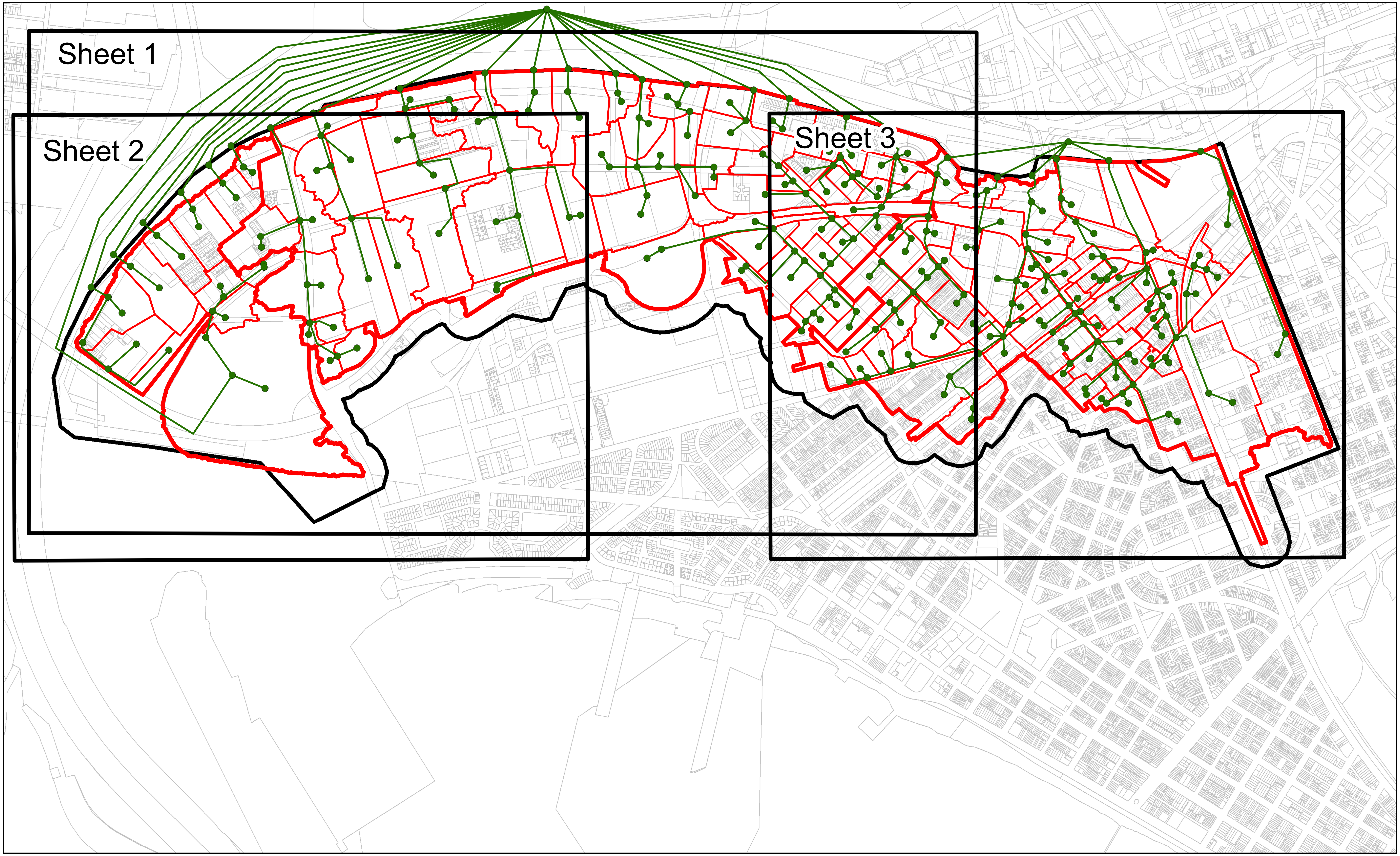
Appendices

Appendix A – Hydrological Modelling

Contents

A.1 RORB Network Layout (4 page – Figures A.1, A.2, A.3 and A.4)
A.2 RORB Catchment Files (14 pages)
A.3 Subarea-weighted Impervious Fraction (3 pages)
A.4 IFD Tables (2 pages)

A.1 RORB Network Layout



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary
Parcels
Catchment Boundary
Subcatchment Boundaries
RORB Model Nodes
RORB Model Reaches

GHD

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number 12511721
Revision A
Date 23/09/2019

