Camden Council
70 Central Ave
Oran Park NSW
2570

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4 March 2024

Attention: Maria Pinto

Dear Maria,

Re: Pondicherry Precinct – Flooding and Water Cycle Management
Review of Flood Assessment

1. INTRODUCTION

WMAwater was engaged by Camden Council (Council) to undertake a review of the "*Pondicherry Precinct – Flooding and Water Cycle Management*" report (Calibre, September 2023, referred to as the report) and associated flood modelling that was undertaken. This was prepared by Calibre Professional Services Pty Ltd (Calibre) for Department of Planning and Environment and Camden Council, dated 29 September 2023.

WMAwater undertook the review and the outcomes were contained in a letter (referred to as the review) to Council dated 15 December 2023. There were several issues identified and these were discussed in a meeting held on 11 January 2024. Calibre has addressed these issues and provided an updated "*Pondicherry Precinct – Flooding and Water Cycle Management*" report (Calibre, February 2024, referred to as the updated report), in addition to a memorandum "*Pondicherry Precinct – Flood and Water Cycle Management*" dated 7 February 2024. Associated flood modelling files were also provided. A meeting was also held on 6 February 2024 in which Calibre provided an overview of their response to WMAwater's review. These are collectively referred to as the response. This letter contains the outcomes of WMAwater's follow-up review of Calibre's response.

2. SCOPE OF REVIEW

The work undertaken for this review included the following tasks:

- Run hydrologic models supplied by Calibre to confirm results;
- Review hydrologic models and results;
- Run hydraulic models supplied by Calibre to confirm results;
- Review hydraulic models; and
- Review the updated Flooding and Water Cycle Management Report sections relevant to the assessment of flood impacts, including the memorandum.

3. PREVIOUS ASSESSMENTS

It is understood that Calibre's assessment builds upon the masterplan for the Oran Park Precinct, as water from this precinct discharges into the Pondicherry Precinct. The Oran Park masterplan has undergone several iterations since the first masterplan was prepared by Brown Consulting in March 2007. The last update was documented in a letter dated 13 January 2023, and this was reviewed by WMAwater. Part of the overall strategy for stormwater quantity management for Oran Park included provision of detention basin 'B1'. This basin is required to mitigate flows from the Oran Park Precinct, however, it is being assessed and constructed as part of the Pondicherry Precinct.

4. HYDROLOGY MODEL REVIEW

4.1. Hydrologic Model Data Provided

Calibre provided the following XP-RAFTS hydrologic models:

- Pre-development XP-RAFTS models for the 1% AEP event and 3 critical durations (e.g. *Calibre_All_Pre-Dev_USC_RAFTS_v06_ARR2016_Design_Mid_01pc_030m.xp* for the 30 minute storm event)
- Post-development XP-RAFTS models for the 1% AEP event and 3 critical durations (e.g. *Calibre_pre_to_post_rafts_USC_RAFTS_v06_ARR2016_Design_Mid_01pc_030m_NAL.xp* for the 30 minute storm event)
- Post-development XP-RAFTS model for the 1% AEP event 30 minute duration *Calibre_pre_to_post_rafts_USC_RAFTS_v06_ARR2016_Design_Mid_01pc_030m_Detention.xp*

No GIS files of the catchment boundaries were provided, however, it is understood that no change to subcatchment boundaries was made. Result files were provided in the form of TUFLOW .ts1 files supplied as part of the TUFLOW model.

4.2. Running of Hydrologic Models

The XP-RAFTS models were successfully run and the results were compared to those provided. There were no differences for the pre-development model, and only minor differences for the post-development model. The changes were minor (peak flow within 0.01 m^3/s) and it was considered that the correct models were provided. These differences may be attributed to the version of XP-RAFTS that the model was run in.

4.3. Hydrologic Model Review Outcomes

The approach adopted by Calibre for the hydrologic assessment is considered reasonable for the generation of inflows for the TUFLOW model. The pre-development and post-development model setup are consistent with the Regional Model User Guide.

