ARUP

Technical Note

Project title	RFD 2022 Major Flood Model Update Stanley River and Neurum Creek (SRN) Catchment
Job number	305456-00
File reference	Peer Review Technical Note
cc	Alana Mosely
Prepared by	Greg Rogencamp, Kok Keng Tan
Date	3 February 2025
Subject	Independent Technical Review – Technical Note

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1. Introduction

City of Moreton Bay (CMB) is currently undertaking a major flood model update of the Stanley River and Neurum Creek (SRN) Catchment and has commissioned Arup to undertake an independent technical review of the hydrologic and hydraulic models in line with CMB project brief requirements.

This technical note documents the methodology and findings associated with the review.

2. Supplied Data

This technical review has been undertaken using the following supplied data:

CMB Methodology Reports:

- RFD ARR 2019 Methodology and Pilot Study Report (Arup, 2021)
- Draft HEH Modelling Methodology technical note (BMT, 2022)
- Bridge modelling method technical note (BMT, 2022)

GIS:

- POI Locations
- Stream and rain gauge locations
- Sub-catchment, reach and junctions

WBNM Model:

- Model and associated results for the following events:
  - Design events (existing and future conditions)
  - Historical events (February 2022, January 2011, May 2015)

TUFLOW Model:

- TUFLOW Control file (SRN_R_003a_~s1~_~e1~~e2~_~e3~_~e4~_67)
- All associated TUFLOW model input files for calibration and design events
- All associated TUFLOW model results and log files for calibration and design events
- Check files

Report

The following documentation was received:

- A work in progress report to assist with the flood model review
- Internal review records for model calibration dated May 2023
- Internal review records for HEH model development April 2024

Other

- Blockage calculation spreadsheet for bridges and culverts.
- Spreadsheets summarising critical event selection process and final summary at 21 POI's
- Spreadsheet showing scoring for all events/duration/HEH points from final HEH model.
- Memo for IFD sensitivity analysis modelling for Redcliffe catchment (Water Tech, 2023)

3. Summary and Recommendation

The models and methodology were generally found to be sound and in line with current best industry practices. For details of review elements and comments, refer to the 'Flood Model Verification Record' attached at the end of this technical note.

Reliance Statement

The sole purpose of this technical note the associated services performed by Arup is in accordance with the scope of services set out in the contract between Arup and CMB for the Project. In preparing this technical note, Arup has relied upon, and presumed accurate, information provided by CMB. Except as otherwise stated in this technical note, Arup has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Arup has undertaken this peer review in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures, and practices at the date of issue of this technical note. For the reasons outlined above however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in the technical note, to the extent permitted by law.

This assessment has been prepared on behalf of, and for the exclusive use of, CMB, and is subject to, and issued in accordance with, the provisions of the contract between Arup and CMB. Arup accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this technical note and flood modelling by any third party.

DOCUMENT CHECKING

	Prepared by	Checked by	Approved by
Name	Kok Keng Tan	Greg Rogencamp	Greg Rogencamp
Signature			

Attached: QA review form

ARUP

Subject	Flood Model Review Checklist		
Date	13 January 2025	Doc Ref	305456_SRN_CHECK
123123			

Flood Assessment Model Checklist			
Project Name	RFD 2022 Major Flood Model Update Stanley River and Neurum Creek (SRN) Catchment	**Date**	13/1/2025
		Version	2

DESIGNER		
Company / Staff	**CMB**	Sean Cowan

REVIEWER		
Company / Staff	**Arup**	Greg Rogencamp, Kok Keng Tan

Notes:

- This checklist is a tool to be used by modellers as a QA mechanism.
- This checklist is a general overview of typical design elements.
- This checklist is to be used for all phases of design. It is to be completed and included at each formal review phase of the project. It is best employed as a living document during the execution of a project.

1 Calibration Performance Checklist

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
WBNM and TUFLOW Calibration Performance				
Missing and incorrect data has been dealt with appropriately	A source of uncertainty that could have appreciable effects on the calibration outcomes is the rainfall depths – this relates to its recorded (and subsequently applied) distribution and intensity. The Thiessen polygon approach is a standard and proven approach. However, it can never guarantee accurate application of rainfall, acknowledging (i) the coarseness of the gauge network density, and (ii) its inability to capture the inherent localised variability of actual weather events. As noted in the report, the Woodford and Ferris Knob gauge rainfall totals were manually increased by 20% across the 2022 and 2011 events. 1. **While this approach seems reasonable for the February 2022 event as higher rainfall total was captured at nearby gauges, is there other justification or reasoning behind this adjustment? (i.e. historical radar images).** 2. **What is the basis to support a similar approach for the January 2011 event? No nearby rainfall gauge recorded totals above 800 mm.** 3. **How would the outcome differ without the 20% artificial rainfall increase in the 5m TUFLOW model run ?** 13/1/25: Responses noted. Between the two major events (2022 and 2011), there is a consistent trend where	**Query 1:** Historical rainfall images were not used to support rainfall adjustments. Increases to rainfall were based on initial modelling of the February 2022 and January 2011 model events. After testing various parameters to try improve model calibration, modelling still underpredicted water levels in these events. It was decided that it was possible the current rain gauge network may not provide adequate spatial distribution of these rainfall events (particularly considering the size of the catchment), and consequently it was considered possible that some volume in the storm may be missing. As part of this independent review process, rainfall radar images have been viewed to see if further justification could be gained for the rainfall increase. The process was inconclusive; see APPENDIX A **Query 2:** A January 2011 test was initially run without the rainfall increase (but with the adopted increases to Manning's n values). Like the February 2022 event model results, the 2011 model results under-predicted compared to the	Medium	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
	Woodford Gauge requires a manual rainfall uplift to achieve a better match on peak flood level. The radar image in Appendix A indicates that high-intensity rainfall did occur over the mid-catchment region. This suggests that the current mid-catchment rainfall gauge network is insufficient to adequately capture rainfall variation. Overall, given the available data and approach, it is considered that the standard model parameters relevant for subsequent design event runs have been appropriately calibrated and the performance is unlikely able to be improved further. Based on the information presented, it is deemed that sufficient research and testing have been conducted and approach taken is in line with best practice. This comment is now closed.	recorded peak. Results of this test are shown in APPENDIX B of this document. A 20% increase in rainfall was then tested which produced good correlation to gauge levels. It was believed this was a more reasonable approach to calibration than further increases to roughness values. Note - the May 2015 event applied parameters from the February 2022 event, including the rainfall increase, without initially testing model results without the rainfall increase. As May 2015 was a validation event only, no update is proposed at this stage. **Query 3:** Similar to the test discussed above, a sensitivity has been undertaken, using the final TUFLOW model and removing the 20% increase to rainfall for the January 2011 event, to see how the outcome would differ. Result figures are also shown in APPENDIX B. The following was noted: • Peak water level reduced at the Woodford gauge by approximately 310mm compared to the original validation results. The overall shape remained fairly similar to original results - the main difference is at the event peak.		

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
		• Peachester gauge demonstrates minor peak water level reductions of approximately 80mm. • In general, the largest water level reductions were at Woodford and the surrounding catchments.		
Peak and volume of flow hydrograph match	The WBNM model was jointly calibrated with TUFLOW to flood level hydrographs at two gauge locations along Stanley River (Woodford and Peachester). The timing, pattern and peak flood levels across all three (3) events are reasonably well matched to those recorded. Validation against the flood marks data, on the other hand, showed mixed results. There is likely some limitations around the reliability of flood mark data. Accordingly, it may be more prudent to place greater weight on the performance at the stream gauge. 13/1/25: Response noted.	This statement aligns with adopted approach; focus was placed on alignment with gauge recorded results primarily, with flood mark results subsequently reviewed.	Commentary No action	Closed
Other comments/issues	Majority of the crossings leading towards the stream gauge are overtopped in larger floods. Hence, it is deemed that the effect of debris blockage/structure losses is insignificant. The key approach to improved calibration performance at both stream gauge locations was through increasing rainfall depths being applied. Notably, values for Material Type 1 (i.e. Low Grass Grazing) which forms the majority of the floodplain was increased to 0.06. For the February 2022 event, comparison of calibration results at Woodford Gauge between run T28 (Base) versus Modified Manning's (T26) showed negligible improvement.	**Regarding stream roughness values;** A sensitivity test was undertaken during SRN calibration, which increased the waterbody Manning's (TMF ID =15) from 0.03 to 0.04. Details regarding this test are within APPENDIX C. This test concluded that it was not beneficial to increase the waterbody Manning's n value as it did not significantly increase peak water levels at the gauges. **Regarding continuing loss values;**	Medium	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
	In reviewing the 'Z0' grid, most of the high intensity flow leading towards the gauge locations occurs within the channels covered by 'Waterbody', which is defined as 0.03. As these are highly vegetated mountainous streams, a higher Manning's n value could be justified. **Has any further effort been expended to review the roughness values of the streams (i.e. adopt a higher Manning's n for 'Waterbody' to improve the calibration results)?** Of note, the continuing loss values applied for calibration events (1mm/hr) are lower than ARR Data Hub losses. Application of lower continuing loss, in effect, also increases the rainfall depths being applied. It may be worthwhile to sensitivity check the calibration event performance when standard design losses (2.1mm/hr) are adopted. 13/1/25: Responses noted. Comment closed.	Noted that lowering continuing loss values essentially increases rainfall depth. The chosen value was an outcome of calibration and was only used during calibration runs (ARR Data Hub values used for design event runs). In the initial part of calibration modelling (Feb 2022), a test was undertaken comparing use of 0mm/hr and 2.5mm/hr continuing loss. Results of this test are shown in APPENDIX D. This test indicated dropping the continuing loss value from 2.5 to 0mm/hr increased peak water levels by 300-400mm at the Woodford gauge (noting that this was an earlier build of the model). This was a significant outcome as the model was underpredicting water levels. As a zero continuing loss value is unrealistic, a 1mm/hr continuing loss value was adopted to support better model calibration. It is noted some other RFD catchments also utilise continuing loss values of 1mm/hr in calibration events - lower than ARR Data Hub values. However, it is identified that the February 2022 and January 2011 events were multi-day flood events. It is possible that over such a long duration, continuing loss could reduce through the event as the catchment becomes more saturated and infiltration reduces. This may justify the use of a lower continuing loss value as compared to design event simulations,		

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
		which for this catchment occur over a shorter duration. Some commentary on reduced CL for long events can be found in ARR19 (see Section 3.7.2) which may be relevant in this scenario. As such, ultimately ARR Data Hub loss values were adopted for design event runs.		

