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MEMORANDUM

To	Kate Berg (City of Melbourne)	From	Julian Skipworth
Copy	Luke Cunningham and Rianda Mills (Rain Consulting)	Reference	30005 CityOfMelb Southbank TUFLOW Modelling
Date	21 April 2020	Pages	9
Subject	Southbank Flood Modelling Update and Climate Change Scenarios		

Dear Kate,

Water Modelling Solutions was been contracted by City of Melbourne and Melbourne Water to update the City of Melbourne Southbank TUFLOW model and model a number of climate change scenarios. The scope of works for this project included:

1) Reviewing the existing RORB and TUFLOW models for adequacy of use and noting any recommended changes
2) Updating the model in accordance with approved changes following the review
3) Creating new hydrological outputs from RORB based upon increasing the rainfall intensity by 18.5% and converting to ts1 format for input into TUFLOW
4) The inclusion of updated Yarra River tailwater conditions based on the 2019 Lower Yarra River Flood Study (GHD) for both existing and climate change scenarios
5) Running the existing conditions scenario for the 1% AEP event, and climate change scenarios for the 1%, 2%, 5%, 10% and 20% AEP events for a full range of storm durations.

A range of improvements were implemented into the TUFLOW model following a review of the model and approval by City of Melbourne and Melbourne Water and these are described below.

The project deliverables are attached with this memorandum and include gridded and vector results for the range of modelled events. A Shapefile is also attached which contains a polygon of the recommended “Limit of Mapping” for the outputs.

1 HYDROLOGY

The existing Southbank RORB model was available for use and used to generate rainfall excess design hyetographs with an 18.5% increase in rainfall intensity representing climate change scenarios. ARR1987 rainfall was adopted which is consistent with other City of Melbourne flood mapping projects completed or under completion across the municipality.

The existing (i.e. today’s climate) RORB results for the 1% AEP event were used to model the 1% AEP existing rainfall scenario and was not modified from the original RORB output files. The RORB model and output files have been included as a deliverable for the project.

2 TUFLOW MODEL UPDATES

Following a review of the TUFLOW model and with the approval of City of Melbourne and Melbourne Water a range of updates were made to the Southbank TUFLOW model. Key findings from the review and adopted changes that were implemented are summarised in the following sections.

Most changes were minor in nature and adopted in order to bring the model in accordance with best modelling practice and ensure consistency. Other changes such as new hydrology inputs and changing the tailwater boundary conditions were required to incorporate the new climate change scenario.

2.1 TCF REVIEW

The comments and changes to the TCF file are summarised below.

Item	Comment	Updates to Model
Model Build	TUFLOW Classic was used for the original modelling, the model version used was not available.	Adopted the latest version of TUFLOW Classic (2018-03-AE).
Timestep	A timestep of 0.5s was used in the original modelling and has been adopted for this project.	A timestep of 0.5 seconds was retained.
Precision	Double precision will be adopted. This is consistent with the Melbourne Water technical specifications for flood modelling which recommends double precision be used when the rainfall excess approach using TUFLOW SA polygons set to ALL is adopted	Double precision adopted.
Check MI Save Date	This could be changed from OFF to warning.	Changed to warning.
Outputs	Results could be better organised by giving each scenario and event a separate folder in the form results\<<s1>>_<<e2>>_<<e1>> etc. Currently all results are written to the same folder.	Each scenario given its own result directory when output from the model to make navigating the results easier.

2.2 TEF REVIEW

The comments and changes to the TEF file are summarised below.

Item	Comment	Updates to Model
New Event	New tidal condition to be added for Climate Change scenario.	"Yarra10y2019" event added as tailwater condition in the Yarra River for Climate Change.
End Times	Generally, the end times look fine. However, the 72hr storm has an end time of 72hrs. May need to be extended a couple of hours to ensure peak is reached, although the difference will be minimal and only relevant for areas which are purely volume-dependent and have a large storage volume available. All other longer duration end times have an extra two hours beyond the length of the storm.	Changed end time for 72hr storm to 74hrs for consistency.

2.3 ECF REVIEW

The comments and changes to the ECF file are summarised below.