The assessment of pre-developed and post-developed flow comparisons was undertaken with the XP-RAFTS model. It was demonstrated that the peak flows arriving at the Pondicherry Lake were not significantly different. This was provided in Attachment F of the updated report, with a summary provided in Section 5.1 of the updated report. The conclusion reached was that the increase in peak flows was not significant with the increase in impervious area, due to the timing of the flows. The report states "The results show that at the Pondicherry Lake location the difference in peak flow is

only 0.3 m^3/s as a result of the increase in impervious areas. This is a result of the timing of the catchment areas." (p. 16).

WMAwater agrees with this assessment, although it is noted that there is an increase in peak flows between the pre-development and post-development models for the 30 minute and 720 minute storms, of up to 1.5 m^3/s, or 4% increase in peak flow arriving at the Pondicherry Lake location. It is in the 360 minute event that the peak flows reduce by 0.3 m^3/s. When compared to the 'Council model' (i.e. partial Oran Park development), the change in peak flows was also noted to be minor. The difference is up to 0.7 m^3/s (or 2%) in the 720 minute storm event. It is noted that while timing is considered important for this assessment, the XP-RAFTS model is not set up to provide adequate simulation of routing, which affects the timing of flows.

As demonstrated by the hydrographs provided, however, there is also an increase in volume of flow arriving at the proposed basin, driven particularly by the increase in initial runoff from impervious surfaces, rather than at the peak of the hydrograph. These volumes are also important when considering storage of water in detention basins. It was demonstrated with the XP-RAFTS model that there was sufficient volume in the proposed Pondicherry Lake to ensure a reduction in peak flows. This assessment demonstrates that the post-development flows would be attenuated to below pre-developed flow conditions. However, this only considers pre-development peak flows arriving at the proposed lake (existing farm dam 4) location. It does not consider the existing attenuation provided by the existing farm dam. It also does not consider wider floodplain behaviour such as routing, storage and timing of flows. While the statement "the results show that the lake has sufficient volume to ensure that the existing flows are not aggravated as a result of the Oran Park and Pondicherry Precincts" (p. 22) is true at face value based on the results, it is not valid when considering wider floodplain behaviour. This is considered further in the TUFLOW modelling (see Section 6).

The assessment of the Pondicherry Lake detention basin was undertaken with the XP-RAFTS model. The representation of the lake in the XP-RAFTS model is considered reasonable. It is noted, however, that the outlet (stated to be an 18 m wide control pit) has a stage-discharge relationship slightly lower than the standard weir equation, and it appears that orifice flow is assumed to be induced at approximately a 1.2 m depth above the outlet. These are reasonable assumptions at this stage of the development. The provided stage-storage relationship (Section 5.3.2.4.3 of the updated report) also appears reasonable, although it is noted that above RL 78.1 mAHD, the storage curve in the XP-RAFTS model deviates from the one reported. This is above the 1% AEP level in the basin, and as such this is not considered to be a significant issue. It is also noted that the report states that the permanent water level is 77.3 mAHD (Section 5.3.2.2), however, it appears as though the modelling adopts a level of 77.0 mAHD.

4.4. Hydraulic Model Data Provided

The following data was provided related to the hydraulic models:

- Upper South Creek TUFLOW model that can be run with different scenarios:
  - Pondicherry-2020_~e1~_~e2~_~s1~_~s2~_240201_HQ1_ILP_rev_J2.tcf
- Full TUFLOW result files (including .flt grids) for the 'greenway-500' scenario for the full range of flood events including the 50% AEP, 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events, for the critical durations as identified in the Regional Model User Guide.
- Full TUFLOW result files (including .flt grids) for the 'existing' scenario for the 1% AEP event, for the critical durations as identified in the Regional Model User Guide.