2 WBNM Hydrologic Modelling Checklist

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Catchment Definition				
Catchment boundary drawn correctly	Extents seem slightly underestimated at BRC001_16543, ONE001_17200, and NEU009_00000; while appear slightly overestimated at STL040_01967. No updates are needed at this time - but this could be improved in future model revisions 13/1/25: Response noted.	Noted, to be considered in future update	Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Sub-catchment boundaries drawn correctly	Variation in sub-catchment sizes and shapes are observed. No updates are needed at this time - but the following could be improved in future model revisions: • Refine sub-catchment boundaries to align with transport routes (e.g., MBC008_00429) and stream gauge locations (e.g., STA001_25783). • Refine sub-catchment boundaries in accordance with topology (i.e. MBC010_00000 can be split into 2 sub-areas contributing into two different watercourses.) • Align delineation to be more consistent with WBNM software guidance 13/1/25: Response noted.	Noted, to be considered in future update	Commentary No action	Closed
Network structure is correct	Spot check indicate definition appropriate.		Commentary No action	Closed
Subareas, reaches and nodes names appropriate	Overall appropriate.		Commentary No action	Closed
Output locations are consistent with project goals	Overall appropriate.		Commentary No action	Closed
Areas have been entered correctly	Spot check indicate definition appropriate.		Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Surface type division is appropriate and correct	Surface type division is based on region wide EIA raster. Visual spot checks were undertaken using ESRI aerial imagery to verify the impervious fraction. The catchment is predominantly undeveloped/rural. Therefore, the overall FI is appropriate. However, FI appears low for localised developed areas. For example, ONE043_00000 consist of high density residential with limited open space, but only has a FI of 30% (existing). Another example, ONE021_0000 consist of various lots under construction with a FI of only 2% (existing) and 6.8% (future). Given that the EIA raster was developed in prior stages and applies to all RFD studies across the region, no updates are needed at this time. It is recommended that the methodology for deriving the EIA raster be reviewed in future model revisions. 13/1/25: Response noted.	See APPENDIX E for imagery. Regarding ONE043_00000, driveways have been missed when defining Fraction Impervious, but otherwise, the spatial definition appears appropriate. It is noted that ARR19 guidance requires reducing impervious area totals to account for direct and indirect connected impervious areas, hence the impervious areas identified were given an effective impervious area of 70% of the total impervious area for this subcatchment. Regarding ONE021_0000, this subcatchment has undergone substantial development over recent years. The landuse raster is based on 2019 aerial photography. Future updates to the RFD will periodically correct out-of-date landuse definitions.	Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Impervious fractions have been entered correctly	Comparison between existing and future conditions fraction impervious indicates that 264 sub-areas (out of the 1173 sub-areas) have reduction in FI, which seems unrealistic. For example, STL011_01403, which includes Neurum Road and some open space, has an existing FI of 20.3% but a projected future FI of 9.6%, which seems unrealistic since the road is unlikely to disappear. Whilst it is desirable to adopt the larger FI between existing and future EIA raster on individual sub-catchments (unless reduction is justified), no updates are required at this time, as the overall FI under future conditions is still an increase from existing conditions. It is recommended that the methodology for deriving the EIA raster be reviewed in future model revisions. 13/1/25: Response noted.	This is an issue due to the different spatial methodologies utilised in the creation of the existing EIA raster and the future EIA raster. For other RFD catchments, where the future FI was less than existing, the future FI value was made equal to the existing value. This was not undertaken for SRN through omission. SRN is generally not a highly-developed area. There are only 10 subcatchments for which the future FI value is 3% or more lower than the existing FI value, so it is agreed that the impact of this omission is likely minimal. The method for deriving the future EIA raster will be reviewed in future model revisions- at minimum, for SRN, future EIA will be made to equal existing EIA.	Commentary No action	Closed
Slope calculations are appropriate and correct	Not applicable as slope is not a catchment parameter in WBNM.		Commentary No action	Closed
Routing calculations are correct	Definition of routing would be important for HEH, given that the critical event is determined wholly in WBNM. For reference, the WBNM guidance to stream lag factor are as follow: For natural catchments and streams, the Stream Lag Factor is set at 1.0. If however the stream is modified so that flow velocities and lag times change, then the Stream Lag Factor can be adjusted accordingly. For example, if the stream is lined so that velocities increase by 50%, then lag times through the stream channel will be 0.67 of the original value, so the Stream Lag Factor would be adjusted to 0.67. Guidelines for the Stream Lag Factor are : Natural channel 1.0 Gravel bed with rip-rap 0.67 Excavated earth 0.5 Concrete lined 0.33 Note: In previous versions of WBNM the value 0.6 was entered in the runfile. In recent versions of WBNM, this factor is built in to the model. For natural streams, you should use a Stream Lag Factor of 1.0. The computer program will then automatically factor the lag times for the stream by 0.6	Correct, the HEH process was undertaken iteratively, and progressively reviewed. Working from upstream to downstream, all HEH points were refined in 12 iterations. As a part of each iteration, multiple stream lag factors were tested for each HEH point. If a good match was unable to be achieved, storage was added to the HEH point (using the ideal SLF value) to try achieve a better match.	Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
	The range of lag factors applied in model is between 0.3 to 2.3, but overall (average across all sub-areas) is closer to 1. There are few slightly out of range values noted which does not seem to match the aerial image or the flow velocities. To name a few: • SLF leading to POI MBC029_01031 was set to 0.3. This is a natural stream with 1% AEP flood velocities approximately 1m/s however with various storages upstream (dams and embankment noted). Whilst out of range, a fair performance in HEH is achieved using this approach. • SLF leading to POI STA001_31038 was set to 2.3 (for several sub-areas covering watercourse from east). Although floodplain is observed, the report highlighted that adopting storage would not improve HEH performance. The overall SLF leading to this POI was higher than WBNM recommended guidelines for natural channel of 1. It is assumed that internal reviews and iterations have occurred to refine the values in conjunction with storages to achieve hydraulic equivalence at selected POIs. Therefore, these values are deemed acceptable, and no changes are recommended. 13/1/25: Response noted.	In some cases, a SLF outside the normal range was selected. Whilst some values may appear synthetically high/low, SLFs were purposefully chosen in line with the general HEH methodology to develop a functional HEH model.		
Special elements have been entered correctly	A total of 24 artificial storages (HSQ) have been applied upstream of selected POI in the WBNM model. Numerous small farm dams/detention basins are located throughout the sub-areas but not explicitly represented in WBNM. The scale of these features is insignificant in comparison to the	Storage was one of only two mechanisms that could be modified in the HEH methodology to achieve a better outcome. Like SLF, it meant that in some cases, an artificial value was applied to achieve satisfactory performance	Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
	overall study - hence it is acceptable to not represent them in model. Artificial storages are generally expected in areas with known storages, large floodplain, or flow transition area. In this case, artificial storages are noted to be applied to improve HEH performance in conjunction with routing parameters. The calculations for deriving storage were not reviewed but are assumed to correctly follow the recommendations in the BMT methodology document. A cursory review was conducted, with commentary below: • There is generally no obvious flood storage upstream of several POI (i.e. STA034_01435, STA069_02931, STA029_04427, MBC025_00709 etc). However, added in conjunction with an altered SLF and resulted in good HEH performance. • No review of how storage curves were derived - however storage seem to be slightly overestimated for MBC029_01031 and STA020_01574. Also, STA020_01574 seem to have a significant amount of storage allocated but no obvious features to support it. • Further improvement at POI STL018_01557 may be possible with inclusion of storage It is assumed that internal reviews and iterations have occurred to refine the values in conjunction with routing parameters to achieve hydraulic equivalence at selected POIs. Therefore, these values are deemed acceptable, and no changes are recommended. 13/1/25: Response noted.	(even if visually identifiable catchment storage features were not apparent). MBC029_01031 - noted storage appears slightly overestimated. Multiple storages were attempted for this point, and a value needed to be adopted to progress the project. Noting- this POI is outside Moreton Bay City Council's LGA, and downstream HEH points are able to achieve satisfactory results despite slight overestimate in storage. STA020_01574 - agreed, WBNM peak is generally lower and appears to overestimate storage. However, considering all events and metrics assessed (peak magnitude, timing and NSE), a good overall result was achieved. For this location storage was added as the HEH score achieved using only SLF was 75 (poor) - adding storage brought the average score down to 19 (below 18 considered 'excellent'). Storage was therefore applied to achieve better hydraulic equivalence. STL018_01557 - potentially could be improved with storage. However, the score achieved using an SLF only approach was good, so adding storage was not seen as necessary.		

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Rainfall				
IFD method and parameters are correct	LIMB IFDs were applied to each sub-area via storm injector. Spot check for IFD applied for STL058_00000 (1% AEP 18 hour event, ARFa) showed consistent rainfall depth applied to WBNM file from Storm Injector. While individual checks were not conducted, the approach is appropriate, and the values are assumed to be correct.		Commentary No action	Closed
Pre-Burst Application	Pre-burst was applied using the GSDM temporal pattern. For design storms longer than 3 hours, the total duration for pre-burst was capped at 4 hours. In longer duration storm, the default temporal pattern timestep is large (i.e. 18-hour storm has a timestep of 60 minutes), resulting in the pre-burst being distributed over only 4 timesteps, which leads to a high burst depth per timestep. Please comment on the rationale for limiting the pre-burst duration to 4 hours and using a GSDM pattern for long duration storm (i.e. duration of 12 hours and longer) and if this has any implication on results. 13/1/25: Response noted. Approach for SRN is consistent and follows the approach for all other catchments. Comment closed.	The original recommendation from the Pilot Study was to use pre-burst temporal patterns published in Jordan et al 2005 for point temporal patterns (durations less than 12hrs) and to use GSAM coastal region pre-burst patterns for areal temporal patterns (durations 12hrs and longer). These patterns were found to be impractical for catchments like Redcliffe, where short storms were critical, as the preburst storm was much greater in length than the burst storm, affecting model run times. Testing was completed on multiple catchments (other than SRN) to identify an alternative approach to preburst patterns, which was then applied to SRN. The following decision was made for preburst pattern application, which was adopted for all catchments (inclusive of SRN): 1. Apply median preburst depth values distributed using the 1hr GSDM pattern for storm durations of 1hrs and less 2. Apply median preburst depth values distributed using the 2hr GSDM pattern for storm durations of 1.5 and 2 hours. 3. Apply median preburst depth values distributed using the 4hr GSDM pattern for storm durations of 3 hours and greater. Reasoning included:	Low	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
		• Preburst "remnant" (preburst less initial loss) is significant for multiple catchments in MBRC and requires distribution using a preburst pattern • Limited guidance available on preburst patterns • Testing for Sidling and Pumicestone minor basins indicates cannot distribute over a 2 hour preburst storm (a proposal developed after Redcliffe catchment testing) without impacts on peak storm flows • Testing for Sidling indicates preburst over 4+ hours using GSDM pattern has 'acceptable' impacts on peak flow • Testing for Pumicestone indicates preburst over 6+ hours using GSDM pattern has 'acceptable' impacts on peak flow • 4hrs will produce conservative results for some catchments but allows practical run times • GSDM pattern is better than an even-distribution (completely artificial) pattern		
Duration and intensities are correct	Full suite of storm duration (30 min to 5760 min) simulated. Duration coverage appropriate for catchment.		Commentary No action	Closed
Temporal patterns and zones are correct	Spot check indicated East Coast North patterns were adopted for design events up to 0.05% AEP. The application of classification (frequent, intermediate, rare) and zones (areal and point TP) appears appropriate.		Commentary No action	Closed

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
ARF applied correctly	ARF categories between ARFa to ARFj simulated, covering area ranges between 1km^2 to 575km^2. This is appropriate for size of catchment. Of note, ARF is only applied for design rainfall depths and not pre-burst depths. However, the effect of pre-burst on the final outcome of this study is deemed minimal. Therefore, no update is required. Comment noted here for info only. 13/1/25: Response noted.	ARF is not applied to preburst for all RFD catchments. The approach to preburst was modified subsequent to the Pilot study (primarily owing to use of LIMB IFDs) and will be re-visited at a future model update.	Commentary No action	Closed
Allowance for Climate Change incorporated as per brief	Allowance for climate change (i.e. 20% increase in design rainfall depths) is only applied for design rainfall and not pre-burst. However, the effect of pre-burst on the outcome of this study is deemed minimal. Therefore, no update is required. Comment noted here for info only. 13/1/25: Response noted.	This is consistent with other RFD models, and is due to a limitation with Storm Injector. The Storm Injector method for preburst does not allow for increasing preburst with climate change when preburst depths are used. The approach to preburst was modified subsequent to the Pilot study (primarily owing to use of LIMB IFDs) and will be re-visited at a future model update.	Commentary No action	Closed

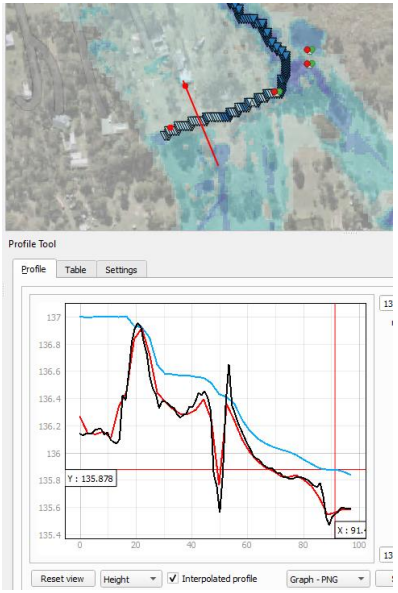
Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Extreme event modelling methodology is in line with ARR19	The extreme event (i.e. 0.1% and 0.05% AEP) modelling methodology aligns with ARR19. However, 1% AEP pre-burst values are adopted for rare events (no scaling). The effect of pre-burst on the outcome of this study is deemed minimal. Therefore, no update is required. This approach differs to the pilot study methodology. It is recommended to clarify any differently adopted approach in reporting. 13/1/25: Response noted. Comment closed.	The pilot study methodology recommendation (that the 1% AEP pre-burst to main burst ratio is applied to the 0.1% AEP main burst to calculate the 0.1% AEP pre-burst value) was not applied to any catchment during this Regional Flood Database major update. At the time of the Pilot Study, the use of LIMB IFDs was not considered. As such, following the Pilot Study advice directly would result in inconsistencies in preburst values, with events greater than 1% AEP using values based on a ratio to LIMB IFDs, and events less than 1% AEP using depths based on BoM 2016 IFDs. The appropriate approach to preburst with custom IFDs will be re-considered in the next RFD update. The current approach for SRN is consistent with the approach for all other catchments and will be highlighted in the project report.	Low	Closed
Losses and coefficients				
Loss method and values is appropriate	Spot check supplied Storm Injector file indicated the following has been applied appropriately in line with pilot study recommended methodology: • IL and CL method using ARR Data Hub values. • Embedded burst filtering • ICA Burst loss applied. 13/1/25: Response noted.	EIA is determined outside of Storm Injector and Storm Injector functionality relating to indirectly connected impervious area is not utilised.	Commentary No action	Closed
Simulation				

Check Item	Reviewer Comments (Arup)	Designer Response (CMB)	Rank	Reviewer Closeout
Run time step and duration are appropriate	Simulation files auto-generated using Storm Injector. Warning messages were observed in WBNM out file which state: "Less than 95% of the rainfall excess has appeared as runoff". This is attributed by the large storages and lag introduced to the model. Hence, although the peaks are captured, the hydrographs may not fall to zero. An independent volume check was carried out with a 100mm storm (0mm IL and 0mm/h CL) which indicated that the ultimate volume difference captured in TUFLOW is <5%. Hence this effect is deemed minor. Approach deemed appropriate.		Commentary No action	Closed
Hydraulic Equivalence Performance				
Model Performance	Comparison of peak flow hydrograph (across a common duration/TP/ARF) between the WBNM model against the TUFLOW model output highlighted reasonably good match in majority of the POIs across the range of event magnitude studied (20%, 5%, 1% and 0.05% AEP). Overall, the model is deemed an acceptable compromise.		Commentary No action	Closed

