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Mr Alexander Nikolic
Western Parkland City Authority
50 Belmore Street
PENRITH NSW 2750

2nd February 2024

Dear Alex,

BRADFIELD CITY CENTRE MASTERPLAN
FLOOD IMPACT ASSESSMENT FOR THE STAGE 2A & STAGE 2B REF WORKS

I refer to your email correspondence dated 11th October 2023 in which you requested a fee proposal from Worley Consulting (then Advisian) for the preparation of an addendum letter to support the current Stage 2A and future Stage 2B Review of Environmental Factors (REF) submissions for the proposed Bradfield City Centre development.

I understand that the Western Parkland City Authority (WPCA) requires a Flood Impact Assessment (FIA) to be undertaken to assess the impacts of the proposed Stage 2A and Stage 2B REF works on existing flood characteristics in the vicinity of the site. Worley Consulting has previously undertaken a FIA to support the Master Plan application submission to the NSW Department of Planning and Environment. The findings of this FIA are detailed in a report titled '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

As part of that FIA, Worley Consulting developed a purpose-built TUFLOW hydraulic model of the catchment extending upstream from the Bradfield City Centre site. This model was adopted and used to assess the impact of the proposed Stage 2A and Stage 2B REF works on existing flood characteristics along Moore Gully and along Thompsons Creek during the 1% Annual Exceedance Probability (AEP) flood event.

This addendum letter serves to document the findings of the FIA for the proposed Stage 2A and Stage 2B REF works and should be read in conjunction with the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

1. Baseline Investigations – Existing Flood Conditions

The Bradfield City Centre development, the Stage 2A REF area and the Stage 2B REF area is located within the catchment of Thompsons Creek which is a tributary of the upper reaches of Wianamatta South Creek. The development is sited on land that adjoins Thompsons Creek and Moore Gully. Moore Gully is a tributary of Thompsons Creek and flows from west to east near the southern boundary of the Stage 2A REF area.

The existing flood conditions along Moore Gully and Thompsons Creek for the 1% AEP event are presented in Section 3 of the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

Flood mapping for Thompsons Creek and Moore Gully under existing conditions is presented in Figure A1 to Figure A4 in Appendix 1 of the 2023 report.

2. Technical Assessment – Post-Development Flood Conditions

2.1 Model Modifications to Reflect Proposed Development

In order to quantify the potential impacts of the proposed Stage 2A and Stage 2B REF works, the TUFLOW flood model that was developed to assess existing flood conditions across the site was modified to incorporate the post-development landform and proposed land use associated with the development proposal.

The post-development design surface and the proposed stormwater drainage network was prepared by SMEC and provided to Worley Consulting by WPCA. This design surface and the stormwater network were incorporated into a post-development version of the TUFLOW model (refer **Figure 1**).

The TUFLOW flood model was also modified to represent the proposed changes in land use within the REF areas by incorporating a post-development version of the hydraulic roughness. The hydraulic roughness delineation under post-development conditions is shown in **Figure 2**. The corresponding roughness coefficients (i.e., Manning's 'n' value) have previously been documented in Section 3 of the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

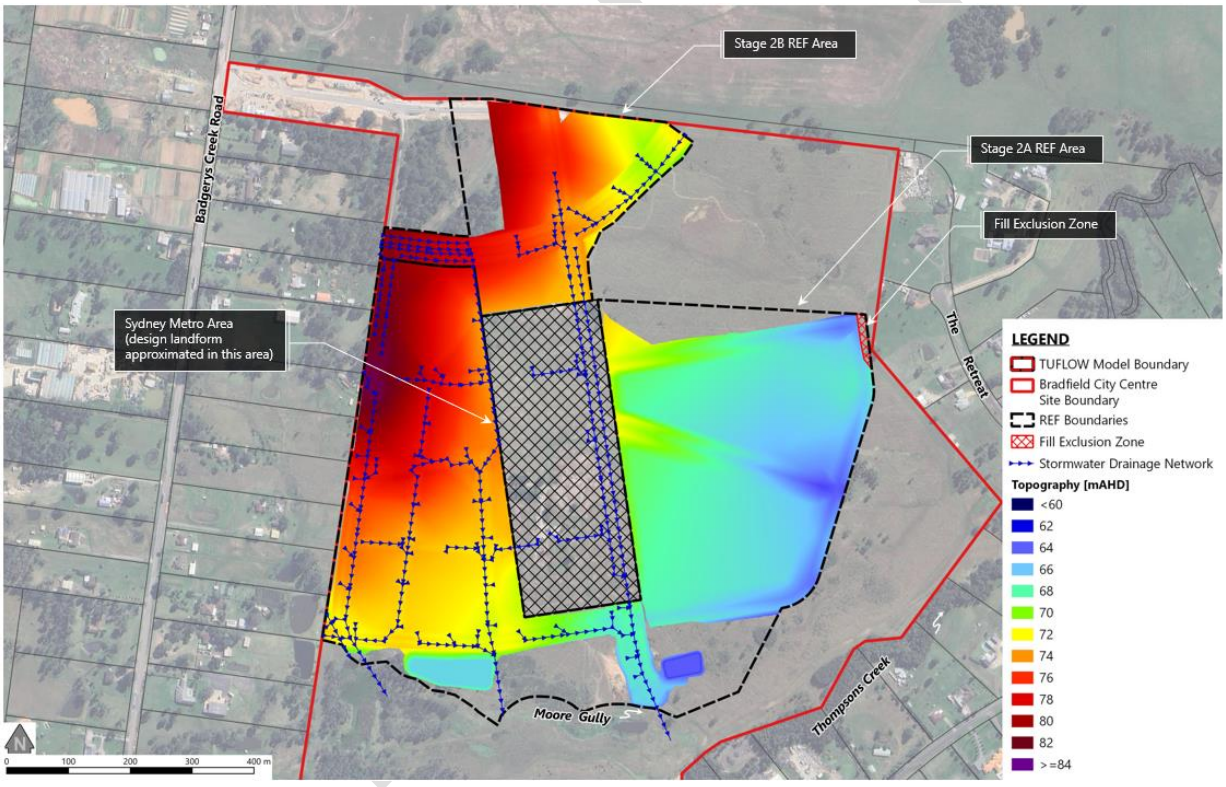

Figure 1 Design land surface and stormwater drainage network for the Stage 2A and Stage 2B REF areas [*source: SMEC*]

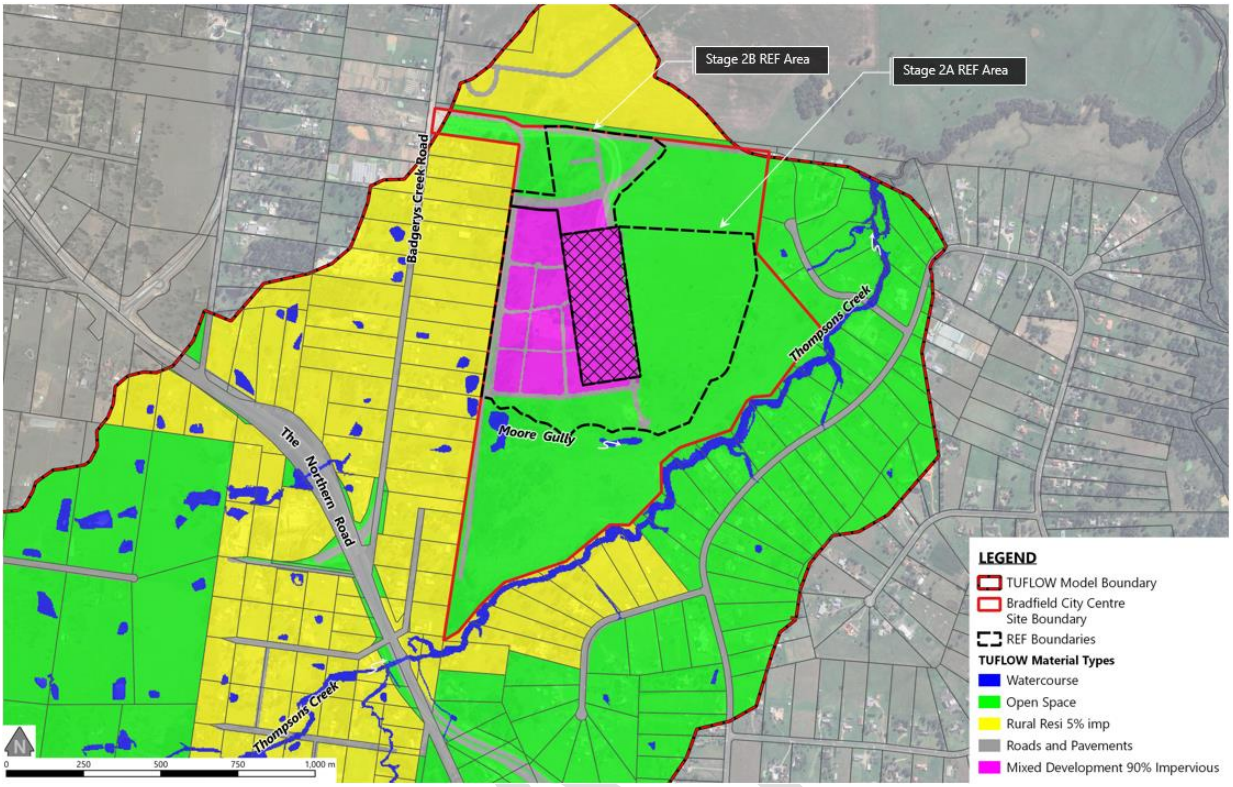

Figure 2 TUFLOW model hydraulic roughness delineation for Stage 2A & Stage 2B REF conditions

2.2 Overview of Key Assumptions

The key assumptions documented in items (i) to (iii) in Section 5.2 of the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023) have also been adopted for the post-development flood modelling of the Stage 2A and Stage 2B REF works. Item (iv) has not been assumed as a stormwater drainage network was provided as part of the Stage 2A and Stage 2B REF design.

An overview of additional key assumptions adopted in the post-development flood modelling for the Stage 2A and Stage 2B REF works is provided in the following.

(a) The eastern portion of the Stage 2A REF area has been assumed to be an open grassed area as per instructions provided by WPCA.

(b) A small section of the provided design surface was omitted from the TUFLOW flood model in the north-eastern corner of the Stage 2A REF area. There is an existing overland flow path at this location and preliminary testing indicated that the filling of this area would lead to the diversion of overland flows into a neighbouring property. Accordingly, it is recommended that this area should not be filled to preserve the existing overland flow path at this location. This area has been referred to as the 'fill exclusion zone' and is shown in **Figure 1**.

(c) No landform was provided for the Sydney Metro area. The post-development landform was approximated by interpolating from available design land surface elevations along the perimeter of this area. This approach was adopted following discussions with WPCA staff.

2.3 Flood Modelling Results for Post-Development Conditions

The modified flood model was used to simulate the 1% AEP flood in order to assess the flood behaviour at the site under post-development conditions. Flood mapping for Thompsons Creek and Moore Gully under post-development conditions is presented in **Appendix A** and includes mapping of peak flood depths, levels, velocities and hazards. All mapping is presented superimposed over the proposed Stage 2A and Stage 2B REF boundaries.

The following flood mapping for the 1% AEP event has been provided:

- **Figure 2AB-1**: Peak flood depths (Stage 2A & Stage 2B post-development conditions)
- **Figure 2AB-2**: Peak flood levels (Stage 2A & Stage 2B post-development conditions)
- **Figure 2AB-3**: Peak flow velocities (Stage 2A & Stage 2B post-development conditions)
- **Figure 2AB-4**: ARR 2019 flood hazard categories (Stage 2A & Stage 2B post-development conditions)

The flood modelling results show that the predicted flood behaviour along Thompsons Creek and Moore Gully are similar to existing conditions. As shown in the mapping listed above, runoff across the REF areas is generally concentrated along the road network and flows to the east and south towards Thompsons Creek.

3. Impacts and Mitigation Assessment

The magnitude and location of any changes in flood characteristics arising from the proposed Stage 2A and Stage 2B REF works is established by comparing the results generated from flood simulations for the existing and post-development scenarios. A discussion of the observed changes is outlined in the following sections.

3.1 Impact on Peak Flood Levels

Flood level difference mapping was prepared from the modelling results to quantify any off-site impacts that could be caused by the proposed development. Difference maps are created by comparing peak flood level estimates at each grid cell in the flood model from the results of simulations undertaken for both existing and post-development scenarios. This effectively creates a contour map of predicted changes in peak flood levels (i.e., increases and decreases) and allows visual assessment of the impact of the development on existing peak flood levels.

Flood level difference mapping was developed and is presented in **Figure 2AB-5**. As shown in the legend, increases in peak flood level are represented as different shades of red and decreases in peak flood level are represented as shades of blue. The white shading indicates changes in peak flood level that are between +/- 0.02 metres, which is considered to be negligible.

As shown in **Figure 2AB-5**, the proposed Stage 2A and Stage 2B REF works is predicted to result in some minor changes to peak 1% AEP flood levels. However, any potential flood level increases are expected to occur within the Bradfield City Centre site boundary or on land designated for 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' as per the Land Reservation Acquisition Map for the Western Parkland City State Environmental Planning Policy (WPCA SEPP).

As shown in the mapping presented in **Figure 2AB-5**, the Stage 2A and Stage 2B REF works are not expected to lead to flood level increases on neighbouring private properties.

3.2 Impact on Peak Flow Velocities

A difference map was also created to quantify any changes on peak flow velocities associated with the proposed Stage 2A and Stage 2B REF works. The velocity difference mapping that was developed for the 1% AEP flood is presented in **Figure 2AB-6**.

The proposed development is not predicted to result in any notable changes to floodwater flow velocities outside of the Bradfield City Centre boundary or outside the WPCA SEPP acquisition boundaries.

3.3 Impact on Flood Hazard

Peak 1% AEP flood hazard mapping was prepared for the post-development scenario and is shown in **Figure 2AB-4**.

Peak 1% AEP flood hazard mapping for existing conditions was shown in Figure A4 in Appendix 1 of the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

Comparison of the two figures described above shows that only minimal changes are predicted to the flood hazard classification. Flood hazards are predicted to remain between H1 and H3 along Moore Gully and within the Bradfield City Centre site boundary.

The Stage 2A and Stage 2B REF works are not predicted to lead to any material changes to flood hazard categories in adjoining private properties.

4. Recommendations and Conclusions

An assessment of the potential impacts of the Stage 2A and Stage 2B REF works on existing flood behaviour was undertaken using a TUFLOW flood model of the Thompsons Creek and Moore Gully catchments. This TUFLOW model was previously developed and used for the '*Bradfield City Centre Master Plan Application Flood Impact Assessment*' (Advisian, 2023).

The impact of the Stage 2A and Stage 2B REF works was quantified by comparing peak flood characteristics under Stage 2A and Stage 2B REF post-development conditions against peak flood characteristics under existing (pre-development) conditions.

The following conclusions can be drawn from the assessment.

- The proposed Stage 2A and Stage 2B REF works are not expected to result in any significant impact on existing flood behaviour or flood characteristics along Thompsons Creek or Moore Gully.
- The minor flood level and flow velocity increases are restricted to land which is designated as 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' in the State Environmental Planning Policy (Western Parkland City) 2021 Land Reservation Acquisition Map.
- The flood modelling was undertaken with the assumption of a 'fill exclusion zone' in the north-eastern corner of the Stage 2A REF area (refer **Figure 3**). This assumption was made based on an existing flow path at this location.
- It is recommended that fill should not be placed in the 'fill exclusion zone' as filling of this area is expected to change the existing flow path at this location. This could lead to increases in peak flood levels and flow velocities on adjoining private residential properties.

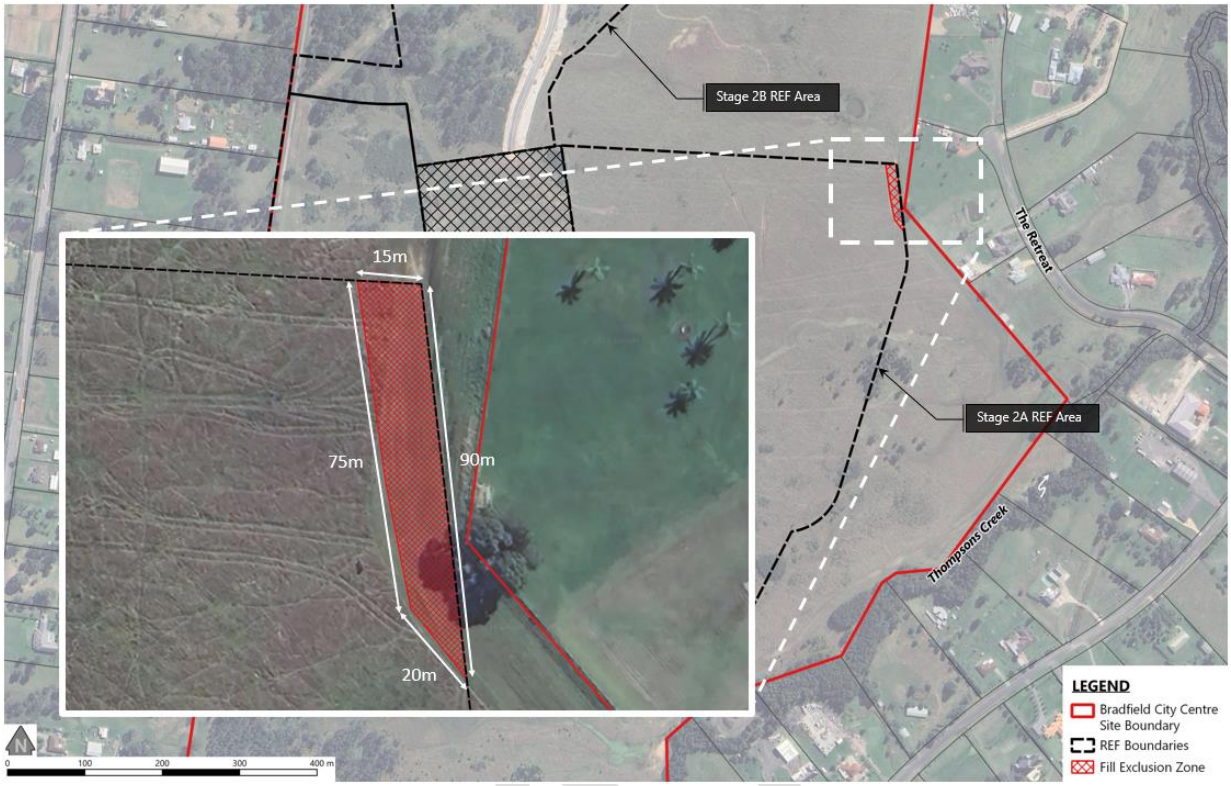

Figure 3 Fill exclusion zone in the Stage 2A REF Area

5. References

Advisian (2023) *'Bradfield City Centre Master Plan Application – Flood Impact Assessment'*, prepared for Western Parkland City Authority.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2019), *'Australian Rainfall and Runoff: A Guide to Flood Estimation'* Commonwealth of Australia.