4.5. Running of Hydraulic Models

The memorandum indicated that the model should be run with -s2 as “greenway-500”. This scenario also aligns with the result files provided. It is noted that this is different to the updated report, which states that -s2 should be “dev-interum”, and a different tcf is referenced than what was provided (Section 5.3.2.4.1 of the updated report). It is understood that the “dev-interum” scenario is without the dewatering of farm dam 2. For the purposes of the review, the “greenway-500” scenario was run.

The existing conditions (pre-development) scenario was also run, using -s2 as “existing”.

The TUFLOW model provided was re-run for the 1% AEP event for “existing”, “dev-interum” and “greenway-500” scenarios. The enveloped results (maximum results taken from 3 durations simulated for the 1% AEP event) were compared with enveloped grids produced by WMAwater based on the individual result grids provided by Calibre. This comparison indicated no difference in the results obtained for the 1% AEP event, indicating the model was successfully run and results were replicated.

4.6. Hydraulic Model Review Outcomes

The following items were checked during the hydraulic review:

- Terrain representation (Digital Elevation Model or DEM) including terrain modifications such as breaklines;
- Surface roughness;
- Hydraulic structures;
- Boundary conditions;
- Initial conditions;
- Modelled events and scenarios;
- Result grids; and
- Comparisons of results grids, between the Regional Model, the pre-development scenario and post-development scenario.

The outcomes of the review are summarised in the following sections below.

4.6.1. Initial Water Level

The initial water levels applied are consistent with the updated report and at the levels that represent the lowest outlet level. However, the initial water level polygon for the proposed Pondicherry Lake does not cover the entire lake area. At the start of the simulation this results in a 3 m ‘wall’ of water suddenly being released into ‘dry’ areas of the lake. This results in high velocities simulated within the lake (see in Calibre’s velocity maps), when in reality velocities within storage areas are typically very low. A screenshot is provided in Figure 1.

