35 Honeysuckle Drive - Flood Risk & Impact Assessment

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1 Introduction

This report has been commissioned by KDC to undertake a flood impact and flood risk assessment as part of the DA process for the development of 35 Honeysuckle Drive (herein referred to as the Site (refer Figure 1-1).

An original Flood Management Plan was prepared for the Site by Lawson & Treloar in 1999 and in subsequent studies, which provided different estimations of flood conditions within the Honeysuckle redevelopment precinct. To remove the uncertainty regarding flood planning levels for the redevelopment area BMT was engaged by HDC to undertake the *Honeysuckle Redevelopment Area Flood Study* (2018).

This study serves to review existing flood studies and outline the qualitative flood risks to the site, including the assessment of flood impacts arising from the proposed development in line with current best practice flood modelling and floodplain management.

1.1 Background Information

The Site is located within the Cottage Creek catchment, which drains to the Throsby Basin in Newcastle Harbour. The site is located on Honeysuckle Drive and is drained primarly by a network of subsurface stormwater pipes that discharge to either Cottage Creek or terminate directly to Newcastle Harbour. During major events, the conveyance capacity of the drainage network is exceeded resulting in the excess flow being conveyed as overland flow, particularly along Honeysuckle Drive.

The Cottage Creek catchment is around 8 km^2 in size, comprised predominantly of urban residential development. The upper catchment is relatively steep, draining the ridgeline of Scenic Drive and Merewether Heights to flatter topography around National Park. The downstream end of the catchment is the commercial centre of Hunter Street and King Street, close to the proposed development site.

Flooding in the Cottage Creek catchment is generally fast and a result of the capacity of the stormwater drainage network being exceeded. Floodwaters recede quickly, however blockages of the stormwater network can prolong inundation in the area. Historically, major flooding of Cottage Creek occurred in 1988, 1990 and 2007.

The TUFLOW model developed for the *Honeysuckle Redevelopment Area Flood Study* was used in this assessment.

1.2 Description of Proposed Works

The site at 35 Honeysuckle Drive is located at the centre of the Honeysuckle Redevelopment Area, between the designated floodways of Steel Street and Worth Place. Doma Group is planning on constructing an eight-storey building on the site comprised of seven levels of residential apartments, a ground floor for commercial use and two basement level carparks.

Title:
Study Locality

Figure: 1-1

Rev: B

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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2 Previous Studies

2.1 *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018)

BMT was commissioned by HDC to undertake the *Honeysuckle Redevelopment Area Flood Study* to provide updated flood planning levels and flood risk information for the Waterfront and Cottage Creek precincts of the Honeysuckle Redevelopment Area at Newcastle West. Previous flood studies undertaken in the area provided varying estimations of flood conditions resulting in uncertainty in determining flood planning levels for the redevelopment area.

This report formed the baseline conditions for the conceptual design of the development footprints within the Redevelopment Area.

Model development & calibration

The TUFLOW hydraulic model utilised in the study was based on the NCC Throsby and Cottage Creeks and CBD TUFLOW model (BMT, 2008). Due to the coarse resolution of the model and advancements in TUFLOW it was deemed beneficial to develop a more detailed flood model of the area to reduce uncertainties and better represent the complex flow path interactions. As such, the model resolution was changed from 10 m to 1 m using 2014 LPI LiDAR.

The model was also updated with 3D break lines, such as solid walls and railway embankments, to represent hydraulic controls not present in the original model. The model also included recent changes to the catchment including the Newcastle Light Rail alignment and Newcastle Transport Interchange. Updates to the pit and pipe representation across the catchment was also undertaken as part of the study.

Several floodways were represented within the TUFLOW model to maintain the free passage of flow from the upstream Cottage Creek catchment through to Throsby Basin. The floodways included:

- a 50 m wide corridor at the northern end of Fig Tree Park (the western end of the Honeysuckle Redevelopment Area)
- two 20 m wide floodways in the Throsby Precinct between Honeysuckle Drive and Throsby Basin at 2.3 m AHD
- a 20 m wide floodway in the Cottage Creek Precinct between Honeysuckle Drive and Throsby Basin at 2.3 m AHD (Steel Street floodway)
- a 20 m wide corridor between buildings along the existing Worth Place floodway alignment
- a 10 m wide floodway in the Honeysuckle Central Precinct to allow for overland flow between Worth Place/Steel Street and Wright Lane

The model was configured to accommodate the ARR 2016 updates released in December 2016, which currently represents the best practice guideline for the industry. This included revisions to the rainfall estimates as part of IFD 2016, changes to the representation of temporal patterns across the catchment and the determination of critical durations.

The hydraulic and hydrologic models were calibrated against the June 2007 East Coast Low event to establish key model parameters and to confirm the functioning of the model in predicting real flood events. The models generally showed good agreement with the recorded June 2007 flood levels.

Design flood conditions

Design flood modelling was undertaken for the 10%, 5%, 1%, 0.5%, 0.2% AEP events and the Probable Maximum Flood (PMF). Results demonstrated that the site was not inundated during any of the events up to the 0.5% AEP event, with only minor flooding across the site during the 0.2% AEP event. During the PMF event extensive inundation was modelled across the site as the peak flows are far exceed the available drainage capacity of Cottage Creek.

The design flood modelling was also undertaken using the ARR 2016 structure blockages. From the modelling and analysis of peak flood levels at four reporting locations it was evident that the ARR Blockage scenario at the 1% AEP event provides for a similar flood condition to that of the 0.5% AEP event without consideration of structure blockages, as shown in 2.1 below. Increases in peak flood levels resultant of the modelled blockages were mostly identified in the areas immediately adjacent to the Cottage Creek channel, floodways and the roadways upstream of major blocked structures.

Table 2-1 Modelled Peak Flood Levels (m AHD) for Blockage Scenarios (BMT, 2018)

Flood Event	Peak Level (m AHD)			
	Location 1 – western end of Honeysuckle Drive	Location 2 – overland flow path west of Cottage Creek	Location 3- midway along Honeysuckle Drive	Location 4 – eastern end of Honeysuckle Drive
1% AEP	2.34	1.81	1.89	1.76
0.5% AEP	2.47	2.31	2.43	1.86
0.2% AEP	2.69	2.69	2.54	2.08
1% AEP Blockages	2.47	1.67	2.41	1.76
PMF	3.21	3.13	2.82	2.57

Flood impacts of Honeysuckle Redevelopment Area

The study found that the critical flood condition for assessing impacts of the proposed Honeysuckle Redevelopment Area is the local catchment flooding. Due to the backwater nature of ocean inundation from Throsby Basin, the proposed development would have little to no impact on the ocean design event flood levels.

The study area is predominantly impacted during events greater than the 0.5% AEP event, as more frequent flood events are largely contained by Cottage Creek. As such, the flood assessment focussed on the rare flood events as minor to no impacts are experienced during more frequent events due to their limited inundation extents. Structure blockages were applied during the impact assessment to increase the overland flows through the site, to better identify potential impacts associated with the proposed development.

The modelled development scenarios resulted in peak flood impacts that were largely contained within the Redevelopment Area. Increases of up to +0.2 m were modelled along Honeysuckle Drive and the Steel Street floodway. During the 1% AEP event flood level impacts were modelled along Cottage Creek, with negligible impacts to existing adjacent buildings. During the 0.5% and 0.2% AEP events the modelled flood impacts were broader, impacting on adjacent properties around the Honeysuckle Central area, particularly during the 0.2% AEP event (up to +0.30 m).

Floodways

As noted earlier, floodways were incorporated into the model to better maintain the existing flood conditions of the catchment. Most of the floodways were modelled at a flat level of 2.3 m AHD, consistent with the intended seawall promenade. The HWC floodway was modelled as inactive during all the flood events and was found to be redundant due to its limited impact on the overall modelled flood conditions.

The study notes that the performance of the floodways requires that they provide sufficient conveyance of the expected overland flood flows and should be relatively clear of obstructions (except for minor street landscaping and furniture items within reason).

Flood planning

The 1% AEP best practice flood hazards were determined using the Best Practice Flood Risk Management approach to flood hazard mapping (D. McLuckie et. al., 2014). The high flood hazard areas were largely localised to the channels of Cottage Creek which were classified as H6 and H5 hazard areas. Isolated areas of H4 hazards were located within flood storage areas. As the site is not inundated during the 1% AEP event, there were no modelled flood hazard impacts on site. During the PMF event the high hazard areas (H5 and H6) were mostly confined to the main floodways along Steel Street, Cottage Creek and Worth Place and along the roadways. Flood storage within the western portion of the development area were classed as H4.

The study identified a low Risk to Property classification for the study area as most of the site is flood free at the 1% AEP event. The Risk to Life classification in the area is relatively high (L4) due to the short response time afforded by flooding from local catchment runoff. As such, the provision of on-site flood-free refuge was recommended.

Discussions with Council during the study identified that due to the significant impact of potential structure blockages within the study area, it was prudent to incorporate structure blockages into the process for defining appropriate FPLs. As such, the FPLs were calculated based on the 1% AEP design event with structure blockages and a freeboard of 0.4 m (contrary to the 0.5 m freeboard stipulated in the Newcastle Development Control Plan 2012). Furthermore, due to the potential for ocean flooding, the minimum FPL was set to 2.8 m AHD to account for areas where the local catchment flooding levels may have resulted in an FPL below this.

3 Flood Impacts of Proposed Development

As noted in the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018), the critical flood condition in terms of assessing the proposed development at 35 Honeysuckle Drive is the local catchment flooding. The proposed development is unlikely to impact on the ocean design flood levels due to the backwater nature of ocean inundation arising from the Throsby Basin.

The relative impact of the proposed development at 35 Honeysuckle Drive has been considered in terms of its potential adverse impacts on local catchment flood behaviour and deviation from the potential impacts outlined in the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018). As such, the developed scenario from the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018) with the HDC Preliminary Layout forms the baseline condition against which the potential flood level impacts of the proposed development at 35 Honeysuckle Drive have been compared. The potential flood level impacts have been compared for the 1%, 0.5%, 0.2% AEP events and the PMF ***without*** structure blockages, and for the 1%, 0.5%, 0.2% AEP events ***with*** structure blockages to ensure all flood impacts have been considered.

Details in the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018) developed scenario (herein referred to as the baseline condition for comparison) included:

- available design details for the Newcastle Light Rail
- ground elevations in the development area set to 2.3 m AHD, consistent with the proposed seawall level
- proposed development layout
- removal of the HWC floodway

The developed scenario for the proposed development at 35 Honeysuckle Drive includes the above with the addition of the details for the ground floor plan provided in DA-0201[02] - Floor Plan.pdf.

3.1 35 Honeysuckle Drive Post-Development Flood Modelling *without* Structure Blockages

The post-development flood modelling without structure blockages was undertaken for the 1%, 0.5%, 0.2% AEP events and the PMF event, with mapping available in Appendix B.

During the 1% AEP event the site remains free of flood water, resulting in no change to the peak flood levels within the Redevelopment Area or the local catchment. As the site becomes inundated during the 0.5% and 0.2% AEP events, additional flood level impacts are experienced within the seawall esplanade to the north of the site (between the development footprint and the seawall). At the 0.5% AEP event modelled increases were up to 0.04 m and up to 0.06 m for the 0.2% AEP event. No additional impacts were modelled outside of the seawall esplanade. These increases in flood levels are likely due to the redistribution of flow around the detailed footprint of the proposed 35 Honeysuckle Drive development, with no inundation of the actual development occurring during these events.

During the PMF event reductions to peak flood levels of up to 0.10 m were modelled within the catchment. The majority of the reductions to peak flood levels were modelled along Honeysuckle

Drive and the Cottage Creek Precinct. Associated increases in peak flood levels were modelled on the northern side of the proposed development within the seawall esplanade of up to 0.20 m. The platform area of the development becomes inundated with floodwaters up to 0.30 m deep. This inundation occurs as the platform is elevated at 2.90 m AHD, below the level of the PMF (up to 3.40 m in the vicinity of the site). In the baseline condition it was conservatively assumed that the entire development area would be above the PMF level.