RORB Network Layout

Key Map

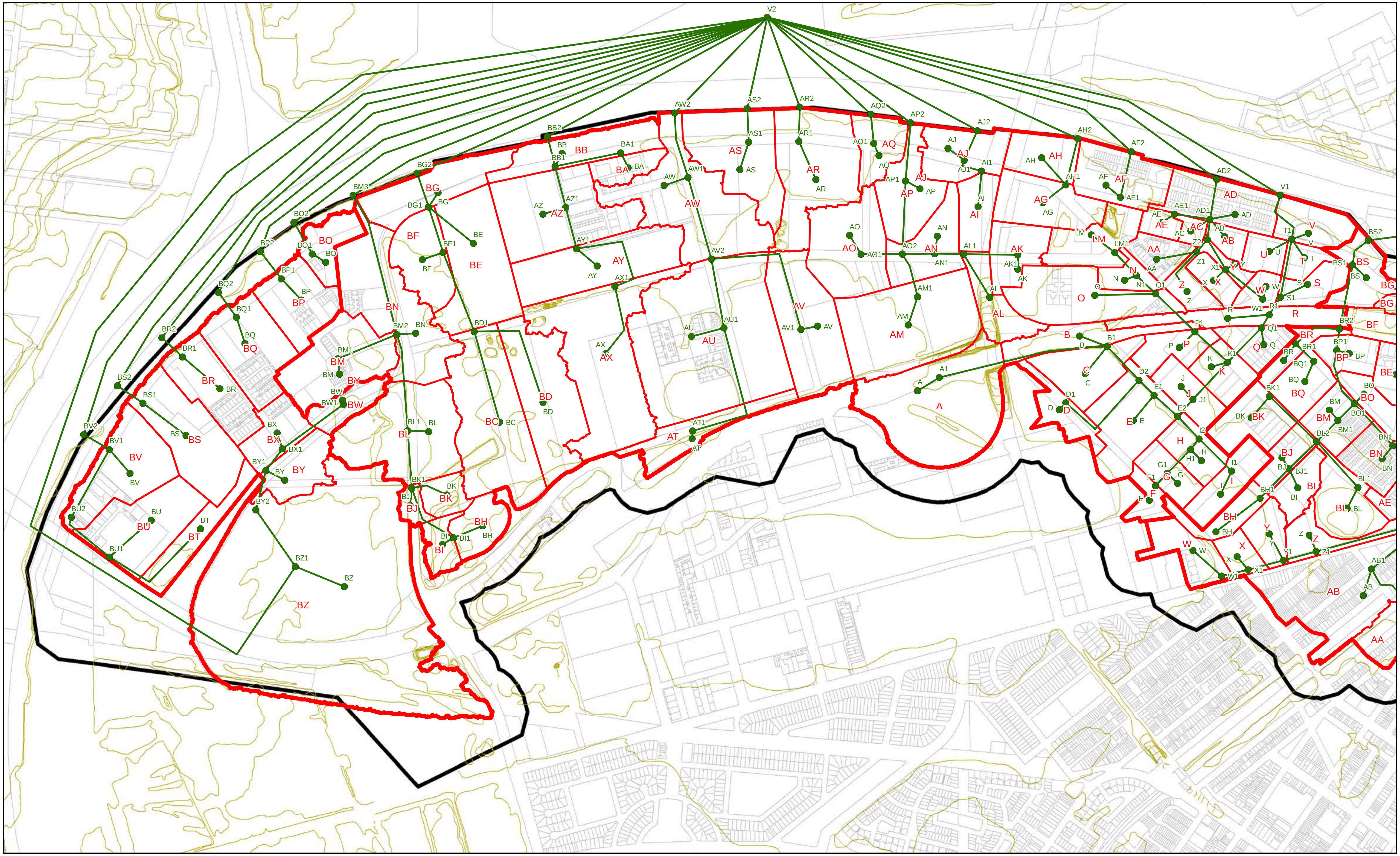
Figure A.1

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

A.2 RORB Catchment Files



Paper Size A3

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Model Boundary
- Parcels
- Ground Contours (1m Interval)
- Catchment Boundary
- Subcatchment Boundaries
- RORB Model Nodes
- RORB Model Reaches

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	23/09/2019

RORB Network Layout

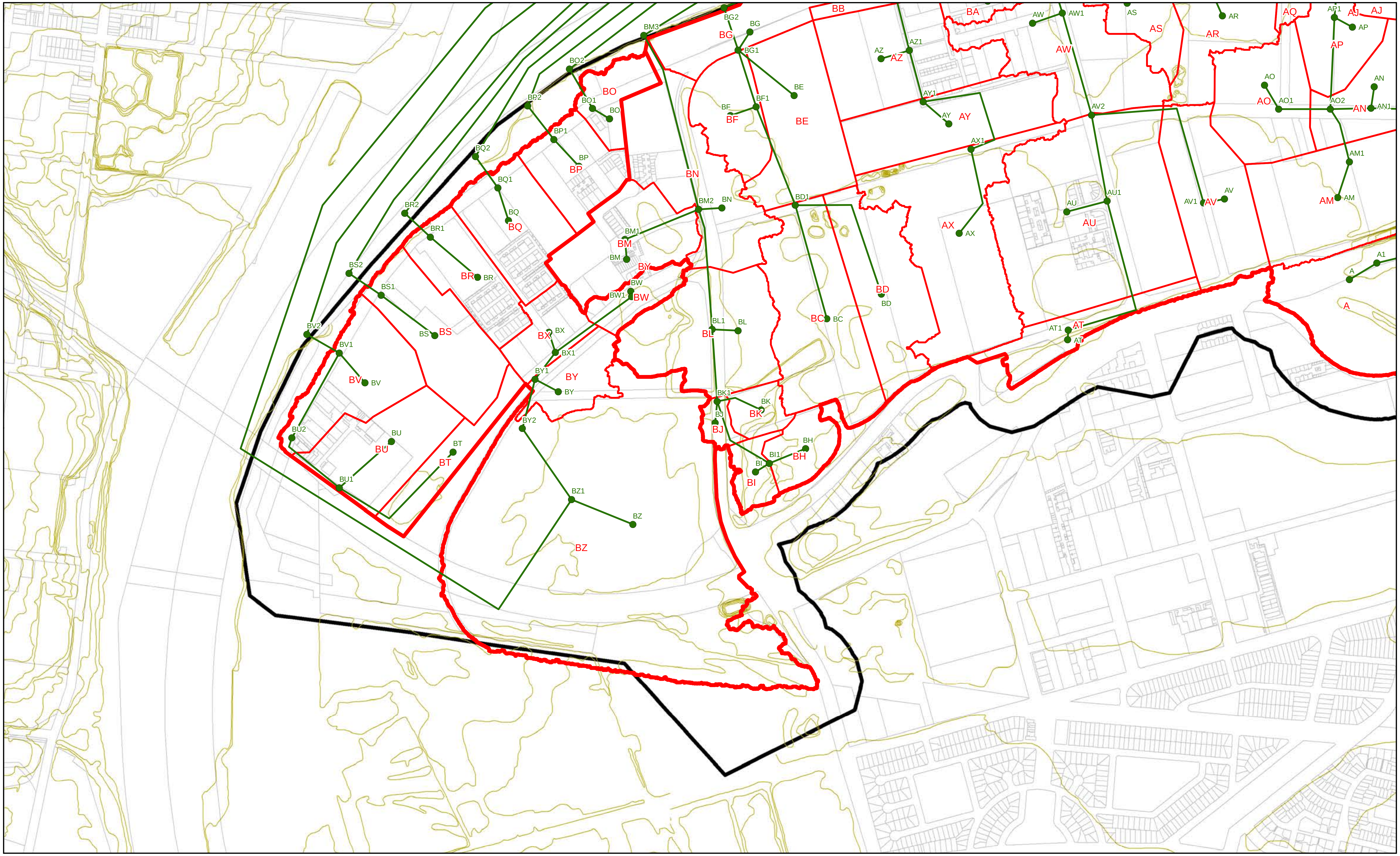
Sheet 1 of 3 - NW Catchments

Figure A.2

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan



Paper Size A3

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary
Parcels
Ground Contours (1m Interval)
Catchment Boundary
Subcatchment Boundaries
RORB Model Nodes
RORB Model Reaches