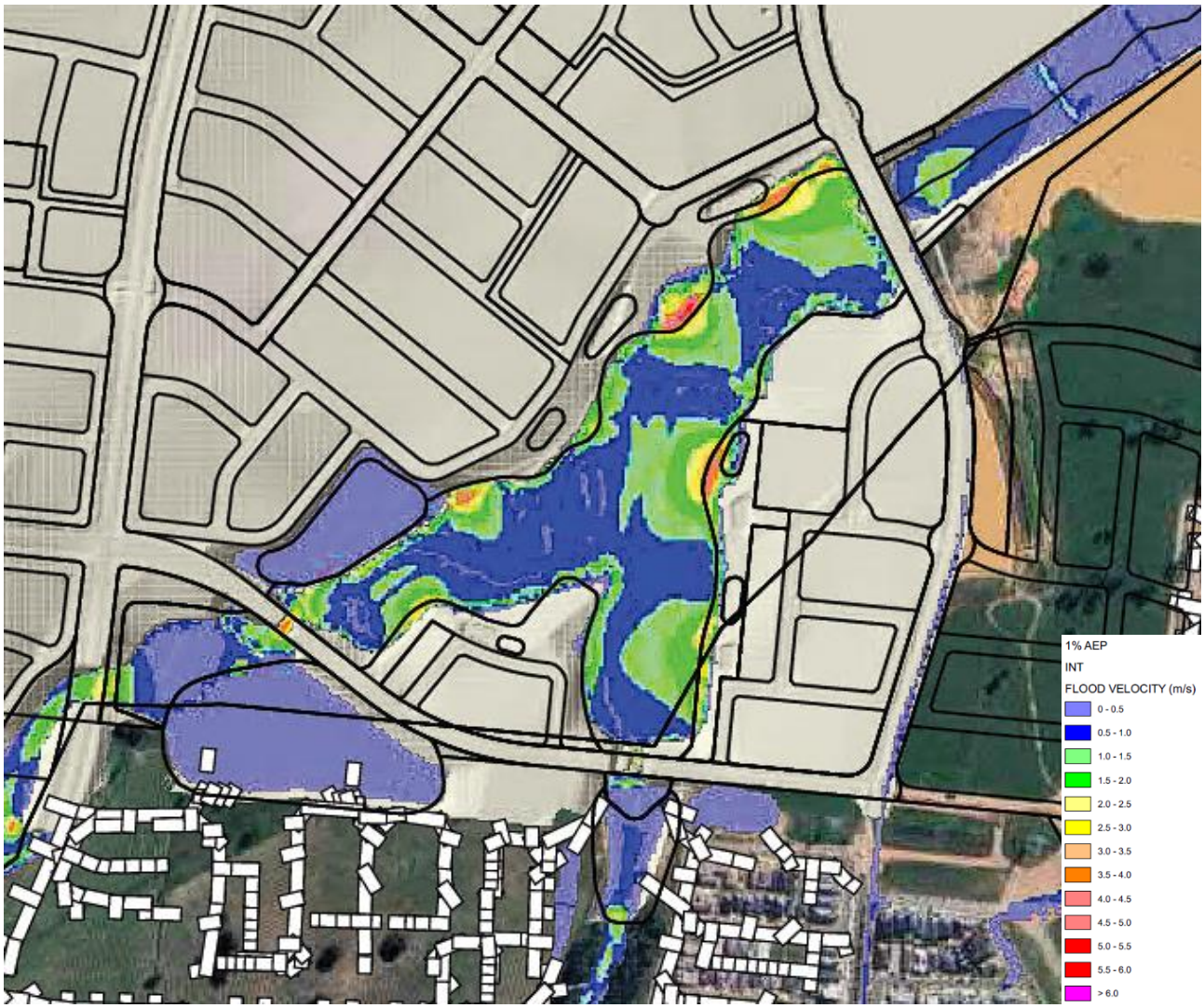

Figure 1: High velocities modelled within the proposed Pondicherry Lake due to initial water level polygon

This also results in a lowering of the water level in the entire lake at the start of the simulation, as shown in Figure 2.