3 Hydraulic Design Event Modelling checklist

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
General setup				

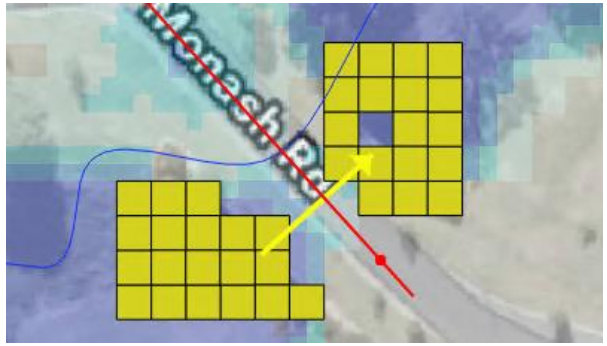
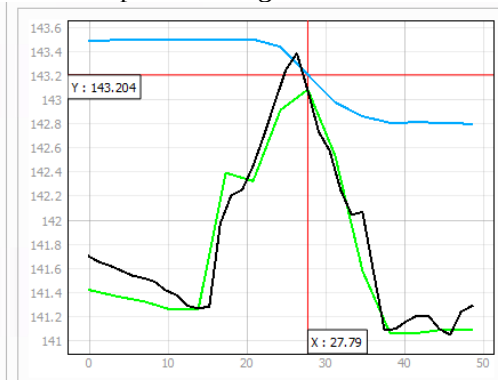
Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Any changes to model version since calibration review?	2020-10-AF-iSP-w64 version and unblocked scenario adopted for calibration. No change for existing scenario simulation. Appropriate.		Commentary No action	Closed
Model simulation run to completion?	Supplied tlf files shows simulations have run through to completion.		Commentary No action	Closed
Are event (~e~) and or scenario (~s~) logic commands used? If yes, are the options listed in the handover document?	Used and well documented.		Commentary No action	Closed
Terrain Representation (2D Domain)				
Is the cell (grid) size appropriate for the intended purpose of the modelling?	5m used. Appropriate.		Commentary No action	Closed
Is the cell size smaller than water depth in main channel/flow path of the subject study? If yes, Wu sub-grid turbulence scheme (i.e. 2020 TUFLOW HPC or newer) must be used.	Wu sub-grid turbulence scheme used. Appropriate.		Commentary No action	Closed
Is the model grid orientation appropriate?	While not ideal for this specific model (orientation orthogonal to east/west), it is deemed acceptable and consistent with other RFD studies.		Commentary No action	Closed
Is sub-grid sampling (SGS) used as the topography sampling method	SGS not used. Spot check against LiDAR showed majority of the terrain is well defined under 5m grid resolution. 13/1/25: Response noted.	Not used in final model, though was utilised to some degree during model calibration.	Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are topography modifiers appropriately applied?	Topography modifiers applied at roads, streamlines and inlet/outlet of culverts are generally appropriate. Minor suggestion noted below for future model revisions: • Terrain modifier for local channel applied within sub-area MBC004_03070. However, the ridge (immediately south of the channel, see below cross section) could also be reinforced. Based on LiDAR, the top of the ridge is showed to be higher than 1% AEP flood levels along parts of the ridge.  13/1/25: Response noted.	Ridge to be explicitly represented within future model update.	Commentary No action	Closed
Other Issues/Comments	Various watercourses flow through a series of local farm dams/detention basins and local road crossings within private properties.		Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	A detailed representation of these features is not feasible; therefore, the current model representation for these areas is considered the best approach (using a combination on LiDAR and IWL). It is important to note that flow characteristics along these watercourses may change if modifications are made within the properties; however, this will have minimal implications to the overall study objectives.			
Roughness				
Are the manning's values appropriate?	Manning's n value for four (4) types of vegetation coverage (which covers majority of the modelled wet areas) were amended from pilot study recommended values, as a result of calibration process. Notably, values for Material Type 1 (i.e. Low Grass Grazing) which forms the majority of the floodplain was altered to a constant 0.06 once flood depth exceeds 0.2m. A review of Google Streetview for areas covered under this land use suggest that this is not a 'one-size-fits-all' value, but is considered an acceptable compromise.		Commentary No action	Closed
Is / are the Materials Layer(s) delineation reasonable relative to the model cell size?	The SRN model consist almost of rural/ forested / open paddock land type. Surface coverage delineation of vegetation is defined by raster. A cursory review of the DEM_M check file indicates that the raster delineation and classification is not a true reflection of the on ground conditions. In reality, there is a greater variation of vegetation within the floodplains and creeks, and additional classifications could have been included for this catchment. Conducting manual corrections would be difficult and unlikely to add value. Hence, Manning's n values had to be altered. While this approach is not ideal, it is considered an acceptable compromise.	With respect to vegetation classification, throughout the region there are different 'types' of natural environments, e.g. eucalyptus forests, pine forests, swampland, tropical environments, as well as grassland, paddock, lawn etc. A quantifiable approach to vegetation density was created, involved using vegetation classed LAS points within the first 2m above the ground to inform the 'understory density' roughness layers. It is	Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	Spot check showed that other manually defined material layers delineation (i.e.. correction at bridge crossings etc.) are appropriate. 13/1/25: Response noted.	believed this has greatly supported calibration of models across the region, with numerically consistent definitions of areas of 'dense' vegetation. Whilst review of ground conditions in the SRN catchment does visually highlight a great degree of variation of vegetation, it is believed the understory density vegetation classification method makes progress towards quantifying different vegetation types which present a similar hydraulic roughness value.		
If multiple material input layers are used, is data layering of the Materials Layer(s) correct (i.e. The order of the files with the TUFLOW Geometry Control File)? Note, bottom most layer takes precedence where datasets overlap.	Materials layering appropriate.		Commentary No action	Closed
1d Hydraulic Structures				
Are the pipe/channel alignments correct?	Spot check indicate that pipe alignments are generally adequate. Minor observations that could be considered for future revisions: 1) Few RCBC with height larger than width noted.	1) Noted - most of these instances have been carried over from the 002c model. A couple of culverts new to 003a model have height>width but	Commentary No action	Closed

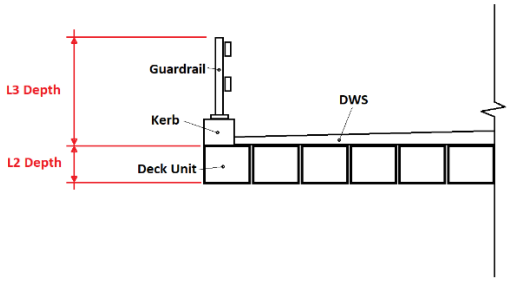
Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	2) Few low-level crossings appear to be missing definition of cross drainage (i.e. d/s of NEU054_02569, ONE035_01799 STO004_03215, west of bridge STL_34_02612). However, not critical. 3) Direction of culvert 039_00000 at low level crossing appear incorrect. 13/1/25: Response noted.	were as per available GIS data (noting reliability may be limited). Future modelling phase could undertake site visits to confirm culvert sizes. 2) Noted that there may be missing culverts in some areas. Whilst a significant effort was made to include key culverts (~100 new culverts in 003a model as compared to previous version) it is very possible that culverts are omitted. The identified missing culverts will be reviewed for consideration for inclusion in the next model update. - NEU054_02569 - not in Council GIS data - ONE035_01799 - unsure where this is referring to, potentially on private property. - STO004_03215 - minor culvert at top of Stony Ck catchment - no GIS details available. - STL_34_02612 - culvert is outside region. Could be added next update to improve results in Somerset region. Noted - 039_00000 culvert inverts appear flat - this was adopted from the 002c model. Future modelling phase could undertake site visit to confirm.		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are pipes connected throughout system (any snapping issues)?	Spot check indicate that pipe connections are generally adequate. Minor observations that could be considered for future revisions: • Extensive number of 1d_2d connections noted at Monash Road (001_12726) but one cell is missed in downstream end.  • Model definition of the road crest at this crossing could also be improved using 2d_zsh.  13/1/25: Response noted.	001_12726 - extensive SX connection included for culvert stability. Noted that one cell has been missed; connection to be improved in next model update. Agreed - road crest topography to be improved at next model update as 2019 LiDAR representation is poor. Road will likely still overtop in the same event (5% AEP appears immune, then 2% AEP overtops in multiple spots).	Commentary No action	Closed