New South Wales Government (2021) *'State Environmental Planning Policy (Precincts – Western Parkland City) 2021'* – Land Reservation Acquisition Map provided by Western Parkland City Authority.

We trust that this addendum letter provides the required information to support the current Stage 2A and future Stage 2B Review of Environmental Factors (REF) submissions for the proposed Bradfield City Centre development.

Yours faithfully
WORLEY CONSULTING

Chris Thomas
Principal Consultant
NSW Practice Lead – Water Resources

APPENDIX A

1% AEP FLOOD MAPPING [STAGE 2A & STAGE 2B REF WORKS]

FIGURE 2AB-1

DRAFT

Moore Gully tributary

Moore Gully

Moore Gully

The Northern Road

Thompsons Creek

N

0 250 500 750 1,000 m

LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- REF Boundaries
- Sydney Metro Area

Peak Flood Depths [m]

- 0.00 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

Prepared by:

worley consulting

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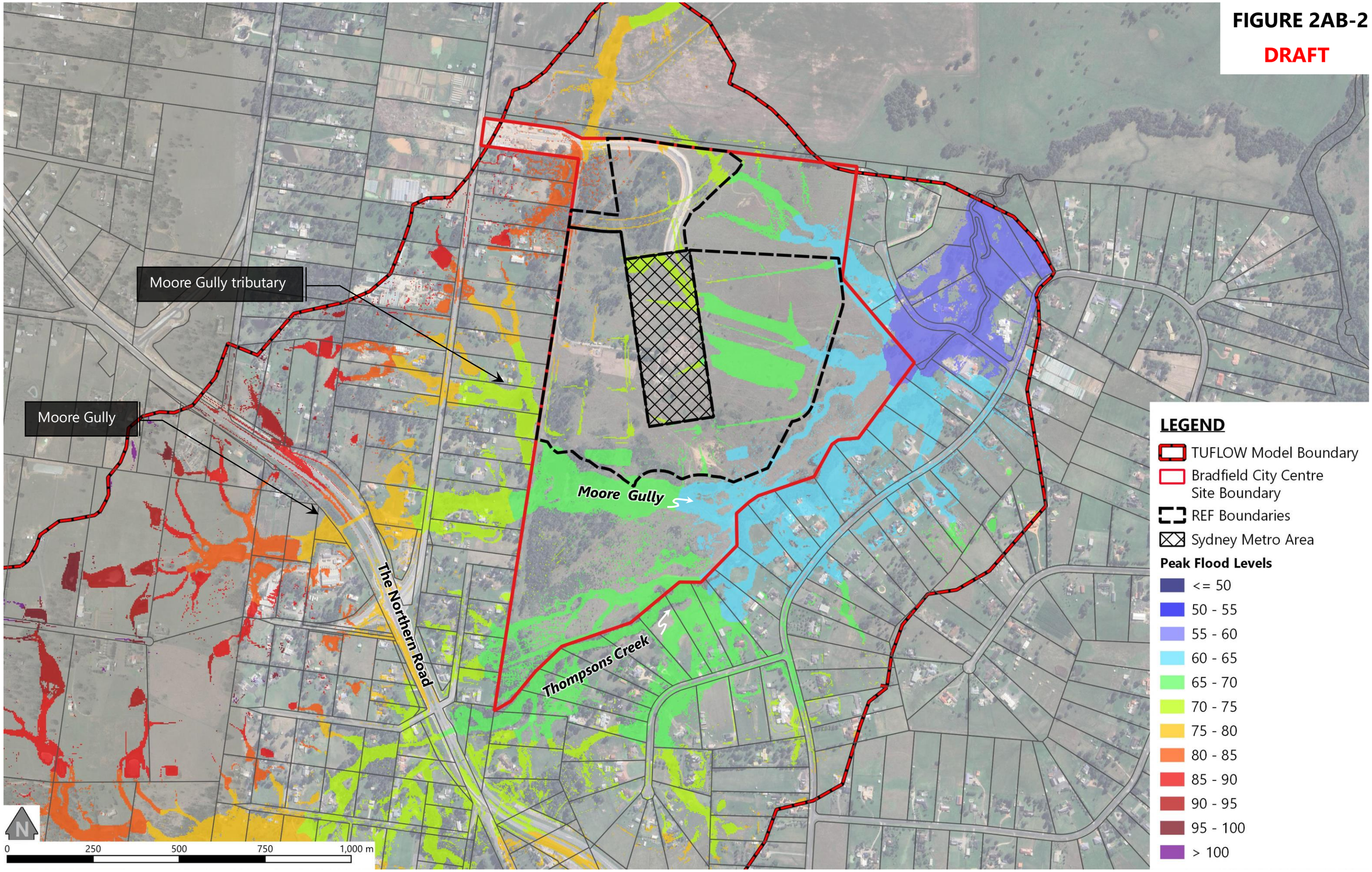
PEAK FLOOD DEPTHS DURING THE 1% AEP EVENT [STAGE 2A & STAGE 2B REF WORKS]

FIGURE 2AB-2

DRAFT



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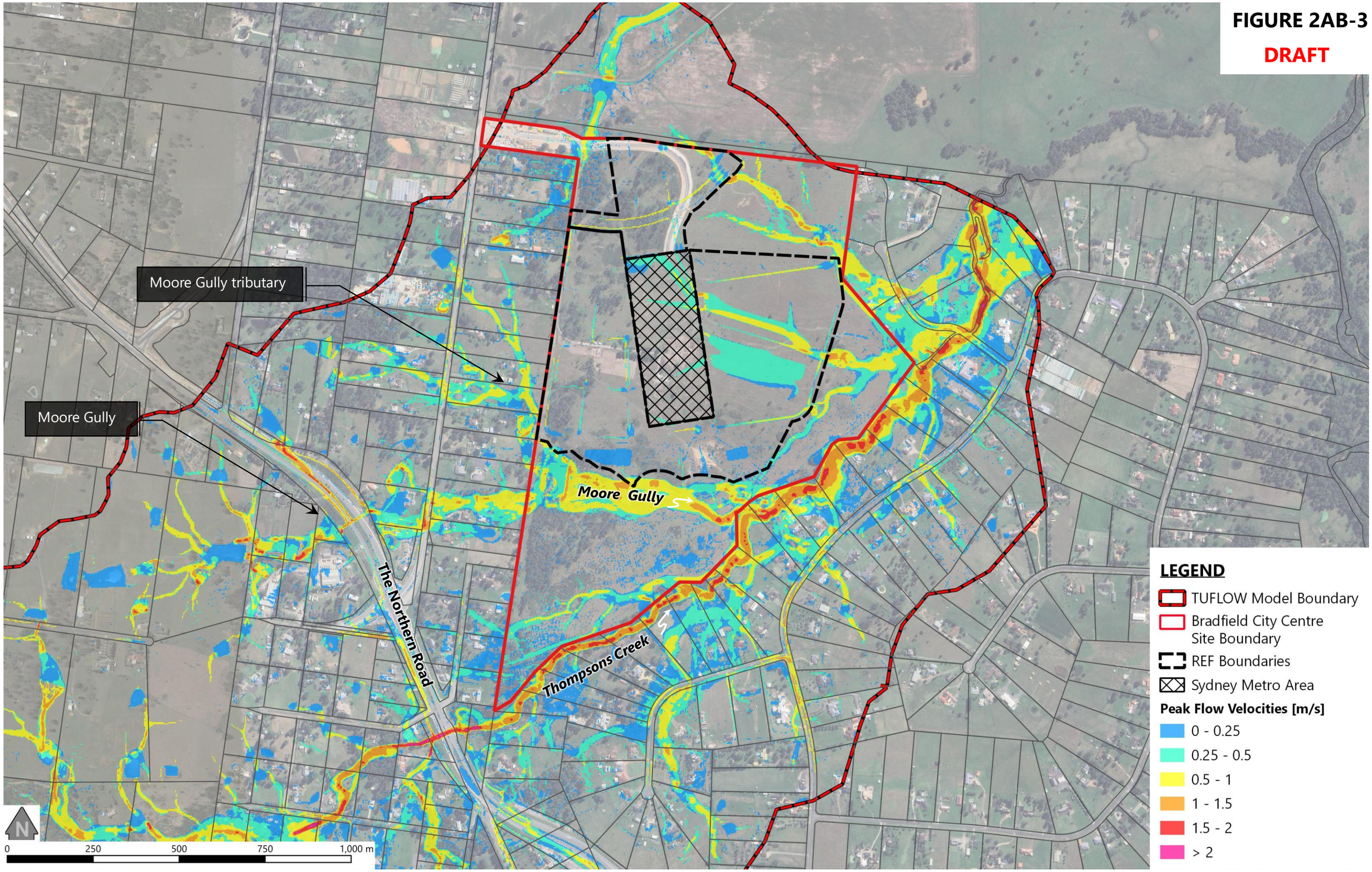
PEAK FLOOD LEVELS DURING THE 1% AEP EVENT [STAGE 2A & STAGE 2B REF WORKS]

FIGURE 2AB-3

DRAFT



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worley consulting

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PEAK FLOW VELOCITIES DURING THE 1% AEP EVENT [STAGE 2A & STAGE 2B REF WORKS]

FIGURE 2AB-4

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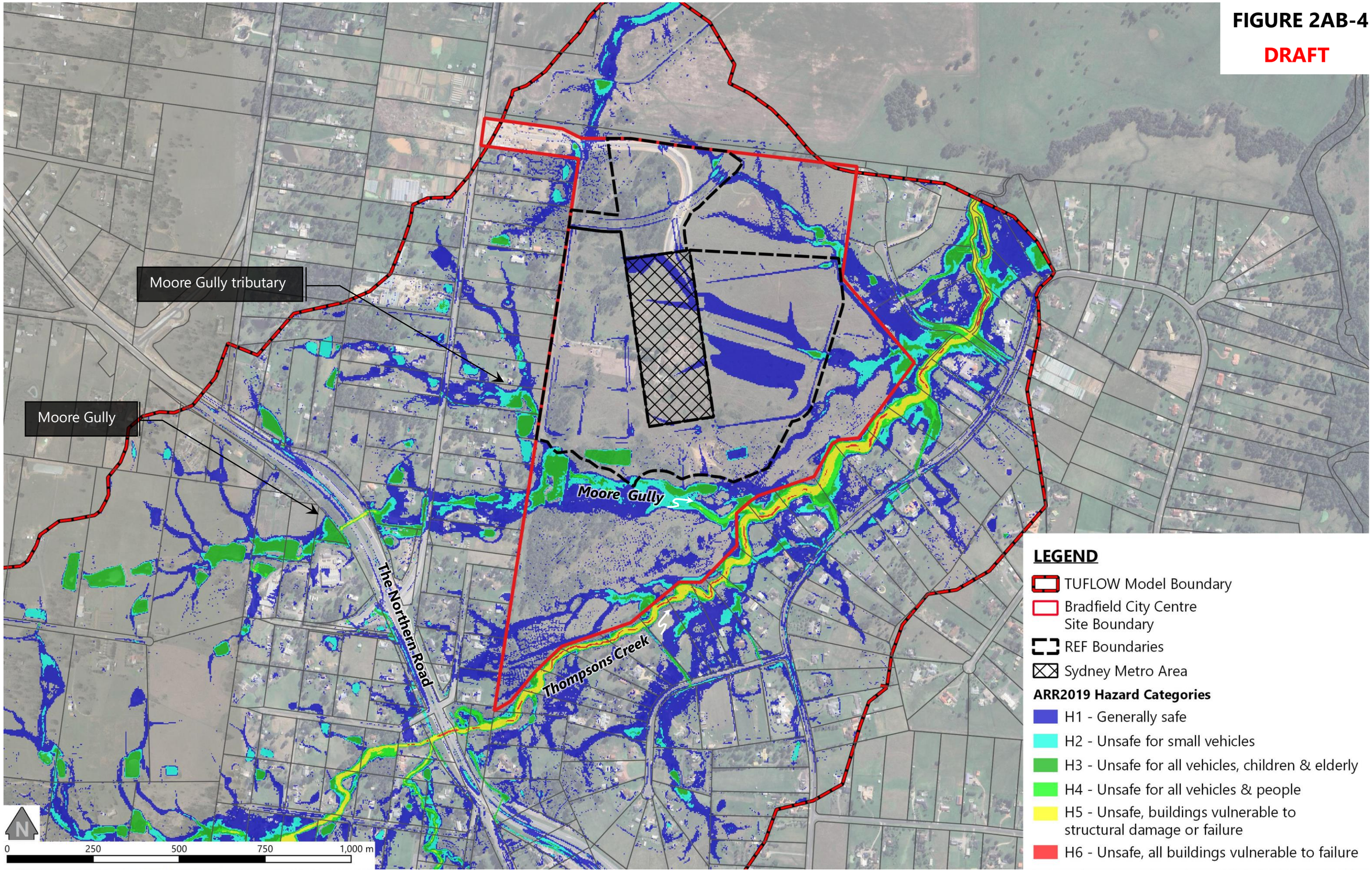

LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- REF Boundaries
- Sydney Metro Area

ARR2019 Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure

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ARR2019 FLOOD HAZARD CATEGORIES DURING THE 1% AEP EVENT [STAGE 2A & STAGE 2B REF WORKS]

FIGURE 2AB-5

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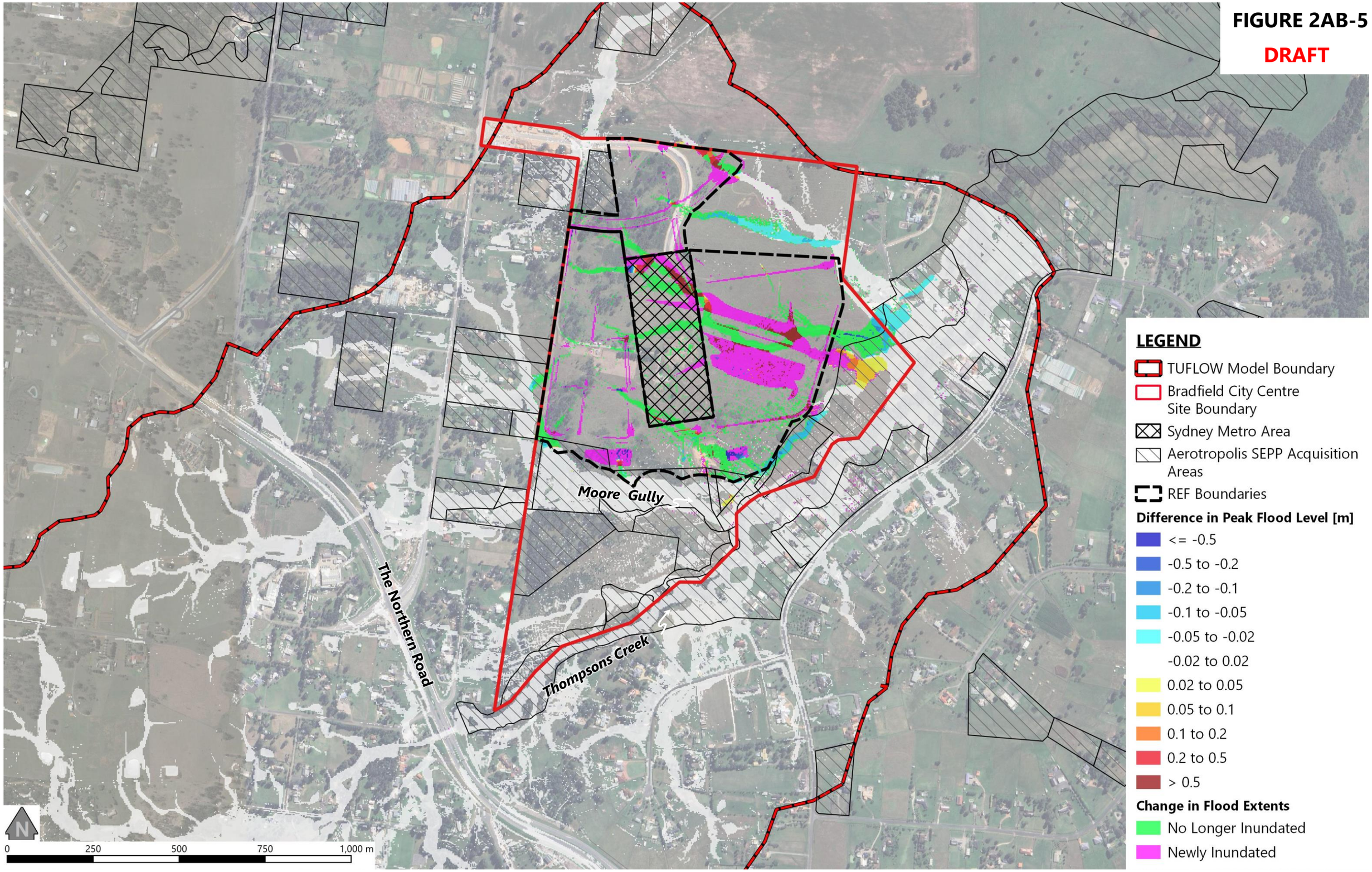

LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- Sydney Metro Area
- Aerotropolis SEPP Acquisition Areas
- REF Boundaries

Difference in Peak Flood Level [m]

- <= -0.5
- -0.5 to -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.5
- > 0.5

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

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IMPACT OF THE PROPOSED STAGE 2A & STAGE 2B REF WORKS ON PEAK FLOOD LEVELS [1% AEP EVENT]

