Moore Point Precinct Planning Proposal, Liverpool

Flood Emergency Response Plan

Leamac Property Group & Coronation Property Co. Pty Ltd

May 2024

rp311015-00172rg_crt240517-Moore Point Precinct FER Plan

*The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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Project: Moore Point Precinct, Liverpool
Flood Emergency Response Plan

Rev	Description	Author	Review	Approval	Date
A	**Draft Flood – Issue for Review**	**RG** R Golaszewski	**CT** C Thomas		09-02-2024
B	**Final Draft Report – Amended to address review comments-**	**RG / CRT** R Golaszewski / C Thomas			19-02-2024
C	**Final Report**	**RG** R Golaszewski	**CT** C Thomas	 C Thomas	21-02-2024
D	**Updated FERP**	**RG** R Golaszewski	**CT** C Thomas	 C Thomas	20-05-2024

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Appendices

Executive Summary

Overview of Planning Proposal

Coronation Property and Leamac Property Group, working together as the Moore Point Joint Landowners Group (**JLG**), have submitted a Planning Proposal for the redevelopment of the Moore Point Precinct at Liverpool. The Precinct covers an area of 31.4 hectares and is located on the eastern side of the Georges River opposite the Liverpool central business district (CBD).

The site that is proposed for redevelopment is situated within the Georges River North Precinct of the Liverpool Collaboration Area and is subject to the priorities and actions of the Liverpool Place Strategy (the Strategy), which was released by the Greater Sydney Commission (GSC) in December 2018. Due to its proximity to the river, there is potential for some areas of the site to be flooded, although history would suggest that this will only occur in rare events.

The Planning Proposal involves cut and fill earthworks across the site including excavation along the eastern foreshore of the Georges River downstream of Liverpool Weir. These works are designed to raise low lying areas of the site to above the flood planning level and thereby meet the requirements of current planning controls. As a result, the works have the potential to cause localised changes to flood characteristics along the section of the Georges River extending from the M5 crossing to Lake Moore.

Flood affectation at the site and across adjoining areas is documented in the *Georges River Flood Study* (the Flood Study) which was published by Liverpool City Council in 2020. The Flood Study confirms that during major floods there is potential for floodwaters to 'spill' from the Georges River and impact parts of the site.

In recognition of the potential for inundation of the site in very rare events, Worley Consulting prepared a strategy for the safe and orderly management of the precinct and its occupants in the occurrence of a major flood emergency. The objective of the strategy is to use all available modes of emergency response to manage the flood hazard that could arise and thereby minimise the risk to future occupants of the precinct.

Gateway Determination

A Flood Impact and Risk Assessment Report (July 2022) and a Flood Emergency Response Strategy (November 2022), were prepared and submitted with the Moore Point Planning Proposal (PP-2022-1602) that was lodged for Gateway Determination in May 2022.

The Gateway Determination was received on 3 April 2023. Section 5.4.4 of the Gateway Determination Report addresses flooding and includes comments and advice from the DPE's Technical Advisory Group (TAG), the DPE's Flood Planning Advisory Panel, as well as representatives from the Department's planning section.

Additional flood related investigations and analysis were undertaken to address comments outlined in Sections 5.4.4 and 10 of the Gateway Determination Report. This included preparation of an updated Flood Impact Assessment Report (January 2024) and a Flood Emergency Response Plan (February 2024) which was targeted at addressing the issues raised by the Department. Work undertaken for the updated FIA Report also involved additional flood modelling to assess modifications to the development layout due to master planning for development of the precinct.

Flood Emergency Response Plan

Introduction

This Flood Emergency Response Plan (**FERP**) has been prepared based on the Flood Emergency Response Strategy (FERS) (2022) and the findings from the additional work completed following the gateway determination, including the finding from the 2024 FIA.

Analysis completed for the FERP indicates that the strategies previously determined as part of the FER can be implemented to ensure the flood risks to future occupants of the Moore Point development will be minimal.

Precinct Access

The FERP relies on a phased approach involving vehicular evacuation, evacuation by foot and shelter-in-place. Key elements of the FERP are as follows.

(i) There are four (4) potential vehicular routes which provide opportunity for access from the development to Newbridge Road during the onset of major flooding of the Georges River (*refer Vehicular Connections V1 to V4 as shown in* **Figure 4-1**). The flood immunity of each route is as follows:

a. Vehicular Connections V1 to V3 all offer the same level of flood immunity which corresponds to a flood that reaches a gauge height of 6.44 metres (*9.2 mAHD*) at the Liverpool Weir Gauge (*refer* **Table 4-2**). This corresponds to a flood immunity that is between a 2% and 1% AEP flood.

b. Access to Vehicular Connection V4 is not predicted to be 'cut' until river water levels reach a gauge height of 7.44 metres (*10.2 mAHD*). This corresponds to a level of flood immunity that exceeds the 1 in 500 AEP event (*refer* **Table 4-2**).

(ii) Two pedestrian footbridges are proposed as part of the development. These will connect the Moore Point Precinct to the Liverpool CBD and to Liverpool Train Station (*refer* **Figure 4-1**). As indicated in **Table 4-2**, access to Pedestrian Footbridges P1 and P2 is not predicted to be 'cut' until river water levels reach a gauge height of 7.44 metres (*10.2 mAHD*) indicating that both pedestrian footbridges will not begin to experience any form of inundation until flooding of the Georges River approaches the magnitude of the 1 in 500 AEP event (*refer* **Table 4-2**).

Both pedestrian footbridges will be designed to be upwardly grading from the development site.

(iii) Emergency vehicle access is proposed to be provided via Newbridge Road and Vehicular Connection V4. As discussed above, this will allow ambulances and other emergency vehicles to access the site during floods up to and including a 1 in 500 AEP event. Emergency vehicle access via the footbridges will not be required.

Flood Warning Assessment

(i) The 2022 Molino Stewart Report states that there is 7.25 hours of available evacuation time for the Moore Point Precinct. This is based on the forecast 12 hours of '*target warning lead time*' less the required time for mobilisation and decision making in accordance with the NSW SES Timeline Evacuation Model (TEM).

The 7.25 hours of evacuation time is considered to be conservative as it appears to only include the time available before a height of 4 metres is reached on the Georges River at the Liverpool Weir gauge. As Newbridge Road is not predicted to be cut by floodwaters until river water levels reach a gauge height of 6.44 metres, there could be up to 2 hours of additional evacuation time available (*refer* **Table 4-2**).

In addition, the available warning time for the Precinct does not take into consideration Vehicular Evacuation Route V4 which will allow evacuation to continue west along Newbridge Road during flooding up until river water levels reach a gauge height of 7.44 metres. This could allow evacuation to occur for a further 1.5 hours from initial inundation of Newbridge Road (*refer* **Figure 4-17**) or 3.5 hours from the time when flood levels are predicted to reach a height of 4 metres on the gauge.

Notwithstanding, the 7.25 hours of available evacuation time documented in the 2022 Molino Stewart Report is considered more than adequate for the Precinct to be evacuated safely via the available vehicular routes and footbridges.

(ii) An analysis of available warning times for potential evacuation triggers was undertaken based on an assessment of the rate-of-rise of flood levels at the Liverpool Weir gauge for the Probable Maximum Flood (PMF) and for the 1 in 500 AEP flood. Flood level (or stage) hydrographs for the 5%, 1% and 1 in 500 AEP floods and the PMF are plotted in **Figure 4-17** for the Liverpool Weir Gauge. Markers indicating the point in time along the 1 in 500 AEP and PMF flood level hydrographs when inundation of the various evacuation routes first occurs is superimposed on the figure.

All flood warning times include twelve (12) hours of minimum 'target warning lead time' before a gauge height of 4 metres is reached as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019). The analysis found that the following flood warning and evacuation times would be available for the Moore Point Precinct.

- There would be between 13.5 and 15.5 hours of combined warning and evacuation time available during a PMF event (*refer* **Table 4-6**).
- Warning and evacuation times would range between 14 and 19 hours during a 1 in 500 AEP event (*refer* **Table 4-7**).
- The length of available time varies depending on the method of evacuation and the specific route chosen.

It is expected that once Volume 3 of the '*Georges River and Woronora River Valley Flood Emergency Sub Plan*' is completed there will be clearer guidance on emergency response planning and SES adopted triggers for evacuation management.

Evacuation Assessment – 2056 Final Development

(i) The capacity for the Moore Point Precinct to be evacuated via the proposed vehicular and pedestrian routes has been assessed and documented in **Table 4.7**. The assessment was based on applying the 5,500 maximum vehicle capacity determined by Molino Stewart (2022). The following was determined for the final development scenario in 2056.

a. It is estimated that 10,500 vehicles could be "in the precinct" prior to the onset of major flooding. However, many vehicle owners may choose to heed advice associated with a Flood Watch which in all likelihood would be issued by BOM up to three (3) days prior to an event of this magnitude and may relocate their vehicles in advance.

b. 12,100 people would evacuate the site via the 5,500 vehicles determined to be the capacity of the transport network allocated to the Moore Point Precinct.

c. The remaining 17,300 people would evacuate from the site via pedestrian Footbridges P1 or P2.

d. 17,300 people could be evacuated via the two footbridges within less than 2 hours.

e. Evacuation over the footbridges could be staggered based on their being 3.5 hours of additional time for evacuation, when based on use of the Minor flood warning being used as a trigger for evacuation.

As there is capacity to safely evacuate all of the population from the Precinct within the available time, it follows that shelter-in-place will only serve as a back-up strategy should it be required. As a risk mitigation measure, all habitable floors and back-up infrastructure will be positioned at or above an elevation of 12.2 mAHD which corresponds to the predicted peak level of the PMF (refer **Section 4.9**).

Evacuation Assessment – Intermediate Stages of Development

Construction of the Moore Point Precinct is proposed to occur over three stages between 2026 and 2056. Evacuation during intermediate stages 1 and 2 was also assessed as part of this FERP. The key findings are documented below.

(i) Stage 1 of the development is to be completed between 2026 and 2036. As shown in **Figure 5-1**, Stage 1 would include Vehicular Connection V1 (*Bridges Road*) and V2 (*Anchor Place*) which are both predicted to be 'cut' once floodwaters reach a height of 6.44 metres (*9.2 mAHD*) at the Liverpool Weir Gauge. Pedestrian Footbridge P2 will be constructed as part of Stage 1 and will provide a pedestrian evacuation route during floods up to and including the 1 in 500 AEP event; or up to a gauge height of 7.44 metres (*10.2 mAHD*).