None of the modelled impacts adversely alter flooding conditions to the neighbouring properties and are all isolated to the seawall esplanade adjacent to the proposed development.

3.2 35 Honeysuckle Drive Post-Development Flood Modelling *with* Structure Blockages

The post-development flood modelling with structure blockages was undertaken for the 1%, 0.5%, 0.2% AEP events, with mapping available in Appendix C.

During the 1% AEP event with structure blockages, inundation across the Redevelopment Area occurs. A small area of additional flood impacts was modelled in the adjacent seawall esplanade to the north of the site, with increases in peak flood levels of up to 0.03 m. No changes to peak flood levels were modelled in the broader catchment and Redevelopment Area.

At the 0.5% AEP event greater increases to peak flood levels of up to 0.05 m were again modelled in the seawall esplanade to the north of the proposed development. Corresponding reductions in peak flood levels of up to 0.04 m were modelled along the Steel Street floodway to the west of the proposed development. Similarly, during the 0.2% AEP event increases in peak flood levels of up to 0.06 m were modelled within the seawall esplanade with corresponding reductions of 0.07 m in the adjacent Steel Street floodway.

As with the modelled impacts without structure blockages, the post-development scenario *with* structure blockages resulted in no additional impacts outside of the seawall esplanade to the north of the proposed development at 35 Honeysuckle Drive. As such, there are no additional impacts to neighbouring properties within the Redevelopment Area as a result of the detailed 35 Honeysuckle Drive development when compared to the flood impacts presented in *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018).

3.3 Steel Street Floodway

The achievement of the accepted flood impacts documented in the *Honeysuckle Redevelopment Area Flood Study* for the ultimate developed scenario at 35 Honeysuckle Drive is dependent on the formalisation of the Steel Street Floodway to a finished surface level of 2.3 m AHD. The existing surface levels along the proposed Steel Street Floodway alignment locally exceed this level. However, the total flow path width of the floodway is the primary factor governing its performance, with the surface level being secondary.

The Steel Street Floodway is located within the Lee 5 lot, adjacent to 35 Honeysuckle Drive. The formalisation of the Steel Street Floodway will form part of the Lee 5 development. If the 35 Honeysuckle Drive development is completed before works on Lee 5, then there will be a period of time during which the Steel Street Floodway is not required, as there will effectively be a 130 m wide

potential for overland flow to Newcastle Harbour between 35 Honeysuckle Drive and Cottage Creek. Once works are undertaken at Lee 5, then the flow path width will become reduced and the Steel Street Floodway alignment will need to be formalised to the required finished surface level of 2.3 m AHD.

4 Flood Risks & Hazards of Proposed Development

4.1 Climate Change

In 2007 the NSW Government released a guideline for practical consideration of climate change in the floodplain management process that advocates consideration of increased design rainfall intensities of up to 30%. So too, the Intergovernmental Panel on Climate Change (IPCC), Bureau of Meteorology and CSIRO have collectively prepared tailored climate change project reports for Australian regions including the East Coast region which include projected changes in heavy rainfall events. The predicted increase in rainfall for the low emissions pathway is 18%, with 25% increases in rainfall predicted for the high emissions pathway.

Consistent with these guidelines, the current recommendations for assessing the potential future climate change impacts on rainfall intensities were released as part of the Australian Rainfall and Runoff (ARR) 2016 Update. This would see around a 13% increase in design rainfall intensities for a 2100 planning horizon.

As noted in the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018), the 0.5% AEP flood condition can be compared to the 1% AEP event in lieu of simulating the design flood events with an increased rainfall intensity to assess the potential impacts of future climate change. In the case of Cottage Creek, the 0.5% AEP flows are around 40% higher than those of the 1% AEP and as such provide a conservative estimate as to the potential impacts of climate change on increased rainfall intensity on the 1% AEP design flood condition.

A range of design flood levels simulated as part of the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018) and this study for 35 Honeysuckle Drive are presented in Table 4-1 below. As shown, each study modelled the 1% AEP event with blockages and the 0.2% AEP event without blockages (as the climate change equivalent event). Comparison of the two studies at the locations in Figure 4-1 demonstrates the negligible impact of the detailed 35 Honeysuckle development on peak flood levels with slight reductions modelled in the Steel Street and HWC Floodway areas. As such, the proposed 35 Honeysuckle Drive development does not impact on climate change impacts in the Redevelopment Area or broader catchment.

Table 4-1 Comparison of Design Flood Levels (m AHD)

Location	Honeysuckle Redevelopment Post-Development Flood Levels (BMT, 2018) 0.2% AEP	Honeysuckle Redevelopment Post-Development Flood Levels (BMT, 2018) 1% AEP with Blockages	35 Honeysuckle Dr Post-Development Flood Levels 0.2% AEP	35 Honeysuckle Dr Post-Development Flood Levels 1% AEP with Blockages
Cottage Creek Floodway	2.64	2.40	2.64 (0)	2.40 (0)
Steel Street Floodway	2.57	2.42	2.54 (-0.03)	2.41 (+0.01)
HWC Floodway	2.77	2.50	2.76 (-0.01)	2.50 (0)

Location	Honeysuckle Redevelopment Post-Development Flood Levels (BMT, 2018) 0.2% AEP	Honeysuckle Redevelopment Post-Development Flood Levels (BMT, 2018) 1% AEP with Blockages	35 Honeysuckle Dr Post-Development Flood Levels 0.2% AEP	35 Honeysuckle Dr Post-Development Flood Levels 1% AEP with Blockages
L1	2.75	2.38	2.75 (0)	2.38 (0)
35 Honeysuckle Dr	2.76	2.50	2.76 (0)	2.50 (0)
L2	2.77	2.41	2.77 (0)	2.41 (0)
L3	2.69	2.41	2.69 (0)	2.41 (0)
L4	2.77	2.50	2.76 (-0.01)	2.50 (0)
L5	2.76	2.50	2.76 (0)	2.50 (0)
L6	2.74	2.49	2.74 (0)	2.49 (0)
L7	2.78	2.46	2.78 (0)	2.46 (0)
L8	2.77	2.47	2.77 (0)	2.47 (0)

Figure 4-1 Climate Change Comparison Locations

4.2 Flood Hazard

4.2.1 Best Practice Flood Hazards

The Best Practice Flood Risk Management approach to flood hazard mapping (D. McLuckie et. al., 2014) classifies the floodplain into six distinct hazard zones (H1 to H6) based on thresholds of flood depth, velocity and depth-velocity product (see Figure 4-2). The adopted thresholds identify when modelled flood conditions would present a risk to people, vehicles and building construction types. A description of each hazard threshold is provided in Table 4-2.

Table 4-2 Flood Hazard Classification Thresholds

Hazard Classification	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles.
H3	Unsafe for all vehicles, children and the elderly.
H4	Unsafe for all people and vehicles.
H5	Unsafe for all people and vehicles. Buildings require engineering design and construction.
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

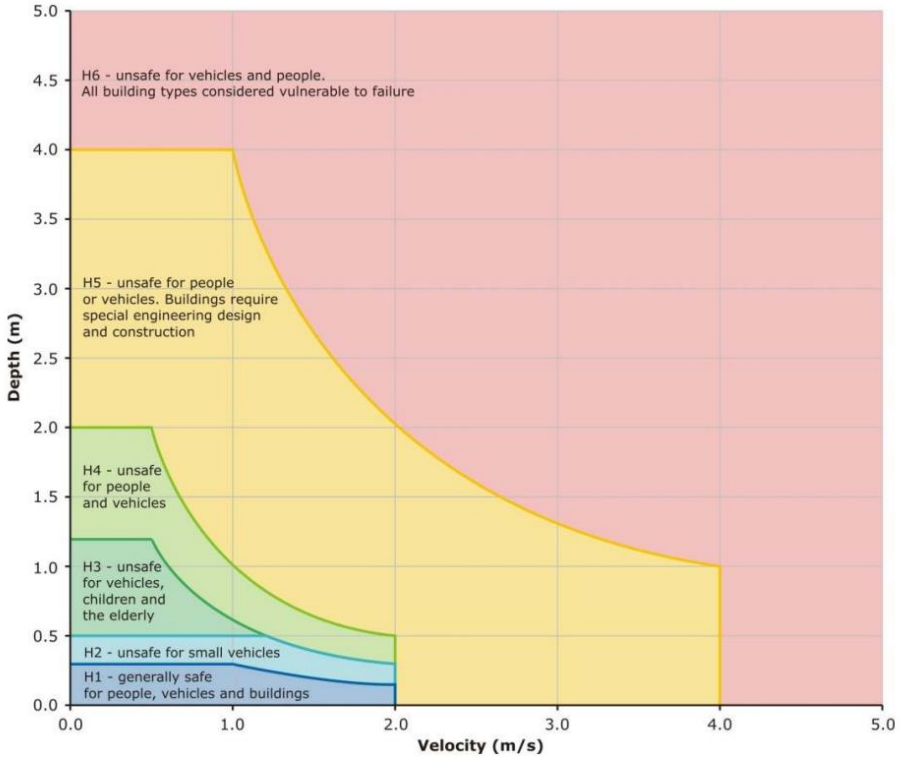

Figure 4-2 Hydraulic Hazard as a Function of Depth and Velocity

4.2.2 Risk to Property and Risk to Life Hazard

The combination of flood depths and flood velocities can be used to assess the risk to property and life based on the hydraulic behaviour of the flood event. Situations where flood depths are shallow, but velocities are high can be just as critical as situations where flood depths are large, but velocities are low. Table 4-3 outlines the risk to property categories adopted by Council's DCP.

Table 4-3 Risk to Property Hazard Classification Thresholds

Hazard Classification	Description
P1	Parked or moving cars remain stable
P2	Parked or moving heavy vehicles remain stable
P3	Suitable for light construction (e.g. timber frame, masonry and brick veneer)
P4	Suitable for heavy construction (e.g. steel frame, reinforced concrete)
P5	Hydraulically unsuitable for normal building construction

In addition to hydraulic behaviour, risks to life are influenced by the flooding mechanism (i.e. flash, river or ocean), as well as the availability of an evacuation route. Generally, evacuation can be expected in areas impacted by riverine or ocean flooding. As such, the risks to life in these areas are low. Flash flooding, however, can represent a significant risk, as there is generally little time to respond or evacuate. If there is an evacuation route available consisting of a continuously rising route to flood free land (above the PMF level), then the risk during a flash flood situation is less than if no route was available.

Risk to life categorisation adopted by Newcastle City Council has been developed taking into account both the availability for evacuation and the hydraulic behaviour, as presented in Table 4-4.

The Risks to Life criteria are determined based on PMF conditions. These extreme flood conditions are adopted as the FDM (2005) is explicit in requiring risks to life to be considered and managed over the full range of flood events (i.e. up to the most extreme conditions, or PMF).

Table 4-4 Risk to Life Hazard Classification Thresholds

Hazard Classification	Description
L1	Sufficient time to evacuate using formal community evacuation plans. Not relevant to flash flooding scenarios.
L2	Short duration flash flooding circumstances where there is an obvious escape route to flood free land and where enclosing waters during the PMF are suitable for wading or heavy vehicles. On site flood refuge **not** necessary and normal light frame residential building are appropriate.
L3	Short duration flash flooding with no warning time and no obvious escape route to flood free land with enclosing waters during the PMF which are suitable for wading or heavy vehicles. On site flood refuge **not** necessary and normal light frame residential buildings and appropriate.
L4	Short duration flash flooding with no warning time and enclosing waters during the PMF **not** suitable for wading or heavy vehicles. On site refuge

Hazard Classification	Description
	is necessary and heavy frame construction or suitable structural reinforcement may be required.
L5	Short duration flash flooding with no warning time and enclosing waters during the PMF unsuitable for normal heavy building construction. Therefore, not possible to construct flood-free refuge. The risk to life is considered extreme and the site is unsuitable for habitation.