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	23/09/2019

RORB Network Layout

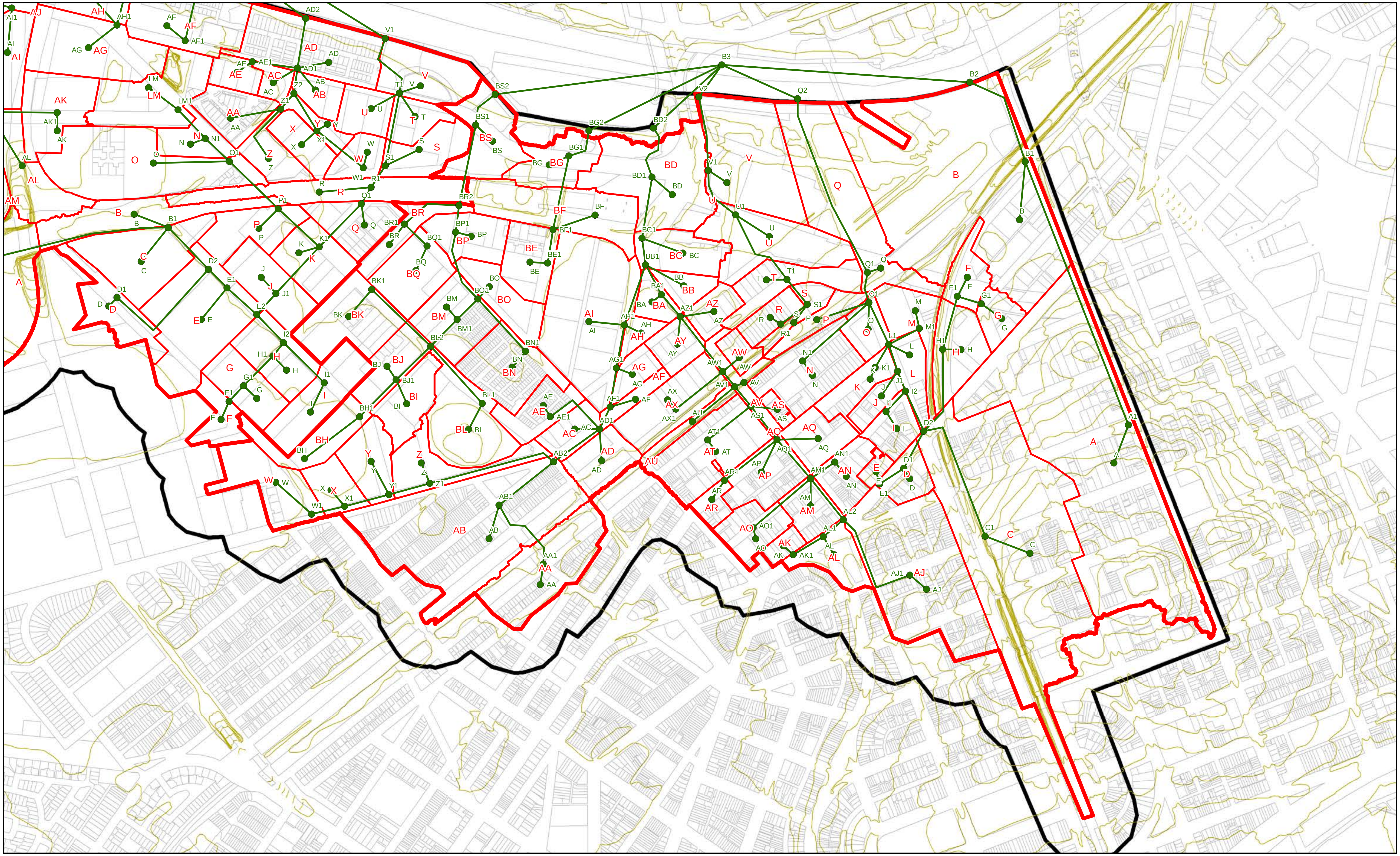
Sheet 2 of 3 - West Catchments

Figure A.3

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan



Paper Size A3

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Model Boundary
Parcels
Ground Contours (1m Interval)
Catchment Boundary
Subcatchment Boundaries
RORB Model Nodes
RORB Model Reaches

GHD

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	23/09/2019

RORB Network Layout

Sheet 3 of 3 - NE Catchments

Figure A.4

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

A.3 Subarea-Weighted Impervious Fraction

Table A-11 North Eastern Catchments – Adopted Subarea Impervious Fraction

SubArea	Area (ha)	Impervious Fraction	SubArea	Area (ha)	Impervious Fraction	SubArea	Area (ha)	Impervious Fraction
A	18.8	0.85	AE	1.5	0.862	BI	1.7	0.88
B	16.8	0.863	AF	0.6	0.709	BJ	1.6	0.9
C	16.4	0.776	AG	0.8	0.9	BK	3	0.9
D	1.1	0.825	AH	0.6	0.9	BL	3.3	0.262
E	0.4	0.899	AI	6.5	0.9	BM	2.4	0.9
F	1.2	0.843	AJ	7.9	0.669	BN	2.7	0.9
G	1	0.872	AK	0.5	0.9	BO	1.7	0.9
H	2.2	0.864	AL	1.6	0.51	BP	1.8	0.9
I	1.2	0.9	AM	1.3	0.87	BQ	2.2	0.9
J	0.7	0.9	AN	1.4	0.873	BR	1.2	0.897
K	1.3	0.9	AO	1.5	0.9	BS	2.6	0.849
L	1.2	0.9	AP	2	0.88			
M	1.7	0.876	AQ	1.5	0.879			
N	3	0.9	AR	0.6	0.9			
O	1	0.9	AS	0.3	0.9			
P	1	0.9	AT	3.5	0.888			
Q	5.8	0.803	AU	0.6	0.783			
R	0.9	0.9	AV	1.1	0.733			
S	0.8	0.9	AW	0.6	0.9			
T	2	0.769	AX	2.6	0.873			
U	3.6	0.831	AY	1.1	0.823			
V	5.1	0.793	AZ	1	0.861			
W	2.6	0.885	BA	0.8	0.853			
X	1.2	0.873	BB	0.8	0.852			
Y	1.7	0.889	BC	1.8	0.837			
Z	2.1	0.577	BD	4.9	0.833			
AA	3.9	0.497	BE	1.9	0.9			
AB	10.2	0.566	BF	3.8	0.831			
AC	1.1	0.83	BG	1.9	0.865			
AD	1.6	0.709	BH	1.9	0.9			

Table A-12 North Western Catchments – Adopted Subarea Impervious Fraction

SubArea	Area (ha)	Impervious Fraction	SubArea	Area (ha)	Impervious Fraction	SubArea	Area (ha)	Impervious Fraction
A	10.6	0.457	AF	4	0.887	BJ	0.8	0.53
B	2.8	0.805	AG	3.9	0.887	BK	1.4	0.511
C	3.5	0.9	AH	2.5	0.898	BL	8	0.882
D	2	0.9	AI	2.2	0.871	BM	5.6	0.9
E	5.1	0.9	AJ	3.4	0.876	BN	7.9	0.868
F	1.1	0.9	AK	2.6	0.897			
G	1.8	0.9	AL	2.5	0.842			
H	2.2	0.9	AM	9.2	0.858			
I	2.5	0.9	AN	3.5	0.899			
J	2.1	0.9	AO	5.7	0.9			
K	2.1	0.9	AP	3.8	0.896			
LM	3.3	0.9	AQ	2.4	0.881			
N	1.2	0.9	AR	7.5	0.889			
O	5.7	0.898	AS	6.2	0.886			
P	1.9	0.9	AT	3.1	0.828			
Q	1.9	0.894	AU	16.9	0.9			
R	3.2	0.8	AV	6.7	0.898			
S	1.8	0.883	AW	8.9	0.898			
T	1.1	0.884	AX	11	0.9			
U	1.3	0.887	AY	6.4	0.9			
V	2.5	0.893	AZ	7.6	0.9			
W	1	0.884	BA	1.4	0.9			
X	1.2	0.898	BB	4	0.857			
Y	0.7	0.9	BC	9.3	0.821			
Z	1.3	0.894	BD	6.7	0.884			
AA	1.6	0.9	BE	7.1	0.9			
AB	0.9	0.882	BF	3.7	0.9			
AC	0.6	0.877	BG	4.3	0.873			
AD	4.1	0.89	BH	2.1	0.5			
AE	0.8	0.887	BI	1.4	0.5			

