MARIBYRNONG RIVER FLOOD EVENT INDEPENDENT REVIEW

Flemington Racecourse Floodwall Second Addendum 19 April 2024

The Hon GT Pagone AM KC
Chair

Mr Mark Babister RPEV
Director
WMAwater Pty Ltd
Panel Member

Professor Holger Maier
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CONTENTS

INTRODUCTION

1. In January 2023 Melbourne Water announced, in its capacity as flood manager as prescribed under the *Water Act* 1989 (Vic), that there would be an independent review into the flooding of the Maribyrnong River which had occurred on 14 October 2022 (the **Flood Event**).

2. The Flood Event was the third highest flood on record for that catchment. Melbourne Water heard through community forums, stakeholder discussions and direct communication of its significance to those impacted.

3. The final composition of the Review Panel, after a process including extensive consultations and detailed probity inquiries, was announced in May 2023 to be as follows:

Chair:	The Honourable G T Pagone AM KC
Members:	Mr Mark Babister RPEV, Director, WMAwater Pty Ltd
	Professor Holger Maier, Director, Systems Cooperative Limited
	Mr Tim Peggie MVPELA, Director Planning, Ethos Urban

4. The Review Panel completed and submitted its final report in August 2023 (the **Final Report**) and provided an addendum on 26 October 2023.

5. At the time of submission of the Final Report, the Review Panel was unable to address Terms of Reference 6 and 7 due to a lack of availability of information required to enable this to be done. In the final report we said:

    a. [Paragraph 163] "*We are specifically required by the Terms of Reference (i) to examine whether the Flemington Racecourse Flood Protection Wall contributed to the extent and duration of the Flood Event; and (ii) to review the efficacy of Melbourne Water's proposed conditions of*

approval and mitigation measures relating to the wall and their implication. The material available to us does not enable us to do either."

b. [Paragraph 187] "*The efficacy of Melbourne Water's proposed conditions of approval and mitigation measures relating to the wall and their implementation could not be assessed by the Review Panel because there is no modelling of the Flood Event that included the Floodwall and the mitigation measures relating to the wall. The VRC was asked in public consultations about any evaluation undertaken by the VRC to evaluate the efficacy of the mitigation measures but was only able to confirm that the Floodwall was able to prevent flooding of Flemington Racecourse and that they had no information on the impact of the Floodwall elsewhere, or how well the mitigation strategies performed*."

c. [Paragraph 190] "*... the current HEC-RAS model used by Melbourne Water is out of date and is not suitable for assessing the efficacy of a specific infrastructure such as the Floodwall and its downstream compensatory measures. Melbourne Water have indicated that a modern hydraulic model that is capable of performing such an assessment is being developed, but this will not be available until April 2024. Once this model is available, it should be used to assess the efficacy of the Floodwall and associated compensatory measures. Given the contentious nature of this issue, this assessment should be subject to independent peer review*."

d. [Recommendation 6] "*Melbourne Water should use the hydraulic model being developed (expected to become available in April 2024) to determine (and be subjected to independent peer review) the impact of the Flemington Floodwall and the efficacy of the associated downstream compensatory works*."

6. On March 15, 2024, Melbourne Water informed the Chair of the Review Panel that the modern hydraulic model for the Maribyrnong River had been developed by consultants Jacobs and invited the Panel to reconvene to address Terms of Reference 6 and 7 to assist Melbourne Water with addressing Recommendation 6 of the Final Report.

7. To assist the Review Panel with its assessment, the following documents were made available by Melbourne Water:

    a. "Summary of investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall" Technical Memorandum - (Jacobs, 2024a); and

    b. "VRC Wall & Mitigation Report" (Jacobs, 2024b).

8. Upon request from the Review Panel, additional information was provided by Melbourne Water (as detailed in document "20240308 Panel further information request table"), including:

    a. "Addendum to VRC Wall & Mitigation Report" (Jacobs, 2024c);

    b. Additional maps;

    c. Raw model output data; and

    d. The actual model files.

9. The Review Panel has utilised information from these investigations to come to its conclusions. It also had the benefit of discussions on 17 April 2024 with Mr Phil Pedruco, Principal Hydrologist and Mr Greg Pharo, Senior Water Resources Engineer, both from Jacobs.

10. This Report is a second Addendum to the Final Report and addresses Terms of Reference 6 and 7.

TERMS OF REFERENCE ADDRESSED IN THIS ADDENDUM

11. The scope and matters to be considered in this Addendum are identified in the Terms of Reference as:

The Flemington Racecourse Floodwall

The Review should:

6. Examine whether the Flemington Racecourse flood protection wall contributed to the extent and duration of the Flood Event.

7. Review the efficacy of Melbourne Water's proposed conditions of approval and mitigation measures relating to the wall and their implementation.

Out of scope

The following matters are outside the scope of the Review:

1. Any specific policy responses.
2. Future potential mitigation measures such as additional flood walls, levees or dams.
3. Overall emergency responses including warnings and evacuation procedure.
4. Flood recovery.
5. Broad planning matters including decisions, frameworks and processes.

FLEMINGTON RACECOURSE FLOODWALL

6. Examine whether the Flemington Racecourse flood protection wall contributed to the extent and duration of the Flood Event.

12. Flemington Racecourse is approximately seven kilometers northwest of the Melbourne Central Business District and has a direct interface with the Maribyrnong River. It occupies an area of 320 acres and is the venue for the Melbourne Cup and has been utilised for horse racing since 1840. The Victoria Racing Club Limited (VRC) was established in 1864 and since 1871 the racecourse has been managed by the VRC under a Crown land lease arrangement now under the *Victorian Racing Club Act 2006*.

13. In the early 2000s the VRC embarked upon a broader master planning process that foreshadowed the subsequent redevelopment of the Flemington Racecourse. One of the initiatives of the masterplan was the development of a bund wall (the **Floodwall**) to provide flood protection from a one percent annual exceedance probability flood event. The VRC has indicated in its submissions to the independent review that the Flemington Racecourse was historically subject to inundation by flood waters from the Maribyrnong River and that between 1974 and 2003, the river broke its banks eight times with impact on the Racecourse. The purpose of the Floodwall is to alleviate such an effect.

14. Construction of the Flemington Racecourse Floodwall commenced in 2007 abutting the southern boundary of the Flemington Racecourse and is adjacent to the Maribyrnong River, as shown in Figure 1.