As shown in **Table 5-3**, it is expected that all 5,500 vehicles predicted by the 2022 Molino Stewart Report could evacuate Stage 1 of the development. This exceeds the number of vehicle spaces that will be provided as part of Stage 1 by 925 spaces (*refer* **Table 5.3**). Accordingly, all vehicles predicted to be on-site once Stage 1 is completed will be able to evacuate during the onset of major flooding of the Georges River.

The 2,420 people that will not be able to leave the precinct via vehicle (*because they won't own one or had arrived via public transport*) will be able to walk to flood free land in the Liverpool CBD via Pedestrian Bridge P2 (*refer* **Table 5.3**). Based on the evacuation timeframes determined by BG&E (refer **Appendix B**) it is estimated this number of people could evacuate in less than 30 minutes. As the available evacuation time is 5.5 hours, there is potential for pedestrian evacuation of these people to be staggered to allow a more gradual influx of people into the Liverpool CBD.

(ii) Evacuation Routes V1 (Bridges Road), V2 (Anchor Place) and V3 (Haigh Avenue) and Pedestrian Footbridge P1 and P2 are all proposed to be available during Stage 2 of the development (2036 to 2046) (refer **Figure 5-1**). There would be no constraints preventing all 5,500 vehicles determined to be the capacity of the transport network allocated to the Moore Point Precinct by the 2022 Molino Stewart Report to evacuate once Stage 2 of the development is completed (2046).

The analysis indicates that 8,189 total vehicle parking spaces will be provided by the end of development of Stage 2 (refer **Table 5-3**). Therefore, it follows that in 2046 there could be up to 2,689 vehicles that remain in the precinct over the duration of a 1 in 500 AEP event.

As one of the proposed footbridges will be completed prior to the commencement of Stage 2 it follows that the remaining population (after vehicular evacuation) will be able to evacuate by foot. As shown in **Table 5-3**, the remaining 8,606 people could evacuate by foot within a 2 hour period. As above, there is approximately 3.5 hours excess time for evacuation by foot into the Liverpool CBD. Evacuation by foot could therefore be staggered.

(iii) Anyone remaining onsite during Stage 1 and Stage 2 will be required to shelter in place within their apartments and/or nominated communal gathering areas.

Flood Emergency Response Management Procedures

Flood emergency response management procedures have also been determined for the proposed development to show how flood risks and evacuation would be managed. The procedures contained in **Appendix A** have been determined with the objective of:

- utilising technology and other means for information dissemination;
- utilising early warning triggers such as severe weather warnings to commence systems maintenance and preparation of the site and people;
- maximising the capacity for future residents and workers to safely evacuate the precinct either by vehicle (up to a maximum of 5,500) or by foot, during the onset of major flooding that would cause the precinct to be isolated for more than 6 hours; and,
- addressing the recommendations made by the flood advisory panel and the 2022 NSW flood inquiry.

1 Introduction

Coronation Property and Leamac Property Group, working together as the Moore Point Joint Landowners Group (**JLG**), have submitted a Planning Proposal for the redevelopment of the Moore Point Precinct at Liverpool. The Precinct is located to the east of the Liverpool central business district (CBD) and on the eastern side of the Georges River (*refer* **Figure 1.1**). It covers an area of 31.4 hectares and has until recently been used for a range of industrial land uses.

The site that is proposed for redevelopment is situated within the Georges River North Precinct of the Liverpool Collaboration Area and is subject to the priorities and actions of the Liverpool Place Strategy (the Strategy), which was released by the Greater Sydney Commission (GSC) in December 2018. Due to its proximity to the river, there is potential for some areas of the site to be flooded, although history would suggest that this will only occur in rare events.

The Planning Proposal involves cut and fill earthworks across the site including excavation along the eastern foreshore of the Georges River downstream of Liverpool Weir. These works are designed to raise low lying areas of the site to above the flood planning level and thereby meet the requirements of current planning controls. As a result, the works have the potential to cause localised changes to flood characteristics along the section of the Georges River extending from the M5 crossing to Lake Moore.

Flood affectation at the site and across adjoining areas is documented in the *Georges River Flood Study* (the Flood Study) which was published by Liverpool City Council in 2020. The Flood Study is based on the results of flood modelling that was undertaken by BMT Pty Ltd (**BMT**). The modelling confirms that during major floods there is potential for floodwaters to 'spill' from the Georges River and impact parts of the site.

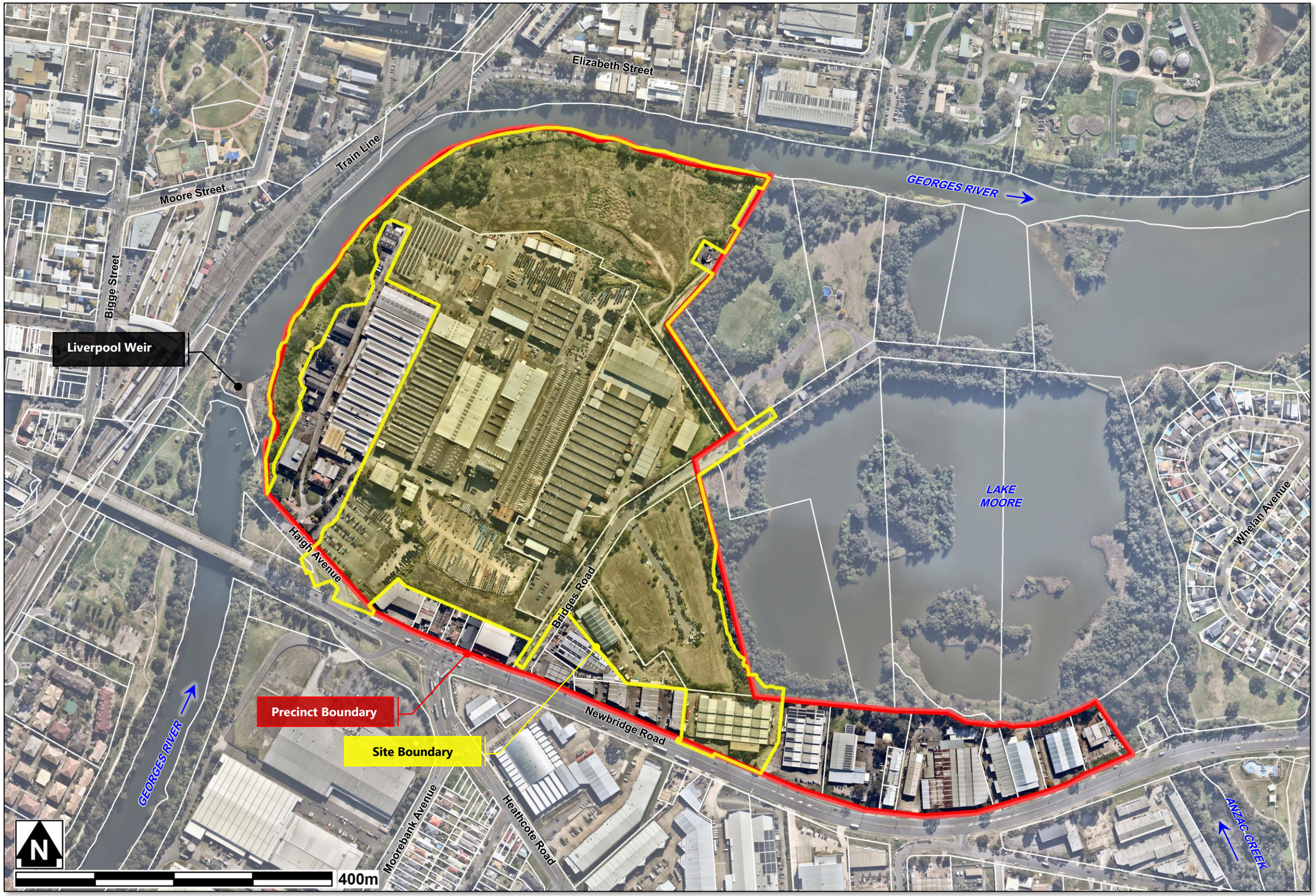
In recognition of the potential for isolation, Advisian (*now Worley Consulting*) and Risk-e Business Consultants Pty Ltd were engaged by the JLG to prepare a strategy for the safe and orderly management of the precinct and its occupants in the occurrence of a major flood emergency. The objective of the strategy is to use all available modes of emergency response to manage the flood hazard that could arise and thereby minimise the risk to future occupants of the precinct.

Reports titled, '*Moore Point Precinct, Liverpool – Flood Impact and Risk Assessment*' (July 2022) and '*Moore Point Precinct, Liverpool – Flood Emergency Response Strategy*' (November 2022), were submitted with the Moore Point Planning Proposal (PP-2022-1602) that was lodged with the NSW Department of Planning and Environment (**DPE**) for Gateway Determination in May 2022.

The Gateway Determination was received on 3rd April 2023. Section 5.4.4 of the Gateway Determination Report addresses flooding and includes comments and advice from the DPE's Technical Advisory Group (TAG), the DPE's Flood Planning Advisory Panel, as well as representatives from the Department's planning section. The following sub-sections of Section 5.4.4 relate to flooding:

- Flood hazard and behaviour (Section 5.4.4.1);
- Food evacuation (Section 5.4.4.2);
- Flood risk mitigation measures (Section 5.4.4.3); and,
- Consideration of 9.1 Direction 4.1 Flooding (Section 5.4.4.4).

FIGURE 1.1



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LOCATION OF THE MOORE POINT PRECINCT

Additional flood related investigations and analysis have been undertaken since receipt of the Gateway Determination including preparation of an updated Flood Impact Assessment (FIA) report titled '*Moore Point Precinct, Liverpool – Flood Impact Assessment*' (January 2024). The additional investigations were undertaken to address comments outlined in Sections 5.4.4 and 10 of the Gateway Determination Report.

Work undertaken for the updated FIA Report also involved additional flood modelling to assess modifications to the development layout due to master planning for development of the precinct.

