Melbourne Water

Fishermans Bend

Baseline drainage plan options

March 2017

Executive summary

Introduction

This report presents options for a baseline drainage plan for the Fishermans Bend Urban Renewal Area. The purpose of this drainage plan is to enable a Redevelopment Services Scheme to be prepared for the Fishermans Bend Urban Renewal Area.

Tidal flooding

Fishermans Bend is located within a relatively low lying area adjacent to the Yarra River, near to where it discharges into Port Phillip Bay, with ground levels generally varying from 1 m AHD to 4 m AHD.

Significant parts of the renewal area are therefore subject to inundation in tidal events, particularly towards the east within the Montague Precinct. This is further exacerbated by the effects of climate change through sea level rise.

The extent of Fishermans Bend subject to tidal flooding is illustrated by the plan in Appendix A1, which shows the areas above and below the 100-yr ARI tide level including the potential effects of climate change (2.4 m AHD). The depths of flooding that would potentially occur are further illustrated in Appendix A2. This shows that depths of flooding would generally be less than 400 mm, but within the low lying Montague Precinct, the depth of flooding would potentially exceed 1.5 m.

Level of service

This report presents baseline drainage plans for four levels of service. It is understood that at some point in the future a decision on an appropriate level of service will be made, and therefore which drainage plan is applicable. Hence, no recommendations have been made as to which baseline drainage plan should be adopted. The four levels of service investigated are defined in the table below.

Levels of service description

Level of service	Standard of flood protection for roads or private realm[See note 4]	Standard of flood protection within property boundaries [See note 5]	Safety risk criteria
Base level of service (5-yr ARI)	5-yr ARI (rainfall event only and no consideration of tidal event)[See note 1]	100-yr ARI (rainfall event only and no consideration of tidal event)[See note 2]	Up to the 100 yr ARI event, designated overland flow paths (inclusive of minor and/or major thoroughfares) should meet a low safety risk in roads category where practical. [See note 3]
Base level of service (20-yr ARI)	20-yr ARI (rainfall event only and no consideration of tidal event)[See note 1]	100-yr ARI (rainfall event only and no consideration of tidal event)[See note 2]	
High level of service (5-yr ARI)	5-yr ARI (rainfall and tidal events considered)[See note 2]	100-yr ARI (rainfall and tidal events considered)[See note 2]	
High level of service (20-yr ARI)	20-yr ARI (rainfall and tidal events considered)[See note 2]	100-yr ARI (rainfall and tidal events considered)[See note 2]	

Notes:

1) Highest Astronomical Tide (HAT) level used for all rainfall events.
2) See Table 1 for rainfall events and corresponding tide levels.
3) In accordance with the MW Flood Mapping Projects, Guidelines and Technical Specifications (MW, 2014) a low safety risk in roads is defined as having a velocity times depth <= 0.40 cumecs/m with a depth <= 0.40 m. Due to its flat nature, flood flow velocities through the renewal area are generally low and therefore depth is the critical component in the safety risk factor. The results presented in this report therefore focus on depth plots rather than velocity or velocity depth plots.
4) Flooding is defined as greater than 50 mm depth.
5) It is assumed that development within property boundaries will be raised up on podiums above the 100-yr ARI event flood level and therefore further mitigation will not be required to achieve this requirement.

Developed conditions flooding without mitigation

The existing drainage system generally would achieve the safety risk criteria in the 100-yr ARI event for the base level of service, with the exception of the area around Ferrars St within the Montague precinct. However, flood protection for roads and the private realm would not be achieved for either the 5-yr or 20-yr ARI standard.

The existing drainage system would not achieve the safety risk criteria in the 100-yr ARI event for the high level of service and further would not provide flood protection for roads and the private realm for either the 5-yr or 20-yr ARI standard.

Flood mitigation measures

The approach to flood mitigation for the baseline drainage plans presented in this report has followed that as outlined in the previous IWM work, where it was termed the 'conventional drainage approach'. A description of the mitigation measures considered is summarised in the following table for each of the identified levels of service.

Flood mitigation measures

Level of service (see Table 2 for description)	Flood mitigation measures
Base level of service (5-yr ARI)	Rainwater tanks, pipe capacity upgrades and raised roads for providing access and egress.
Base level of service (20-yr ARI)	
High level of service (5-yr ARI)	Rainwater tanks, levees, pipe capacity upgrades and pumping.
High level of service (20-yr ARI)	

Flood mitigation with rainwater tanks only

The rainwater tanks would generally help the drainage system to provide flood protection for the roads and private realm under the base level of service for the 5-yr ARI standard, with the exception of the area around Ferrars St. Rainwater tanks would generally not enable the 20-yr standard to be achieved. The rainwater tanks would not sufficiently improve flooding to enable the safety risk criteria in the 100-yr ARI event to be achieved in Ferrars St under the base level of service.

The rainwater tanks would not enable the drainage system to provide flood protection for roads and private realm under the high level of service for either the 5-yr or 20-yr ARI standard. They would also make little difference to the ability of the existing drainage system to achieve the safety risk criteria in the 100-yr ARI event under the high level of service.

Level of service performance summary

In summary, the Fishermans Bend urban renewal area as a whole will not achieve any of the drainage requirements without rainwater tanks combined with further drainage measures. However, if Ferrars St is considered in isolation, the renewal area could achieve some of the requirements without all the drainage measures. This is summarised below in the following table.

Level of service performance summary

Level of service[Note 1]	Existing drainage system (no mitigation)		Existing drainage system with rainwater tanks		Rainwater tanks combined with other measures	
	Flood protection for roads or private realm	Safety risk criteria	Flood protection for roads or private realm	Safety risk criteria	Flood protection for roads or private realm	Safety risk criteria
Base level of service (5-yr ARI)	No	Yes (except Ferrars St)	Yes (except Ferrars St)	Yes (except Ferrars St)	Yes	Yes
Base level of service (20-yr ARI)	No	Yes (except Ferrars St)	No	Yes (except Ferrars St)	Yes	Yes
High level of service (5-yr ARI)	No	No	No	No	Yes	Yes
High level of service (20-yr ARI)	No	Mo	No	Mo	Yes	Yes

Notes:

1) See Table 2 for a description of the levels of service.
2) See Table 3 for a description of the flood mitigation measures for each level of service.

Cost summary

A preliminary estimate of the drainage infrastructure costs for each level of service is presented in the table below.

Drainage infrastructure capital works preliminary cost estimate ($M)

Drainage infrastructure	Base level of service (5-yr ARI)	Base level of service (20-yr ARI)	High level of service (5-yr ARI)	High level of service (20-yr ARI)
Rainwater tanks	34.00	34.00	34.00	34.00
Pipe drainage upgrades	25.69	48.29	16.52	37.47
Pumping stations	0.00	0.00	12.53	12.53
Flood levees	0.00	0.00	3.08	3.08
Total	59.69	82.29	66.13	87.08

Notes:

1) Please refer to Section 8 for further details on the cost estimates and the assumptions made.
2) See Table 2 for a description of the levels of service.

Table of contents

Table index

Appendices

1. Introduction

1.1 Purpose of this report

This report presents options for a baseline drainage plan for the Fishermans Bend Urban Renewal Area.

It includes an assessment of existing flooding conditions, flooding conditions under a future developed scenario incorporating the potential effects of climate change, proposed flood mitigation measures for a range of different levels of service and cost estimates for the proposed mitigation measures.

This report does not include details on the approach to the flood modelling.

The purpose of this drainage plan is to enable a Redevelopment Services Scheme to be prepared for the Fishermans Bend Urban Renewal Area.

This project follows the previous Fishermans Bend Integrated Water Management Options Evaluation work completed by GHD in 2015. That project undertook some initial work on a potential drainage plan but did not include the Employment Precinct, which was not part of the renewal area at the commencement of that project. The Employment Precinct has now been included as part of the preparation of the baseline drainage plan presented in this report.

GHD was engaged by Melbourne Water to undertake this drainage plan in June 2016.

1.2 Scope and limitations

The overall objectives for this project are as follows:

- Define options for a baseline drainage plan.
- Provide cost estimates for the drainage infrastructure required for the baseline drainage plan.

2. Background

2.1 Site description

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.

2.2 The need for a Redevelopment Services Scheme

Melbourne Water needs to prepare a drainage plan as part of this redevelopment and has therefore proposed to setup and operate a Redevelopment Services Scheme (RSS) to efficiently provide the drainage infrastructure required to support the Fishermans Bend urban renewal.

This project is not following the traditional RSS approach, previously developed in 2004. The RSS term is only relevant as far as the investigation covers redevelopment. The need for the RSS effectively stems from the increased flood risk associated with the additional development and people that would be affected by the existing flooding rather than a change in flood levels associated with increased runoff from infill development (as per the original RSS work). At present there is an existing flood risk, which is accepted given the industrial land usage at Fishermans Bend. When this land use changes to residential/commercial there will be an expectation/need of a higher standard of flood protection and improved flood management to avoid the potential increase in flood risk. Therefore the redevelopment of Fishermans Bend will require an improvement to the existing drainage infrastructure, which is a cost to Melbourne Water that may be able to be passed on to the developers through an RSS and developer contributions.

2.3 Previous IWM work

Relevant previous work includes an evaluation of integrated water management (IWM) options (completed by GHD in September 2015) for the Fishermans Bend Urban Renewal Area encompassing the Montague, Lorimer, Sandridge and Wirraway precincts. This project should also include the Fishermans Bend Employment Precinct, which was added to the renewal area after the completion of the previous IWM work.

In the previous IWM work the baseline drainage plan was referred to as the 'conventional drainage approach'. The following comments are made regarding that approach:

- It included rainwater tanks.
- All areas were piped either to the Bay or Yarra River. In low lying areas that do not free drain (i.e. where the tail water conditions presented a significant impediment to drainage capacity), sump and pump infrastructure was used with non-return valves to eliminate back-watering.
- The conventional approach presented in the previous IWM work broadly met the 5-yr ARI requirements, but did not meet the 100-yr ARI requirements.
- Consideration of climate change was not included within the modelling of the conventional drainage approach, presented in the previous IWM work.
- The employment precinct was not included within the modelling.
- The model run-times were long (approximately 5-6 hours for each model hour).

3. Tidal flooding

Fishermans Bend is located within a relatively low lying area adjacent to the Yarra River, near to where it discharges into Port Phillip Bay, with ground levels generally varying from 1 mAHD to 4 mAHD.

Significant parts of the renewal area are therefore subject to inundation in tidal events, particularly towards the east within the Montague Precinct. This is further exacerbated by the effects of climate change through sea level rise.

The tide levels presented in Table 1 have been adopted for this investigation.

Table 1 Tide levels

Event (ARI)	Tide level with no climate change (mAHD)	Tide level with climate change in 2100 (mAHD)
Highest Astromical Tide (HAT)	0.52	Not considered
5	1.10	1.90
20	1.25	2.05
100	1.60	2.40

The extent of Fishermans Bend subject to tidal flooding is illustrated by the plan in Appendix A1, which shows the areas above and below the 100-yr ARI tide level including the potential effects of climate change (2.4 mAHD). The depths of flooding that would potentially occur are further illustrated in Appendix A2. This shows that depths of flooding would generally be less than 400 mm, but within the low lying Montague Precinct, the depth of flooding would potentially exceed 1.5 m.

4. Level of service

Due to the existing risk of flooding in the area, significant drainage infrastructure is likely to be required. It is unclear what level of service the baseline drainage plan should provide and it therefore may be necessary to adopt a lower level of service to manage the costs. This issue is complex and a decision on what would be appropriate is beyond the scope of this current project.

This report presents baseline drainage plans for four levels of service. It is understood that at some point in the future a decision on an appropriate level of service will be made, and therefore which drainage plan is applicable. Hence, no recommendations have been made as to which baseline drainage plan should be adopted. The four levels of service investigated are defined in Table 2.

Table 2 Levels of service description

Level of service	Standard of flood protection for roads or private realm[See note 4]	Standard of flood protection within property boundaries [See note 5]	Safety risk criteria
Base level of service (5-yr ARI)	5-yr ARI (rainfall event only and no consideration of tidal event)[See note 1]	100-yr ARI (rainfall event only and no consideration of tidal event)[See note 2]	Up to the 100 yr ARI event, designated overland flow paths (inclusive of minor and/or major thoroughfares) should meet a low safety risk in roads category where practical. [See note 3]
Base level of service (20-yr ARI)	20-yr ARI (rainfall event only and no consideration of tidal event)[See note 1]	100-yr ARI (rainfall event only and no consideration of tidal event)[See note 2]	
High level of service (5-yr ARI)	5-yr ARI (rainfall and tidal events considered)[See note 2]	100-yr ARI (rainfall and tidal events considered)[See note 2]	
High level of service (20-yr ARI)	20-yr ARI (rainfall and tidal events considered)[See note 2]	100-yr ARI (rainfall and tidal events considered)[See note 2]	

Notes:

1) Highest Astronomical Tide (HAT) level used for all rainfall events.
2) See Table 1 for flood events and corresponding tide levels.
3) In accordance with the MW Flood Mapping Projects, Guidelines and Technical Specifications (MW, 2014) a low safety risk in roads is defined as having a velocity times depth <= 0.40 cumecs/m with a depth <= 0.40 m. Due to its flat nature, flood flow velocities through the renewal area are generally low and therefore depth is the critical component in the safety risk factor. The results presented in this report therefore focus on depth plots rather than velocity or velocity depth plots.
4) Flooding is defined as greater than 50 mm depth.
5) It is assumed that development within property boundaries will be raised up on podiums above the 100-yr ARI event flood level and therefore further mitigation will not be required to achieve this requirement.

5. Developed conditions flooding without mitigation

5.1 Base level of service

The flood depth plots for developed conditions without mitigation covering the base level of service are presented in Appendix B1, B2 and B3 for the 100-yr ARI, 20-yr ARI and 5-yr ARI events respectively.

The existing drainage system generally achieves the safety risk criteria in the 100-yr ARI event for the base level of service, with the exception of the area around Ferrars St within the Montague precinct where flood depths would reach between 0.5m and 1m.

In many locations across each of the precincts flood protection for roads and the private realm is not achieved by the existing drainage system under the base level of service for either the 5-yr or 20-yr ARI standard. Flood depths would generally reach between 0.05m and 0.40m with the greatest depths of flooding occurring again in the area around Ferrars St where flood depths would reach between 0.5m and 1m.

5.2 High level of service

The flood depth plots for developed conditions without mitigation covering the high level of service are presented in Appendix B4, B5 and B6 for the 100-yr ARI, 20-yr ARI and 5-yr ARI events respectively.

Only within the relatively higher Wirraway Precinct would the existing drainage system generally achieve the safety risk criteria in the 100-yr ARI event for the high level of service. Elsewhere significant flooding would occur, with the worst appearing within the three lower lying precincts of Lorimer, Sandridge and Montague towards the east of the renewal area. In these locations flood depths would reach up to between 1.5m and 2m. In the Employment precinct, most of the flooding issues would occur along Lorimer St directly adjacent to the Yarra River.

Similar to the base level of service, in many locations across the precincts the existing drainage system does not achieve flood protection for the roads and the private realm under the high level of service for either the 5-yr or 20-yr ARI standard. The worst flooding would occur within the three lower lying precincts of Lorimer, Sandridge and Montague where flood depths would reach up to between 1.0m and 1.5m.

6. Flood mitigation measures

6.1 General approach

The approach to flood mitigation for the baseline drainage plans presented in this report has followed that as outlined in the previous IWM work, where it was termed the 'conventional drainage approach'. A description of the mitigation measures considered is summarised in Table 3 for each of the identified levels of service.

Further details on the flood mitigation measures is presented in Section 7, which presents the results of the flood mitigation approaches.

Table 3 Flood mitigation measures

Level of service (see Table 2 for description)	Flood mitigation measures
Base level of service (5-yr ARI)	Rainwater tanks and pipe capacity upgrades and raised roads for providing access and egress.
Base level of service (20-yr ARI)	
High level of service (5-yr ARI)	Rainwater tanks, levees, pipe capacity upgrades and pumping.
High level of service (20-yr ARI)	

6.2 Fishermans Bend Strategic Framework Plan requirements for rainwater tanks

The Fishermans Bend Strategic Framework Plan (SFP) requires rainwater tanks to be installed on each new building within urban growth area. There are two main requirements within the SFP, which could influence the size of the rainwater tanks:

- 7.1 To make efficient use of stormwater not overload existing drainage and create green urban environments which protect the environmental health of urban waterways and Port Phillip Bay.
- 7.2 To reduce the need to augment potable water supplies.