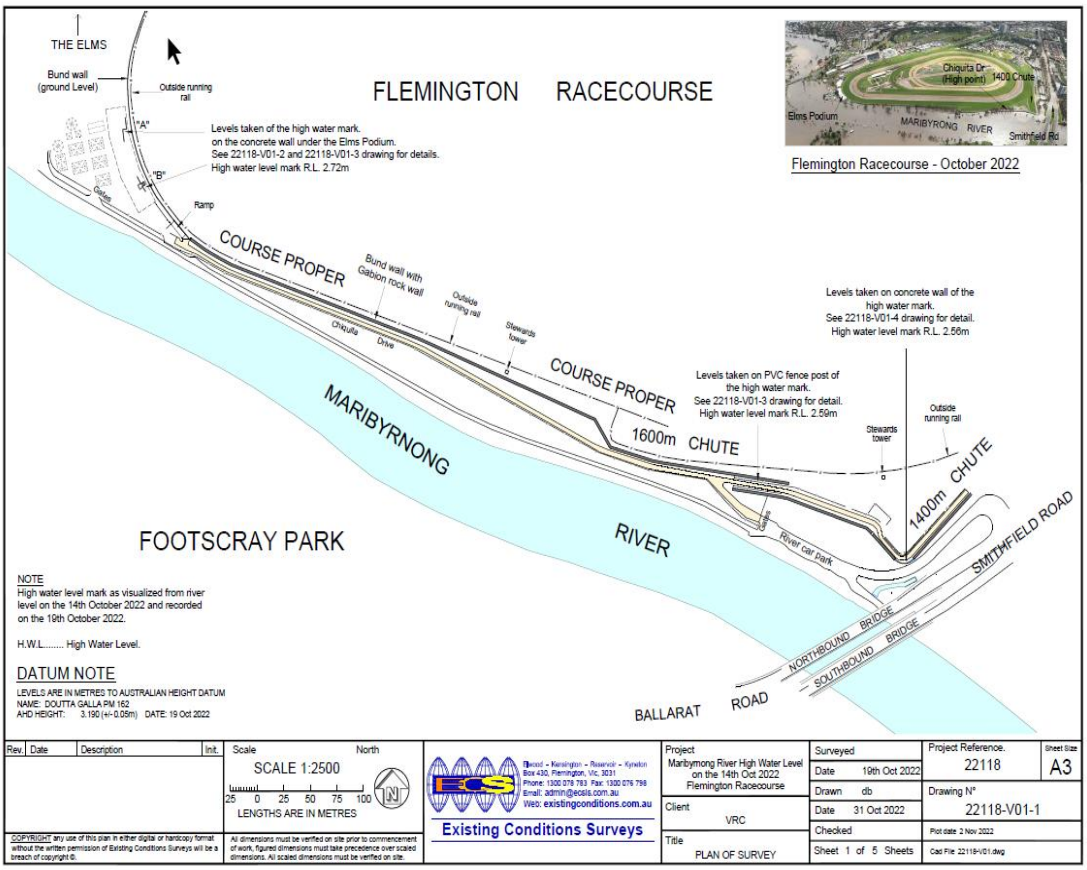

Figure 1: Location and outline of Flemington Floodwall.
(Source: Survey Plan as provided by VRC).

15. The Floodwall is approximately 900 metres in length. The material appearance of the Floodwall for most of its length is characterized by a gabion wall construction with complementary landscaping (as depicted in Figure 2). The Floodwall also acts to secure the southern boundary of the Flemington Racecourse.

Figure 2: Photo of a portion of the Flemington Floodwall.
(Source: Panel supplied photo 2/5/2023).

16. The proposed mitigation works associated with the construction of the Floodwall were (see Figure 3):

    a. Hydraulic improvements to Footscray Road Bridge; and

    b. Hydraulic improvements to the Northern Railway.

Figure 3: Location of Flemington Flood Wall and Associated Compensatory Works. (Source: Additional documents provided to IRP by Melbourne Water upon request, 5. Background Documents – Flemington Wall, File titled "Location_plan_map_opt.pdf").

17. The hydraulic improvements to Footscray Road Bridge (one of the compensatory works required by Melbourne Water; see Figure 4) consisted of the removal of the bluestone abutment from the left (eastern) bank and the construction of flow training walls upstream and downstream of this location, to improve the flow beneath the bridge, which was estimated to lower the total head loss (water level difference) across the bridge from 266 mm to 211 mm. No works were proposed for the right (western) abutment since the effect of similar changes were considered to be minimal because of the upstream jetty and the downstream wharf structures. These works led to the streamlining of the left (eastern) bridge abutment and were expected to lower the flood level by approximately 55 mm.

Figure 4: Location of hydraulic improvements to Footscray Road, including downstream end of bluestone abutment to be removed.
(Source: GHD 2003 report supplied by VRC).

18. The hydraulic improvements to the Northern Railway Culverts (the other compensatory works required by Melbourne Water; see Figure 5) consisted of lowering the road embankment located immediately downstream of the railway culverts in that location, thus increasing their capacity. Removing this obstruction was estimated to increase the capacity of the culverts and the waterway immediately downstream and to lower upstream flood levels by 44 mm.

19. The executive summary of the 2003 GHD report *Flemington Racecourse Flood Protection: Investigation of Maribyrnong River Flood Protection May 2003* for VRC stated "... the mitigation works proposed in the report involve providing additional conveyance and thereby 'neutralising' the afflux" and "If additional mitigation works at the Railway culverts were implemented the effect would be to over-compensate for the Flemington floodwall, i.e. to lower 100-year ARI flood levels between Footscray Road and Maribyrnong Village." Consequently, construction of the Floodwall and associated compensatory works should not have resulted in any increase in flooding.

Figure 5: Road embankment downstream of the Northern Railway Culverts. (Source: GHD 2003 report supplied by VRC).

20. In April 2023, consultants Jacobs were commissioned by Melbourne Water to develop a modern flood model of the Maribyrnong River (the **2024 Maribyrnong River Flood Model**) that is able to quantify the impact of the Floodwall and associated compensatory works using state-of-the-art approaches.

21. This model represents the topography of the catchment surface and bathymetry of the river channel in a three-dimensional digital elevation model, to which inflows of water are added at the upstream end. The flow of water through the river channel and over the floodplain is then modelled using relevant equations representing the physics of water flow.

22. For the 2024 Maribyrnong River Flood Model, this is achieved using a two-dimensional unsteady flow modelling approach (implemented using the software package TUFLOW) (Jacobs, 2024b), thereby enabling two-dimensional features (e.g. topography, infrastructure) and temporal changes in river flow and flooding to be considered explicitly, in contrast to the model of the lower Maribyrnong River that was used prior to this (the 2003 1d HEC-RAS model developed by consultants GHD).

23. In addition to using a more modern and sophisticated numerical modelling approach, the 2024 Maribyrnong River Flood Model was developed:

    (i) using the latest data and information, including detailed, high-resolution data of the topography of the catchment and bathymetry of the river channel; and
    (ii) in accordance with the latest industry guidelines (Australian Rainfall and Runoff 2019) and Melbourne Water procedures (Melbourne Water Flood Mapping Project Specifications -2023)) (Jacobs, 2024b).

24. A core principle in developing hydraulic models, such as the 2024 Maribyrnong River Flood Model, is model calibration and validation. This is a process where models are fine-tuned to reproduce observed historical events (calibration) and then, where possible, blind tested on other events that were not used in the fine-tuning process (validation). This process is critical, as it ensures that the model provides a reasonable representation of the real world. Where this process has been carried out, the model is referred to as "calibrated". The degree to which a model is calibrated is generally a function of the available data, including rainfall and stream flow records, and for hydraulic models, recorded flood levels along the river.

25. Jacobs calibrated the 2024 Maribyrnong River Flood Model to the October 2022 Flood Event to ensure that the model represented the Flood Event as accurately as possible.

26. It can be seen from Figure 6 that the modelled flood response (blue line) matched the recorded flood response (black line) well, especially in terms of peak water level. Consequently, based on the evidence made available to the Review Panel, the 2024 Maribyrnong River Flood Model seemed to be calibrated well to the October 2022 Flood Event.