FIGURE 2AB-6

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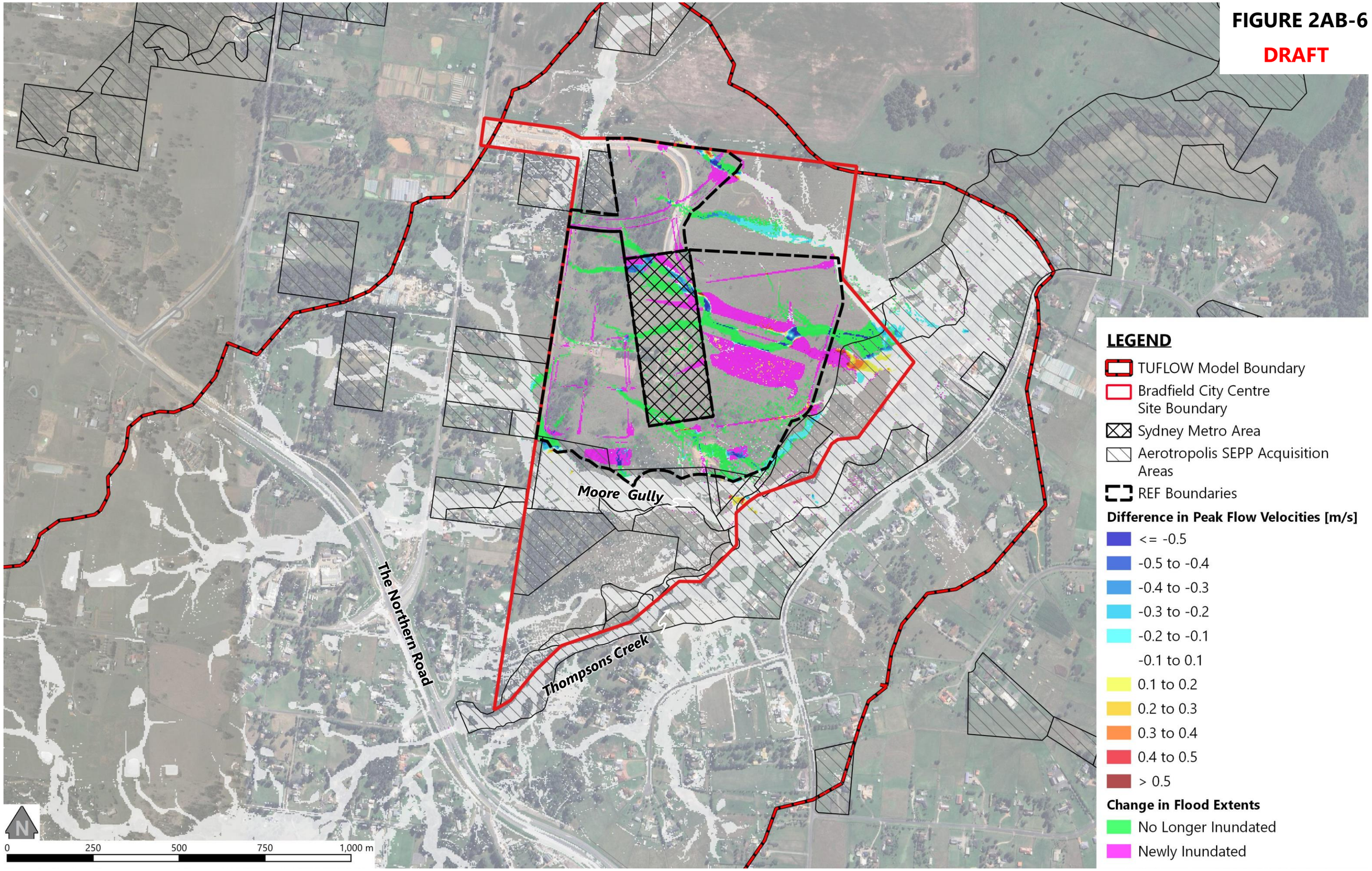


LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- Sydney Metro Area
- Aerotropolis SEPP Acquisition Areas
- REF Boundaries

Difference in Peak Flow Velocities [m/s]

- <= -0.5
- -0.5 to -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- > 0.5

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

Prepared by:

worley consulting

fg311012-00683_240117_Bradfield Masterplan REF2A FIA_AppendixA_A3L.pdf

IMPACT OF THE PROPOSED STAGE 2A & STAGE 2B REF WORKS ON PEAK FLOW VELOCITIES [1% AEP EVENT]

Western Parkland City Authority

Bradfield City Centre
Master Plan Application

Flood Impact Assessment

Prepared by Advisian Pty Ltd

October 2023

wpca.sydney

NSW GOVERNMENT

Acknowledgement of Country

Aboriginal people have had a continuous connection with the Country encompassed by the Western Parkland City (the Parkland City) from time immemorial. They have cared for Country and lived in deep alignment with this important landscape, sharing and practicing culture while using it as a space for movement and trade.

We Acknowledge that four groups have primary custodial care obligations for the area: Dharug/Darug, Dharawal/Tharawal, Gundungurra/Gundungara and Darkinjung. We also Acknowledge others who have passed through this Country for trade and care purposes: Coastal Sydney people, Wiradjuri and Yuin.

Western Sydney is home to the highest number of Aboriginal people in any region in Australia. Diverse, strong, and connected Aboriginal communities have established their families in this area over generations, even if their connection to Country exists elsewhere. This offers an important opportunity for the future of the Parkland City.

Ensuring that Aboriginal communities, their culture, and obligations for Country are considered and promoted will be vital for the future of the Parkland City. A unique opportunity exists to establish a platform for two-way knowledge sharing, to elevate Country and to learn from cultural practices that will create a truly unique and vibrant place for all.

Garungarung Murri Murri Nuru
(Beautiful Grass Country)
Artwork created by Dalmarri artists Jason Douglas and Trevor Eastwood for the Western Parkland City Authority

Version	Status	Date	Prepared By	Reviewer	Comments
1	Draft Report	3/07/2023	LT / CRT		
2	Final Report	4/07/2023	CK (WPCA)	JA (WPCA)	Final revisions made involving formatting and spelling
3	Final Report	2/08/2023	Jason Azucena (WPCA)	Jason Azucena (WPCA)	
4	Publish	17/08/2023	----	Jason Azucena (WPCA)	
5	Publish	12/09/2023	----	Hannah Gilvear (WPCA)	Amendment to Table 1
6	Publish	19/10/2023	----	Hannah Gilvear (WPCA)	Update Lot and DP

Executive Summary

The existing flood characteristics along Moore Gully and Thompsons Creek during a 1% Annual Exceedance Probability (AEP) event have been assessed using a purpose-built TUFLOW model of the catchment extending upstream from the Bradfield City Precinct. The results from this modelling have been validated by reference to the results of the broad-scale flood modelling that was completed as part of work documented in a report titled, *'Wianamatta South Creek Catchment Flood Study - Existing Conditions'* (2022). The existing conditions modelling for the 2022 study was undertaken using an RMA-2 flood model that was originally developed for Penrith City Council as part of the *'Updated South Creek Flood Study'* (2015), and which was substantially extended to assess flooding across the Aerotropolis Precincts.

In order to quantify the potential impacts of the proposed Bradfield City Centre development, the TUFLOW flood model was modified to incorporate the post-development landform and proposed land use associated with the development proposal. The modified TUFLOW model was used to assess flood characteristics along Moore Gully and Thompsons Creek under post-development conditions during a 1% AEP event.

The impact of the Bradfield City Centre was assessed by comparing the post-development model results against the model results derived for existing conditions. The comparison shows that the development as currently proposed will result in some off-site increases to estimated peak 1% AEP flood levels and flow velocities for existing conditions. However, these increases are limited to three areas; one along Moore Gully in the area immediately adjacent to and upstream of the development precinct; another along Thompsons Creek near to and downstream of its confluence with Moore Gully; and a downstream location along the eastern edge of the precinct (refer **Figure A9** and **Figure A10**).

The 1% AEP flood level increases predicted near the Thompsons Creek / Moore Gully confluence range between 0.03 and 0.06m. Increases of this magnitude exceed those typically accepted as being within the accuracy of the modelling or data on which the modelling relies on. However, the location and extent of the predicted increases occur on land which is designated as 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' on the Land Reservation Acquisition Map that accompanies State Environmental Planning Policy (Western Parkland City) 2021. Hence, the predicted increases in 1% AEP flood level and any associated increase in the frequency of flooding of the land will not manifest to cause an adverse impact to the future use of the affected land. Moreover, the affected land will be dedicated to open space and/or a drainage function, and therefore the future use is compatible with or can be tailored to accommodate the predicted increase in flood affectation.

Due to the limited extent of the impacts elsewhere along Moore Gully, it is anticipated that they can be mitigated through further refinement of the post-development land surface near the precinct boundaries as well as implementation of the stormwater drainage network that is proposed for the development.

Accordingly, it is recommended that the following be undertaken to address the predicted off-site impacts.

a) The design land surface for the Bradfield City Precinct should be further refined along the western site boundary near the new Moore Gully alignment. The refined land surface should allow for greater conveyance of flow in an easterly direction along Moore Gully and from the north-western tributary that drains to it. The refined land surface should allow for a waterway opening to allow flows from the catchment to the north-west of the site to enter Moore Gully. The refined land surface should also allow for a swale in a north-south alignment along the western site boundary to convey flows into Moore Gully. The exclusion of these features will likely lead to increases in flood level and/or flow velocity in areas outside of the site boundary.

b) The design should also allow for culverts to be installed along the western site boundary to alleviate local ponding on the western side of the road.

c) A stormwater drainage network should be designed and installed to alleviate the ponding of runoff in the streets of the proposed development. This will serve to reduce the magnitude and extent of the off-site impacts at this location.

Contents

Figures

Tables

Glossary of Terms

AS	Australian Standard
Aerotropolis	Western Sydney Aerotropolis
BC Act	Biodiversity Conservation Act 2016
CIV	Capital Investment Value
DA	Development Application
DP	Deposited Plan
DPE	Department of Planning and Environment
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
LEP	Local Environmental Plan
LGA	Local Government Area
NSW Government	State Government for NSW
SEPP	State Environmental Planning Policy
AEP	Annual Exceedance Probability
mAHD	metres above Australian Height Datum
ARI	Average Recurrence Interval
FPA	Flood Planning Area
FPL	Flood Planning Level
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

1 Introduction

1.1 Purpose of this report

This report accompanies the Master Plan Application for the Bradfield City Centre submitted to the Department of Planning and Environment (DPE).

The purpose of this report is to define existing flood characteristics along the sections of Moore Gully and Thompsons Creek that run through or adjoin the Bradfield Precinct and to assess the impact of the proposed Bradfield City Centre development on those flood characteristics. Mitigation measures are to be provided where flood impacts are identified.

1.2 The Western Sydney Aerotropolis

The Western Sydney Aerotropolis is an 11,200-hectare region set to become Sydney's third city (the Western Parkland City), and the gateway and economic powerhouse of Western Sydney.

The Aerotropolis comprises of the new Western Sydney (Nancy-Bird Walton) International Airport surrounded by five initial precincts which include the Aerotropolis Core, Wianamatta– South Creek Northern Gateway, Agri-business and Badgerys Creek outlined in **Figure 1** overleaf.

The final Aerotropolis planning package, including the Precinct Plan and State Environmental Planning Policy (SEPP) Amendment, was gazetted by DPE in March 2022 and the Development Control Plan Phase 2 was finalised in November 2022. These documents have been used to inform the preparation of the Bradfield City Centre Master Plan.

The proposed Master Plan Application for the site has also been prepared using the Western Sydney Aerotropolis Master Plan Guideline and Master Plan Requirements.

2 Bradfield City Centre

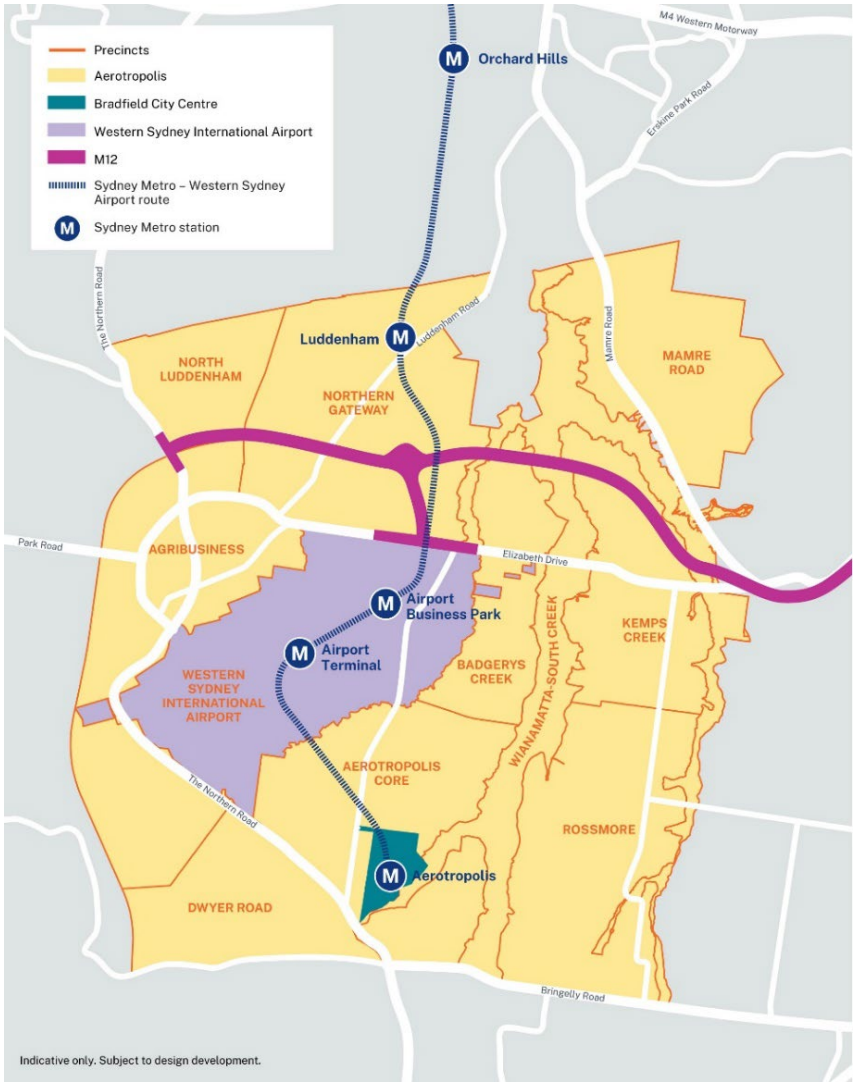
2.1 Strategic Context

The Bradfield City Centre is located to the south-east of the new Western Sydney International (Nancy-Bird Walton) Airport at the intersection of Badgerys Creek Road and The Northern Road (refer **Figure 1**).

The Sydney Metro Western Sydney Airport line will run through the site, providing connections from the key centre of St Marys through to stations at Orchard Hills, Luddenham, Airport Business Park, Airport Terminal and the Aerotropolis, which is located within the site.

The site is surrounded by several key roads and infrastructure corridors including Bringelly Road, Badgerys Creek Road, Elizabeth Drive, the M12 and The Northern Road.

Figure 1 - Strategic Context



Set on natural waterways, Bradfield City Centre presents a rare opportunity to showcase the best urban design and to create a thriving, blue and green, connected City in which Australians will want to live, learn, and work. The Bradfield City Centre will be a beautiful and sustainable 22nd Century City. It will foster the innovation, industry and technology needed to sustain the broader Aerotropolis and fast track economic prosperity across the Western Parkland City.

2.2 The Master Plan Site

The street address for Bradfield City Centre is 215 Badgerys Creek Road, Bradfield (the Site) within the Liverpool Council Local Government Area (LGA). The site is legally described as Lot 3101 DP 1282964 and has an area of 114.6 hectares, with road access to Badgerys Creek Road located at the north-western corner. The site spans across the Aerotropolis Core and Wianamatta-South Creek Precinct, within Western Sydney Aerotropolis. The Site is outlined in **Figure 2** below.

The Site is predominantly zoned Mixed Use under the Western Parkland City SEPP, with a small portion of Enterprise zoned land located on the north-western corner of the site. The site also includes Environment and Recreation zoned land mostly along Thompsons Creek.

Figure 2 - Master Plan Site

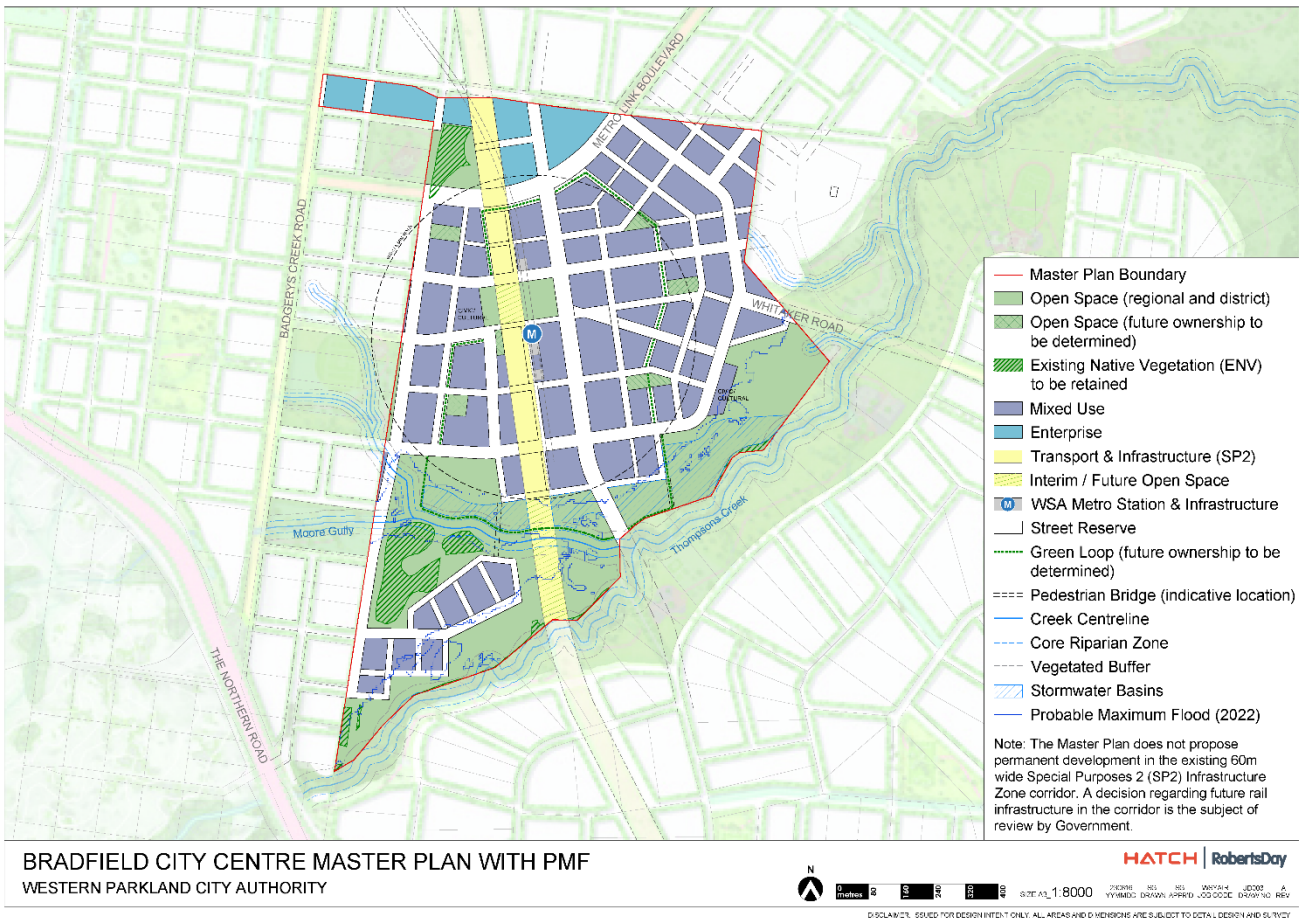
2.3 The Bradfield City Centre Master Plan

The Western Parkland City Authority has prepared a Master Plan (**Figure 3** below) in accordance with the DPE Master Plan Requirements.

