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Northbank Enterprise Hub Business and Industrial Park - Regional Flooding Assessment

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Northbank Enterprise Hub Business and Industrial Park – Regional Flooding Assessment

Prepared For:	ADW Johnson
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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BMT WBM Pty Ltd BMT WBM Pty Ltd 126 Belford Street BROADMEADOW NSW 2292 Australia PO Box 266 Broadmeadow NSW 2292 Tel: +61 2 4940 8882 Fax: +61 2 4940 8887 ABN 54 010 830 421 www.wbmpl.com.au	***Document :*** R.N1900.001.03_RegionalFlooding.docx ***Project Manager :*** Darren Lyons ***Client :*** ADW Johnson ***Client Contact:*** Scott Day ***Client Reference***

Title :	Northbank Enterprise Hub Business and Industrial Park – Regional Flooding Assessment
Authors :	Darren Lyons
Synopsis :	This report details the regional flood impact assessment of the proposed Northbank Enterprise Hub Subdivision major project application. Revision incorporates additional reporting to address DoP comments.

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1 INTRODUCTION

1.1 Purpose of this Report

This report has been commissioned by ADW Johnson for the purposes of identifying potential opportunities/constraints to proposed future development on Tomago Road, Tomago with respect to regional Hunter River flooding. The report investigates the potential impacts of the proposed development on existing flood conditions and identifies potential options to mitigate adverse flood impact. Separate reports have been prepared by BMT WBM in regard to stormwater management (BMT WBM, 2012a) and local site drainage/flooding (BMT WBM, 2012b).

The assessment includes a detailed flood investigation using the existing TUFLOW flood model to quantify flooding impacts and to determine the potential merits of any mitigation measures. The existing flood model was developed for the Williams River Flood Study, completed by BMT WBM in 2009 on behalf of Port Stephens Council (Council). Council has kindly given permission to use the existing model in the current flood risk assessment.

The flood impact assessment presented in this document details the nature of the proposed development, the analysis undertaken to quantify potential flood impact, and demonstration of the viability of flood mitigation options to manage flood impact both within the proposed development and on neighbouring property. The flood impact assessment herein provides a basis for assessing the Part 3A application in respect to floodplain management principles.

1.2 Site Location

The proposed Northbank Enterprise Hub development area is located on the left bank floodplain of the North Arm of the Hunter River (shown in red on Figure 1-1).

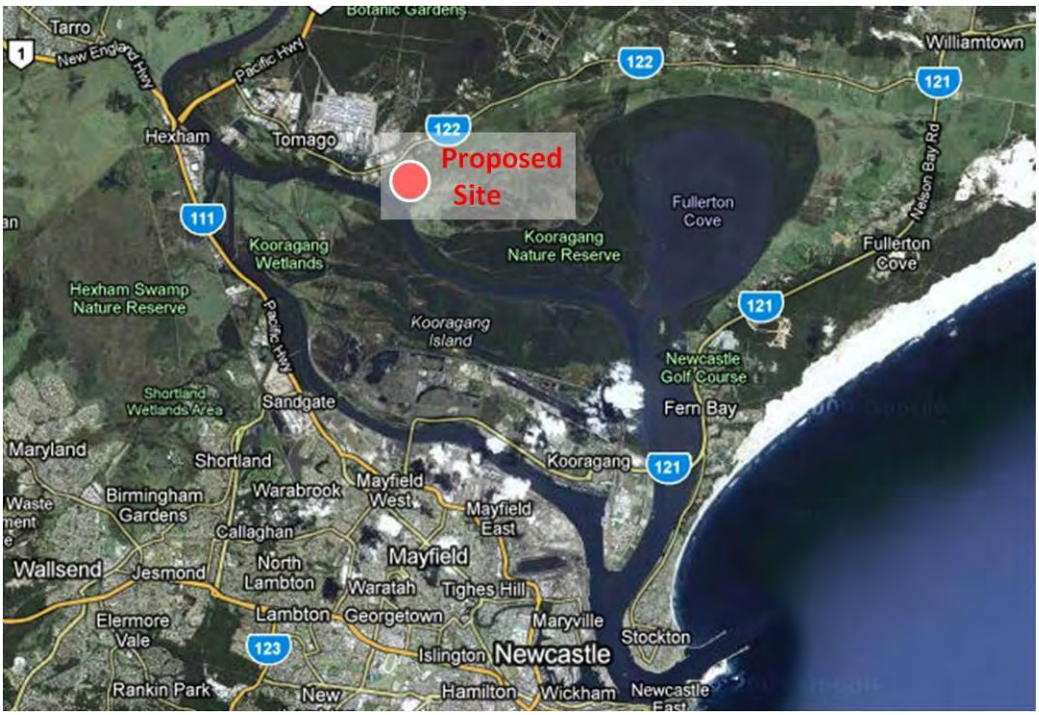


Figure 1-1 Site Locality (image Google)

1.3 Computer Modelling Tool

A detailed two dimensional computer model of the Lower Hunter floodplain was developed by BMT WBM as part of the Williams River Flood Study (BMT WBM, 2009), on behalf of Port Stephens Council and Dungog Shire Council. The model used a regular 40 by 40 m grid, covering an area of some 120 square kilometres.

There is considerable interaction between flooding in the lower parts of the Williams River and the Hunter River. Hence, the 2D1/D TUFLOW model of the Williams River was linked to a 2D/1D TUFLOW model of the Hunter River. This Hunter River model was developed as part of a project for the Roads and Traffic Authority (RTA) investigating a new Pacific Highway crossing of the Hunter River.

The hydraulic model was calibrated to the February 1990, March 1978 and May 2001 flood events. In terms of the Lower Hunter relevant to the subject proposed development site, the February 1990 flood event was the principal event used to calibrate the lower section of the Williams River model and the lower Hunter River model, being the largest Hunter River flows (coincident with a Williams River flood). The February 1990 event is approximated as a 5% AEP flood event based on the flood frequency analysis of long-term flood level record at Raymond Terrace.

The same computer model that was developed for the Williams River Flood Study has been used for the investigations described in this report. However, the model has been updated locally in the vicinity of the site with topographical data derived from ADW Johnson ground survey and Council's LIDAR survey data. The same model resolution has been retained, i.e. uniform fixed grid of 40m x 40m cell size. Note that that TUFLOW samples elevation points at the cell centres, mid-sides and corners, so a 40m cell size results in DEM elevations being sampled every 20m. Given the scale and nature of flooding in the Hunter River floodplain, this resolution provides an appropriate representation of flood conditions.

2 EXISTING FLOOD BEHAVIOUR

2.1 Flooding Mechanisms

The Hunter River catchment covers an area of the order of 22,000km^2 which flows into the Tasman Sea through the Port of Newcastle. The lower reaches of the Hunter system are tidal and forms the Hunter River estuary. Three major rivers discharge into the estuary, namely the Hunter River, the Paterson River and the Williams River. The confluence of the Williams River and Hunter River is at Raymond Terrace approximately 30 km upstream of the estuary mouth (i.e. Newcastle Harbour). The Paterson River joins the Hunter River between Morpeth and Hinton some 15 km upstream of Raymond Terrace. The estuary extends a further 20 km along the Hunter River to the tidal limit at Oakhampton, near Maitland.

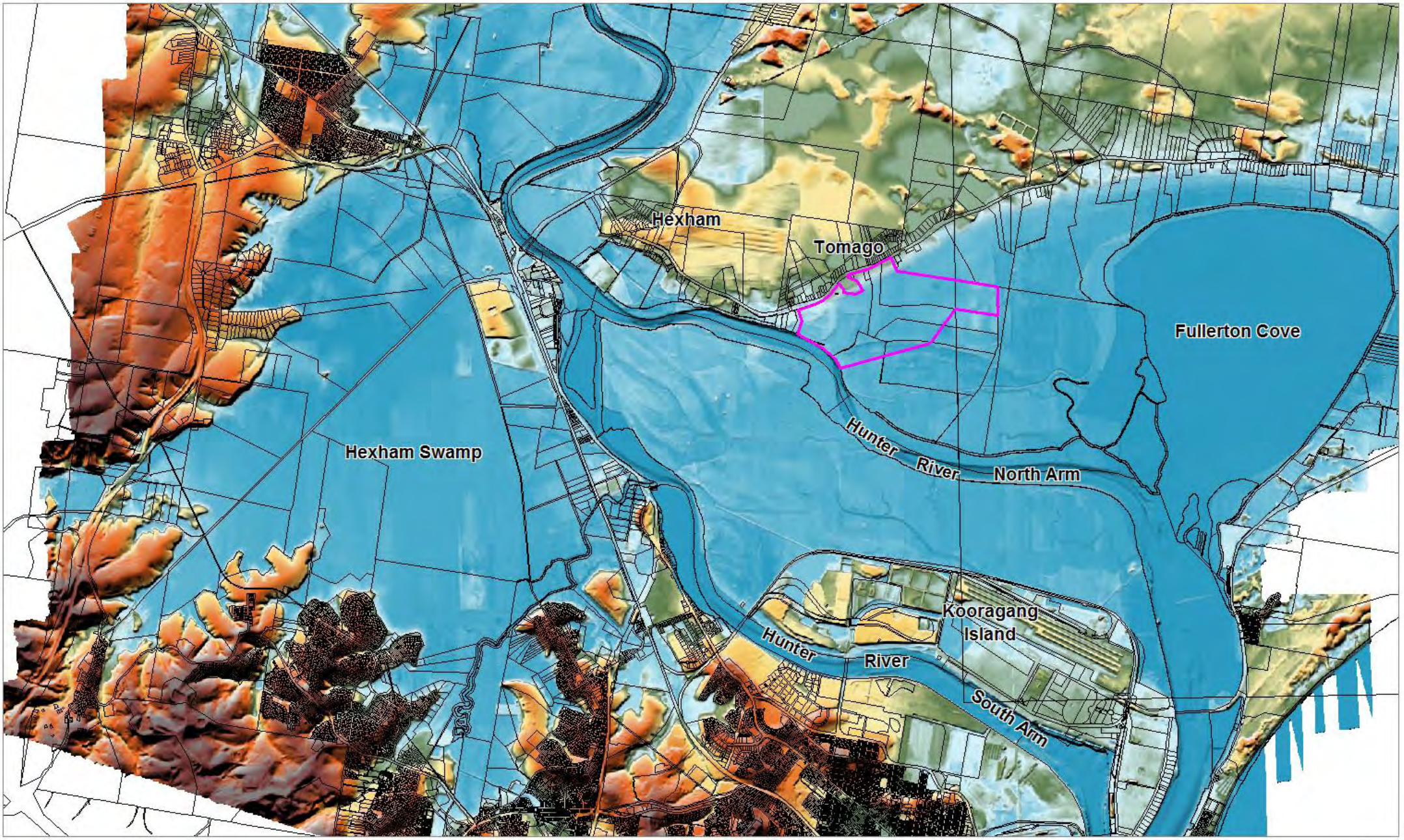
The proposed development site is located on the reach of the Hunter River that lies downstream of Hexham Bridge (approximately 15km upstream of the mouth). In this reach, the Hunter River main channel splits into two arms, the North Arm and the South Arm, separated by Kooragang Island. The topography of the Hunter River floodplain in the region of the proposed development is shown in Figure 2-1. Further topographical detail of the site is shown in Figure 2-2b. The local topography shown is principally derived from LiDAR data acquired by the NSW Dept. of Planning in 2007. Given uncertainties in the LiDAR data particularly in the presence of dense vegetation, ground survey of the site was undertaken by ADWJohnson to LiDAR. The coverage of the additional ground survey is shown Figure 2-2.

The Hunter River has experienced many floods during its recorded history. The largest flood on record was in 1955. After this event, which claimed 14 lives, the Hunter Valley Flood mitigation Scheme was established, which has subsequently instigated 160km of levees, 3.8km of spillways, 40km of control banks, 245 floodgates and 120km of drainage canals (DNR, 2007).

Within the Lower Hunter Estuary, the 1955 flood caused extensive overbank inundation, with flood depths of up to three metres across the Kooragang Island wetlands. This flood has been estimated at approximately a 1 in 100yr event (PWD, 1994). When the floodwaters reach the upstream end of Kooragang Island, approximately 75% of the flow continues down the North Arm, and 25% down the South Arm. Numerous floodgates along the River prevent backwater inundation of floodplain areas during smaller flood events, however, in larger events the floodgate structures are overtopped and the floodplains inundated.

Ocean water levels, influenced by storm surge and the tide, have an effect on flood levels within the lower estuary, up to Green Rocks. In higher frequency low discharge floods, the flow is contained within the rivers banks and levees. As flood severity increases, floodwaters overtop the natural and man-made levees and flow across the floodplain.

The proposed development site itself largely occupies the floodplain on the left bank of the Hunter River North Arm. This floodplain receives flow spilling over the banks of the Hunter River and in major flood events will be subject to significant inundation. Hunter River flooding, being from catchment derived, ocean derived or combinations is accordingly the dominant flooding mechanism. The proposed development has only a limited local catchment with only a small amount of contributing local catchment area to the north of Tomago Road.