Based on guidance received from Victorian Planning Authority (VPA) in relation to the intent of the Strategic Framework Plan (SFP) requirements, it was understood during the previous IWM work that the rainwater tanks would need to capture the first 101 mm (equivalent to the total rainfall from a 5 year 72 hour storm event) from the building roof and any podium hardstand, and retain a minimum of 50% of this volume. It was assumed that given the tanks would be typically drawn down reasonably fast (i.e. within 24-48 hours) there was no requirement to separate the retention and detention elements of the rainwater tank.

For illustrative purposes and based on the work completed as part of the previous IWM project, the average size that a building scale rainwater tank would need to be was 278 kL, with 50% for reuse (139 kL) and 50% for slow release (139 kL). The average size of 278 kL was based on:

- * An average building roof area of 1903 sqm.
- * An average contributing podium area of 853 sqm (representing 70% of the podium, based on the land use assumptions derived by GHD in collaboration with VPA).

In practice, the size of the rainwater tanks will vary from site to site.

These tanks would be designed to primarily detain flood peaks with an orifice (leaky tank) half way up the tank. These tanks would perform two functions as follows:

- Provide rainwater to the building scale third pipe network (primary supply) – bottom 50% of tank (139 kL on average).
- Have the ability to slowly release water to the Yarra River and Port Phillip Bay (after the flood peak has receded) – top 50% of the tank (139 kL on average).

Since completing the IWM work, it has been agreed between Melbourne Water and the Fishermans Bend task force that the rainwater tanks as part of the baseline drainage plan would not need to capture the first 101 mm (equivalent to the total rainfall from a 5 year 72 hour storm event) from the building roof and any podium hardstand. Instead, the rainwater tanks should only be sized to have a capacity of 0.5m^3 per 10m^2 from the building roof and any podium hardstand. This change will effectively half the size of the rainwater tanks compared with that calculated as part of the previous IWM work.

6.3 Rainwater tank performance

6.3.1 Critical duration

The critical durations for flooding under the base level of service (HAT level) are presented in Appendix C1, C2 and C3 for the 100-yr, 20-yr and 5-yr ARI events respectively.

Generally for each of the events presented, the longest critical duration for flooding within the renewal area was 9 hours and this occurred in the Montague precinct. Elsewhere, throughout the other precincts, the critical duration was lower, generally reaching up to 4.5 hours.

The critical durations for flooding under the high level of service are presented in Appendix C4 for the 100-yr ARI event. Generally, the longest critical duration for the high level of service was 3 hours.

6.3.2 Runoff volumes and effect on flood extents

Based on the typical areas presented in Section 7.2, the roof and podium runoff volumes across each of the durations for the 5-yr, 20-yr and 100-yr ARI events are presented in Appendix C5.

This shows that a rainwater tank size of 139KL (based on a tank volume of 0.5m^3 per 10m^2 of roof or podium area) would be sufficient to capture the total runoff in the 5-yr ARI event (9 hour duration) with no allowance for climate change. For a 4.5 hour storm duration, a rainwater tank size of 139KL would be sufficient to capture the total runoff in the 5-yr ARI event with allowance for climate change and almost sufficient in the 20-yr ARI with no allowance for climate change (153KL required).

The reduction in flood levels that is achieved with rainwater tanks only (139KL) in the 5-yr ARI event and a HAT tide level (0.52mAHD) is presented in Appendix C6. This shows that for that scenario the rainwater tanks would generally remove the existing flooding that is predicted to occur throughout many parts of the urban renewal area with significant reductions elsewhere.

7. Flood mitigation results

7.1 Rainwater tanks only

7.1.1 Base level of service

The flood depth plots for developed conditions with mitigation provided by rainwater tanks only covering the base level of service are presented in Appendix D1, D2 and D3 for the 100-yr ARI, 20-yr ARI and 5-yr ARI events respectively.

The rainwater tanks generally help the drainage system to provide flood protection for the roads and private realm under the base level of service for the 5-yr ARI standard (whereas without rainwater tanks it generally does not). The main exception to this is the area around Ferrars St within the Montague precinct where flood depths would still reach between 0.05m and 0.4m.

In the 20-yr ARI event, the rainwater tanks provide an improvement but the existing drainage system still would not provide flood protection in many locations across each of the precincts with flood depths generally reaching between 0.05m and 0.40m.

The existing drainage system without rainwater tanks generally achieved the safety risk criteria in the 100-yr ARI event under the base level of service, with the exception of the area around Ferrars St (see Section 5.1). Rainwater tanks would reduce the flooding in this area, but flood depths would still reach between 0.5m and 1m.

7.1.2 High level of service

The flood depth plots for developed conditions with mitigation provided by rainwater tanks only covering the high level of service are presented in Appendix D4, D5 and D6 for the 100-yr ARI, 20-yr ARI and 5-yr ARI events respectively.

The rainwater tanks help the drainage system to provide flood protection for roads and private realm under the high level of service generally in the higher parts of the renewal area, which cover the Wirraway Precinct and parts of the Employment Precinct. In the lower areas covering the Montague, Sandridge and Lorimer Precincts and generally along Lorimer St through the Employment Precinct, significant flooding would still occur.

The rainwater tanks would make little difference to the ability of the existing drainage system to achieve the safety risk criteria in the 100-yr ARI event under the high level of service (see Section 5.2).

7.2 Rainwater tanks with further drainage works

7.2.1 Base level of service

The drainage infrastructure required to achieve the base level of service is summarised in Table 4 and their locations are presented on the flood depth plots presented in Appendix E.

Table 4 Required drainage infrastructure works for the base level of service

Level of service (see Table 2 for description)	Drainage infrastructure
Base level of service (5-yr ARI)	Pipe upgrades as follows: • Boundary St • Ferrars St • Kerr St • Montague St
Base level of service (20-yr ARI)	Pipe upgrades as follows: • Boundary St • Ferrars St • Kerr St • Montague St • Salmon St

The flood depth plots for developed conditions under a base level of service with mitigation provided by rainwater tanks and further drainage works are presented in Appendix E1 to E4. Appendix E1 and E2 show the 100-yr ARI event with the pipe upgrade works associated with achieving the 20-yr and 5-yr ARI flood protection for the roads and private realm respectively. With either of these upgrade works, the safety risk criteria would then be achieved in the 100-yr ARI event. Appendix E3 and E4 show the depth plots for the 20-yr ARI and 5-yr ARI events respectively.

7.2.2 High level of service

The drainage infrastructure required to achieve the higher level of service is summarised in Table 5 and their locations are presented on the flood depth plots presented in Appendix E5 to E8.

Table 5 Required drainage infrastructure works for the high level of service

Level of service (see Table 2 for description)	Drainage infrastructure	
High level of service (5-yr ARI)	Levees	
High level of service (20-yr ARI)	Flap gates at all stormwater pipe discharge points Pipe upgrades as follows:	
	• Boundary St • Kerr St • Little Ingles St • White St	• Ferrars St • Montague St • Salmon St
	Pumping stations located as follows:	
	• Lorimer St (1 - 8) • Salmon St • Turner St • Montague St	• South Wharf Dr • White St • Kerr St • Ferrars St

E5 and E6 show the 100-yr ARI event with the pipe upgrade works associated with achieving the 20-yr and 5-yr ARI flood protection for the roads and private realm respectively. With either of these upgrade works, the safety risk criteria would then be achieved in the 100-yr ARI event. Appendix E7 and E8 show the depth plots for the 20-yr ARI and 5-yr ARI events respectively.

Flood levees

Flood levees would be required around the perimeter of the renewal area to provide protection from tidal flooding. The alignment of the flood levees is presented on the flood depth plots in Appendix E5 to E8.

It has been assumed for the preparation of this baseline drainage plan that flood levees will only extend around the Fishermans Bend growth area, following the boundary of the renewal area, and will not extend around any other areas outside of the growth area.

The specific alignment of the flood levee and its form would be subject to many considerations. For example, the flood levee could be incorporated within the design of new buildings and/or new roads, which could potentially be raised to provide the barrier. With regards to providing protection from tidal flooding, it is possible that the alignment of the flood levee could be changed to accommodate other potential considerations.

A summary of the main details for the flood levee are presented below in Table 6.

Table 6 Main flood levee details

Total length	5928m
Crest level	Varies. It is not less than 2.4mAHD (100-yr ARI tide level with the effects of climate change in 2100) but may be higher in some locations subject to the additional effect of flows generated from rainfall runoff.
Freeboard	0m (as discussed and agreed with the Fishermans Bend Task Force)
Height	Varies with ground level. See Appendix E5 for the 100-yr ARI flood depth plot. The depth of flooding presented along the alignment of the flood levee is equal to the required height of the levee.

The required height of the flood levee varies around the perimeter of the renewal area and around some parts, where ground levels are relatively higher, a flood levee is not required at all. Broadly, the flood levee would be required along northern boundary, adjacent to the Yarra River, of the Employment, Lorimer and Montague Precincts. It would then extend along parts of the southern boundary of the Sandridge and Montague Precincts. No flood levee would be required around the perimeter of the Wirraway Precinct, due to its relatively higher ground level.

A longitudinal profile of the flood levee height is presented in Appendix E9. Generally the height of the flood levee varies from where it ties into existing ground up to a maximum height of approximately 1.5m where it passes through the Lorimer, Sandridge and Montague Precincts. The general height of the flood levee would be between 0.5 and 1.0m.

For the purpose of this drainage plan and until further details are known about the form of the levee, it was agreed with the Fishermans bend Task Force that no freeboard should be included with the height of the levee.

Pumps

Pumping stations have been combined with the flood levees to enable rainfall runoff within the renewal area to be discharged out of the renewal area when tide levels are high and don't allow this to occur under gravity. Flap gates would be required at the outlets of all stormwater pipe outlets to prevent tidal waters from flooding the renewal area when tide levels are sufficiently high.

The pumping station locations have been identified based on hydraulic considerations only. No consideration was given to the exact location of the pumping station and the practicality of that location. Therefore, the location of the pumping stations was identified where modelled flooding was observed to occur within the renewal area and where the main existing stormwater pipe drains were located that serviced those areas. The location of all pumping stations was constrained to be on land within the renewal area.

A total of eight pumping stations were identified and their locations are shown on the flood depth plots in Appendix E5 to E8. The modelling showed that the pumping stations would only be required along the northern boundary of the renewal area, discharging into the Yarra River.

The pumping stations were represented in the modelling simply as discharge points where water was allowed to freely leave the model at the pumping station locations to prevent flooding from occurring. The peak flow rates at each pumping station from that modelling are presented in Table 7. This approach has not considered any optimisation of the pumping rate through potential additional storage to reduce the peak pumping rate.

Table 7 Modelled peak pumping rates in the 100 yr ARI event

Pumping location	Modelled peak pumping rate in the 100-yr ARI event (m^3/s)
Lorimer St 1	3.39
SWhDr_2	2.15
Lorimer St 2	2.12
Lorimer St 4	1.22
Montague St	6.40
White St	1.08
Ferrars St	2.23
Lorimer St 3	0.84
Salmon St	4.33
Turner St	2.93
Kerr St	1.45
Lorimer St 8	0.26
Lorimer St 6	0.39
Lorimer St 5	1.39
Lorimer St 7	1.31

8. Drainage works costs

8.1 Cost summary

A preliminary estimate of the drainage infrastructure costs for each level of service is presented in Table 8.

GHD has prepared these preliminary cost estimates using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of determining developer contributions as part of the RSS and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works/ can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Table 8 Drainage infrastructure capital works preliminary cost estimate ($M)

Drainage infrastructure	Base level of service (5-yr ARI)	Base level of service (20-yr ARI)	High level of service (5-yr ARI)	High level of service (20-yr ARI)
Rainwater tanks	34.00	34.00	34.00	34.00
Pipe drainage upgrades	25.69	48.29	16.52	37.47
Pumping stations	0.00	0.00	12.53	12.53
Flood levees	0.00	0.00	3.08	3.08
Total	59.69	82.29	66.13	87.08

Notes:

1) See Table 2 for a description of the levels of service.

8.2 Rainwater tanks

The cost estimate for the rainwater tanks was provided by the Fishermans Bend Taskforce and was based on a tank size of 140KL.

8.3 Pipe drainage

The pipe drainage costs were calculated using Melbourne Water's drainage scheme costing spreadsheet (2013).

A breakdown of the costs estimates for the pipe drainage is presented in Appendices F5 to F8 for each of the levels of service. In these calculations a cost factor of 3 was applied to the standard pipe rates, which reflects the additional costs of constructing drainage pipelines along major roads within busy central areas of Melbourne.

It can be observed from Table 8 that the pipe drainage upgrade costs for the high level of service are lower than for the base level of service. This has occurred due to the inclusion of pumping stations with the high level of service, which help provide additional capacity in the system and reduce the need for pipe drainage upgrades.

8.4 Pumping stations

Appropriate cost rates for pumping stations are not available within Melbourne Water's drainage scheme costing spreadsheet. Estimates for the pumping station costs were therefore based on available documented rates and relevant tender prices that GHD is aware of as follows:

- NSW Reference Rates Manual, NSW Office of Water, June 2014.
- Tender price for the stormwater pumping station at Flemington Racecourse.

There is significant uncertainty with these pump station cost estimates as they will depend on a number of factors that have not been determined at this stage including:

- Pump station configuration and amount of civil works needed.
- Actual site location and the cost of the land.
- Access to the site for construction.

The preliminary pumping station cost estimates include a contingency of 30%.

A breakdown of the costs estimates for the pumping stations is presented in Appendix F9.

The cost estimates make no allowance for the following:

- Land take costs.
- Operation and maintenance costs.

8.5 Flood levees

As with the pumping stations, there is significant uncertainty with the flood levee cost estimates as they will depend on a number of factors (as discussed in Section 7.2.2) that have not been determined at this stage including:

- Actual alignment and the cost of the land.
- The form of the levee and whether it will be incorporated within new future development through walls on new buildings or raised road levels.
- Access to the site for construction.

Following discussion with Melbourne Water, the preliminary cost estimate was therefore based on a nominal rate of $\$1000/m^3$, assuming that the levee would be 1m wide.

The cost estimate makes no allowance for the following:

- Land take costs.
- Potential savings/extra costs from the incorporation of the flood levee within new future development.

8.6 Cost distribution

The drainage infrastructure capital works preliminary cost estimates, distributed between developer and the different drainage authorities are presented below in Table 9 to 12 for the different levels of service. These works are also presented in Appendix F1 to F4, which show their locations split between the different drainage authorities.

The following assumptions were made for the cost distribution:

- The cost of the levee and pumping stations would be the responsibility of the Council whose municipality they would be located in.
- The cost of the pipe drainage upgrades downstream from catchments generally greater than 60ha would be the responsibility of Melbourne Water. The cost of all other pipe drainage upgrades would be the responsibility of the Council whose municipality they would be located in.
- The cost of rainwater tanks will be the responsibility of developers.

Table 9 Base level of service (5-yr ARI) drainage infrastructure capital works preliminary cost estimate distributed by drainage authority ($M)

Drainage infrastructure	Port Phillip City Council	Melbourne City Council	Melbourne Water	Developer	TOTAL
Rainwater tanks	0.00	0.00	0.00	34.00	34.00
Pipe drainage upgrades	15.10	9.63	0.96	0.00	25.69
Pumps	0.00	0.00	0.00	0.00	0.00
Levees	0.00	0.00	0.00	0.00	0.00
Total	**15.10**	**9.63**	**0.96**	**34.00**	**59.69**

Table 10 Base level of service (20-yr ARI) drainage infrastructure capital works preliminary cost estimate distributed by drainage authority ($M)

Drainage infrastructure	Port Phillip City Council	Melbourne City Council	Melbourne Water	Developer	TOTAL
Rainwater tanks	0.00	0.00	0.00	34.00	34.00
Pipe drainage upgrades	23.50	21.51	3.28	0.00	48.29
Pumps	0.00	0.00	0.00	0.00	0.00
Levees	0.00	0.00	0.00	0.00	0.00
Total	**23.50**	**21.51**	**3.28**	**34.00**	**82.29**

Table 11 High level of service (5-yr ARI) drainage infrastructure capital works preliminary cost estimate distributed by drainage authority ($M)

Drainage infrastructure	Port Phillip City Council	Melbourne City Council	Melbourne Water	Developer	TOTAL
Rainwater tanks	0.00	0.00	0.00	34.00	34.00
Pipe drainage upgrades	11.62	4.90	0.00	0.00	16.52
Pumps	3.11	9.42	0.00	0.00	12.53
Levees	0.48	2.60	0.00	0.00	3.08
Total	**15.21**	**16.92**	**0.00**	**34.00**	**66.13**

Table 12 High level of service (20-yr ARI) drainage infrastructure capital works preliminary cost estimate distributed by drainage authority ($M)

Drainage infrastructure	Port Phillip City Council	Melbourne City Council	Melbourne Water	Developer	TOTAL
Rainwater tanks	0.00	0.00	0.00	34.00	34.00
Pipe drainage upgrades	25.83	9.07	2.57	0.00	37.47
Pumps	3.11	9.42	0.00	0.00	12.53
Levees	0.48	2.60	0.00	0.00	3.08
Total	**29.42**	**21.09**	**2.57**	**34.00**	**87.08**

9. Conclusions

Based on the work presented in this report, the following conclusions have been drawn:

Tidal flooding

- Significant parts of the renewal area are vulnerable to inundation in tidal events, particularly towards the east within the Montague Precinct. This problem is further exacerbated by the effects of climate change through sea level rise.