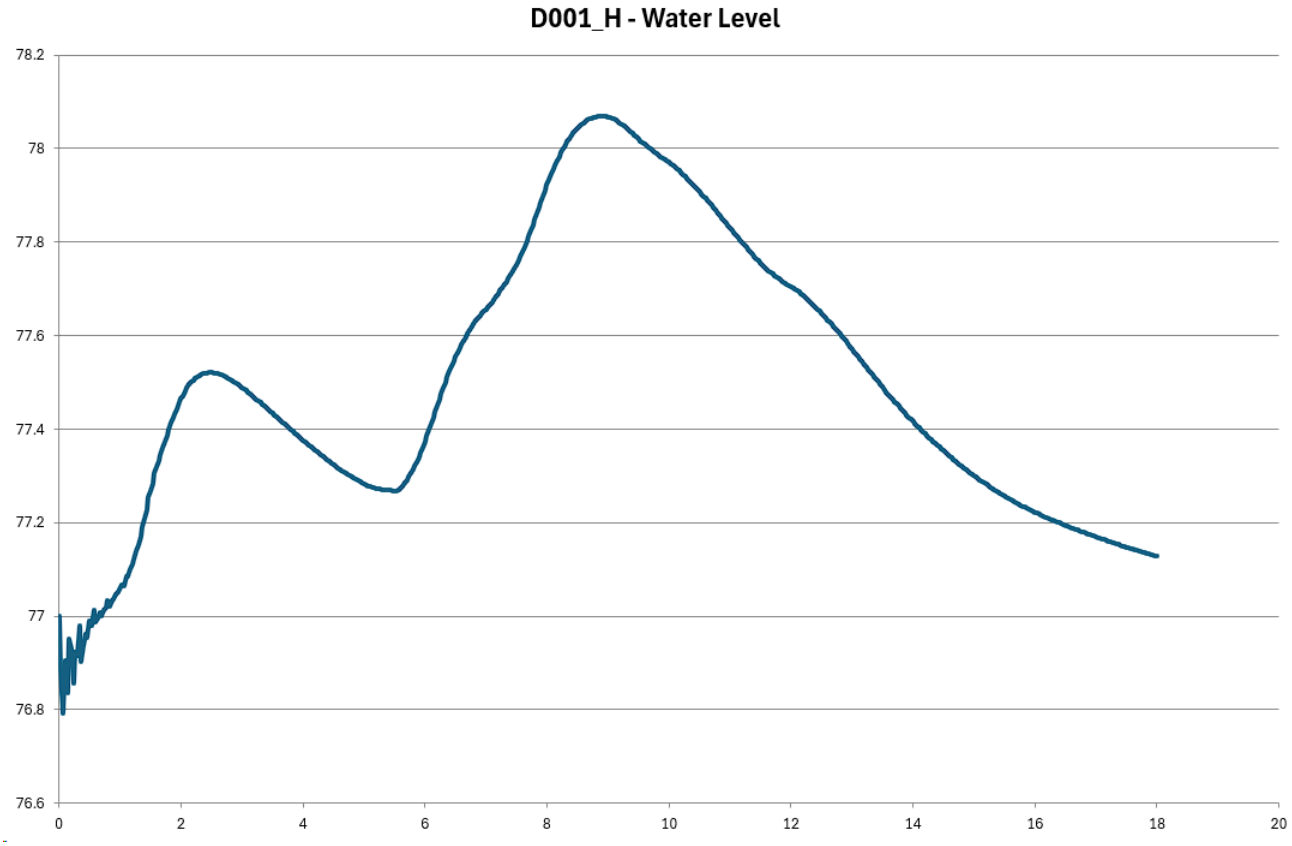

Figure 2: Lowering of water levels in the proposed Pondicherry Lake at the start of the simulation

This considered to be a minor issue that would not have a significant influence on the outcomes of the flood assessment.

4.6.2. Road Crossings

The proposed road crossings have been implemented with 2d_lfcsh polygons. This approach is considered reasonable at this stage of the proposal. However, the eastern road crossing is not implemented correctly and results in a complete blocking of flows., which are diverted around the structure. This is shown in Figure 3. This considered to be a minor issue that would not have a significant influence on the outcomes of the flood assessment.