LEGEND

Ground Level (m AHD)

- 0.0 - 2.5
- 2.5 - 5.0
- 2.5 - 7.5
- 7.5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- 50

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
Existing Hunter River Floodplain Topography

Figure: 2-1

Rev: A

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

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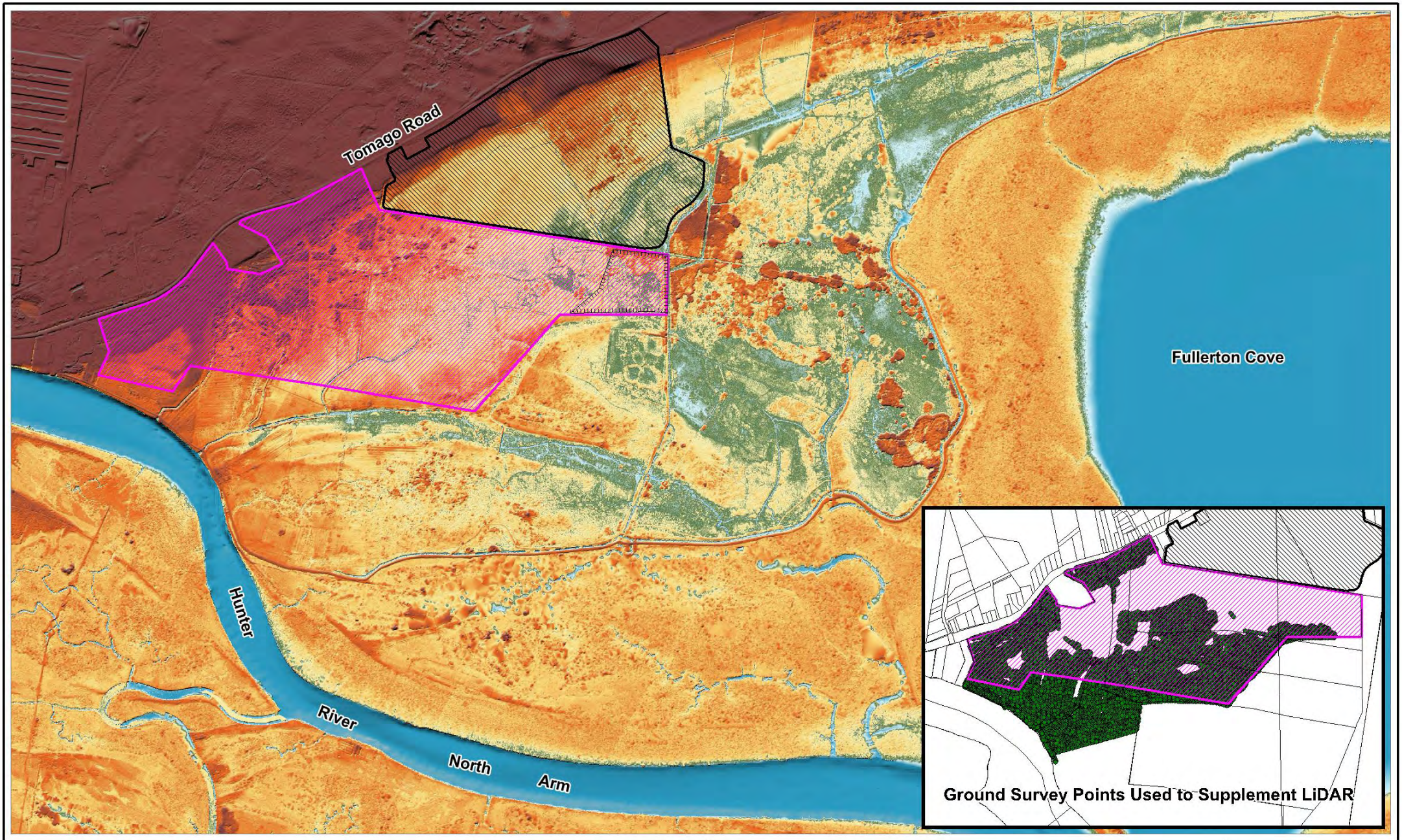


LEGEND

Ground Level (m AHD)

-0.5 - 0.0	0.60 - 0.80
-0.0 - 0.20	0.80 - 0.10
0.20 - 0.40	1.0 - 2.0
0.40 - 0.60	>2.0

Adopted Fill Footprint for modelling

EXISTING PART 3A APPROVAL 07-0086 & EPBC APPROVAL 2007/3345

Area removed from final footprint

Title:

Northbank Enterprise Hub Flood Risk Assessment
Detail of Local Topography

Figure: **2-2**

Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Local_Topography_Detail.WOR

The assessment outlined in this report is based on a previous development layout that was modified following completion of the modelling. We understand that the only significant change to the previous layout is associated with a reduction in developable land adjacent to the eastern boundary of the Project Site. Specifically, we understand the small portion of land shown as "area removed from final footprint" in Figure 2-2 is no longer proposed for development as this land (approximately 14.5ha) has been confirmed as part of an area of Endangered Ecological Community (EEC). The reduced developed footprint of the modified layout would not be expected to have a significant change from the modelled condition, with the principal control on flood behaviour being the fill footprint of the eastern portion of the site that impacts on initial spills from the Hunter River to the floodplain.

2.2 Design Flood Conditions

The existing Williams River/Hunter River flood model has been used to simulated design flood conditions for the development assessment. Model simulations for a range of design event magnitudes have been undertaken to establish existing flooding conditions across the site and to:

- Set minimum fill level requirements for the proposed development; and
- Provide baseline conditions for assessing the impact of the proposed development on flooding.

The design inflows to the system utilise a combination of flows derived from flood frequency analysis of available gauging station data in addition to locally derived sub-catchments inputs from rainfall-runoff modelling. The combined Williams River and Hunter inflows provide for the consistency with the frequency analysis of the long term gauge records at Raymond Terrace.

The downstream boundary at the Port of Newcastle utilises a dynamic tidal condition. The peak tidal elevations include provision for 50% AEP storm surge providing for a peak tidal boundary of 1.2m AHD.

Table 2-1 summarises the simulated peak flood levels at the proposed development site for a range of design event magnitudes. There is general flood water level gradient from west to east across the site, such that the peak water levels represent the maximums at the western (upstream) and eastern (downstream) site boundaries.

Table 2-1 Design Flood Levels for Proposed Development Site

Design Flood Magnitude	West Boundary of Development	East Boundary of Development
10% AEP	No major flooding	No major flooding
5% AEP	1.7m AHD	1.3m AHD
2% AEP	2.1m AHD	1.6m AHD
1% AEP	2.8m AHD	2.4m AHD
PMF	6.7m AHD	6.5m AHD

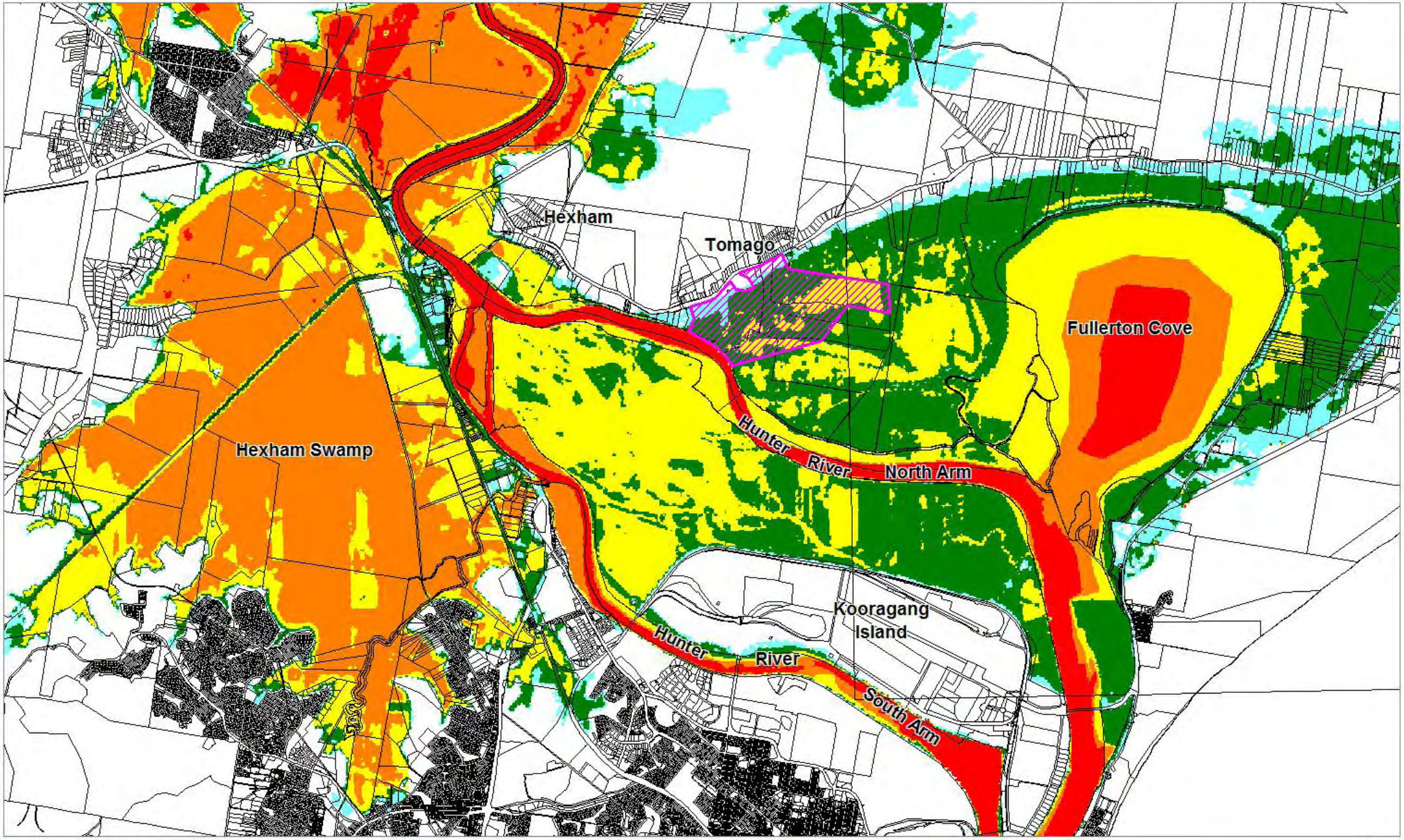
The nature of flooding across the proposed development site is similar for a range of design event magnitudes. This principally originates from floodwaters leaving the Hunter River North Arm to fill the broader floodplain area bounded by Tomago Road and Fullerton Cove. Similar inundation extents and flooding patterns are exhibited for most design magnitudes, albeit with different inundation

depths corresponding to the flood severity. No major overbank flooding through the proposed development site is simulated for events of 10% AEP and below.

The 1% AEP design flood event is typically used as the flood planning event for development control. The design flood conditions across the broader Hunter River floodplain for the 1% AEP event representing peak flood depth, peak flood velocity and peak flow-rate per unit area, or unit flow (q), are presented in Figure 2-3 to Figure 2-5. Corresponding figures showing additional detail at the proposed development site are shown in Figure 2-6 to Figure 2-8. Additional design flood mapping for the 10% AEP, 5% AEP and 2% AEP events is included in Appendix A.

Typical inundation depths across the proposed development site for the 1% AEP event are of the order of 1 – 2m. Lower depths are evident on the northern part of the site adjacent to Tomago Road along which the natural topography is significantly higher. Peak flood velocities are typically less than 0.5 m/s, but locally higher near to the Hunter River where the main overbank flows are initiated. The unit flow distribution (refer Figure 2-5) clearly shows the location of the major overflows to the left floodplain of the Hunter River North arm, particularly in the vicinity of the proposed development.

The right floodplain of the Hunter River North Arm is somewhat restricted by the elevated embankment of the rail loop associated with Kooragang Island which affords some flood protection. Accordingly, there is a general redistribution of the flow to the left floodplain including the area of the proposed development site.



LEGEND

Depth (m)

- 0.0 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Flood Depth (Existing Conditions)

Figure: **2-3**

Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

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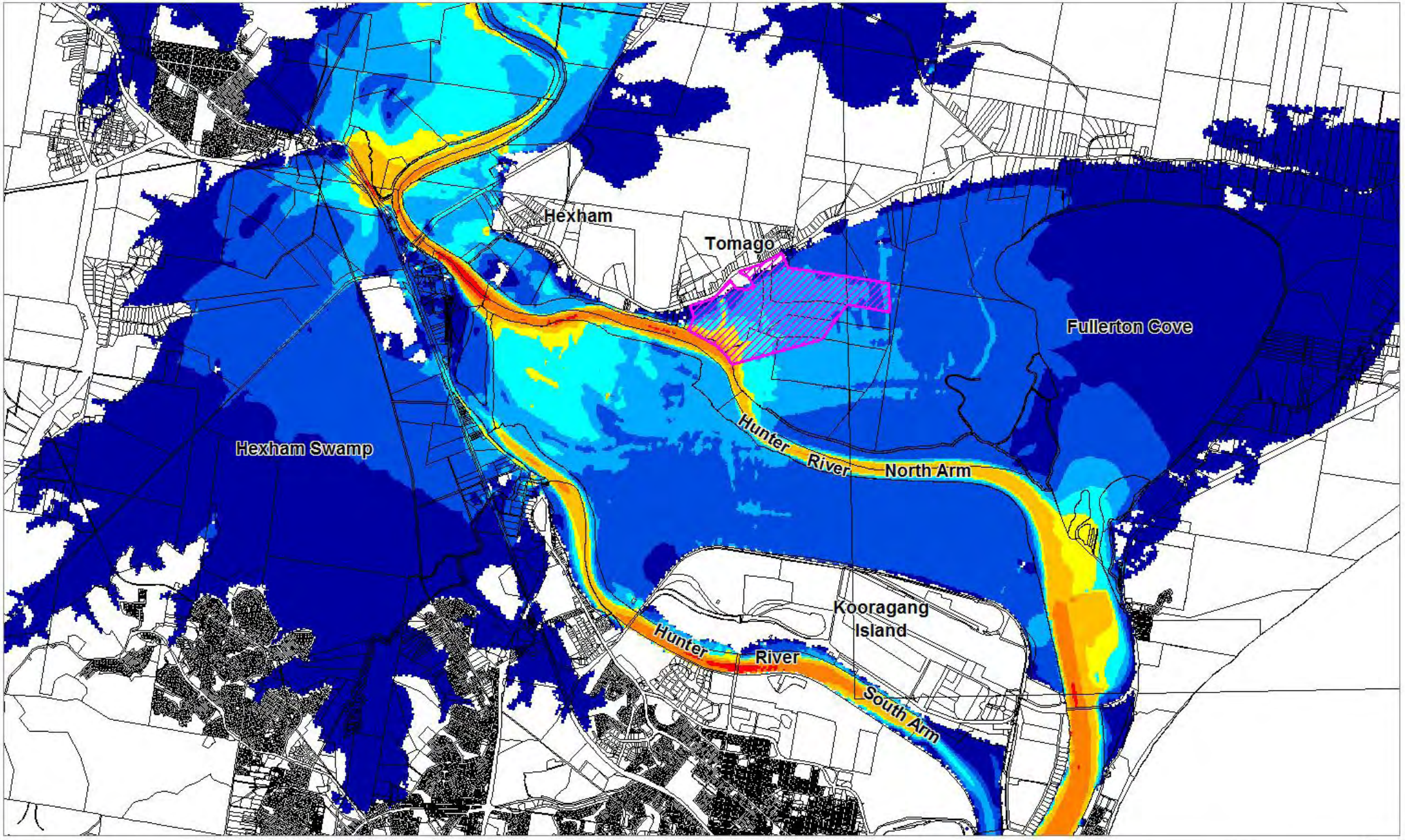