This Flood Emergency Response Plan (**FERP**) has been prepared based on the Flood Emergency Response Strategy (FERS) (2022) and the findings from the additional work completed following the gateway determination, including the finding from the 2024 FIA. It has been prepared in consultation with representatives from the JLG and with other consultants working on the project, including David Owens from Risk-e Business Consultants.

2 The Moore Point Precinct

2.1 Description of the Existing Precinct

As shown in **Figure 1.1**, the Moore Point Precinct covers approximately 38.5 ha of land and is located between Newbridge Road to the south, the Georges River to the north and west, and Lake Moore to the east. The Precinct is currently used for industrial purposes with a collection of separate businesses operating on the site.

The topography across the Precinct is shown in **Figure 2.1**. The thematic mapping of land elevation shown in **Figure 2.1** is based on Light Detection and Ranging Survey (LiDAR) that was collected in 2019.

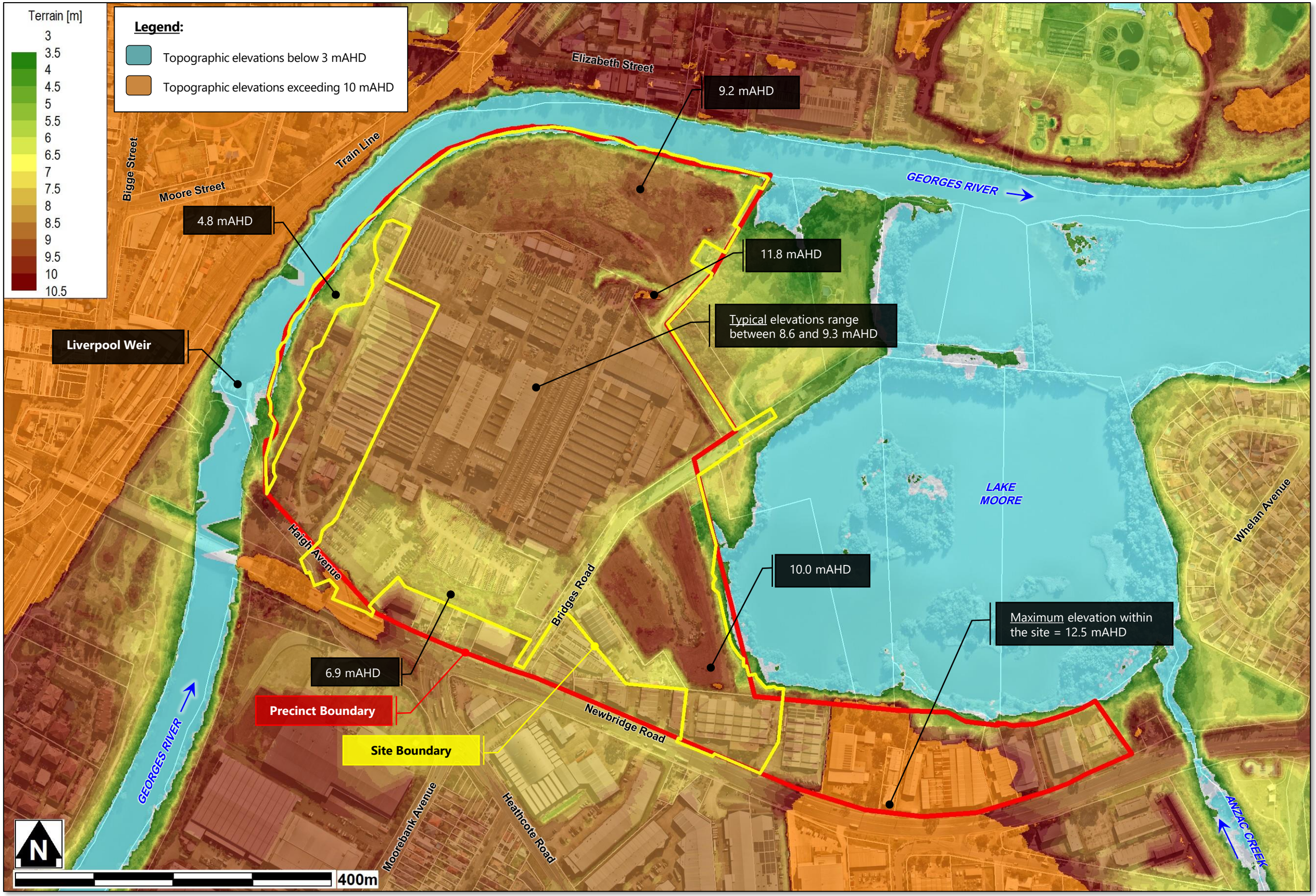
As shown, the site is elevated above the Georges River and Lake Moore with typical elevations across the centre of the site ranging between 8.6 and 9.3 mAHD. A maximum elevation of 12.5 mAHD occurs along the southern boundary of the site adjacent to Newbridge Road. Areas of lower lying land are generally limited to the perimeter of the site where it adjoins the banks of the Georges River. A depressed section of the site with elevations as low as 6.9 mAHD exists between Haigh Avenue and Bridges Road. These lower elevations extend along Bridges Road through to Lake Moore (*refer* **Figure 2.1**).

The higher terrain that extends through the centre of the site prevents floodwaters from "cutting across" the site and bypassing the meander bend in the Georges River downstream of Liverpool Weir. River levels do not rise to a height sufficient to allow floodwaters to overtop this ridge line until they reach an elevation of 9.4 mAHD at Liverpool Weir (*refer* **Figure 2.1**).

Much of the Precinct is covered by industrial buildings that are aligned north-to-south or orthogonal to the direction that flow would travel through the site if the eastern bank of the Georges River was overtopped. As shown by the examples presented in **Plate 2.1**, these industrial buildings are typically of a solid build capable of blocking or slowing the passage of floodwaters. Much of the remainder of the site is used for the storage of materials which would also serve to impede any flows crossing the site.

Plate 2.1 Examples of Existing Industrial Factories located on the Moore Point Precinct

FIGURE 2.1



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EXISTING TOPOGRAPHY ACROSS AND IN THE VICINITY OF THE MOORE POINT PRECINCT

2.2 Vision for the Proposed Development

The site is situated within the Georges River North Precinct of the Liverpool Collaboration Area. The Collaboration Area is subject to the priorities and actions of the Liverpool Place Strategy (Strategy), which was released by the then Greater Sydney Commission (GSC) in December 2018 (*refer* **Plate 2.2**).

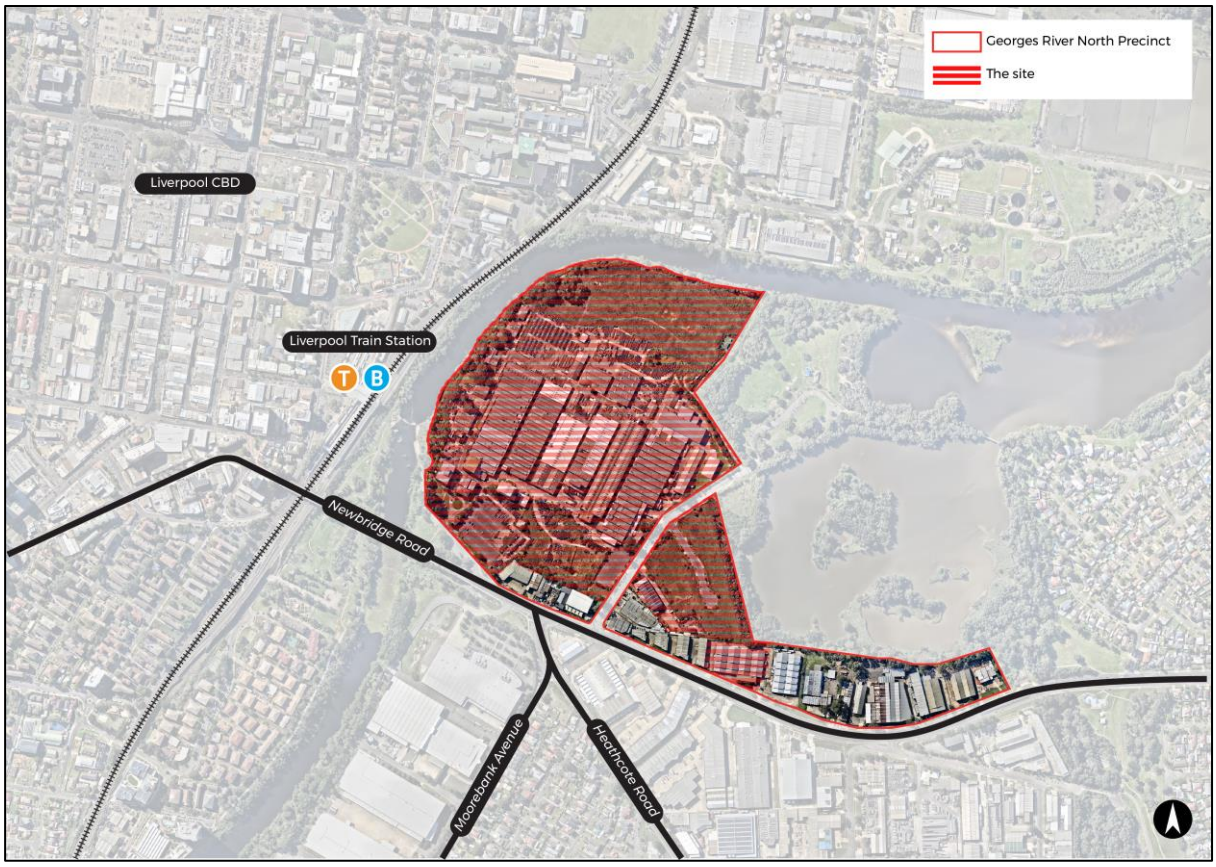


Plate 2.2 Site Aerial (*Source: Nearmap modified by Mecone*)

The Strategy states that by 2036, Liverpool will be a rejuvenate river city, offering diverse and growing residential and employment opportunities. Major health, education and retail precincts, and a mixture of open space and parkland along the Georges River, will create a rich mix of workplaces, public space, shops and entertainment areas (*refer* **Plate 2.3**).