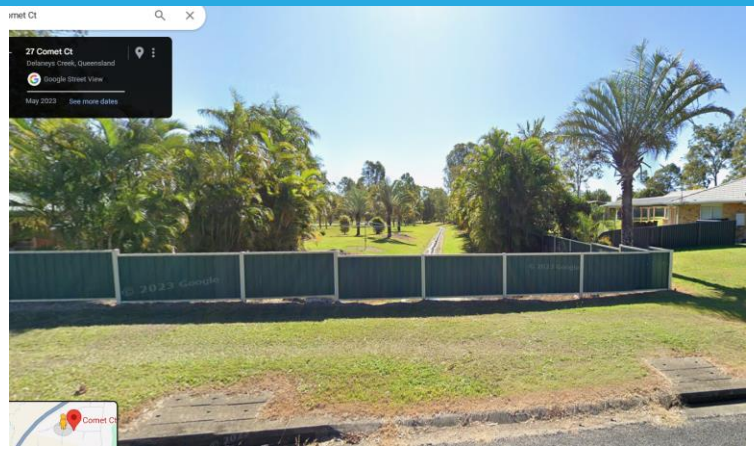
Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Is network free of grade or cover issues?	Minor observations noted for future improvements as below: 1) Spot check indicate few locations (i.e. culvert 018_07125, 001_09451) obvert almost at road level. Although the size of these culvert is questionable, this is not critical as this crossing is already significantly overtopped. 2) Downstream invert of 056_00920 appear to be higher than creek bed. 3) Few negative/zero slopes noted. 13/1/25: Response noted.	018_07125 - agreed, culvert obvert and crest are very close. 001_09451 - agreed, 3.5m diameter is large and obvert similar to road level. In both cases, road is significantly overtopped. Culvert dimensions could be checked in future site visit to inform next model update. 056_00920 - noted that invert is above the creek bed. This may be possible in reality; aerial photography indicates scour downstream. This location will be considered for a site visit to inform future model updates.	Commentary No action	Closed
Do drainage network asset sizes logical (i.e. increase as move down system)?	Appropriate.		Commentary No action	Closed
Are pipe lengths defined properly?	Appropriate.		Commentary No action	Closed
Are pipe manning's n appropriate? Is the manhole loss approach appropriate?	Appropriate.		Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Is the pipe geometry orientation appropriate for Engelund losses?	Appropriate.		Commentary No action	Closed
Are additional form loss pipe losses set correctly where required?	Additional form loss in pipe applied in line with methodology for blockage. Appropriate.		Commentary No action	Closed
Are contraction coefficients appropriate?	Appropriate.		Commentary No action	Closed
Is pit modelling approach appropriate?	Appropriate.		Commentary No action	Closed
Are pit loses set appropriately?	Appropriate.		Commentary No action	Closed
Is the model 1D network free from Additional Nodal Area (ANA) values, of if these have been used are the values appropriate?	N/A		Commentary No action	Closed
Are entry/exit losses set or are they automatically defined for pipes that have SX outlets?	Please comment on the rationale behind the following: • Some culverts (RCBC type) adopted entry loss of 0.4. These culverts are not significantly bigger in size/ number than the other locations which adopted the standard 0.5 value. • 037_00801b does not appear to have any losses defined. 13/1/25: Response noted. Comment closed.	**Regarding entry loss;** These loss values were retained from the previous 002c model. Noted that this deviates from the standard value applied for other RCBC culverts. Consideration will be given to changing these loss values	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		during next model update to be consistent with other culverts. **Regarding 037_00801b;** Noted - this will be updated during next model update.		
2d Hydraulic Structures				
Are there any culverts represented as 2D bridges? 2D bridges should not be used for Culvert representation unless the culvert size is greater than the cell size.	Culverts are modelled using 1d_nwk approach. Only a couple of culverts are larger than the 5m size. Selected approach is deemed appropriate.		Commentary No action	Closed
Is the approach used to define the additional hydraulic losses associated with bridges appropriate? What bridge form loss calculation method has been used (Method A (cumulative), Method B(Portion), Method C, Method D). Note, Method C and D are only available from release version 2020-10-AA or newer.	Method B used. Fit for purpose as align with other RFD studies. Minor observations noted below for consideration: • It is noted that bridge definition uses polygon method. The delineation is suitable for 5m grid resolution, however if cell size changes, may need to be re-adjusted. Potential to be updated to line method in future revisions. • The road level defined within 2d_lfcsh (i.e. L2 obvert) appear to be slightly lower than road levels. (i.e. the bridges over D'Aguilar Highway (STL_03_00564, STO_01_02777, STL_34_02612 and STL034_02612). But these crossings are overtopped so not critical. • The L1 obvert level appear to be incorrectly defined within 2d_lfcsh (STL_34_00000) (i.e. L1 obvert higher than road levels). But this crossing is overtopped so no issue.	**RE polygon method:** Noted - consideration will be given to updating bridge modelling method during next model update to ensure cell size independence. **RE L2 obvert:** For these bridges, L2 depth was specified based on the deck thickness (excluding kerb) from design drawings. However, in doing so, the deck wearing surface (DWS) has not been accounted for in L2 depth (it falls in L3 as per below bridge diagram example). Including DWS in L2 may account for minor difference in levels between the adjacent road crest and bridge deck level. Bridge representation in the	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	• A blanket L3 definition of 1.1m high and 30% blockage adopted. However, this parameter may not apply to several bridge crossings (i.e. ONE_01_01906). Note: Method D is recently available which can be considered in future revisions. With majority of bridge crossings overtopped in large floods within this catchment, Method D can be considered in future revisions due to its ability to represent overtopping better. 13/1/25: Response noted. Comment closed.	model should be reviewed during next model update to incorporate latest modelling guidance and advice.  **RE L1 obvert for STL_34_00000:** Noted - This bridge has been upgraded since the 2014/2015 002c STA model; however, it is outside the CMB region and new design information wasn't available and couldn't be visually confirmed at the time of update. Previous L1_FLC = 0.13 was applied as it is a reasonably standard value for bridges. L2 and L3 applied consistently with other bridges. This bridge representation in model should be reviewed during next model update. At this time, Council will request from SRC the design information or will undertake site visit to approximate dimensions. **RE ONE_01_01906:**		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		MBCC Response: Noted - a blanket L3 definition was applied to all bridges based on pilot study outcomes, which may be overly conservative. Bridge representation in the model will be reviewed during next model update to consider incorporation of latest modelling guidance and advice (including consideration of Method D).		
Provide spreadsheets outlining how form loss values are derived with reference to publications including page, chapter, section table etc.	General checks noted to be completed internally. Spot check showed FLC values of bridge generally ranges up to 0.25 which is within standard range. Appropriate.		Commentary No action	Closed
Other hydraulic structures	There is a fence at the crossing downstream of Comet Ct (see below). This is not currently defined but could form a blockage for overtopping flows (1% AEP flows currently overtopped by ~0.2m). This can be considered along with terrain enforcement of channel and raised kerb along Comet Ct.	This version of the RFD update saw fauna fences included within the models, but not other private fences. As this road overtops, this fence will be considered for inclusion during the next model update.	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	 Other areas to note are newly established residential areas such as the crossing at Monash Road (001_12726). 13/1/25: Response noted. Comment closed.			
Boundary Conditions				
Are tailwater level(s) or slope parameters associated with HQ downstream boundaries correct? Note, the 2020-10-AA version of HPC and newer uses a consistent approach with Classic for HQ boundaries.	Tailwater values based on fixed values taken from Seqwater's Somerset Dam HW gauge (143305A). For climate change runs, tailwater remain unchanged. This however only affect results at areas close to the boundary that is outside of CMB boundary. Method appropriate. Suggest note this limitation in report. 13/1/25: Response noted.	Gauge-based tailwater levels are utilised for calibration events only. Present-day design event tailwater levels were based on guidance from Seqwater. No future conditions levels were available and so no differences exist between future scenario and existing scenario tailwater conditions. This will be stated within the model report. It is also noted that Seqwater guidance was not provided for the 20% and 10% AEPs. In these instances, tailwater levels from the 002c model have been maintained.	Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are the model upstream and downstream boundaries a sufficient distance away from the study area?	Appropriate.		Commentary No action	Closed
Are model inflows correct?	loc and tot correctly applied. Split catchments ratios were also correctly applied. No issues found.		Commentary No action	Closed
Is the flow distribution acceptable?	Inflows applied using 2d_sa method (loc and tot). A cursory review of placement of 2d_sa indicate generally well defined. Minor observations noted for future improvements: • STL005_00799a appear to be placed upstream of a road with no cross drainage and not along the waterway corridor. • Various dams upstream of culvert 006_00977b observed, potentially having more flood storage. The 2d_sa along this watercourse could be further split along with some 2d_zsh to refine creek definition. • Splitting of 2d_sa under sub-area MBC013_00415, MBC001_12726, ONE019_00833 and MBC005_00557 (to cover upstream waterways crossing various of private properties) could be considered. 13/1/25: Response noted. Comment closed.	**RE STL005_00799:** Noted - as part of next model update, culverts in this catchment should be identified and included in the model. It is noted that while inclusion of culverts in this area may allow the local roadside depression to drain in minor events, it is otherwise unlikely to have a significant impact on results as the Stanley River floodplain is located directly downstream. **RE dams upstream of 006_00977b:** Noted - this is an item that could be explored in potential future updates to catchment hydrography. Catchment was split at this location to give an indication of immunity of Keliher Rd, which wasn't previously captured in 002c model. **Splitting of 2d_sa:** - MBC013_00415 - Catchment is relatively small and flow path is captured within Council's overland	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		flow model, so not warranted to be included in the river and creek model. - MBC001_12726 - Catchment could be further refined to explicitly model the tributary seen within aerial photography to have standing water. However, it's noted that most of this tributary is on Council property, and that private property areas further upstream would be considered overland flow. To be considered at next update. - ONE019_00833 - Catchment could be updated to explicitly model Townstead Road crossing should Council desire detailed information about the performance of this culvert; upstream of this point would be within the remit of the Overland Flow models. The model as currently configured is not considered inappropriate. Desire for further refinement to be considered at next update. - MBC005_00557 - Most of the land containing this tributary is not private property. Catchment could be updated to better define tributary and explicitly represent culvert crossing at Bullaburra Road should Council desire detailed hydraulic information about this culvert crossing; otherwise, capture within Council's overland flow models considered acceptable. Desire for		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		further refinement to be considered at next update.		
Are the 1D-2D linkages defined correctly?	Generally appropriate.		Commentary No action	Closed
Are there terrain adjustments at 1D-2D linkages? If yes, are they appropriate?	Terrain adjustment polygons observed at few locations (i.e. 076_01179, 012_01224a etc). Terrain adjustments applied at Culvert 007_01794. The levels appear to be higher than LiDAR slightly and this culvert also has a 0% slope. Please comment the basis of values adopted in the terrain modifiers. 13/1/25: Response noted. Comment closed.	Data for culvert 007_01794 has been carried forward from the 002c model. Noted that culvert slope in the model is flat - culvert is not in Council's stormwater GIS database and inverts are unable to be verified with Council data. A design drawing (from 1965) was found; unfortunately, this did not specify culvert invert levels. Confirmation of invert levels with survey could be undertaken for future update. It is noted that the 2019 lidar on the road is unusual (thinner than the rest of the road alignment) so a zsh was used on the road to enforce a two-cell width. Topography around connecting SX cells was enforced at invert level to ensure good transition - there is a >0.5m drop from invert level (138 mAHD) to adjacent 2019 lidar terrain on western side.	Low	Closed
Are IWL conditions applied correctly?	Yes. IWL setting generally appropriate.		Commentary	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
			No action	
TUFLOW Run Files				
Is the 2D dtStar value reported in the *<<simulation>>.hpc.dt.csv* file greater than recommended minimum relative to the grid cell size for TUFLOW HPC simulations based on the dominant control number (courant, celerity or diffusion number)?	Sample of log files checked – No issues identified.		Commentary No action	Closed
Are TUFLOW default parameters used? If non-default values are used, list them and justify their use?	Defaults used. No issues identified.		Commentary No action	Closed
Log File				
If HPC, are there no repeat timestep, if there are, are they acceptable?	Sample of log files checked – No issues identified.		Commentary No action	Closed
Are there no Negative Depth Warnings, if there are, are they acceptable?	Sample of log files checked –Few common warnings/check messages observed but no issues identified.		Commentary No action	Closed
Messages Layer				

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are there no ERRORs in the messages layer?	N/A		Commentary No action	Closed
CHECK 2118 and WARNING 2118: Are ZC values lowered by a reasonable amount and do the lowered cells match the neighbouring terrain?	Terrain modification around culverts noted to be slight mismatch with neighbouring terrain. However overall appropriate.		Commentary No action	Closed
WARNING 1100: Are the invert mismatches acceptable?	No issues identified.		Commentary No action	Closed
CHECK 1401 and CHECK 1402: Are these failures in automatic manholes creation ok?	N/A		Commentary No action	Closed
CHECK 1111: Are these overwrites mistakes or by design?	N/A		Commentary No action	Closed
Are the other Checks and Warnings in the messages layer acceptable?	No issues identified.		Commentary No action	Closed
Results				
Is *Map Output Data Types == dt* specified for review of the location that defines the minimum timestep for the simulation?	Spot check conducted for Dt grid. No issues identified.		Commentary No action	Closed
Are there any topographic or boundary condition input definition errors	No issues identified.		Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
which correlate to the location of minimum timestep?				
Check results stability at Culvert SX inlet/outlet; where instability existing consider using SX polygon with A Factor set to 5.	Storage factors between 5 to 20 already applied at few culvert locations currently overtopped (i.e. 076_01179, 012_01224a etc) to improve stability. Spot check for selected runs and culvert locations indicated no stability issue.		Commentary No action	Closed
Are there PO lines at all key locations?	PO location coverage appear adequate.		Commentary No action	Closed
Are pipes flowing full where expected (refer to _CCA.mif)?	Spot check conducted. Majority of pipe flows appear reasonable. Minor observations noted as below which can be amended in future revisions: • No flow in 005_00799b and 005_00799c due to placement of 2d_sa inflow location • 037_00043 flowing part full but road overtops due to the configuration of height vs width (1.2m high and 0.45m wide) 13/1/25: Response noted.	Future model update to address.	Commentary No action	Closed
Are maximum water surface levels (h) realistic?	Cursory review indicate water surface levels overall realistic along watercourses. Significant ‘spikes’ noted around dams. Also, minor ‘spikes’ and ‘dips’ are observed around hydraulic structures. However, this issue is common across TUFLOW.		Commentary No action	Closed
Are maximum velocities (v) realistic?	Cursory review indicate velocities overall realistic along watercourses. Significant ‘spikes’ noted around dams. However, this does not affect overall study objectives.		Commentary No action	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Are flows in pipes and channels realistic?	No issues identified.		Commentary No action	Closed
Is the model extent sufficient, such that the area of inundation does not abut against the model extent code boundary for the largest modelled flood event?	Predominantly sufficient except around sub-area BRC022_00000, MBC006_00977 for extreme event. 13/1/25: Response noted. Comment closed.	**RE BRC022_00000** - The 0.05% AEP grid touches model boundary in the future (blocked and unblocked) scenarios only; no other AEP or scenario touches the model boundary at this location. The model boundary is to be amended in a future model update. **RE MBC006_00977** - Agreed, code boundary will be extended in this location to include additional upstream catchment in the next model update. A limited reliability note will be applied to the model results in this area.	Low	Closed
Do flood extents for the range of modelled event magnitude follow a logical order of progression (1% > 2% > 5% AEP etc.)	Results appear adequate in order of progression. Only very minor, discrete, insignificant patches of anomalies are observed (i.e. where flood levels in smaller AEP is higher) 13/1/25: Response noted. Though, no significant instances of anomalies were observed during initial review.	The model report will note any significant instances of anomalies.	Commentary No action	Closed
Critical Duration Distribution is realistic?	Due to the significant model run time in TUFLOW, critical event selection was based on WBNM. Three (3) critical duration/TP combination per AEP event was determined from a selection of 21 POIs, based on which provided the best overall performance. The selection of critical duration generally aligns with the range informed by previous study. With this approach however, it is impossible to cater for every location within the catchment.	**RE critical event distribution:** As acknowledged by review comments, this is expected to occur at some locations. This can be partially due to limitations in the HEH model (there are scenarios in which it is difficult to get a hydrology model to replicate complex hydraulic model conditions), and partially due to a maximum envelope resulting in a different POI's critical storm's surface level	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
	There are few minor limitations noted with that method: • It was observed that the critical event distribution shown under the TUFLOW enveloped maximum grid differ from HEH WBNM model selection at few POIs. • The trends of critical duration along Stanley River appear unusual in the smaller events (i.e. 20% and 10% AEP). Where, the middle duration/ARF grid dominates most of the upper tributaries and even the downstream extents of the model. However, the peak flood level differences between the various critical events are generally less than 0.1 m. • The peak flow difference between critical event and adopted event at the POIs range from -10% to 25%. For example, at STA001_13561, the critical event consistently underestimates; and at NEU001_07434, the critical event consistently overestimates, exceeding the 10% tolerance. Can CMB please comment on the expected difference in peak flood level resulting from these discrepancies? 13/1/25: Responses noted. Comment closed.	overruling the 'correct' storm surface level e.g. where a HEH point located at the downstream end of a tributary overlaps with the Stanley River floodplain, the critical duration in TUFLOW will likely be dictated by the floodplain instead of the local tributary. **RE critical duration in the smaller events:** Critical duration analysis of E00 events generally seems to be logical. Three durations have been run for all AEPs - short, middle and long durations. For all AEPs the short duration is generally critical in the very upper reaches. This then generally transitions into the middle duration for mid-catchment, and then for a significant portion of the main Stanley River, the long duration is critical. Agreed that for the 20% and 10% AEPs there is an unusual trend in the lower part of the Stanley River floodplain in which the middle duration is critical, where one would expect it to be the long duration storm. This is possibly related to constant tailwater levels being applied in the model, which pre-fill volume in the lower floodplain over a similar extent. Whilst unusual, there is only a small water level		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		difference between the two durations in this area. **RE Peak Flow difference**; Council accepted a tolerance of +/- 10% difference in peak flow between the adopted and critical event at each HEH point, in acknowledgement that a hydrology model cannot exactly replicate conditions captured by a hydraulics model. This target range was achieved for most points in the SRN model. No HEH points had an underprediction outside of the accepted range (STA001_13561 had a maximum underprediction of -6%, which was within target range). Some points exceeded this range by a small amount, and in these instances, commentary has been provided in the modelling report to explain and justify. In general, a conservative model which overpredicted flow at a point was seen as preferable to a model which underpredicted flows. Only one HEH point (NEU001_07434) featured a large overprediction in flow (overestimates at this POI ranged from 15-24%). A sensitivity has been undertaken, running the adopted event and critical event at NEU001_07434 in		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		TUFLOW for the 0.1% AEP, to see how peak water level changes when adopting an event with a 22% over-estimate. The results of this comparison are shown in APPENDIX F. By adopting an overpredicting event at the POI, the following was noted: • There was approx. 180mm increase in peak water level as compared to the critical event at the POI location. • There was up to approx. 350mm increase in peak water level as compared to the critical event at areas upstream and downstream of the POI location. • Further upstream in the narrower well-defined reaches of Neurum Ck and Delaney Creek, differences over 350mm were identified. However, it is noted that the comparison results become less relevant when moving further upstream from NEU001_07434 and closer to other HEH points (DEL001_05933 and NEU001_18117) where the critical duration changes. The same can be said downstream of NEU001_07434 where flooding from the Stanley River becomes the critical event.		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		• In the area of interest, only a minor increase in flood extent was noted (this area has a wide floodplain).		
Other Issues/Comments	How does the updated model peak flood level compare to the previous RFD model? 13/1/25: Responses noted. Comment closed.	The 003a 1% AEP E00 (unblocked) results were compared to the equivalent 002c results. In general, water levels are higher in the new model. Within the main reach of the Stanley River, levels are significantly higher. In the upper tributaries, there are both increases and reductions in water level. Results of this comparison are shown in APPENDIX G. This result is not unexpected. It is particularly noted that the previous 002c model in calibration produced peak water levels below that recorded by approximately 1m at Woodford and 0.5m at Peachester. The calibration has been improved in the 003a models, with increased water levels now closer to recorded gauge levels than the 002c model. Other sources of differences between the model versions include: *Boundary Conditions* In the lower part of the Stanley River, updated tailwater levels are higher than the	Low	Closed