Item	Comment	Updates to Model
1D Timestep	1D timestep of 0.25 timestep is lower than minimum 1D timestep of 0.5 s according to Melbourne Water guidelines.	1D time step changed to 0.5 second and resulted in no change to mass error.
Entry/Exit Losses	A form loss of 0.2 was applied to one pit layer but not to the others. No inlet and outlet losses had been applied to pit entry/exits.	0.2 form loss removed as unnecessary. A total entry/exit loss of 10 applied for side entry pits as per Melbourne Water guidelines.
Contraction Losses	The input layer **1d_nwke_WEL_E01_pipe_009.mif** had a width contraction loss of 0.9 applied. The other two pipe network layers that make up the 1d network of the model domain have no contraction loss applied which is inconsistent.	0.9 contraction losses removed from the pipes that had these losses applied.
1d_bc Boundary Condition	Due to varying tidal level with the new tidal level ascii's the 1d_bc boundary initial water levels connected to the pipes draining to the Yarra River cannot be set at a constant value. A more efficient solution is to convert those boundaries to 1D/2D SX boundary ensuring the pipes discharge into the Yarra River.	1d_bc layer removed and pipes connected via 1d/2d SX lines to the 2D domain allowing them to discharge into the Yarra River.

2.4 TBC REVIEW

The comments and changes to the TBC file are summarised below.

Item	Comment	Updates to Model
2d_bc layer	The 1d_bc boundary condition based on an initial water level for the pipes draining to the Yarra was removed due to a varying tidal level. It was considered best to connect the pipes with 2d SX connections.	2d_bc with 2d SX connections for pipes draining to the Yarra River was added.

2.5 TGC REVIEW

The comments and changes to the TGC file are summarised below.

Item	Comment	Updates to Model
Grid Size	The existing model grid cell size was 3 metres which is acceptable for the purpose of the modelling.	3 meters was retained and is consistent with Melbourne Water guidelines.

DEM Files	It is noted that the model reads in three DEM files, which haven't been provided with the supplied model files.	Files were subsequently provided as 1.5m DEM Z check files. These were manually edited to remove a number of -50 mAHD values on the periphery of the DEM.
Terrain	Some artificial depressions were noted in the terrain data in locations where there are presently high-rise buildings, and caused ponding of water. Likely a result of poor processing and filtering in the original LiDAR dataset.	Larger depressions were filled in using a Z shape to interpolate across using the MERGE ALL option.
IWL	Grids were provided for initial water level and tailwater conditions based on the 10% AEP flood event in the Yarra and the 10% AEP + sea level rise which are to be used for downstream tailwater conditions for the existing and climate change scenarios.	In some areas the provided Yarra IWL grids didn't match in well with the Southbank model topography resulting in some minor instabilities early in the model run. To improve this situation, water levels were allowed to settle, and once settled the resulting Yarra water level was extracted and used as a revised model IWL grid. This process was repeated for both existing and CC scenarios.

2.6 TMF REVIEW

The comments and changes to the TMF file are summarised below.

Item	Comment	Updates to Model
Roughness Values	The value for a water surface (applied to the Yarra River which is modelled as a standing body of water) is somewhat higher than would be expected at 0.045. A more typical value would be around 0.025 to 0.03. Given this area is the outfall of the model it won't have a significant impact on the results.	Roughness value for water bodies (Yarra River) reduced to 0.03.

2.7 OTHER COMMENTS

Some other general comments are made below:

Item	Comment	Updates to Model
Model Approach	It is noted that the modelling is based on a "rainfall excess" approach and applied in TUFLOW using a "rainfall to the kerb" approach. The rainfall excess approach refers to excess rainfall hyetographs being extracted from RORB and applied to SA polygons in TUFLOW. The "rainfall to the kerb" approach refers to rainfall being applied to SA polygons along the road kerbs and is an approach used in heavily urbanised catchments,	The modelling approach has not been altered and is deemed to be appropriate.

	with the assumption that nearly all buildings will be directly connected to the Council and road drainage network.	
Limits of Mapping	It is recommended that when the results are processed and combined with other datasets that they are clipped back to the polygon shown in Figure 3. This polygon is the recommended limit of mapping and ensures any erroneous results in close vicinity to the downstream boundary are removed from the dataset.	It is recommended that the results are clipped to the Limit of Mapping polygon shown in Figure 3 (also provided as a Shapefile).

The TUFLOW model schematisation is shown in Figure 1 and the model terrain in Figure 2.

The recommended limits of mapping are shown in Figure 3 and the Limit of Mapping Shapefile is also attached with this report.