Under the Strategy, the site is identified as 'mixed use', which comprises:

> *'a mixture of commercial, retail, residential and community uses that provide sustainable employment, that is complementary to, and not in competition with, the commercial core'*

The summary from the 2019 Annual Report for the Liverpool Collaboration Area highlighted the key steps that had been commenced and completed to address the imperatives acknowledged in the Strategy. These included:

- engagement with TfNSW to prepare the Liverpool Place-based Integrated Transport Strategy and accelerated investment; and,
- preparation of flood studies and a floodplain risk management plan which was completed by Liverpool City Council.

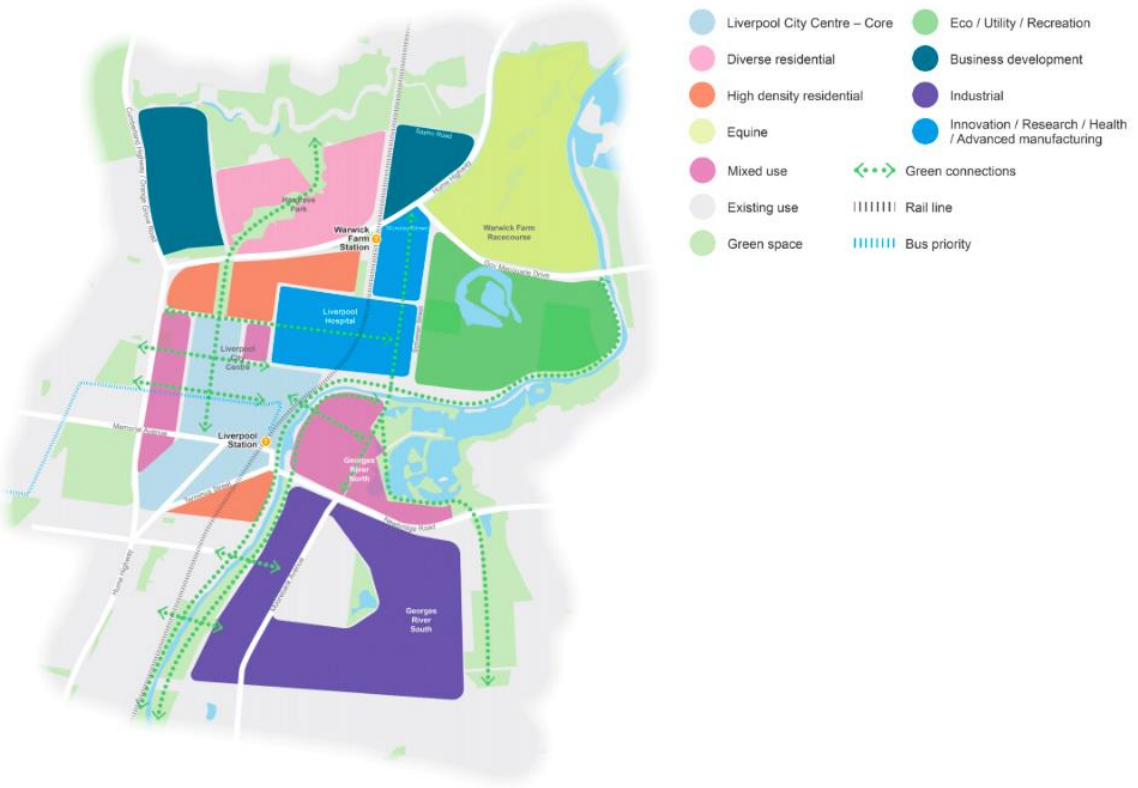


Plate 2.3 A Place Strategy for Liverpool
(Source: Liverpool Collaboration Area Place Strategy (2018))

The land uses presented in the Strategy are reinforced in Liverpool City Council's Local Strategic Planning Statement (LSPS), which identifies the site for investigation as residential/ mixed use to support the CBD and Innovation Precinct in tandem with linking open space and green corridors.

The LSPS provides the following short to medium term action (12-24 months) specific to the Georges River North Precinct:

> *Action 11.2 Amend LEP to rezone Georges River Precinct north of Newbridge Road as a mixed-zone to support the Liverpool CBD and innovation Precinct, with an extensive open space system and cross-river linkages (short term).*

The Planning Proposal involves the creation of a mixed-use precinct, providing new homes, jobs and open space adjoining the Georges River and connecting to Liverpool CBD. Key features of the proposal include:

- adaptive re-use of existing heritage;
- foreshore embellishments and new open spaces;
- educational and cultural facilities;
- connections to Liverpool CBD and Liverpool Train Station; and,
- transport, intersection and collector road improvements.

The Planning Proposal aligns with the priorities of the NSW Government and the implementation phase of the Place Strategy by delivering new jobs, infrastructure, green spaces and housing to the Collaboration Area. The Planning Proposal responds to The Pulse of Greater Sydney's performance indicators, which fall under the key themes of the design philosophy as outlined in the following section.

3 Moore Point Design Philosophy

3.1 Strategic Guidance

Moore Point has been designed as a "Car Lite" precinct, in line with Government policy which promotes walking, cycling and public transport as the preferred modes of transport. At Moore Point we aim to provide future residents and visitors with connectivity choices which reduces dependency on private vehicle ownership.

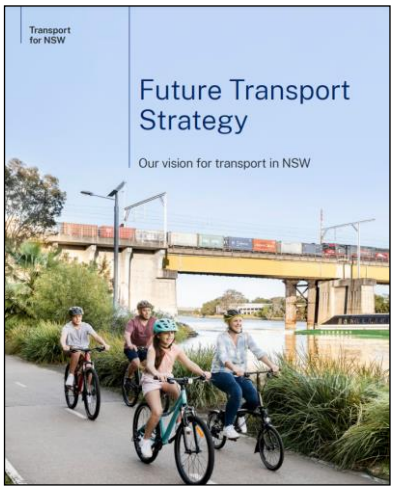
Relevant NSW guidance was utilised to inform the "What" and the "How" of the future mobility strategy for the Moore Point Precinct. The Future Transport Strategy outlines the vision for transport in NSW, a vision that has provided the input to the "What" the Moore Point Precinct seeks to achieve through its future mobility networks.

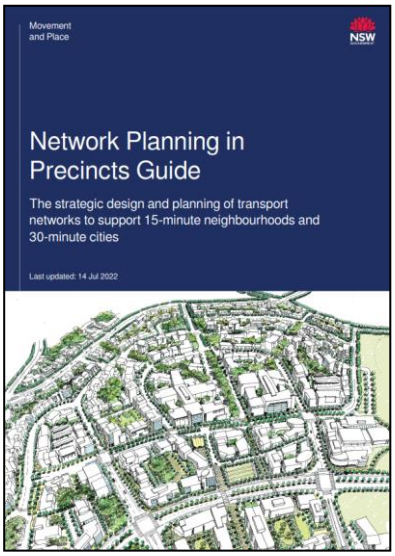
The *NSW Movement & Place – Network Planning in Precincts Guide*, provides the strategic design and planning of transport networks to support 15-minute neighbourhoods and 30-minute cities. This guide has been used to determine the "How" with regard to how the future mobility strategy will be achieved.

Both of these strategic documents seek to reduce car dependency and increase the mode share of walking, cycling and public transport, in particular in urban areas. This outcome we believe we have achieved through the design and staging of the Moore Point Precinct, which will result in a future population with a reduced car ownership within the precinct.

More detail on the alignment of these strategic documents and the outcomes that are being targeted is presented in the following table.

More detail on the specific actions and outcomes is provided below.

Guidance Document	Alignment
 NSW Future Transport Strategy	The NSW Future Transport Strategy, released in August 2022, sets the strategic directions for Transport to achieve world-leading mobility for customers, communities, businesses and our people, including supporting a forecast population growth of 3.5 million people by 2061. The strategy outlines the areas of focus to deliver customers "better alternatives to driving and a more sustainable transport system that fosters participation and inclusion. To do this, we will need to improve connections through stronger investment in public transport, and walking and cycling networks, supported with travel demand management and improved digital connectivity." A number of strategic directions and responses, identified in Future Transport, have driven the development of the Moore Point Precinct including: • Enhance 30-minute metropolitan cities • Support thriving and healthy 15-minute neighbourhoods • Support car-free, active, sustainable transport options • Support growth around public transport • Improve parking provision and management • Provide customer journey resilience



NSW Movement & Place – Network Planning in Precincts Guide

The *NSW Movement & Place – Network Planning in Precincts Guide* (the guide) provides best practice principles, tools, examples and case studies of a transport network that facilitates the efficient movement of people and goods while supporting 15-minute neighbourhoods and 30-minute cities, as well as the desired place, safety, public health and wellbeing, environmental and economic outcomes.

The guide shifts the emphasis in network planning from a hierarchy of roads towards a complete network that is place-based and prioritises walking, cycling, public transport. This is the process we have followed in developing the Transport Access and Management Plan for the Moore Point Precinct, guided by many some of the range of identified issues and opportunities, relating to integrated mobility that have been prevalent in the planning of developments locally, nationally and internationally including:

Relevant Problem Statements:

- **Mode Shift:** A car-centric transport network leads to congestion, unattractive places and high levels of carbon emissions. However, without good provisions for walking, cycling and public transport, people will choose to drive out of convenience.
- **Mode Shift:** Too many parking spaces in well-connected urban areas can lead to low walking, cycling and public transport use and unintended traffic congestion.
- **Land-use integration:** Residential development is sometimes staged with limited consideration for walking, cycling and public transport, requiring residents to drive from the outset.
- **Infrastructure, services and technology:** Walking, cycling and public transport are often considered last with the assumption they can be incorporated into the road network once it's completed. This results in poor walking and cycling experience with indirect connections and limited infrastructure.

Our guiding opportunities:

- **Mode Shift:** High uptake of walking, cycling and public transport delivers significant health, environmental and economic benefits, creates resilient communities, and enables our communities to be more equitable, inclusive and liveable for everyone. It also reduces congestion.
- **Mode Shift:** Fewer car parking spaces means more space for footpaths, playgrounds, safe crossings, street trees, outdoor dining and bike lanes.
- **Land-use integration:** A precinct with integrated land use and transport makes it more convenient to walk, cycle and take public transport between destinations. This results in less congestion, lower average vehicle kilometres and lower emissions.
- **Infrastructure, services and technology:** Prioritising walking, cycling and public transport creates multimodal transport networks that become the backbone of accessible precincts. This leads to successful places, a stronger economy and better safety, public health and wellbeing.