Developed conditions flooding without mitigation

- The existing drainage system generally would achieve the safety risk criteria in the 100-yr ARI event for the base level of service, with the exception of the area around Ferrars St within the Montague precinct. However, flood protection for roads and the private realm would not be achieved for either the 5-yr or 20-yr ARI standard.
- The existing drainage system would not achieve the safety risk criteria in the 100-yr ARI event for the high level of service and further would not provide flood protection for roads and the private realm for either the 5-yr or 20-yr ARI standard.

Flood mitigation with rainwater tanks only

- The rainwater tanks would generally help the drainage system to provide flood protection for the roads and private realm under the base level of service for the 5-yr ARI standard, with the exception of the area around Ferrars St. Rainwater tanks would generally not enable the 20-yr standard to be achieved. The rainwater tanks would not sufficiently improve flooding to enable the safety risk criteria in the 100-yr ARI event to be achieved in Ferrars St under the base level of service.
- The rainwater tanks would not enable the drainage system to provide flood protection for roads and private realm under the high level of service for either the 5-yr or 20-yr ARI standard. They would also make little difference to the ability of the existing drainage system to achieve the safety risk criteria in the 100-yr ARI event under the high level of service.

Flood mitigation with rainwater tanks and further drainage works

- Rainwater tanks combined with pipe upgrade works to improve the drainage of Boundary St, Ferrars St, Kew St and Montague St would be required for the drainage system to provide flood protection for the roads and private realms under the base level of service for the 5-yr ARI standard. Further pipe upgrade works on Salmon St would be required to achieve 20-yr ARI standard.
- Rainwater tanks combined with pipe upgrade works, levees and pumps would be required for the drainage system to provide flood protection for the roads and private realms under the high level of service for the 5-yr and 20-yr ARI standards. The pipe upgrades would be required to improve the drainage of Boundary St, Ferrars St, Kew St, Montague St, little Ingles St, Salmon St and White St. Pump stations would be required at Lorimer St (x8), South Wharf Drive, Salmon St, White St, Turner St, Kerr St, Montague St and Ferrars St.

- With the above upgrade works, the safety risk criteria would be achieved in the 100-yr ARI event for either the base or high level of service.
- The preliminary capital cost estimate for base level of service (5-yr ARI) would be $59.69M. This cost would increase to $82.29M for the base case if a 20-yr ARI standard of flood protection for the roads and private realm was adopted.
- The preliminary capital cost estimate for high level of service (5-yr ARI) would be $66.13M. This cost would increase to $87.08M for the high level of service if a 20-yr ARI standard of flood protection for the roads and private realm was adopted.

In summary, the Fishermans Bend urban renewal area as a whole will not achieve any of the drainage requirements without rainwater tanks combined with further drainage measures. However, if Ferrars St was considered in isolation, the renewal area could achieve some of the requirements without all the drainage measures. This is summarised below in Table 13.

Table 13 Level of service performance summary

Level of service	Existing drainage system (no mitigation)		Existing drainage system with rainwater tanks		Rainwater tanks combined with other measures	
	Flood protection for roads or private realm	Safety risk criteria	Flood protection for roads or private realm	Safety risk criteria	Flood protection for roads or private realm	Safety risk criteria
Base level of service (5-yr ARI)	No	Yes (except Ferrars St)	Yes (except Ferrars St)	Yes (except Ferrars St)	Yes	Yes
Base level of service (20-yr ARI)	No	Yes (except Ferrars St)	No	Yes (except Ferrars St)	Yes	Yes
High level of service (5-yr ARI)	No	No	No	No	Yes	Yes
High level of service (20-yr ARI)	No	Mo	No	Mo	Yes	Yes

Notes:

1) See Table 2 for a description of the levels of service.
2) See Table 3 for a description of the flood mitigation measures for each level of service.

10. Recommendations

Based on the work presented in this report, the following recommendations are made:

1. A decision needs to be made on what level of service should be adopted for the drainage plan (see Table 2). This should involve:

   i) City of Melbourne and the City of Port Phillip to confirm their requirements for the standard of flood protection for roads and private realm.

   ii) Melbourne Water (possibly others) to confirm whether a base level of service (no consideration of tidal events) or high level of service (with consideration of tidal events) should be adopted.

2. Safe access and egress will need to be considered further, in particularly for the base level of service. This should be considered as part of a broader floodplain management plan.

3. A decision needs to be made and further work undertaken on when drainage works should occur and how they should be staged. This could have potentially a significant effect on the total cost of the drainage works as some costs would likely be deferred. The staging of drainage works will be subject to a number of factors, in particular the level of service required (see recommendation 1), the timing and location of development, the timing of when the renewal area should achieve the required level of service (at present the existing drainage does not entirely achieve any of the defined levels of service) and the gradually increasing effects of climate change.

4. A decision needs to be made on how costs should be presented for the drainage works, which make appropriate allowance for the uncertainty on site specific details, land costs and how the works should be integrated with future development. For example, the flood levees could potentially be integrated with the roads, which could be raised to the required flood level, or formed by walls as part of future development (see Section 8 for further discussion). It may take some time to resolve these particular matters and therefore an appropriate costs allowance will need to be made for the cost estimates now.

5. A decision needs to be made on whether it is acceptable to construct a flood levee just around the perimeter of the Fishermans Bend urban renewal area, as has been assumed within this report. This would provide flood protection from tidal flooding for just the Fishermans Bend urban renewal area, while leaving existing adjacent flood prone areas unprotected. Politically this may be a problem and further, a regional approach may be a better overall solution.

6. Further work should be undertaken to update the costs of the drainage works to include an estimate of the operational and maintenance costs. This would provide a more complete picture, in particular the total cost of the pumping stations.

7. There is a potential opportunity to better optimize the drainage plan through the joint consideration of capital and operational costs and whether the occasional use of pumps is a more cost effective outcome than the upgrade of existing drainage pipes. More regular use of pumping stations may also lead to a potentially more reliable solution.

GHD

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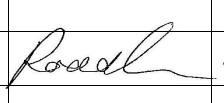
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	P Joyce	R Mickelson		R Mickelson		18/11/2016
Final	P Joyce	R Mickelson		R Mickelson		17/2/2017

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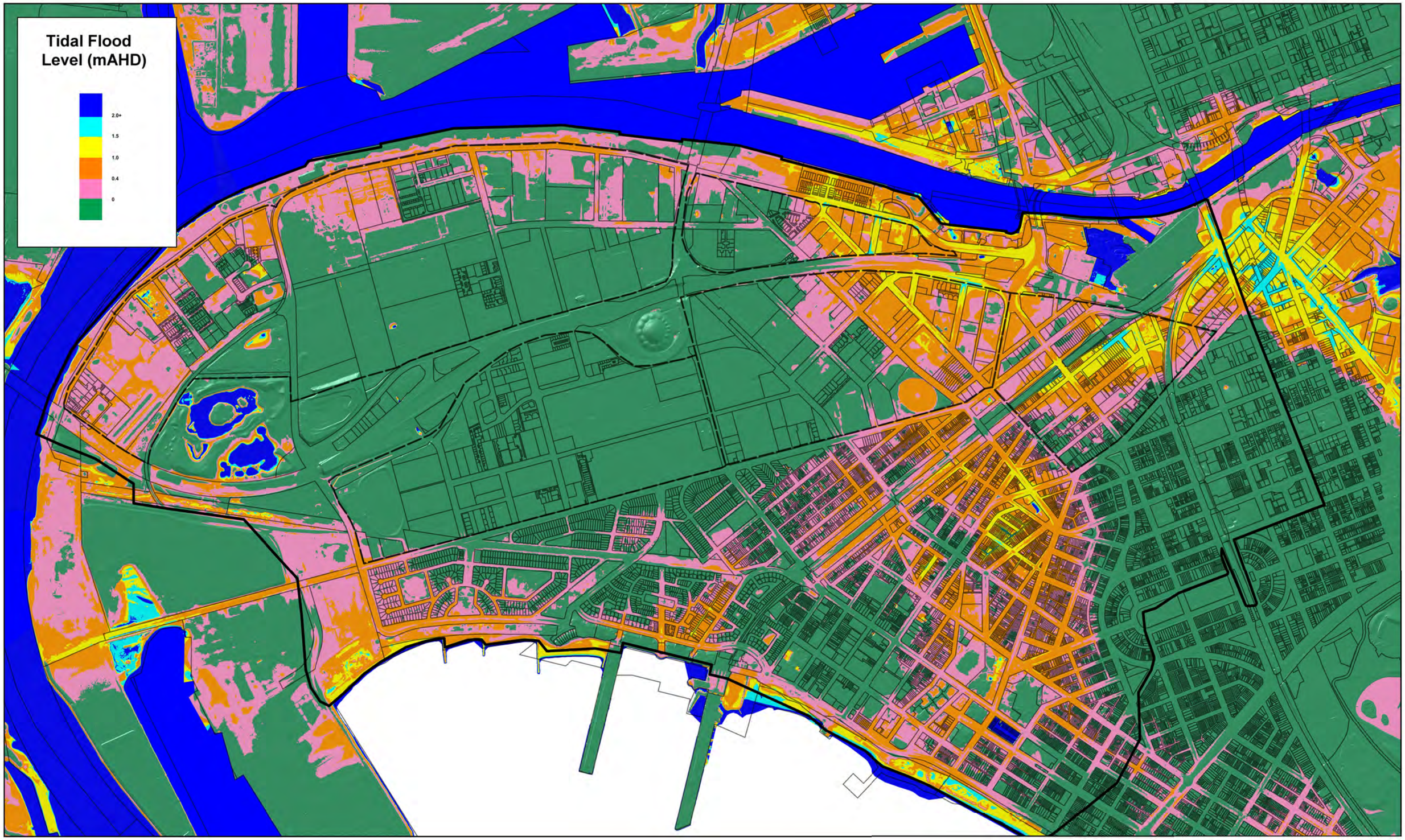
Appendices

Appendix A – Tidal flooding



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

Depths of flooding with the 100-yr ARI tide level including climate change (2.4mAHD)

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure A2

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - GROUND LEVELS A2.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

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Ground Level (mAHD)

39.4

2.4

-6.4

1:15,000 (at A3)

N

LEGEND

Precinct Boundaries

Hydraulic Model Boundary

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

MELBOURNE WATER
FISHERMAN'S BEND RSS

Land above and below 2.4mAHD (100-yr ARI tide level including climate change)

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure A1

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - GROUND LEVELS A1.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

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Appendix B – Developed conditions without mitigation

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 - 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

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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
20 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure B2

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

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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
5 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure B3

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

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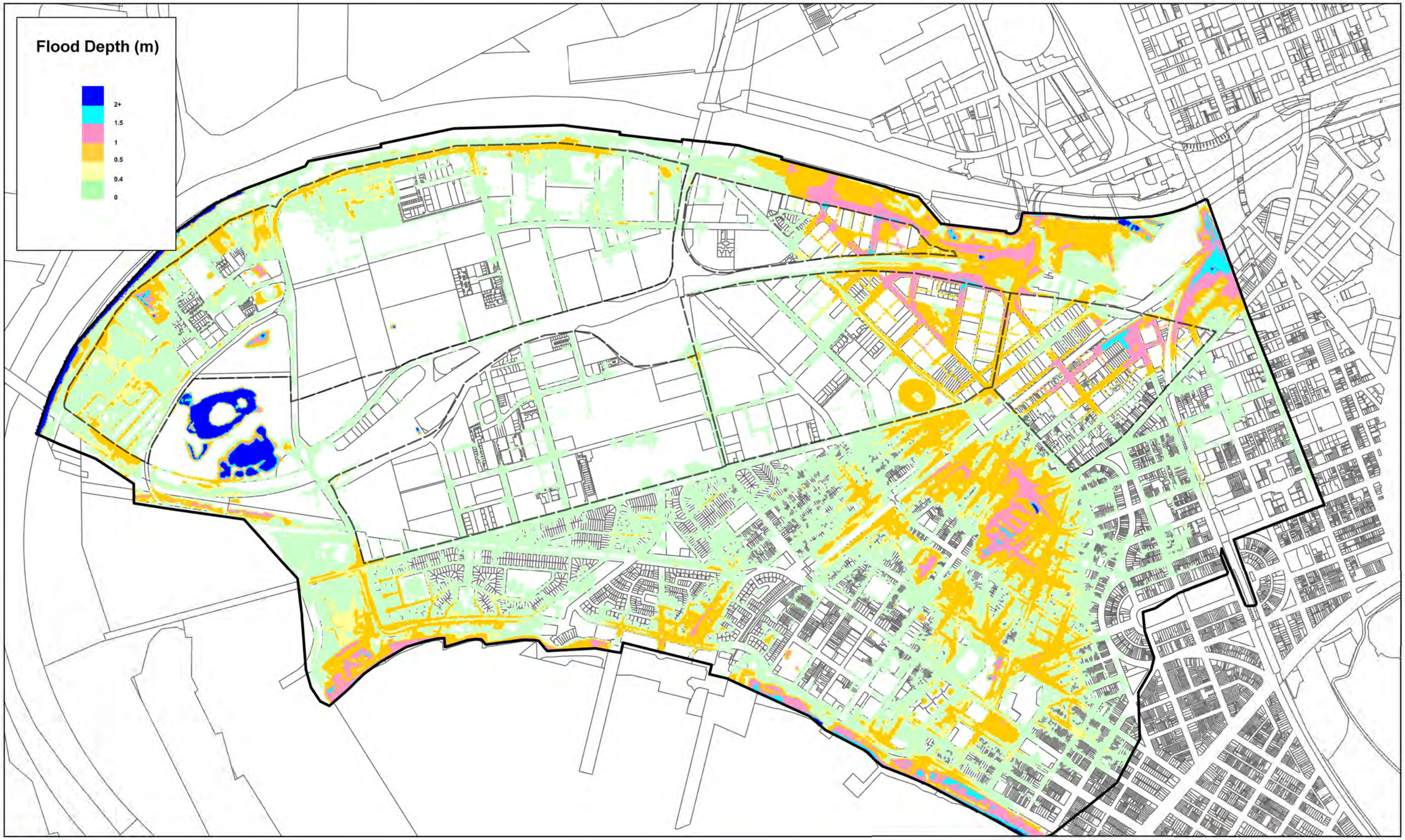

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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N

LEGEND

Precinct Boundaries

Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Developed conditions without mitigation
100 year ARI Rainfall - 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: hihartenthaler

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Flood Depth (m)

2+
1.5
1
0.5
0.4
0.05
0

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
20 year ARI Rainfall - 2.05 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure B5