Table A-13 Western Catchments – Adopted Subarea Impervious Fraction

SubArea	Area (ha)	Impervious Fraction
BO	2.2	0.9
BP	3.8	0.9
BQ	5.1	0.9
BR	4.1	0.9
BS	6	0.9
BT	2.7	0.9
BU	5.5	0.9
BV	5.6	0.9
BW	1.8	0.868
BX	2.5	0.9
BY	2.7	0.637
BZ	39.2	0.272

A.4 IFD Table

Table A-14 Rainfall IFD Table

Location: Fishermans Bend (144.925 E, 37.825 S)

	18.77	
12 HR DUR 2 ARI	3.62	mm/hr
72 HR DUR 2 ARI	1.08	mm/hr
1 HR DUR 50 ARI	39.07	mm/hr
12 HR DUR 50 ARI	7.08	mm/hr
72 HR DUR 50 ARI	2.20	mm/hr
G (skewness)	0.36	mm/hr
F2 Geo factor 2 ARI	4.29	
F50 Geo factor 50 ARI	14.94	

Duration		Design Rainfalls for Average Recurrence Intervals								
(min)	(hr)	1 (mm/hr)	2 (mm/hr)	5 (mm/hr)	10 (mm/hr)	20 (mm/hr)	50 (mm/hr)	100 (mm/hr)	200 (mm/hr)	500 (mm/hr)
5	0.083	46.7	62.5	86.7	103.4	125.5	157.7	184.6	214.2	257.7
6	0.100	43.7	58.5	80.9	96.4	116.9	146.7	171.6	199.0	239.2
7	0.117	41.2	55.0	76.0	90.5	109.7	137.5	160.8	186.3	223.8
8	0.133	39.0	52.1	71.9	85.5	103.6	129.7	151.6	175.5	210.7
9	0.150	37.2	49.6	68.3	81.2	98.3	123.0	143.6	166.3	199.5
10	0.167	35.5	47.4	65.2	77.4	93.6	117.1	136.7	158.2	189.6
11	0.183	34.1	45.4	62.4	74.0	89.5	111.9	130.5	151.0	180.9
12	0.200	32.7	43.6	59.9	71.0	85.9	107.3	125.1	144.6	173.1
13	0.217	31.6	42.0	57.7	68.3	82.5	103.1	120.1	138.8	166.2
14	0.233	30.5	40.6	55.6	65.9	79.5	99.3	115.6	133.6	159.8
15	0.250	29.5	39.3	53.7	63.6	76.8	95.8	111.5	128.8	154.1
16	0.267	28.6	38.1	52.0	61.6	74.3	92.6	107.8	124.4	148.8
17	0.283	27.8	36.9	50.4	59.7	72.0	89.7	104.3	120.4	143.9
18	0.300	27.0	35.9	49.0	57.9	69.8	86.9	101.1	116.7	139.4
19	0.317	26.3	34.9	47.6	56.3	67.8	84.4	98.2	113.3	135.2
20	0.333	25.6	34.0	46.3	54.8	66.0	82.1	95.4	110.0	131.4
25	0.417	22.8	30.2	41.1	48.4	58.2	72.3	84.0	96.8	115.3
30	0.500	20.6	27.4	37.1	43.7	52.4	65.0	75.4	86.8	103.3
35	0.583	18.9	25.1	33.9	39.9	47.9	59.3	68.7	79.0	93.9
40	0.667	17.6	23.3	31.4	36.8	44.2	54.6	63.2	72.6	86.3
45	0.750	16.4	21.7	29.2	34.3	41.1	50.8	58.7	67.4	80.0
50	0.833	15.4	20.4	27.4	32.2	38.5	47.5	54.9	63.0	74.7
55	0.917	14.6	19.3	25.9	30.3	36.2	44.7	51.6	59.2	70.2
60	1.000	13.9	18.3	24.5	28.7	34.3	42.3	48.8	55.9	66.2
75	1.250	12.0	15.9	21.2	24.8	29.6	36.4	42.0	48.1	56.9
90	1.500	10.7	14.1	18.8	22.0	26.2	32.2	37.1	42.5	50.2
120	2.000	8.9	11.7	15.5	18.1	21.5	26.4	30.4	34.8	41.0
180	3.000	6.8	8.9	11.8	13.7	16.3	19.9	22.9	26.2	30.8
240	4.000	5.6	7.4	9.7	11.3	13.4	16.3	18.7	21.4	25.1
300	5.000	4.8	6.3	8.3	9.7	11.5	14.0	16.0	18.3	21.4
360	6.000	4.3	5.6	7.4	8.5	10.1	12.3	14.1	16.1	18.8
420	7.000	3.9	5.1	6.6	7.7	9.1	11.1	12.7	14.4	16.9
480	8.000	3.5	4.6	6.1	7.0	8.3	10.1	11.5	13.1	15.4
540	9.000	3.3	4.3	5.6	6.5	7.6	9.3	10.6	12.1	14.1
600	10.000	3.1	4.0	5.2	6.0	7.1	8.6	9.9	11.2	13.1
660	11.000	2.9	3.7	4.9	5.6	6.7	8.1	9.2	10.5	12.3
720	12.000	2.7	3.5	4.6	5.3	6.3	7.6	8.7	9.9	11.6
780	13.000	2.6	3.4	4.4	5.1	6.0	7.3	8.3	9.4	11.0
840	14.000	2.5	3.2	4.2	4.8	5.7	6.9	7.9	9.0	10.5
900	15.000	2.3	3.1	4.0	4.6	5.5	6.6	7.6	8.6	10.1
960	16.000	2.3	2.9	3.9	4.5	5.3	6.4	7.3	8.3	9.7
1020	17.000	2.2	2.8	3.7	4.3	5.1	6.2	7.0	8.0	9.4
1080	18.000	2.1	2.7	3.6	4.1	4.9	5.9	6.8	7.7	9.1
1140	19.000	2.0	2.6	3.5	4.0	4.7	5.7	6.6	7.5	8.8
1200	20.000	2.0	2.6	3.4	3.9	4.6	5.6	6.4	7.2	8.5
1440	24.000	1.7	2.3	3.0	3.5	4.1	5.0	5.7	6.5	7.6
1800	30.000	1.5	2.0	2.6	3.0	3.5	4.3	5.0	5.6	6.6
2160	36.000	1.3	1.7	2.3	2.7	3.1	3.8	4.4	5.0	5.9
2880	48.000	1.1	1.4	1.9	2.2	2.6	3.2	3.6	4.2	4.9
3600	60.000	0.9	1.2	1.6	1.9	2.2	2.7	3.1	3.6	4.2
4320	72.000	0.8	1.1	1.4	1.6	1.9	2.4	2.7	3.1	3.7