The Master Plan sets out a framework for future development within the Bradfield City Centre which includes:

- Road network, key connectors to adjoining land and the regional road network (existing and future)
- Block structure
- Indicative open space network
- Sustainability strategy
- Social and infrastructure strategy
- Arts and culture strategy
- Infrastructure servicing strategy

Figure 3 - Master Plan



2.4 The Proposal

The Bradfield City Centre Master Plan is intended to facilitate the growth of the centre over time. The Master Plan has established the following three planning horizons for technical assessments.

Table 1 - Planning & Development Horizons

Phase	Indicative Timeframe	Estimated employment	Estimated residential population	Estimated Gross Floor Area (cumulative)
Immediate	2026	1,000 - 1,200 jobs	0 residents	48,500 sqm
Medium-term	2036	8,000 - 8,300 jobs	3,000 - 3,100 residents	341,000 sqm
Long-term	2056	20,000 – 24,000 jobs	15,000 – 15,200 residents	1,258,000 sqm

Note: The table above is an estimate of the population and employment forecast used for the purposes of modelling only.

The master plan has the capacity to accommodate ~10,000 residential dwellings. In accordance with NSW Government policy a proportion of the residential dwellings will be affordable housing. The timing and delivery of residential dwellings will be subject to market demand and future master plan reviews that consider the impact of additional population on the scope and timing of social and physical infrastructure.

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3 Baseline Investigations – Existing Flood Conditions

The Bradfield City Centre is located within the catchment of Thompsons Creek which is a tributary of the upper reaches of Wianamatta South Creek. Additionally, Wianamatta South Creek is a tributary of the Hawkesbury River. It drains a 414 km2 catchment that extends from its headwaters near Narellan in the south, to its confluence with the Hawkesbury River near Windsor. Wianamatta South Creek generally flows from south to north through the catchment with the commercial centres of Penrith and Blacktown located to the west and east, respectively. Large areas of the catchment have been urbanised particularly in the vicinity of these commercial centres (Advisian, 2020).

The Bradfield City Centre will be sited on land that adjoins Thompson Creek and Moore Gully. Moore Gully is a tributary of Thompsons Creek and flows from west to east through the southern portion of the site before discharging into Thompsons Creek at the south-eastern site boundary. Thompsons Creek flows from south-west to north-east along the site boundary and discharges into Wianamatta South Creek about 1.7 kilometres downstream of the Site.

The existing flood conditions along Moore Gully and Thompsons Creek are presented in the following.

3.1 Background Studies

A number of previous hydrologic and hydraulic investigations have been undertaken to examine the nature and extent of flooding in the Wianamatta South Creek catchment. These include the following reports:

- *'Flood Study Report, South Creek'* (Department of Water Resources, 1990)
- *'South Creek Floodplain Management Study'* (Willing and Partners Pty Ltd, 1991)
- *'ADI St Mary's Watercycle & Soil Management Study - Final Study Report'* (Sinclair Knight Merz, 1998)
- *'Austral Floodplain Risk Management Study and Plan'* (Perrens Consultants, 2003)
- *'South Creek Floodplain Risk Management Study and Plan'* (Bewsher Consulting, 2004)
- *'Upper South Creek Flood Study'* (WMA Water, 2012)
- *'Upper South Creek Floodplain Risk Management Study and Plan'* (Cardno, 2014)
- *'Updated South Creek Flood Study'* (WorleyParsons, 2015)
- *'South Creek Floodplain Risk Management Study and Plan'* (Advisian, 2020)
- *'Wianamatta South Creek Catchment Flood Study – Existing Conditions'* (Advisian, 2022)
- *'Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment'* (Advisian 2023)

The work completed as part of the *'Wianamatta South Creek Catchment Flood Study – Existing Conditions'* (*Advisian, 2022*) involved a comprehensive update of the XP-RAFTS hydrologic model of the catchment that

was relied upon for the 2015 Flood Study and the 2020 Floodplain Risk Management Study. It also involved substantial refinement and extension of the RMA-2 flood model that was used for both of these previous studies to simulate flood behaviour between the Bringelly Road crossing in the south and the Richmond Road crossing near Windsor. The updates to the models were undertaken to ensure that they captured contemporary catchment conditions.

3.2 Hydrologic Modelling

The updated XP-RAFTS model was used to simulate the flood hydrology for a range of event including the 1% AEP design event.

Temporal patterns and Intensity-Frequency-Duration (IFD) data were adopted based on *Australian Rainfall and Runoff 1987* (ARR 1987). This is consistent with the 2015 Flood Study and the *'Wianamatta (South) Creek Catchment Flood Study – Existing Conditions'* report which was published in 2022. The 2022 Study found that ARR 1987 based design flood estimation procedures achieved a better validation to flood-frequency-analysis at the Elizabeth Drive gauge than ARR 2019 based procedures.

Standard pervious area design loss rates for NSW east of the western slopes have been adopted, namely an initial loss rate of 10 mm and a continuing loss rate of 2.5 mm/hr.

A 36-hour critical storm duration was adopted for catchment areas along the Wianamatta South Creek corridor, while 2-hour and 9-hour storm durations were also adopted to simulate the critical duration along many of the smaller tributaries that drain to Wianamatta South Creek. It was determined that the critical storm duration along Thompsons Creek and Moore Gully was 2 hours.

Accordingly, the 2-hour duration storm was simulated in the flood model.

3.3 Hydraulic Modelling

A new two-dimensional TUFLOW hydraulic model was developed for the Bradfield City Centre, including the upstream catchments of Moore Gully and Thompsons Creek. This new TUFLOW hydraulic model was developed in order to provide a tool that was tailored to determining flood behaviour in the immediate vicinity of the Bradfield City Centre, given that the existing RMA-2 model domain covered the entire Wianamatta South Creek floodplain between Bringelly Road and Richmond Road.

3.3.1 Model Domain and Terrain

The TUFLOW model extent comprises an area of 9.2 km^2 as shown in **Figure 4**. This extent covers the Thompsons Creek and Moore Gully catchments which drain towards the site and Wianamatta South Creek, including areas upstream of The Northern Road and Bringelly Road / Greendale Road.

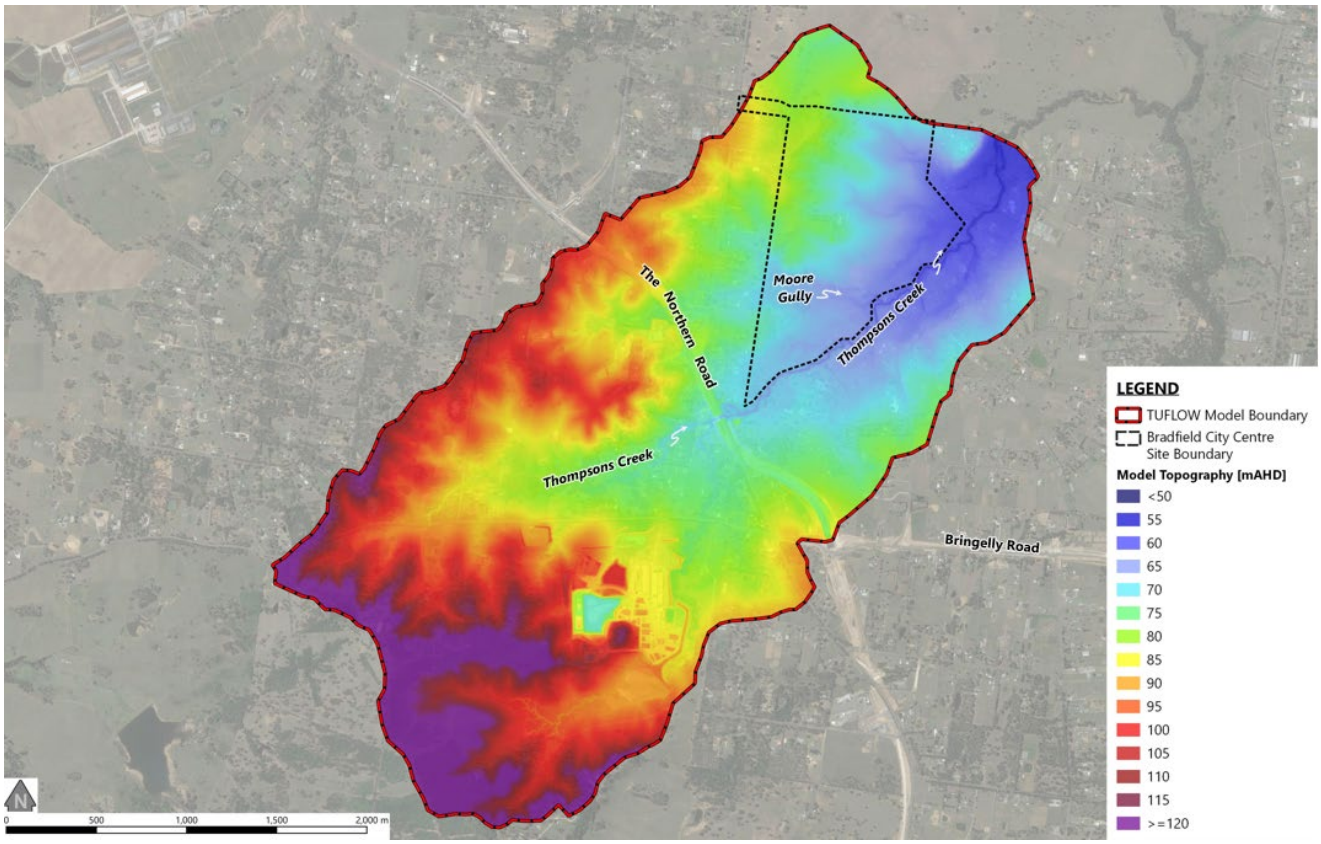
A model grid size of 3 metres was adopted to resolve the terrain and hydraulic characteristics of the study area to a high level of detail. This results in the terrain being sampled a 1.5-metre centres.

The TUFLOW model terrain was constructed using a 1-metre resolution digital elevation model (DEM) derived from LiDAR survey captured in 2019. The DEM was obtained from the ELVIS on-line elevation data portal.

No structural survey data was provided for the project. Accordingly, TUFLOW model techniques were adopted to hydraulically approximate major culverts in 2D and enable flow continuity across road embankments.

The model terrain is also shown in **Figure 4**.

Figure 4 - TUFLOW Model Boundary and Model Topography (Existing Conditions)



3.3.2 Hydraulic Roughness

Hydraulic roughness coefficients (Manning's 'n') are used to represent the resistance to flow of different surface materials. Hydraulic roughness has a major influence on flow behaviour in hydraulic models.

The TUFLOW model extent was delineated into several categories of surface material types using cadastral data and aerial photography. To ensure consistency, the adopted material types and associated Manning's 'n' roughness values were selected with reference to the values adopted in the RMA-2 flood model that was developed and applied as part of the *Wianamatta South Creek Catchment Flood Study* (2022).

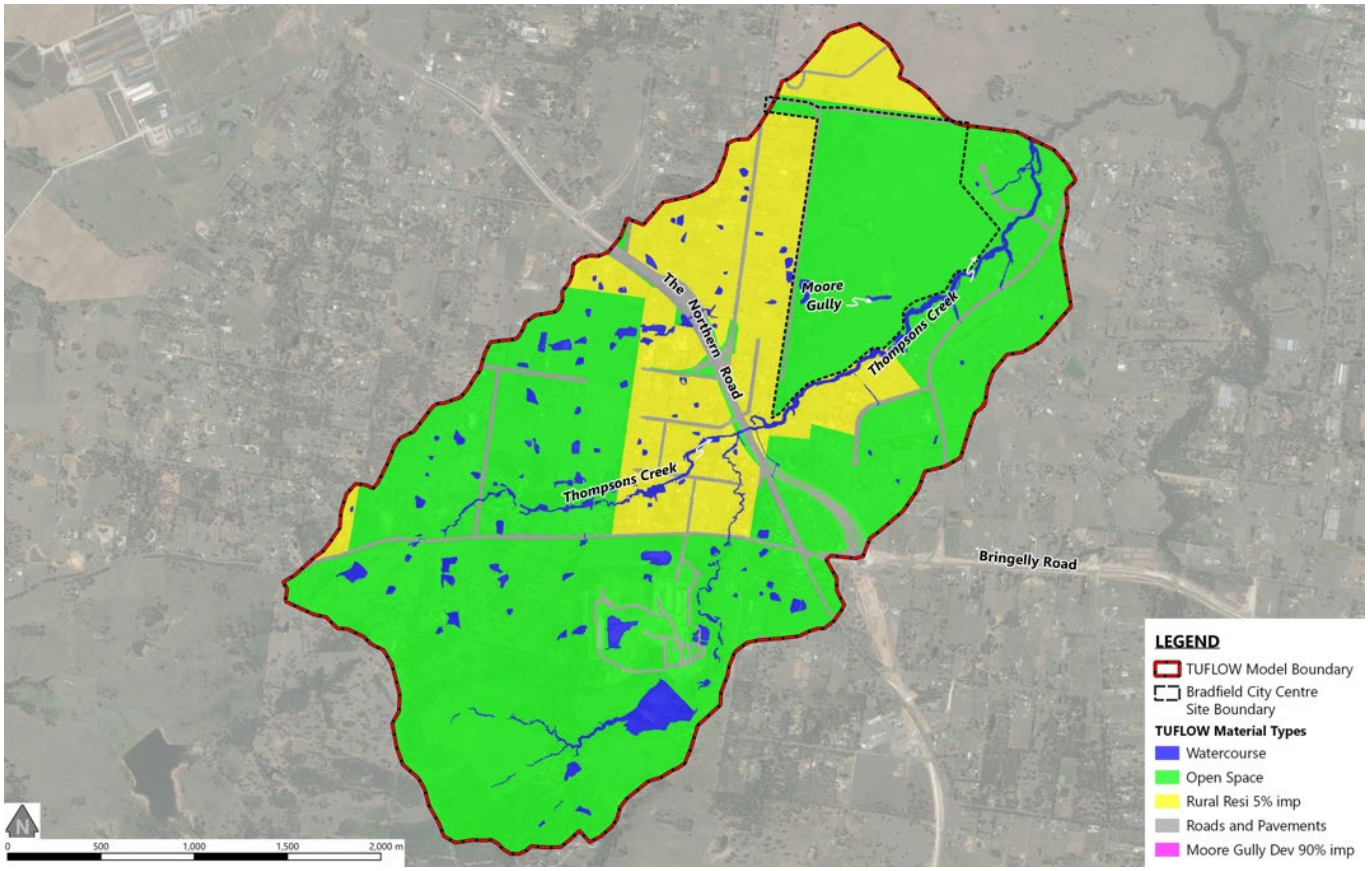
Manning's 'n' roughness coefficients applied in the TUFLOW model are listed in **Table 2**, with the delineation of hydraulic roughness zones shown in **Figure 5**.

Table 2 - Adopted Manning's 'n' Hydraulic Roughness Coefficients

Material Type	Manning's 'n'	% Impervious
Watercourses	0.055	100
Open Space	0.05	0
Vegetation – Low to Medium Density	0.08	0
Vegetation – High Density	0.12	0
Rural	0.05	2
Rural Residential	0.08	5
Residential	0.10	40
Road	0.03	100
Bradfield Development	0.05*	90

**Low Manning's 'n' adopted to reflect increase in runoff generation*

Figure 5 - TUFLOW Model Hydraulic Roughness Delineation (Existing Conditions)



3.3.3 Initial Water Levels

Numerous farm dams of varying sizes are located within the TUFLOW model extent. These water storages are typically assumed to be 'full' at the beginning of design storm simulations so that they do not unduly reduce flow rates and volumes.

Accordingly, initial water levels were assigned for 88 farm dams. The farm dam locations and their full storage levels were derived through a review of preliminary TUFLOW modelling results and interrogation of LiDAR to determine minimum elevations at which flows would discharge from the dams.

3.3.4 Model Boundary Conditions

The 'direct rainfall' hydrologic modelling approach was adopted whereby rainfall is input directly to the TUFLOW hydraulic model which then resolves the rainfall-runoff process based on the terrain and surface material information.

This approach was adopted in part due to the presence of numerous small farm dams. Experience shows that the influence of these small farm dams on hydrologic behaviour is often not well resolved in a traditional hydrologic model.

A normal-depth outflow boundary was placed across each watercourse / flow path at the downstream extent of the model. Water levels along these boundaries are calculated by the software according to the flow rate, bed slope and surface materials.

3.4 Flood Modelling Results for Existing Conditions

Flood mapping for Thompsons Creek and Moore Gully under existing conditions is presented in **Appendix 1**. This includes mapping of peak flood depths, levels, velocities, and hazards for the 1% AEP design event. All mapping is presented superimposed over the proposed Bradfield City Centre site boundary. The following flood mapping has been provided:

- **Figure A1**: Peak flood depths during the 1% AEP event (existing conditions)
- **Figure A2**: Peak flood levels during the 1% AEP event (existing conditions)
- **Figure A3**: Peak flow velocities during the 1% AEP event (existing conditions)
- **Figure A4**: ARR 2019 flood hazard categories during the 1% AEP event (existing conditions)

The flood modelling results show that there are several overland flow paths which discharge into Moore Gully and Thompsons Creek in the vicinity of the Bradfield City Centre. There are several farm dams located 'on-line' along the alignment of the main Moore Gully channel and its tributaries. The results indicate that there is also an overland flow path which drains northward near the north-western corner of the Bradfield City Centre.