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

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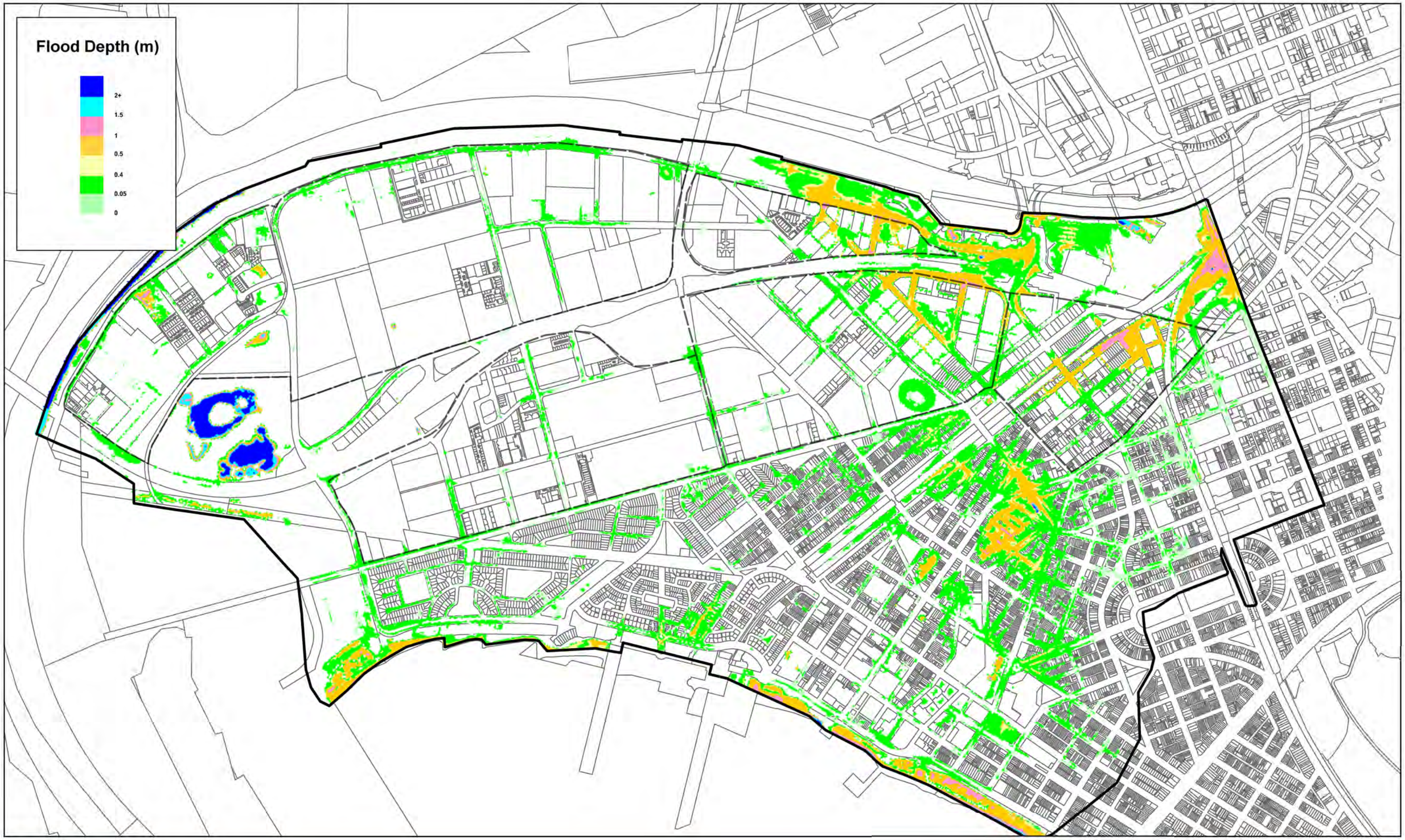

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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

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LEGEND

Precinct Boundaries

Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Developed conditions without mitigation
5 year ARI Rainfall - 1.9 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure B6

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

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Appendix C – Rainwater tanks

Critical Duration

- 72 hr
- 48 hr
- 36 hr
- 30 hr
- 24 hr
- 18 hr
- 12 hr
- 9 hr
- 6 hr
- 4.5hr
- 3 hr
- 2 hr
- 1 hr
- 45 min
- 30 min
- 25 min
- 20 min
- 15 min
- 10 min

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

Critical duration - Flood mitigation - Rainwater tanks only
100 year ARI Rainfall - 0.52 mAHD Tailwater

Figure C1

Job Number	31-34157
Revision	0
Date	21 02 2017

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - CRIT DUR.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

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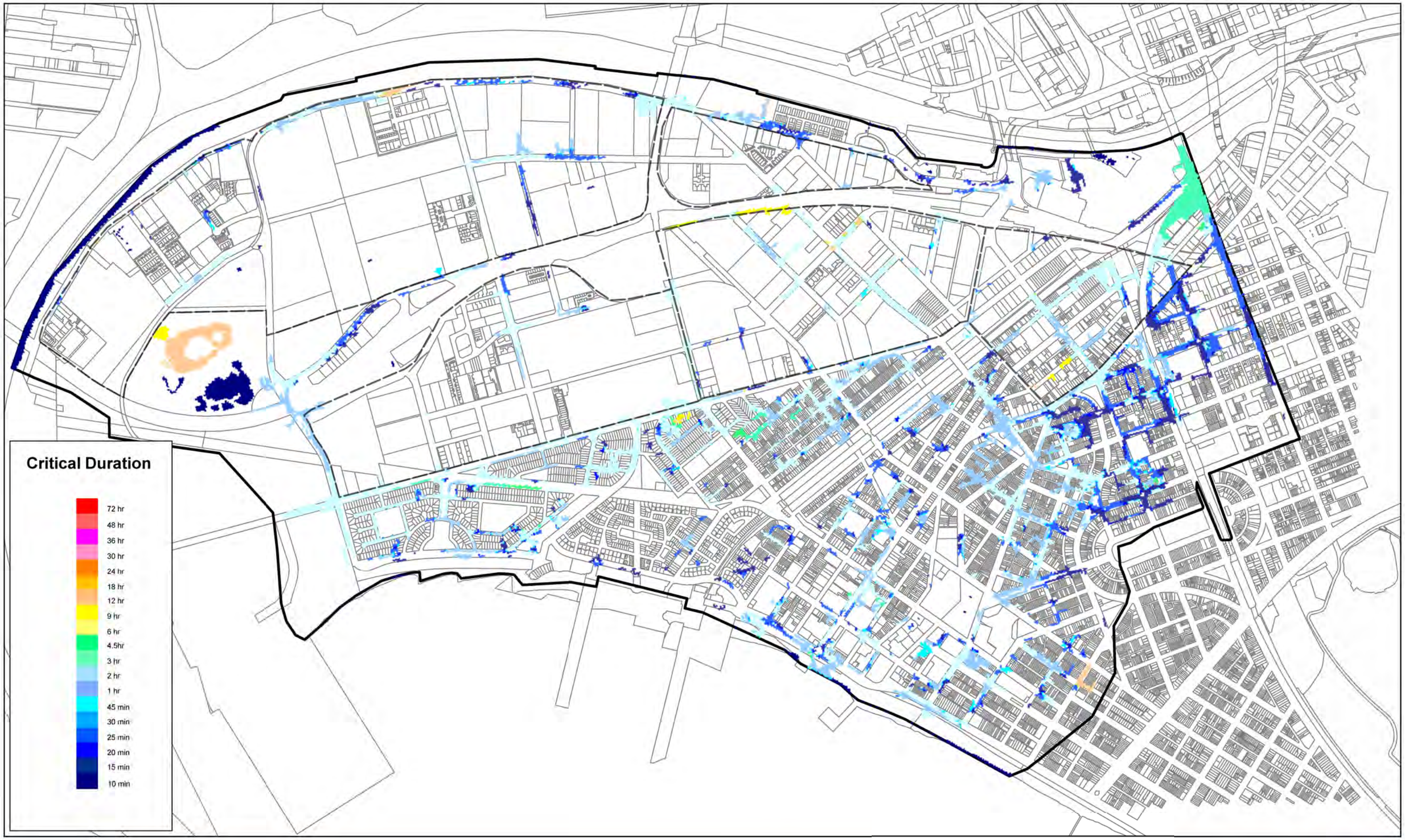

1:15,000 (at A3)

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

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Critical duration - Flood mitigation - Rainwater tanks only
20 year ARI Rainfall - 0.52 mAHD Tailwater

Figure C2

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - CRIT DUR.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

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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

Critical duration - Flood mitigation - Rainwater tanks only
5 year ARI Rainfall - 0.52 mAHD Tailwater

Figure C3

Job Number	31-34157
Revision	0
Date	21 02 2017

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - CRIT DUR.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

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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

Flood Levee

MELBOURNE WATER
FISHERMAN'S BEND RSS

Critical duration - Flood mitigation - High LOS (20yr ARI)
100 year ARI Rainfall - 2.4 mAHD Tailwater

Figure C4

Job Number	31-34157
Revision	0
Date	21 02 2017

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - CRIT DUR.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

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Appendix C5: Roof and podium runoff volumes

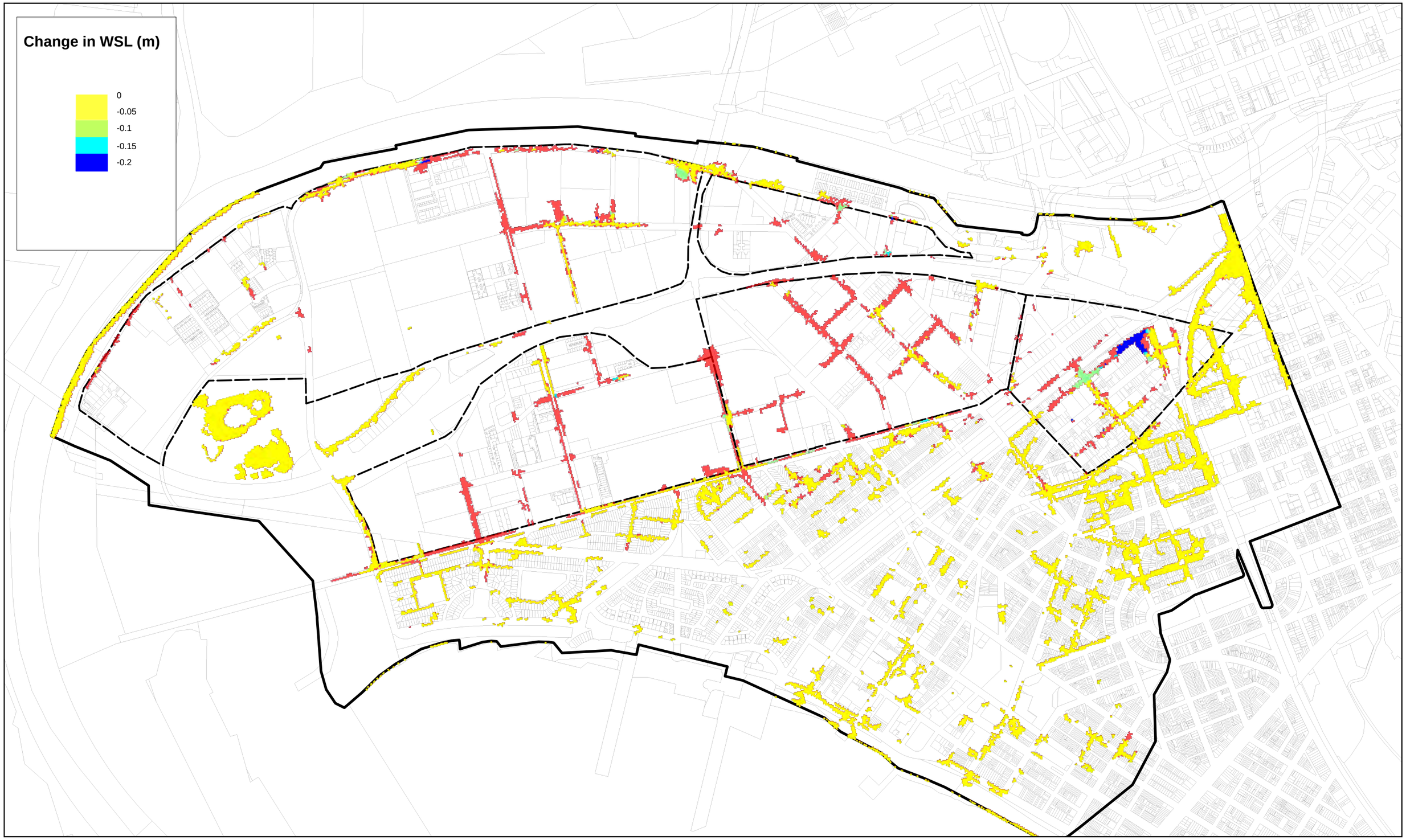
5 year							
Duration	Hours	IFD			IFD with Climate Change		
		Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]	Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]
10m	0.167	65.18	10.86	30	75.28	12.55	35
15m	0.250	53.74	13.44	37	62.07	15.52	43
20m	0.333	46.35	15.45	43	53.53	17.84	49
25m	0.417	41.07	17.11	47	47.44	19.77	54
30m	0.50	37.08	18.54	51	42.83	21.41	59
45m	0.75	29.24	21.93	60	33.78	25.33	70
1h	1.0	24.53	24.53	68	28.34	28.34	78
1_5h	1.5	18.81	28.22	78	21.73	32.59	90
2h	2.0	15.52	31.04	86	17.93	35.86	99
3h	3.0	11.80	35.40	98	13.63	40.89	113
4_5h	4.5	8.96	40.32	111	10.35	46.57	128
6h	6.0	7.37	44.23	122	8.51	51.09	141
9h	9.0	5.60	50.44	139	6.47	58.26	161
12h	12.0	4.62	55.38	153	5.33	63.97	176
18h	18.0	3.58	64.46	178	4.14	74.46	205
24h	24.0	2.98	71.63	197	3.45	82.73	228
30h	30.0	2.58	77.52	214	2.98	89.53	247
36h	36.0	2.29	82.48	227	2.65	95.27	263
48h	48.0	1.88	90.37	249	2.17	104.37	288
72h	72.0	1.40	100.76	278	1.62	116.38	321

20 year							
Duration	Hours	IFD			IFD with Climate Change		
		Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]	Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]
10m	0.167	93.64	15.61	43	108.16	18.03	50
15m	0.250	76.79	19.20	53	88.70	22.17	61
20m	0.333	65.95	21.98	61	76.17	25.39	70
25m	0.417	58.25	24.27	67	67.28	28.03	77
30m	0.50	52.44	26.22	72	60.56	30.28	83
45m	0.75	41.08	30.81	85	47.44	35.58	98
1h	1.0	34.29	34.29	95	39.61	39.61	109
1_5h	1.5	26.18	39.27	108	30.24	45.35	125
2h	2.0	21.53	43.06	119	24.87	49.73	137
3h	3.0	16.29	48.88	135	18.82	56.46	156
4_5h	4.5	12.32	55.42	153	14.22	64.01	176
6h	6.0	10.10	60.60	167	11.66	69.99	193
9h	9.0	7.64	68.78	190	8.83	79.44	219
12h	12.0	6.27	75.28	207	7.25	86.95	240
18h	18.0	4.89	87.96	242	5.64	101.60	280
24h	24.0	4.08	98.01	270	4.72	113.20	312
30h	30.0	3.54	106.31	293	4.09	122.78	338
36h	36.0	3.15	113.32	312	3.64	130.88	361
48h	48.0	2.59	124.53	343	3.00	143.83	396
72h	72.0	1.94	139.48	384	2.24	161.10	444

100 year							
Duration	Hours	IFD			IFD with Climate Change		
		Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]	Intensity (mm/h)	Depth (mm)	Required Tank Size (KL)[1]
10m	0.167	136.69	22.78	63	157.88	26.31	73
15m	0.250	111.54	27.89	77	128.83	32.21	89
20m	0.333	95.42	31.81	88	110.22	36.74	101
25m	0.417	84.02	35.01	96	97.04	40.43	111
30m	0.50	75.43	37.72	104	87.13	43.56	120
45m	0.75	58.73	44.05	121	67.83	50.87	140
1h	1.0	48.81	48.81	135	56.37	56.37	155
1_5h	1.5	37.11	55.66	153	42.86	64.29	177
2h	2	30.43	60.86	168	35.14	70.29	194
3h	3	22.93	68.79	190	26.49	79.46	219
4_5h	4.5	17.26	77.66	214	19.93	89.70	247
6h	6	14.11	84.66	233	16.30	97.79	269
9h	9	10.63	95.70	264	12.28	110.53	305
12h	12.0	8.70	104.42	288	10.05	120.61	332
18h	18.0	6.80	122.45	337	7.86	141.43	390
24h	24.0	5.70	136.79	377	6.58	157.99	435
30h	30.0	4.96	148.67	410	5.72	171.72	473
36h	36.0	4.41	158.75	438	5.09	183.35	505
48h	48.0	3.64	174.93	482	4.21	202.04	557
72h	72.0	2.73	196.76	542	3.16	227.26	626

Notes

1) This represents the tank size required to capture all the runoff for that duration from typical roof and podium (70%) area.