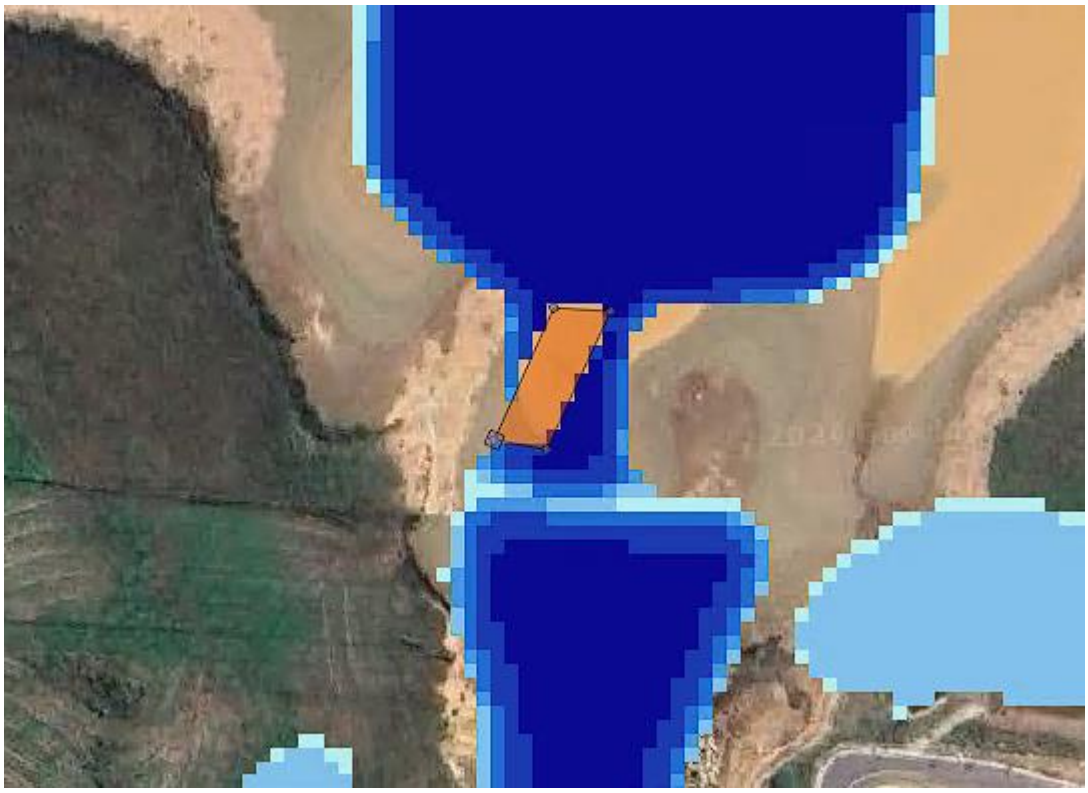

Figure 3: Incorrect LFCSH representing a road crossing.

4.6.3. Materials

The surface roughness values have been adopted based on the Regional Model. For the post-developed conditions, this includes a Mannings 'n' of 0.045 for the proposed residential areas. This was adopted in the Regional Model for rural residential areas. The proposed residential areas should be modelled as 'medium density residential', with a Mannings 'n' of 0.06. This value could even by higher since proposed buildings are not included in the model. The same approach would apply for the proposed commercial areas simulated for the post-development scenario. Since flooding is contained within the creek corridor up to and including the 1% AEP event, and in the PMF only minor affectation of developed areas is simulated, this would have little impact on the flood behaviour and would not have a significant influence on the outcomes of the assessment.

5. FLOODING AND WATER CYCLE MANAGEMENT REPORT REVIEW

5.1. Data Provided

The following data was provided related to the reporting:

- "Pondicherry Precinct - Flooding and Water Cycle Management" (Calibre, prepared for Department of Planning and Environment / Camden Council, 7 February 2024), including associated attachments.
- Memorandum "Pondicherry Precinct – Flood and Water Cycle Management", dated 7 February 2024.

These two documents are referred to as the updated report and the memorandum, respectively.

5.2. Review Outcomes

The updated report documents the background information, planning context, flood study and water cycle management plan. WMAwater's review covers the flood study component of the report. This is contained in Section 5 of the updated report.

The report briefly describes the project background and approach for water management. The hydrologic and hydraulic modelling that has been undertaken was sufficiently documented, including figures and tables to complement the text. The methodology and results are presented, although broad statements such as "The flood modelling has shown that the stormwater strategy ensures no aggravating of flood levels within South Creek" are provided rather than stating what the impacts are. The flood impact assessment is discussed further in Section 6.

Table 1 presents a checklist of items required by the Regional Model User Guide and whether they have been provided.

Table 1: Regional Model User Guide Requirements Checklist

Item	Regional Model User Guide Requirement	Provided by Calibre?
1	Mapped Comparisons of peak flood levels:	
a	1% AEP comparison with re-run of the regional model	No, but the regional model has been adopted as the base case.
b	1% AEP comparison between pre-developed model and regional model	Not applicable as the regional model is adopted as the base case.
c	1% AEP comparison between post-developed hydrology update and pre-developed model	Not provided, although discussion on hydrologic model results is provided in lieu of this.
d	20%, 5% and 1% AEP comparison between post-developed model and pre-developed model	Yes.
2	Flow hydrographs for pre-development and post-development models at the downstream boundary of the site, confluence with South Creek and Bringelly Road for the 20%, 5% and 1% AEP events.	Not provided, however flood mapping is provided and discussion of hydrologic model results (including hydrographs) is provided.
3	Peak flood depth maps for pre-development and post-development conditions for the 20% AEP, 5% AEP, 1% AEP and PMF events	Yes.
4	Documentation of all model adjustments	Yes
5	Documentation of assumptions for proposed hydraulic structures and detention basins	Yes, in sufficient detail for a planning proposal.
6	Provision of the XP-RAFTS and TUFLOW model files	Yes