LEGEND

Velocity (m/s)

0.0 - 0.2	0.8 - 1.0
0.2 - 0.4	1.0 - 1.5
0.4 - 0.6	1.5 - 2.0
0.6 - 0.8	>2.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Flood Velocity (Existing Conditions)

Figure: 2-4

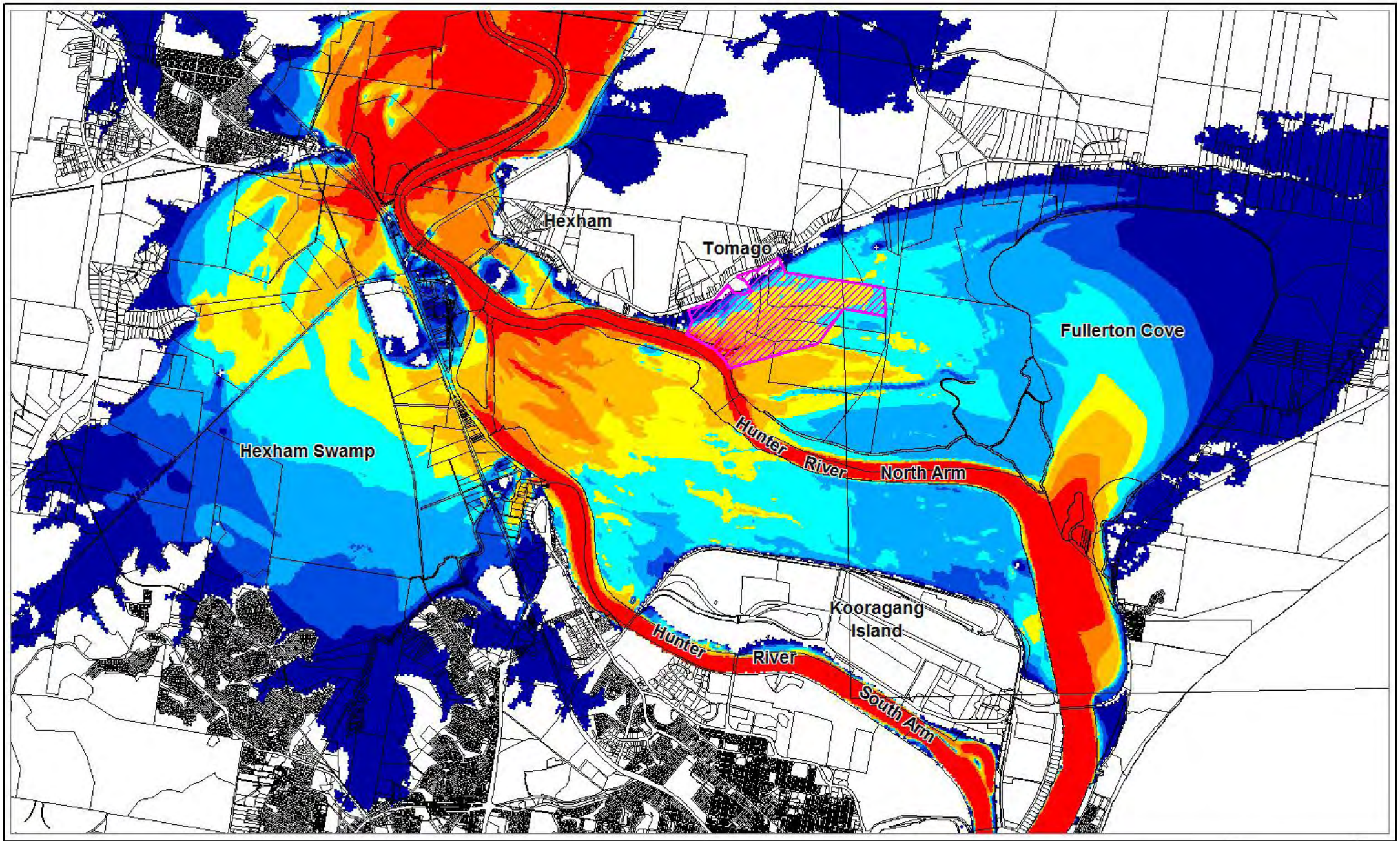
Rev: A

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Existing_1%AEP_Flood_Velocity.WOR



LEGEND

Unit Discharge (m3/s/m)

0.0 - 0.2	0.8 - 1.0
0.2 - 0.4	1.0 - 1.5
0.4 - 0.6	1.5 - 2.0
0.6 - 0.8	>2.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Unit Discharge (Existing Conditions)

Figure: 2-5

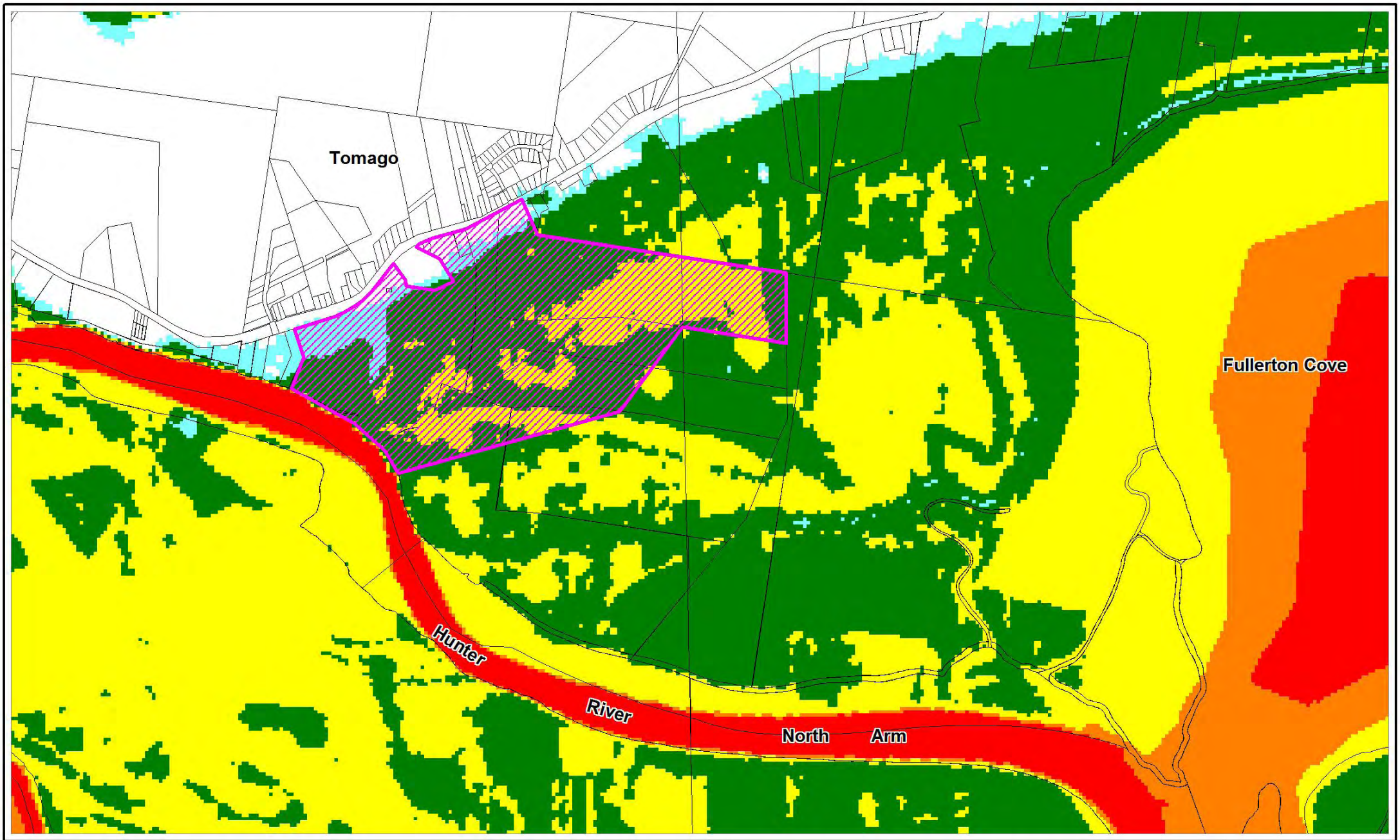
Rev: A

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Existing_1%AEP_Flood_Discharge.WOR



LEGEND

Depth (m)

- 0.0 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- >4.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Flood Depth (Existing Conditions)

Figure: **2-6**

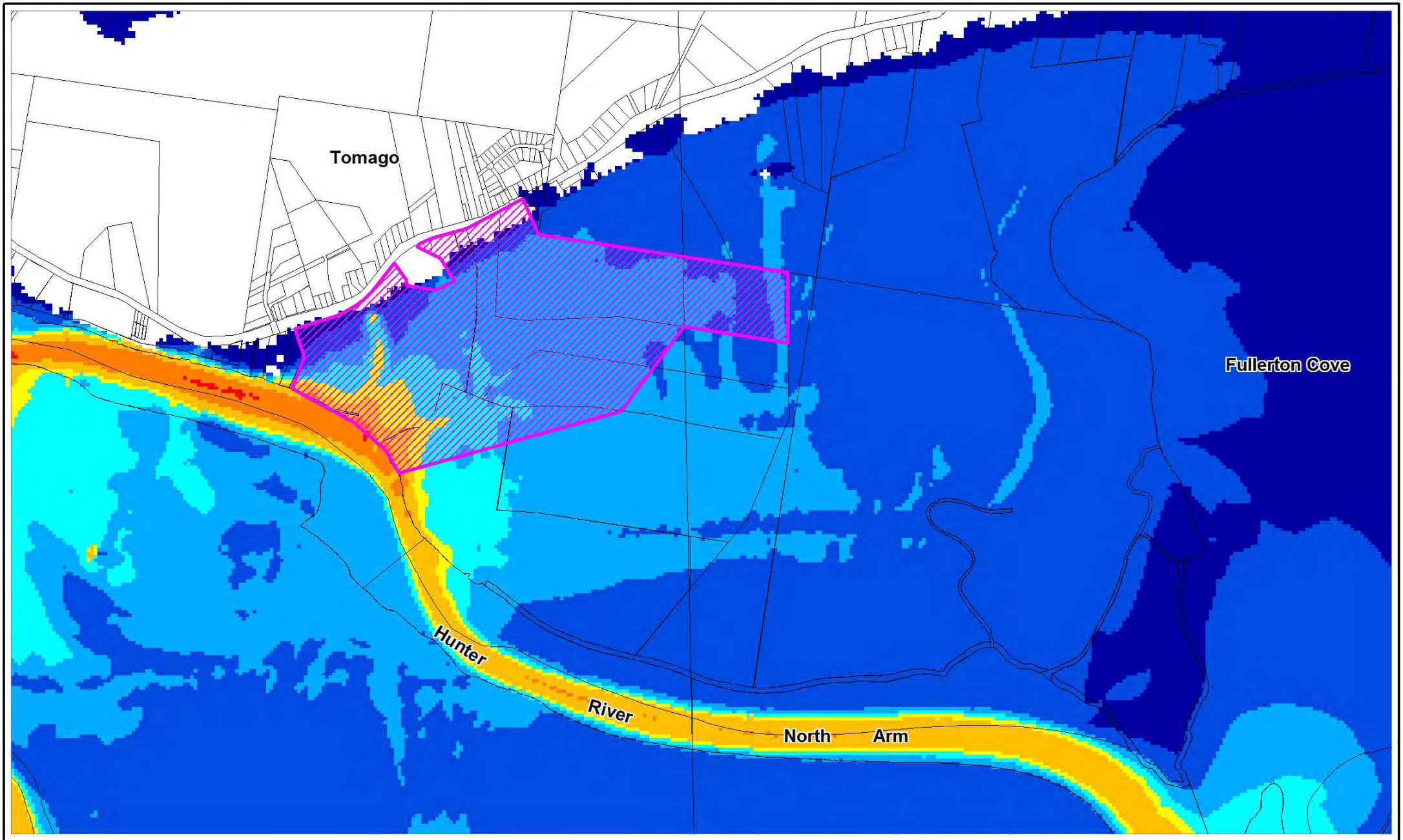
Rev: **A**

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Existing_1%AEP_Flood_Depth_detail.WOR



LEGEND

Velocity (m/s)

0.0 - 0.2	0.8 - 1.0
0.2 - 0.4	1.0 - 1.5
0.4 - 0.6	1.5 - 2.0
0.6 - 0.8	>2.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Velocity (Existing Conditions)

Figure: **2-7**

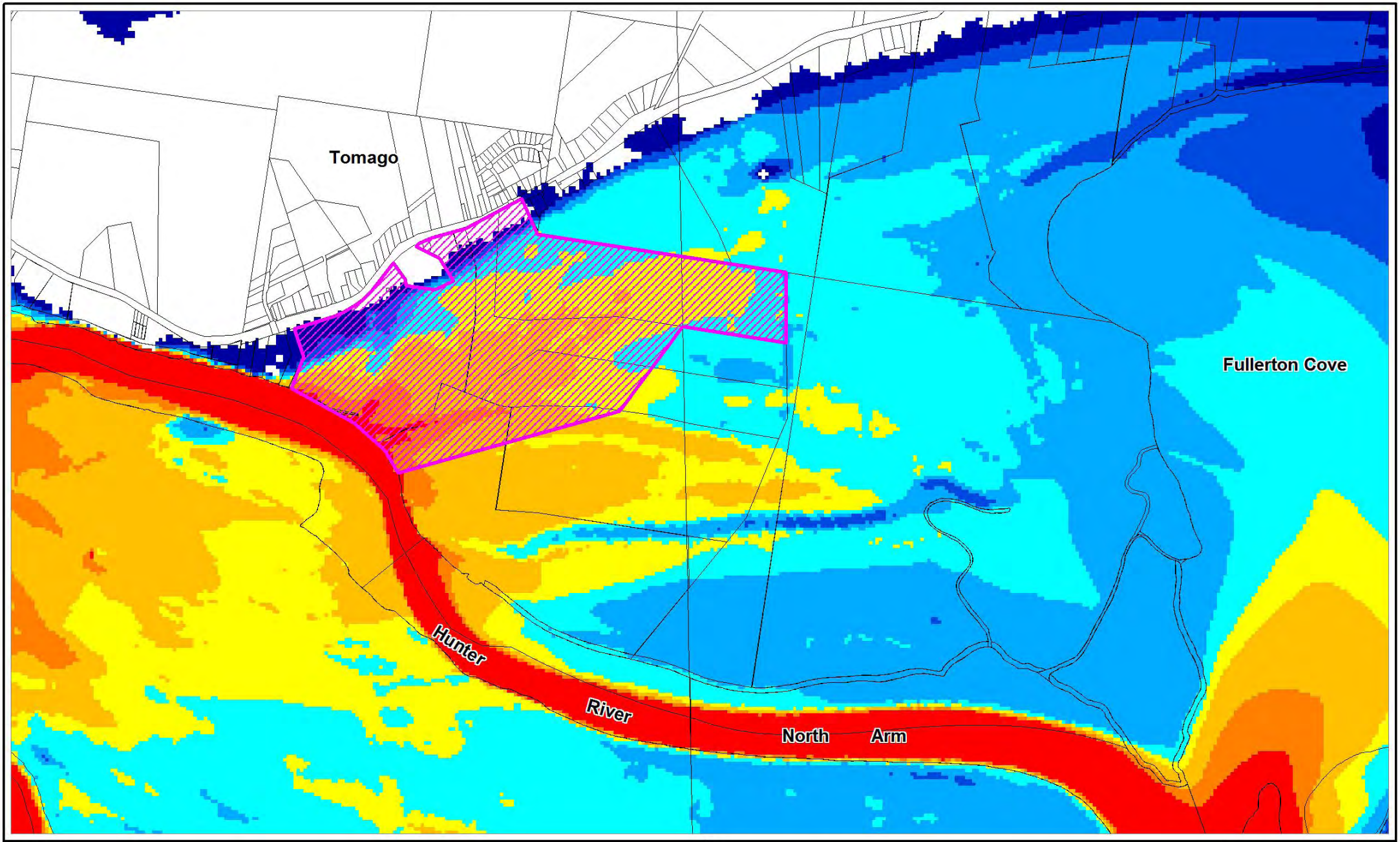
Rev: **A**

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Existing_1%AEP_Flood_Velocity_detail.WOR