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

Areas where rainwater tanks have removed flooding

MELBOURNE WATER
FISHERMAN'S BEND RSS

Afflux (Rainwater Tanks Case - No Tanks Case)
5 year ARI - 0.52 mAHD Tailwater

Job Number	31-34157
Revision	A
Date	30 01 2017

Figure C6

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - Afflux - TANKS.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: hlhartenthaler

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Appendix D – Flood mitigation results – Rainwater tanks only

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

Flood mitigation - Rainwater tanks only
100 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure D1

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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: hlhartenthaler

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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

Flood mitigation - Rainwater tanks only
20 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure D2

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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

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Flood Depth (m)

2+
1.5
1
0.5
0.4
0.05
0

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

Flood mitigation - Rainwater tanks only
5 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure D3

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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

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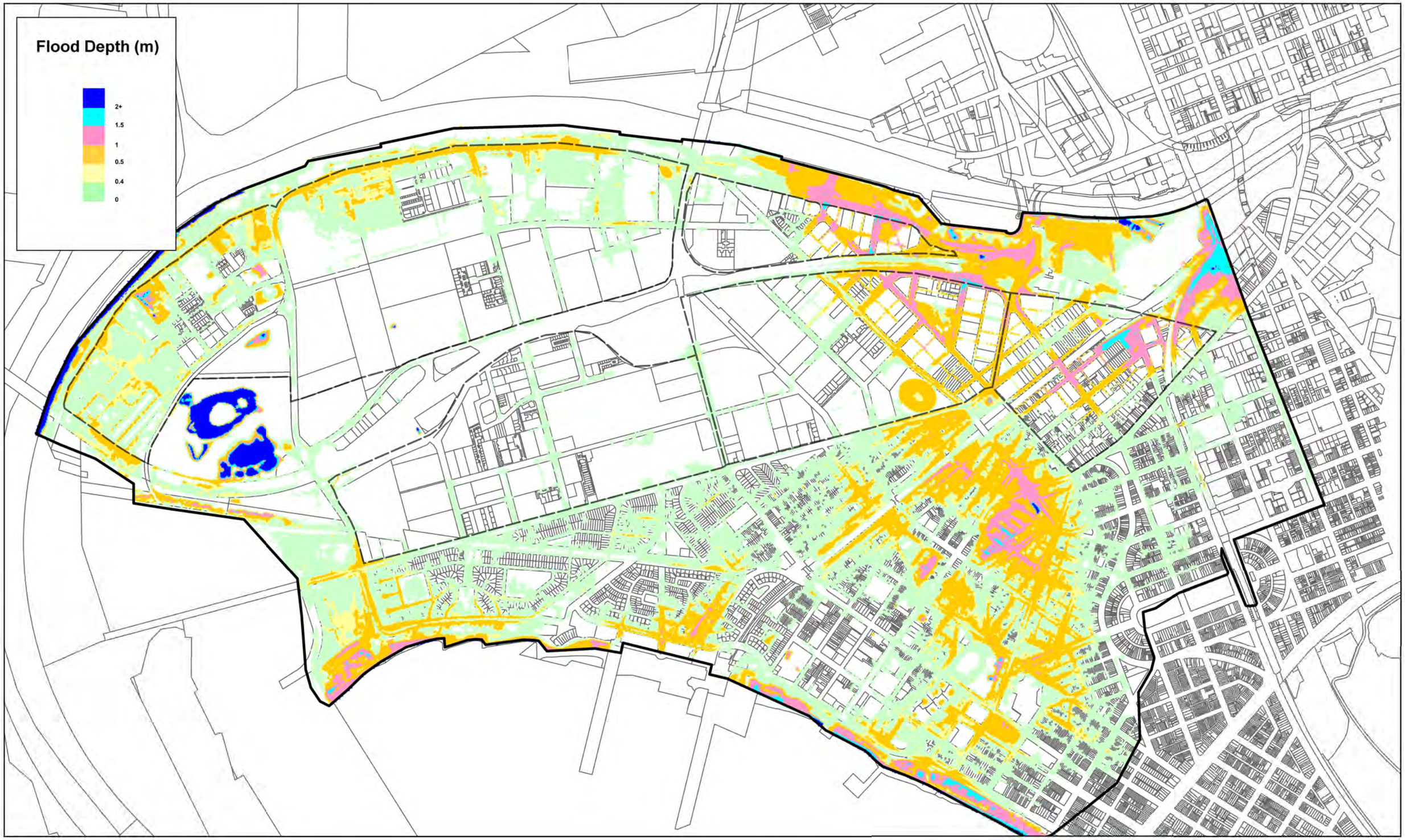

1:15,000 (at A3)

N

LEGEND

Precinct Boundaries

Hydraulic Model Boundary

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

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Rainwater tanks only
100 year ARI Rainfall - 2.4 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure D4

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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

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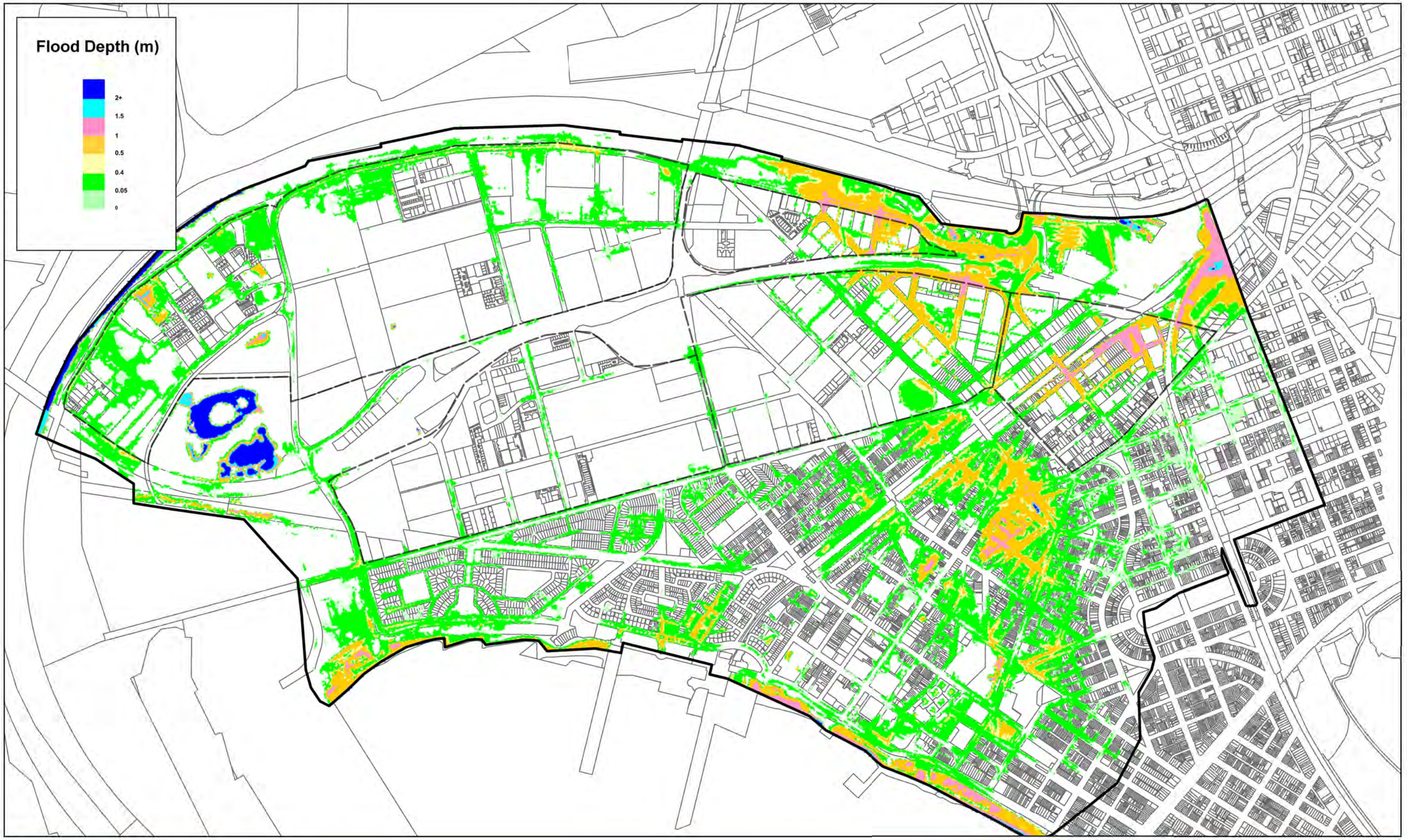

1:15,000 (at A3)

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

Flood mitigation - Rainwater tanks only
20 year ARI Rainfall - 2.05 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure D5

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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

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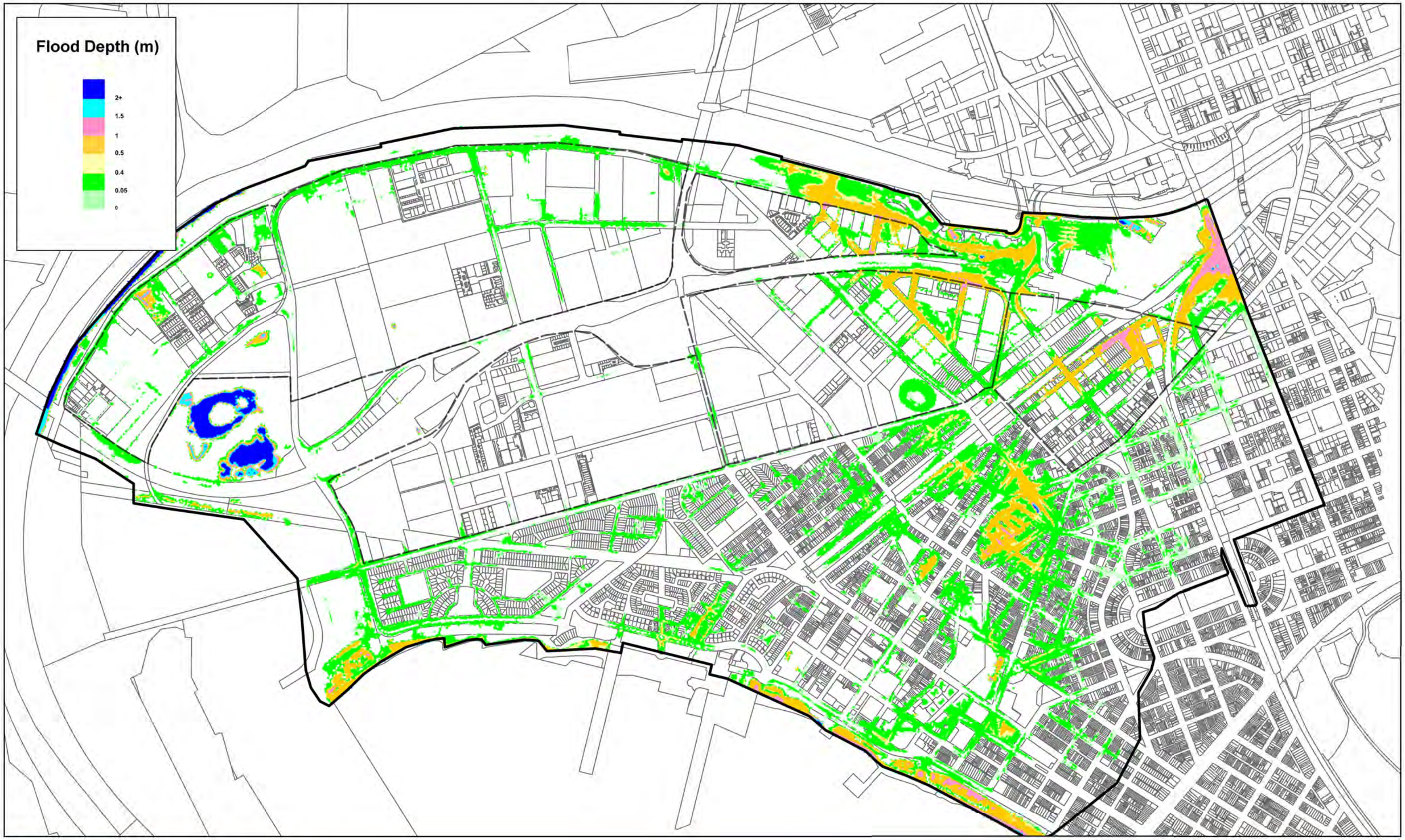

1:15,000 (at A3)

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

Flood mitigation - Rainwater tanks only
5 year ARI Rainfall - 1.9 mAHD Tailwater

Job Number	31-34157
Revision	0
Date	21 02 2017

Figure D6

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRED - DEPTH.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

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Appendix E – Flood mitigation results – Rainwater tanks with further drainage works

Flood Depth (m)

2+
1.5
1
0.5
0.4
0

Salmon Street
Kew Street
Boundary Street
Montague Street
Ferrars Street

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

Upgraded Drainage Line
Precinct Boundaries
Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Base level of service (20-yr ARI)
100 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number 31-34157
Revision 0
Date 21 02 2017

Figure E1

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP1 - DEPTH.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: hlhartenthaler

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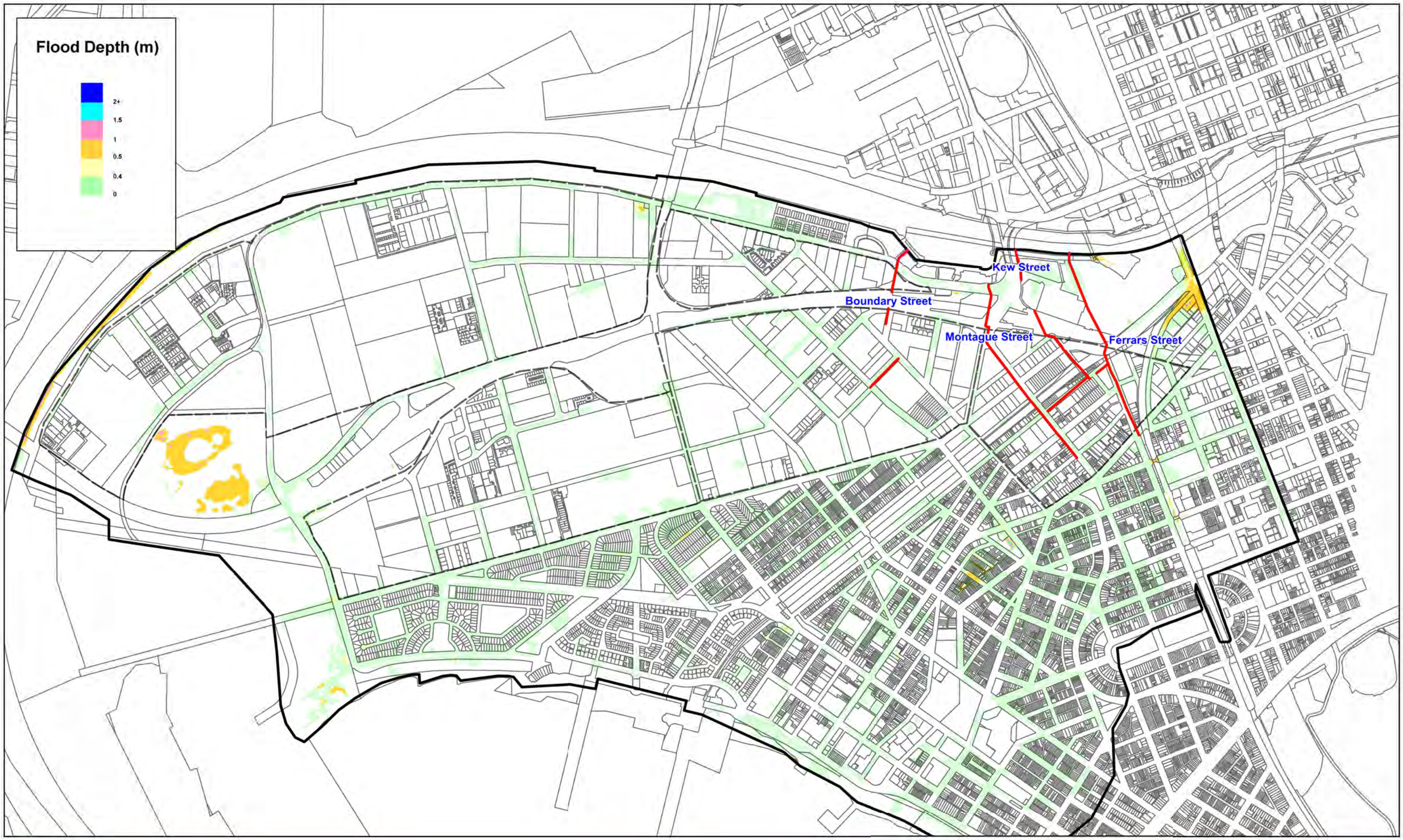