Table A-15 Rainfall IFD Table - 18.5% Higher Intensities

Location: Fishermans Bend (144.925 E, 37.825 S)

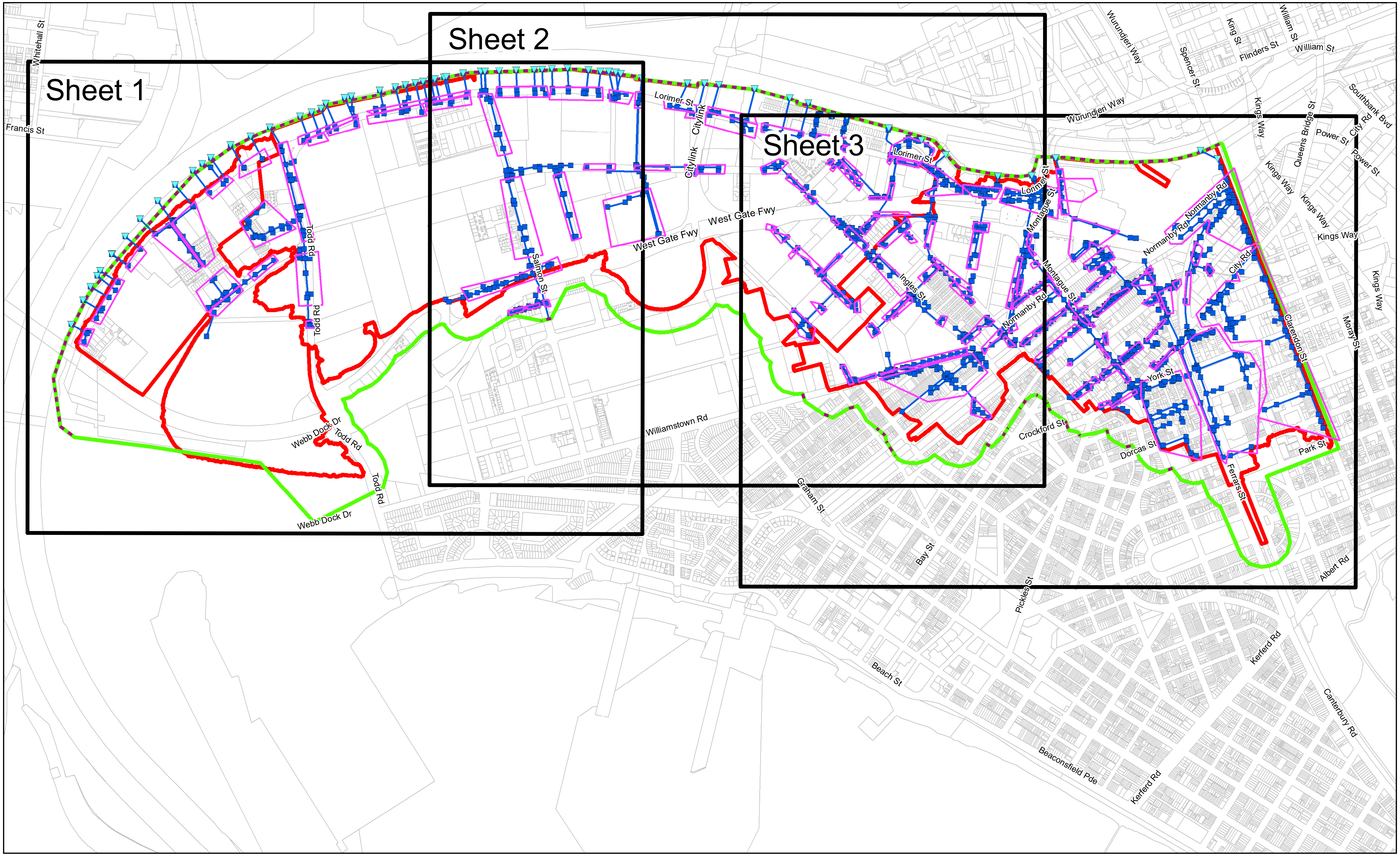
	22.24	
12 HR DUR 2 ARI	4.29	mm/hr
72 HR DUR 2 ARI	1.28	mm/hr
1 HR DUR 50 ARI	46.30	mm/hr
12 HR DUR 50 ARI	8.39	mm/hr
72 HR DUR 50 ARI	2.61	mm/hr
G (skewness)	0.36	mm/hr
F2 Geo factor 2 ARI	4.36	
F50 Geo factor 50 ARI	15.99	