The Bradfield City Centre lies between Thompsons Creek to the east and the Thompsons Creek watershed to the west, with elevations ranging from about 85 to 55 mAHD. The TUFLOW modelling results include all creeks, tributaries, and overland flow paths in the upper catchment of Thompsons Creek. Accordingly, the range of 1% AEP peak flood levels is comparable to that of the terrain itself, ranging from about 60 to 75 mAHD.

The peak 1% AEP flood depths along major flow paths are typically less than 1 metre except along Thompsons Creek. Flow velocities are also generally quite low and do not exceed 1 m/s except along Thompsons Creek and in small areas of localised steep terrain.

The model results indicate that floodwaters are generally confined within the channels of Moore Gully and Thompsons Creek during the 1% AEP event. The model results also indicate that the downstream model boundary performs well in allowing floodwaters to “flow out” of the model and does not cause water to “back up” into the development site.

4 Assessment Requirements and Policy Context

4.1 Master Plan Requirements

The DPE have issued Master Plan Requirements (MPRs) to the Authority for the preparation of a Master Plan for Bradfield City Centre. A review of the MPRs was undertaken to identify those requirements which require consideration of the risk of flooding. The review identified that some elements of MPR 14 require specific consideration of the potential for development to cause adverse flood impacts and / or increase flood risk to future occupants of the city. Accordingly, this report has been prepared to address these requirements which are listed in **Table 3**.

Table 3 - Master Plan Requirements

Reference	Master Plan Requirement	Where addressed
14 Flood Planning	The draft master plan must be supported by a Flood Impact and Risk Assessment (FIRA) prepared by a suitably qualified person in line with the Flood Risk Management Guide. The FIRA is to: • be informed by relevant studies • include the necessary flood mapping and stormwater reporting describing and addressing stormwater quantity and quality control management strategy, onsite detention, overland flow paths, concept design plans and drawings • include a flood impact assessment for existing and post development conditions with hydrologic and 2D hydraulic modelling for range of storm events • model and assess the impacts of future development on flood behaviour • identify emergency management arrangements for a range of flood events • demonstrate consistency with the WPC SEPP, NSW Floodplain Development Manual, Flood Risk Management Guide and other local or State studies, policy guidance, and management plans • undertake MUSIC Modelling. The draft master plan is to consider the submissions from DPE - Environment and Heritage Group and Liverpool City Council (Attachment A).	This report

A range of agency and council requirements for development of the Master Plan have also been provided to the Authority. Those that relate to flooding and floodplain management are outlined in **Table 4**.

In considering these requirements, it is noted that Advisian is the author of the following reports identified by DPE as those which should be referenced when considering flooding and flood impacts for development sites within the Aerotropolis Precinct, including Bradfield.

- *Western Sydney Aerotropolis Flood Impact Assessment'* (in draft, 2021) prepared for the Western Sydney Planning Partnership
- *Wianamatta South Creek Catchment Flood Study – Existing Conditions* (2022) prepared for Infrastructure NSW
- *Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment* (2023); prepared for Infrastructure NSW.

Advisian also developed the flood model that these reports rely upon.

The DPE requirement is that the analysis of flood impacts makes use of the latest information presented in these reports and on the model on which that information is based. A further requirement is that the development be consistent with the provisions of the Draft Aerotropolis Phase 2 DCP. The FIA for the Bradfield development, including the modelling on which it relies, has been undertaken in accordance with these documents, the provisions of the Aerotropolis Phase 2 DCP and guidelines outlined in the NSW Floodplain Development Manual (2005).

Table 4 - Agency and Council Comments

Reference	Agency and Council Comment	Where addressed
Liverpool City Council **5. Flood Plain Engineering Response**	A Water Cycle Management Strategy covering both mainstream & overland flooding on the site must be prepared and necessary information as outlined below submitted for assessment with future master planning documents: ▪ Flood impact assessment covering both mainstream & overland flooding must be undertaken for existing and post development conditions with hydrologic and 2D hydraulic modelling for range of storm events up to the 1 %AEP event. ▪ Existing overland flow paths on the site to be managed and conveyed safely. Existing overland flow paths through the site from external catchment shall not be obstructed and be accommodated into proposed stormwater drainage system up to the 1%AEP storm event. Post development flood impact assessment shall consider future development of external catchments in accordance with Aerotropolis Precinct plan. Detailed flood impact assessment report with necessary flood mapping for pre & post development scenarios, stormwater report describing & addressing stormwater quantity & quality control management strategy and hydrologic/hydraulic analysis, concept design plans & drawings of master plan development to be submitted for preliminary assessment of the proposal.	Sections 4, 6 and 7 of this report
Department of Planning and Environment (Environment and Heritage Group) 5. Flooding	At this stage of the Master Planning process, the available information includes: 1. a Structure Plan and high-level strategy to deliver some key elements such as preservation of infrastructure corridor, staging of delivery of civic spaces, provisions related to open spaces and access, environmental zones, and alignment of key roads 2. a Public Domain Concept Plan. The fully established details for various developments within the area of the Master Plan, including the detail of proposed basins, potential earthworks and filling, infrastructure design, vegetation, final landform along with other urban development are not available at this Stage. These details are required to model and assess the impact of development on flood behaviour or to address emergency management during construction and operation. Moreover, a flood impact and risk assessment which includes post development modelling will only be based on assumption for the development components. It will be a duplication of the preliminary assessment undertaken by Advisian for the Planning Partnership Office i.e., *Western Sydney Aerotropolis Precincts – Flood Impact Assessment*. Given the lack of availability of key post developed information to inform post development flood modelling, development components will need to be considered through analysis of the post developed modelling over time through case-by-case flood impact and risk assessments (FIRAs) consistent with the provisions of the Draft Aerotropolis Phase 2 DCP. This must be reflected as a key outcome of the Master Plan. A broader view on the cumulative impacts of development will need to be the likely	Sections 4, 6 and 7 of this report

Reference	Agency and Council Comment	Where addressed

	ongoing responsibility of the relevant council to ensure these impacts are managed.
	
	Accordingly, the assessment requirements identified in Section 18. Flooding of the draft Master Plan Assessment Requirements are not achievable at this stage. EHG has identified appropriate assessment requirements below.
	
	Assessment Requirements
	Use of up-to-date flood information
	The flood map provided in Master Plan Request report dated 8 April 2022 is not consistent with the Government's up to date flood study. The updated flood study is the *Wianamatta South Creek Catchment Flood Study - Existing Conditions (Revision I).*
	EHG notes that a letter was sent to government agencies on 1 July 2022, including WPCA, advising of the updated flood study - the *Wianamatta South Creek Catchment Flood Study - Existing Conditions (Revision I)*. A copy of this advice is provided at Appendix B.
	
	Utilising the best available information for advice related to flood prone land is essential for councils and government agencies to access the exemption from liability afforded by Section 733 of the *Local Government Act 1993*.
	
	Compliance with Draft Development Control Plan
	• Given the sensitivity of the Wianamatta South Creek catchment due to flooding, as identified in the *Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment*, there is significant potential for altered flood behaviour and associated impacts due to development including modification of the landform and other associated development within flood prone land (as defined above).
	• All development must demonstrate compliance with the flood related provisions and objectives of the Draft Aerotropolis Phase 2 DCP (Appendix A), s4.24 of Part 4.4 Chapter 4 of the State Environmental Planning Policy (Precincts—Western Parkland City), the Flood Prone Land Policy, the Floodplain Development Manual, and current Wianamatta South Creek flood studies
	  • *Wianamatta South Creek Catchment Flood Study - Existing Conditions* (*Rev I*) (2022)
	  • *Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment* (2023)
	  • *Western Sydney Aerotropolis Precincts – Flood Impact Assessment* (2022).
	The master plan must outline a process for how objectives and the flood related provisions of the Draft DCP will be delivered through the appropriate approval pathway for each type of development within flood prone land.	

5 Technical Assessment – Post-Development Flood Conditions

5.1 Model Modifications to Reflect Proposed Development

In order to quantify the potential impacts of the proposed Bradfield City Centre development, the TUFLOW flood model that was developed to assess existing flood conditions across the site was modified to incorporate the post-development landform and proposed land use associated with the development proposal.

Three post-development design surfaces were provided by AECOM to represent the proposed landform at the Bradfield City Centre site. After discussions with AECOM, the modelled design surface was developed using a combination of the three provided surfaces as follows:

- 60646285-DESIGN-1000-RDW-TIN_20221122.dwg – to define the landform in the southern half of the Moore Gully channel and the roadway south of the Moore Gully opening.
- 60646285-REF-00-0000-CI-DESIGN-TRIANGLES_MooreGully_Entry.dwg – to define the landform in the northern half of the Moore Gully channel near the Moore Gully opening.
- 60646285-REF-00-0000-CI-DESIGN-TRIANGLES-PLAN_26062023.dwg – to define the landform in all other parts of the development.

The adopted design surface is shown in **Figure 6**, while the cut and fill required to implement the design surface is shown in **Figure 7**. Areas of cut and areas of fill are shown in shades of blue and red, respectively.

The design surface includes a realignment of Moore Gully within the site boundary. The proposed alignment of Moore Gully is about 50 metres south of the existing alignment. The design surface also includes a retaining wall along the eastern site boundary (refer **Figure 6**).

A temporary swale which runs in a north-south alignment along the western property boundary has also been included to convey flows southwards towards the new Moore Gully alignment until the land to the west is developed. The proposed road network includes a road along this western boundary.

Additionally, a waterway opening has been incorporated in the flood modelling at the point where this road crosses the drainage swale that drains the land to the north-west to Moore Gully (refer **Figure 6**).

Following some preliminary testing, some minor ponding was predicted to occur in a localised area upstream (west) of the road which runs along the western site boundary. Accordingly, two box culverts measuring 1.2 m (W) x 0.3 m (H) were included in the post-development TUFLOW model to alleviate the ponding in this area (refer **Figure 6**).

The TUFLOW flood model was also modified to represent the proposed changes in land use within the site boundary by incorporating a post-development version of the hydraulic roughness. It is envisaged that the development will result in an increase in impervious areas within the site boundary due to the future mixed use

/ enterprise areas. The hydraulic roughness delineation under post-development conditions is shown in **Figure 8**. The corresponding roughness coefficients (Manning's 'n') have previously been documented in **Table 2**.

Figure 6 - Design Land Surface for the Bradfield City Centre (*Source: AECOM*)

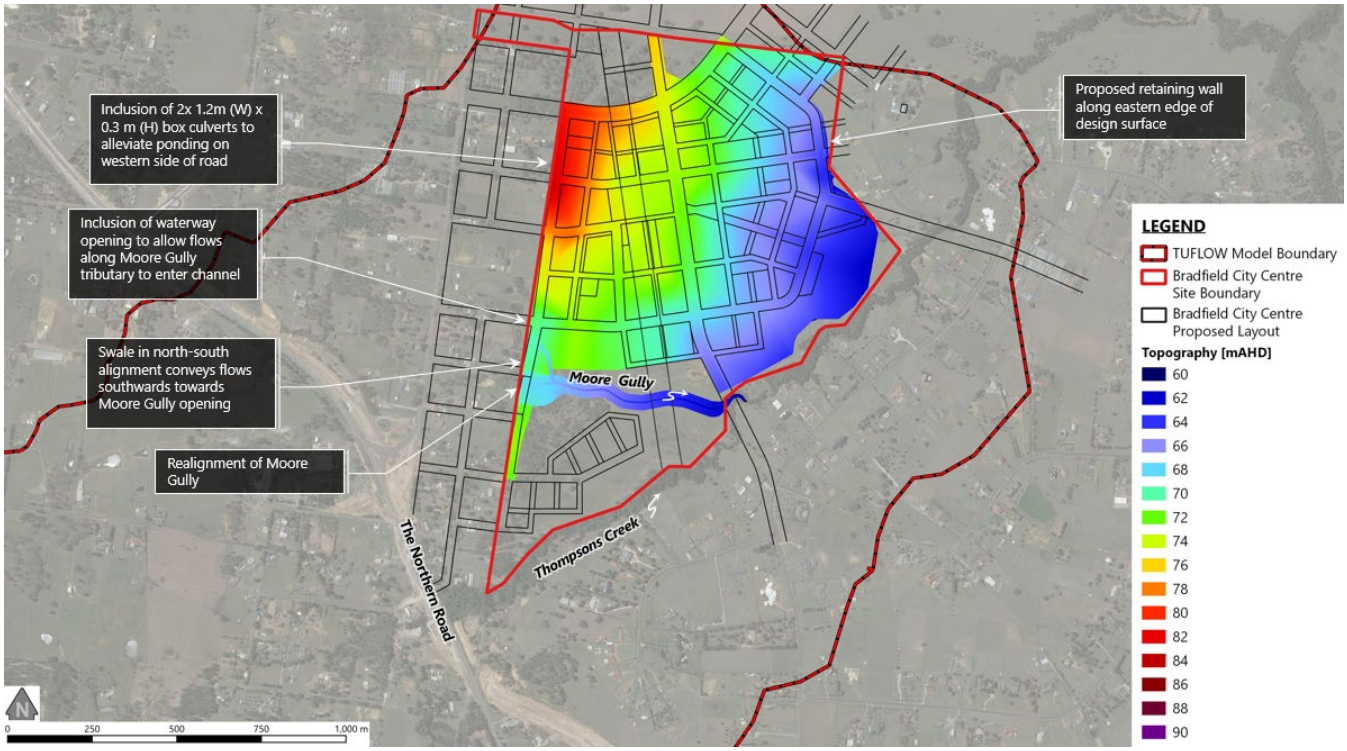


Figure 7 - Cut and Fill Earthworks Plan

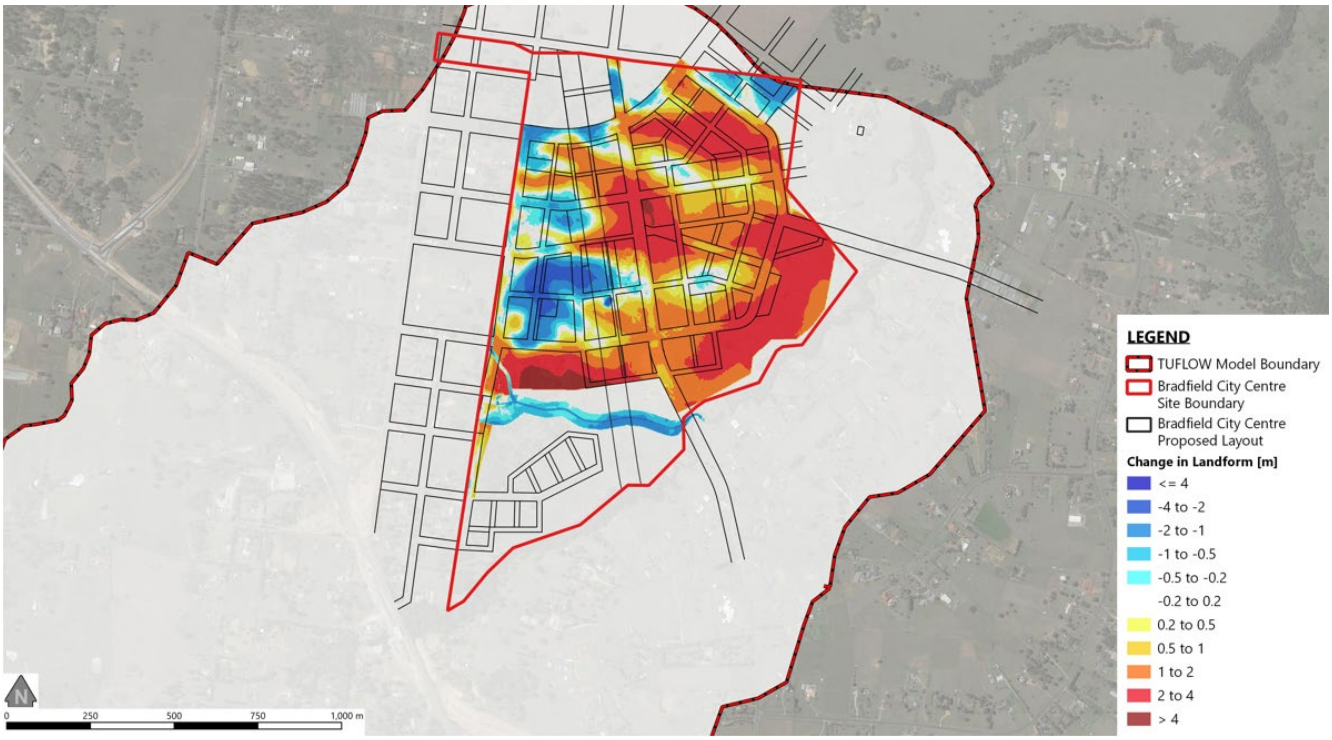
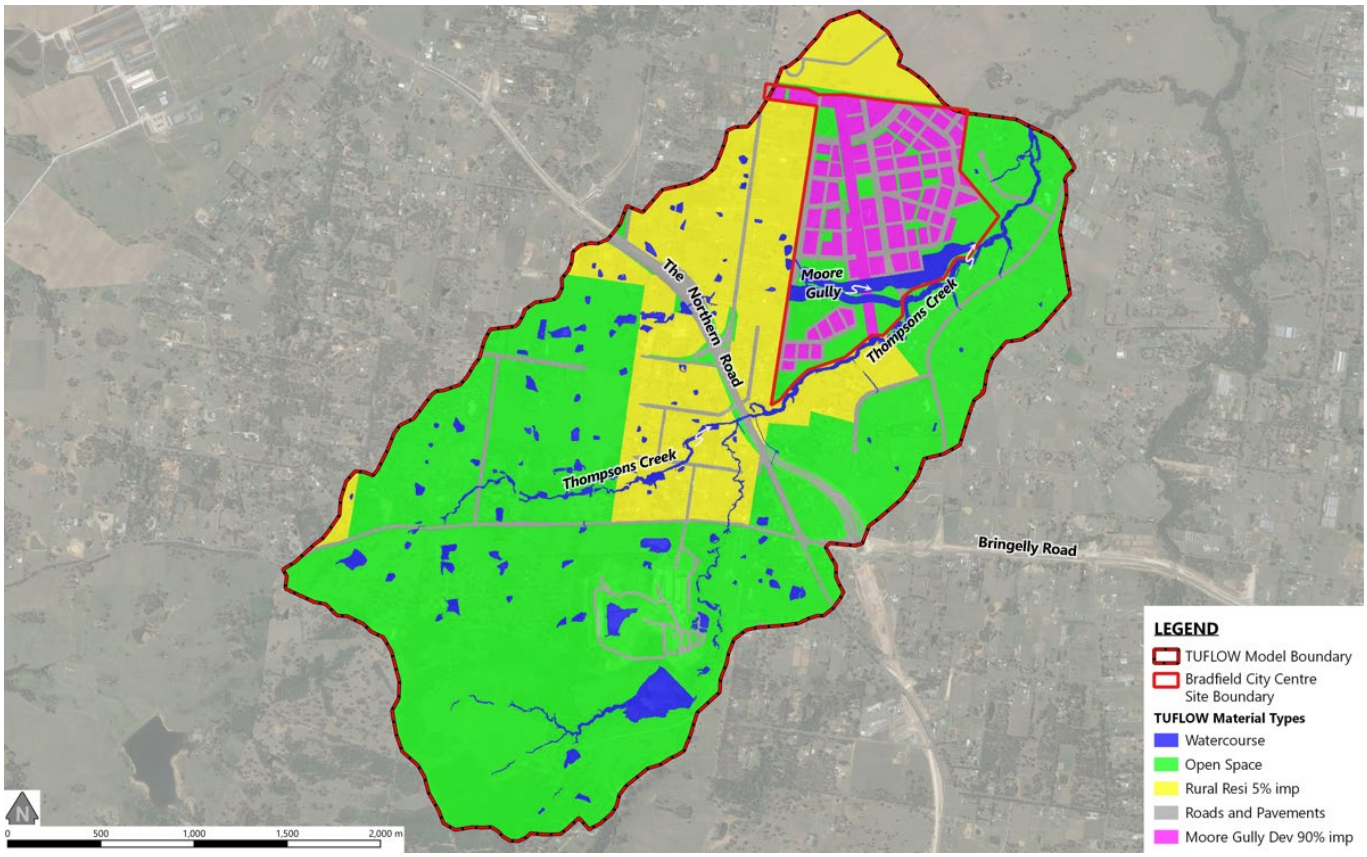


Figure 8 - TUFLOW Model Hydraulic Roughness Delineation (Post-Development Conditions)



5.2 Overview of Key Assumptions

An overview of the key assumptions adopted in the post-development flood modelling is provided in the following.