3.2 Core Points of Alignment with Government Strategy

3.2.1 Enhance 30-minute metropolitan cities

The 30-minute city concept focusses on ensuring most people can access key destinations, such as CBDs and Strategic Centres, Major Health Precincts, Tertiary education institutions and significant cultural and leisure destinations by public transport in 30 minutes. A key action and outcome identified within this direction is to enhance 30-minute travel catchments in the Six Cities Region and reduce reliance on private vehicles to access key destinations in our cities as well as supporting a more sustainable transport system.

The Moore Point precinct is centrally placed, within easy walking or cycling distance to the major transport interchange at Liverpool Station, meaning connectivity to a range of key destinations within 30-minutes by public transport will be available to future residents of Moore Point. In addition, the significant waterfront and commercial amenity provided within the precinct is located with easy walking access to the train station and existing Liverpool CBD and will further enhance Liverpool as a key destination improving 30-minute city outcomes for many residents in Sydney's central and western regions.

Moore Point has been flexibly designed to accommodate a range of public transport services within the precinct also, including bus networks and a potential future Metro station. The proximity to many key destinations locally including Liverpool Hospital and University campuses means that Moore Point is perfectly positioned and connected to function as part of a 30-minute city, with less private vehicle reliance than many precincts in Sydney's west.

3.2.2 Support thriving and healthy 15-minute neighbourhoods

Transport's 15-minute neighbourhood concept aims to support local communities, sustainability and healthy lifestyles by prioritising place making, walking, cycling, micro mobility and last mile freight, to support 15-minute access to connected, local transport networks, precincts and local destinations.

Moore Point has been designed from the ground up, in consultation with Local and State Governments as a 15-minute neighbourhood aligning with the actions outlined for new developments in the Future Transport Strategy. Moore Point is a genuine mixed-use precinct, which provides for jobs, homes, education and services in a strategic centre, and delivers on the GCC's objectives for a rebalanced Sydney.

P2.1 – 15-Minute Neighbourhood Actions
P2.1a – Partner with councils, Local Aboriginal Land Councils and other NSW Government agencies to support 15-minute neighbourhoods.
P2.1b – Explore reforms to planning policies and developer contribution regimes to ensure connected walking, cycling and bus networks in new release areas.

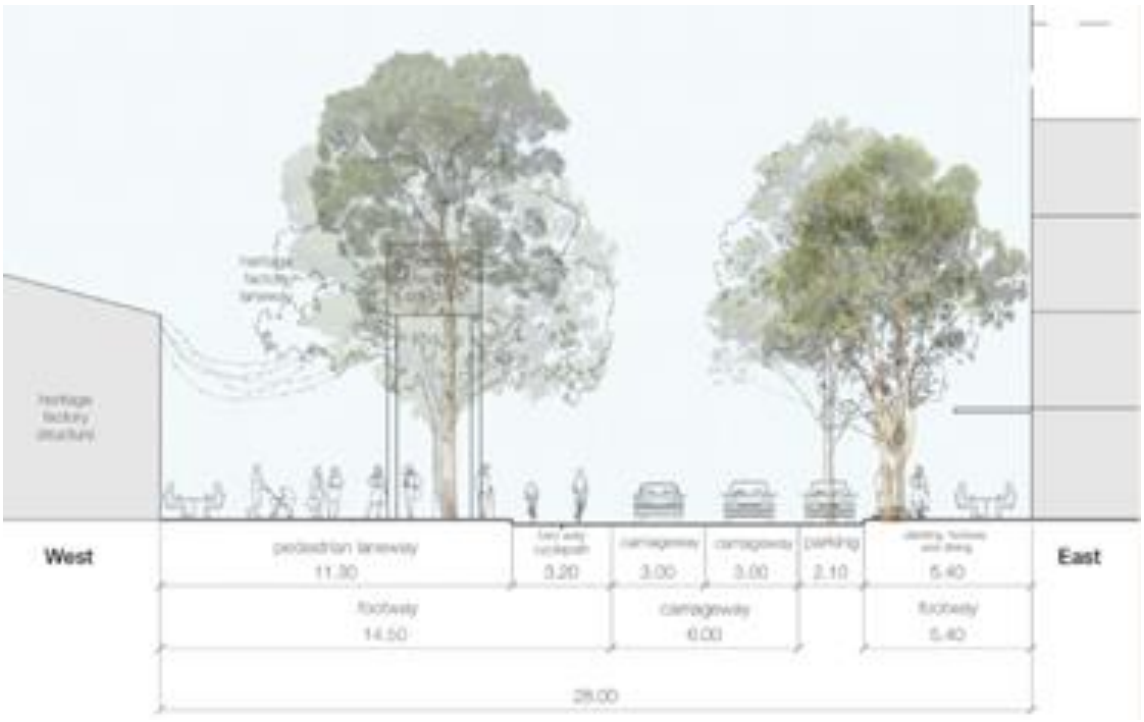
The delivery of new walking and cycling connections across the Georges River, better linking the Health Precinct and Liverpool CBD and Station will also support these neighbourhoods in reducing car dependency and improving their 15-minute neighbourhood outcomes.

3.2.3 Support car-free, active, sustainable transport options

Investment in walking, cycling and micro mobility programs will give people more choice in how they move. The benefits of more people choosing these options include improved air quality and urban amenity, reduced car use and traffic congestion, and a general improvement in the health of communities.

To achieve this, the Strategy identifies the need to integrate safe and separate, first and last mile walking and cycling connections and trip facilities into plans and projects to promote active transport for all travel purposes for people of all ages and abilities. This has been a fundamental in the planning of the Moore Point precinct, where the street network has been designed to offer spaces for a range of uses and support the various Movement & Place needs of future residents, workers and visitors.

The network provides 17edicateed walking and active transport spaces, generous footpaths to encourage activation, space for urban greening and limits the space allocated to private vehicles.



3.2.4 Support growth around public transport

Growth around frequent public transport could accommodate some of NSW's growing need for jobs, education and housing, and simultaneously increase the viability of major public investments, particularly in metro, rail and light rail.

The Moore Point precinct is conveniently located adjacent to the Liverpool CBD and will have direct walking and cycling access to the Liverpool Transport Interchange via a dedicated walking and cycling bridge. The Strategy identifies that Smarter high-density development can bring network-wide efficiencies, improve agglomeration economics, and deliver place making benefits, including more walkable neighbourhoods, and improved accessibility and liveability for residents.

Delivering this for Moore Point will result in a reduced reliance on private vehicles, with residents and visitors choosing active or public transport as their preferred mobility option.

3.2.5 Improve parking provision and management

The Future Transport Strategy identifies that careful parking management in metropolitan centres can encourage more people to use public transport, thereby reducing congestion, improving productivity on the roads, and making public transport services faster and more reliable.

Moore Point has responded to this with a progressive parking strategy which aligns the proposed parking provision with the lowest permissible under the current Liverpool DCP, and gradually reduces this provision throughout the delivery of subsequent stages as active transport and networks are completed and more amenity and services are introduced.

3.2.6 Provide customer journey resilience

Future Transport outlines the need to plan our places mindful of the increasing frequency of natural events such as heat waves, storms, bushfires, and flooding. We must "focus on the unique characteristics of places, including their vulnerability to different types of extreme weather and natural hazards, the level of redundancy in their road and rail networks, the capacity of evacuation routes, and the capability of local resources to restore and repair networks after major events."

To do this, we will need to collaborate with multiple levels of government and work with diverse stakeholders, this is the process we have followed at Moore Point, engaging from an early stage to ensure the precinct is planned mindful of future risks and the capacity of supporting transport systems and the needs of a community with reduced car dependence.

Mindful of this context, Moore Point has been planned to utilise the capacity of the surrounding road network, and strong active transport links for evacuation in combination with the ability to shelter in place to achieve a safe outcome in the event of a flooding incident.

4 Flood Warning and Evacuation Assessment

4.1 Precinct Access

Access to the Moore Point Precinct will occur via the locations identified in **Figure 4-1**. These points of access are sequential upgrades to existing intersections which will be timed to align with the proposed development yield and accounting for background network growth.

As shown in **Figure 4-1**, there are four (4) proposed vehicular access points, three of which connect to Newbridge Road and one to Haigh Avenue. Two pedestrian footbridges are also proposed that cross the Georges River and provide pedestrian access to Liverpool Train Station and Liverpool CBD.