LEGEND

Unit Discharge (m3/s/m)

0.0 - 0.2	0.8 - 1.0
0.2 - 0.4	1.0 - 1.5
0.4 - 0.6	1.5 - 2.0
0.6 - 0.8	>2.0

Development Lot Boundary

Title:

Northbank Enterprise Hub Flood Risk Assessment
1% AEP Peak Unit Discharge (Existing Conditions)

Figure: **2-8**

Rev: **A**

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Existing_1%AEP_Flood_Discharge.WOR

2.3 Comparison with Previous Studies

The current assessment utilises the detailed two dimensional computer model of the Lower Hunter floodplain developed by BMT WBM as part of the Williams River Flood Study (BMT WBM, 2009). This model is considered to provide the best representation of this reach of the Hunter River floodplain, incorporating recent LiDAR based topographical data.

The Lower Hunter River Flood Study (PWD, 1994) incorporated the development of a MIKE-11 1-dimensional (1D) model of the lower Hunter River from Green Rocks to Newcastle. In 2008, DHI completed the Upgrading of the Lower Hunter Flood Model at Hexham.

It is noted there is some difference in the simulated design flood levels between the current study and the results presented in DHI (2008). BMT WBM consider the results presented in the current assessment to be the best representation of design flood conditions in this reach of the River (and consistent with recent reporting for the Williams River Flood Study, Williamtown-Salt Ash Flood Study and Pacific Highway Upgrade – F3 to Heatherbrae). The reasons for the difference in results to the previous Lower Hunter Flood Study is discussed below.

The Upgrading of the Lower Hunter Flood Model at Hexham (DHI, 2008) incorporated a partial conversion of an existing one-dimensional (1D) hydraulic model to a two-dimensional (2D) representation in the Hexham / Hexham Swamp area in order to improve the description and detail of modelled flood behaviour in this area (DHI, 2008). As noted in the DoP comments, there is some discrepancy in estimated peak flood levels at the project site between the DHI (2008) report and the BMT WBM analysis.

In reviewing the DHI report and associated modelling files, the left floodplain of the North Arm of the Hunter River has been represented as significantly constricted. Beyond the Fullerton Cove ring levee, the floodplain has been assumed as being a non-convective flow area, only providing for flood storage. This representation is shown in Figure 2-9 being an extract from the previous flood study. The figure shows the simulated flow distribution between the river channel and floodplain. It is evident that the flow is constrained on the northern floodplain to a narrow width adjacent to the main channel.

Review of available topographical (recent LiDAR) and aerial photography do not provide any evidence of a major constriction in floodplain conveyance to warrant representation of the broader floodplain area as non-convective storage only. . It is noted that this portion of the floodplain was not upgraded to the 2D representation and remains as a 1D representation as per the original 1994 flood study. Accordingly, it assumed that this erroneously modelled floodplain constriction has been carried through from the original modelling.

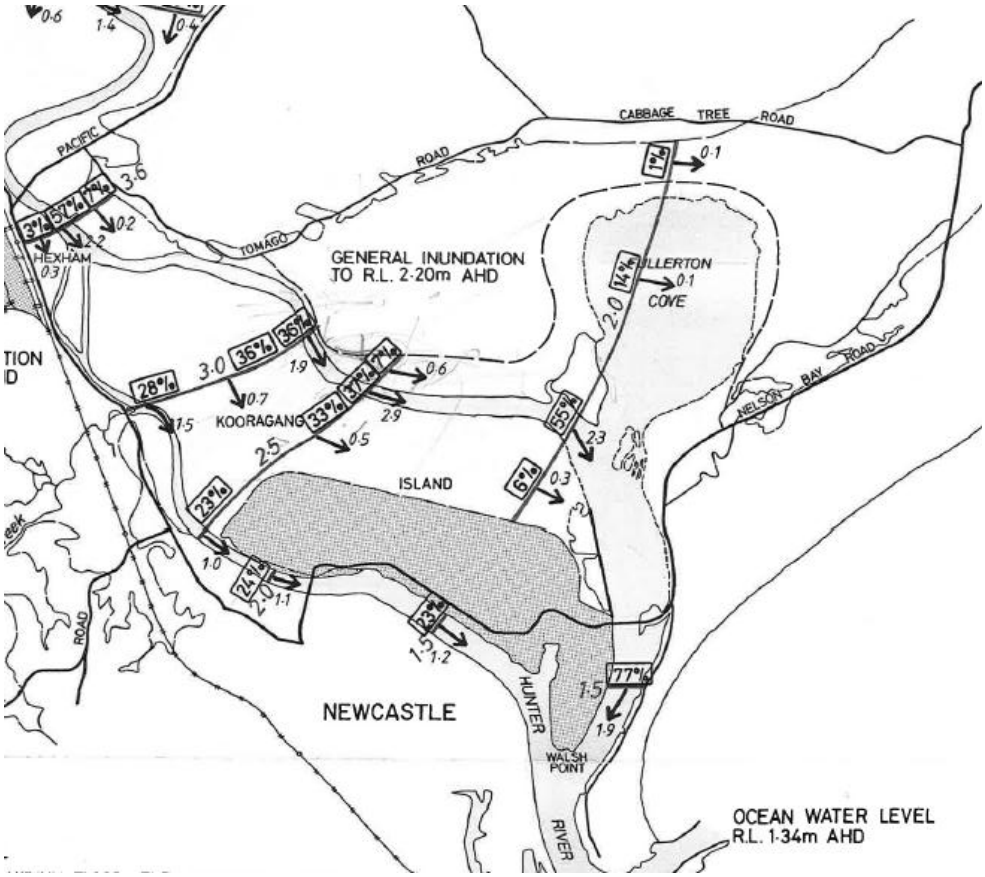


Figure 2-9 Schematic of Flow Distribution from Lower Hunter Flood Study

The modelled constriction of the floodplain results in a significant steepening of the local water level gradient, as indicated by the DHI (2008) peak water level results shown in Figure 2-10. With left floodplain of the North Arm of the Hunter restricted, the modelled flood flows are effectively "funnelled" through the main channel of the Hunter River North Arm and the floodplain area to south between Kooragang Island. The approximate location of the floodplain constriction is annotated on Figure 2-10. Given typical floodplain elevations across this transect (of the order of 0.5 to 1.0m AHD), the entire floodplain would be active at the 1% AEP flood level and be expected to convey a significant proportion flow through to Fullerton Cove.

The constriction of the northern portion of the floodplain and the impact on modelled flow distribution is further evidenced in the velocity vector plot from DHI (2008) shown in Figure 2-11. The direction of the simulated velocity vectors show flow largely being concentrated to the floodplain area between the Hunter River North Arm and Kooragang Island as a result of the flow constriction on the northern floodplain.

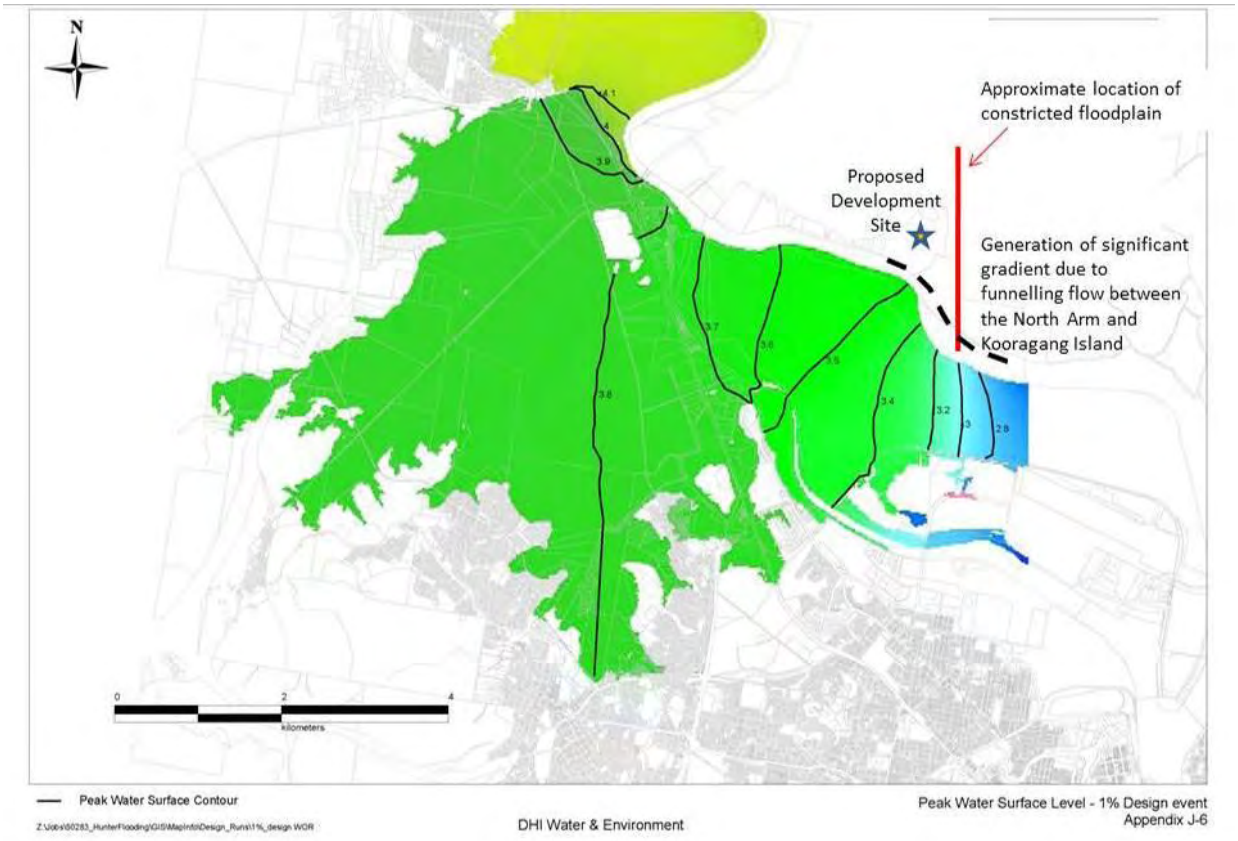


Figure 2-10 Peak 1% AEP Flood Level Contours (DHI, 2008)

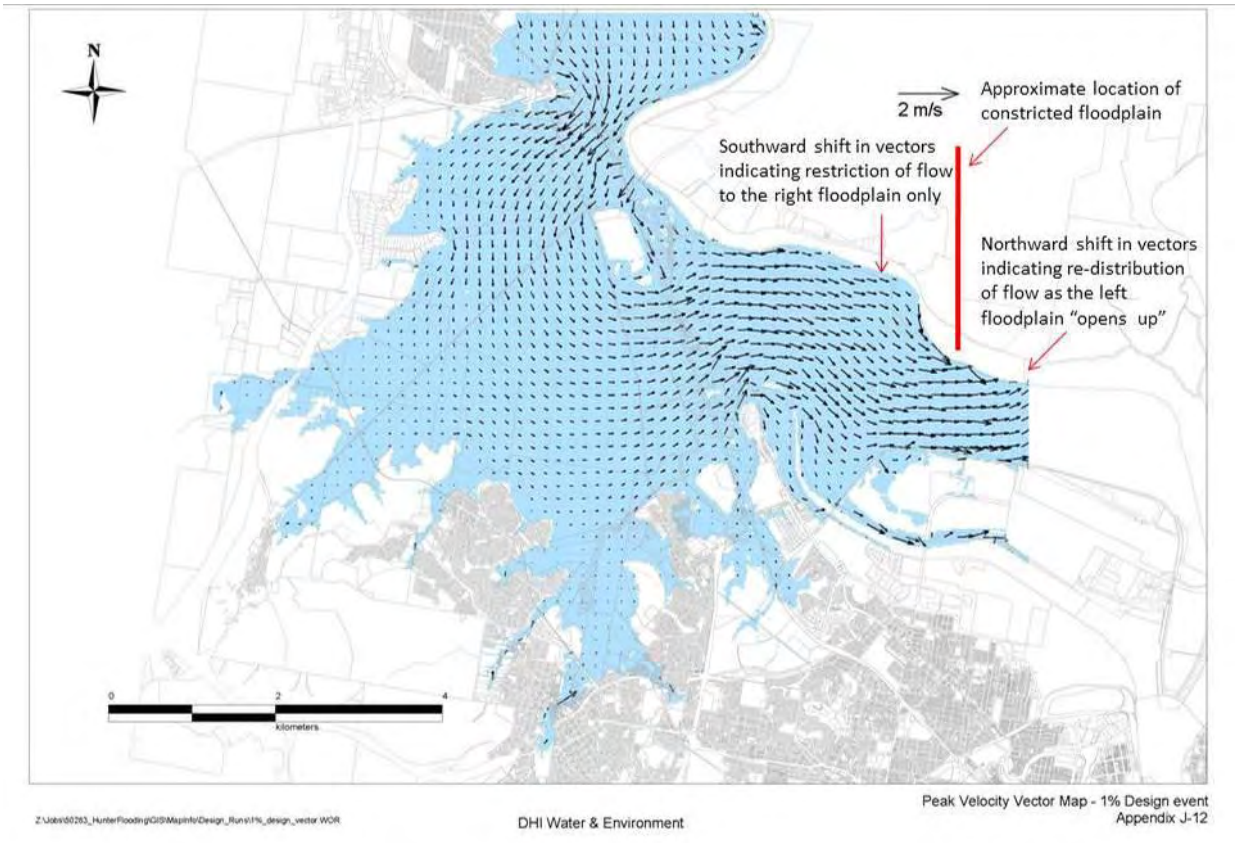


Figure 2-11 Peak 1% AEP Velocity Vectors (DHI, 2008)

Downstream of the approximate location of the modelled flow constriction, the velocity vectors turn towards the north, indicating a redistribution of flow back to the northern floodplain area flowing towards Fullerton Cove.