(i) It is understood that the land surrounding the Bradfield City Centre site will also be developed as part of the proposed development of the wider Western Sydney Aerotropolis. However, no details have been provided for the post-development landform in areas outside of the Bradfield City Centre site. Accordingly, the post-development version of the TUFLOW flood model has not included any changes to the existing landform in these areas.

(ii) It is also understood that work associated with the Western Sydney Aerotropolis project would lead to an increase in imperviousness in areas outside of the Bradfield City Centre. The increase in imperviousness in areas upstream of the Bradfield City Centre site would generate greater volumes of runoff when compared to existing conditions. It is anticipated that the greater volume of runoff would lead to flood level and flow velocity increases along major watercourses and flow paths which would not be associated with the Bradfield City Centre development. Accordingly, the post-development TUFLOW model has not included increases in imperviousness in areas outside of the Bradfield City Centre site. Therefore, the assessment only considers the flood impacts which would arise solely from the Bradfield City Centre development.

(iii) It is understood that Sydney Water plans to provide detention systems to mitigate the additional runoff which would be generated due to the increase in imperviousness across the wider Western Sydney

Aerotropolis development. The details of these detention systems were not available at the time of writing.

(iv) The proposed stormwater drainage network within the Bradfield City Centre development has not been provided and therefore has not been included in the post-development TUFLOW model.

5.3 Flood Modelling Results for Post-Development Conditions

The modified flood model was used to simulate the 1% AEP flood in order to assess the flood behaviour at the site under post-development conditions. Flood mapping for Thompsons Creek and Moore Gully under post-development conditions is presented in **Appendix 1**, including mapping of peak flood depths, levels, velocities, and hazards. All mapping is presented superimposed over the proposed Bradfield City Centre site boundary and proposed lot and road layouts.

The following flood mapping has been provided:

- **Figure A5**: Peak flood depths during the 1% AEP event (post-development conditions)
- **Figure A6**: Peak flood levels during the 1% AEP event (post-development conditions)
- **Figure A7**: Peak flow velocities during the 1% AEP event (post-development conditions)
- **Figure A8**: ARR 2019 flood hazard categories during the 1% AEP event (post-development conditions)

The flood model results show that the predicted flood behaviour along Thompsons Creek and the section of Moore Gully upstream of the Bradfield City Centre site are relatively similar to existing conditions. The results also indicate that the new channel for Moore Gully is able to effectively convey the 1% AEP peak flow towards Thompsons Creek.

Runoff within the Bradfield City Centre is generally concentrated along the road network and flows to the east and south towards Thompsons Creek.

6 Impacts and Mitigation Assessment

The magnitude and location of any changes in flood behaviour arising from the proposed Bradfield City Centre development is established by comparing the results generated from flood simulations for the existing and post-development scenarios.

6.1 Impact on Peak Flood Levels

Flood level difference mapping was prepared from the modelling results to quantify any off-site impacts that could be caused by the proposed development. Difference maps are created by comparing peak flood level estimates at each grid cell in the flood model from the results of simulations undertaken for both existing and post-development scenarios. This effectively creates a contour map of predicted changes in peak flood levels (i.e., increases and decreases) and allows visual assessment of the impact of the development on existing peak flood levels.

Flood level difference mapping was developed and is presented in **Figure A9**. As shown in the legend, increases in peak flood level are represented as different shades of red and decreases in peak flood level are represented as shades of blue. The white shading indicates changes in peak flood level that are between +/- 0.01 metres, which is considered to correspond to no change.

As shown in **Figure A9**, the proposed Bradfield City Centre development is predicted to result in some minor changes to peak 1% AEP flood levels on land that is outside the development boundary. These locations are as follows (refer **Figure A9**).

- Off-site Impact 1: increases in peak flood levels near to and downstream of the confluence of Moore Gully and Thompsons Creek.
- Off-site Impact 2: increases in peak flood levels and extents downstream of the retaining wall at the eastern boundary of Bradfield City Centre.

It is noted that Off-site Impact 1 is predicted to occur primarily in the riparian corridor of Thompsons Creek. The flood level increases in this area typically range from 0.02 to 0.04 metres, up to a maximum of 0.06 metres in localised areas. However, it is important to note that these flood level increases are predicted to occur on land which has been designated for 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' as per the Land Reservation Acquisition Map for the Western Parkland City State Environmental Planning Policy.

Additionally, overland flows travelling eastward along the road network are predicted to overtop the kerb and gutter system and spill over the retaining wall before flowing into Thompsons Creek. These overtopping flows are predicted to cause Off-site Impact 2, comprising flood level increases in localised areas of up to 0.06 metres.

6.2 Impact on Peak Flow Velocities

A difference map was also created to quantify any changes on peak flow velocities associated with the proposed Bradfield City Centre development. The velocity difference mapping that was developed for the 1% AEP flood is presented in **Figure A10**.

The proposed development is also predicted to result in some changes to floodwater flow velocities outside of the Bradfield City Centre boundary at the locations of Off-site Impact 3 and Off-site Impact 4.

Off-site Impact 3 occurs within the Moore Gully channel just upstream of the Bradfield City Centre site boundary. Increases in flow velocity of up to 0.25 m/s are predicted to occur at this location. It is noted that this increase to flow velocities is confined to a very localised area and does not extend outside of the Moore Gully channel.

Increases in flow velocity of up to 0.22 m/s are predicted in localised areas east of the retaining wall at the location of Off-site Impact 4. These increases to flow velocity are also attributed to overland flows overtopping the kerb and gutter system at the eastern edge of the development and spilling over the retaining wall.

6.3 Impact on Flood Hazard

Peak 1% AEP flood hazard mapping was prepared for the post-development scenario and is shown in **Figure A8**. Comparison of **Figure A4** and **Figure A8** shows that only minimal changes are predicted to the flood hazard classification. Flood hazards are predicted to remain between H1 and H3 along Moore Gully and within the Bradfield City Centre site boundary.

6.4 Recommendations

The Bradfield City Centre development is not expected to result in any broadscale change to flood behaviour along Thompsons Creek or along Moore Gully upstream of the site. The difference mapping shown in **Figure A9** and **Figure A10** shows that the proposed Bradfield City Centre is predicted to cause some flood level and flow velocity increases. However, the results of the post-development flood modelling shows that these impacts are limited to localised areas just adjacent to the site boundary or do not extend outside of the riparian corridors of Moore Gully and Thompsons Creek.

Off-site Impact 1 comprises flood level increases of up to 0.06 metres which typically occur within the Thompsons Creek riparian corridor. Moreover, these impacts are predicted to occur on land which has been designated as 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' in the State Environmental Planning Policy (Western Parkland City) 2021 Land Reservation Acquisition Map.

The 1% AEP flood level increases predicted near the Thompsons Creek / Moore Gully confluence range between 0.03 and 0.06m. Increases of this magnitude exceed those typically accepted as being within the accuracy of the modelling or data on which the modelling relies on. However, the location and extent of the predicted increases occur on land which is designated as 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' on the Land Reservation Acquisition Map that accompanies State Environmental Planning Policy (Western Parkland City) 2021.

Hence, the predicted increases in 1% AEP flood level and any associated increase in the frequency of flooding of the land will not manifest to cause an adverse impact to the future use of the affected land. Moreover, the affected land will be dedicated to open space and/or a drainage function, and therefore the future use is compatible with or can be tailored to accommodate the predicted increase in flood affectation. Therefore,

these impacts are considered to be acceptable as they do not increase flood levels in privately owned land.

The design and implementation of a stormwater drainage network to service the proposed roadways would serve to capture some of the runoff flowing eastward and southwards towards Thompsons Creek. It is likely that this would reduce or prevent runoff from overtopping the kerb and gutter system near the eastern site boundary and spilling over the retaining wall. Accordingly, the implementation of a stormwater drainage network could mitigate the flood level and flow velocity increases associated with Off-site Impact 2 and Off-site Impact 4.

The localised off-site impact within the Moore Gully channel just upstream of the site (Off-site Impact 3) could be mitigated through further refinement of the post-development landform. Refinements to the design land surface should aim to allow greater conveyance of flow along Moore Gully and the tributary that drains the catchment to the north-west of the site.

It is noted that the post-development model included a number of features which are important in allowing flows to drain efficiently into the site.

- A waterway opening which allows flows from the Moore Gully tributary to enter the channel at the western site boundary;
- A swale in a north-south alignment which conveys flows southward towards the Moore Gully opening near the western site boundary; and
- A set of two box culverts measuring 1.2 m (W) x 0.3 m (H) at the western site boundary which alleviates minor local ponding on the upstream (western) side of the road.

It is noted that these features should be included in the post-development landform for the next design stage. The omission of these features would likely lead to flood level or flow velocity increases outside of the Bradfield City Centre site boundary.

The locations of these features have been shown in **Figure 6**.

The recommendations described above are summarised in **Table 5**.

Table 5 - Recommendations

Ref	Recommendation	Timeframe	Responsible
1	Further refinement of the post-development landform along the new Moore Gully alignment to allow greater conveyance of flows along Moore Gully.	Prior to relevant planning approval	WPCA
2	Further refinement of the design surface to include a waterway opening to allow flows from the catchment to the north-west of the site to enter Moore Gully.	Prior to relevant planning approval	WPCA
3	Further refinement of the design surface to include a north-south swale along the western site boundary to convey flows into Moore Gully	Prior to relevant planning approval	WPCA
4	Inclusion of culverts at the western site boundary to alleviate local ponding on the western side of the road.	Prior to relevant planning approval	WPCA
5	Design and implementation of a stormwater drainage network to cater for ponding and flows along the	Prior to relevant	WPCA

	proposed roadways and to prevent overtopping of the road formation at the eastern edge of the development.	planning approval

7 Conclusions

An assessment of the potential impacts of the Bradfield City Centre development on existing flood behaviour was undertaken using a TUFLOW flood model of the Thompsons Creek and Moore Gully catchments. The TUFLOW model was used to simulate existing flood conditions in the vicinity of the Bradfield City Centre and to assess the impact of the proposed development on those flood conditions. The impacts were quantified by comparing peak flood characteristics under post-development conditions against peak flood characteristics under existing conditions.

The following conclusions can be drawn from the assessment:

- The proposed Bradfield City Centre development is not expected to result in any significant impact on existing flood behaviour along Thompsons Creek or along sections of Moore Gully upstream of the site. Off-site impacts are restricted to localised areas immediately adjacent to the development site or otherwise do not extend outside of the riparian corridors of Thompsons Creek and Moore Gully.
- The proposed Bradfield City Centre development is predicted to lead to an increase in 1% AEP flood along Thompsons Creek near to and downstream of its confluence with Moore Gully (Off-site Impact 1 in **Figure A9**). The peak flood levels are expected to typically increase by 0.02 to 0.04 metres and up to a maximum of 0.06 metres in some localised areas. However, this impact does not extend outside of the Thompsons Creek riparian corridor. Furthermore, these impacts occur on land which is designated as 'Local Open Space and Drainage' and/or 'Stormwater Infrastructure' in the State Environmental Planning Policy (Western Parkland City) 2021 Land Reservation Acquisition Map.
- The proposed Bradfield City Centre development is predicted to lead to a localised increase in 1% AEP flood level and extent in the area to the north-east of the site (refer to Off-site Impact 2 in **Figure A9**). A flood level increase of up to 0.06 metres is predicted in this area. This increase in flood level is predicted to occur along an overland flow path that drains to Thompsons Creek and is caused by stormwater runoff overtopping the road formation that has been designed to service the north-eastern section of the site.
- The proposed Bradfield City Centre development is expected to lead to a very localised increase in flow velocity within the Moore Gully channel just upstream of the site boundary. A flow velocity increase of up to 0.25 m/s is predicted in this area. However, this impact occurs in a very localised area and is confined within the Moore Gully channel.
- The proposed Bradfield City Centre development is expected to lead to a localised increase in flow velocities (Off-site Impact 4) near the location of Off-site Impact 2. A flow velocity increase of up to 0.22 m/s is predicted in this area. This impact is also caused by stormwater runoff overtopping the proposed road formation and spilling over a retaining wall that is currently proposed along the north-eastern site boundary.
- The proposed Bradfield City Centre development is not predicted to lead to any material changes to the flood hazard in the vicinity of the site.

Due to the limited extent of the flood impacts, it is anticipated that they can be mitigated through further refinement of the post-development landform near the precinct boundaries as well as incorporation of the stormwater drainage network that is proposed to service the site. Notwithstanding, in order to ensure that these off-site impacts are minimised, it is recommended that the following be undertaken during the next phase of the concept design:

1. The design land surface for the Bradfield City Precinct should be further refined along the western site boundary near the new Moore Gully alignment. The refined land surface should allow for greater conveyance of flow in an easterly direction along Moore Gully and from the north-western tributary that drains to it. The refined land surface should allow for a waterway opening to allow flows from

the catchment to the north-west of the site to enter Moore Gully. The refined land surface should also allow for a swale in a north-south alignment along the western site boundary to convey flows into Moore Gully. The exclusion of these features will likely lead to increases in flood level and/or flow velocity in areas outside of the site boundary.

2. The design should also allow for a set of culverts along the western site boundary to alleviate local ponding on the western side of the road.

3. A stormwater drainage network should be designed and installed to alleviate the ponding of runoff in the streets of the proposed development. This will serve to reduce the magnitude and extent of Off-site Impacts 2 and 4.

8 References

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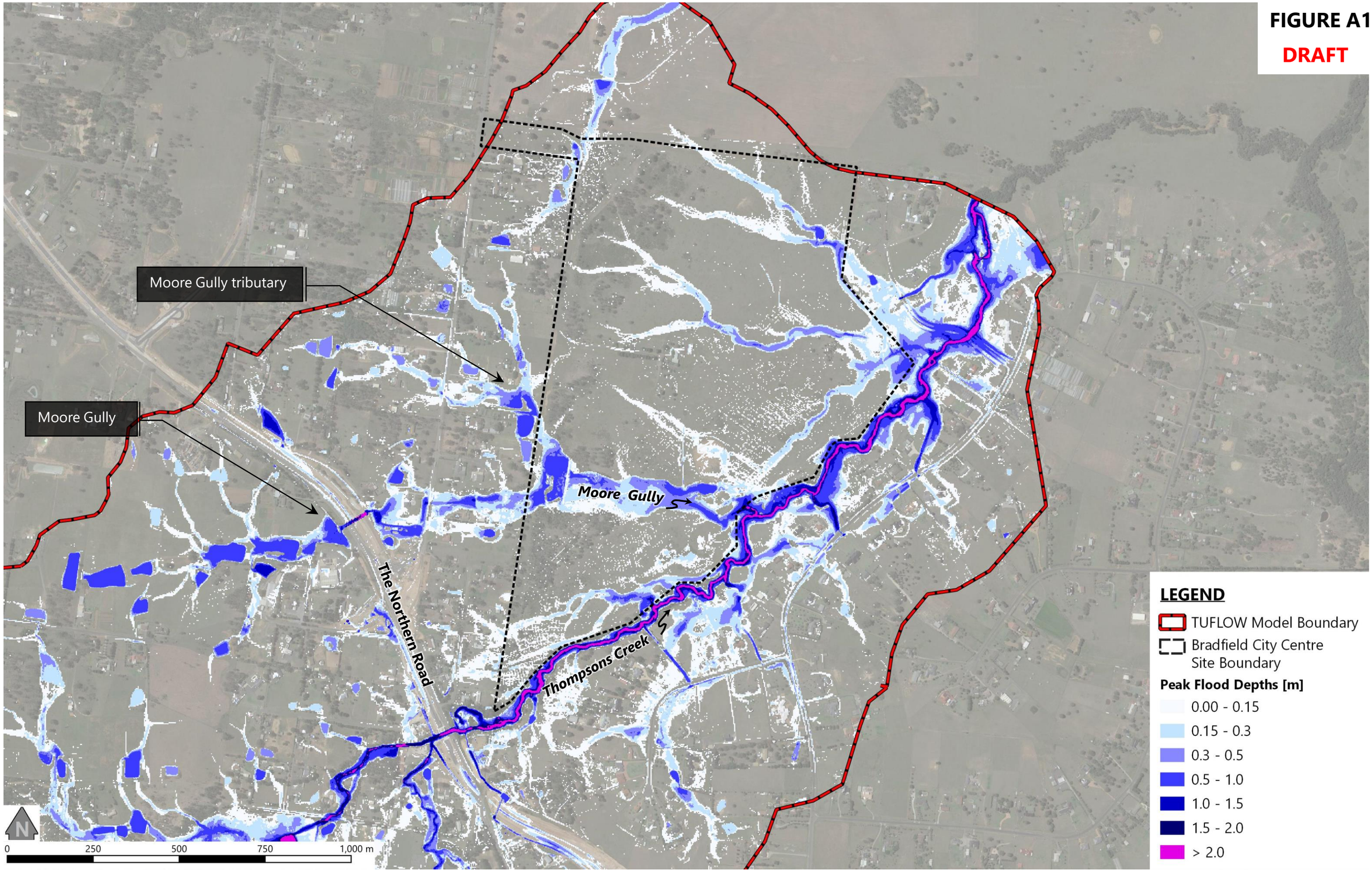
Appendix 1