1:15,000 (at A3)

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

Upgraded Drainage Line

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Base level of service (5yr ARI)
100 year ARI Rainfall - 0.52 mAHD Tailwater

Figure E2

Job Number	31-34157
Revision	0
Date	21 02 2017

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRPIPES - DEPTH.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

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Flood Depth (m)

2+
1.5
1
0.5
0.4
0.05
0

Salmon Street
Kew Street
Boundary Street
Montague Street
Ferrars Street

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
Upgraded Drainage Line

MELBOURNE WATER
FISHERMAN'S BEND RSS

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Flood mitigation - Base level of service (20-yr ARI)
20 year ARI Rainfall - 0.52 mAHD Tailwater

Figure E3

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRPIPES - DEPTH.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

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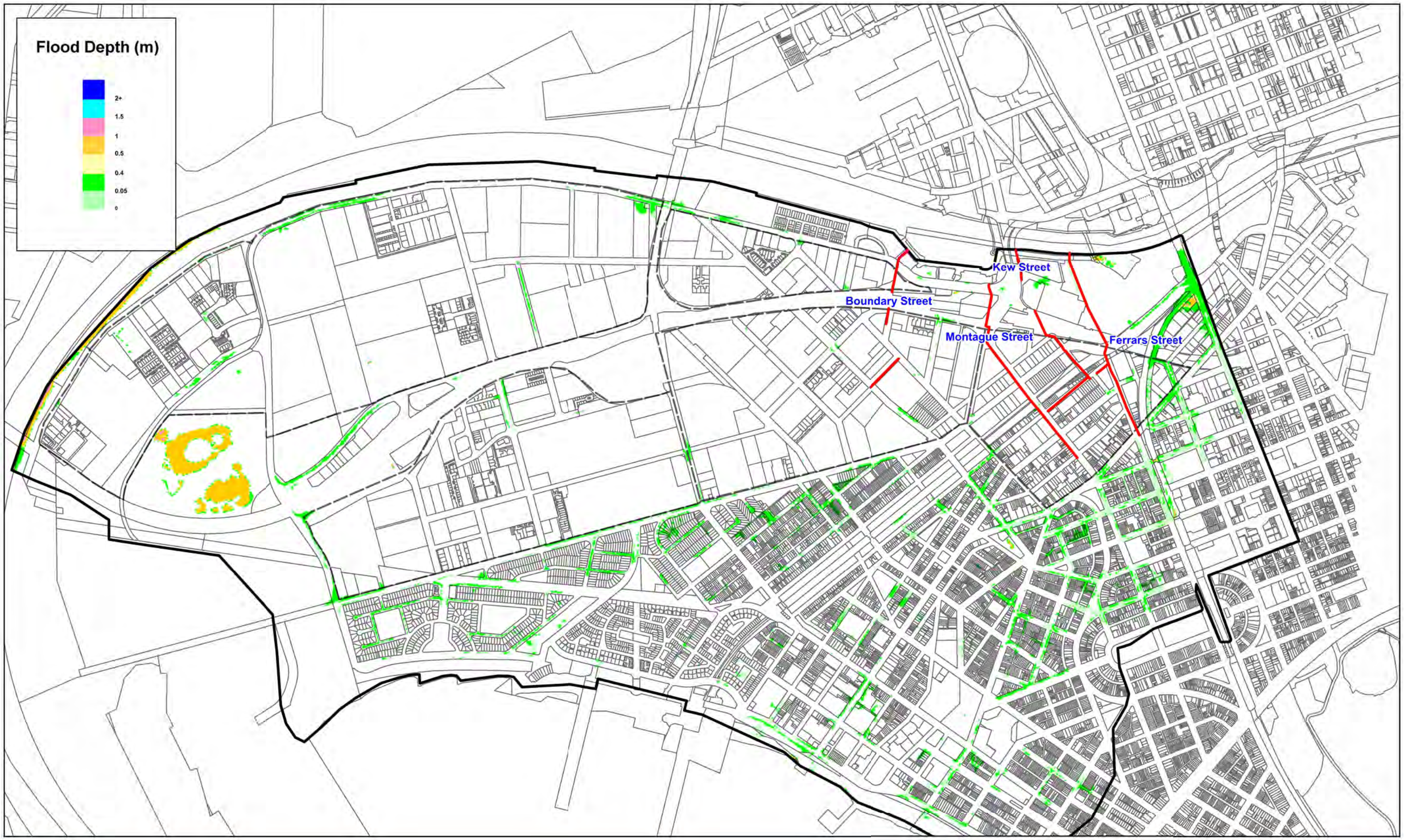

1:15,000 (at A3)

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

Upgraded Drainage Line

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Base level of service (5yr ARI)
5 year ARI Rainfall - 0.52 mAHD Tailwater

Job Number 31-34157
Revision 0
Date 21 02 2017

Figure E4

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP1 - DEPTH.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

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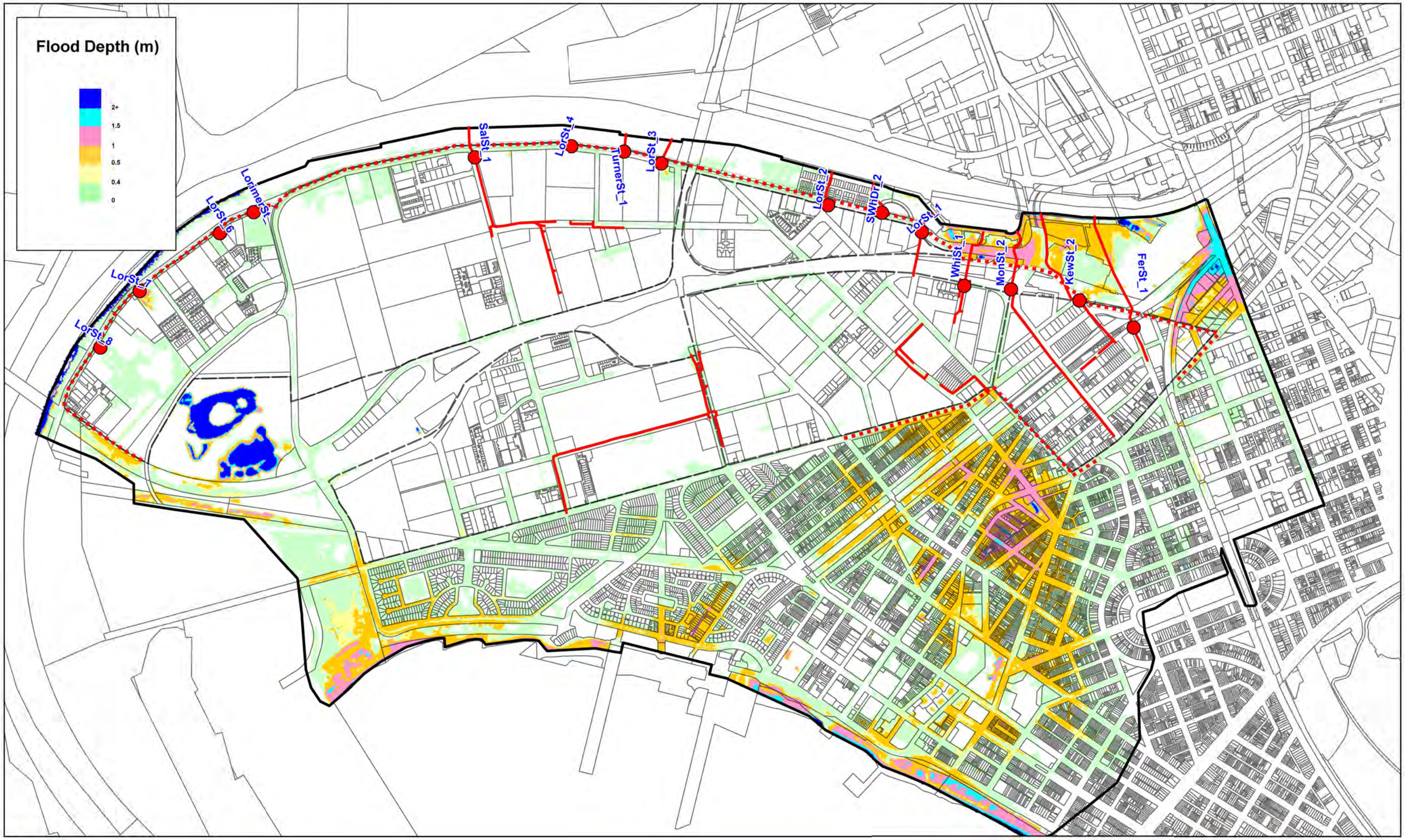

1:15,000 (at A3)

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

N

LEGEND

- Flood Levee
- Upgraded Drainage Line
- Pump Stations
- Precinct Boundaries
- Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (20yr ARI)
100 year ARI Rainfall - 2.4 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure E5

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP2 - DEPTH.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

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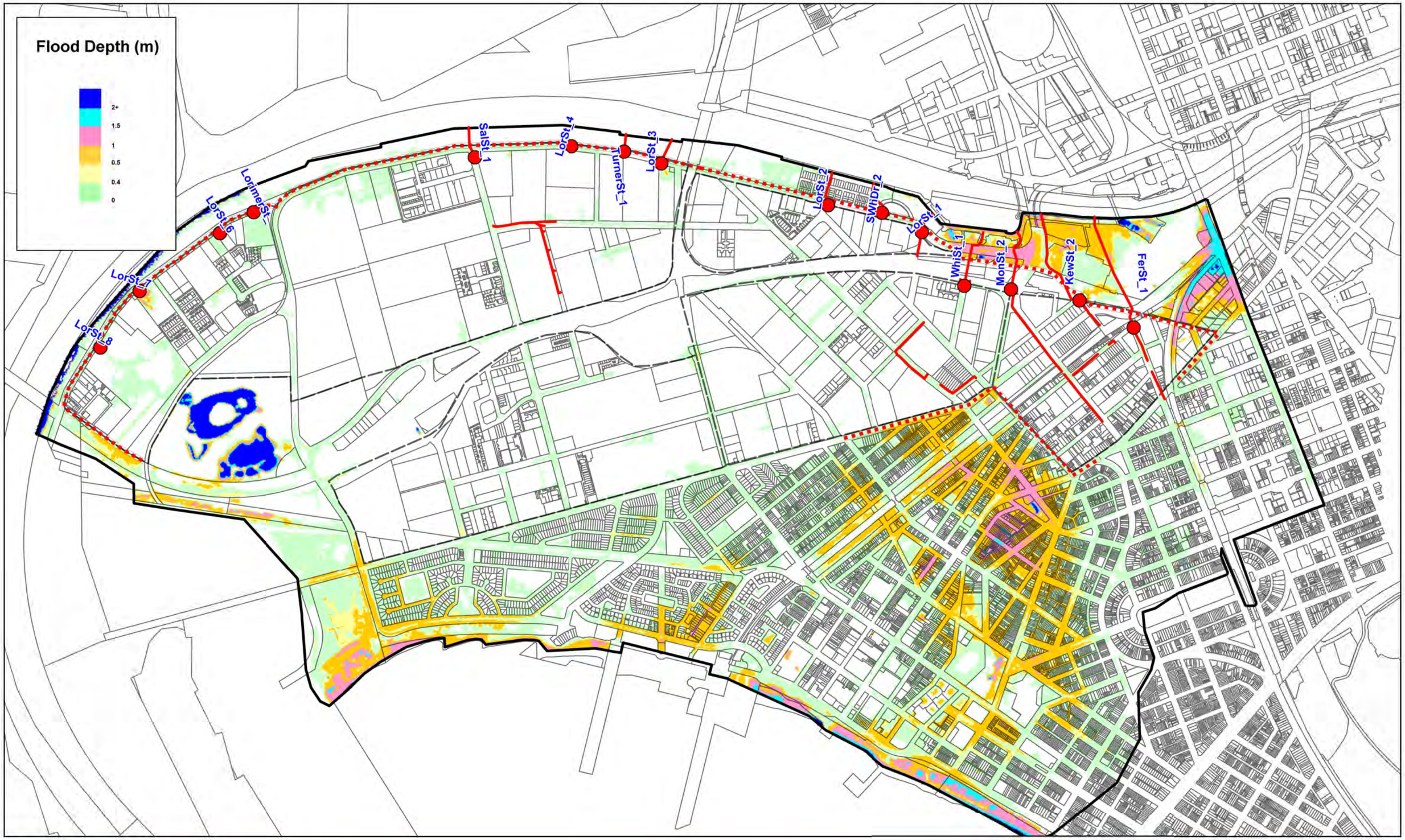

1:15,000 (at A3)

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

N

LEGEND

- Flood Levee
- Upgraded Drainage Line
- Pump Stations
- Precinct Boundaries
- Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (5yr ARI)
100 year ARI Rainfall - 2.4 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure E6

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP2 - DEPTH.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

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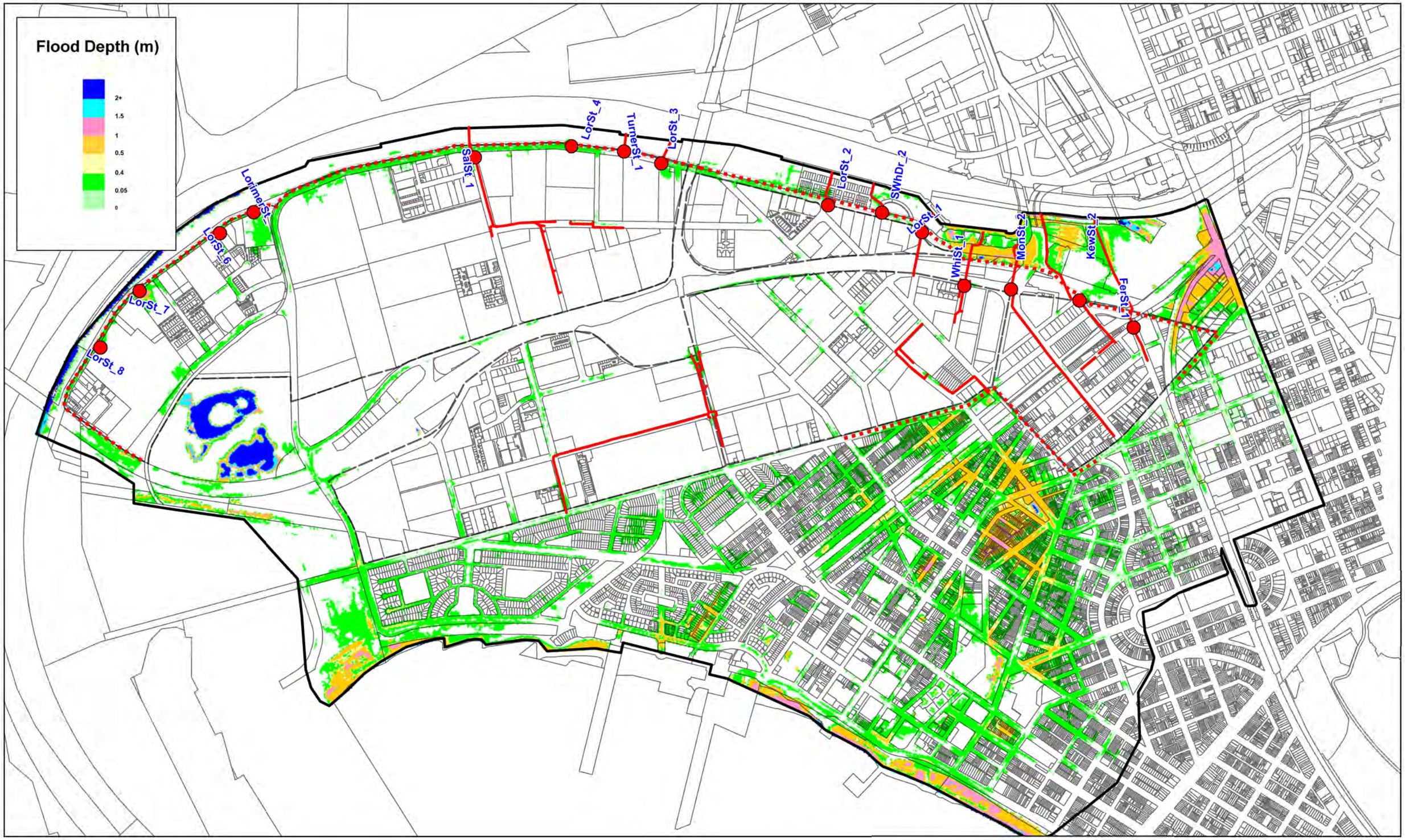