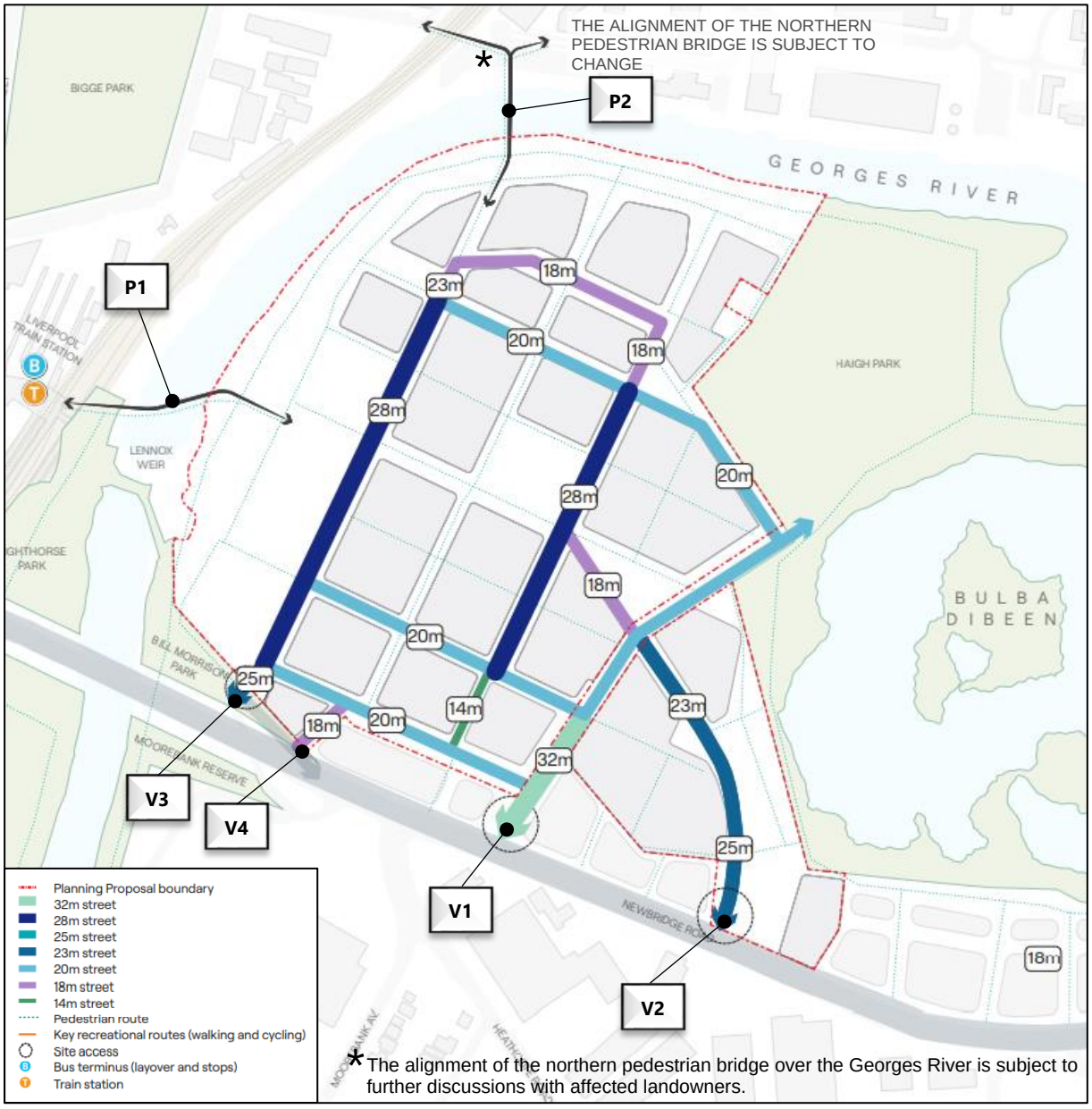


Figure 4-1 Proposed points of access and egress from the Moore Point Precinct
Source: Moore Point Masterplan – Gateway Revised Planning Proposal (December 2023)

4.2 Development Information Relevant to the Flood Emergency Response Plan

Information relevant to the FERP has been extracted from the Planning Proposal package and is outlined in **Table 4-1**. The table includes information on the forecast number of people, workers and cars that could be attributed to residential and commercial land uses. The information has been further divided into the three proposed stages of development with key completion dates forecast to be 2036, 2046 and 2056.

The information in **Table 4-1** indicates that the final Moore Point Precinct development is forecast to introduce 29,400 people and up to 10,500 cars to the site.

Table 4-1 Development Information During the Final and Intermediate Stages

Development Information	**Stage 1** (2036)	**Stage 2** (2046)	**Stage 3 / Final Development** (2056)
Residential:			
- Number of units	4,237	7,548 *(+3,311)*	10,742 *(+3,194)*
- Number of residents (*based on 2 people per unit*)	8,474	15,096 *(+6,622)*	21,484 *(+6,388)*
- Number of cars	4,025	6,508 *(+2,483)*	8,073 *(+1,565)*
Commercial:			
- Commercial Gross Floor Area (GFA)	109,478 m^2	210,064 m^2 *(+100,586 m^2)*	328,516 m^2 *(+118,452 m^2)*
- Number of workers ^	2,638	5,060 *(+2,422)*	7,918 *(+2,858)*
2- Number of cars	1,095	1,670 *(+575)*	2,346 *(+676)*
Visitors:			
- Number of visitors	/	/	/
- Number of workers	/	/	/
School Students/Staff:			
- Number of cars (*20 cars per school for staff*)	20	20 *(+ 0)*	40 *(+20)*
Total Number of Cars (Residential/Commercial/Visitor)	**4,575**	**8,198**	**10,459**
Total Number of People (Residential/Commercial/Visitor)	**11,112**	**20,156**	**29,402**

^ *Number of workers and cars reduced by 50% to account for the number of workers that would also be residents and others who would not go to work during the later stages of a forecast flood event due to reduced business operations (as is to be recommended as part of the flood emergency response plan) or personal choices.*

4.3 Available River Level Gauges

There are two river level gauges located along the Georges River upstream of the Moore Point Precinct. Records from these gauges can be viewed to monitor the progress of a flood to determine whether river levels are rising, steady or falling, the rate-of-rise or fall and the current river level. Depending on the location of the gauge, this information can provide an early indication of what is to come or confirm conditions nearby to a location of interest and in the vicinity of key evacuation routes.

The river level gauges located along the Georges River upstream of the Moore Point Precinct are listed in **Table 4-2**. Additional details including gauge ownership, distance of each gauge from the site and hyperlinks to real-time records are also provided.

Table 4-2 Available River Level Gauges along the Georges River Upstream of the Site

Gauge ID	Gauge Name	Ownership	Gauge Datum	Distance Upstream of the Site (km)	Link to Realtime Records
213018	Georges River at Minto Heights	NSW Water	AHD	17.3	https://realtimedata.waternsw.com.au?ppbm=213018|213_SYDNEY|SURFACE_WATER&rs&1&rslf_org http://www.bom.gov.au/fwo/IDN60233/IDN60233.566082.plt.shtml
213400 / 566054	Georges River at Liverpool Weir	DPIE BCD	Local ^	0.0	https://mhl.nsw.gov.au/Station-213400 http://www.bom.gov.au/fwo/IDN60233/IDN60233.566054.plt.shtml

^ *Gauge Zero is at 2.762 mAHD*

The Georges River at Liverpool Weir gauge (ARWC No. 213400) is monitored by the SES and relied upon for issuing flood warnings and managing evacuation and road closures. The following gauge heights are important for flood warnings and for the management of emergency response protocols:

- Gauge Height of 2 metres – Minor Flood Warning
- Gauge Height of 3 metres – Moderate Flood Warning
- Gauge Height of 4.5 metres – Major Flood Warning

The above gauge heights are to the local gauge datum which has gauge zero set at an elevation of 2.762 mAHD. Accordingly, the above gauge heights for minor, moderate and major flood warnings can be translated to the following river levels:

- Gauge Height of 4.762 mAHD – Minor Flood Warning
- Gauge Height of 5.762 mAHD – Moderate Flood Warning
- Gauge Height of 7.262 mAHD – Major Flood Warning

The Major gauge height corresponds to:

- a flood level approaching that predicted at the peak of a 10% Annual Exceedance Probability (AEP) event; and,
- a level that is approximately 0.9 metres below the peak flood level predicted for a 5% AEP event.

The Georges River at Minto Heights gauge (ARWC No. 213018) is not relied upon by the SES or BOM for forecasting or evacuation planning. In that regard, the NSW Office of Water website states that the gauge is relied upon for 'quantity monitoring only'. Notwithstanding, the location of the gauge over 17 kilometres upstream of the site makes it a valuable information source that can provide advanced warning and information for a flood event.

The locations of the Minto Heights and Liverpool Weir river gauges are shown in **Figure 4-2**.

4.4 Flooding of the Moore Point Precinct and Evacuation Routes

The risk of flooding of the Moore Point Precinct under pre and post-development conditions is documented in a report prepared by Advisian titled, '*Moore Point Precinct – Flood Impact Assessment*' (*Advisian, 2024*) (*referred to herein as the Moore Point FIA*). The modelling completed for the Moore Point FIA indicates that most areas of the proposed development will not experience inundation due to flooding of the Georges River in events up to and including the 1 in 500 AEP flood. Evacuation from the development would also still be possible via vehicle or pedestrian evacuation routes.

Initial inundation of the Moore Point Precinct and Newbridge Road is predicted to occur via the following three mechanisms termed T1 to T3:

- T1 – Rising flood levels across Lake Moore leading to inundation of Newbridge Road via the proposed overland flow route and/or backing up through the local stormwater network (*refer T1 on* **Figure 4-3**).
- T2 – Overtopping of the Georges River embankment upstream of Newbridge Road leading to increased flooding along Newbridge Road and the lower lying parts of the development adjacent to Newbridge Road (*refer T2 on* **Figure 4-3**).
- T3 – Floodwaters breaking the riverbanks near the Liverpool Weir leading to floodwaters entering the precinct from the east and flowing towards Lake Moore (*refer T3 on* **Figure 4-3**).