Duration		18.5% Higher Design Rainfalls for Average Recurrence Intervals								
(min)	(hr)	1 (mm/hr)	2 (mm/hr)	5 (mm/hr)	10 (mm/hr)	20 (mm/hr)	50 (mm/hr)	100 (mm/hr)	200 (mm/hr)	500 (mm/hr)
5	0.083	55.4	74.1	102.7	122.5	148.7	186.9	218.7	253.8	305.4
6	0.100	51.8	69.3	95.8	114.2	138.5	173.9	203.4	235.8	283.5
7	0.117	48.8	65.2	90.1	107.2	130.0	163.0	190.5	220.8	265.2
8	0.133	46.3	61.8	85.2	101.3	122.7	153.8	179.6	208.0	249.7
9	0.150	44.0	58.8	81.0	96.2	116.5	145.8	170.2	197.0	236.4
10	0.167	42.1	56.1	77.2	91.7	111.0	138.8	162.0	187.4	224.7
11	0.183	40.4	53.8	73.9	87.7	106.1	132.6	154.7	178.9	214.4
12	0.200	38.8	51.7	71.0	84.2	101.7	127.1	148.2	171.3	205.2
13	0.217	37.4	49.8	68.3	81.0	97.8	122.1	142.3	164.5	196.9
14	0.233	36.1	48.1	65.9	78.1	94.3	117.6	137.0	158.3	189.4
15	0.250	35.0	46.5	63.7	75.4	91.0	113.5	132.2	152.6	182.6
16	0.267	33.9	45.1	61.7	73.0	88.0	109.7	127.7	147.5	176.3
17	0.283	32.9	43.8	59.8	70.7	85.3	106.2	123.6	142.7	170.5
18	0.300	32.0	42.5	58.0	68.6	82.7	103.0	119.9	138.3	165.2
19	0.317	31.1	41.4	56.4	66.7	80.4	100.0	116.3	134.2	160.3
20	0.333	30.3	40.3	54.9	64.9	78.2	97.2	113.1	130.4	155.7
25	0.417	27.0	35.8	48.7	57.4	69.0	85.7	99.6	114.7	136.7
30	0.500	24.5	32.4	43.9	51.7	62.1	77.1	89.4	102.8	122.4
35	0.583	22.5	29.7	40.2	47.3	56.7	70.2	81.4	93.6	111.3
40	0.667	20.8	27.6	37.2	43.7	52.3	64.7	74.9	86.1	102.3
45	0.750	19.5	25.7	34.7	40.7	48.7	60.1	69.6	79.9	94.8
50	0.833	18.3	24.2	32.5	38.1	45.6	56.3	65.1	74.6	88.5
55	0.917	17.3	22.9	30.7	35.9	42.9	53.0	61.2	70.2	83.2
60	1.000	16.4	21.7	29.1	34.0	40.6	50.1	57.8	66.3	78.5
75	1.250	14.3	18.8	25.1	29.4	35.1	43.1	49.8	57.0	67.4
90	1.500	12.7	16.7	22.3	26.0	31.0	38.1	44.0	50.3	59.5
120	2.000	10.5	13.8	18.4	21.4	25.5	31.3	36.1	41.2	48.6
180	3.000	8.0	10.6	14.0	16.3	19.3	23.6	27.2	31.0	36.5
240	4.000	6.6	8.7	11.5	13.3	15.8	19.3	22.2	25.3	29.8
300	5.000	5.7	7.5	9.9	11.5	13.6	16.6	19.0	21.6	25.4
360	6.000	5.1	6.6	8.7	10.1	12.0	14.6	16.7	19.0	22.3
420	7.000	4.6	6.0	7.9	9.1	10.8	13.1	15.0	17.1	20.0
480	8.000	4.2	5.5	7.2	8.3	9.8	11.9	13.7	15.5	18.2
540	9.000	3.9	5.1	6.6	7.7	9.1	11.0	12.6	14.3	16.8
600	10.000	3.6	4.7	6.2	7.1	8.4	10.2	11.7	13.3	15.6
660	11.000	3.4	4.4	5.8	6.7	7.9	9.6	11.0	12.4	14.6
720	12.000	3.2	4.2	5.5	6.3	7.4	9.0	10.3	11.7	13.7
780	13.000	3.0	4.0	5.2	6.0	7.1	8.6	9.8	11.1	13.0
840	14.000	2.9	3.8	5.0	5.7	6.8	8.2	9.4	10.7	12.5
900	15.000	2.8	3.6	4.8	5.5	6.5	7.9	9.0	10.2	12.0
960	16.000	2.7	3.5	4.6	5.3	6.2	7.6	8.7	9.8	11.5
1020	17.000	2.6	3.4	4.4	5.1	6.0	7.3	8.3	9.5	11.1
1080	18.000	2.5	3.2	4.2	4.9	5.8	7.0	8.1	9.2	10.7
1140	19.000	2.4	3.1	4.1	4.7	5.6	6.8	7.8	8.9	10.4
1200	20.000	2.3	3.0	4.0	4.6	5.4	6.6	7.6	8.6	10.1
1440	24.000	2.1	2.7	3.5	4.1	4.8	5.9	6.8	7.7	9.0
1800	30.000	1.8	2.3	3.1	3.5	4.2	5.1	5.9	6.7	7.8
2160	36.000	1.6	2.1	2.7	3.1	3.7	4.6	5.2	6.0	7.0
2880	48.000	1.3	1.7	2.2	2.6	3.1	3.8	4.3	4.9	5.8
3600	60.000	1.1	1.4	1.9	2.2	2.6	3.2	3.7	4.2	5.0
4320	72.000	0.9	1.2	1.7	1.9	2.3	2.8	3.2	3.7	4.4

Appendix B – Hydraulic Modelling

Contents

Figure B.1 - TUFLOW Model Layout –Key Map
Figure B.2 - TUFLOW Model Layout –Sheet 1 of 3
Figure B.3 - TUFLOW Model Layout –Sheet 2 of 3
Figure B.4 - TUFLOW Model Layout –Sheet 3 of 3
Table B.1- TUFLOW Model Layers



Paper Size A3

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Catchment Boundary
- 2D Domain (Code Boundary)
- Parcels
- Modelled Pipes
- Modelled Pits
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	01/10/2019