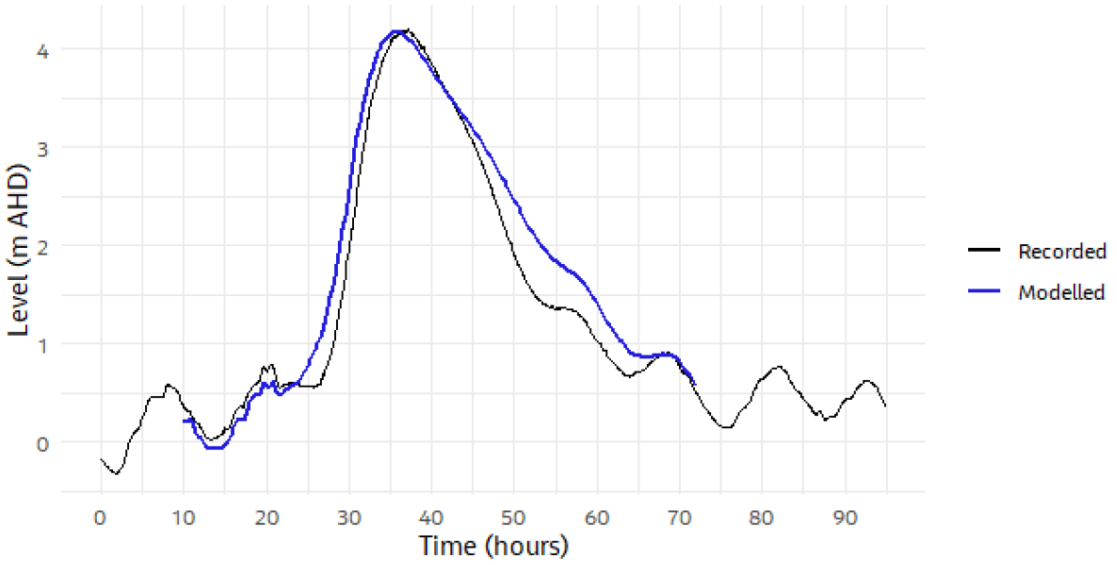

Figure 6: Calibration results for 2024 Maribyrnong River Flood Model: Modelled and recorded water levels at Chifley Drive gauge for the 2022 Flood Event.
(Source: Jacobs, 2024b).

27. However, it should be noted that development of the 2024 Maribyrnong River Flood Model had not been completed at the time of writing and the Review Panel did not have access to the full calibration report.

28. The Panel met on 17 April 2024 with Mr Phil Pedruco, Principal Hydrologist and Mr Greg Pharo, Senior Water Resources Engineer, both from Jacobs, to obtain a better appreciation of the calibration and validation undertaken by Jacobs in producing their 2024 report. The Panel had written to Jacobs on 15 April 2024 indicating the further information they sought on the calibration process: see Attachment A.

29. The meeting on 17 April 2024 began with Mr Pedruco presenting to the Panel in response to the matters which the Panel had foreshadowed in their correspondence of 15 April 2024. The results from the draft calibration report presented during the meeting demonstrated that a comprehensive calibration and validation process had been undertaken. The flood model was not just calibrated to the October 2022 flood, but was also validated against the January 2011, September 1993 and October 1983 events and was verified to the May 1974 event.

30. Using inflows based on the recorded flood levels at Keilor gauge, the model reproduced the observed flood hydrograph at the Maribyrnong Gauge and the peak flood levels from Avondale Heights to the junction with the Yarra River for the 1993 and 1983 events. The fit for the much smaller 2011 event is not as good. The model also fits well to the limited information available for the 1974 flood.

31. While the fit to the smaller 2011 flood is not as good, the results provided confidence that the model reproduced large floods and is a suitable tool for assessing the impact of the Floodwall and mitigation works.

32. A full review of the 2024 Maribyrnong River Flood Model is beyond the scope of this Review, but the panel has reviewed the model to determine whether it adequately incorporates the Floodwall, the associated compensatory works and other physical features that can have a significant impact on water levels, such as the Footscray Road Bridge and the Northern Railway Bridge. This review showed that:

    a. The compensatory works are modelled by raising/lowering the terrain in the model where appropriate.

    b. The Floodwall is modelled by merging the terrain level with the terrain around it, which is a good approximation of the terrain without the Floodwall.

    c. The bridges in the model are represented as "2D_BG" shapes, which is a modern form of layered flow constriction designed to represent the flow constriction caused by the bridge.

33. To determine whether the Floodwall contributed to the extent and duration of the Flood Event, Jacobs ran the calibrated 2024 Maribyrnong River Flood Model

under the conditions experienced during the October 2022 Flood Event for three scenarios (Jacobs, 2024b):

a. Base Case (with Floodwall and with compensatory works): This scenario modelled the impact of the Flood Event under the conditions as they would have been during the event – with the Floodwall and the corresponding compensatory works in place.

b. Scenario 1 (without Floodwall and without compensatory works): This scenario modelled the impact of the Flood Event without the Floodwall and associated compensatory works in place. This provides the best possible representation of the conditions as they were prior to the construction of the Floodwall. However, it should be noted that some of the modelled conditions are likely to be different from the conditions that existed prior to the construction of the Floodwall due to the need to make certain assumptions (e.g. what the ground surface was like in the location where the Floodwall is at present) and due to changes in the catchment since construction of the Floodwall (e.g. development in the floodplain).

c. Scenario 2 (with Floodwall and without compensatory works): This scenario modelled the impact of the Flood Event with the Floodwall in place, but without the associated compensatory works. This provides the best possible explicit assessment of the impact the compensatory works have on flood depth, duration and extent.

34. Based on the assessment of the information provided, the Review Panel concludes that, for the October 2022 Flood Event, the contributions of the Floodwall to the extent and duration of the Flood Event are as follows:

a. Construction of the Floodwall and associated compensatory works increased the extent of the flooding in some areas (see orange areas

in Figure 7). The modelled increase in flood extent resulting from the construction of the Floodwall and associated compensatory works is approximately 1% (Jacobs, 2024b). The area where there is an increase in flood extent is distributed both upstream and downstream of the Floodwall.

b. Construction of the Floodwall and associated compensatory works may have contributed to the duration of inundation of some of the flooded areas. In their report, Jacobs concluded that "the duration of the flood peak did not change within the model reporting tolerance of five minutes by the presence of the VRC flood wall" (Jacobs, 2024b). Upon reviewing detailed time series outputs, the Review Panel concludes that:

    i. The only areas where the duration of inundation may have been increased due to the construction of the Floodwall and associated compensatory works are at the fringes of the flood extent. Time series output points have not been provided in these areas.

    ii. At Raleigh Road Bridge, the change in the rise of the flood is within the tolerances of the accuracy of the model, and the peak is extended by around 45 minutes (Figure 8).

35. Construction of the Floodwall and associated compensatory works also:

a. Protected the Flemington Racecourse from flooding (see pink areas in Figure 7 and green areas in Figure 9).

b. Did not have a measurable impact on Rivervue retirement village.

c. Increased the depth of flooding in some areas (see Figure 9).