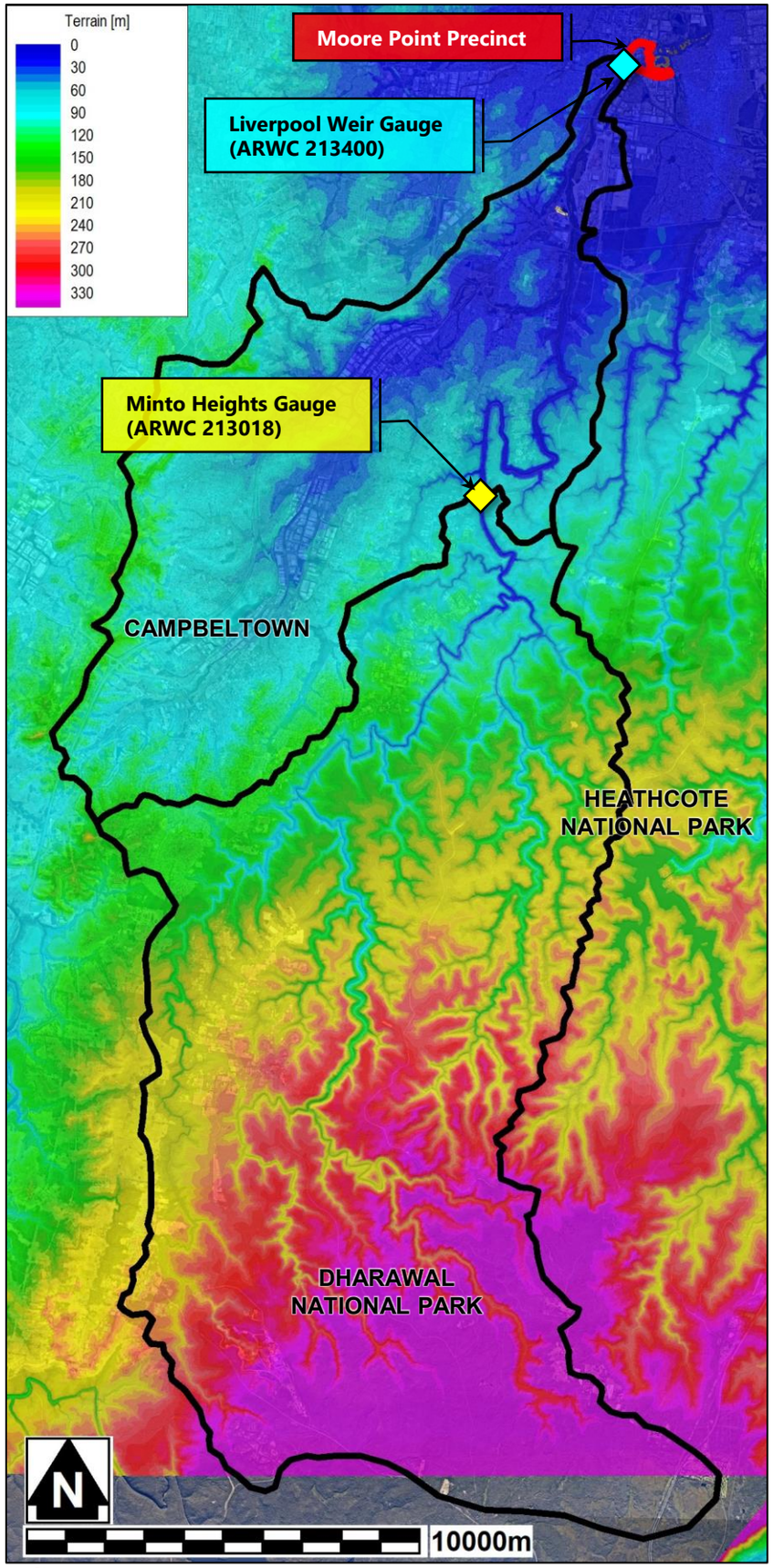
Flooding mechanisms T1 and T2 are predicted to occur prior to the peak of a 1 in 100 AEP flood. T1 is predicted to occur first leading to shallow flooding across the low point along Newbridge Road. Flooding mechanism T2 is predicted to occur shortly after, leading to widespread inundation of Newbridge Road including existing development to the south and lower lying parts of the development including Bridges Road.

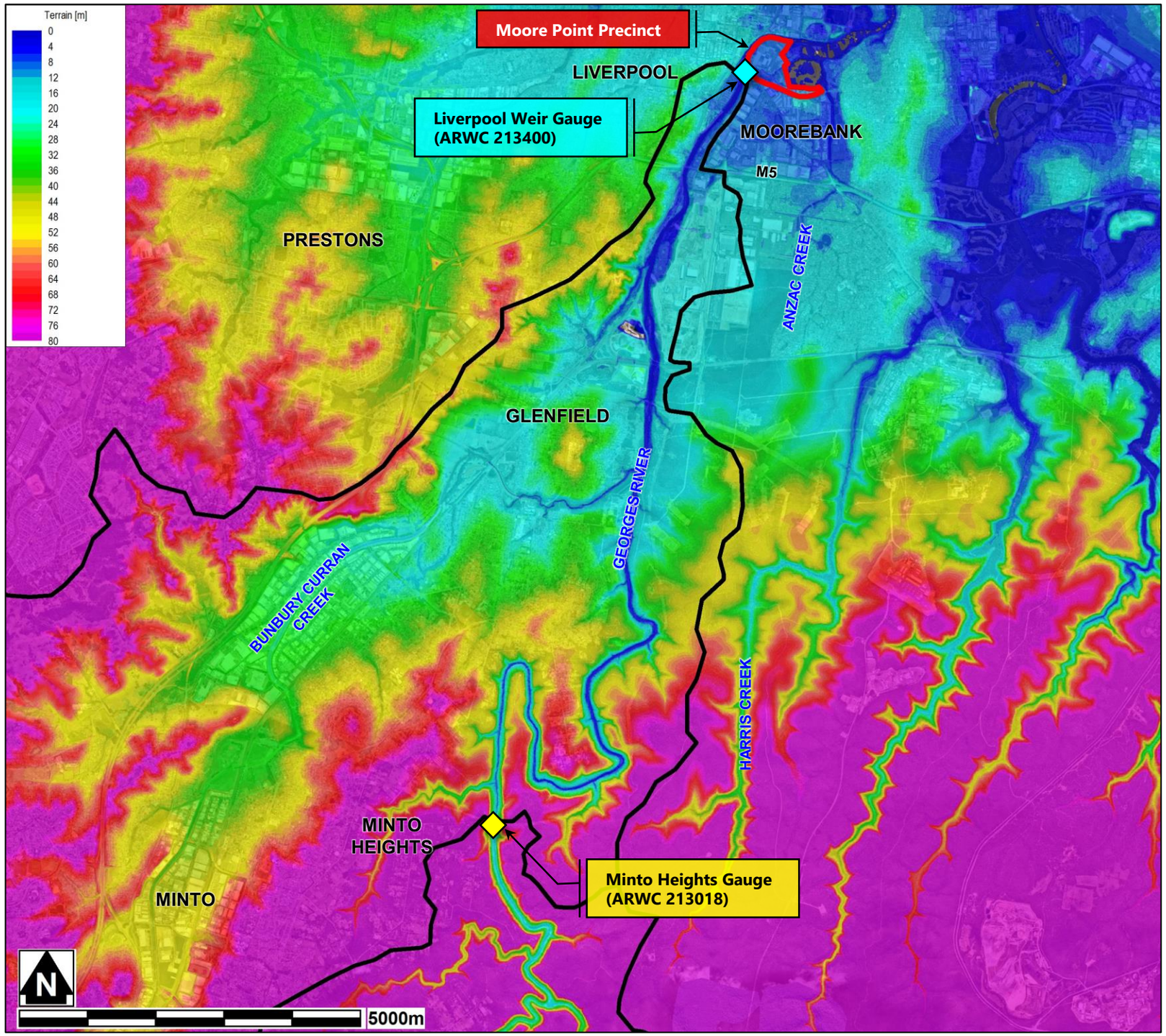
Floodwaters are not predicted to inundate the development from the west near Liverpool Weir (*refer T3 on* **Figure 4-3**) until flooding along the Georges River exceeds conditions predicted at the peak of a 1 in 500 AEP event. As shown in **Figure 4-3**, this would not occur until flood levels at the Liverpool Weir gauge reach about 10.20 mAHD. This translates to a gauge reading of about 7.44 metres.

In the event floodwaters continue to rise above a gauge height at Liverpool Weir of 7.44 m (*10.20 mAHD*), floodwaters would spread throughout the development leading to inundation of internal roads. This would prevent any further evacuation of the Precinct via vehicle and pedestrian routes.

A more detailed breakdown of flooding across the Moore Point Precinct during various stages of Georges River flooding is included in **Section 4.3.2**. The breakdown includes reference to flood conditions during the assigned minor, moderate and major Liverpool Weir gauge heights and includes indicators showing which evacuation routes would remain open at various stages of flooding.

FIGURE 4-2





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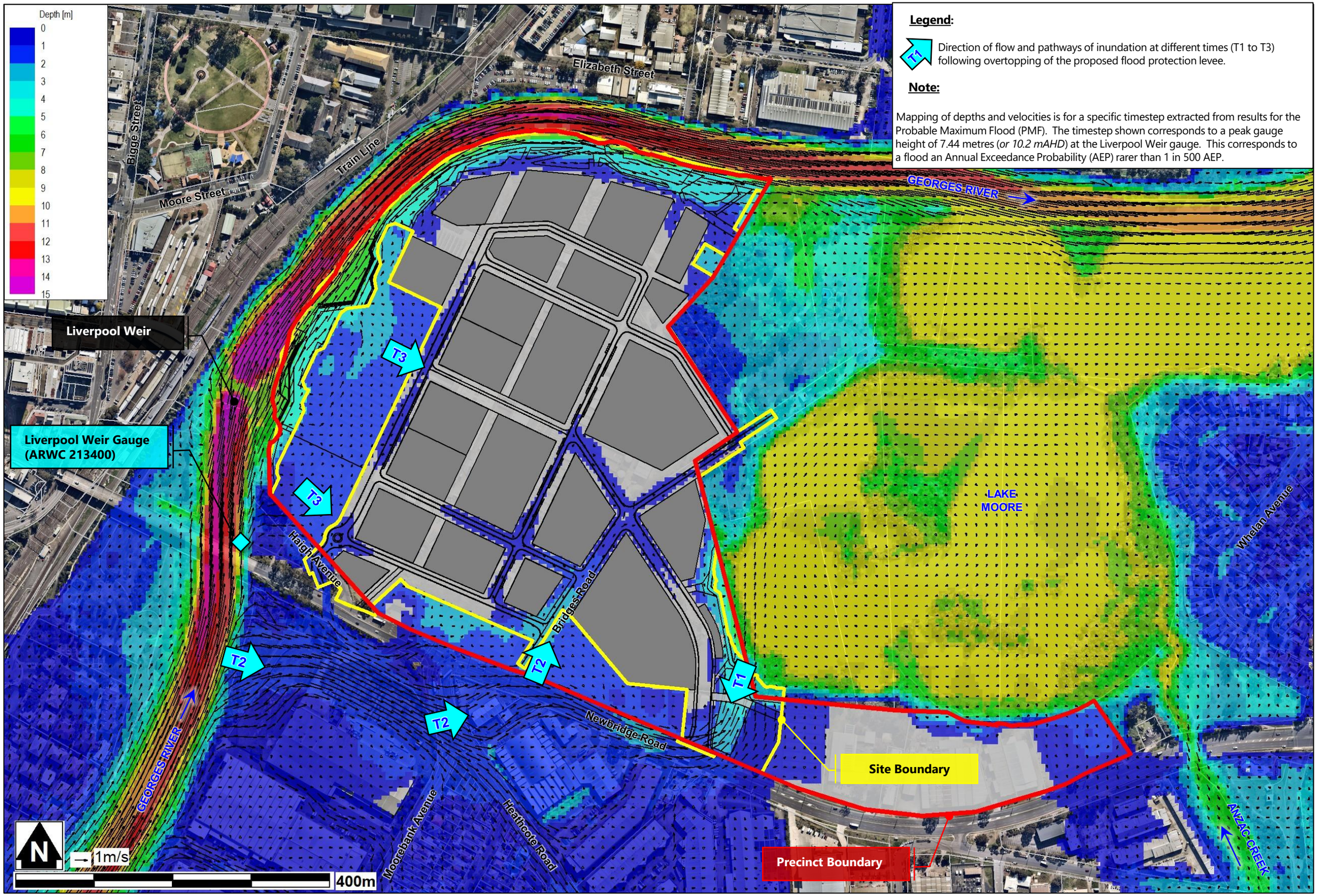
LOCATIONS OF THE MINTO HEIGHTS AND LIVERPOOL WEIR GAUGES ALONG THE GEORGES RIVER

FIGURE 4-3



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FLOOD MECHANISMS LEADING TO FLOODWATERS INUNDATING THE SITE AND EVACUATION ROUTES

4.4.1 Evacuation Routes

As discussed in **Section 4.1** and shown in **Figure 4-1**, the proposed development includes four (4) vehicular and two (2) pedestrian access points. Three (3) of the vehicular access points connect to Newbridge Road to the east of the Georges River. The last vehicular connection is located to the south-west of the Precinct connecting to Haigh Avenue (*refer* **Figure 4-1**).