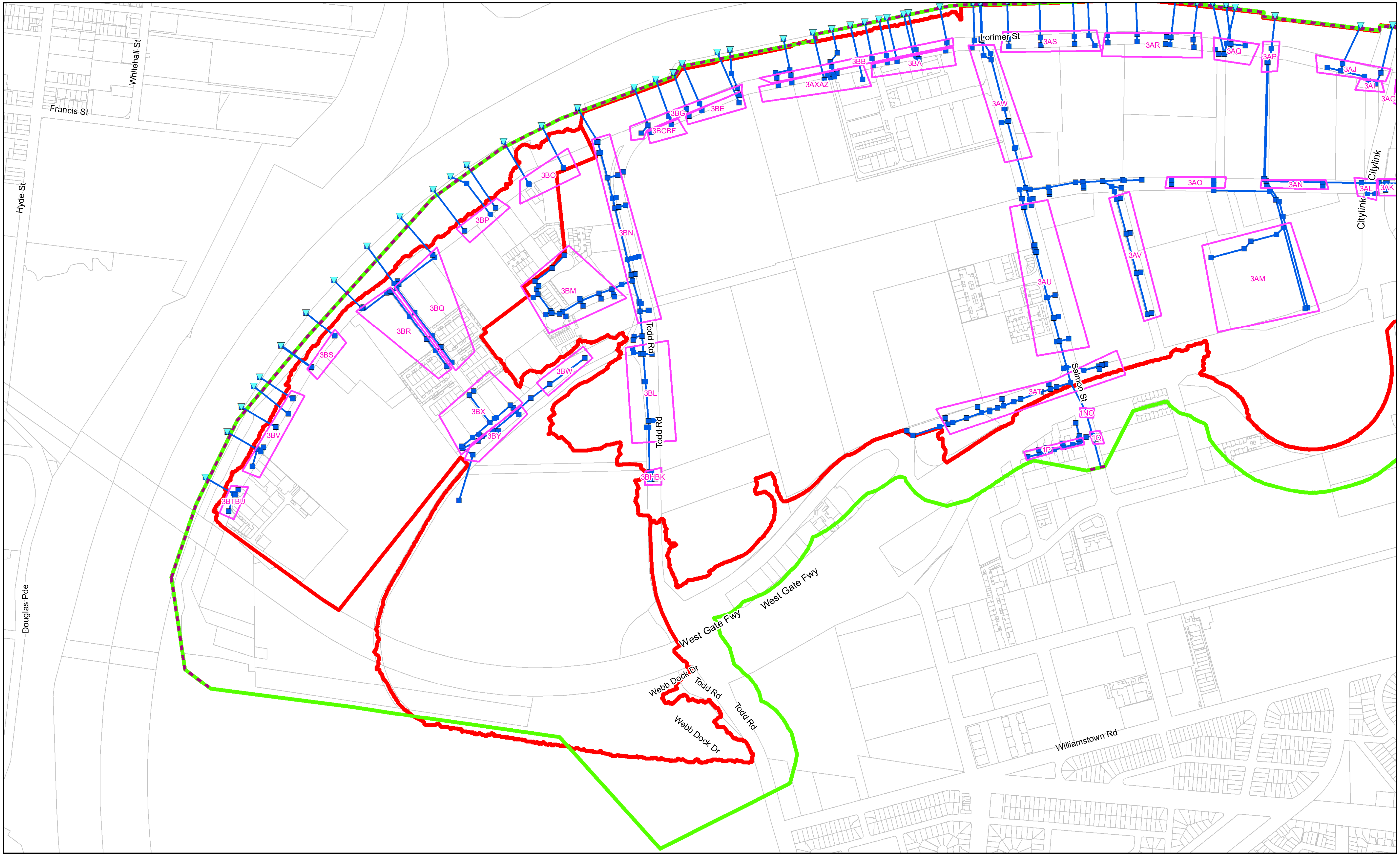
TUFLOW Model Layout
Key Map

Figure B.1

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan



Paper Size A3

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Catchment Boundary
- 2D Domain (Code Boundary)
- Parcels
- Modelled Pipes
- Modelled Pits
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions

GHD

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number 12511721
Revision A
Date 01/10/2019

TUFLOW Model Layout

Sheet 1 of 3

Figure B.2

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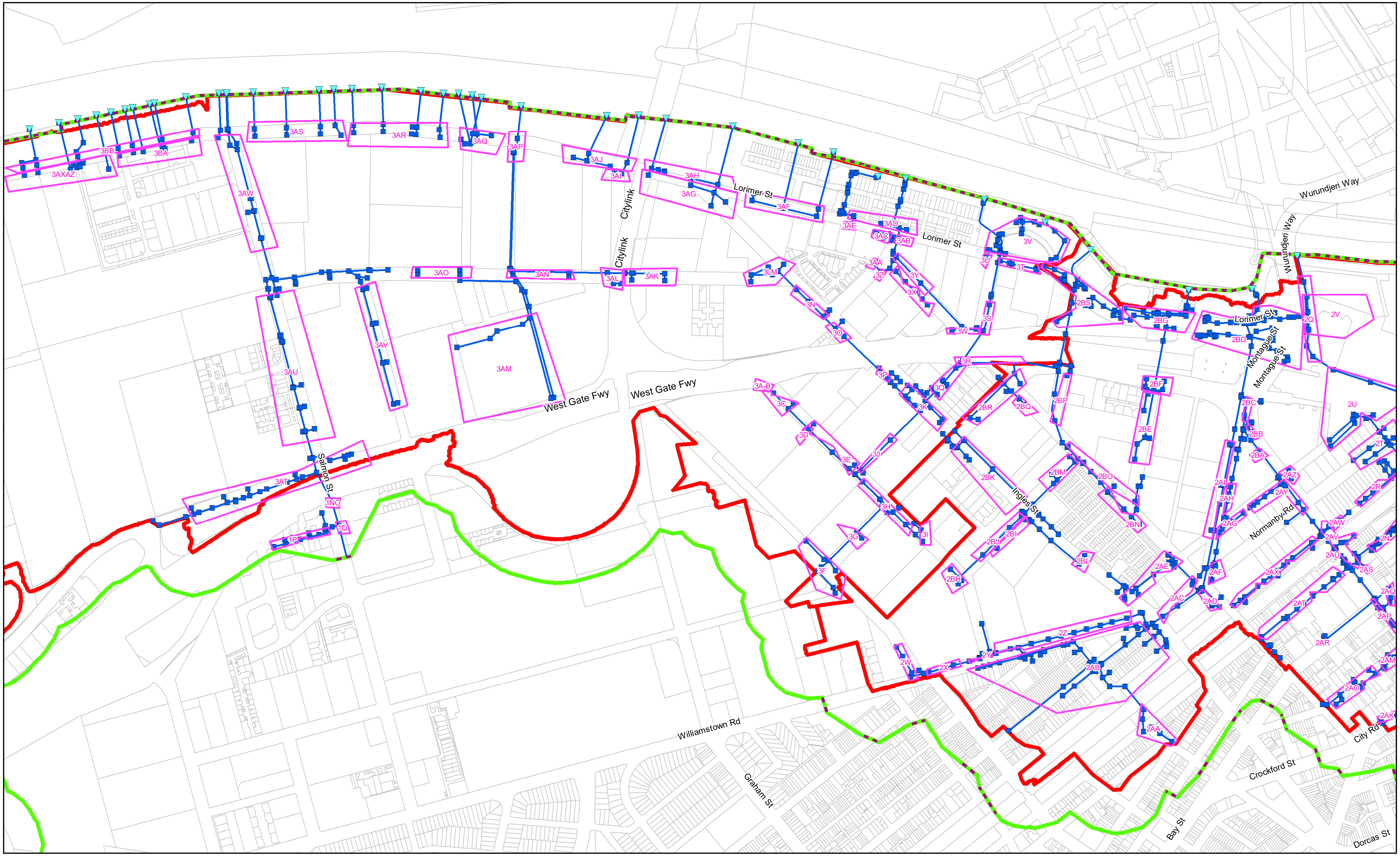
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan



Paper Size A3

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Catchment Boundary
- 2D Domain (Code Boundary)
- Parcels
- Modelled Pipes
- Modelled Pits
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