4.2.2.1 35 Honeysuckle Drive Post-Development Flood Risks without Structure Blockages

The best practice flood hazard categories adopted for the Cottage Creek catchment are presented in Appendix D, along with the Risk to Property and Risk to Life categories, for the 1% AEP event without structure blockages.

The change in flood hazard categorisation is presented in Figure D-1 to demonstrate the negligible impact of the proposed development at 35 Honeysuckle Drive. Evidently, there is no change in flood hazard categories at the 1% AEP event to neighbouring properties or to the broader Redevelopment Area. Due to the lack of inundation across the site during the 1% AEP event without structure blockages, higher flood hazard categories are mostly confined to designated floodways, such as Cottage Creek, and some roadways. The majority of the Redevelopment Area is categorised as a H1 hazard which is generally not constrained by flow conditions or vulnerability of the public.

The Risk to Property and Risk to Life is shown in Figure D-3 and Figure D-5 for the general Redevelopment Area (BMT, 2018) and for the detailed proposed development at 35 Honeysuckle Drive. Similar to the flood hazard at the 1% AEP event without structure blockages, the risk to property does not change with the addition of the detailed 35 Honeysuckle footprint due to lack of floodwater across the site. As such, P5 areas are confined to the main flood channels, such as Cottage Creek, with P1 to P2 areas scattered across the Redevelopment Area.

The Risk to Life hazard for the proposed development is similar to that presented for the general Redevelopment Area. The majority of the Redevelopment Area was classified as H4 hazards, with areas of H5 along Cottage Creek, Worth Place and the Steel Street floodway and areas of H3 along the seawall esplanade. With the inclusion of the detailed proposed footprint of 35 Honeysuckle Drive, the hazard categories are mostly distributed the same, with some slight changes to the extent of H3 hazards to the north of the proposed development and a greater extent of H5 hazards along the Steel Street floodway. There are no changes to the Risk to Life hazard categories assigned to neighbouring properties.

4.2.2.2 35 Honeysuckle Drive Post-Development Flood Risks with Structure Blockages

The best practice flood hazard categories adopted for the Cottage Creek catchment are presented in Appendix D, along with the Risk to Property categories for the 1% AEP event without structure blockages.

Similar to the 1% AEP event without structure blockages, the 1% AEP event *with* structure blockages results in the same flood hazard conditions as outlined in the *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018) and therefore presents a negligible change in categorisation in Figure D-2.

The 1% AEP event with structure blockages initiates flooding within the Redevelopment Area and presents flood hazard conditions dissimilar to the 1% AEP event *without* structure blockages. The majority of the Redevelopment Area is classified as H1 which by definition presents a low hazard to pedestrians, buildings and cars. The roadways along Honeysuckle Drive adjacent to the proposed development are classified as H2 and H3 hazards which can be unsafe for cars and pedestrians. Higher hazard areas (H5 and H6) are again confined to Cottage Creek.

The Risk to Property is shown in Figure D-4 for the general Redevelopment Area (BMT, 2018) and for the detailed proposed development at 35 Honeysuckle Drive. The inclusion of the detailed footprint of 35 Honeysuckle Drive has minor impacts on the Risk to Property categorisation. There is a slight adjustment to the location of P2 areas within the Steel Street floodway and a greater area of P1 within the seawall esplanade. Both changes are due to the redistribution of flow around the detailed footprint, with no adverse changes to the risk categorisation i.e. there are no increases in risk immediately surrounding the development or within the Redevelopment Area.

4.3 Design Implications

4.3.1 Risk to Property

The study area overall has a low Risk to Property classification that has not adversely changed with the inclusion of 35 Honeysuckle Drive, further emphasised by the flood-free nature of the area during the 1% AEP event without structure blockages. As such many of the provisions for Risk to Property would have already been satisfied. As noted in *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018), basement garages may be acceptable where all potential entry points are at or above the PMF level, excepting that vehicular entry points can be at the FPL. From the provided document *2018-04-18_5711-35HD - GA Set.pdf*, the vehicular entry point is set to 2.90 m AHD, the FPL for the site. As such, the basement parking, assuming water entry points are at or above the PMF level, will comply with Council's DCP.

From perusal of the proposed development plans, the electrical substation is elevated to 2.45 m AHD which is 0.45 m below the FPL. However, Ausgrid's requirements for the flood immunity of substation infrastructure is only to that of the 1% AEP and not the FPL. Therefore, provided that the substation is set at a level of 2.5 m AHD, the requirements of management of risk to property in relation to the substation will be satisfied.

4.3.2 Risk to Life

The short response time afforded by flooding from local catchment runoff means that much of the site has a relatively high risk to life. The L4 classification requires the provision of on-site flood-free refuge. As the proposed development is multistorey, on-site flood-free refuge is provided on the floors located above the ground retail level of the development, i.e. the first flood of the building, as the ground floor is located at the FPL, which is below the PMF level. As recommended in *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018), as the proposed development is located in an area surrounded by L4 and greater hazards and will provide flood-free refuge, the building must be of a construction type able to withstand the effects of flooding and will require design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF).

4.3.3 Flood Planning Level (FPL)

The Flood Planning Level (FPL) is used to manage the risk to property presented by the flood hazards. It is defined by the Newcastle Development Control Plan (DCP) 2012 as being the 1% AEP flood level plus a 0.5 m freeboard, for all occupiable rooms of all buildings.

Following discussions with Council it was agreed that due to the significant impact of potential structure blockage within some locations of the study area it was prudent to incorporate structure blockages into the process for defining appropriate FPLs (BMT, 2018). Therefore, the FPLs for the development sites across Honeysuckle have been defined using a freeboard of 0.4 m above the 1% AEP design event with structure blockages.

The FPL for the proposed development at 35 Honeysuckle Drive as derived by this impact assessment is 2.90 m AHD (2.50 m AHD + 0.40 m freeboard) which agrees with previously recommended FPLs in *Honeysuckle Redevelopment Area Flood Study* (BMT, 2018). As such, the proposed development does not impact on previously recommended FPLs.

5 Flood Emergency Response Plan

5.1 Introduction

It is important to be prepared in the event of a flood. A Flood Emergency Response Plan (FERP) is required to ensure occupants are suitably informed of the property specific flood risk, what to do to prepare for a flood, and what to do during a flood.

This FERP was prepared for the proposed development at 35 Honeysuckle Drive in its entirety and assists owners/residents with the preparation of an SES Home Emergency Plan for their individual residential unit and business owners/occupants with the preparation of an SES Emergency Business Continuity Plan. This approach was adopted due to the need for the unit/business specific plans to include personal information such as key emergency contacts and any occupant specific requirements (e.g. number of residents, medical needs, pets), which cannot be fully captured by this Plan.

It is recommended that each individual unit owner/occupant prepares an SES Home Emergency Plan (http://www.seshomeemergencyplan.com.au/index.php) and that each business owner/occupant develops an SES Emergency Business Continuity Plan (http://www.sesemergencyplan.com.au/business/). To assist with this, terms and expressions often referred to when discussing flooding behaviour, flood risk or floodplain management at a site are provided at the end of this document.

Being prepared for a flood event will help residents (and retail/commercial customers and staff) respond better and recover faster if a major flood event was to occur. Additionally, being prepared ensures that risk to property and risk to life is minimised by personnel on site having adequate knowledge during a flood emergency.

5.2 SES Home Emergency Plan and Emergency Business Continuity Plan

The NSW SES has developed an interactive online tool that residential property owners can use to prepare property (i.e. house/unit) specific Home Emergency Plans. Information on the interactive online tool can be found at the following locations:

- http://www.floodsafe.com.au/make-an-emergency-plan/home-emergency-plan
- http://www.seshomeemergencyplan.com.au

They have also developed a similar online tool that business owners/operators can use to prepare site specific Emergency Business Continuity Plans. Information on the interactive online tool can be found at the following web address:

- http://www.sesemergencyplan.com.au/business/

The interactive online tools ask the user a series of questions. Based on the responses to the questions, actions are listed for what to do before, during and after a flood event. Once all questions have been answered, the online tools produce an editable version of the Home Emergency Plan or

Emergency Business Continuity Plan (depending on the tool used) that can then be filled out by the owner/occupant and used in the event of a flood emergency.

The SES Home Emergency Plan includes the following information:

- Local flood behaviour specific to the site
- Description of trigger levels linked to site evacuation
- List of people/animals to be included in the plan (i.e. list of people/animals that the resident is responsible for in the event of an emergency)
- Requirements and specific actions for elderly, disabled, vulnerable persons and young children
- Evacuation route to be followed in the event of a flood
- Contents of an emergency kit to be used in the event of a flood emergency
- What needs to be done to prepare your home in the event of a flood
- Information about what to do in the event of an evacuation warning
- Who to contact in the event of a flood emergency
- Actions to be followed immediately after and during the recovery phase of a flood event.

The contents of the SES Emergency Business Continuity Plan specific to flood risk include the following:

- Description of local flood behaviour specific to the site
- Description of triggers and actions to take in the event of a flood
- Evacuation plan to be followed in the event of a flood (if required) (including evacuation point, triggers for evacuation and how to manage particular evacuees)
- List of actions to be completed to prepare the business for a flood event (including who is responsible for actioning each item and how often each action should be reviewed)
- List of actions to be followed when a flood event is imminent/occurring
- List of emergency contacts in case of a flood emergency
- List of actions to be followed during the recovery phase of a flood event.

Most of the above information can be readily entered by the homeowner/business owner/occupant or is automatically generated as part of the SES interactive online tool. However, some of the above information is not readily available. This document provides the information that is not readily available to an occupant/owner but can be added to an SES Home Emergency Plan or Emergency Business Continuity Plan at a later stage. The information contained in this document includes:

- Description of the local flood behaviour (including design flood event mapping) (to be used to complete the “Know Your Risk” section of the SES Home Emergency Plan/Emergency Business Continuity Plan)

- Evacuation considerations (to be used to complete the “Know where to go” and “Evacuating” sections of the SES Home Emergency Plan/Emergency Business Continuity Plan)
- List of key flood safety measures (to aid in the completion of the several sections of the SES Home Emergency Plan/Emergency Business Continuity Plan).

5.3 Description of Proposed Works

The development at 35 Honeysuckle Drive, Newcastle proposes to construct a residential and commercial building comprising two seven storey towers and a podium base including retail outlets with two levels of basement car parking. The development proposes to include the construction of a new residential and commercial building, with a footprint of approximately 3300 m^2. The development will comprise 92 residential apartments, eight retail spaces located on the ground floor and 190 car parking spaces split over two basement levels.

As outlined in the Flood Impact Assessment completed for the site (L.N20778.008), Newcastle City Council (Council) mandates the appropriate flood planning level (FPL) for the site. Council has identified that the minimum floor level for occupiable rooms on the site is 2.90 m AHD.

The building has been designed with the following key floor levels:

- The minimum floor level of residential apartments (level 1 and above) is significantly greater than 2.9 m AHD (assuming a minimum ground level ceiling of 2 m above the floor level). This would be well above the required FPL and above the PMF level.
- The minimum floor level of retail spaces is 2.90 m AHD, which is consistent with the required FPL.
- The basement/lower ground car parking level is set at -3.10 m and -0.10 m AHD.

5.4 Emergency Evacuation Procedure

Based on the local flood behaviour near the development during major flood events, there will limited warning time and no routes for safe evacuation from the site. Floodwaters would likely begin inundating the streets surrounding the building within 1 hour of the onset flood producing rainfall. It is therefore recommended that people seek flood free refuge within the building, as more hazardous flood conditions would present themselves within the adjacent road corridors.