1% AEP Flood Mapping for Existing and Post-Development Conditions

FIGURE A1

DRAFT



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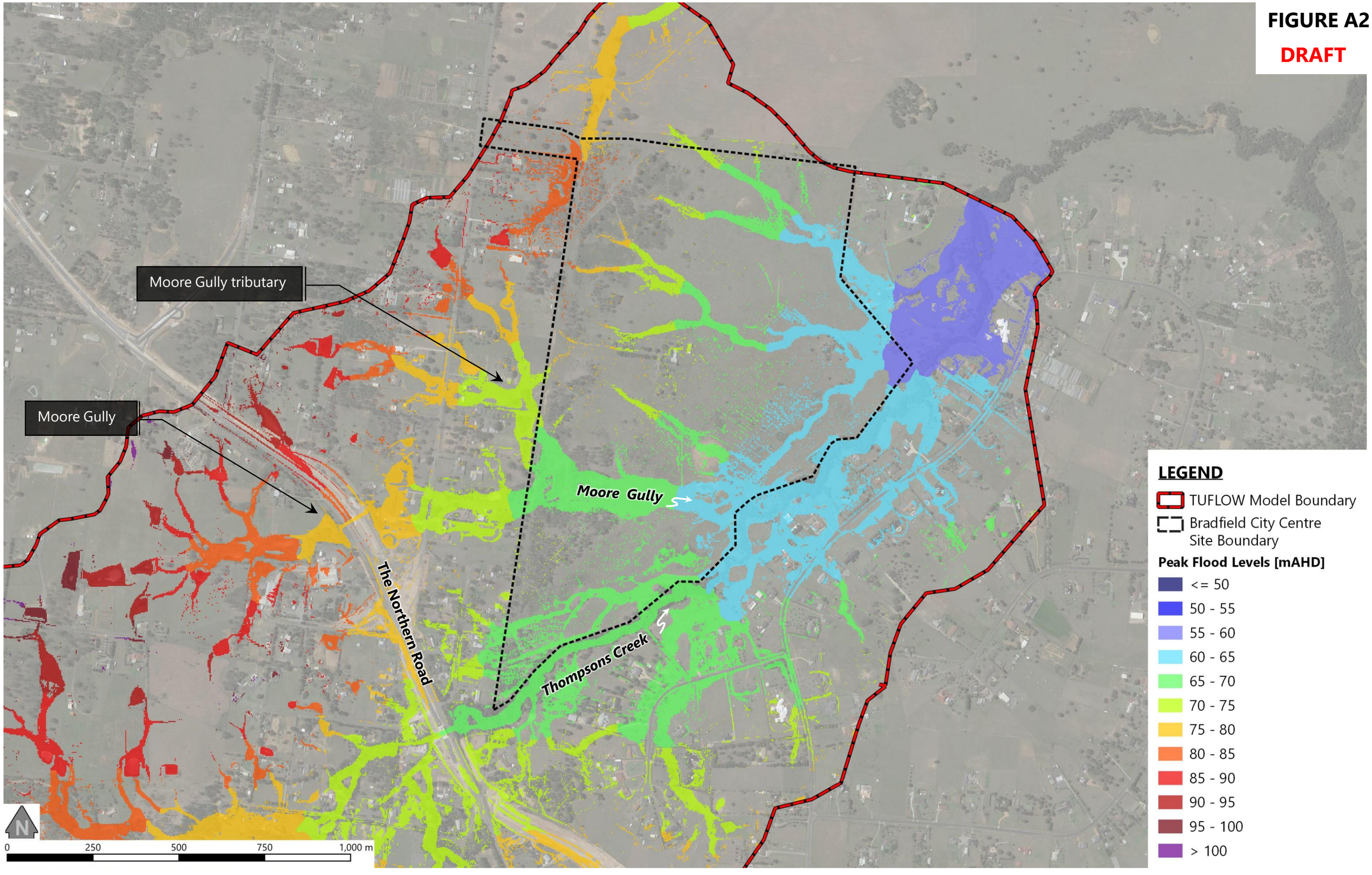
PEAK FLOOD DEPTHS DURING THE 1% AEP EVENT [EXISTING CONDITIONS]

FIGURE A2

DRAFT



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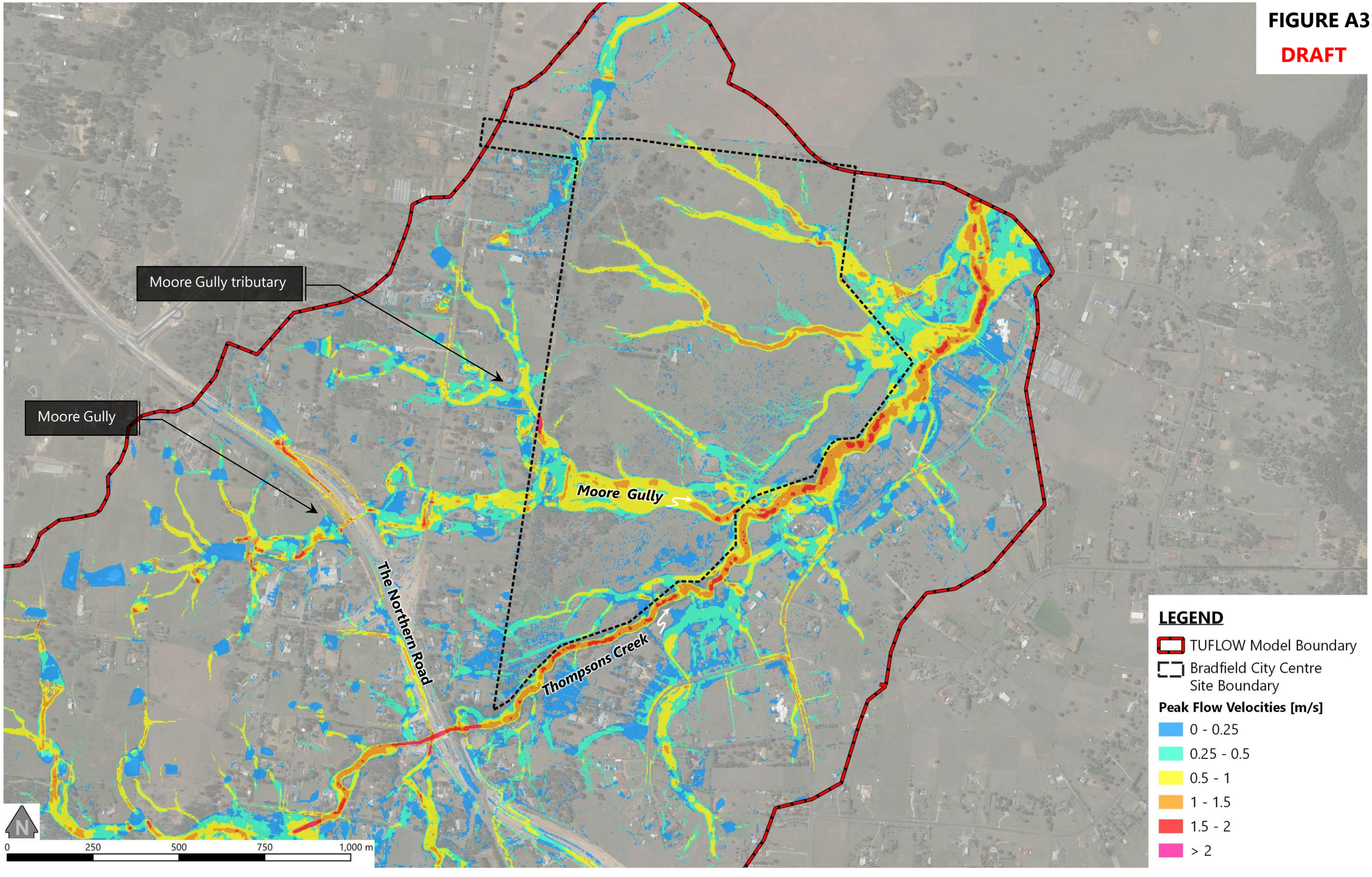
PEAK FLOOD LEVELS DURING THE 1% AEP EVENT [EXISTING CONDITIONS]

FIGURE A3

DRAFT



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PEAK FLOW VELOCITIES DURING THE 1% AEP EVENT [EXISTING CONDITIONS]

FIGURE A4

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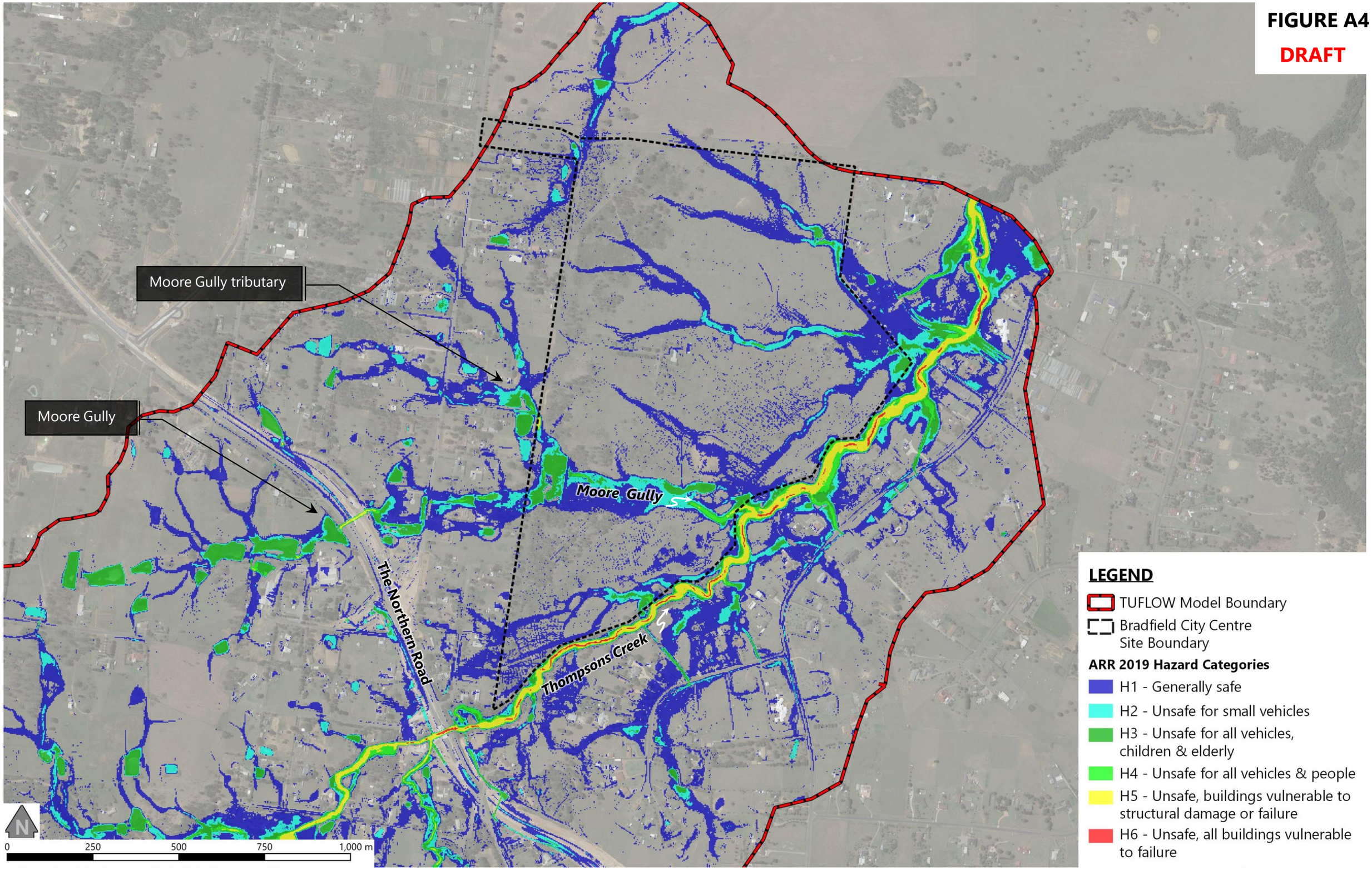

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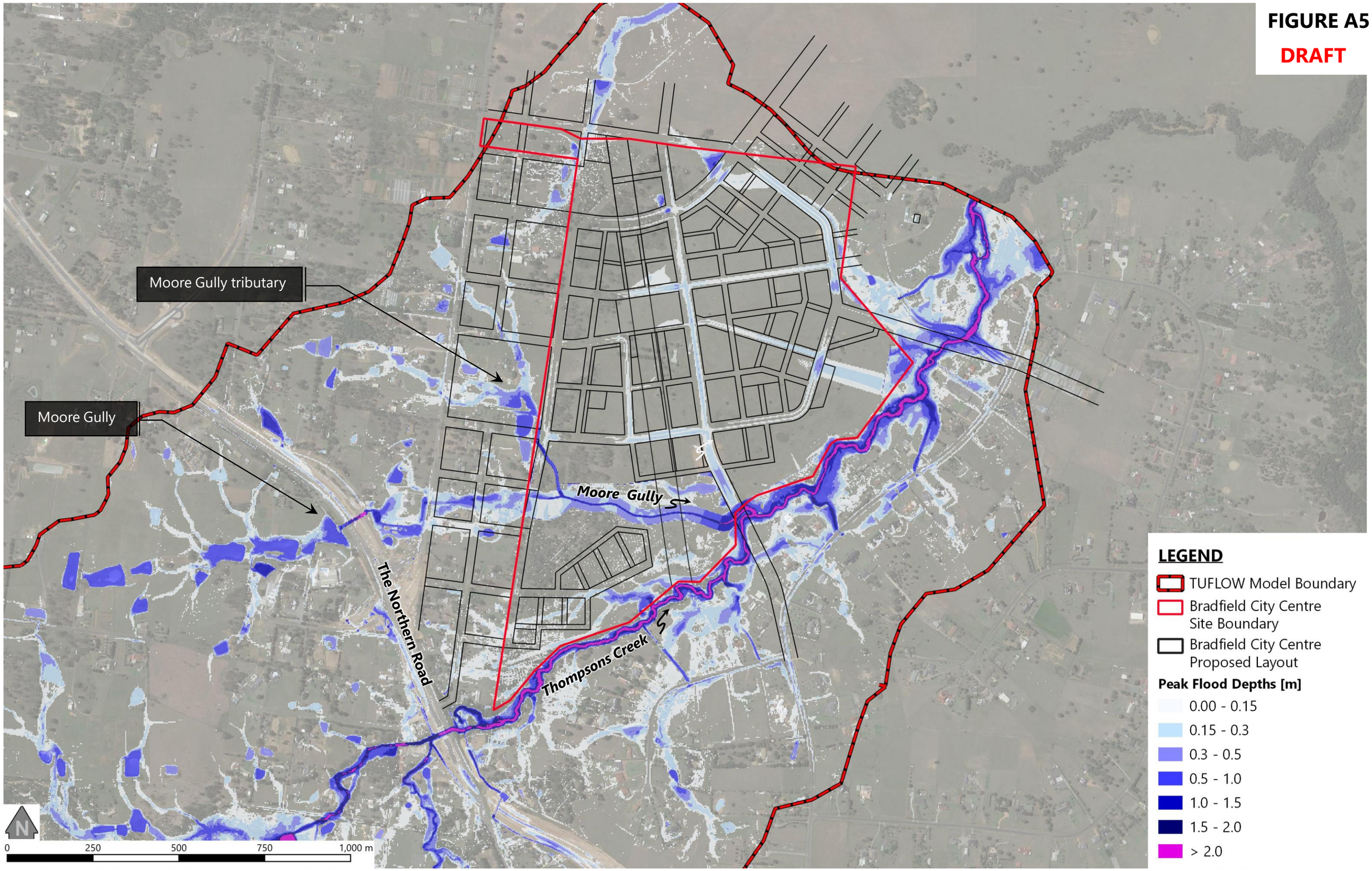
ARR2019 FLOOD HAZARD CATEGORIES DURING THE 1% AEP EVENT [EXISTING CONDITIONS]

FIGURE A5

DRAFT



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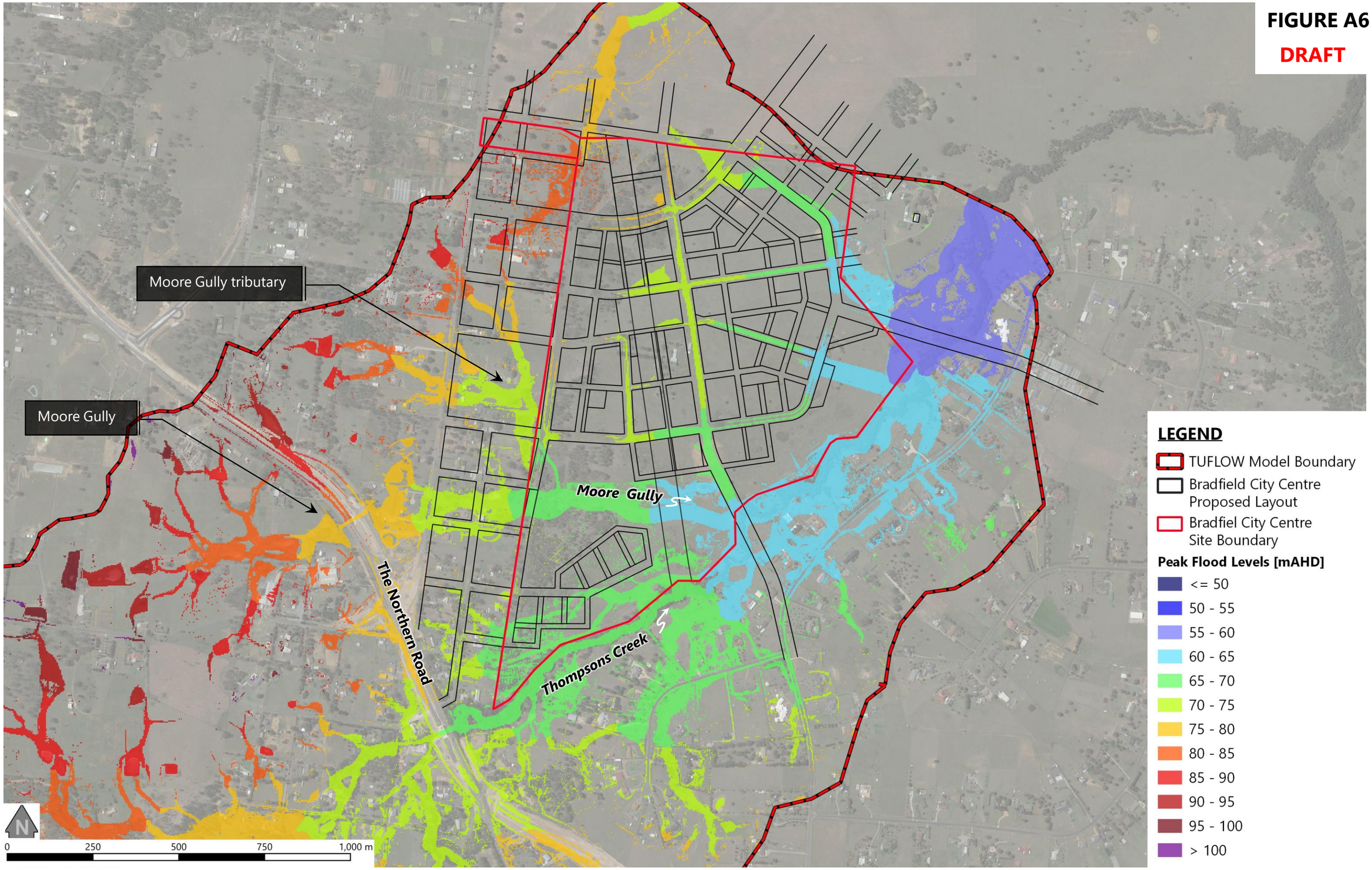
PEAK FLOOD DEPTHS DURING THE 1% AEP EVENT [POST-DEVELOPMENT CONDITIONS]