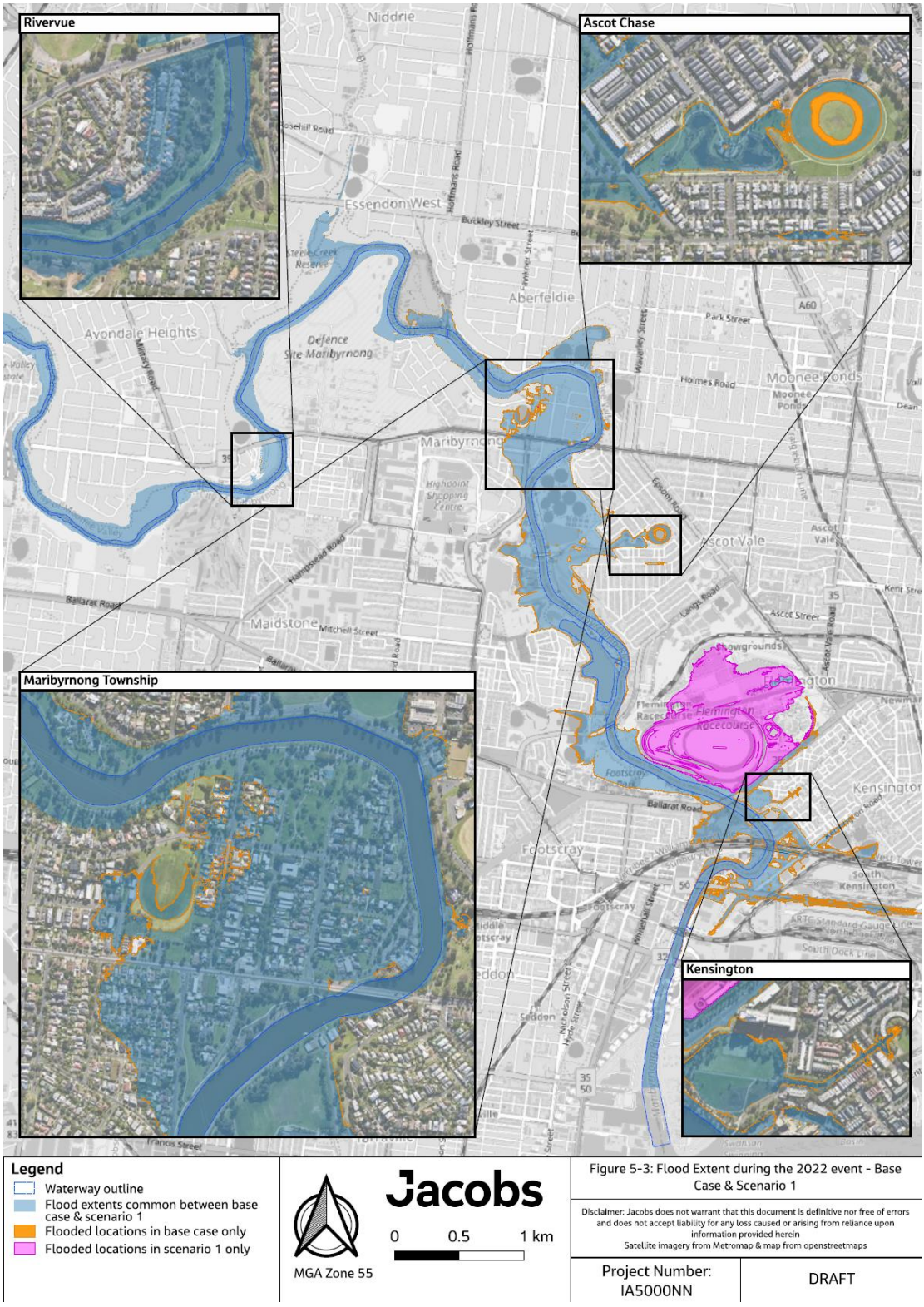

Figure 7: Map showing modelled changes in the extent of the October 2022 Flood Event due to the construction of the Floodwall and associated compensatory works, where areas coloured orange indicate the additional flood extent due to the construction of the Floodwall and associated compensatory works and areas coloured pink indcate areas that are no longer flooded due to the construction of the Floodwall and associated compensatory works.
(Source: Jacobs, 2024b).