Job Number	12511721
Revision	A
Date	01/10/2019

TUFLOW Model Layout

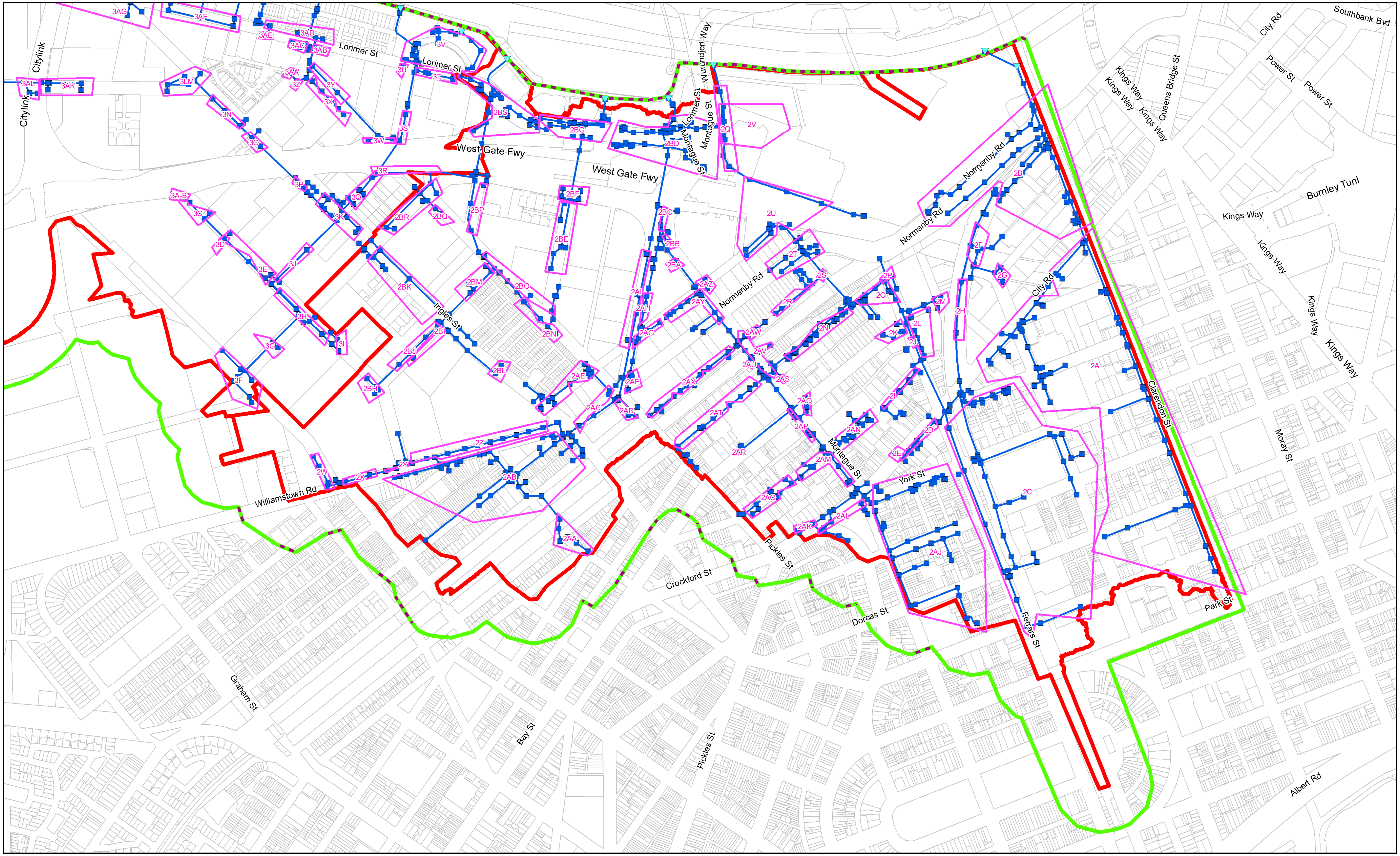
Sheet 2 of 3

Figure B.3

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan



Paper Size A3

0 37.5 75 150 225 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Catchment Boundary
- 2D Domain (Code Boundary)
- Parcels
- Modelled Pipes
- Modelled Pits
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions

MELBOURNE WATER
FISHERMANS BEND WATER SENSITIVE DRAINAGE & FLOOD STRATEGY

TUFLOW Model Layout

Sheet 3 of 3

Job Number	12511721
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Figure B.4

G:\31\36555\GIS\Maps\Working\3136555_Fishermans_Bend_Flood_Mapping_A3L.mxd

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

Data source: VicMap, 2017; Melbourne Water, LiDAR, Precinct Boundaries, 2018. Created by: bkryan

Table B-16 MapInfo Deliverables –TUFLOW Model Layers

Layer name	Description
TCF FILE	
2d_po_FB.TAB	Printout lines
2d_po_FB_Cut_Down.TAB	Printout lines
2d_iwl_FB_Lake.TAB	Initial water level polygons for Salt Water Lake and Fresh Water Lake.
ECF FILE	
1d_nwk_FB_ExClarendonFuturePumpNodes.TAB	Clarendon future pump nodes
1d_nwk_FB_ExPipes.TAB	City of Melbourne, City of Port Phillip and Melbourne Water Pipes
1d_nwk_FB_ExPits.TAB	City of Melbourne, City of Port Phillip and Melbourne Water Pits
1d_nwk_FB_FutureClarendonPumpNode.TAB	Clarendon future pump nodes
1d_bc_FB_inflows.TAB	Inflow polygons for hydrographs
1d_bc_FB_TWL.TAB	Downstream boundary conditions on the Yarra River pipe outlets
1d_bc_FB_TWL_ToBeRemoved.TAB	Downstream boundary conditions on the Yarra River pipe outlets
TGC FILE	
2d_loc_FB.TAB	Location line defining origin and angle of 2D domain
2d_code_FB_Cut_Down_r1.TAB	Code boundary
LiDAR 1m DEM.flt	Underlying terrain data
2d_zsh_FB_CecilSt.TAB	Smoothing DTM
2d_zsh_FB_DEM_Corrections.TAB	Underlying terrain raised
2d_zsh_FB_LightRail.TAB	Removing bridge decks from the LiDAR DTM
2d_zsh_FB_MCEC.TAB	Smoothing DTM
2d_zsh_FB_Plummer.TAB	Removing bridge decks from the LiDAR DTM
2d_zsh_FB_Plummer2.TAB	Removing bridge decks from the LiDAR DTM
2d_zsh_FB_ToddRd.TAB	Removing bridge decks from the LiDAR DTM
2d_zsh_FB_YarraSpotLevels.TAB	Survey levels along the Yarra River – draped over the DTM
2d_mat_FB_Existing.TAB	Underlying materials polygons
2d_mat_FB_ExistingNarrowLaneways.TAB	Underlying materials polygon for laneways
TBC FILE	
2d_bc_FB_Cross_Catchment.TAB	Downstream boundary conditions for ‘cross-catchment’ overland flow paths
2d_bc_FB_r1.TAB	Boundary conditions

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12511721-87947/https://projectsportal.ghd.com/sites/pp17_02/fishermansbendfloodm/ProjectDocs/12511721-RPT-Fishermans Bend Flood Mapping.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A						20.12.19
0	B. Ryan	R. Kanakaratne	*R. Kanakaratne*	P. Joyce		06.11.20

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