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		previous iteration (for most AEPs this difference is over 1m), so consequently water levels in the lower part of the model are higher. At the confluence of Neurum Creek and Stanley River, the Neurum Creek model previously had a constant tailwater based on results from the Stanley River model. As the models have now been merged, this boundary is no longer required and changes in the area are expected. *Model Roughness* Spatial representation of material roughness in the model is significantly different in the new model. Whereas previously all land use categories were defined using manually delineated GIS polygons, the new model now uses a raster to represent vegetation and features in more granular detail. Updates to Manning's n values during calibration have intentionally resulted in increases in water level. These changes were applied to vegetation layers which feature heavily within the floodplain. *Topography* Most of the model has been updated from 2014 LiDAR to 2019 LiDAR (with the		

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
		exception of the Sunshine Coast Council area in which the previous LiDAR data has been retained). Various differences in topography are noted throughout the model, which may contribute to differences in water level. *Input Rainfall* The 003a RFD uses LIMB IFD data. When comparing LIMB to the previously used ARR87 data varies, in some locations LIMB is higher and in others it is lower. This will likely influence model water levels to some degree. Regarding preburst - in line with ARR19 guidance, the 003a model now includes preburst (002 version did not). Parts of the SRN model are thought to be volume influenced (particularly upstream of the highway in the Stanley River). Noting that median preburst depths in this catchment are not insignificant, the addition of preburst rainfall may contribute to increased water levels as compared to the previous model. *Model Engine* It is reasonable to expect that implementing a new solver (HPC vs Classic) may cause differences in model outputs.		

Subject Flood Model Review Checklist

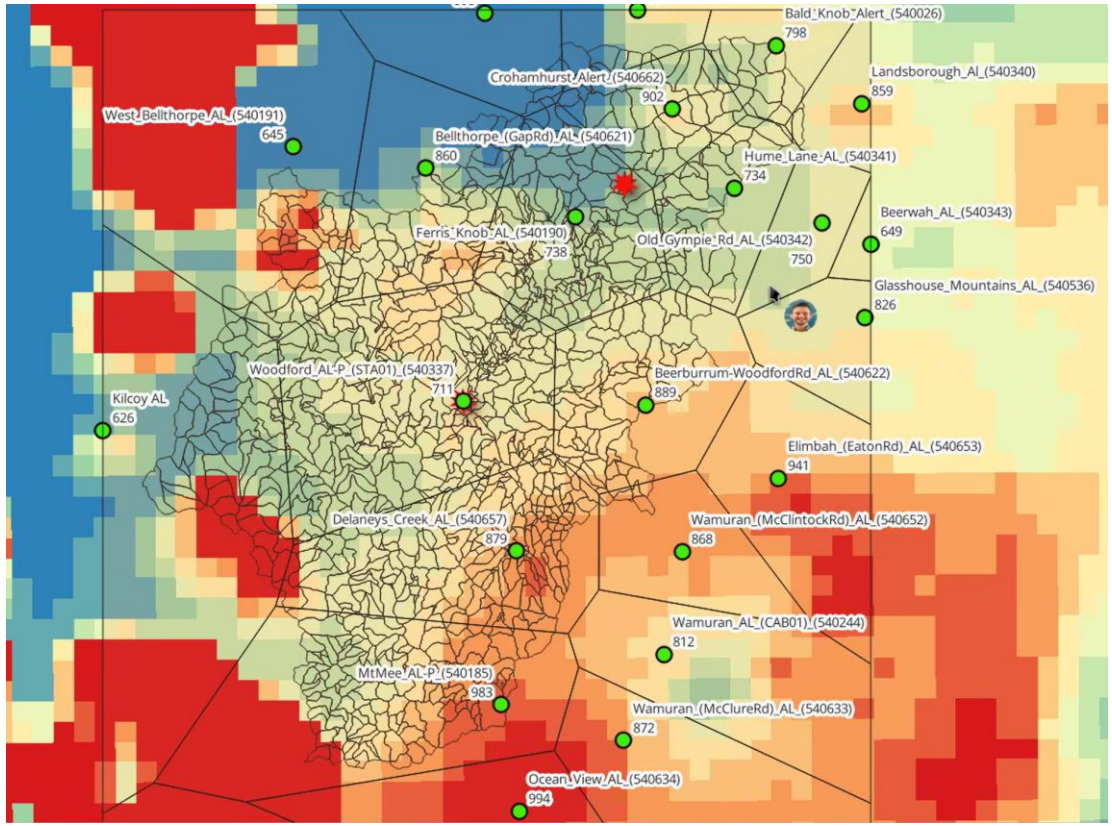
Date 13 January 2025 Job No/Ref 305456_SRN_CHECK

Check Item	Reviewer Comments	Designer Response	Rank	Reviewer Closeout
Structure Blockage				
Structure Blockage Calculation and Application	Culvert and bridge blockage calculations adopted L_{10} of 4m. Whilst this follows the guidance from pilot study methodology, this value may be underestimated for this particular catchment. Comment for note only. Calculation for bridge blockages assumed the smallest span and deemed a conservative approach. Appropriate. Blockage factors for both bridges and culverts have been calculated and applied per recommended methodology. 13/1/25: Responses noted.	Noted - this review item to be considered in the next update.	Commentary No action	Closed

APPENIDX A

The first image below is a total of the radar rainfall over the February 2022 event. It could be identified that the West Bellthorpe Alert rainfall gauge appears to underestimate the rainfall experienced for the subcatchments informed by this gauge. However, for other areas the analysis is somewhat inconclusive. The radar north of Bellthorpe Alert appears somewhat suspect, but if taken to be true, indicates that the area of higher rainfall between Bellthorpe AL, Ferris Knob AL and Woodford AL could be underestimated by the recorded gauge levels.

This is emphasised if focused on the total rainfall radar for one main part of the event. The calibration results indicate the effect of the 20% rainfall increase is negligible prior to 25/2/2022; the results do indicate influence on peak results for the 25/2/2022 (see below hydrograph). Looking at the radar for the 25/2/22 (third image below), a higher area of rainfall is seen to occur in-between the Bellthorpe, Ferris Knob and Woodford AL gauges.