At simulated flood levels of the order of 3.0 – 3.5m AHD, the extensive northern floodplain area between the Hunter River North Arm and Tomago Road would be active, providing significant conveyance of floodwater to Fullerton Cove. This is illustrated in Figure 2-12 showing the simulated velocity vector distribution from the modelling undertaken for the current study. As expected under major flood event conditions, Figure 2-12 shows the activation of the major floodplain area between the Hunter River North Arm and Tomago Road and the resultant major redistribution of flow towards Fullerton Cove.

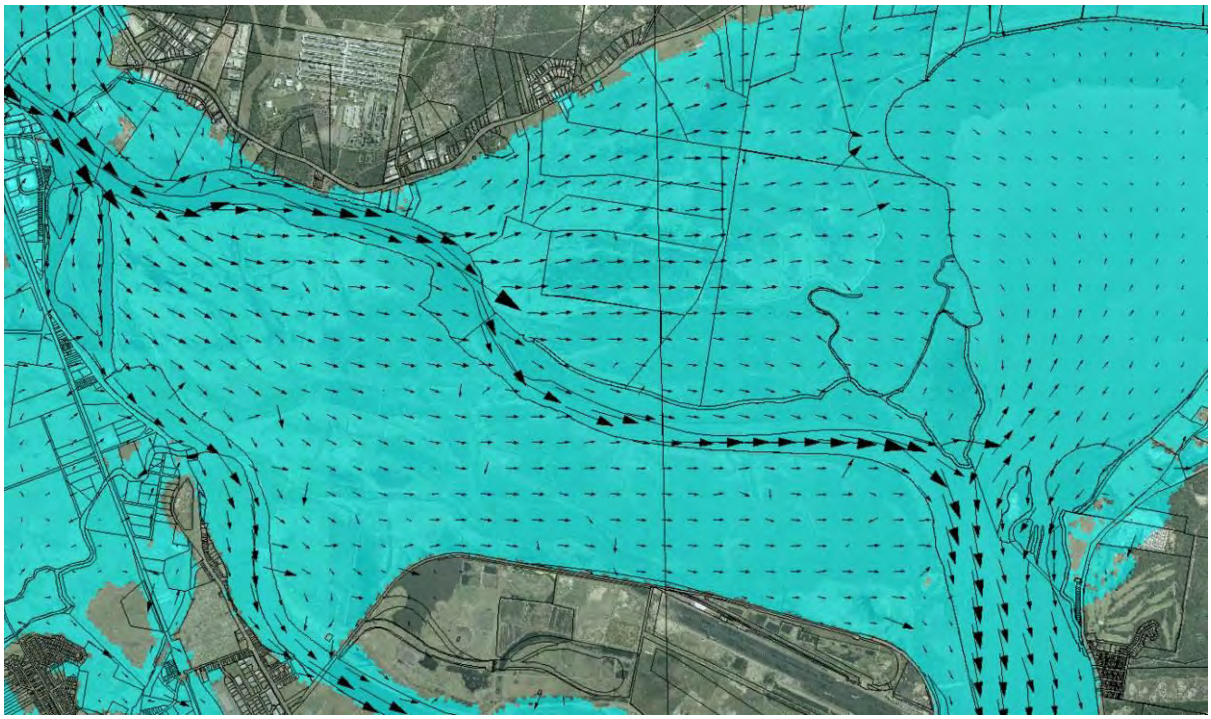


Figure 2-12 Peak 1% AEP Velocity Vectors (BMT WBM, 2011)

With the activation of this major floodplain area, generation of a significant flood water level gradient as indicated by the DHI (2008) results would not be expected. It is significant to note that both the DHI (2008) and the current study modelling provides for similar peak 1% AEP flood levels at Hexham Bridge of around 3.9m AHD. The influence of the floodplain constriction modelled by DHI does not extend as far upstream of Hexham Bridge.

Accordingly, BMT WBM consider the modelling presented in the current study to provide the most appropriate representation of flood behaviour in this reach of the Hunter River floodplain, and a suitable base case for assessment of the potential flood impact of the proposed Northbank Enterprise Hub development.

3 PROPOSED DEVELOPMENT

3.1 Description

Typical development control policies for this nature of development would require as a minimum for all building floor levels to be constructed to a minimum level of the 1% AEP flood level plus 0.5m freeboard. As existing ground levels in some sections of the development area are in the order of RL 0.5m AHD, extensive fill is required on site to provide flood immunity to above the 1% AEP flood level (minimum 2.5m AHD).

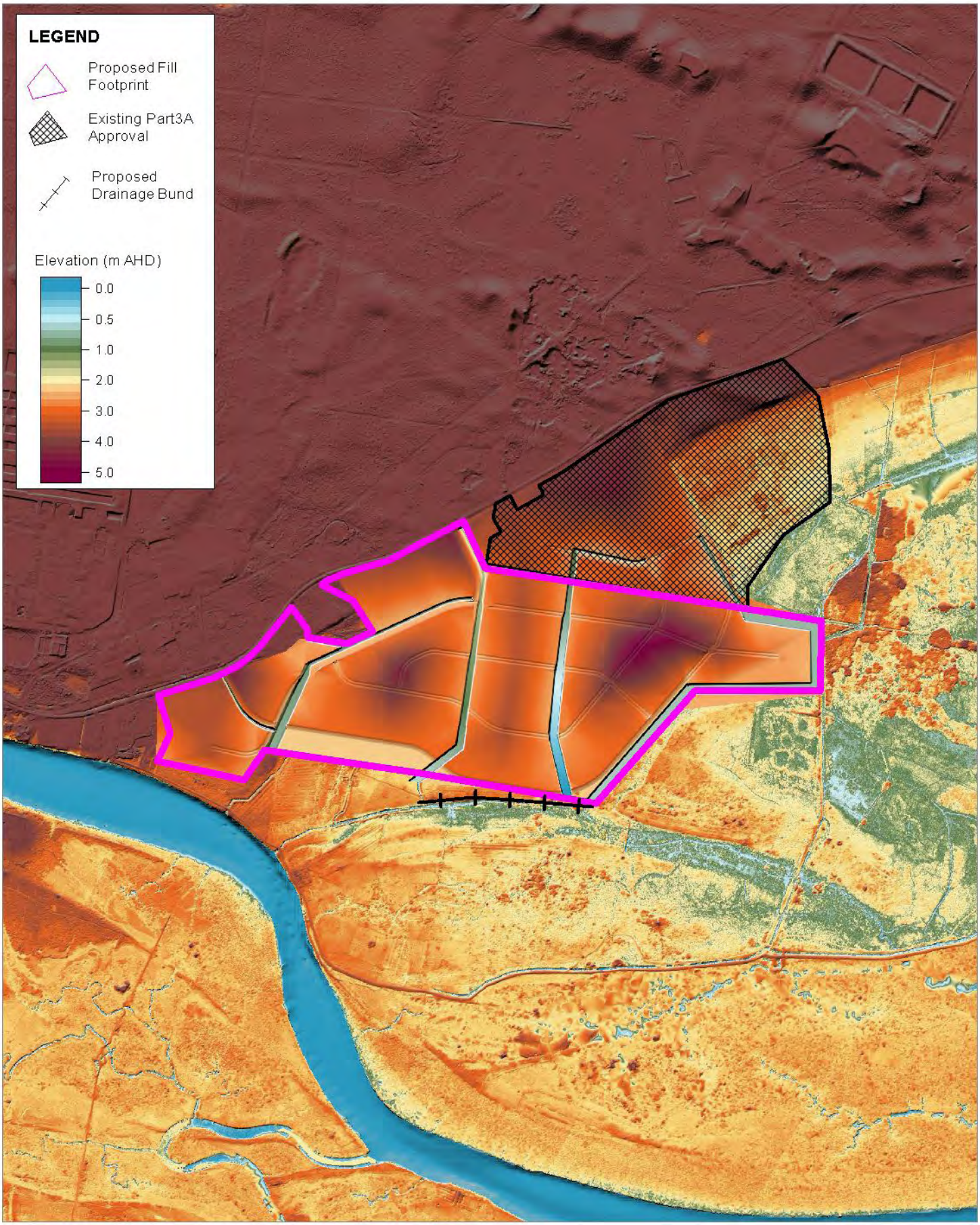
The proposed development footprint is shown in Figure 3-2. For the flood assessment, it has been assumed that the whole development land has an elevation in excess of the 1% AEP flood level (ie the whole development area has been excluded from interacting with the floodplain for storage and flow conveyance). This is a conservative assumption, as there may be some scope for having lower levels on individual land parcels (eg external hardstand areas, landscaping areas, etc). However, final details of the internal layout of the development would be determined at detailed design and at this stage of the flood impact assessment has not been considered further.

The proposed finished level of the development generally rises from approximately 3m AHD at the perimeter to approximately 4.5m at the high point to provide for suitable internal site drainage. The minimum fill level of 3m AHD of the developed site is above the existing peak 1% AEP flood level as described in Table 2-1.

A drainage bund has also been proposed in the stormwater drainage strategy (BMT WBM, 2012b) which is located on the eastern perimeter of the south eastern lot boundary. The bund height is approximately 1.2m AHD, of similar height to the Fullerton Cove levee that exists downstream.

The proposed development footprint has given consideration to the hydraulic categories across the site for the 1% AEP event. There are no prescriptive methods for determining what parts of the floodplain constitute floodways, flood storages and flood fringes. Descriptions of these terms within the Floodplain Development Manual (NSW Government, 2005) are essentially qualitative in nature. The hydraulic categories as defined in the Floodplain Development Manual are:

- **Floodway -** Areas that convey a significant portion of the flow. These are areas that, even if partially blocked, would cause a significant increase in flood levels or a significant redistribution of flood flows, which may adversely affect other areas.
- **Flood Storage -** Areas that are important in the temporary storage of the floodwater during the passage of the flood. If the area is substantially removed by levees or fill it will result in elevated water levels and/or elevated discharges. Flood Storage areas, if completely blocked would cause peak flood levels to increase by 0.1m and/or would cause the peak discharge to increase by more than 10%.
- **Flood Fringe -** Remaining area of flood prone land, after Floodway and Flood Storage areas have been defined. Blockage or filling of this area will not have any significant affect on the flood pattern or flood levels.



Title:

Proposed Development Footprint and Fill Level

Figure: 3-1

Rev: A

N

0 0.5 1km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath :K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Development_DEM.WOR

Preliminary hydraulic categories shown in Figure 3-2 have been defined utilising combinations of flood depth, velocity and velocity * depth product (sometimes referred to as unit discharge). Two categorisations have been shown based on the criteria summarised in Table 3-1.

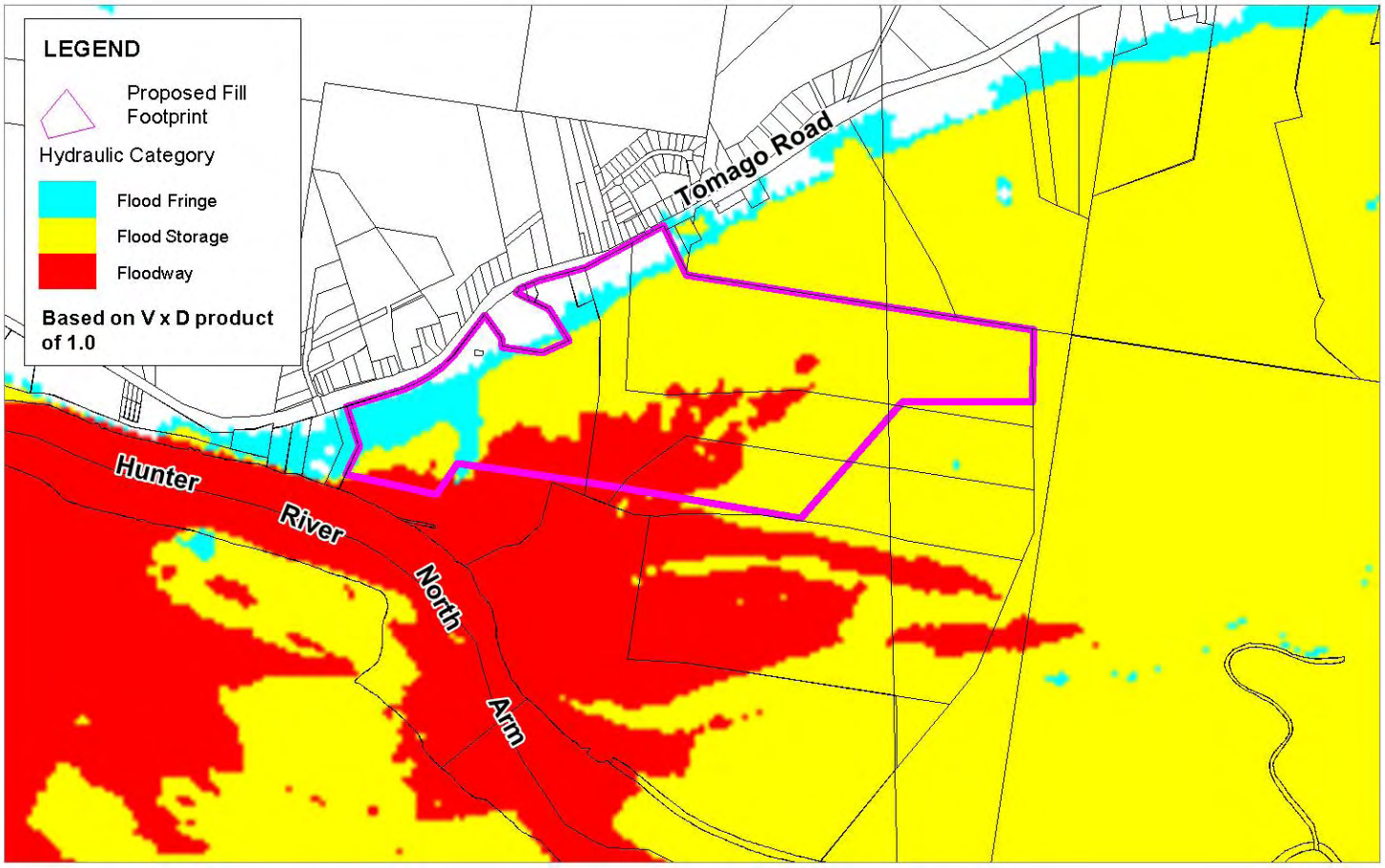
	Classification 1	Classification 2
Floodway Areas and flowpaths where a significant proportion of floodwaters are conveyed (including all bank-to-bank creek sections).	Velocity * Depth > 0.5 at the 1% AEP event	Velocity * Depth > 1.0 at the 1% AEP event
Flood Storage Areas where floodwaters accumulate before being conveyed downstream. These areas are important for detention and attenuation of flood peaks.	Velocity * Depth < 0.5 and Depth > 0.5 metres at the 1% AEP event	Velocity * Depth < 1.0 and Depth > 1.0 metres at the 1% AEP event
Flood Fringe Areas that are low-velocity backwaters within the floodplain. Filling of these areas generally has little consequence to overall flood behaviour.	All other area to flood extent of the PMF event	All other area to flood extent of the PMF event