In general, it is considered that the report meets the requirements of the Regional Model User Guide. It is recommended that in future flood assessments as the proposal progresses that in addition to

afflux mapping, that an analysis of peak flows be undertaken for the 20% AEP, 5% AEP and 1% AEP events to understand the changes to peak flows. The provision of hydrographs would also benefit the understanding of the timing of flows.

6. FLOOD IMPACT ASSESSMENT

The flood impact assessment is presented from both the hydrologic model (comparison of peak flow rates, as discussed in Section 4.3) and the hydraulic model (flood difference mapping presented in Section 5.3.2.6 of the updated report). The conclusion of the flood difference mapping was that "the flood modelling has shown that the stormwater strategy ensures no aggravating of flood levels within South Creek." (p. 28). The flood level difference mapping, comparing the proposal to the Regional Model, demonstrates no increase in peak flood level within South Creek (downstream of the confluence with flows from farm dam 2) to Bringelly Road for the 50% AEP to 2% AEP events. In the 1% AEP event, however, there are increases in peak flood level at Bringelly Road. These impacts are up to 13 mm when compared to the Regional Model. If the 'existing' scenario is taken as the base case, these impacts are up to 16 mm. These impacts are not described in the updated report, but are shown visually in the afflux mapping.

In conjunction with the afflux mapping, a summary of peak flows was provided in attachment G of the updated report. At history station G052 (downstream of the precinct discharge to South Creek), the peak flows reduce for the 50% AEP to 5% AEP events. For the 2% AEP and 1% AEP events, however, there are increases in peak flows of approximately 3 m^3/s and 2 m^3/s, respectively. This represents approximately 4% and 2% increase in peak flow rates for the 2% AEP and 1% AEP events.

The flood impact assessment methodology presented in the updated report is considered reasonable for the planning proposal stage, however, the adopted base case scenarios do not truly reflect the intention of the Pondicherry Lake as the primary flood mitigation structure for a large proportion of both Oran Park and Pondicherry Precincts. Two base case scenarios have been utilised – the Regional Flood Model and an 'Existing' scenario, and there are issues with both of these:

- Adopting the Regional Model as the base case means that there is a significant portion of Oran Park is already developed. Comparing the proposal to a semi-developed Oran Park does not demonstrate that overall, the flows leaving the Pondicherry Lake (or rather the downstream farm dams) are no greater than the pre-developed conditions, which is the intended function of the lake.
- Adopting the 'Existing' scenario as the base case means that the hydrology is correct in assuming pre-developed land conditions for the generation of runoff, however, in the TUFLOW model, the Oran Park development still exists. This means that existing runoff is routed along roads, in stormwater pipes and through detention basins. This approach is also not truly reflective of pre-developed conditions. Comparing the proposal to a the 'existing' scenario provides a closer base case to true 'pre-developed' conditions, although the routing of flows (which may also affect timing) would not be accurate.

An alternative methodology was simulated by WMAwater. This involved utilising the 'Existing' scenario hydrology (such that it would represent pre-developed conditions runoff), and the 'total' flow at the existing farm dam 4 (node 1028) was applied directly in the TUFLOW model. In order to provide a 'like-for-like' comparison, this approach was also adopted for the proposed development, applying 'total' flows directly into the proposed Pondicherry Lake. This avoids the issue of routing pre-developed flows through the developed Oran Park precinct. It is recognised, however, that the delay links applied in the XP-RAFTS model would not accurately represent true routing of runoff for

either the pre-development or post-development scenario. Notwithstanding the limitations of this approach, it is considered a valid approach when compared with the limitations of the above impact assessment methods. The flood impact assessment undertaken using this method resulted in an increase in the peak 1% AEP water level at Bringelly Road of 30 mm. This is in the order of twice the impact using the alternative two methods.