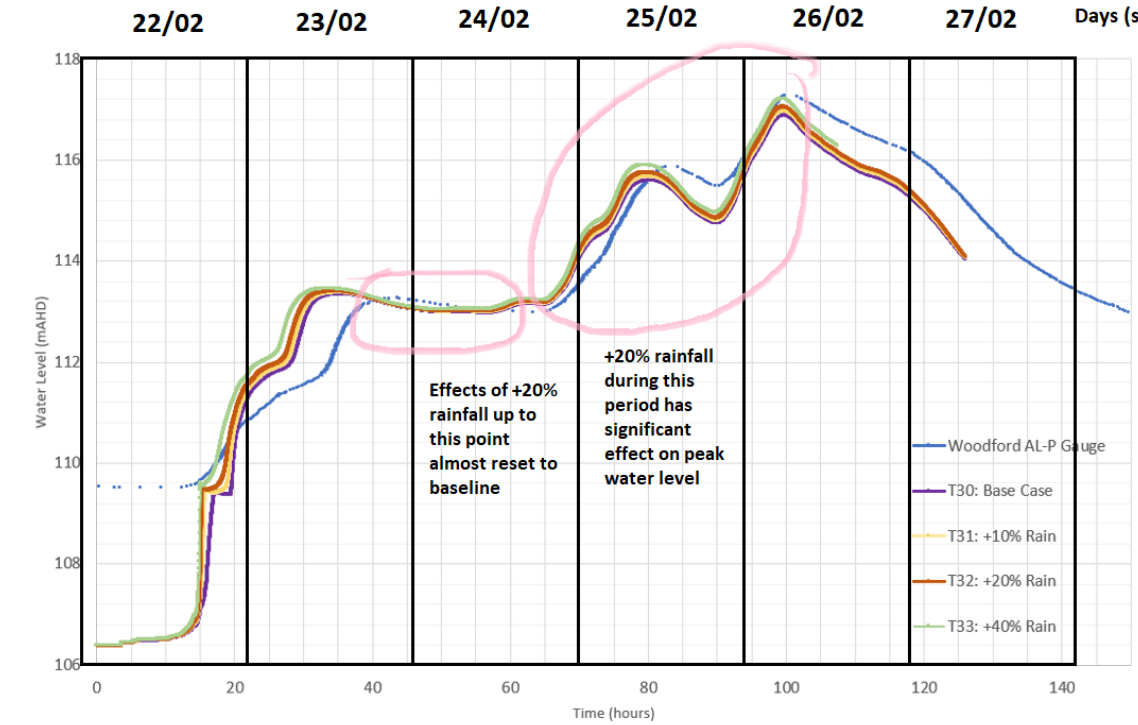
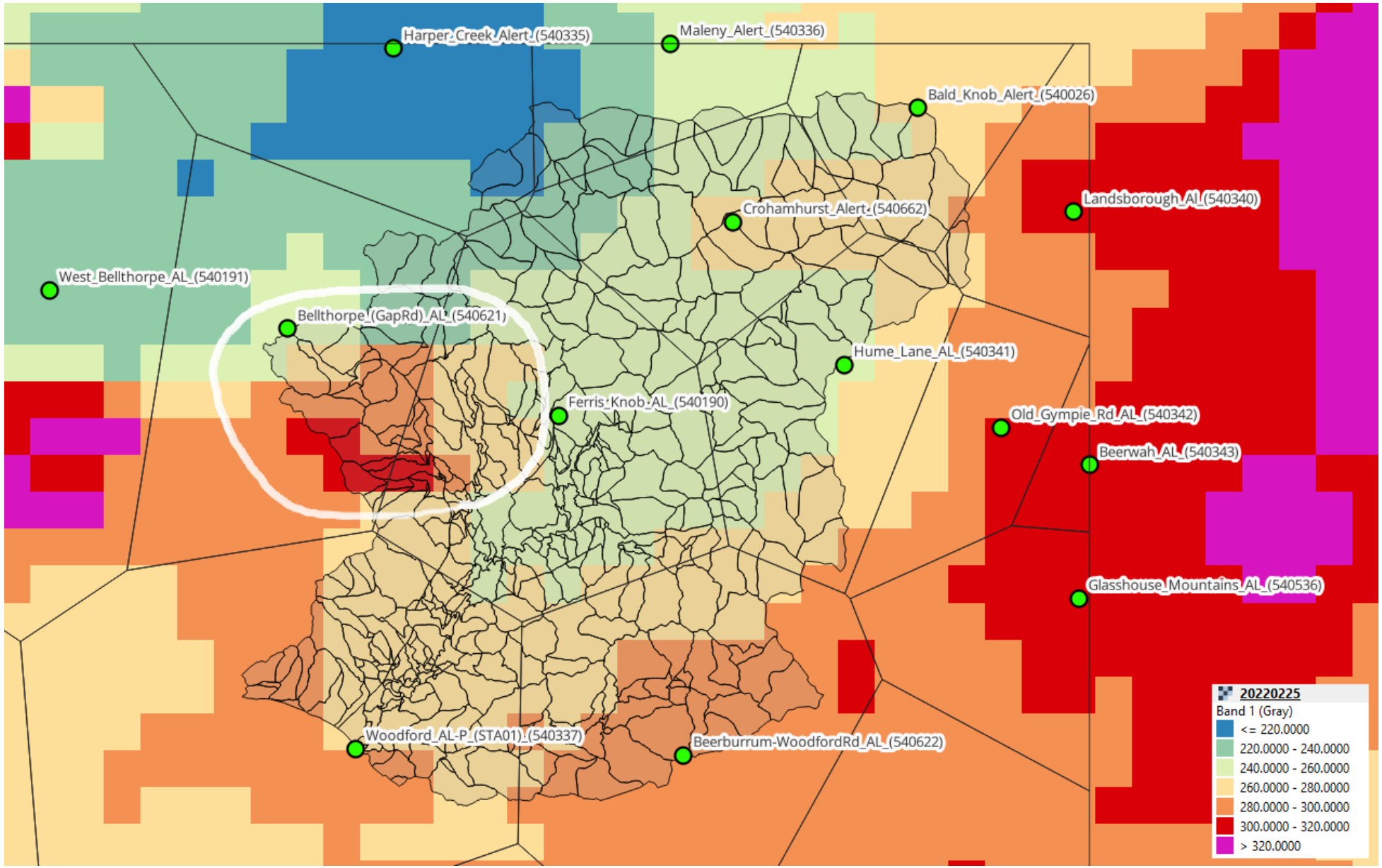
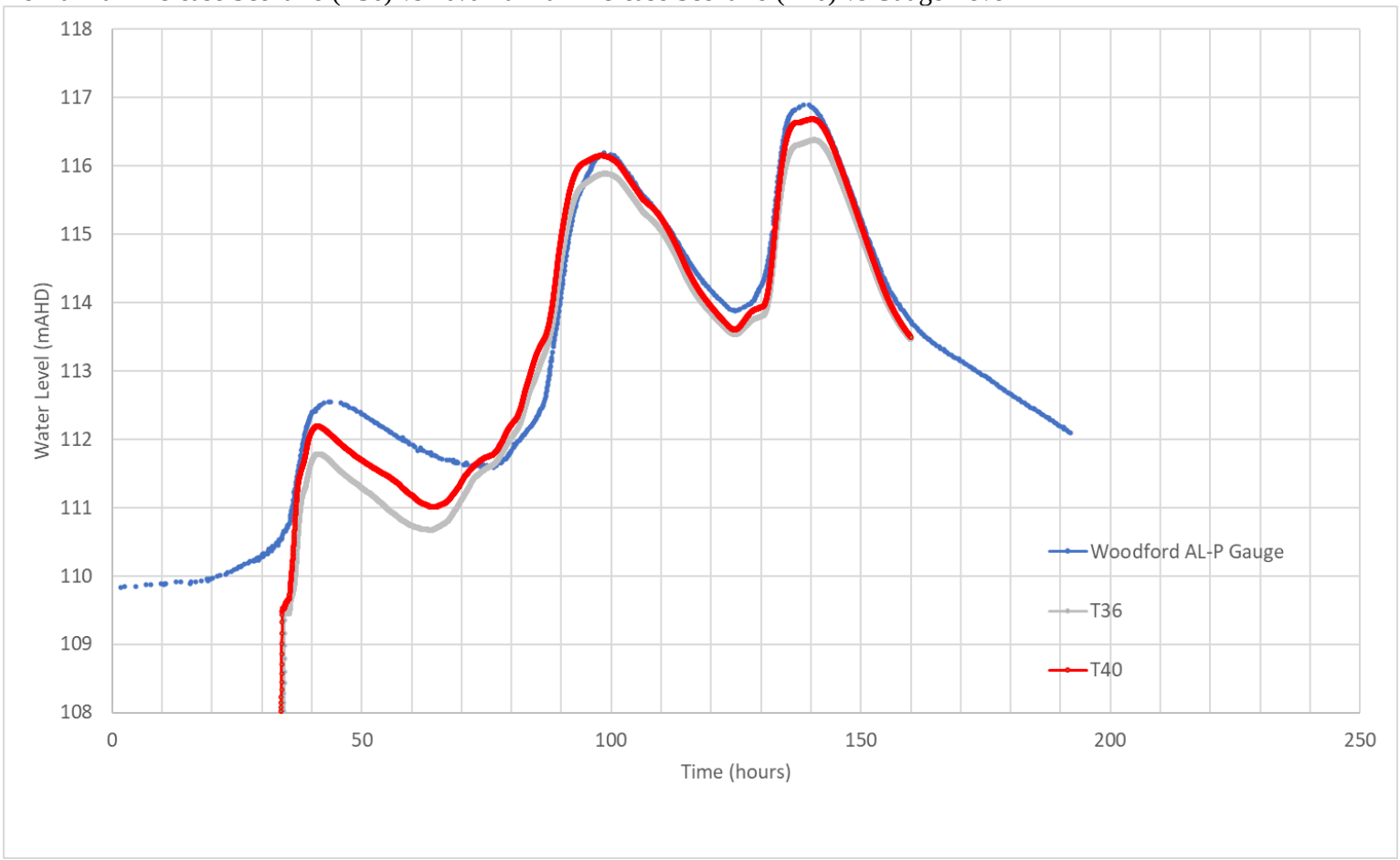


Figure 5 - Calibration - Base Case vs Rainfall Increase Scenarios - Woodford AL-P Gauge

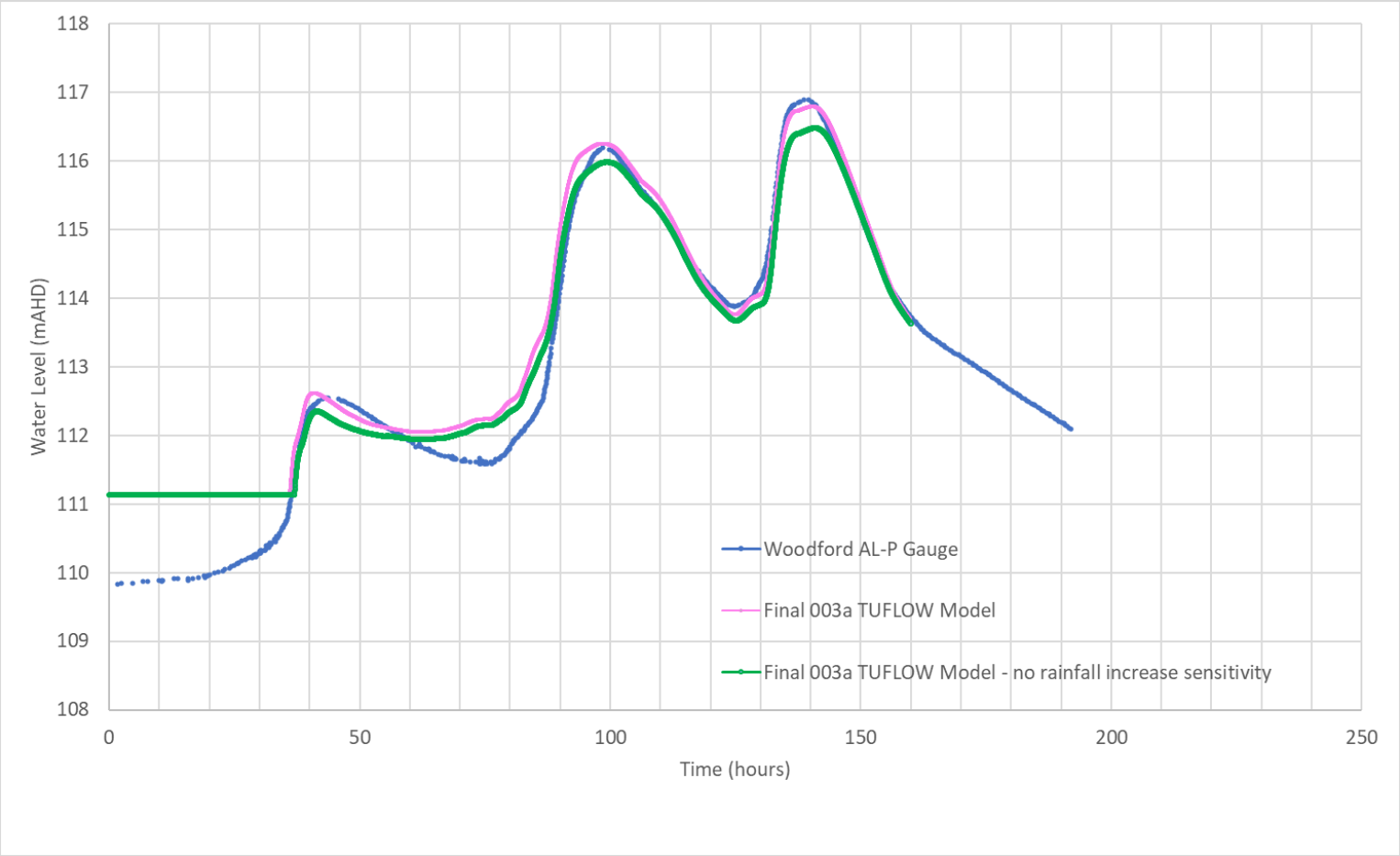

Harper_Creek_Alert_(540335)
Maleny_Alert_(540336)
Bald_Knob_Alert_(540026)
Landsborough_Al_(540340)
Crohamhurst_Alert_(540662)
West_Bellthorpe_AL_(540191)
Bellthorpe_(GapRd)_AL_(540621)
Hume_Lane_AL_(540341)
Ferris_Knob_AL_(540190)
Old_Gympie_Rd_AL_(540342)
Beerwah_AL_(540343)
Glasshouse_Mountains_AL_(540536)
Woodford_AL-P_(STA01)_(540337)
Beerburrum-WoodfordRd_AL_(540622)
20220225
Band 1 (Gray)
<= 220.0000
220.0000 - 240.0000
240.0000 - 260.0000
260.0000 - 280.0000
280.0000 - 300.0000
300.0000 - 320.0000
> 320.0000

APPENDIX B

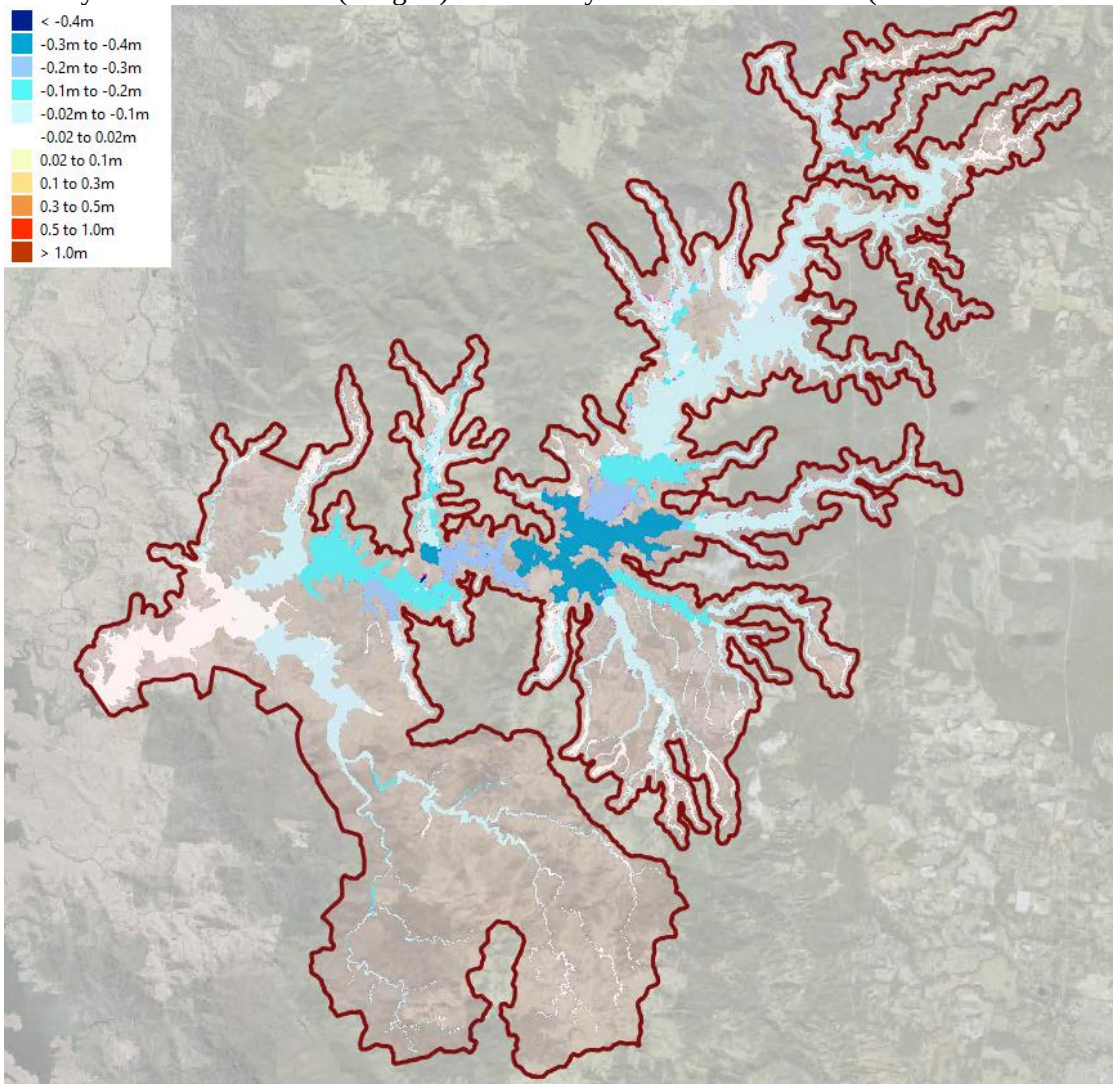
Graph for Query 2 - January 2011 - Calibration Phase Model - Sensitivity Test
No Rainfall Increase Scenario (T36) vs 20% Rainfall Increase Scenario (T40) vs Gauge Level



Graph for Query 3 - January 2011 - Final Model (5m grid) - Sensitivity Test
No Rainfall Increase Scenario vs 20% Rainfall Increase Scenario vs Gauge Level



January 2011 - Final Model (5m grid) - Sensitivity Test - WL Difference (No Rainfall Increase - 20% Rainfall Increase)



APPENDIX C

A test was undertaken during SRN calibration, which increased the waterbody Manning's (TMF ID =15) from 0.03 to 0.04.
Plots below are at the Woodford and Peachester WL gauges, and include:

- Recorded gauge level
- T30: Base Case
- T36: Base Case with Increased Low Grass Grazing (ID=1) AND Medium Dense Vegetation (ID=3) Manning's n
- T38: Base Case with Increased Low Grass Grazing (ID=1) AND Medium Dense Vegetation (ID=3) AND Waterbody (ID=15) Manning's n

Note - these scenarios **DO NOT** include the +20% rainfall increase utilised by the final calibration run.