5.4.1 Residential Apartments

In the instance of a flood event equivalent to a PMF, the building is surrounded by floodwaters largely categorised as H2 and H3. However, Level 1 and above (i.e. all residential apartments) will remain free from inundation during events up to and including the PMF. Taking in to account the limited available warning time, the distribution and hazard classification of floodwaters surrounding the development, the possible depth of inundation on the ground floor, and the relatively short duration of floodwaters surrounding the building, the risk of navigating the floodwaters surrounding the building to evacuate the residential units exceeds the risk of remaining in the building. Therefore, the recommended action for the residential unit occupants during such an event is to return to and/or stay within their apartments (i.e. effectively sheltering in place and remaining on-site in the residential levels from Level 1 up). It is recommended that the stairwell be used to access and move between

the residential floors in the event of a flood rather than reliance on the elevators, as they may not remain in operation during a major flood event.

5.4.2 Car Parking (Basement Level)

As previously stated, the basement level car parking areas have flood immunity up to the 1% AEP event as the vehicular entry is located at the FPL. In the PMF, the basement car parking levels could become inundated and therefore, persons located in these areas are advised to immediately evacuate to residential areas on level 1 and above. The internal stairwell which provides access from the basement levels to the ground floor and above should be used. Once persons from the basement levels are on the residential apartment levels (level 1 and above) they should shelter in place (as per the evacuation procedure for residential apartment occupants).

In a PMF event the conditions within the basement car parking areas could become particularly hazardous. Hydraulic calculations were undertaken to determine the likely rate of rise of flood waters spilling into the basement in such an event. This found that there would be a period of around 20-30 minutes from the time of initial onset of flooding in the basement until the conditions became unsuitably deep for wading. It is reasonable to assume that during the unlikely occurrence of such an incident, sufficient time would be available to evacuate to the ground floor or higher via available stairwells. The basement plans indicate that the doors open inward into the stairwells, which would enable safe evacuation from the underground car park to the upper levels of the building in the event of an extreme flood.

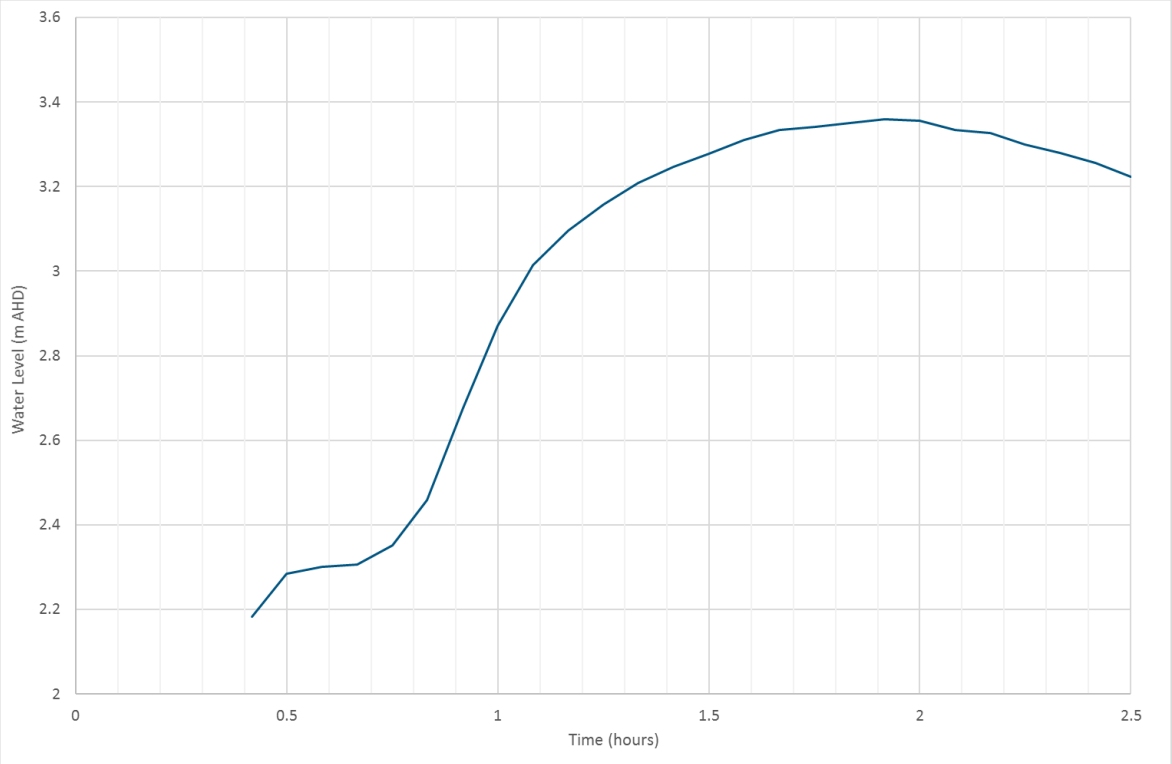

Figure 5-1 Modelled PMF Water Level Hydrograph at 35 Honeysuckle Drive

5.4.3 Retail Areas

As previously discussed, the elevation of the retail areas is 2.90 m AHD. This elevation will ensure these areas are not inundated in events up to and including the 1% AEP, however they may be inundated to significant depths during the PMF event. As with other areas on-site below the PMF level, the emergency evacuation procedure for the retail areas is to seek refuge inside the building, sheltering in place on level 1 or above.

The isolated retail lot in the north-eastern corner of the development will need to evacuate to the eastern portion of the main retail area within the main tower of the development. The modelled hazard within the outdoor area that must be traversed by the evacuees is H2, the conditions of which can be safely navigated (refer Figure 4-2).

On the ground floor there is access to four internal stairs (two in the eastern portion and two in the western portion) amongst the retail areas. All patrons within the retail areas on the ground floor will need to access the stairs and move to level 1 as shown in Figure 5-2 (see red arrows). Apart from the isolated retail lot, all other retail areas have internal doors to access the internal stairs. Therefore, where possible internal access should be used preferentially rather than exiting outside the building.

According to the plans provided, there is no vegetation or landscaping planned in these locations which will impact on the use of these routes. As these routes are located at the FPL, inundation should only occur during PMF conditions. These routes should be kept clear of future landscaping or vegetation that would impede the movement of people during a major flood. It should be noted that the proposed flood egress routes rely upon fire stair access to flood free refuge. Therefore, a protocol needs to be in place to ensure that the fire stair entrances are unlocked and available to be used during major flood events.

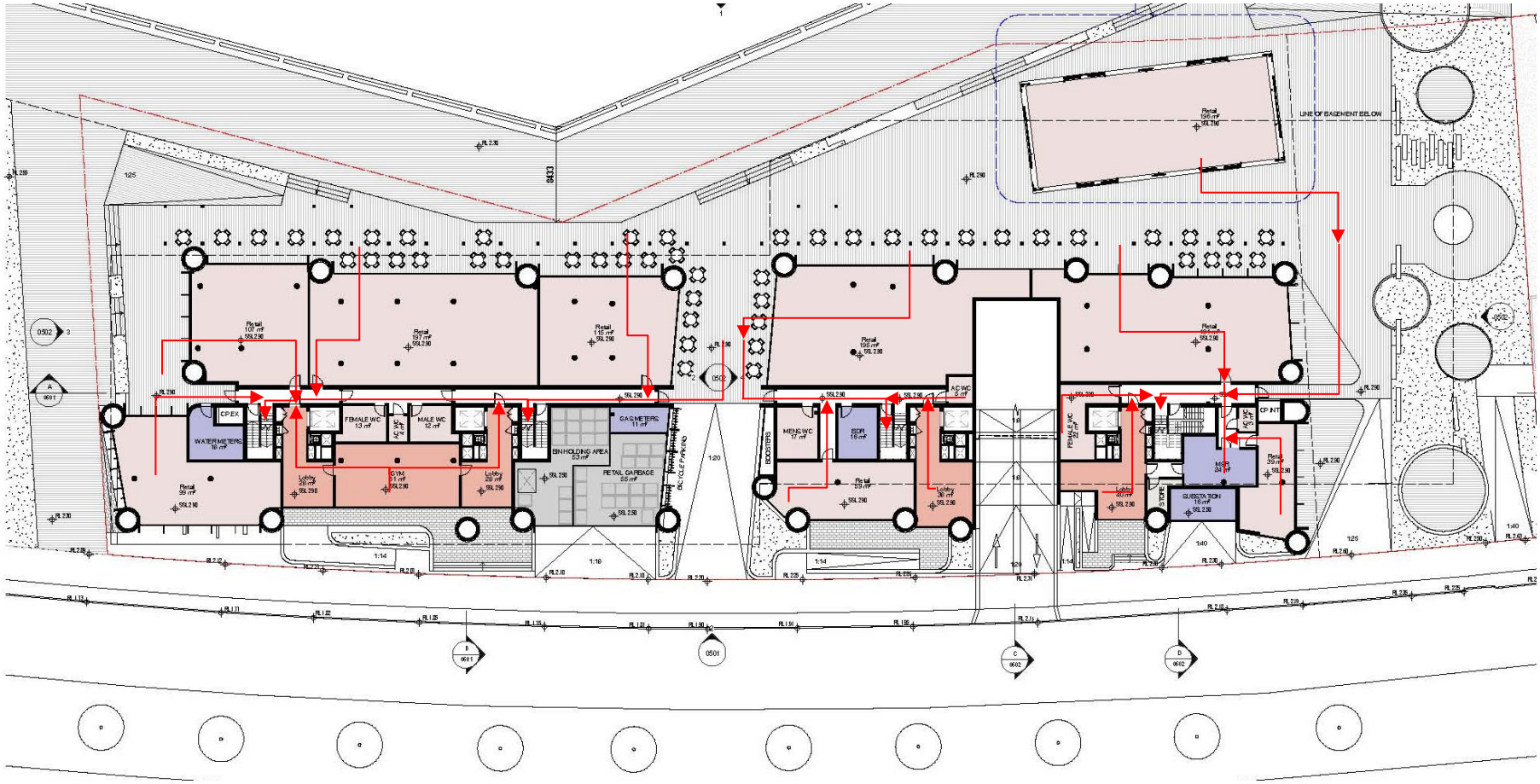

Figure 5-2 Possible Evacuation Routes

5.5 Before a Flood

Outlined below are several flood safety measures to be followed before a flood. Guidance on how to address each measure is included in the NSW SES interactive online tool, with supporting information provided in this document.

- Using the information contained in this document, in conjunction with property specific information such as resident/occupant details and key contact person/s, prepare a NSW SES Home Emergency Plan (http://www.seshomeemergencyplan.com.au) or SES Emergency Business Continuity Plan (http://www.sesemergencyplan.com.au/business/)
- Prepare an Emergency Flood Kit (i.e. first aid kit, torches, batteries, bottled water, non-perishable food items, important documents, medication; blankets and spare clothes) as detailed in the NSW SES Home Emergency Plan;
- In case of a night time flood event, locate your NSW SES Home Emergency Plan and Emergency Flood Kit in an accessible location and utilise torches and other emergency lighting as required;
- Identify the needs of any vulnerable persons likely to be on-site in the event of a flood emergency (i.e. elderly, disabled, young children) and include instructions in the NSW SES Home Emergency Plan/Emergency Business Continuity Plan to address these needs (e.g. identify a care support person to provide assistance in the event of a flood etc.);
- Inspect the property for available elevated areas to relocate any hazardous substances, furniture, equipment and belongings to (this only applies to ground and lower ground levels);
- Locate utilities such as gas, water, and electricity and note their elevations in relation to the premises and surroundings in the Emergency Business Continuity Plan;
- It is recommended that multiple communication media are maintained on Site (e.g. internet, mobile phone, landline phone, radio, satellite phone etc.) so that if one communication platform fails there is a redundancy in place to maintain effective communication with emergency services during a flood event;
- Communicate to all family members and/or occupants of the premises the NSW SES Home Emergency Plan/Emergency Business Continuity Plan, location of the Emergency Flood Kit, and discuss the risk of flooding to the site, contact/communication methods, and actions to take before, during and after a flood event.