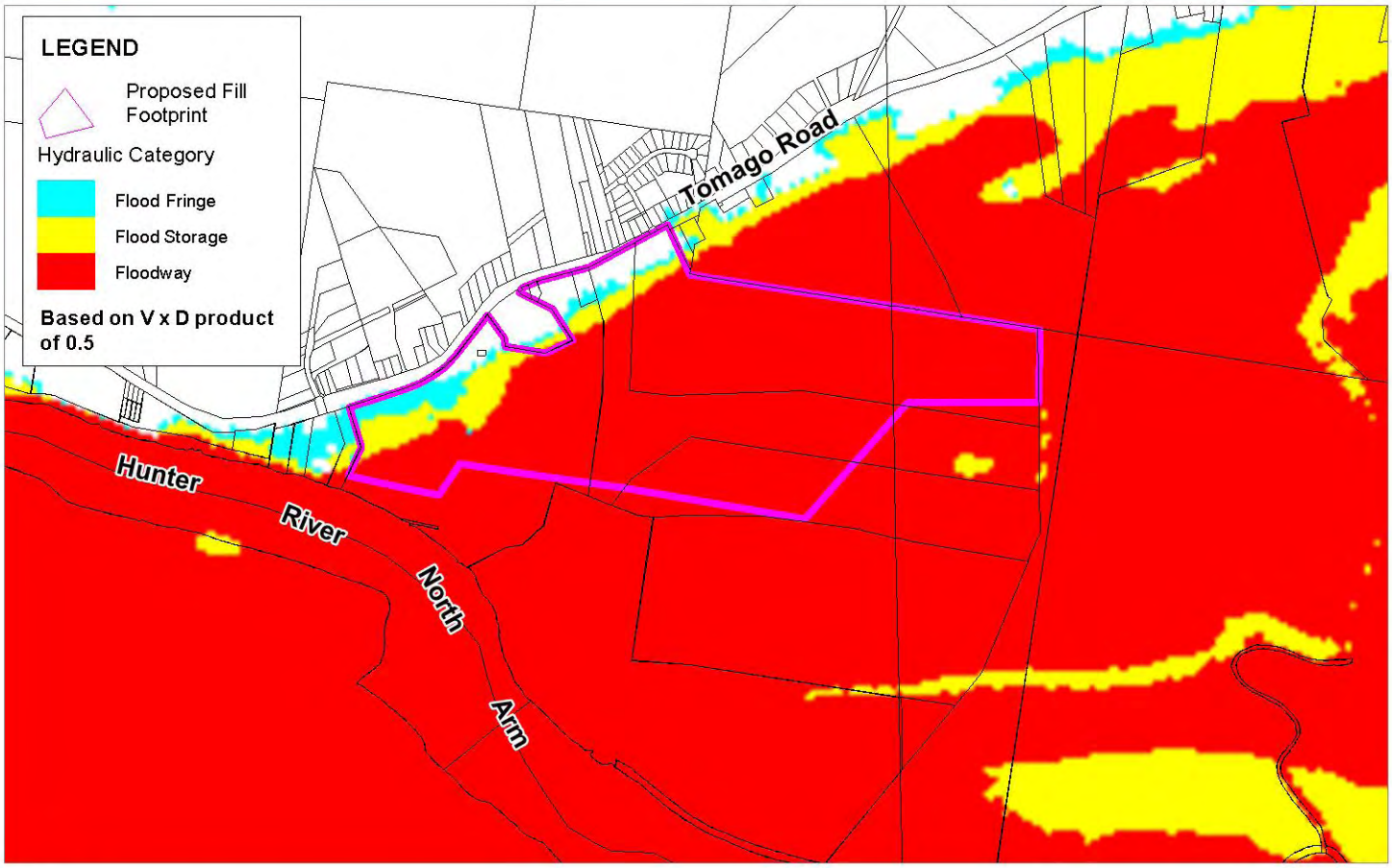
Refer to separate images for classification 1 and 2 within Figure 3.2

Table 3-1 Hydraulic Categories

Clearly the adoption of lower velocity-depth thresholds for floodway classification results in significantly greater proportion of the floodplain to be defined as floodway.

These floodway areas in the vicinity of the proposed development largely represent the major overbank flooding flow paths as flow spills from the river and re-distributes to the left floodplain. The adopted development footprint aims to minimise the encroachment on the defined floodway area. A number of iterations of the proposed development footprint were undertaken in order to broadly identify a footprint that enabled developable area to be maximised whilst enabling flood impacts to be managed.





Title:

Provisional 1% AEP Hydraulic Categories

Figure: 3-2

Rev: A

N

0 0.75 1.5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\Hydraulic Categories.WOR

3.2 Impacts

The existing hydraulic model has been modified accordingly to represent the proposed development and assess the potential flood impacts. The modelled ground levels within the development footprint (shown in Figure 3-2) have been elevated to remove this area from the active floodplain completely for events up to 1% AEP event, providing no temporary flood storage or conveyance. In addition, the land incorporated in the existing PART 3A Approval 07-0086 & EPBC Approval 2007/3345 has been removed from the active floodplain area. Accordingly, the results show the cumulative impact.

The relative impact of the proposed development footprint in terms of changes in peak flood water level and peak flood velocity for the range of design events considered is shown in Figure 3-3 to Figure 3-8. The greatest changes in peak flood water level and velocity are for the 1% AEP event. Increases in peak water level of up to 0.18m are simulated immediately adjacent to the development footprint. The region of highest afflux is generally contained within the development lot boundary. However, immediately west of the proposed development, there is some existing property where changes in peak flood level for the 1% AEP are approximately 0.1 – 0.18m. For lower order events (i.e. 2% AEP event and below) the majority of this development is unaffected. Given the limited extent and magnitude (<0.18m) of the simulated afflux at these properties, it is anticipated that local works (minor bunding or filling) could provide appropriate mitigation if required.

Peak flood level increases of the order of 0.05 – 0.1m for the 1% AEP are simulated for approximately 3km upstream of the proposed development site. This area is largely occupied by the Kooragang Wetlands in which the 1% AEP flood depths through this region are of the order 2 – 3m. The extent of the impacts on peak flood levels extends as far as Hexham Swamp, although changes in water level are small (<0.04m). These minor changes in flood level are not expected to have any significant impact on existing development fringing the Swamp. Typically the topography rises relatively steeply from the extremities of the Swamp, such that additional floodplain inundation is negligible for such small increases in peak flood water level.

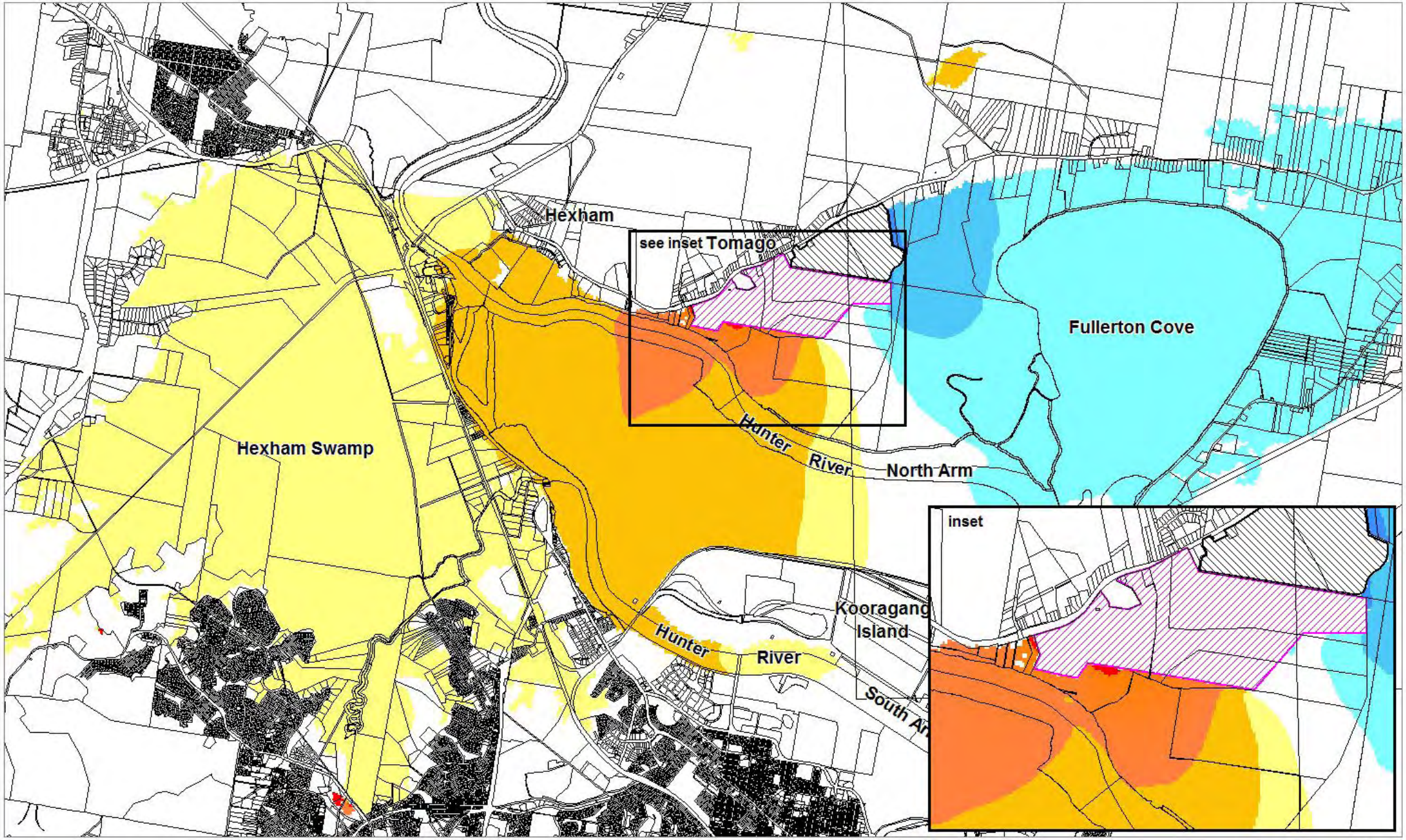
The broad extent of the increase in peak flood levels including into Hexham Swamp arises from the reduction in floodplain conveyance at the proposed development site, resulting in redistribution of floodplain flows. Flows are increased slightly in the Hunter River South Arm (as shown by increased water levels and velocities) is addition to greater flood volume within the Hexham Swamp storage area.

The changes in peak velocities for the 1% AEP event as a result of the proposed development are typically less than 0.1m/s with some local increases up to 0.2 – 0.3 m/s. In general these peak velocity increases are located adjacent to the proposed fill platform. With typical velocities still less than 1m/s, the minor changes in peak velocity are not expected to provide any significant scour risk or damage to existing vegetation.

The impact on peak water level and peak velocity for the 2% AEP and 5% AEP events generally show a similar pattern to the 1% AEP event, albeit at reduced magnitudes and extents. Typical peak flood level increases for the 2% AEP event are less than 0.05m with negligible impact shown outside the proposed development lot boundary for the 5% AEP event.

For the PMF event, the pattern of the impacts are similar compared to the 1% AEP event, however, the magnitude of impact is increased. With peak flood levels of the order of 6.6m AHD under PMF

conditions, the entire development site is inundated with flood depth in excess of 3m. Under existing conditions, there is a considerable flow through the development area such that the proposed development fill provides for a substantial obstruction to flow at the PMF level. The impact on peak flood level local to the site for the PMF is of the order of 0.15m, similar to the 1% AEP impact. The broader region of impact across Hexham Swamp shows increases in peak flood level of the order of 0.07m. Typical flood depths at the PMF level are of the order of 7-8m, such that in relative terms the impact represents a marginal increase in peak flood level for the simulated flood condition.