FIGURE A6

DRAFT



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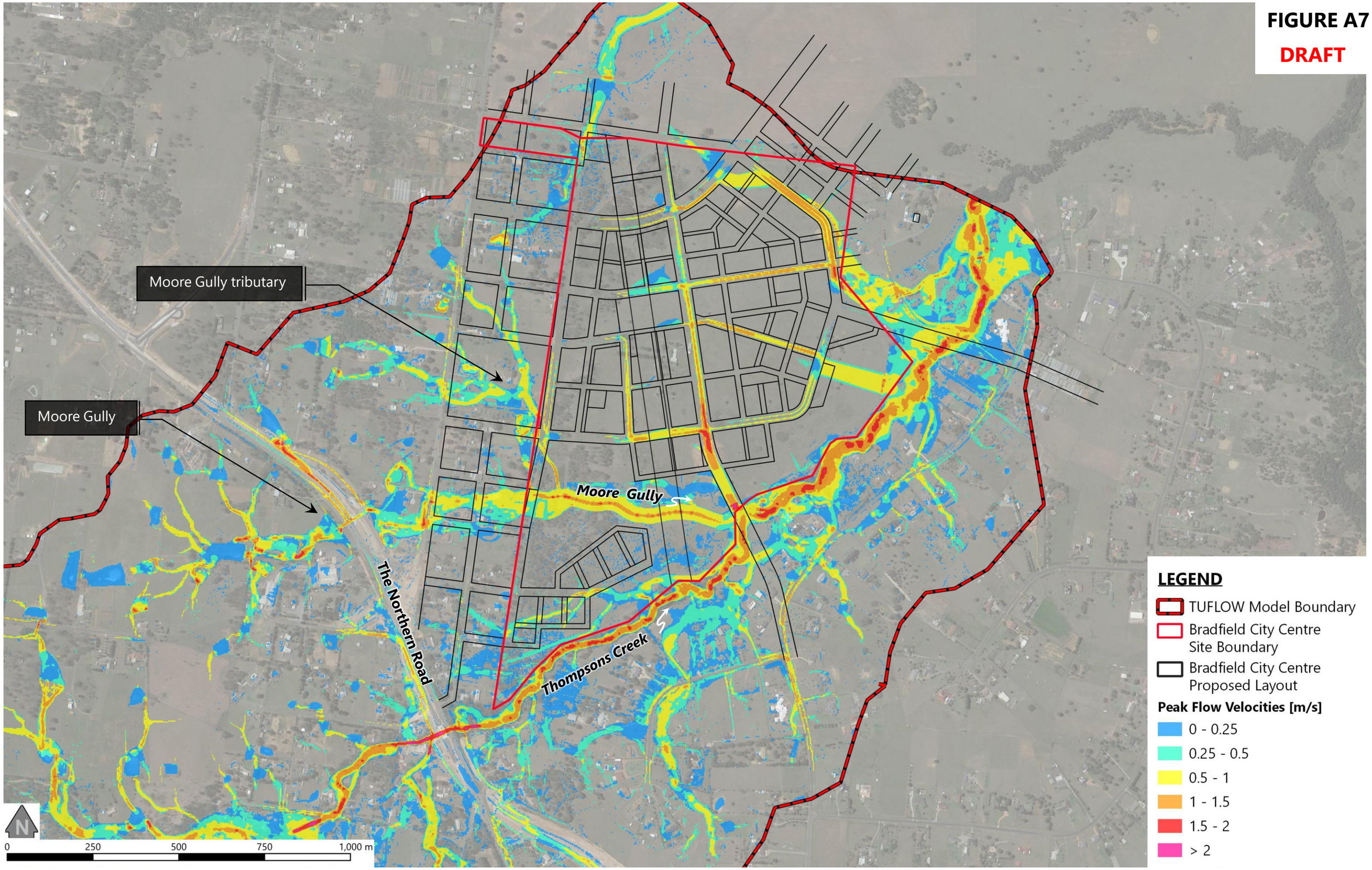
PEAK FLOOD LEVELS DURING THE 1% AEP EVENT [POST-DEVELOPMENT CONDITIONS]

FIGURE A7

DRAFT



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PEAK FLOW VELOCITIES DURING THE 1% AEP EVENT [POST-DEVELOPMENT CONDITIONS]

FIGURE A8

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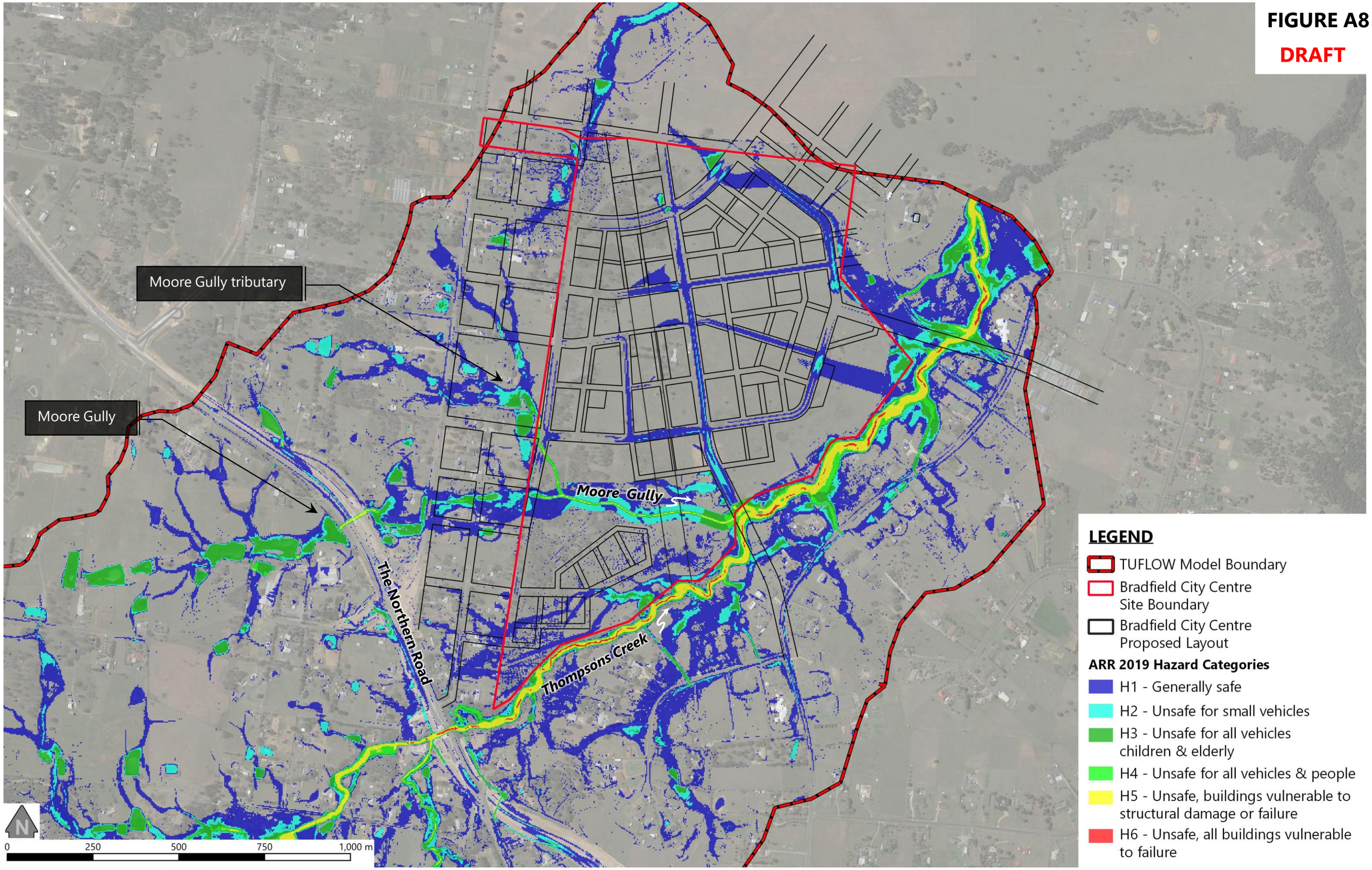

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ARR2019 FLOOD HAZARD CATEGORIES DURING THE 1% AEP EVENT [POST-DEVELOPMENT CONDITIONS]

FIGURE A9

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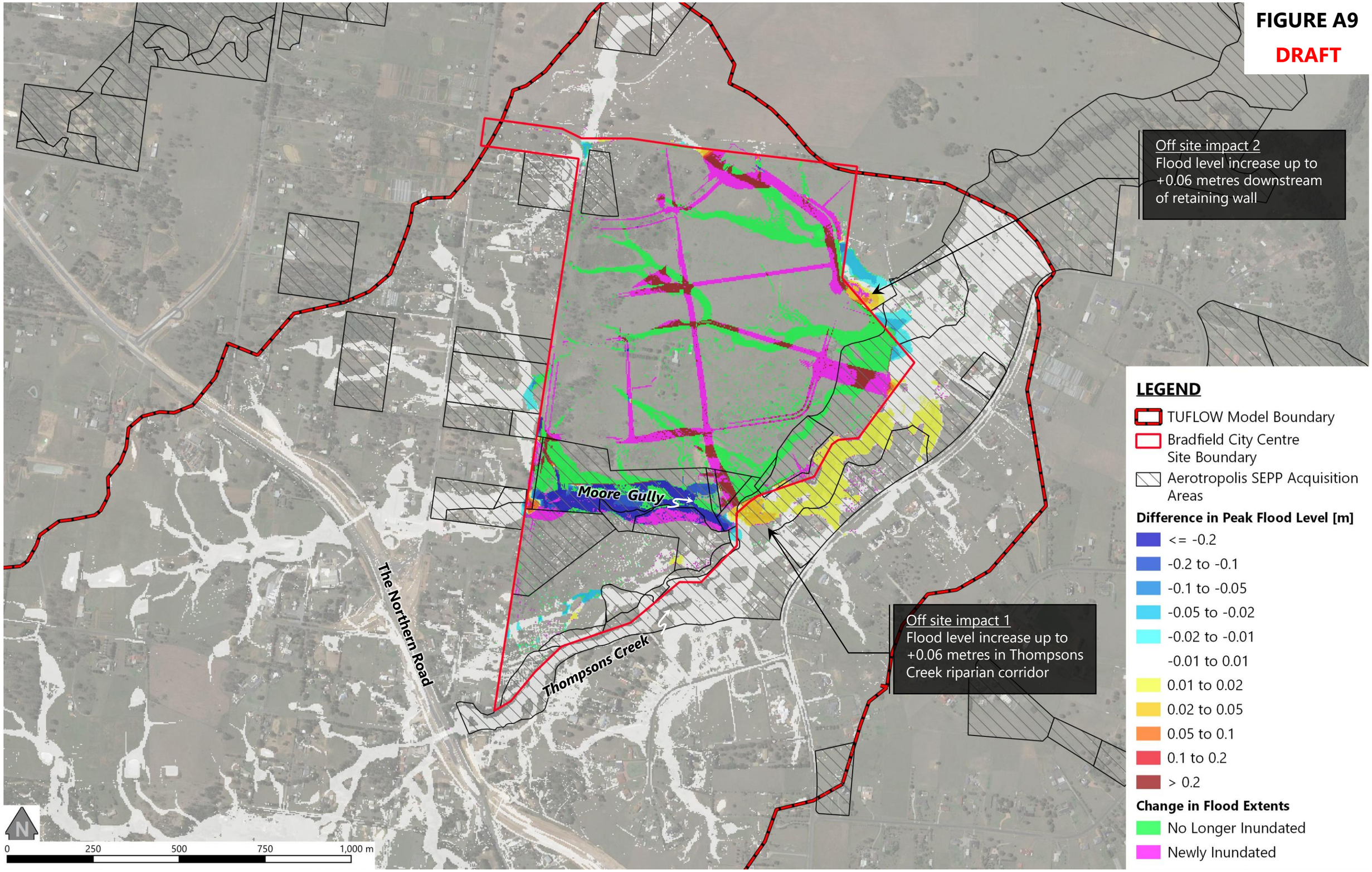

LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- Aerotropolis SEPP Acquisition Areas

Difference in Peak Flood Level [m]

- <= -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

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IMPACT OF THE PROPOSED DEVELOPMENT ON PEAK FLOOD LEVELS [1% AEP EVENT]

FIGURE A10

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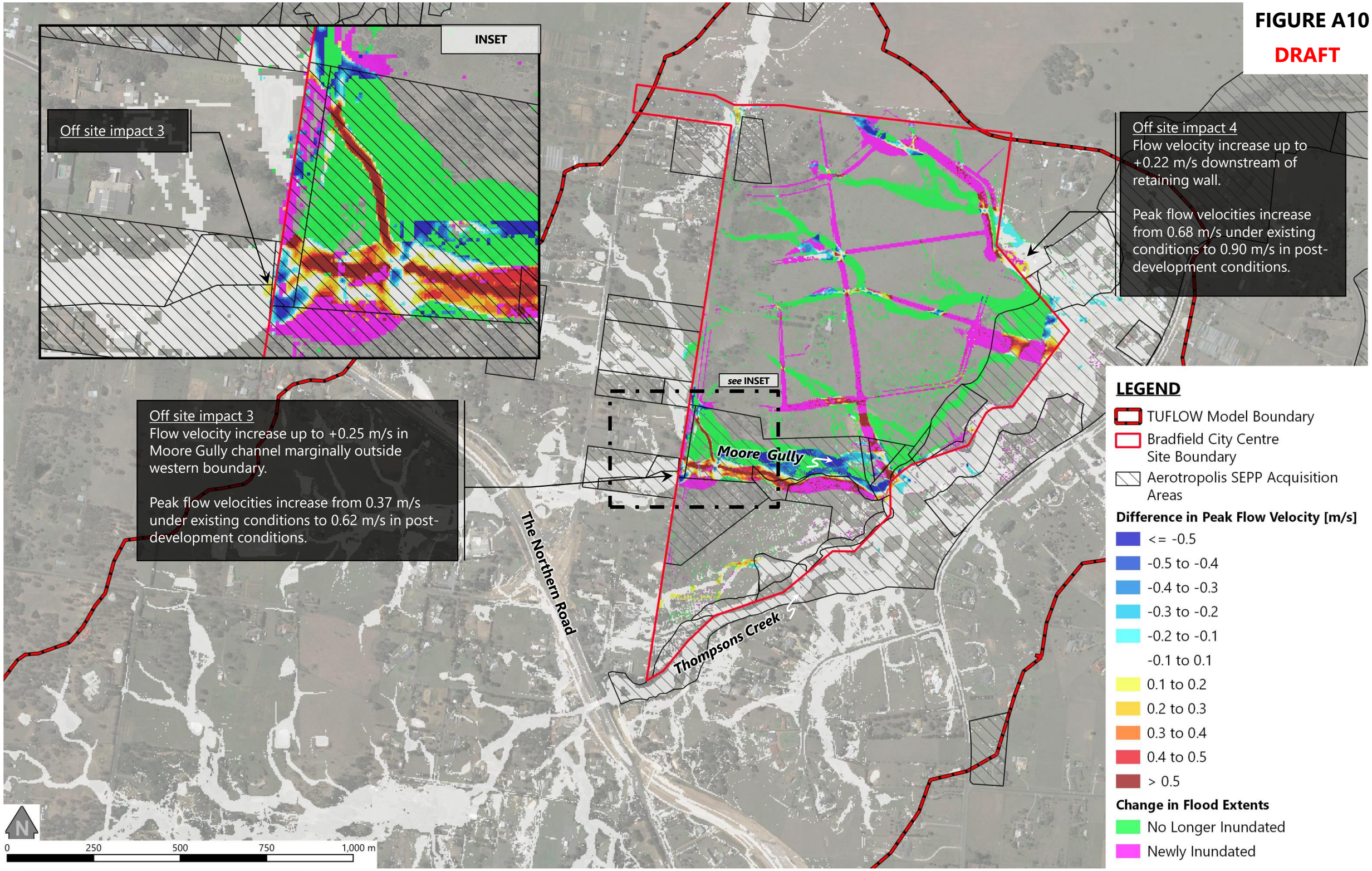

LEGEND

- TUFLOW Model Boundary
- Bradfield City Centre Site Boundary
- Aerotropolis SEPP Acquisition Areas

Difference in Peak Flow Velocity [m/s]

- <= -0.5
- -0.5 to -0.4
- -0.4 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.5
- > 0.5

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

Prepared by:

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IMPACT OF THE PROPOSED DEVELOPMENT ON PEAK FLOW VELOCITIES [1% AEP EVENT]

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NSW GOVERNMENT