The proposed flood mitigation strategy does not rely solely on the proposed Pondicherry Lake (regardless of the conclusions reached with the hydrologic modelling that indicated the proposed lake had “sufficient volume”). It also requires modifications to farm dams 2 and 3 in order to be effective. Prior to the dewatering of farm dam 2, (simulated by the “dev_interum” scenario in the TUFLOW model), the afflux upstream of Bringelly Road in the 1% AEP event was 0.09 m. Under the current scenario, storage in farm dam 2 is required to ensure no (or minimal) downstream impacts). This essentially deflects the management of flood impacts to the downstream precinct. This was also the approach taken with Oran Park. It is understood that this is likely required due to the interim nature of the solution and the issues with flood peak timing with South Creek. The Greenways Precinct will need to tie up any ‘loose ends’ and ensure that the final discharge to South Creek is managed appropriately.

Given the stage of the development (planning proposal), the opportunity to refine the lake configuration (and interim farm dam configuration) and the opportunity for further mitigation works to be integrated into the downstream Greenway Precinct, these impacts as presented in the updated report are considered reasonable. It should be demonstrated at later design stages that a flood mitigation strategy can achieve no increase in flood levels at Bringelly Road, considering an appropriate base case condition.

7. CONCLUSIONS AND RECOMMENDATIONS

WMAwater has undertaken a review of the Pondicherry Precinct – Flooding and Water Cycle Management Report (Calibre, 2024) and the associated modelling provided. The review focussed on the ‘flood study’ component of the report.

The hydrologic modelling is considered to be a reasonable representation of the pre-development and post-development conditions for the purpose of a flood impact assessment. While the hydrologic modelling can inform the design of the proposed mitigation structures, for the main Pondicherry Lake it is recommended that the TUFLOW model results be used due to the complex flood behaviour across the wider floodplain, where routing, storages and timing of flows appears to be critical.

The hydraulic modelling of the proposed development is considered to be a reasonable representation. There were only minor issues identified with the model that would not significantly affect the outcome of the flood assessment. There are limitations in the adopted approach for representing the pre-developed conditions which may influence the outcomes of the flood impact assessment. Given the stage of the development (planning proposal), the opportunity to refine the lake configuration (and interim farm dam configuration) and the opportunity for further mitigation works to be integrated into the downstream Greenway Precinct, the approach and the results are considered reasonable. It should be demonstrated at later design stages that a flood mitigation strategy can achieve no increase in flood levels at Bringelly Road, considering an appropriate base case condition.

The remaining items covered by the flood study, including hazard assessment, flow distribution and velocities, climate change, flood evacuation and the flood behaviour in the western catchments are

considered reasonable. The items raised in WMAwater's previous assessment were addressed as follows:

- XP-RAFTS and TUFLOW models aligning with the report were provided
- Details of flood mitigation structures were provided
- Evacuation was further detailed
- Flooding through the western catchment was mapped and briefly described
- Downstream impacts were mapped and described
- The full range of flood events were assessed
- The assessment has considered accounting for the Oran Park development for the Pondicherry Precinct flood mitigation strategy

The updated report is considered to meet the requirements of the conditions outlined in the Department of Planning and Environment Conditional Gateway Determination (24 July 2023). The updated report demonstrates that, for the purpose of a planning proposal, the proposed development is compatible with the flood hazard and a flood mitigation strategy can be developed to ensure no adverse downstream impacts. This strategy will require refinement as the design of the precinct progresses.

Yours Sincerely,

WMAwater

Michael Reeves

Principal