1:15,000 (at A3)

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

N

LEGEND

- Flood Levee
- Upgraded Drainage Line
- Pump Stations
- Precinct Boundaries
- Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (20yr ARI)
20 year ARI Rainfall - 2.05 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure E7

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP2 - DEPTH.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: hlhartenthaler

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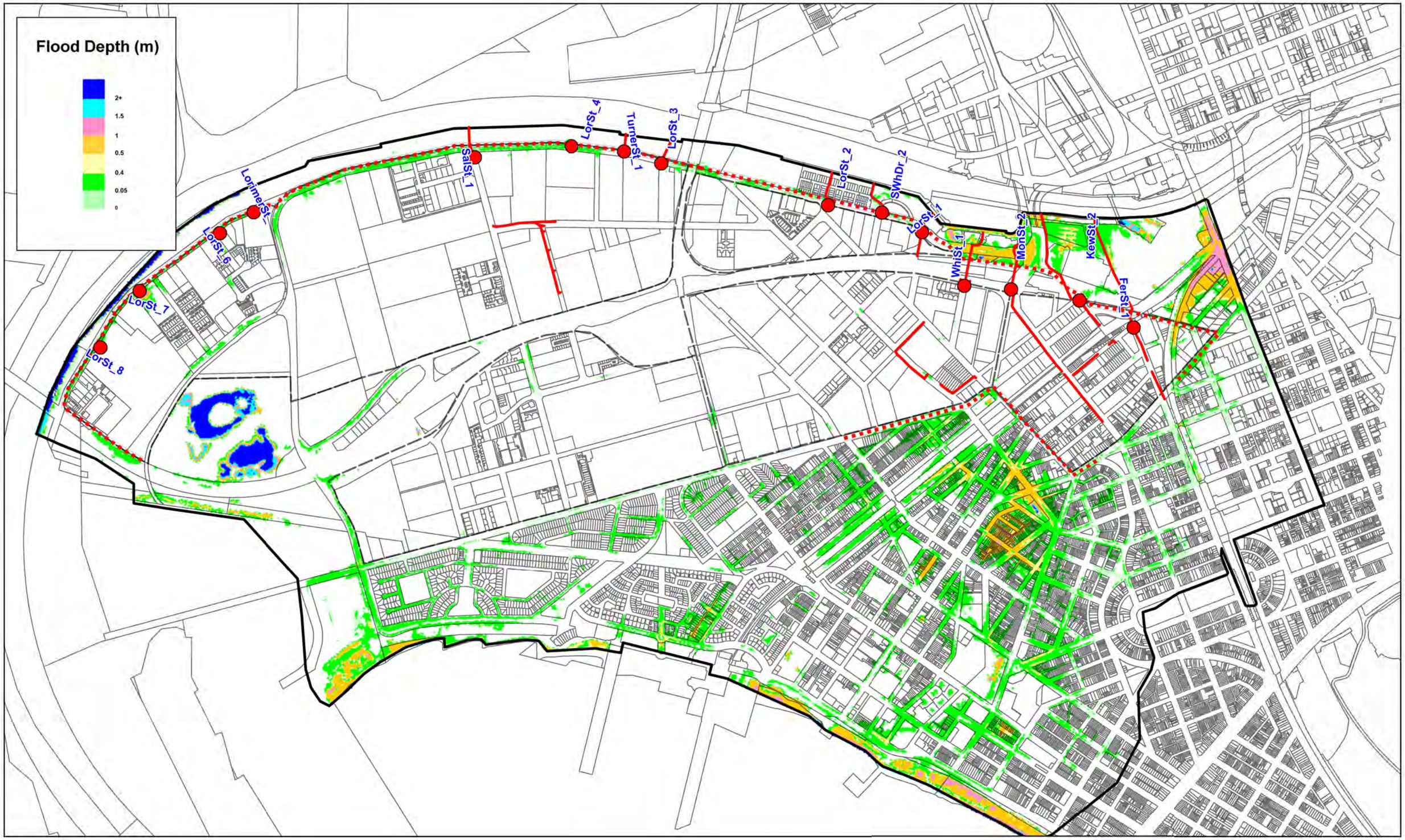

1:15,000 (at A3)

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

N

LEGEND

- Flood Levee
- Upgraded Drainage Line
- Pump Stations
- Precinct Boundaries
- Hydraulic Model Boundary

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (5yr ARI)
5 year ARI Rainfall - 1.9 mAHD Tailwater

Job Number | 31-34157
Revision | 0
Date | 21 02 2017

Figure E8

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - TRP2 - DEPTH.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

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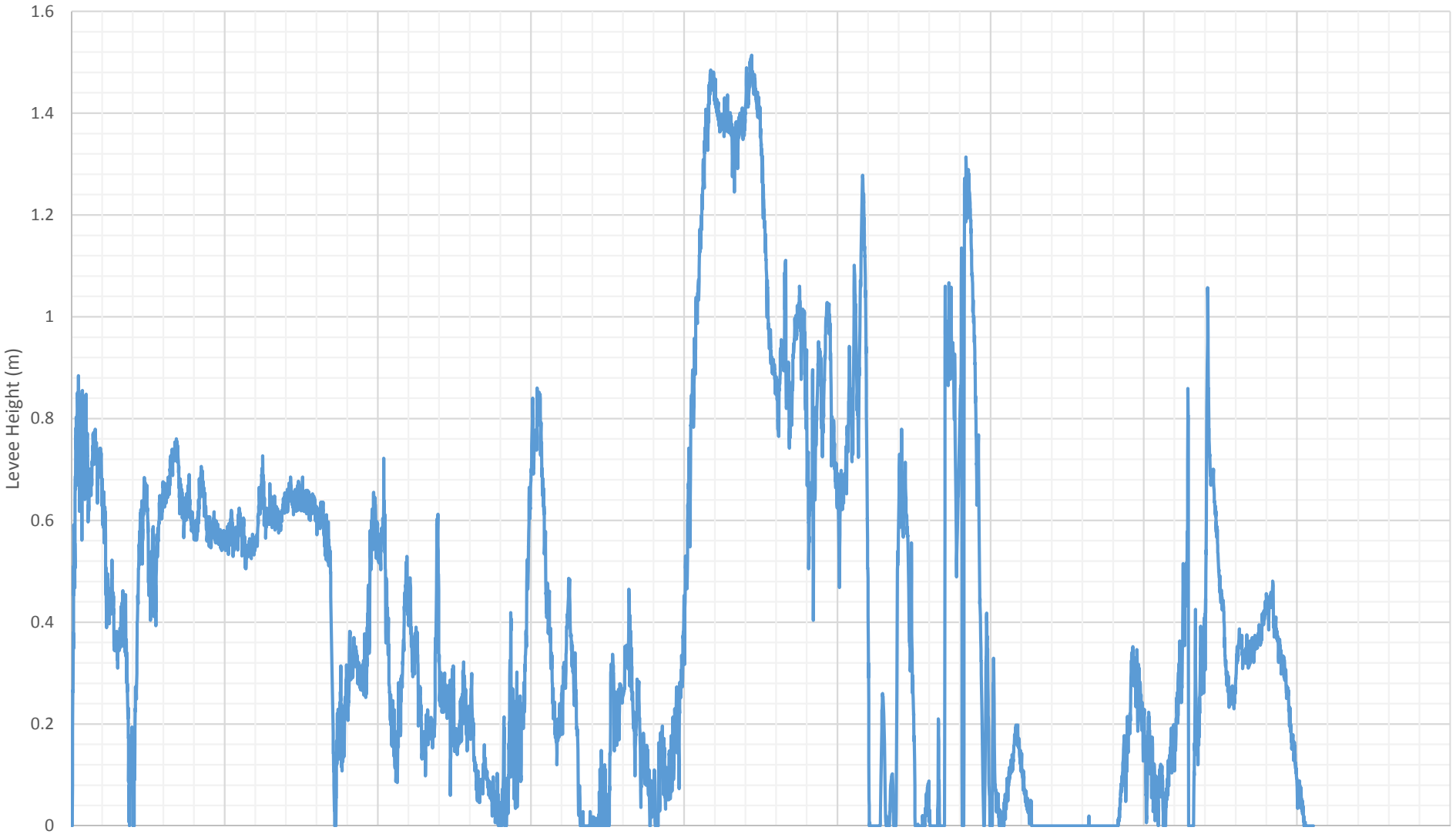
Appendix E9: Levee height longitudinal profile



Note: Distance taken from Western boundary

Appendix F – Cost estimates

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

- Melbourne Water Catchment (>60ha)
- City of Melbourne Pipe Upgrade
- City of Port Phillip Pipe Upgrade
- Melbourne Water Pipe Upgrade
- City of Melbourne Boundary
- City of Melbourne Levee
- City of Port Philip Levee
- Precinct Boundaries

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Base level of service (20yr ARI)
Drainage infrastructure upgrade responsibility

Job Number | 31-34157
Revision | 0
Date | 22 02 2017

Figure F1

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - EXISTING INFRASTRUCTURE.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

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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

- Melbourne Water Catchment (>60ha)
- City of Melbourne Pipe Upgrade
- City of Port Phillip Pipe Upgrade
- Melbourne Water Pipe Upgrade
- City of Melbourne Boundary
- City of Melbourne Levee
- City of Port Philip Levee
- Precinct Boundaries

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - Base level of service (5yr ARI)
Drainage infrastructure upgrade responsibility

Job Number | 31-34157
Revision | 0
Date | 22 02 2017

Figure F2

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - EXISTING INFRASTRUCTURE.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

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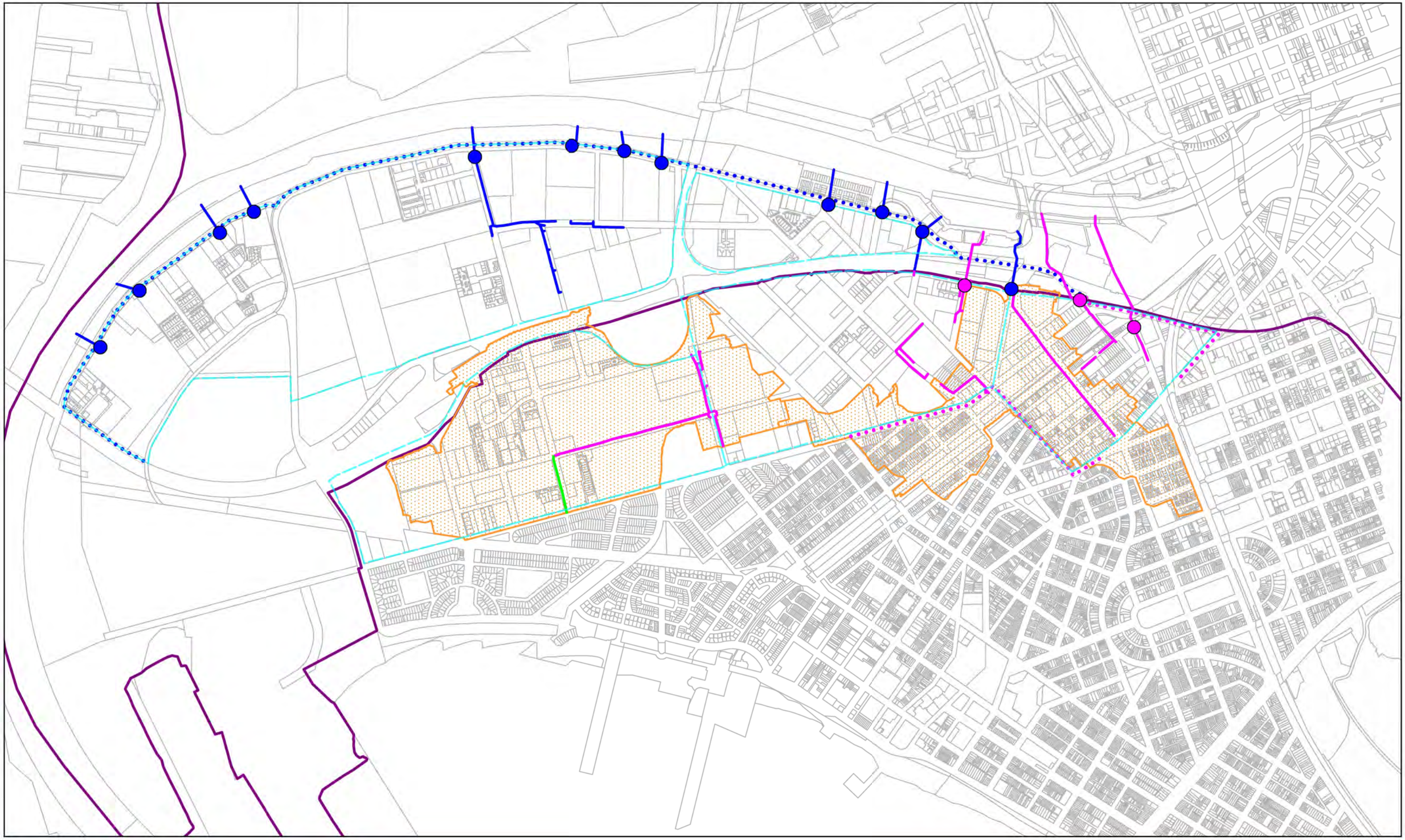

1:15,000 (at A3)

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

N

LEGEND

- Melbourne Water Catchment (>60ha)
- City of Melbourne Pipe Upgrade
- City of Port Phillip Pipe Upgrade
- Melbourne Water Pipe Upgrade
- City of Melbourne Pump Station
- City of Melbourne Boundary
- City of Melbourne Levee
- City of Port Philip Levee
- Precinct Boundaries
- City of Port Phillip Pump Station

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (20yr ARI) Drainage infrastructure upgrade responsibility

Job Number 31-34157
Revision 0
Date 22 02 2017

Figure F3

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - EXISTING INFRASTRUCTURE.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

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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

- Melbourne Water Catchment (>60ha)
- City of Melbourne Pipe Upgrade
- City of Port Phillip Pipe Upgrade
- Melbourne Water Pipe Upgrade
- City of Melbourne Pump Station
- City of Melbourne Boundary
- City of Melbourne Levee
- City of Port Philip Levee
- Precinct Boundaries
- City of Port Phillip Pump Station

MELBOURNE WATER
FISHERMAN'S BEND RSS

Flood mitigation - High level of service (5yr ARI)
Drainage infrastructure upgrade responsibility

Job Number | 31-34157
Revision | 0
Date | 22 02 2017

Figure F4

G:\31\34157\GIS\Maps\Working\Fishermans Bend Task Force Mapping - EXISTING INFRASTRUCTURE.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

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Appendix F5: Preliminary cost estimate breakdown for pipe upgrades

Base level of service - 5-yr ARI

Summary

Work Type	Cost
Pipes	$ 20,843,931
Structures	$ 4,850,000
Total ($)	$ 25,693,931

Drainage Branch Cost Breakdown

Work Type	Quantity	Unit	Rate ($/unit)	Factor	Cost
BOUNDARY ST					
600 mm diameter pipe		m	$1,150	3	$0.00
675 mm diameter pipe	174	m	$1,200	3	$627,584.76
900 mm diameter pipe		m	$1,350	3	$0.00
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	68	m	$1,575	3	$320,454.70
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe	286	m	$1,855	3	$1,590,883.25
1575 mm diameter pipe	73	m	$2,062	3	$453,518.15
1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe		m	$2,435	3	$0.00
1900 mm diameter pipe	59	m	$2,555	3	$449,915.57
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	17	No.	$50,000		$850,000
					$4,292,356
FERRER ST					
600 mm diameter pipe		m	$1,150		$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe	64	m	$1,350	3	$258,816.47
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe		m	$1,575	3	$0.00
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe		m	$1,855	3	$0.00
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe	282	m	$2,435	3	$2,058,915.71
1900 mm diameter pipe	53	m	$2,555	3	$409,797.73
2100 mm diameter pipe	479	m	$3,110	3	$4,468,959.44
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00