LEGEND

Afflux (m)

-0.20 - -0.50	0.02 - 0.05
-0.10 - -0.20	0.05 - 0.10
-0.05 - -0.10	0.10 - 0.20
-0.02 - -0.05	0.20 - 0.50
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086 & EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Peak Water Level Afflux (Proposed - Existing) 1% AEP Event

Figure: **3-3**

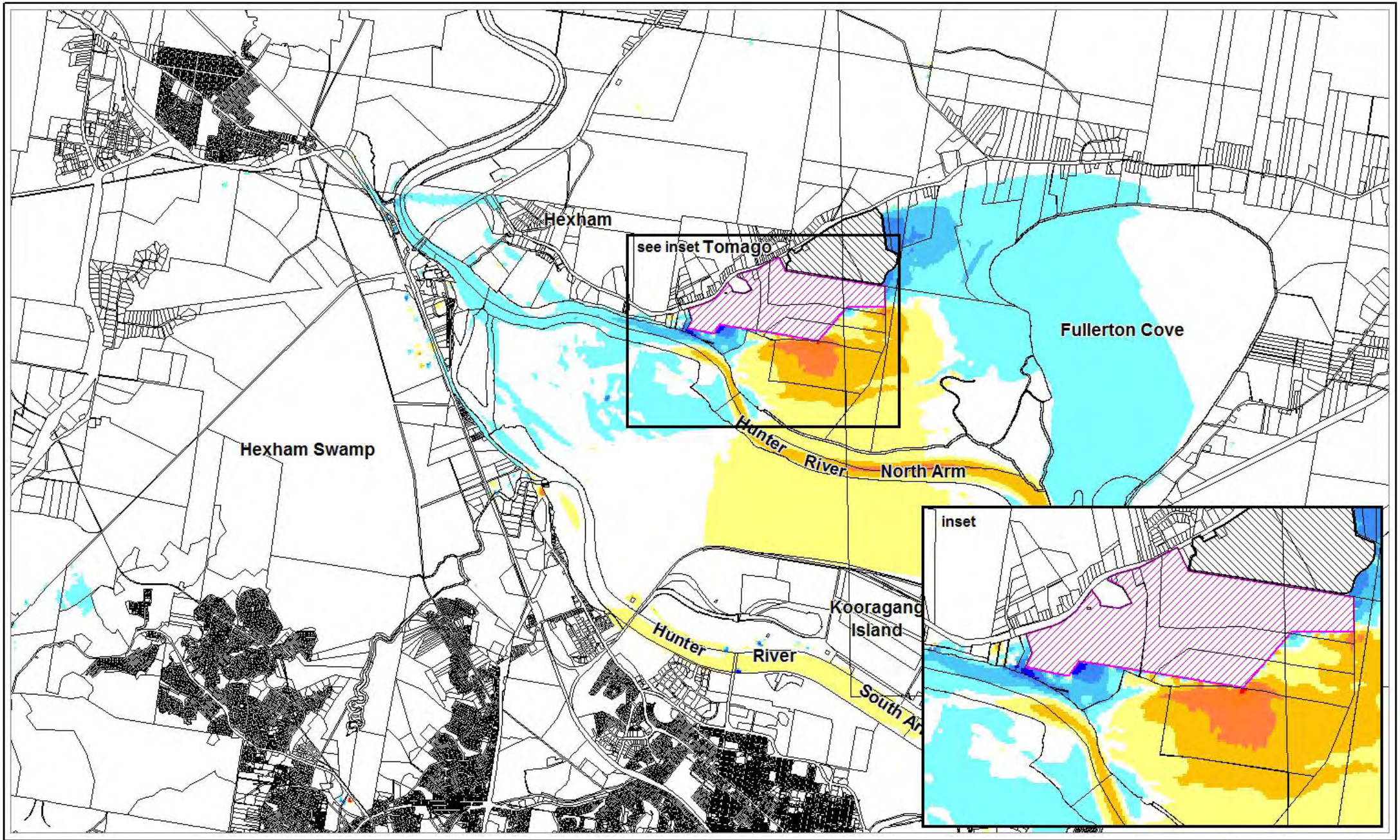
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\HAfflux_1%AEP_Final.WOR



LEGEND

Change in Peak Velocity (m/s)

< -0.50	0.02 - 0.10
-0.20 - -0.50	0.10 - 0.20
-0.10 - -0.20	0.20 - 0.50
-0.02 - -0.10	>0.5
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Change in Peak Velocity (Proposed - Existing) 1% AEP Event

Figure: **3-4**

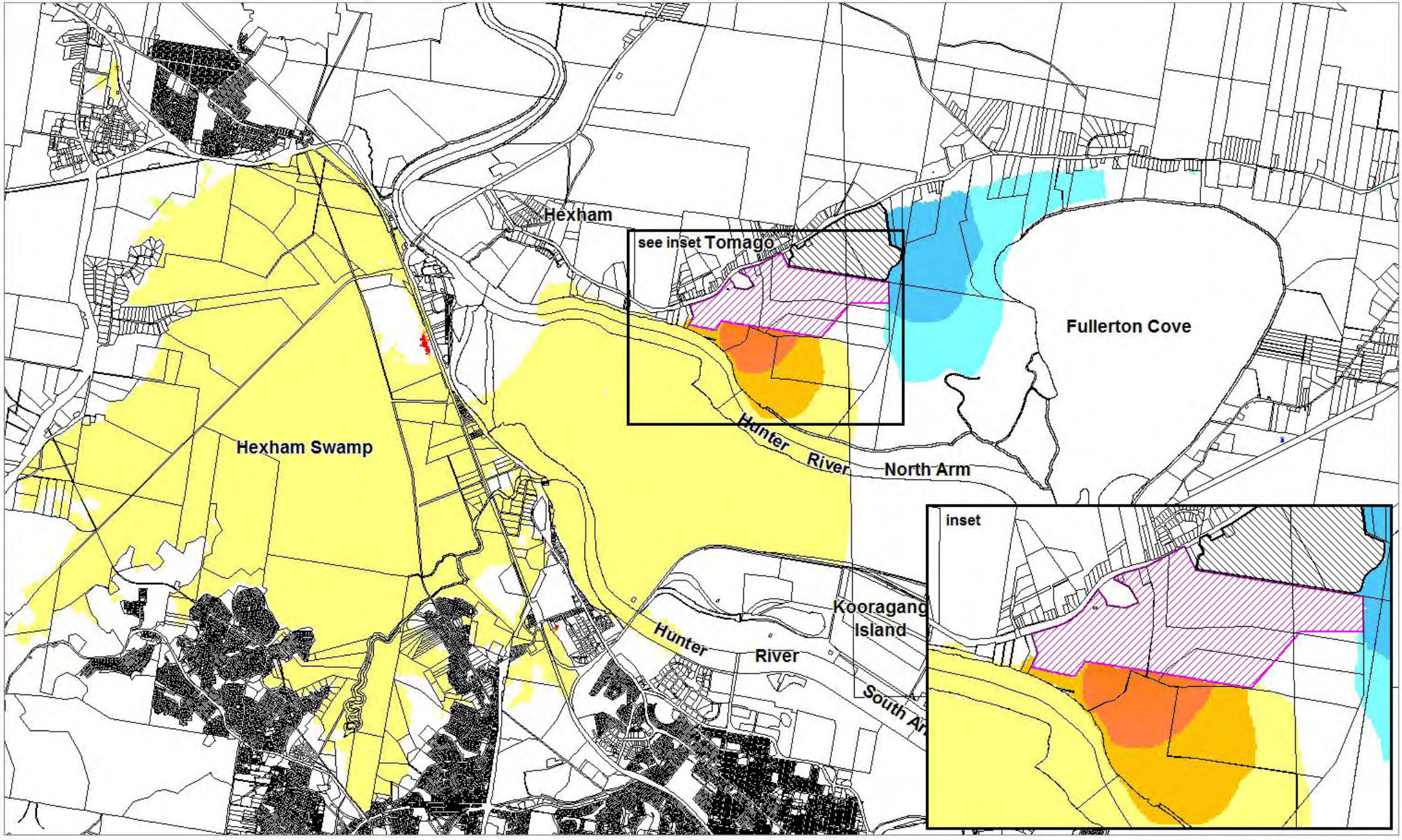
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\VAfflux_1%AEP_Final.WOR



LEGEND

Afflux (m)

-0.20 - -0.50	0.02 - 0.05
-0.10 - -0.20	0.05 - 0.10
-0.05 - -0.10	0.10 - 0.20
-0.02 - -0.05	0.20 - 0.50
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Peak Water Level Afflux (Proposed - Existing) 2% AEP Event

Figure: **3-5**

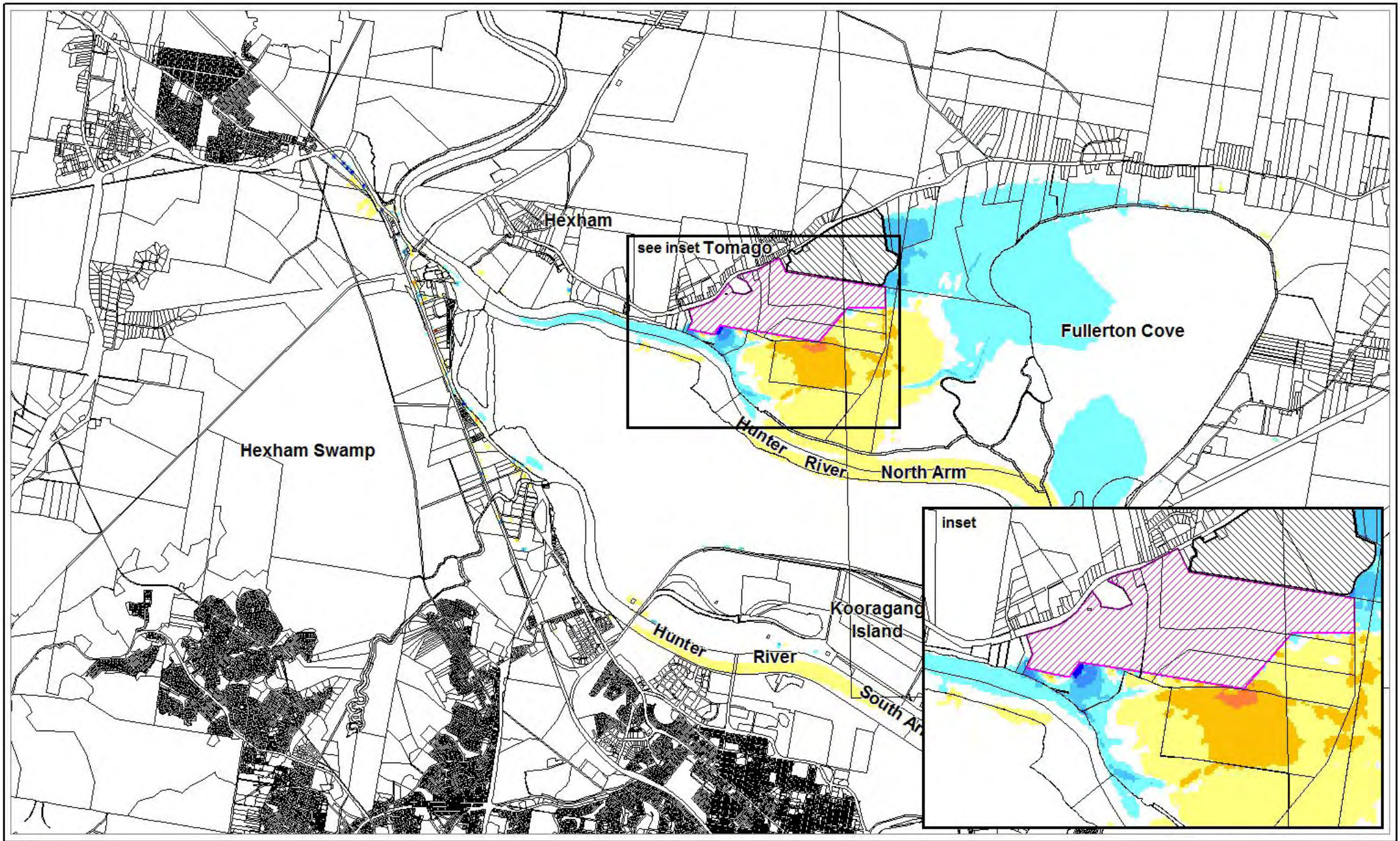
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\HAfflux_2%AEP_Final.WOR



LEGEND

Change in Peak Velocity (m/s)

< -0.50	0.02 - 0.10
-0.20 - -0.50	0.10 - 0.20
-0.10 - -0.20	0.20 - 0.50
-0.02 - -0.10	>0.5
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Change in Peak Velocity (Proposed - Existing) 2% AEP Event

Figure: **3-6**

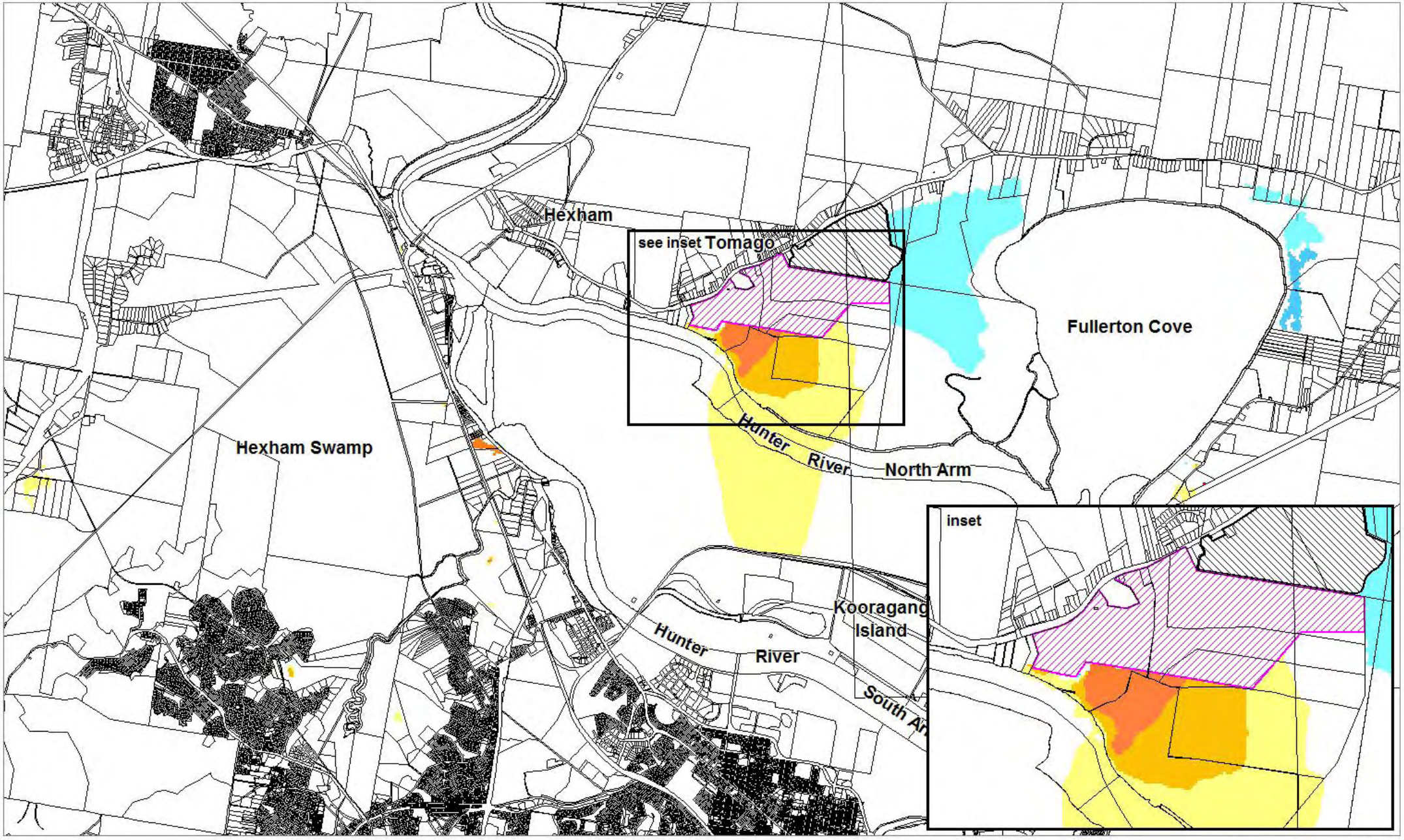
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\VAfflux_2%AEP_Final.WOR