Key points to note:

- Apart from minor differences at lower levels, the T36 and T38 scenarios are very similar. Minor differences at Peachester at lower levels (~130 mAHD) are potentially because flows are contained in channels (hence spatially coinciding with area designated as Waterbody Manning's n roughness value).
- There are only minor differences in peak water levels of 11mm and 13mm at Woodford and Peachester gauges as a result of increasing waterbody Manning's n value.

As such, during calibration it was concluded that it was not beneficial to increase the waterbody Manning's n value, as it did not significantly increase peak water levels at the gauges.

As highlighted in the report, several changes occurred between the calibration stage and the final model runs that should be noted.

- Calibration runs were:
    - Based on a 10m grid size version of the model used for runtime speed, which was updated to a 5m grid size in the final model.
    - Used SGS which was removed from the model at a later stage.
    - Undertaken prior to model update finalisation (further refinement occurred in modelling).
- The final model relocated Woodford gauge PO ~30m closer to the gauge orifice (the difference between the two reporting locations was minimal (19mm difference at peak)).

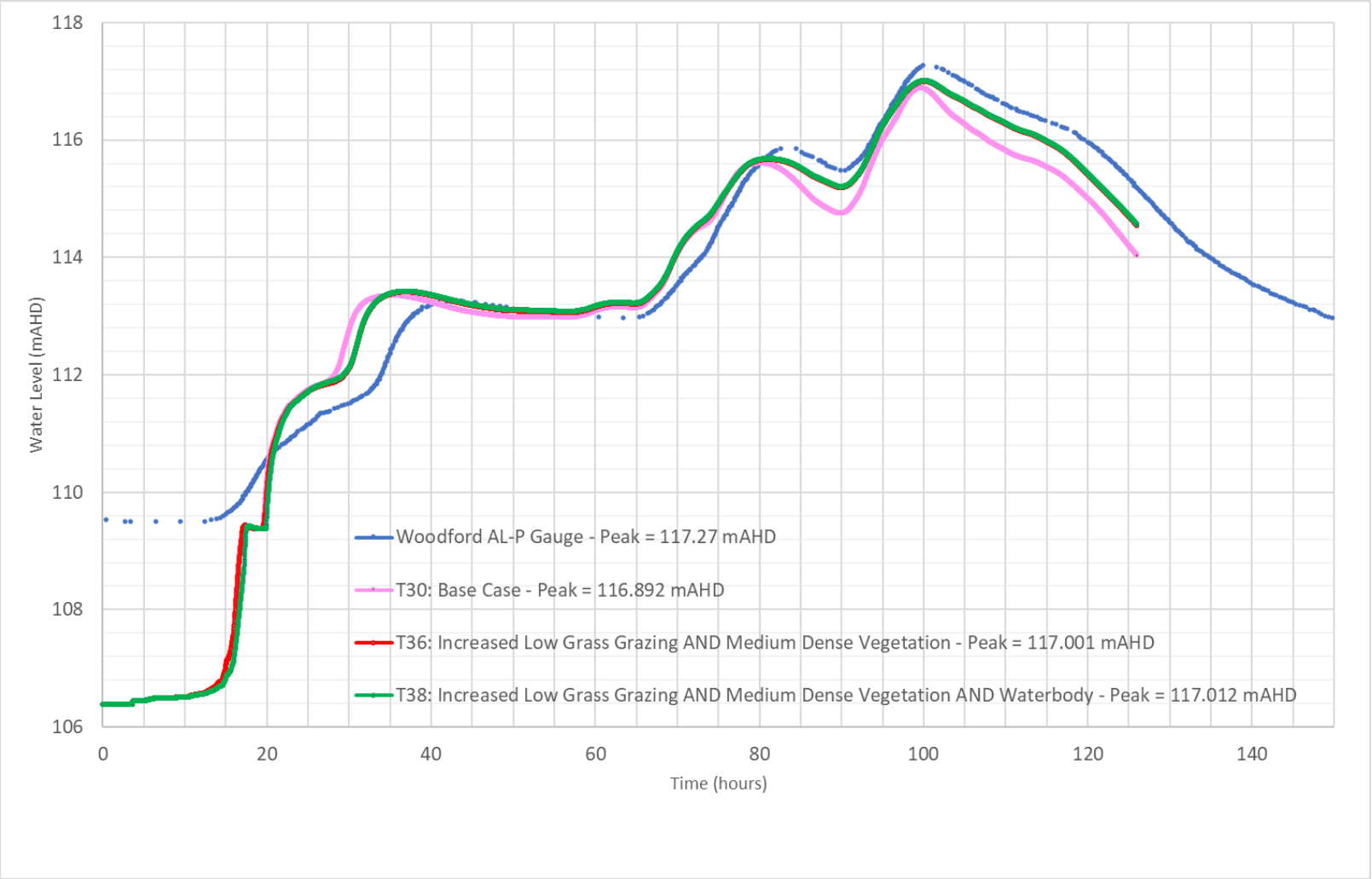
Tests regarding the waterbody roughness value occurred also during calibration analysis for other RFD catchments;

- The BCR model tested different waterway roughness values but focused on testing lower/smoother values, as the catchment was modelling high water levels compared to recorded. It trialled a roughness value of 0.011 (model failure), as well as testing 0.022 and 0.018.

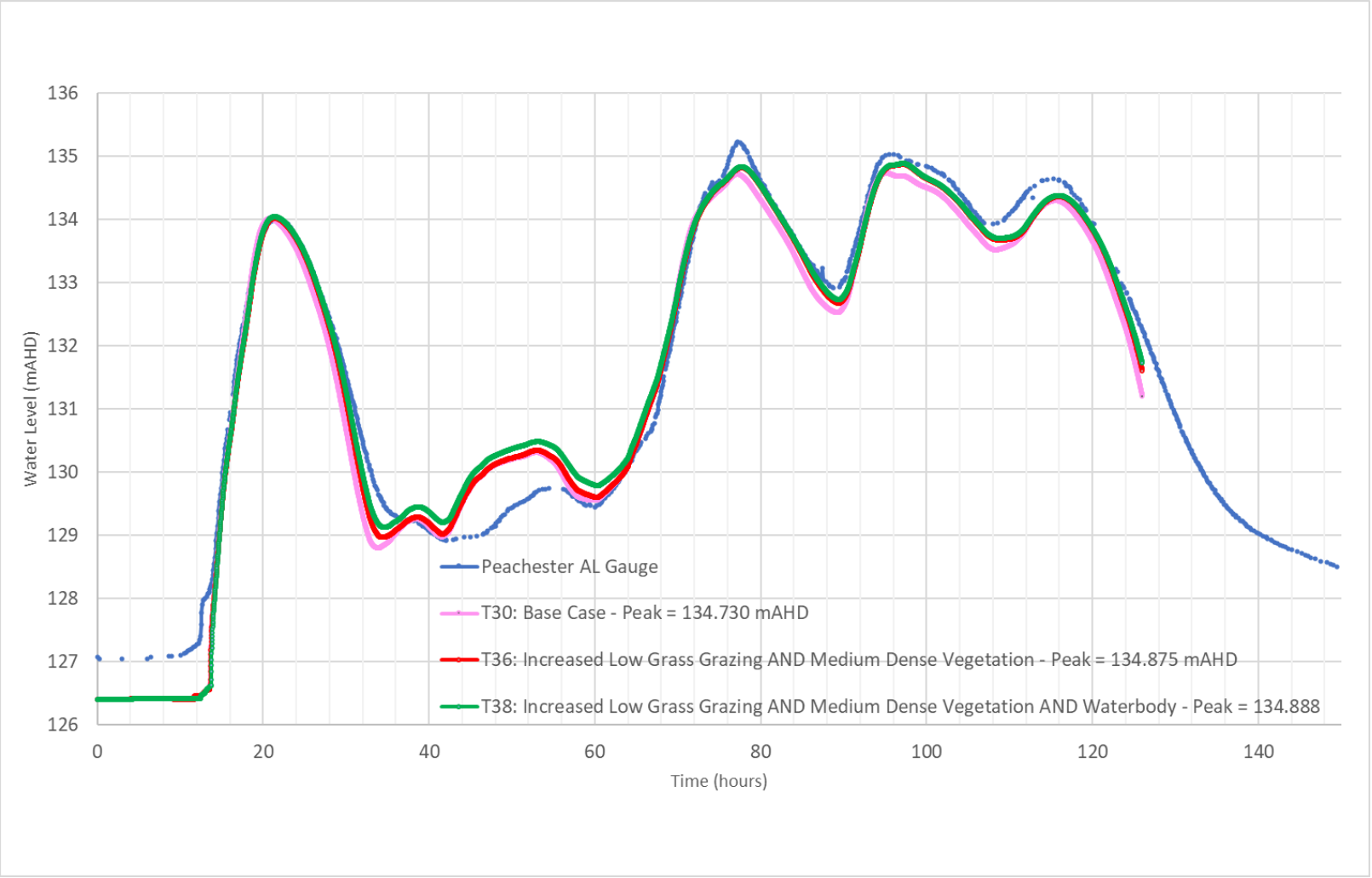
  - A section of the waterway had waterway roughness value lowered to 0.018. This caused the Peak water level to decrease by 140mm at one location, but only 40mm further downstream (downstream of a weir)
- Concurrently, some the southern catchments were seeking higher waterway roughness values to improve calibration. The waterways Manning's n initially tested included 0.045 and 0.08.
- Subsequently there was testing focused on different Manning's n values for vegetation, together with the original waterway roughness value of 0.03. For some southern catchments, it was found that reducing the value from 0.045 to 0.03 caused calibration levels to decrease but not significantly impact peak flood level.
- Ultimately, as it was found the majority of catchments calibrated well with a single set of vegetation roughness values and with a waterway roughness value of 0.03, the direction for other RFD models was towards continuing to use 0.03 (as used by 2014 RFD model), excepting a small stretch of waterway in BCR where it was lowered to 0.018.

In short, since different RFD catchments sought to both decrease and increase the waterway value during calibration, and 0.03 ended up working well for both (together with changes to vegetation roughness), this experience supports how SRN was calibrated (focused primarily on changing vegetation roughness rather than waterway roughness, aside from test mentioned above).