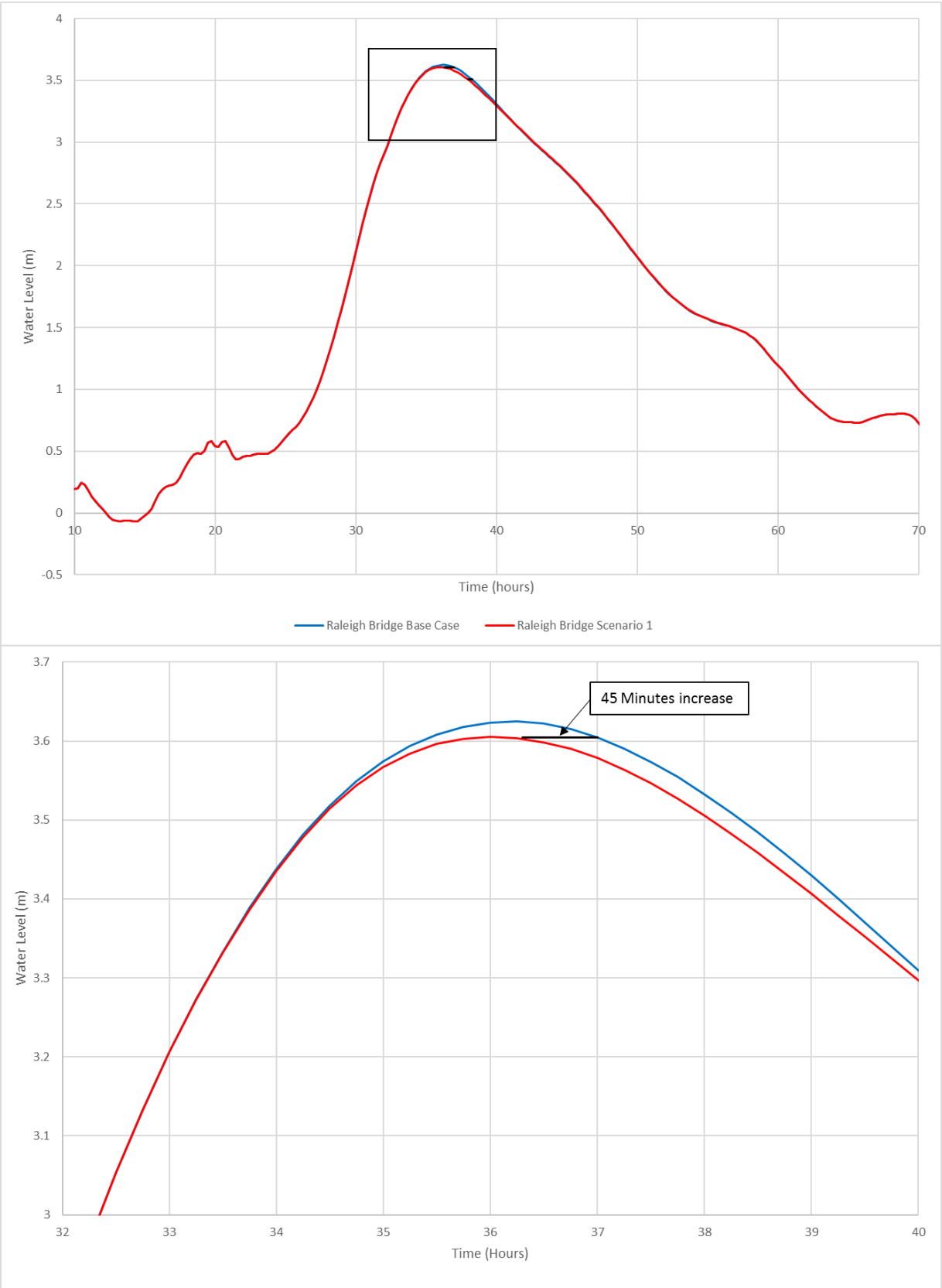

Figure 8: Water level impact of the Floodwall at Raleigh Road Bridge prepared using model results provided by Jacobs
(Source: Analysis of model results provided by Jacobs by the Panel).

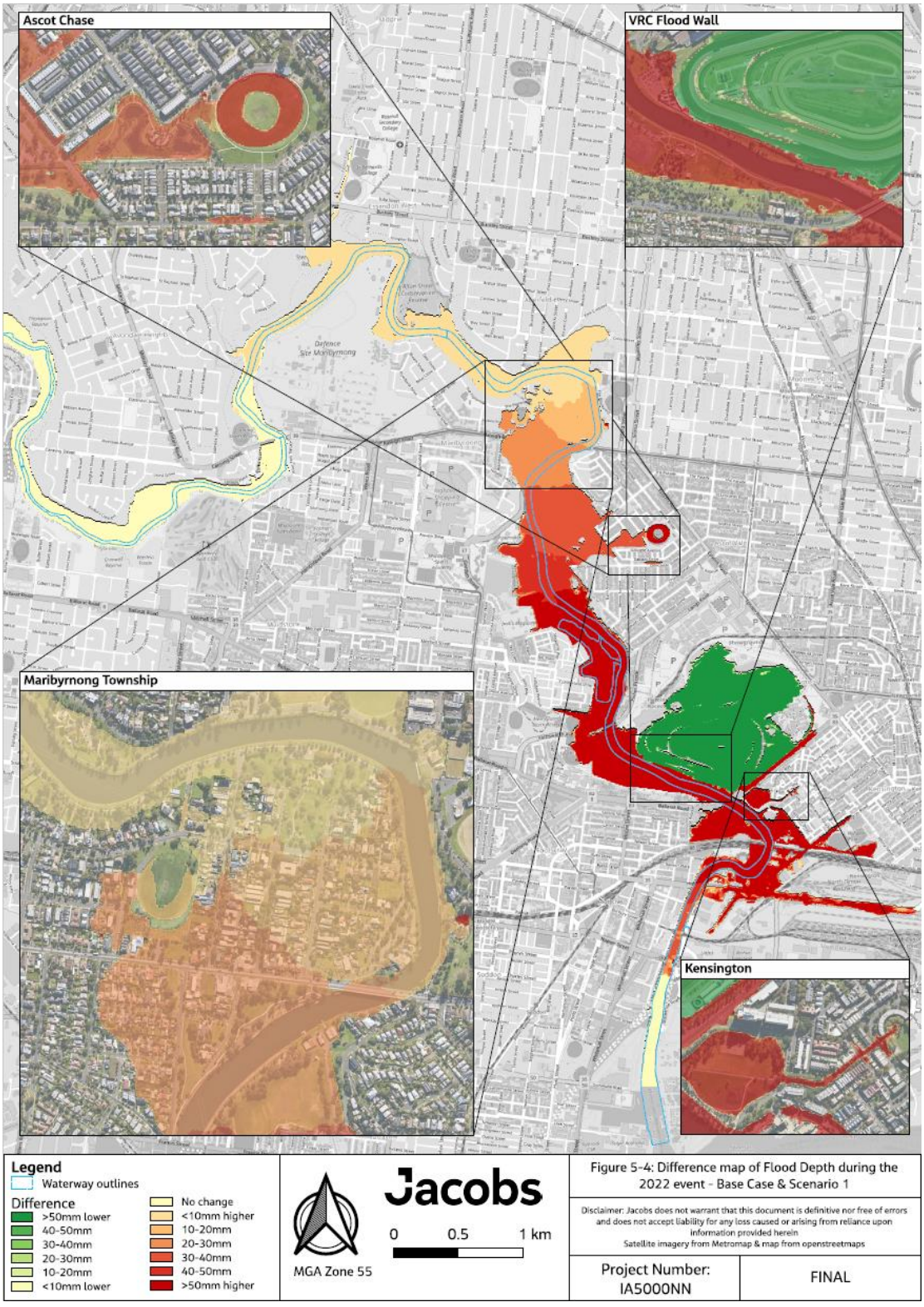

Figure 9: Map showing the modelled increase or decrease in flood depth along the lower Maribyrnong River during the October 2022 Flood Event as a result of the construction of the Fleminton Floodwall and associated mitigation works obtained using the 2024 Maribyrnong River Flood Model.
(Source: Figure 5 – 4a 0-50mm_Depth, supplied by Melbourne Water).

36. The modelled increase in water level resulting from the construction of the Floodwall and associated compensatory works exceeded significantly in several locations the level of +10mm, which is today considered a generally acceptable impact of developments. Those locations included:

    a. An increase of 80mm directly adjacent to the Floodwall in the Maribyrnong River channel, with this impact tapering off upstream of the Floodwall.

    b. An increase of 8-10mm in the upstream parts, and up to 30mm in the downstream parts, of the Maribyrnong township, which affected approximately 240 residential lots in this area. Specifically:

        i. There was an increase of 8mm at the flood marker on the corner of Chifley Drive and Plantation Street; and

        ii. There was an increase of 27mm at Essendon Canoe Club.

    c. An increase of 60-65mm in the industrial areas of West Melbourne and Kensington adjacent to the Maribyrnong River that flooded during the October 2022 event.

37. The modelled increases in flood depths resulting from the construction of the Floodwall and associated compensatory works outlined above have most likely resulted in flooding of some houses that would otherwise not have flooded and increased the flood damage in houses that would have been flooded in the absence of the Floodwall and associated compensatory works (e.g. requiring skirting boards or furniture to be replaced, requiring electrical work to be done, resulting in additional stock losses for businesses etc.).

38. Although impacts in excess of +10mm might be acceptable for projects that are considered to have wide societal benefit, and were generally more acceptable

at the time the Floodwall was built, we note that the guidelines that governed acceptable impacts at the time when the Floodwall was constructed ("Guidelines for Development in Flood-prone Areas" - Melbourne Water, 2003) were silent on numerical figures for acceptable impact but stated as a guiding principle that "potential for adverse impacts on adjacent, upstream or downstream areas must be identified and prevented".