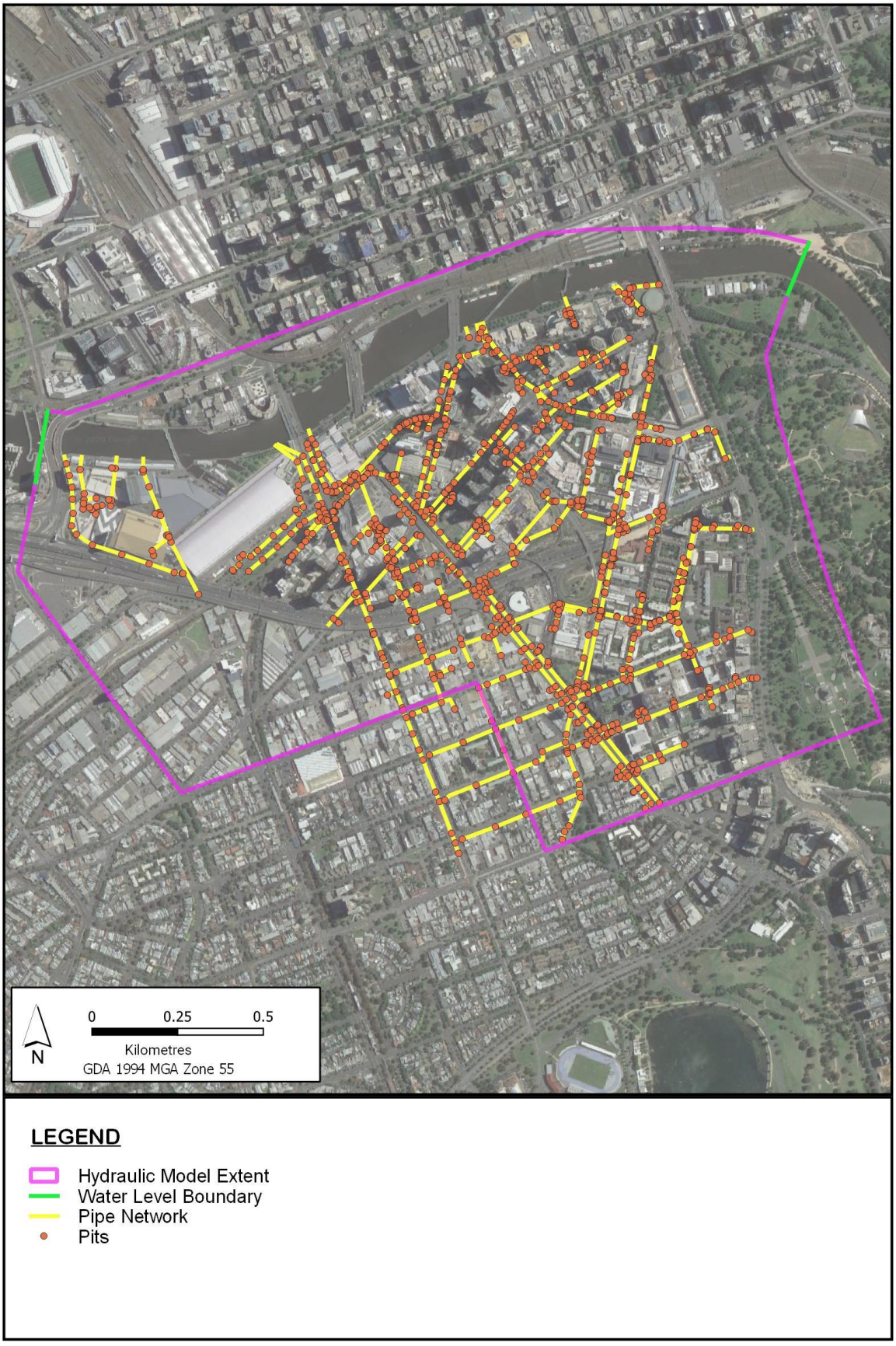

Figure 1 TUFLOW Model Schematisation

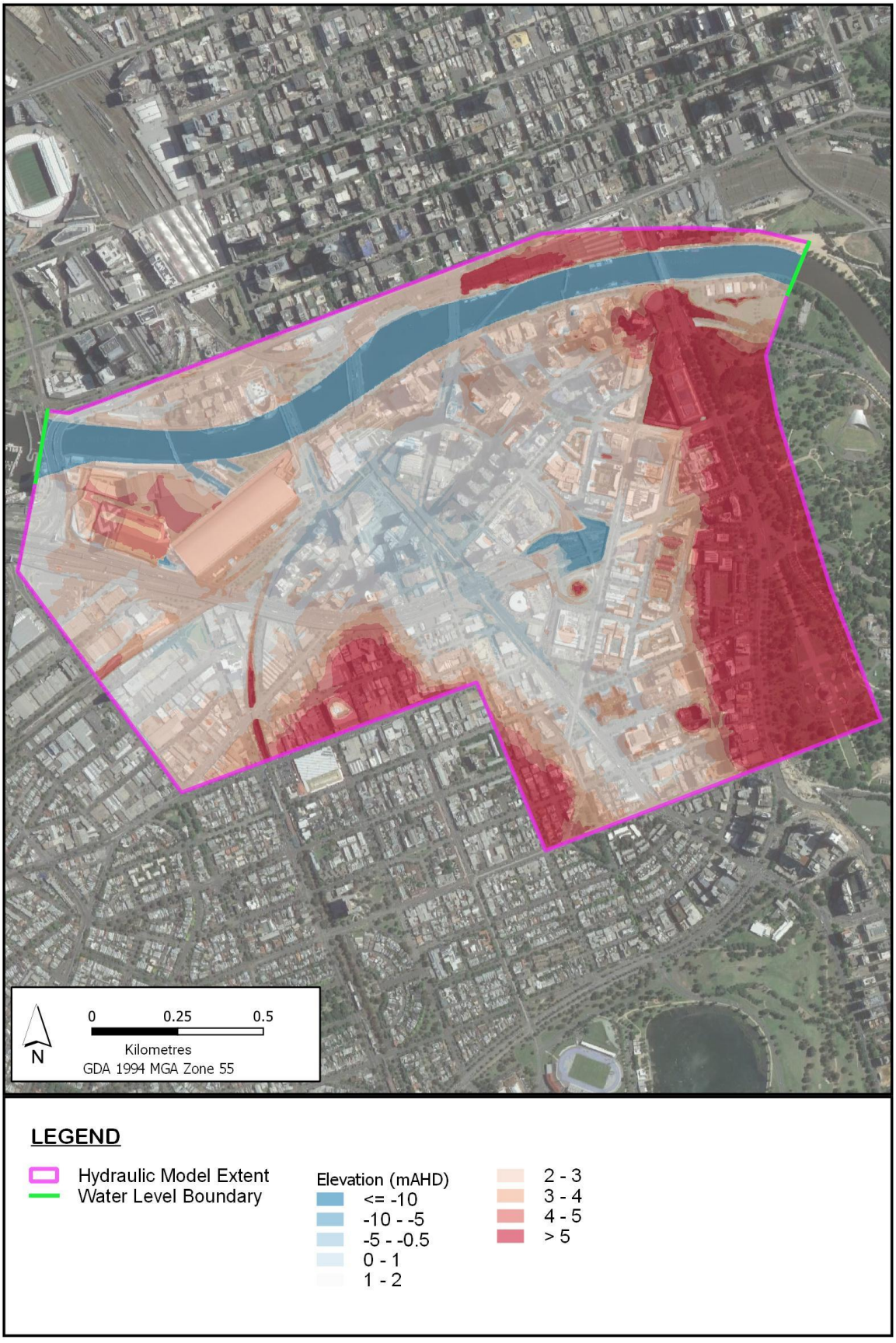

Figure 2 Model Terrain

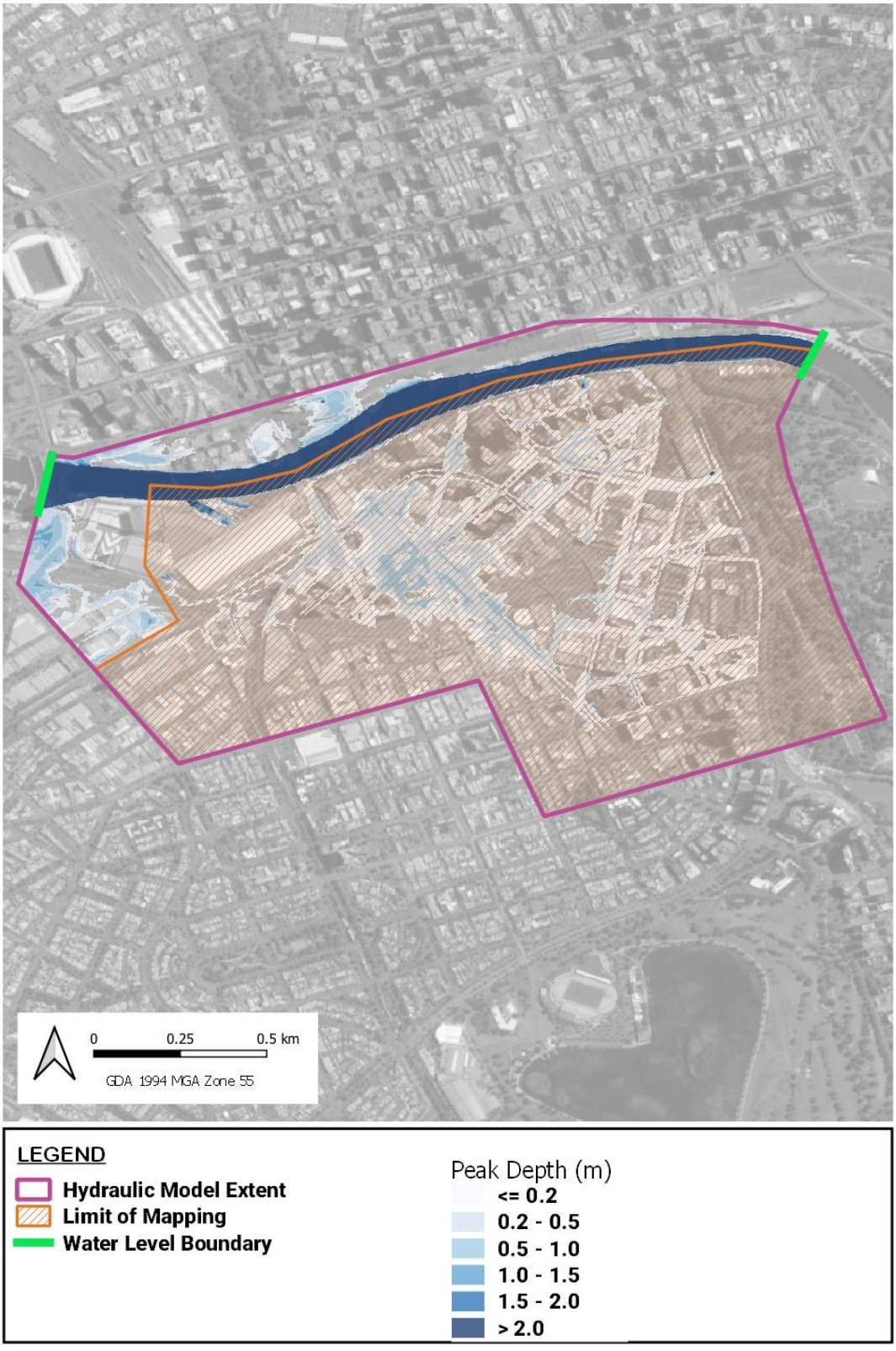

Figure 3 Limit of Mapping

3 MODELLED EVENTS

The design events modelled were the 1%, 2%, 5%, 10% and 20% AEP storm events for climate change conditions with an 18.5% increase in rainfall intensity. The 1% AEP event was also run for existing conditions. These events were all run for durations of 10min, 15min, 30min, 45min, 1hr, 2hr, 3hr, 4.5hr, 6hr, 9hr, 12hr, 18hr, 24hr, 36hr, 48hr, and 72hrs.

4 DELIVERABLES

The deliverables for this project are:

1) The Southbank RORB model and new climate change output files;
2) The updated Southbank TUFLOW model and associated files;
3) Results for the 1%, 2%, 5%, 10% and 20% AEP events for all modelled durations for the Climate Change scenario (18.5% rainfall increase) and the results for the 1% AEP event for the existing case scenario; and
4) Processed maximums for flood heights, depths and velocities for each AEP derived from all the storm durations (climate change and existing conditions).

5 SUMMARY

The Southbank TUFLOW model has been reviewed and updated with some minor changes to ensure constancy with current best practice. Climate Change scenarios have been modelled with an 18.5% increase in rainfall intensity on ARR1987 design rainfall for the 1%, 2%, 5%, 10% and 20% AEP events. The 1% AEP design event has also been modelled for current rainfall conditions.

Please do not hesitate to contact me if you have any feedback or questions.

Yours sincerely,

Julian Skipworth
Regional Manager | Principal Engineer