In addition to the above measures, it is recommended that an education program be developed and implemented for all residents and staff in the building. It is vital that all occupants of the building are informed of the high flood hazard surrounding the building during major flood events and that they are advised on the best course of action in the instance that a flood event occurs. It is recommended that annual ‘refresher’ training or information is disseminated to all residents and staff to ensure new occupants are educated on flood risk and the recommended procedures to follow. The education program should highlight which areas are specifically at risk from flooding (i.e. car parking entry driveway and eastern foyer) and the emergency evacuation response procedure to be followed for each area (residents shelter in place in apartments and lower level retail occupants move to higher levels inside the building).

5.6 During a Flood

Outlined below are a few key flood safety measures to be followed during a flood. Guidance on how to address each measure is included in the NSW SES interactive online tool, with supporting information provided in this document.

- Follow the procedures outlined in this document and details contained in the developed NSW SES Home Emergency Plan/Emergency Business Continuity Plan and locate the Emergency Flood Kit;
- During storm events monitor the BoM website for warnings, ABC radio broadcasts, local emergency services social media pages, and local news outlets;
- Follow all advice and instructions given to you by emergency services;
- Ensure all occupants on-site are informed and in agreeance on the shelter in place approach, and that the Emergency Flood Kit has been collected; and
- Turn off all utilities possible and relocate belongings to higher ground above the predicted flood level if possible (i.e. ground level and below only).

6 Conclusion

In direct response to the SEARS issued for the development (SSD 8999), the following has been demonstrated within the site-specific assessment and overarching flood study for the Honeysuckle Redevelopment Area (*Honeysuckle Redevelopment Area Flood Study*, BMT 2018):

- description of existing flood behaviour and the impact of potential future climate change at the site. There is no ecosystem migration to consider at the site
- the floor levels of the proposed development are set at or above the FPL, with on-site flood-free refuge available above the PMF, for the management of the risk to property and risk to life respectively
- the flood impact modelling assessment shows negligible off-site impacts above those agreed in principal with Council within the *Honeysuckle Redevelopment Area Flood Study*. The provision of designated floodways within the broader Honeysuckle Redevelopment Area mitigates adverse flooding impacts external to the Redevelopment Area. The formalisation of the Steel Street Floodway is not required until works commence on the adjacent Lee 5 site
- a Flood Emergency Response Plan has been developed for the site, to assist in the management of risk to life during an extreme flood event
- the proposed site details in relation to flooding are consistent with those presented in the *Honeysuckle Redevelopment Area Flood Study*, which itself is broadly similar to the original concept plans of the *Cottage Creek Flood Management Plan*
- the floor levels of the proposed development are set at or above the FPL, with on-site flood-free refuge available above the PMF. As such, the site provides compatibility with the flood hazard through robustness of design
- due to the location and heavily modified nature of the site and surrounds, there are no watercourse or riparian impacts to consider.

7 References

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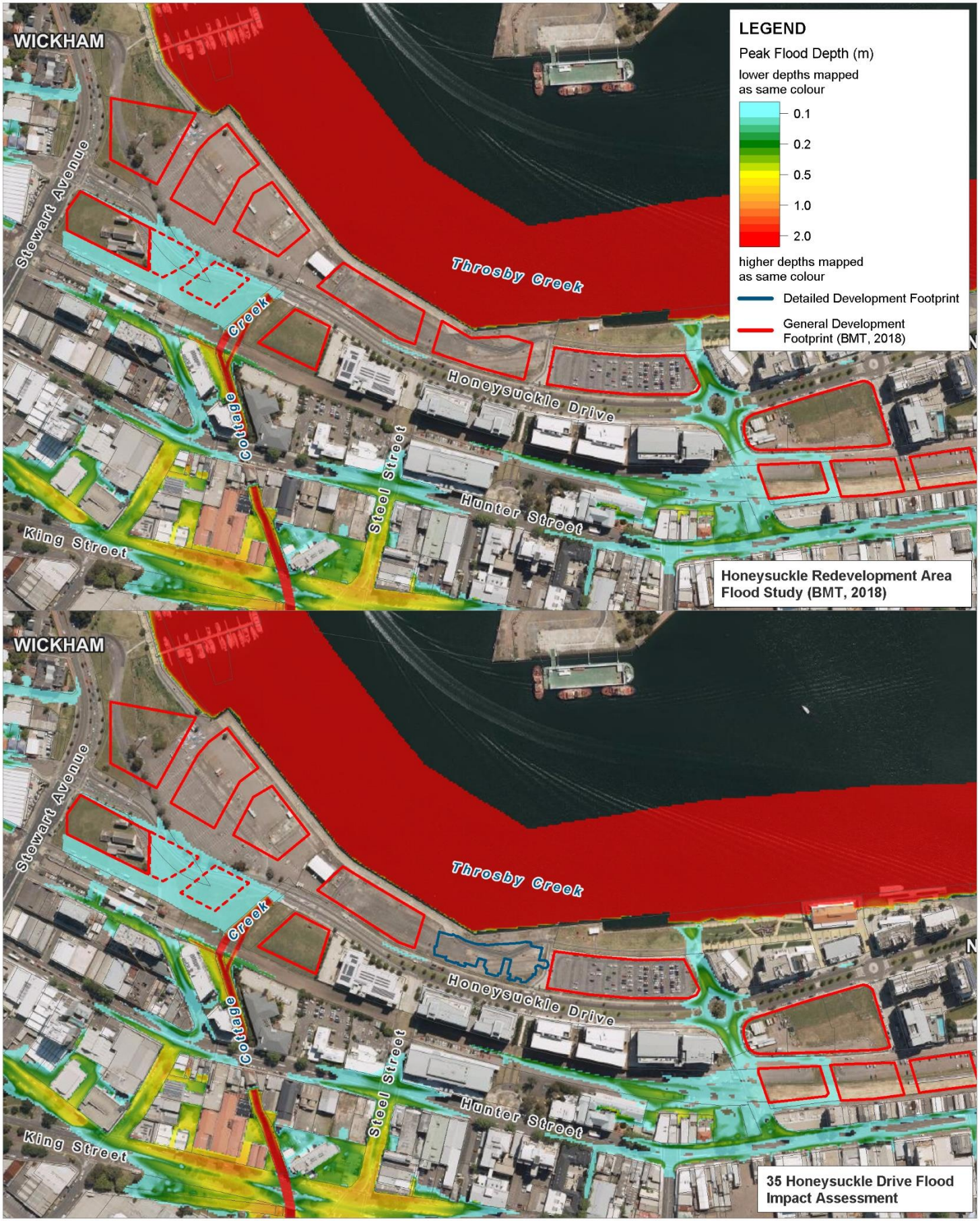
BMT (2018). *Honeysuckle Redevelopment Area Flood Study*

Appendix A Comparison of Flood Conditions



Title:

Comparison of Flood Conditions at 1% AEP Event Without Structure Blockages

Figure: **A-1**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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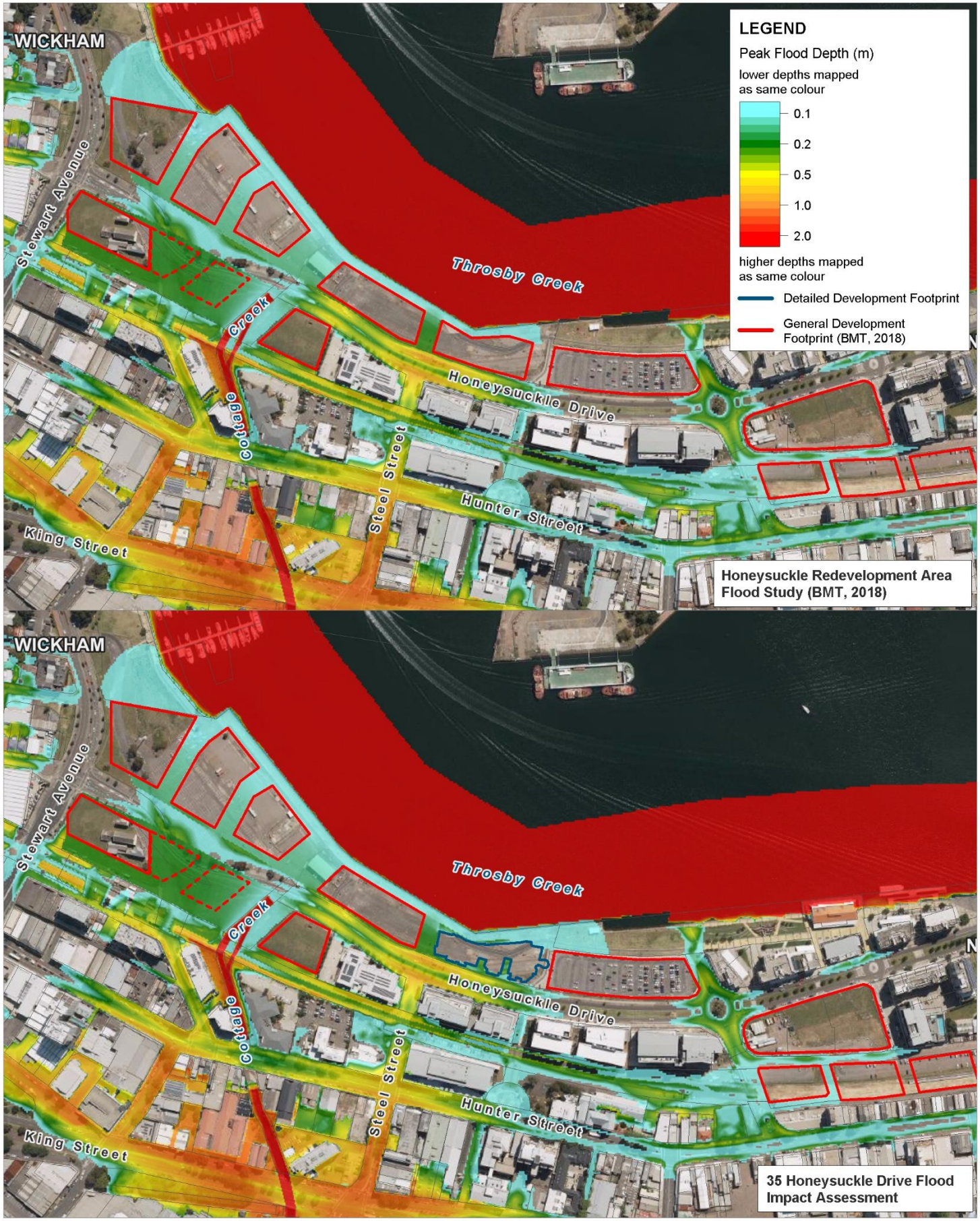

Title:

Comparison of Flood Conditions at 0.5% AEP Event Without Structure Blockages

Figure: **A-2**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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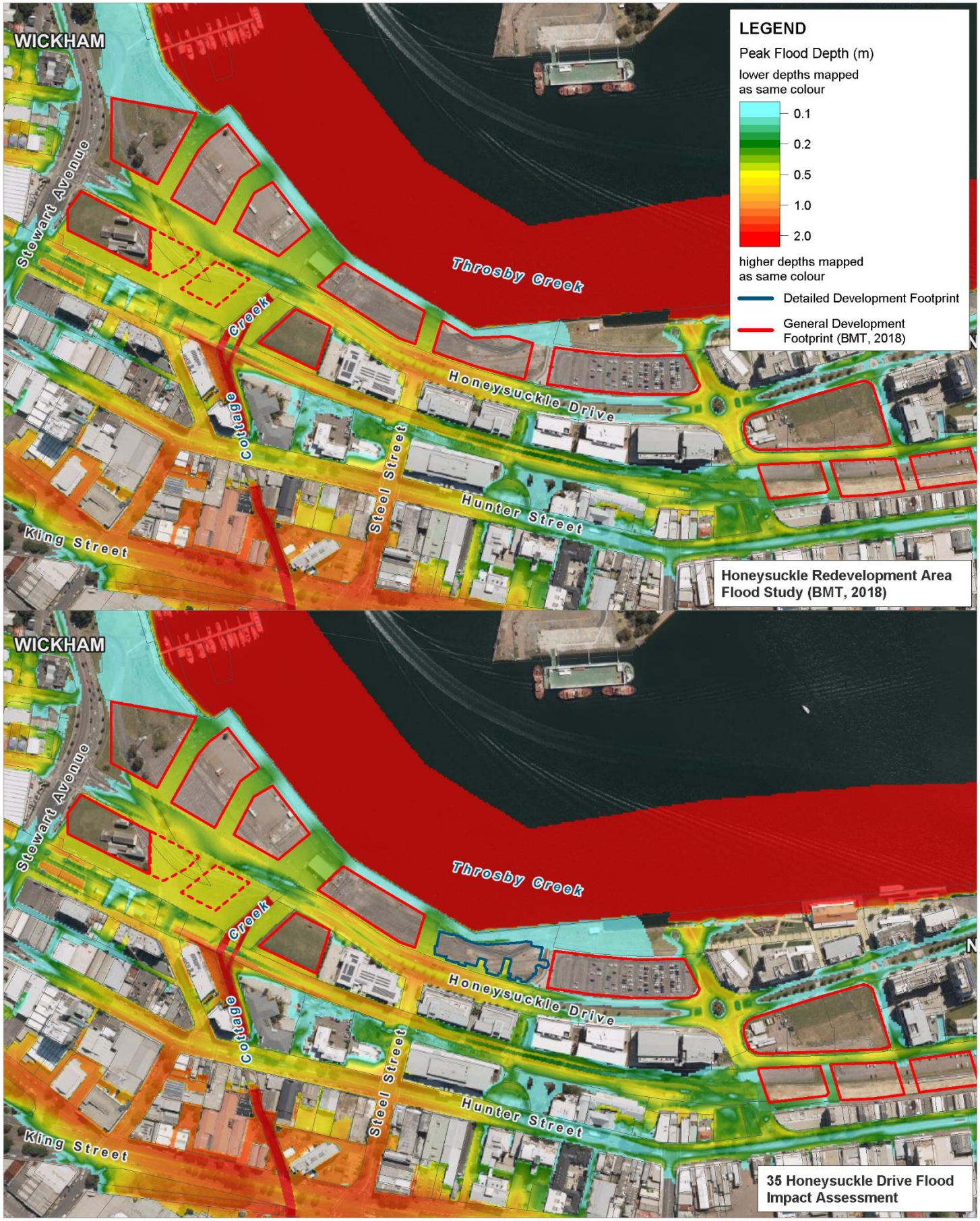

Title:

Comparison of Flood Conditions at the 0.2% AEP Event Without Structure Blockages

Figure: **A-3**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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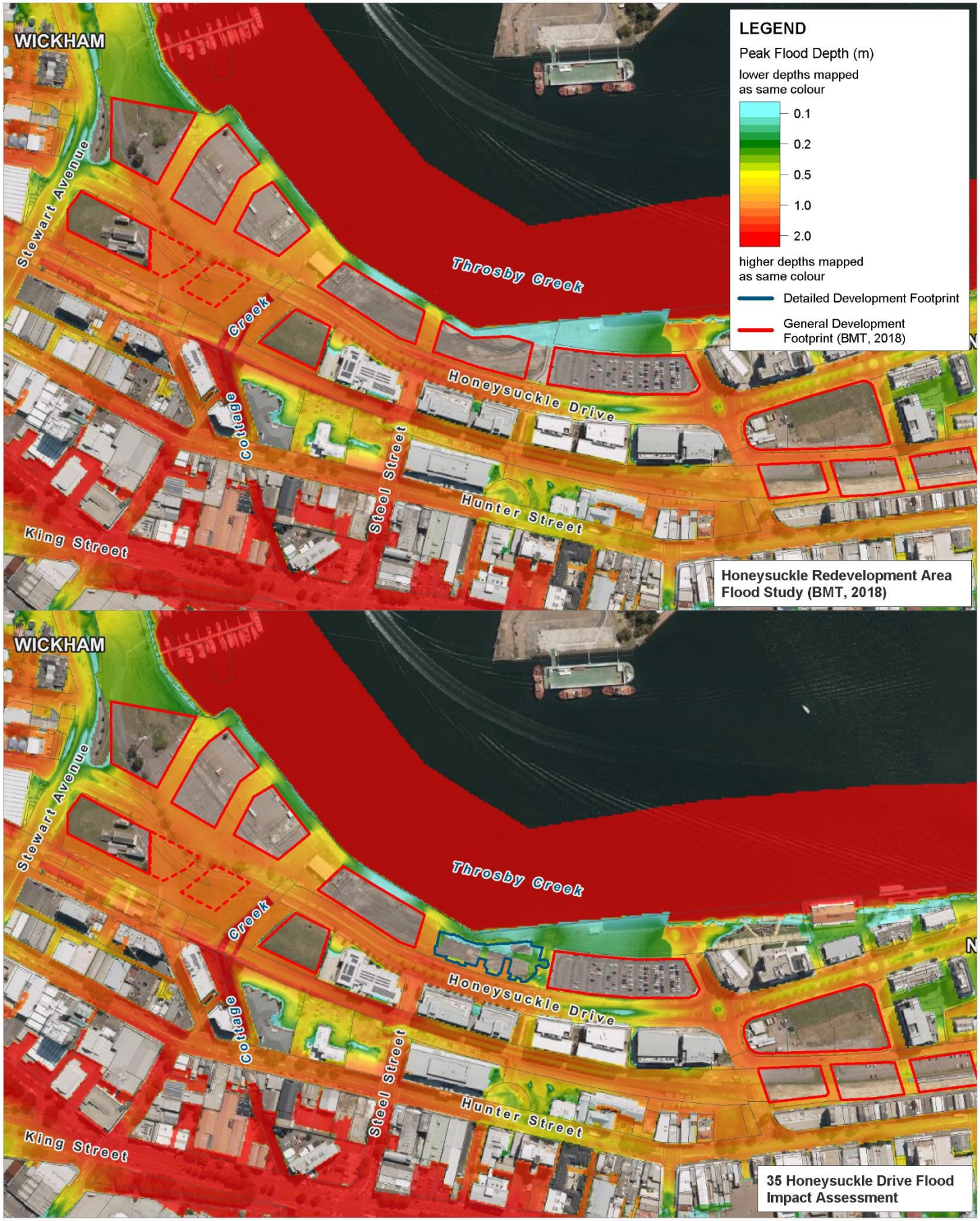

Title:

Comparison of Flood Conditions at the PMF Event Without Structure Blockages

Figure: **A-4**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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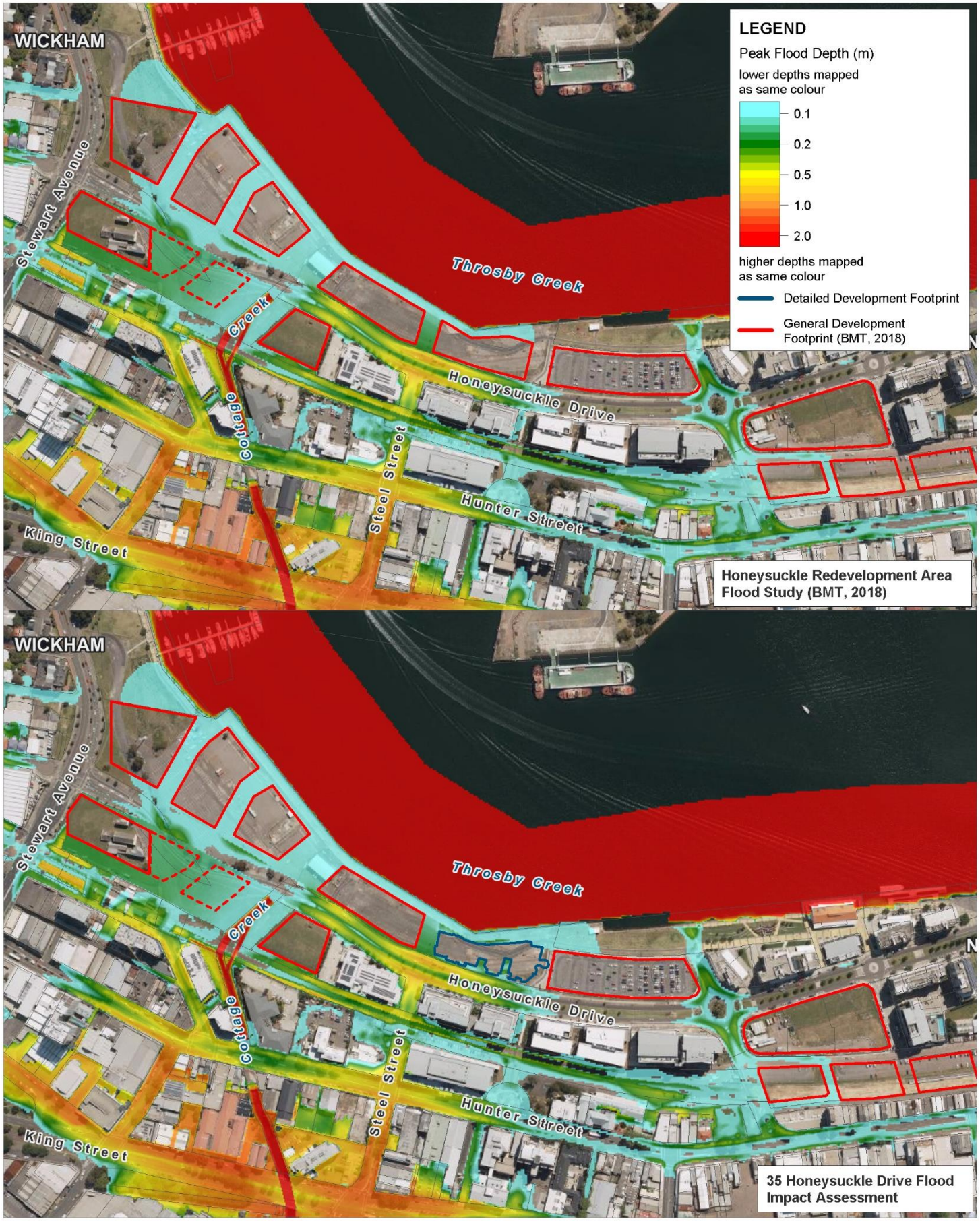

Title:

Comparison of Flood Conditions at 1% AEP Event With Structure Blockages

Figure: **A-5**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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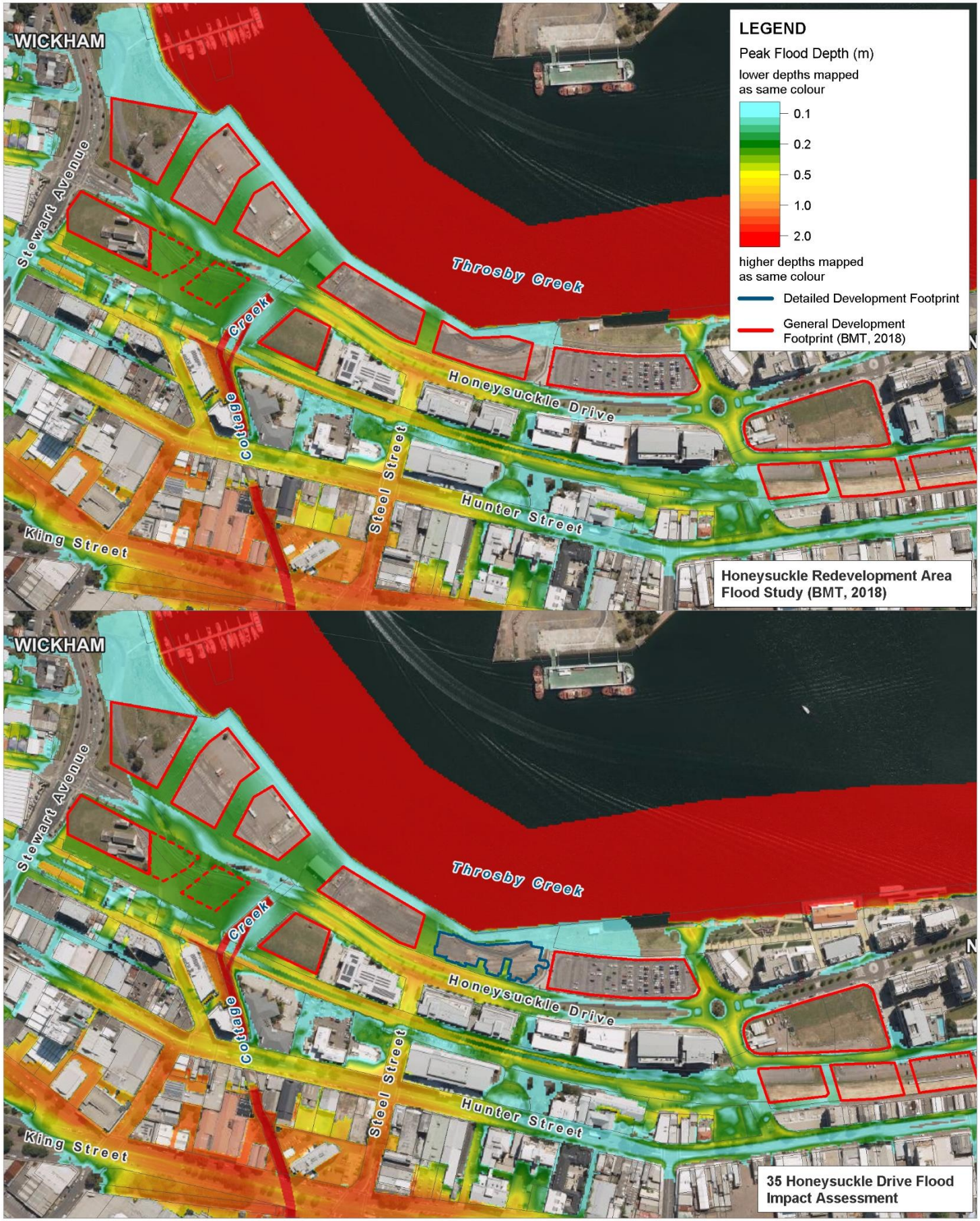

Title:

Comparison of Flood Conditions at 0.5% AEP Event With Structure Blockages

Figure: **A-6**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

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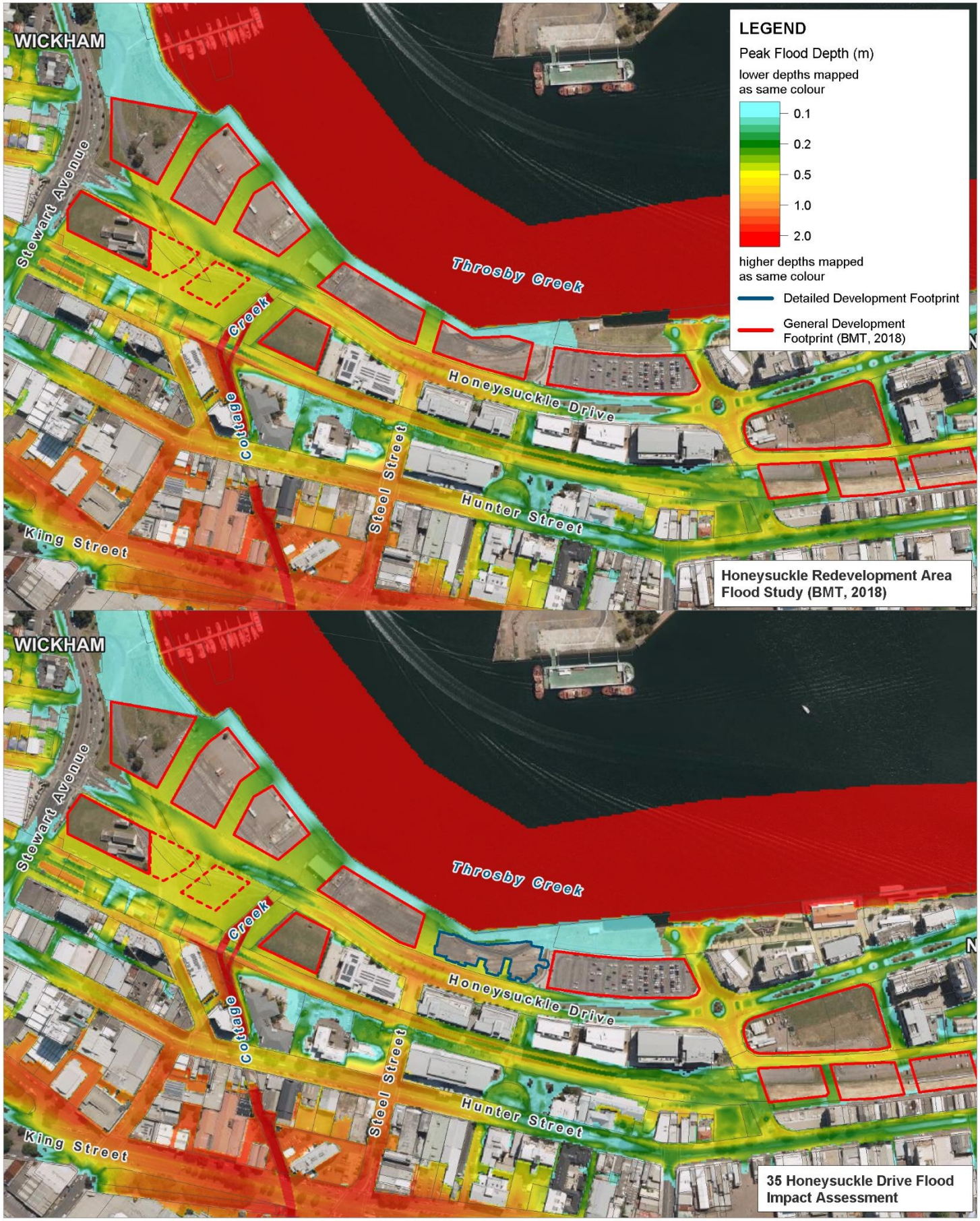

Title:

Comparison of Flood Conditions at 0.2% AEP Event With Structure Blockages

Figure: **A-7**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_022_500y_Conditions_Blocked.WOR

Appendix B Post Development Flood Impacts without Structure Blockages

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 1% AEP Event Without Structure Blockages

N

0 75 150m

Approx. Scale

Figure: **B-1**

Rev: **B**

BMT
www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_004_100y_Unblocked_H_Impact.WOR

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 0.5% AEP Event Without Structure Blockages

Figure: **B-2**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

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Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_005_200y_Unblocked_H_Impact.WOR

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 0.2% AEP Event Without Structure Blockages

Figure: **B-3**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_006_500y_Unblocked_H_Impact.WOR

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the PMF Event Without Structure Blockages

Figure: **B-4**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_007_PMF_Unblocked_H_Impact.WOR

Appendix C Post Development Flood Impacts with Structure Blockages

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 1% AEP Event With Structure Blockages

Figure: C-1

Rev: B

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_008_100y_Blocked_H_Impact.WOR

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 0.5% AEP Event With Structure Blockages

Figure: C-2

Rev: B

N

0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_009_200y_Blocked_H_Impact.WOR

LEGEND

Peak Flood Level Impact (m)

- < -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to +0.02
- +0.02 to +0.05
- +0.05 to +0.10
- +0.10 to +0.20
- > +0.20

Proposed Development Footprint

Title:

Peak Flood Level Impacts for the 0.2% AEP Event With Structure Blockages

N

0 75 150m

Approx. Scale

Figure: C-3

Rev: B

BMT

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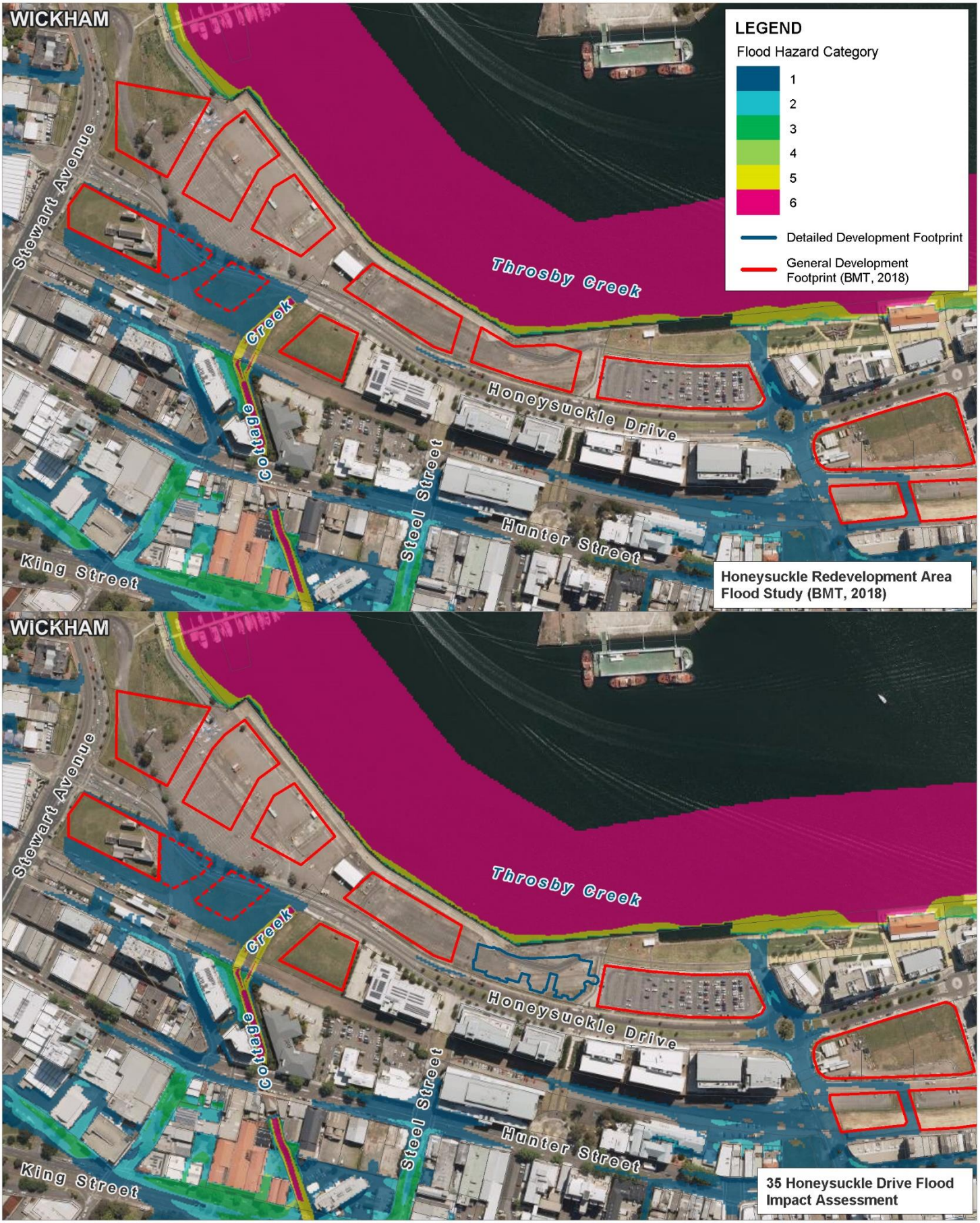
Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_010_500y_Blocked_H_Impact.WOR

Appendix D Flood Hazards



Title:

Comparison of Flood Hazards at 1% AEP Event Without Structure Blockages

Figure: **D-1**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

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Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_011_BPFH_Unblocked.WOR

Title:

Comparison of Flood Hazards at 1% AEP Event With Structure Blockages

Figure: **D-2**

Rev: **B**

N

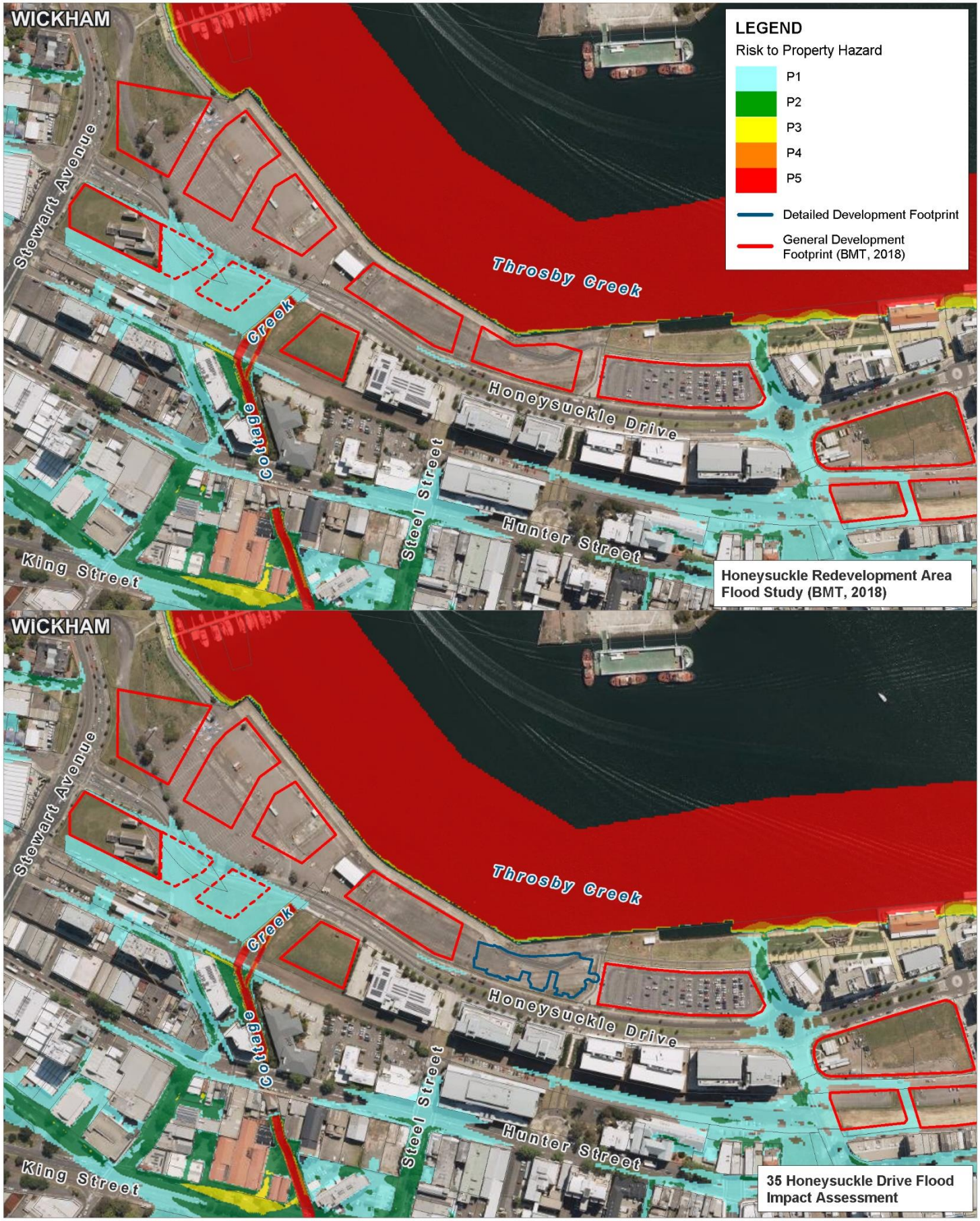
0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_012_BPFH_Blocked.WOR



Title:

Comparison of Risk to Property Hazard Without Structure Blockages

Figure: **D-3**

Rev: **B**

N

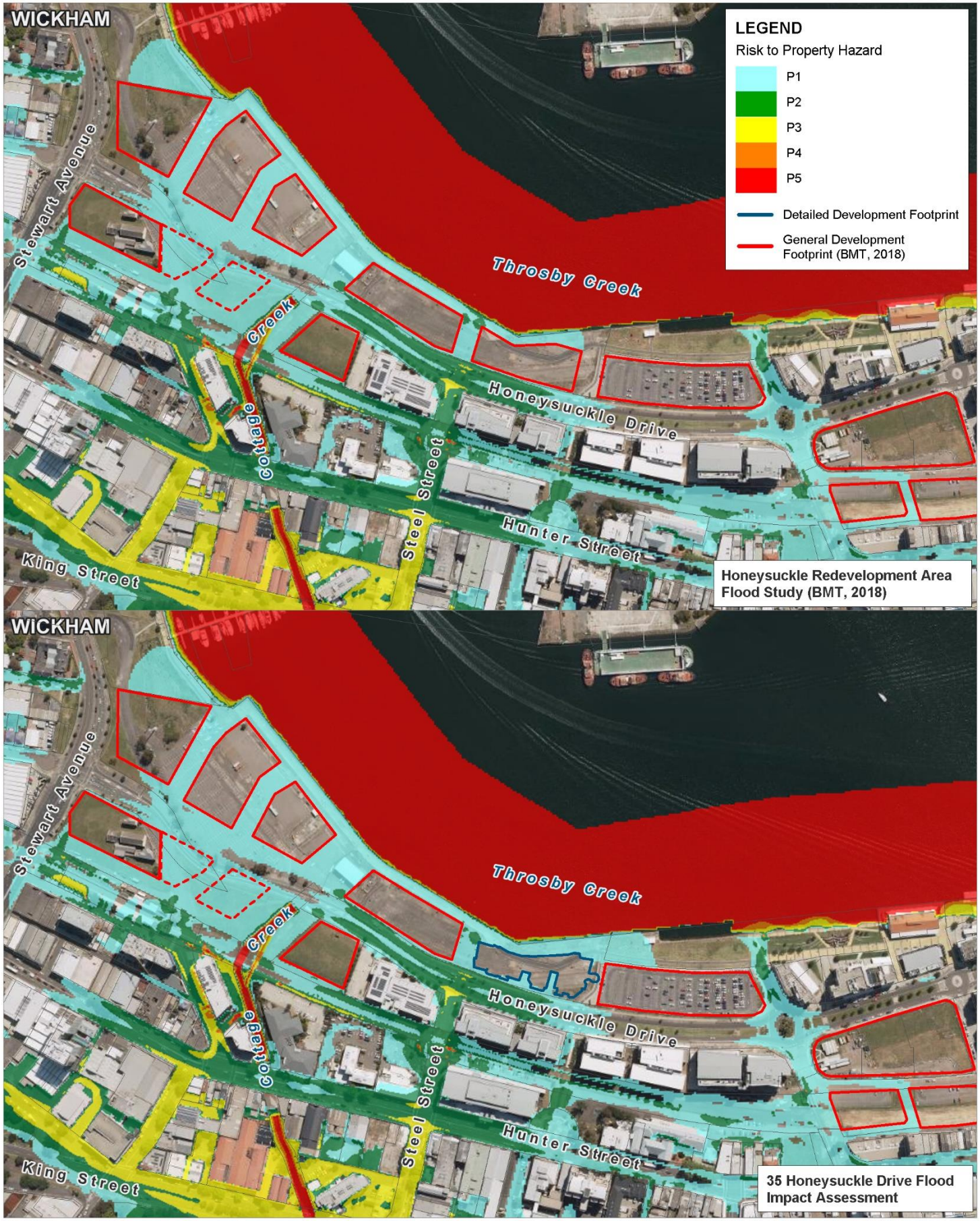
0 75 150m

Approx. Scale

BMT

www.bmt.org

Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_013_PHaz_Unblocked.WOR



Title:

Comparison of Risk to Property Hazard With Structure Blockages

Figure: **D-4**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

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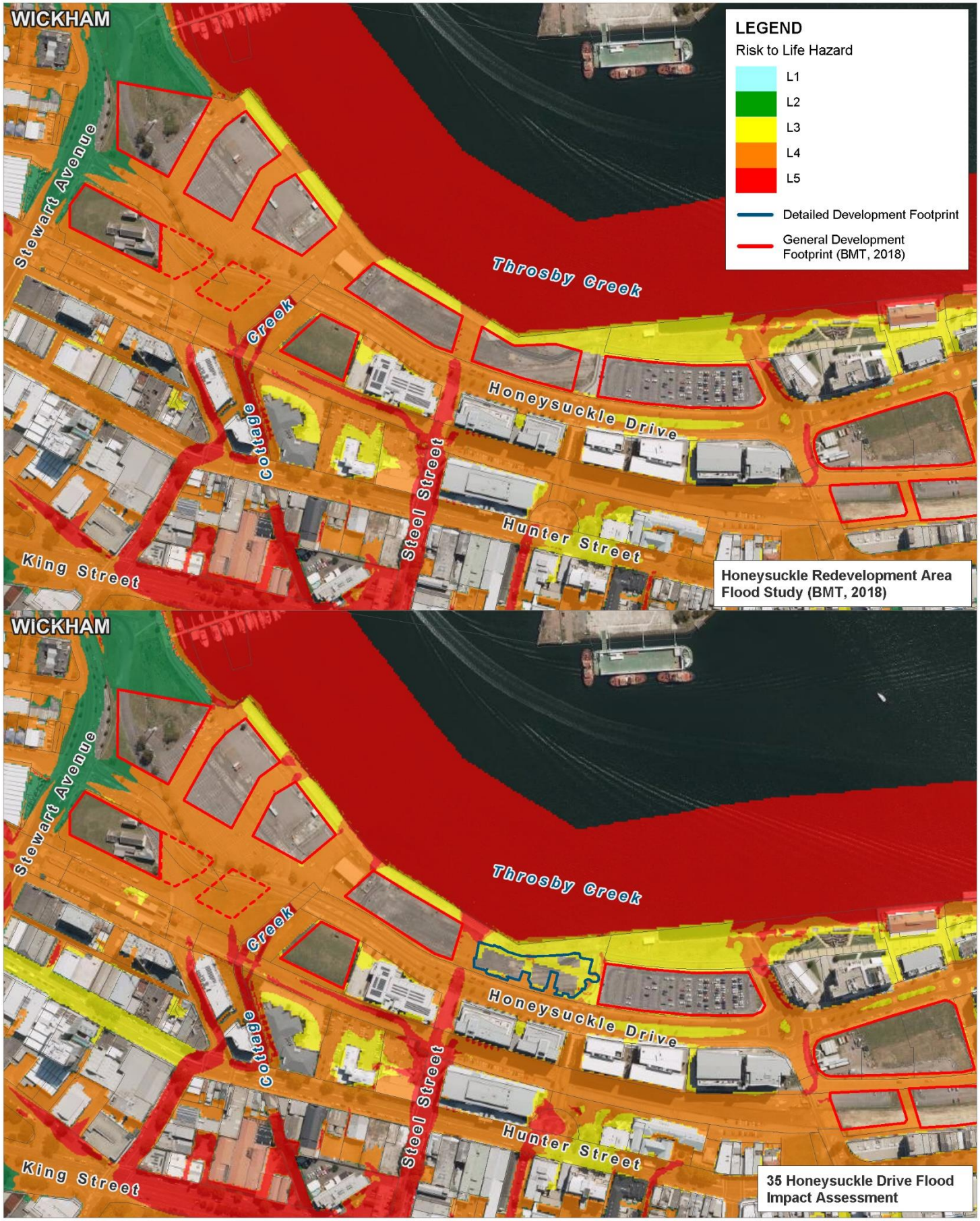
Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_014_PHaz_Blocked.WOR



Title:

Comparison of Risk to Life Hazard Without Structure Blockages

Figure: **D-5**

Rev: **B**

N

0 75 150m

Approx. Scale

BMT

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Filepath: K:\N20970_35HD_FIA\MI\Workspaces\Figures\DRG_015_LHaz_Unblocked.WOR

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