39. The information provided to the Review Panel also clearly indicates that the compensatory works were largely ineffective at mitigating the effect the Floodwall had on the October 2022 Flood Event (Figure 10). The reports provided by Jacobs concluded that "the outcome of the modelling indicates that, for the October 2022 flood event, when the mitigation works are removed, there is a relatively minor change to the peak flood levels and a negligible impact on the extent and duration of the flood peak." (Jacobs, 2024c), with the compensatory measures mitigating depth of flooding by up to 10mm in the vicinity of Footscray bridge and 1mm in the Maribyrnong Township (Jacobs, 2024a).

40. Analysis of the raw model outputs by the Review Panel indicates that for the October 2022 Flood Event:

    a. The compensatory works reduced the flood level by between 8mm and 10mm for approximately 500m upstream of Footscray bridge and by between 4mm and 8mm for a further 2km upstream. Beyond this, the impacts of the compensatory works were negligible.

    b. The compensatory works showed negligible mitigating impact on any flooding in residential areas.

    c. The compensatory works reduced flood levels by 4-5mm in the industrial areas of West Melbourne and Kensington adjacent to the Maribyrnong River.

d. The compensatory works were ineffective at mitigating the magnitude of the impact of the Floodwall.

41. Consequently, based on the modelling results of Jacobs (2024c), the Floodwall compensatory works did not "neutralise" or "overcompensate" for the impacts of the Floodwall as had been stated by GHD in 2003.

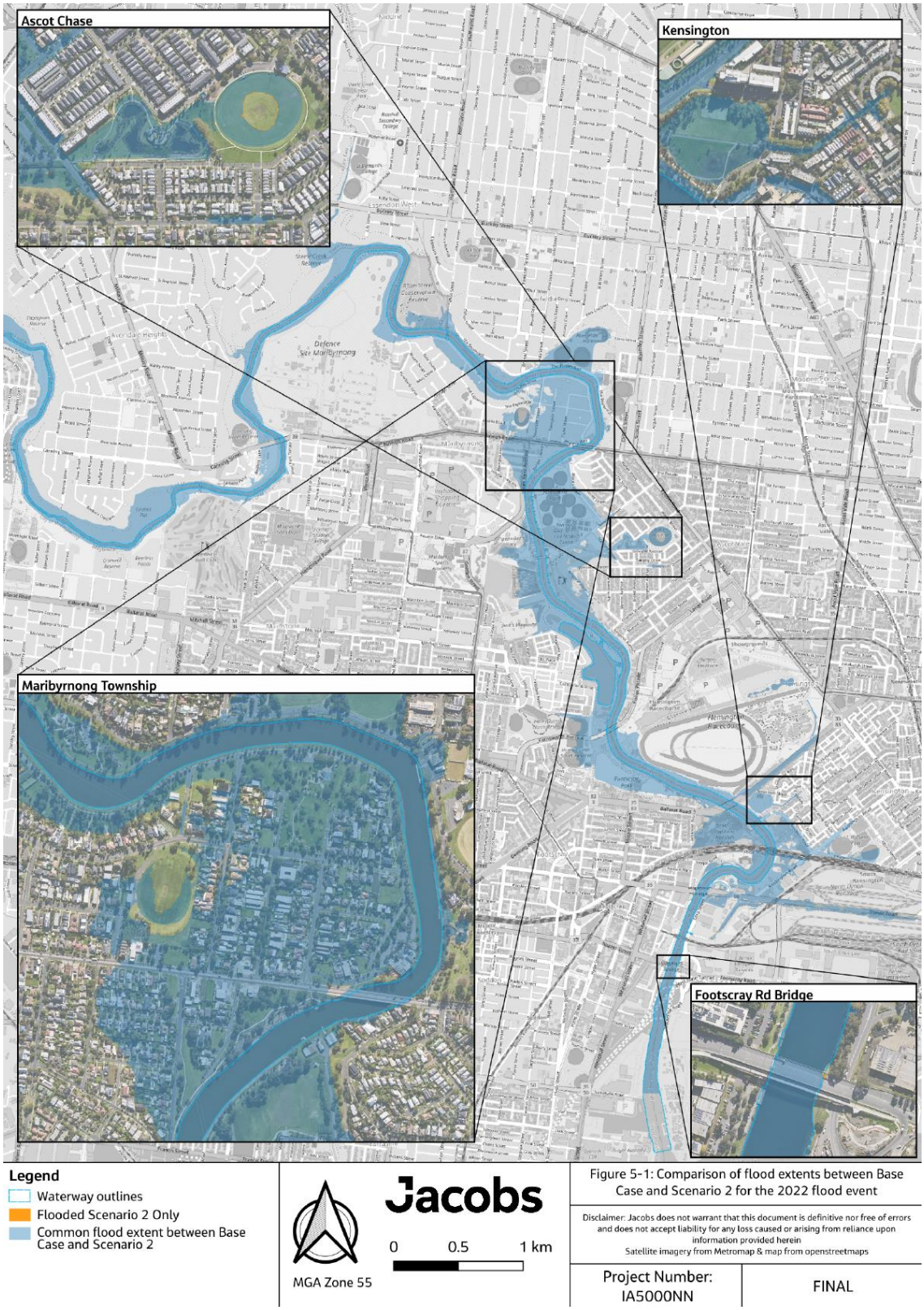

Figure 10: Map showing modelled changes in the extent of the October 2022 Flood Event due to the Floodwall as a result of the impact of the associated compensatory works, where areas coloured orange indicate the additional flood extent due to the absence of the compensatory works. (Source: Jacobs, 2024c).

7. Review of efficacy of Melbourne Water's proposed conditions of approval and mitigation measures relating to the wall and their implementation

42. The land on which the Flemington Racecourse is situated is within the City of Melbourne and is designated within the Melbourne Planning Scheme (Figure 11). The site is zoned Special Use Zone (Schedule 1) and recognizes that "Flemington Racecourse is a major recreational and entertainment resource of State and Metropolitan significance". The Flemington Racecourse is also the subject of the Land Subject to Inundation Overlay (LSIO) (Figure 12).