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Junction Pits, jacking pits & Inlet/Outlet Structures	20	No.	$50,000		$1,000,000
					$8,196,489
			KEW ST		
600 mm diameter pipe	228	m	$1,150	3	$786,100.16
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe		m	$1,350	3	$0.00
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	385	m	$1,575	3	$1,818,989.06
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe		m	$1,855	3	$0.00
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe	105	m	$2,160	3	$680,405.83
1800 mm diameter pipe	62	m	$2,435	3	$450,075.66
1900 mm diameter pipe		m	$2,555	3	$0.00
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC	2	m	$364	3	$2,128.43
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	24	No.	$50,000		$1,200,000
					$4,937,699
			MONTAGUE ST		
600 mm diameter pipe		m	$1,150	3	$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe		m	$1,350	3	$0.00
1050 mm diameter pipe	216	m	$1,455	3	$941,469.39
1200 mm diameter pipe	243	m	$1,575	3	$1,146,447.45
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe	52	m	$1,855	3	$288,978.43
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe	8	m	$2,160	3	$51,178.78
1800 mm diameter pipe	424	m	$2,435	3	$3,093,807.39
1900 mm diameter pipe		m	$2,555	3	$0.00
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC	115	m	$1,774	3	$611,895.31
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC	17	m	$798	3	$40,691.06
1500 x 1300 mm RCBC	32	m	$980	3	$93,246.14
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC	38	m	$1,732	3	$199,672.54
Junction Pits, jacking pits & Inlet/Outlet Structures	36	No.	$50,000		$1,800,000
					$8,267,386

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Appendix F6: Preliminary cost estimate breakdown for pipe upgrades

Base level of service - 20-yr ARI

Summary

Work Type	Cost
Pipes	$ 40,437,717
Structures	$ 7,850,000
Total ($)	$ 48,287,717

Drainage Branch Cost Breakdown

Work Type	Quantity	Unit	Rate ($/unit)	Factor	Cost
BOUNDARY ST					
600 mm diameter pipe		m	$1,150	3	$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe	328	m	$1,350	3	$1,330,164.18
1050 mm diameter pipe	20	m	$1,455	3	$88,271.65
1200 mm diameter pipe	442	m	$1,575	3	$2,087,280.09
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe	316	m	$1,855	3	$1,758,745.91
1575 mm diameter pipe	76	m	$2,062	3	$472,869.34
1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe		m	$2,435	3	$0.00
1900 mm diameter pipe	117	m	$2,555	3	$899,831.14
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC	72	m	$2,351	3	$507,298.35
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	22	No.	$50,000		$1,100,000
					$8,244,461
FERRER ST					
600 mm diameter pipe		m	$1,150		$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe	52	m	$1,350	3	$209,831.43
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	64	m	$1,575	3	$301,952.54
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe		m	$1,855	3	$0.00
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe	334	m	$2,435	3	$2,439,200.86
1900 mm diameter pipe	787	m	$2,555	3	$6,033,732.48
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00

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2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	23	No.	$50,000		$1,150,000
					$10,134,717
KEW ST					
600 mm diameter pipe		m	$1,150	3	$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe	255	m	$1,350	3	$1,031,517.75
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	218	m	$1,575	3	$1,029,111.24
1350 mm diameter pipe	43	m	$1,710	3	$221,702.90
1500 mm diameter pipe		m	$1,855	3	$0.00
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe	306	m	$2,435	3	$2,234,364.72
1900 mm diameter pipe	567	m	$2,555	3	$4,348,930.14
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC	4	m	$364	3	$4,256.87
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC	155	m	$1,055	3	$489,838.58
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	44	No.	$50,000		$2,200,000
					$11,559,722
MONTAGUE ST					
600 mm diameter pipe		m	$1,150	3	$0.00
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe		m	$1,350	3	$0.00
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	383	m	$1,575	3	$1,809,310.61
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe	320	m	$1,855	3	$1,779,817.44
1575 mm diameter pipe		m	$2,062	3	$0.00
1650 mm diameter pipe	416	m	$2,160	3	$2,694,819.39
1800 mm diameter pipe	159	m	$2,435	3	$1,159,997.04
1900 mm diameter pipe		m	$2,555	3	$0.00
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC	77	m	$1,969	3	$453,853.03
1200 x 1200 mm RCBC	12	m	$798	3	$27,684.85
1500 x 1300 mm RCBC	32	m	$980	3	$93,246.14
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC	240	m	$1,730	3	$1,242,871.83
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	42	No.	$50,000		$2,100,000
					$11,361,600
SALMON ST					
600 mm diameter pipe	304	m	$1,150	3	$1,050,250.38
675 mm diameter pipe		m	$1,200	3	$0.00
900 mm diameter pipe	305	m	$1,350	3	$1,234,045.04
1050 mm diameter pipe		m	$1,455	3	$0.00
1200 mm diameter pipe	720	m	$1,575	3	$3,402,920.76
1350 mm diameter pipe		m	$1,710	3	$0.00
1500 mm diameter pipe		m	$1,855	3	$0.00
1575 mm diameter pipe		m	$2,062	3	$0.00

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1650 mm diameter pipe		m	$2,160	3	$0.00
1800 mm diameter pipe		m	$2,435	3	$0.00
1900 mm diameter pipe		m	$2,555	3	$0.00
2100 mm diameter pipe		m	$3,110	3	$0.00
1200 x 450 mm RCBC		m	$364	3	$0.00
2300 x 1500 mm RCBC		m	$1,774	3	$0.00
2300 x 1800 mm RCBC		m	$1,969	3	$0.00
1200 x 1200 mm RCBC		m	$798	3	$0.00
1500 x 1300 mm RCBC		m	$980	3	$0.00
3000 X 1500 mm RCBC		m	$2,351	3	$0.00
1500 x 1400 mm RCBC		m	$1,055	3	$0.00
2300 x 1650 mm RCBC		m	$1,730	3	$0.00
2300 x 1200 mm RCBC		m	$1,732	3	$0.00
Junction Pits, jacking pits & Inlet/Outlet Structures	26	No.	$50,000		$1,300,000
					$6,987,216

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Appendix F7: Preliminary cost estimate breakdown for pipe upgrades

High level of service - 5-yr ARI

Summary

Work Type	Cost
Pipes	$ 11,712,565
Structures	$ 4,800,000
Total ($)	$ 16,512,565

Drainage Branch Cost Breakdown

Work Type	Quantity	Unit	Rate ($/unit)	Factor	Cost
BOUNDARY ST					
450 mm diameter pipe	195	m	$1,000	3	$584,492.52
675 mm diameter pipe	174	m	$1,200	3	$627,584.76
1500 mm diameter pipe	209	m	$1,855	3	$1,162,745.54
Junction Pits, jacking pits & Inlet/Outlet Structures	16	No.	$50,000		$800,000
					$3,174,823
FERRER ST					
1200 mm diameter pipe	283	m	$1,575	3	$1,338,382.24
Junction Pits, jacking pits & Inlet/Outlet Structures	6	No.	$50,000		$300,000
					$1,638,382
KERR ST					
600 mm diameter pipe	165	m	$1,150	3	$568,359.56
900 mm diameter pipe	138	m	$1,350	3	$558,808.11
1200 x 450 mm RCBC	2	m	$364	3	$2,128.43
Junction Pits, jacking pits & Inlet/Outlet Structures	11	No.	$50,000		$550,000
					$1,679,296
MONTAGUE ST					
900 mm diameter pipe	79	m	$1,350	3	$320,653.89
1200 mm diameter pipe	670	m	$1,575	3	$3,166,649.03
1200 x 600 mm RCBC	12	m	$416	3	$14,420.64
Junction Pits, jacking pits & Inlet/Outlet Structures	30	No.	$50,000		$1,500,000
					$5,001,724
LITTLE INGLES ST					
300 mm diameter pipe	1	m	$930	3	$1,882.82
450 mm diameter pipe	193	m	$1,000	3	$580,152.90
Junction Pits, jacking pits & Inlet/Outlet Structures	9	No.	$50,000		$450,000
					$1,032,036
SALMON ST					
525 mm diameter pipe	9	m	$1,075	3	$30,120.82
600 mm diameter pipe	49	m	$1,150	3	$169,243.27
750 mm diameter pipe	329	m	$1,250	3	$1,232,945.25
900 mm diameter pipe	258	m	$1,350	3	$1,045,389.12
1200 mm diameter pipe	11	m	$1,575	3	$51,048.43

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Junction Pits, jacking pits & Inlet/Outlet Structures	19	No.	$50,000		$950,000
					$3,478,747
WHITE ST					
600 mm diameter pipe	75	m	$1,150	3	$257,557.34
Junction Pits, jacking pits & Inlet/Outlet Structures	5	No.	$50,000		$250,000
					$507,557

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Appendix F8: Preliminary cost estimate breakdown for pipe upgrades

High level of service - 20-yr ARI

Summary

Work Type	Cost
Pipes	$ 27,523,222
Structures	$ 9,950,000
Total ($)	$ 37,473,222

Drainage Branch Cost Breakdown

Work Type	Quantity	Unit	Rate ($/unit)	Factor	Cost
BOUNDARY ST					
450 mm diameter pipe	92	m	$1,000	3	$276,802.47
600 mm diameter pipe	195	m	$1,150	3	$672,166.40
900 mm diameter pipe	164	m	$1,350	3	$665,082.09
1200 mm diameter pipe	15	m	$1,575	3	$71,262.45
1500 mm diameter pipe	209	m	$1,855	3	$1,162,745.54
3000 X 1500 mm RCBC	72	m	$2,351	3	$507,298.35
Junction Pits, jacking pits & Inlet/Outlet Structures	23	No.	$50,000		$1,150,000
					$4,505,357
FERRER ST					
650 mm diameter pipe	12	m	$1,180	3	$41,807.40
1350 mm diameter pipe	154	m	$1,710	3	$790,935.71
Junction Pits, jacking pits & Inlet/Outlet Structures	6	No.	$50,000		$300,000
					$1,132,743
KERR ST					
450 mm diameter pipe	78	m	$1,000	3	$235,205.34
600 mm diameter pipe	83	m	$1,150	3	$285,718.31
900 mm diameter pipe	235	m	$1,350	3	$953,597.45
900 x 450 mm RCBC	2	m	$360	3	$2,100.28
Junction Pits, jacking pits & Inlet/Outlet Structures	19	No.	$50,000		$950,000
					$952,100
LITTLE INGLES ST					
300 mm diameter pipe	1	m	$930	3	$1,882.82
600 mm diameter pipe	193	m	$1,150	3	$667,175.66
900 mm diameter pipe	88	m	$1,350	3	$355,711.95
Junction Pits, jacking pits & Inlet/Outlet Structures	12	No.	$50,000		$600,000
					$1,624,770
MONTAGUE ST					
300 mm diameter pipe	2	m	$930	3	$6,342.43
900 mm diameter pipe	136	m	$1,350	3	$550,446.56
1200 mm diameter pipe	161	m	$1,575	3	$762,322.00
1500 mm diameter pipe	37	m	$1,855	3	$205,526.13

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1650mm diameter pipe	437	m	$2,160	3	$2,830,780.22
1200 X 1500mm RCBC	6	m	$998	3	$17,303.03
1350 X 730mm RCBC	16	m	$766	3	$36,446.21
Junction Pits, jacking pits & Inlet/Outlet Structures	38	No.	$50,000		$1,900,000
					$6,309,167

PLUMMER ST

525 mm diameter pipe	11	m	$1,075	3	$36,591.43
600 mm diameter pipe	324	m	$1,150	3	$1,118,900.55
675 mm diameter pipe	19	m	$1,200	3	$68,043.96
900 mm diameter pipe	14	m	$1,350	3	$56,083.19
1050 mm diameter pipe	113	m	$1,455	3	$494,308.31
1200 mm diameter pipe	131	m	$1,575	3	$619,510.06
1500 mm diameter pipe	9	m	$1,855	3	$49,077.35
1650 mm diameter pipe	21	m	$2,160	3	$134,228.02
1800 mm diameter pipe	428	m	$2,435	3	$3,125,697.59
1950 mm diameter pipe	377	m	$2,555	3	$2,891,961.96
2100 mm diameter pipe	129	m	$3,110	3	$1,205,147.70
Junction Pits, jacking pits & Inlet/Outlet Structures	57	No.	$50,000		$2,850,000
					$12,649,550

SALMON ST

300 mm diameter pipe	19	m	$930	3	$54,343.76
600 mm diameter pipe	58	m	$1,150	3	$201,465.54
900 mm diameter pipe	531	m	$1,350	3	$2,148,644.07
1200 mm diameter pipe	666	m	$1,575	3	$3,148,230.98
Junction Pits, jacking pits & Inlet/Outlet Structures	32	No.	$50,000		$1,600,000
					$7,152,684

WHITE ST

450 mm diameter pipe	95	m	$1,000	3	$284,094.30
600 mm diameter pipe	228	m	$1,150	3	$788,234.92
Junction Pits, jacking pits & Inlet/Outlet Structures	12	No.	$50,000		$600,000
					$1,672,329

Appendix F9: Preliminary cost estimate breakdown for pumping stations

High level of service

											4	30%	
Pump Name	Peak Flow (m3/s)	Peak Flow (m3/h)	Rqd Pipe Diameter	Dist to Yarra	Pipe Losses	Level (mAHD	Static Head	Total Head	Power (kW)	Reference Rate ($) 2017	Civil works multiplier	Contingency	COST ESTIMATE $
Lorimer St 1	3.39	12218	1.5	97.3003	0.15	1.05	1.4	1.5	67	278,572	1,114,289.72	334,286.9	**1,450,000**
SWhDr_2	2.15	7751	1.2	149.163	0.30	0.98	1.4	1.7	49	215,454	861,816.01	258,544.8	**1,130,000**
Lorimer St 2	2.12	7632	1.2	149.005	0.29	0.78	1.6	1.9	53	230,514	922,055.65	276,616.7	**1,200,000**
Lorimer St 4	1.22	4392	0.9	84.65	0.25	1.64	0.8	1.0	16	103,581	414,322.87	124,296.9	**540,000**
Montague St	6.40	23040	2.1	266.36	0.26	1.82	0.6	0.8	71	291,052	1,164,208.63	349,262.6	**1,520,000**
White St	1.08	3874	0.9	255.371	0.58	0.95	1.5	2.0	29	146,777	587,108.63	176,132.6	**770,000**
Ferrer St	2.23	8017	1.2	517.774	1.13	1.12	1.3	2.4	70	288,869	1,155,477.57	346,643.3	**1,510,000**
Lorimer St 3	0.84	3024	0.75	113.693	0.41	2.07	0.3	0.7	8	76,277	305,107.57	91,532.3	**400,000**
Salmon St	4.33	15581	1.8	136.039	0.14	1.90	0.5	0.6	36	172,216	688,863.46	206,659.0	**900,000**
Turner St	2.93	10552	1.5	75.4123	0.09	2.06	0.3	0.4	16	104,957	419,827.11	125,948.1	**550,000**
Kew St	1.45	5234	1.05	443.929	0.83	1.55	0.8	1.7	32	158,189	632,756.17	189,826.9	**830,000**
Lorimer St 8	0.26	932	0.45	101.381	0.50	1.80	0.6	1.1	4	61,238	244,953.56	73,486.1	**320,000**
Lorimer St 6	0.39	1415	0.525	118.506	0.59	1.54	0.9	1.4	7	74,102	296,408.44	88,922.5	**390,000**
Lorimer St 5	1.39	4997	1.05	108.986	0.19	1.71	0.7	0.9	16	103,275	413,098.64	123,929.6	**540,000**
Lorimer St 7	1.31	4698	1.05	90.6978	0.14	1.79	0.6	0.7	13	92,192	368,766.10	110,629.8	**480,000**
													12,530,000

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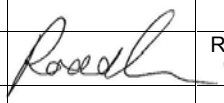
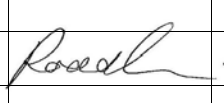
Final	P Joyce	R Mickelson		R Mickelson		17/2/2017

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