Woodford AL-P Gauge:



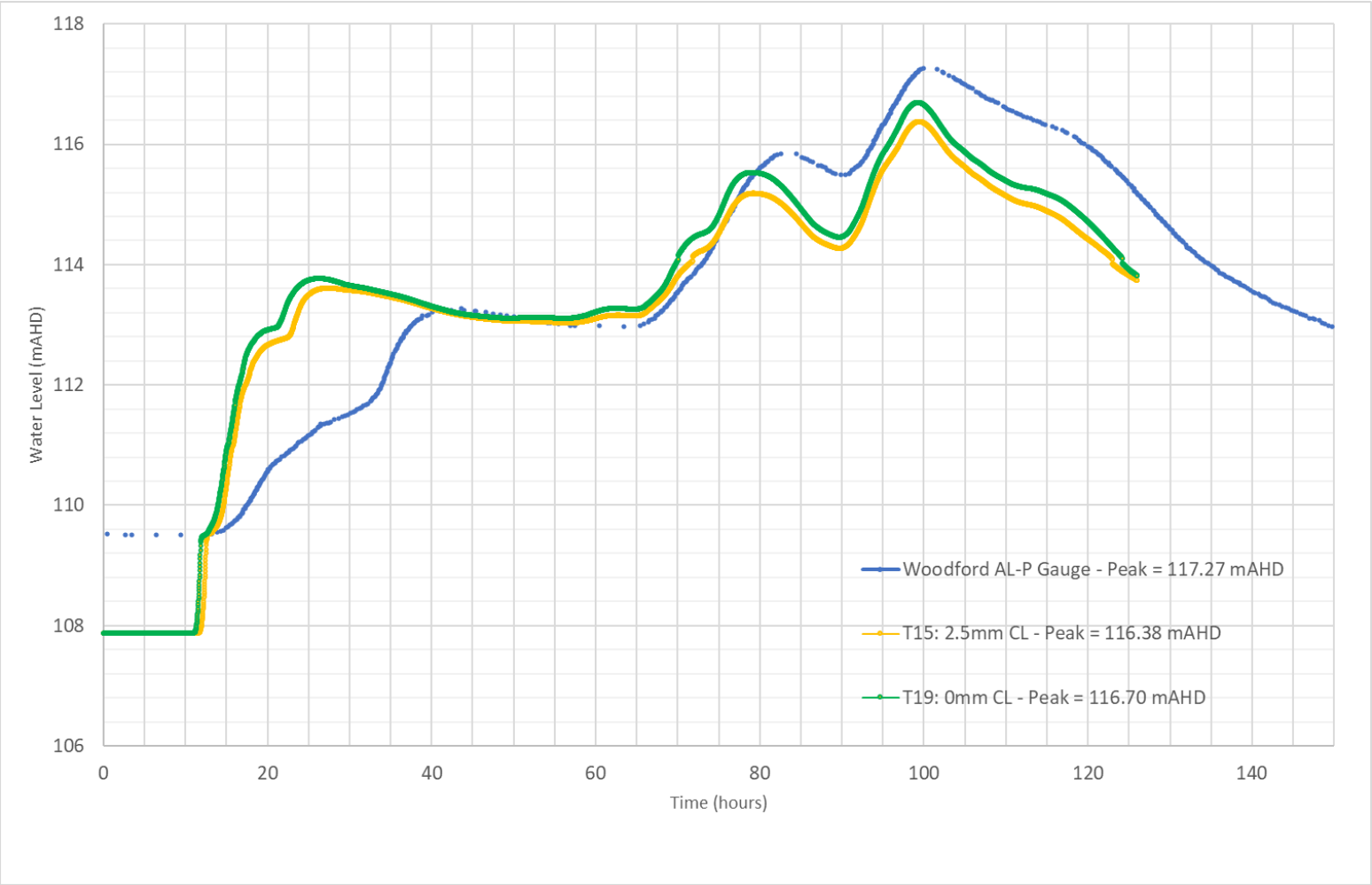
Peachester AL Gauge:



APPENDIX D

February 2022 - Calibration Phase - Sensitivity Test

2.5mm/hr CL (T15) vs 0mm CL (T19) vs Gauge Level (Woodford AL-P)



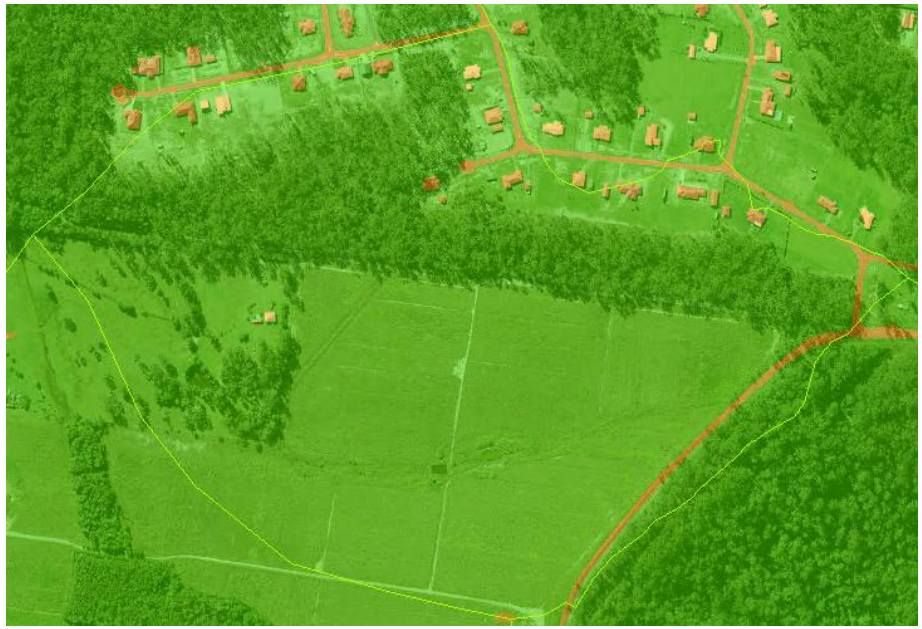
APPENDIX E

ONE043_00000:

The Effective Impervious Area raster appears to adequately capture the roads and buildings; however, it does not capture driveways. It is agreed that the AI process used to derive impervious area and landuse classification has some limitations; however, the benefits gained (precision, regionally-consistent definition of light/medium/dense vegetation, etc) do mean that imperviousness and landuse definitions have improved substantially overall compared to the prior models.

ONE021_0000:

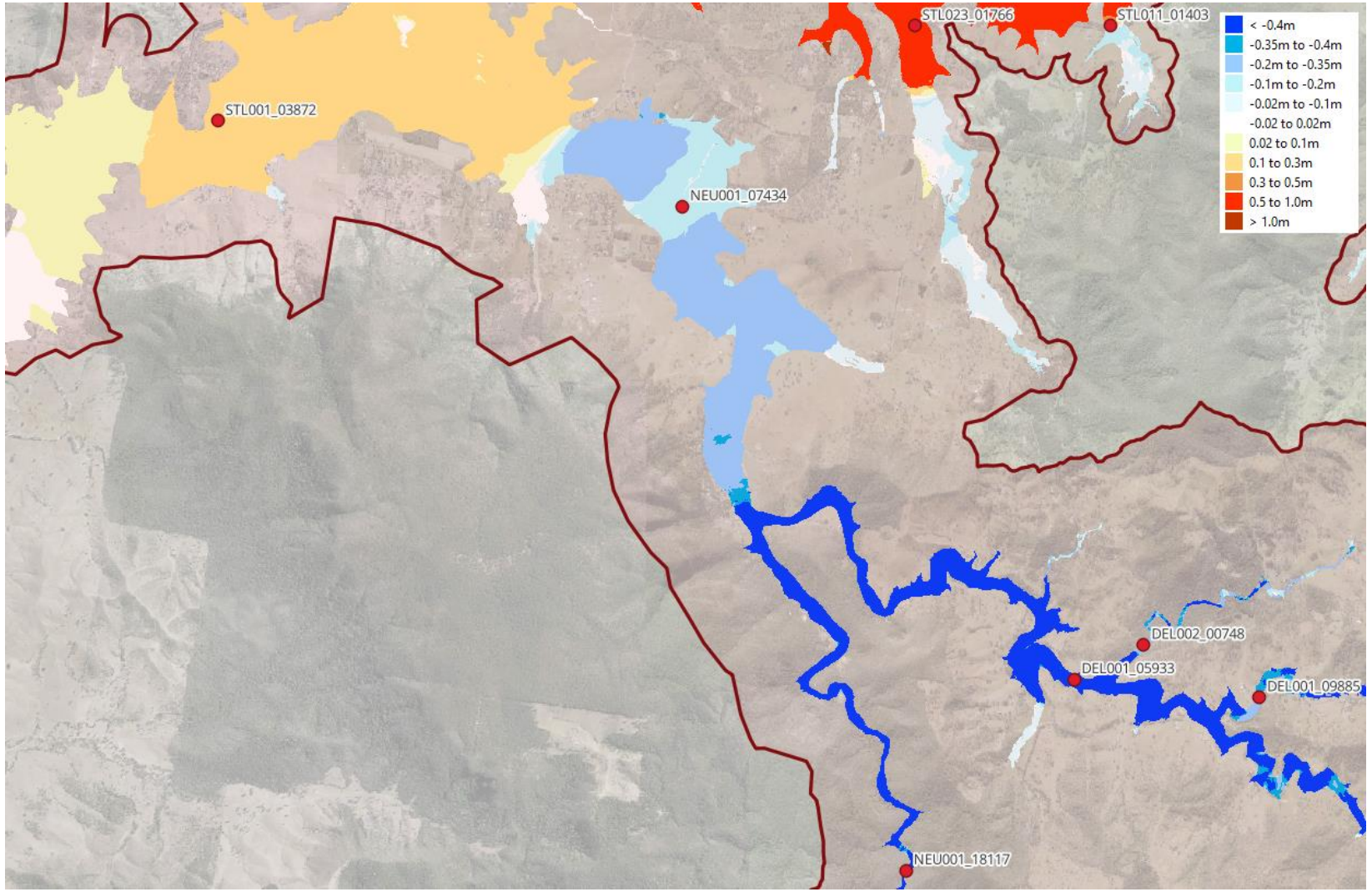
2019 (left) vs latest imagery (right):



Latest imagery compared with Future EIA raster (created/estimated at onset of RFD project):

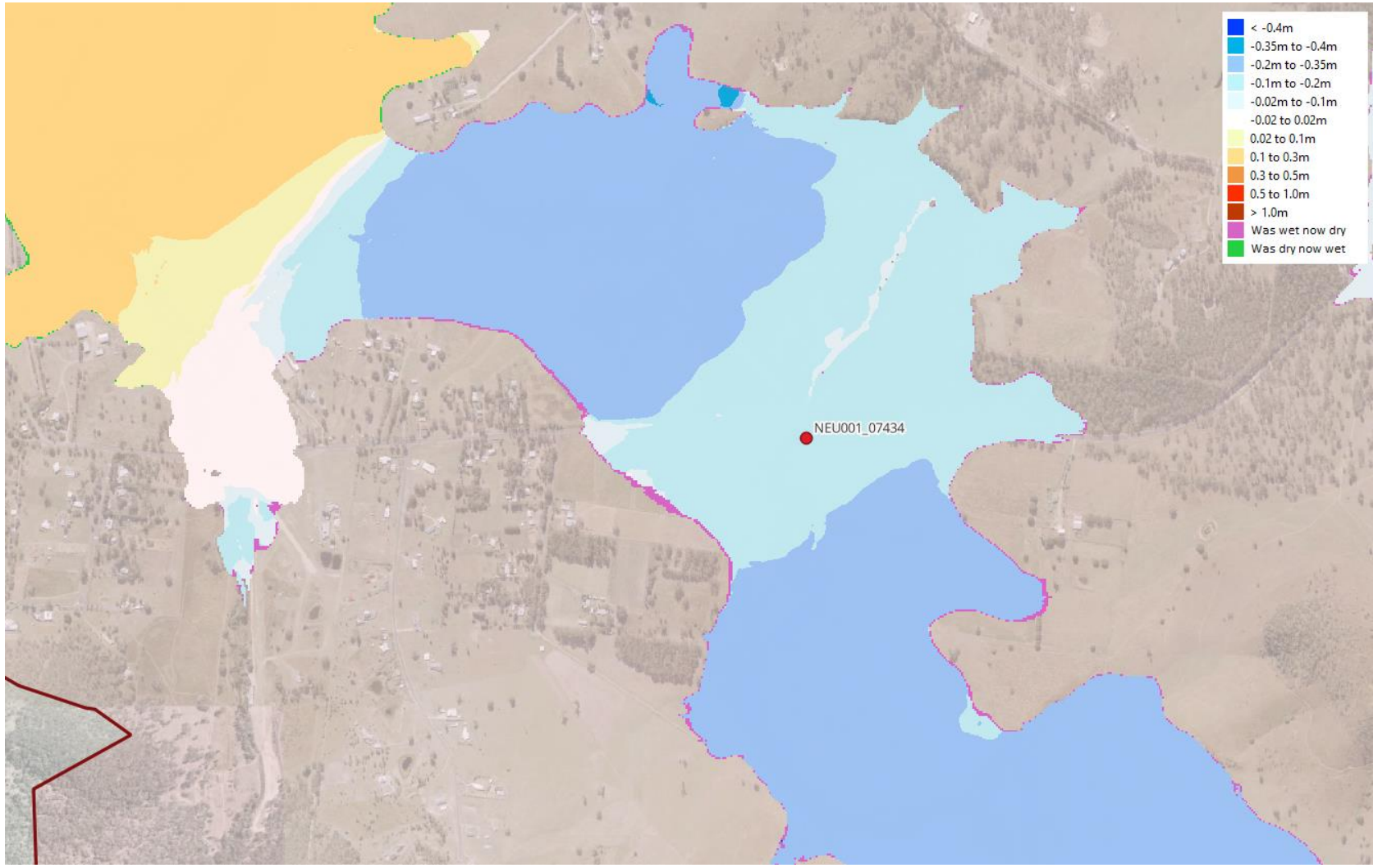
APPENDIX F

Water Level Difference: 0.1% AEP (Critical Event at NEU001_07434 - Adopted Event at NEU001_07434)



Water Level Difference: 0.1% AEP (Critical Event at NEU001_07434 - Adopted Event at NEU001_07434)

Pink indicates decrease in flood extent when using the adopted event compared to the critical event at NEU001_07434



APPENDIX G

Water Level Difference - 1% AEP Existing Unblocked - 003a Model minus 002c Model