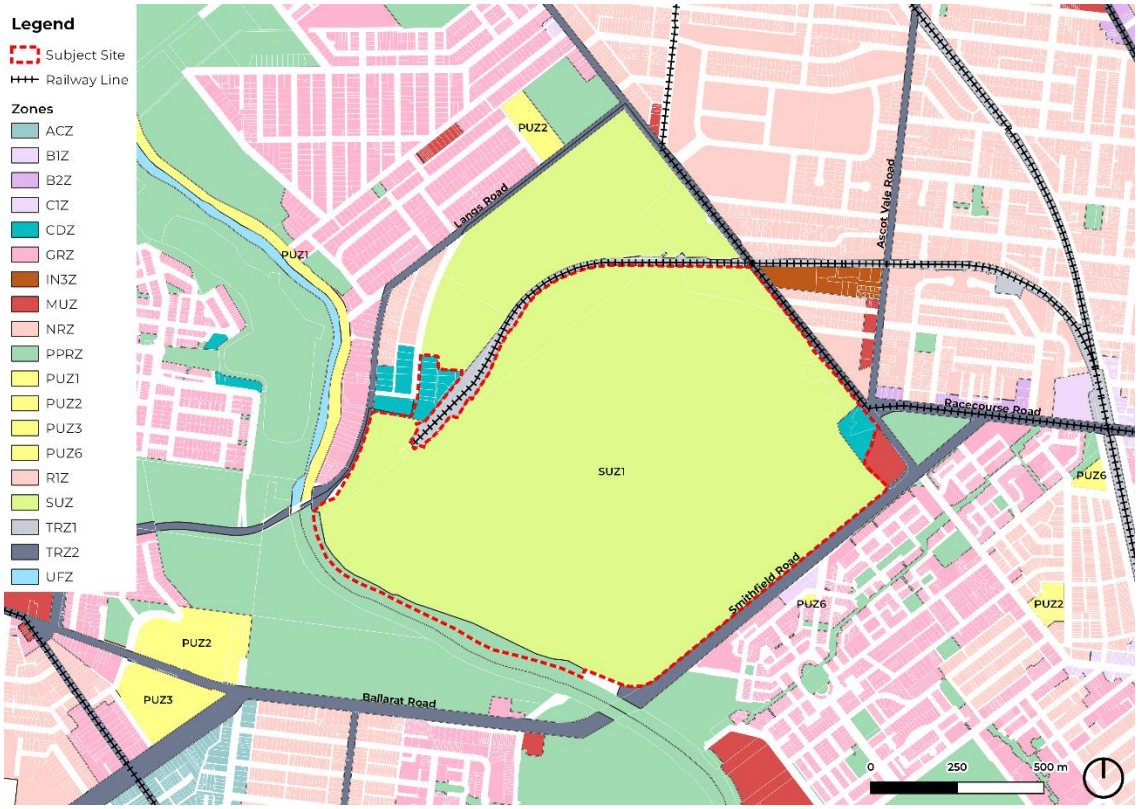

Figure 11: The Flemington Racecourse is designated within the Special Use Zone – Schedule 1 (SUZ1).
(Source: https://mapshare.vic.gov.au/vicplan).

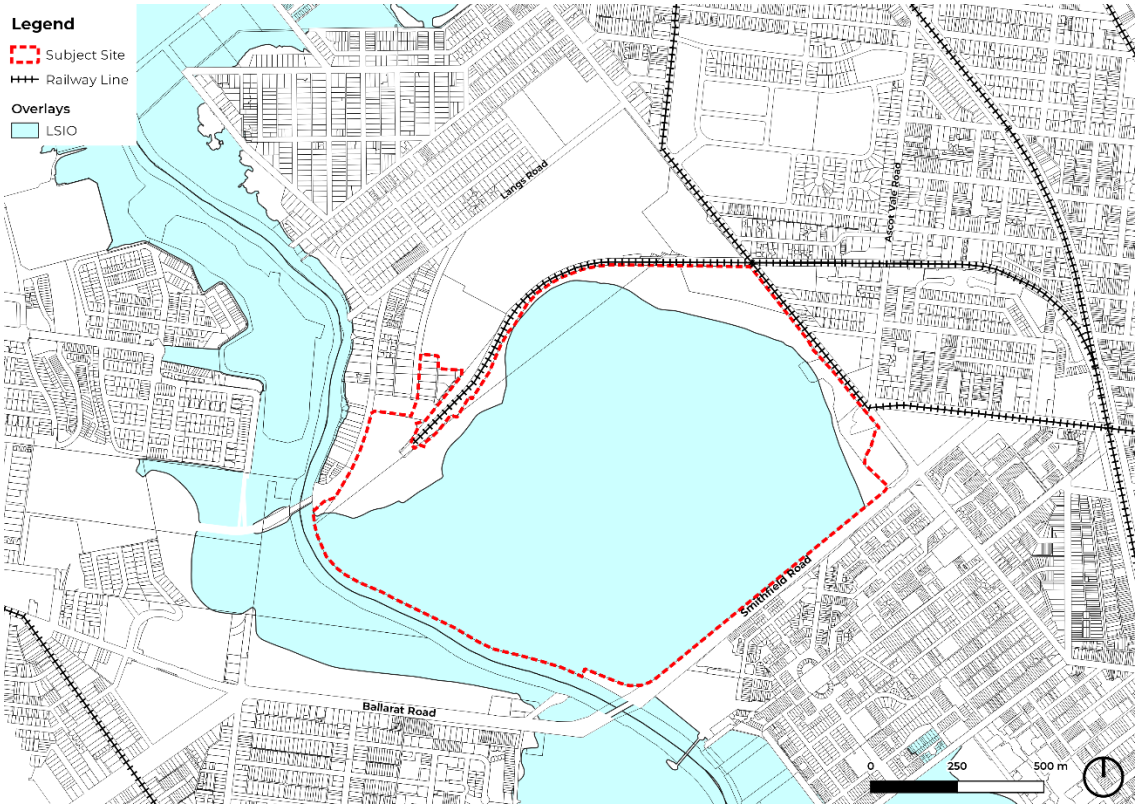

Figure 12: The Flemington Racecourse is also subject to a LSIO.
(Source: https://mapshare.vic.gov.au/vicplan).

43. The Minister for Planning is identified at Clause 72.02-2 of the Melbourne Planning Scheme as the responsible authority for administering and enforcing a provision of the planning scheme for the Special Use Zone – Schedule 1 Flemington Racecourse including issuing any relevant planning permits. An application by the VRC to carry-out "racecourse track upgrade and flood protection works" was submitted to the Minister for Planning on 25 March 2003 (ref: Permit 2003/86).

44. The LSIO that affects the Flemington Racecourse also requires that a planning permit application must be referred to the relevant floodplain management authority under Section 55 of the *Planning and Environment Act 1987*. Melbourne Water is the flood plain management authority in this instance and was therefore a Referral Authority for the permit application. On 22 April 2003, the Department of Sustainability and Environment (DSE), on behalf of the Minister for Planning, referred the VRC planning permit application to

Melbourne Water. The Minister in the role of responsible authority also notified other interested parties (under Section 52 of the *Planning and Environment Act 1987*) of the planning permit application, including the City of Melbourne, Maribyrnong City Council, Moonee Valley City Council and other affected parties.

45. Having received the referral of the planning permit application, Section 56 of the *Planning and Environment Act 1987* required Melbourne Water to consider the application and to inform the Minister of one of the following, namely that:

(a) it did not object to the granting of the permit; or

(b) it did not object if the permit was subject to the conditions specified by the referral authority; or

(c) it objected to the granting of the permit on any specified ground.

46. Melbourne Water, as the Referral Authority, reviewed the planning permit application and on 21 May 2003 wrote to the DSE and requested certain information with respect to Permit 2003/86. The Planning Permit application for the Floodwall was complemented by a report prepared by consultants GHD Group Pty Ltd titled the *Flemington Racecourse Flood Protection: Investigation of Maribyrnong River Flood Protection May 2003*. This report was subsequently peer reviewed by an independent expert in hydraulic engineering and modelling, Dr Robert Keller. Both reports referred to the need for appropriate compensatory works to mitigate adverse impacts of the Floodwall as shown in Figure 3.

47. The proposed compensatory works associated with the construction of the Floodwall were (see Figure 3):

a. Hydraulic improvements to Footscray Road Bridge; and

b. Hydraulic improvements to the Northern Railway.