LEGEND

Afflux (m)

-0.20 - -0.50	0.02 - 0.05
-0.10 - -0.20	0.05 - 0.10
-0.05 - -0.10	0.10 - 0.20
-0.02 - -0.05	0.20 - 0.50
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086 & EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Peak Water Level Afflux (Proposed - Existing) 5% AEP Event

Figure: **3-7**

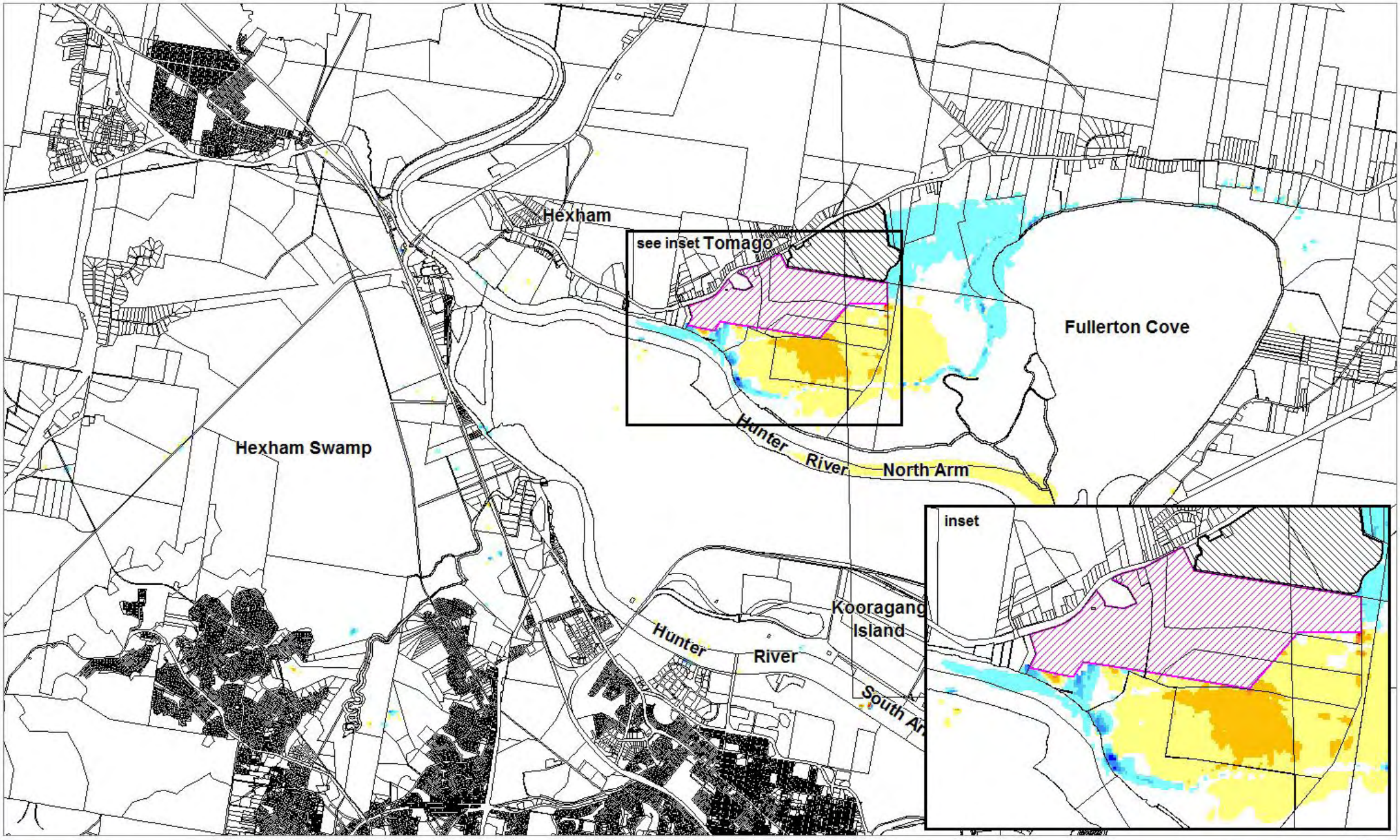
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\HAfflux_5%AEP_Final.WOR



LEGEND

Change in Peak Velocity (m/s)

< -0.50	0.02 - 0.10
-0.20 - -0.50	0.10 - 0.20
-0.10 - -0.20	0.20 - 0.50
-0.02 - -0.10	>0.5
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Change in Peak Velocity (Proposed - Existing) 5% AEP Event

Figure: **3-8**

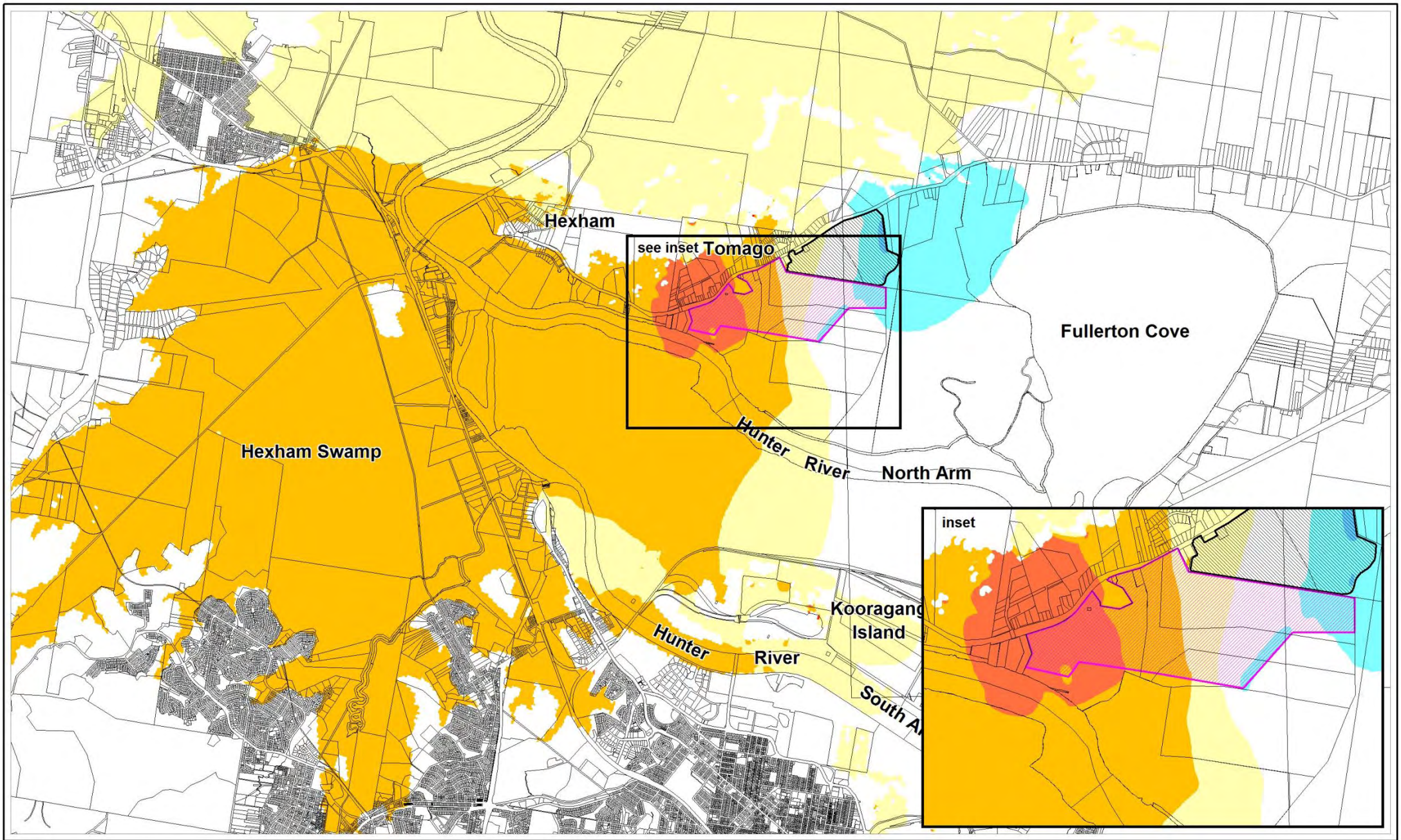
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\VAfflux_5%AEP_Final.WOR



LEGEND

Afflux (m)

-0.20 - -0.50	0.02 - 0.05
-0.10 - -0.20	0.05 - 0.10
-0.05 - -0.10	0.10 - 0.20
-0.02 - -0.05	0.20 - 0.50
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Peak Water Level Afflux (Proposed - Existing) PMF Event

Figure: **3-9**

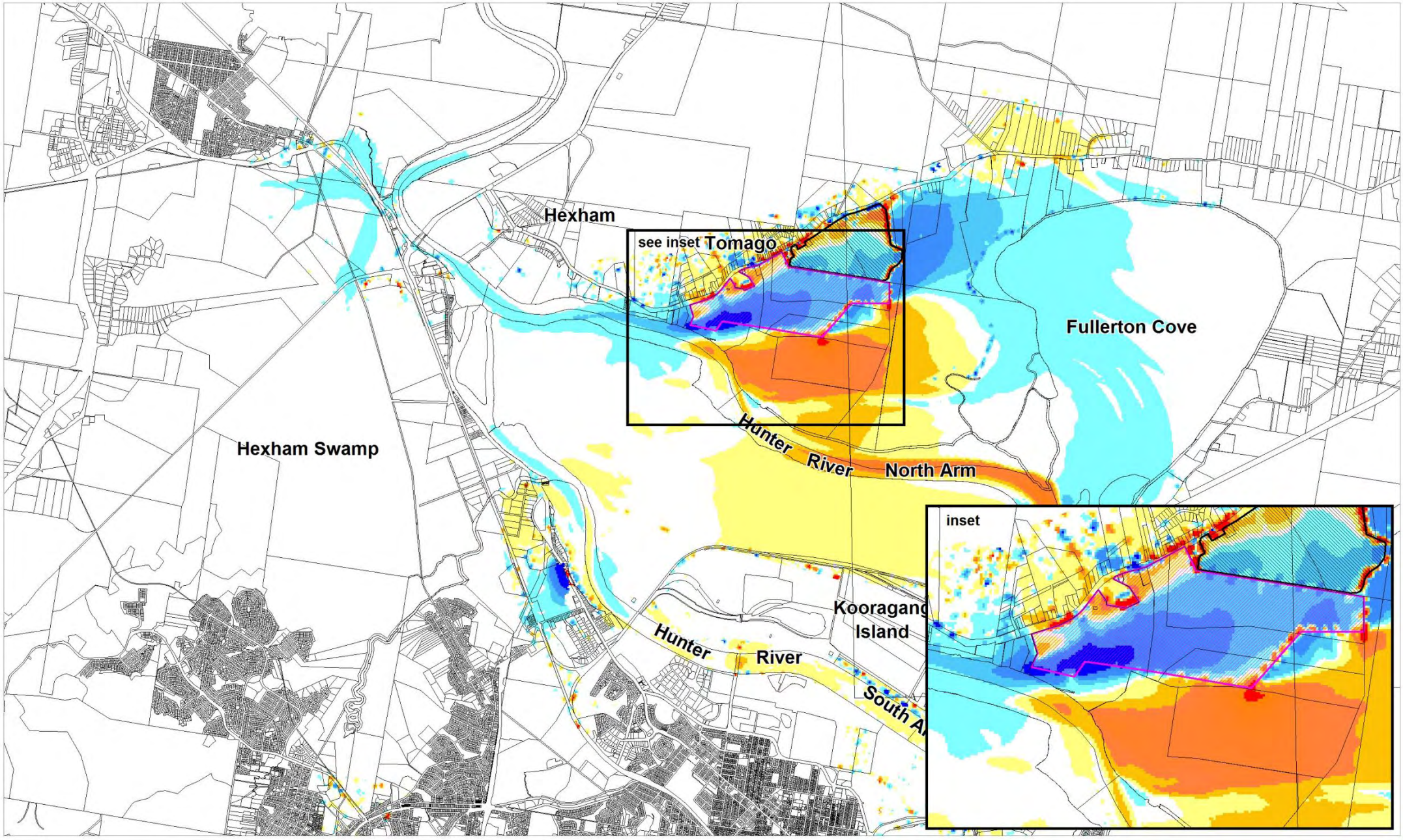
Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\HAfflux_PMF_Final.WOR



LEGEND

Change in Peak Velocity (m/s)

<-0.50	0.02 - 0.10
-0.20 - -0.50	0.10 - 0.20
-0.10 - -0.20	0.20 - 0.50
-0.02 - -0.10	>0.50
-0.02 - 0.02	

Adopted Fill Footprint

EXISTING PART 3A APPROVAL 07-0086
& EPBC APPROVAL 2007/3345

Title:

Northbank Enterprise Hub Flood Risk Assessment
Change in Peak Velocity (Proposed - Existing) PMF Event

Figure: **3-10**

Rev: **A**

0 1.25 2.5km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\VAfflux_PMF_Final.WOR