48. Both the Moonee Valley City Council and the Maribyrnong City Council also engaged external consultants (Water Technology and WBM Oceanics) to review the GHD modelling and to provide professional advice about the impact of the proposed Floodwall. Following this advice, both Councils objected to the planning permit being issued. The issues raised by the objections included a concern that the effects of the Floodwall could be greater than predicted by GHD, and that the mitigating effects of the proposed compensatory works might be less than predicted.

49. The City of Melbourne and other independent parties also objected to the proposed Floodwall. On 3 September 2003, DSE provided Melbourne Water with the Water Technology report. Melbourne Water reviewed the report and, following a meeting with consulting firms Water Technology Pty Ltd and GHD, responded to DSE on 17 September 2003, concluding that the GHD model was technically sound, and that further hydrologic and hydraulic investigation was not warranted because:

- GHD had comprehensively analysed and assessed the available information;

- The model produced had been calibrated and modified for current development conditions; and

- The model could be used to determine the behavior of flood flows in the river.

50. Thereafter, on 14 October 2003, Melbourne Water wrote to DSE confirming that it did not object to the planning permit application, subject to 39 planning

permit conditions, including specific requirements for certain compensatory works being performed.

51. On 5 February 2004, the then Minister for Planning, Ms Mary Delahunty, issued a notice of decision to grant a permit in respect of Application 2003/86 under Section 64 of the *Planning and Environment Act 1987.*

52. An application to the VCAT for a review of the Minister's decision to grant a permit under Section 82 of the *Planning and Environment Act 1987* was subsequently initiated by Maribyrnong City Council, Moonee Valley City Council, the City of Melbourne, Ms Kaye Testro and the Maribyrnong Residents' Association Inc.

53. On 1 April 2004, the Minister directed the Principal Registrar of VCAT to refer the appeals to the Governor in Council for determination pursuant to Clause 58 of Schedule 1 of the *Victorian Civil and Administrative Tribunal Act 1998.*

54. On 3 August 2004, that application was determined by the Lieutenant Governor (acting in place of the Governor) under Clause 58(2)(a) and Clause 61(1)(b) of the *Victorian Civil and Administrative Tribunal Act 1998* and the Minister was directed to issue the permit subject to 49 permit conditions, including those required by Melbourne Water.

55. In December 2005, the VRC appointed Akron Roads Pty Ltd to undertake the flood mitigation works required as a condition of the planning permit. Construction of the Floodwall began in 2007 after the flood mitigation works that had been required as a condition of the planning permit had been completed in January 2006. The construction of the Floodwall was substantially completed around September 2007.

56. Compliance with each of the non-ongoing permit conditions was subsequently obtained, with DSE providing final confirmation of this in a letter to the VRC dated 17 March 2008.

57. The information provided to the Review Panel based on the updated modelling indicates that the compensatory works did not perform as expected, and therefore that they lacked in efficacy, based on the original design for the Flood Event, as:

    a. They only reduced the impact of the Floodwall significantly in the vicinity of some of the compensatory works and were not able to decrease flood depth and extent significantly in the majority of affected areas.

    b. The hydraulic improvements to Footscray Road Bridge only reduced flood levels by 10mm directly upstream and by at most 5mm anywhere outside the banks of the river. This is much less than the expected reductions of 55mm based on the original modelling.

    c. The hydraulic improvements to the Northern Railway Culverts only reduced flood levels by a maximum of less than 7mm directly upstream of the improvements. This is much less than the expected reduction of 44mm based on the original modelling.

ATTACHMENT

A: Correspondence to Jacobs 15 April 2024

15 April 2024

Dear Phil

As per previous correspondence, the Maribyrnong Independent Review Panel would like to meet with representatives of Jacobs to seek further details on aspects of the development of the 2024 Maribyrnong River Flood Model, as detailed in the following documents provided to the Panel by Melbourne Water:

- "Summary of investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall" Technical Memorandum - (Jacobs, 2024a)
- "VRC Wall & Mitigation Report" (Jacobs, 2024b)
- "Addendum to VRC Wall & Mitigation Report" (Jacobs, 2024c)

Specifically, the Panel would like Jacobs to present additional information on the calibration process and results of the 2024 Maribyrnong River Flood Model, as the full calibration report for this model was not made available to the Panel, with the only details of the calibration process given in Appendix A of the "VRC Wall & Mitigation Report" (Jacobs, 2024b), which consists of approximately two-and-a-half pages. Given the importance of knowledge of the calibration process to the Panel's ability to critically assess the model outputs, and hence respond to the relevant Terms of Reference of the Review (Terms of Reference 6 and 7), the Panel would like additional information on the following aspects of the calibration process of the 2024 Maribyrnong River Flood Model at our meeting on Wednesday, April 17, 2024:

- What process was adopted to obtain the best match between the modelled outputs and the corresponding measured values (e.g. process used to adjust model parameters, which performance metrics were used etc.)?
- What are values of calibrated model parameters and how do they compare with known ranges of these values based on an understanding of underlying physical processes?
- Comparisons of modelled and recorded hydrographs for the 2022 Flood Event at other locations than that shown in Figure 8-1 in Jacobs (2024b).
- What is the relative magnitude of the calibration errors and the differences in results presented in the three scenarios presented in the above reports (i.e., without the Floodwall and associated compensatory works, with the Floodwall but without associated compensatory works, without the Floodwall and without the associated compensatory works)?

Kind regards

Wendy Dark
Panel Administrator

REFERENCES

Summary of investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall" Technical Memorandum - (Jacobs, 2024a)

VRC Wall & Mitigation Report" (Jacobs, 2024b)

Addendum to VRC Wall & Mitigation Report" (Jacobs, 2024c)

Flemington Racecourse Flood Protection: Investigation of Maribyrnong River Flood Protection (GHD, May 2003)

Australian Rainfall and Runoff: A Guide to Flood Estimation (Commonwealth of Australia, 2019)

AM STA 6200 Flood Mapping Projects Specification (Melbourne Water, 2021)

Guidelines for Development in Flood-prone Areas (Melbourne Water, 2003)

GLOSSARY AND ABBREVIATIONS

AEP	(Annual exceedance probability): The probability a specific flow or flood level is equalled or exceeded in a given year.
ARR2019	(Australian Rainfall and Runoff 2019): The 2019 and most recent edition of the document that provides guidelines for flood estimation.
Calibration	Tuning the parameters in a model to match known real world data points in order to make the model more representative of real world conditions.
GHD	GHD Group Pty Ltd is a multinational technical professional services firm.
HEC-RAS	One dimensional hydraulic modelling software produced by the US Army Corps of Engineers.
Hydraulic Model	Software that converts flow to flood levels, extent, and depths.
JACOBS	Jacobs Australia Pty Limited is the Australian arm of Jacobs Solutions Inc which is an international technical professional services firm.
LSIO	Land Subject to Inundation Overlay.
Rivervue	Rivervue Retirement Village.
Streamflow Gauge	A gauge that records the water level of a specific point along a waterway.
TUFLOW	A combined one and two dimensional hydraulic modelling software produced by BMT Commercial Australia Pty Ltd.
Validation	Running real world events through a model not used as part of the calibration process in order to

	verify the results of the model in situations not used during calibration.
VRC	Victoria Racing Club Limited.