The pedestrian footbridges are proposed to cross the Georges River and provide pedestrian access to Liverpool Train Station and the Liverpool CBD.

The vehicular and pedestrian access points are all viable evacuation routes during various stages of a flood event. The predicted flood immunity and characteristics of each evacuation route are listed in **Table 4-2**.

Table 4-2 Flood Immunity and Capacity of Potential Evacuation Routes

Evacuation Route Options (Refer **Figure 4-1**)	**Capacity**		**Predicted Flood Immunity**	
	Road Reservation Width	**No. Lanes^**	**AEP**	**Gauge Height**
Vehicular Connection V1: Bridges Road connection to Newbridge Road	32 metres	2 with cycle path	< 1%	6.44 m (*Level -9.20 mAHD*) *2.45 m above 'Major' Gauge Height*
Vehicular Connection V2: Anchor Place connection to Newbridge Road	25 metres	2 with shared foot and cycle path		
Vehicular Connection V3: Connection to Haigh Avenue	25 metres	1 with shared foot and cycle path		
Vehicular Connection V4: Connection to Newbridge Road, west of Bridges Road	18 metres	1	> 1 in 500	7.44 m (*Level -10.20 mAHD*) *3.45 m above 'Major' Gauge Height*
Pedestrian Connection P1: Connection to Liverpool CBD via Liverpool Train Station	/	/	> 1 in 500	7.44 m (*Level -10.20 mAHD*) *3.45 m above 'Major' Gauge Height*
Pedestrian Connection P2: Connection to Liverpool CBD and Liverpool Hospital via Elizabeth Street	/	/		

^ *Lanes are listed per direction and not total.*

Table 4-2 shows that the flood immunity of the potential evacuation routes ranges between the 5% and 1 in 500 AEP events. Provision of Vehicular Connection V4 and Pedestrian Connections P1 and P2 means that evacuation of the Moore Point Precinct will be possible by vehicle or foot while flood levels in the Georges River at the Liverpool Weir gauge do not exceed 10.2 mAHD; i.e., a gauge height of 7.44 metres. This means that evacuation is possible until flooding of the Georges River reaches the magnitude of a 1 in 500 AEP event.

4.4.2 Flood Conditions at Minor, Moderate and Major Gauge Heights

As discussed in **Section 4.2**, the primary gauge for monitoring flooding in the vicinity of the Moore Point Precinct is the Georges River at Liverpool Weir gauge. The gauge is relied upon by the SES for issuing flood warnings and managing evacuation and road closures.

A series of plots have been prepared to show flood conditions at the site during the assigned minor, moderate and major gauge heights. These gauge heights are important as they will be closely monitored by the SES and will likely be referenced when distributing flood updates and evacuation warnings.

Mapping showing the predicted flood levels and extents, flood depths and flow velocities have been prepared for the minor, moderate and major gauge heights. The figures that correspond to each gauge height are listed in **Table 4-3**.

Table 4-3 Flood Conditions Figures for Liverpool Weir Gauge Warning Heights

	Georges River at Liverpool Weir – Gauge Warning Levels ^		
	Minor	**Moderate**	**Major**
Flood Levels and Extents	**Figure 4-4**	**Figure 4-5**	**Figure 4-6**
Flood Depths	**Figure 4-7**	**Figure 4-8**	**Figure 4-9**
Flow Velocities	**Figure 4-10**	**Figure 4-11**	**Figure 4-12**

^ *Corresponding gauge heights are shown in **Section 4.2***

Figures 4-4 to **4-12** show that the Moore Point Precinct will remain largely flood free while the minor, moderate and major gauge heights are recorded at the Liverpool Weir gauge. Flood waters are predicted to start inundating the lower lying parts of the Precinct along the Georges River foreshore. This would impact areas used only for recreational purposes such as green space and pedestrian pathways.

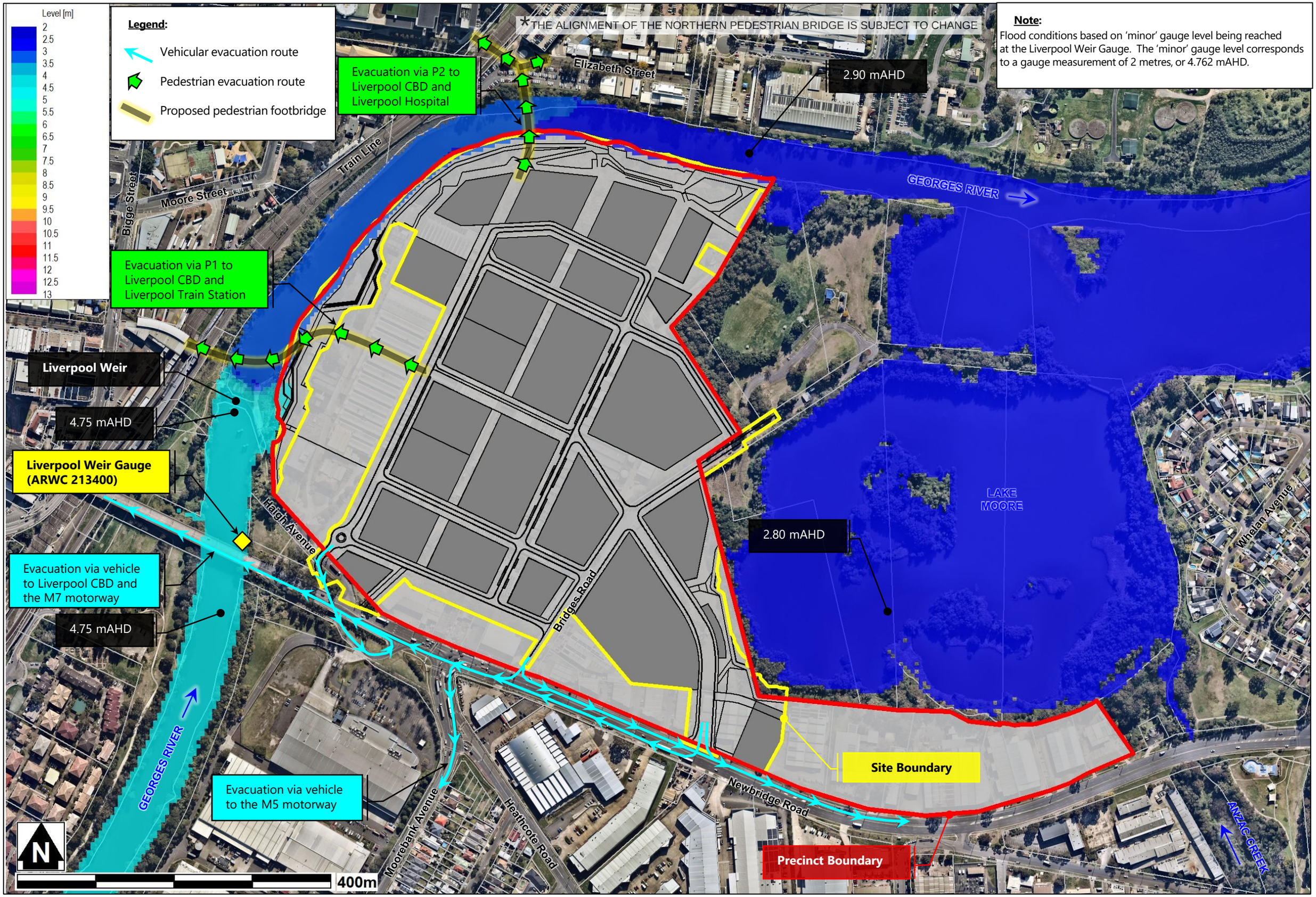
The mapping indicates that evacuation from the Moore Point Precinct will not be impacted during gauge heights up to and including a major warning level. Vehicular movements within the Precinct and onto Newbridge Road, Heathcote Road and Moorebank Avenue will not be impacted.

4.4.3 Flood Conditions Exceeding the Major Gauge Height

As discussed in **Section 4.2**, the major gauge height at the Liverpool Weir gauge corresponds roughly to the peak flood level predicted for a 10% AEP event. Accordingly, there is potential for higher flood levels to occur for events such as the 1% and 0.2% AEP floods.

Mapping showing the predicted flood levels and extents, flood depths and flow velocities have been prepared for a range of gauge heights that correspond to points in time during the rising limb of the Probable Maximum Flood (PMF) at which inundation of the various evacuation routes starts to occur. These gauge heights corresponding to the 1% and 0.2% AEP flood events. Figures have also been prepared for an intermediate gauge height that corresponds to the point of initial overtopping of Newbridge Road. The figures that correspond to these conditions and the corresponding gauge heights are listed in **Table 4-4**.

FIGURE 4-4



Note:
Flood conditions based on 'minor' gauge level being reached at the Liverpool Weir Gauge. The 'minor' gauge level corresponds to a gauge measurement of 2 metres, or 4.762 mAHD.

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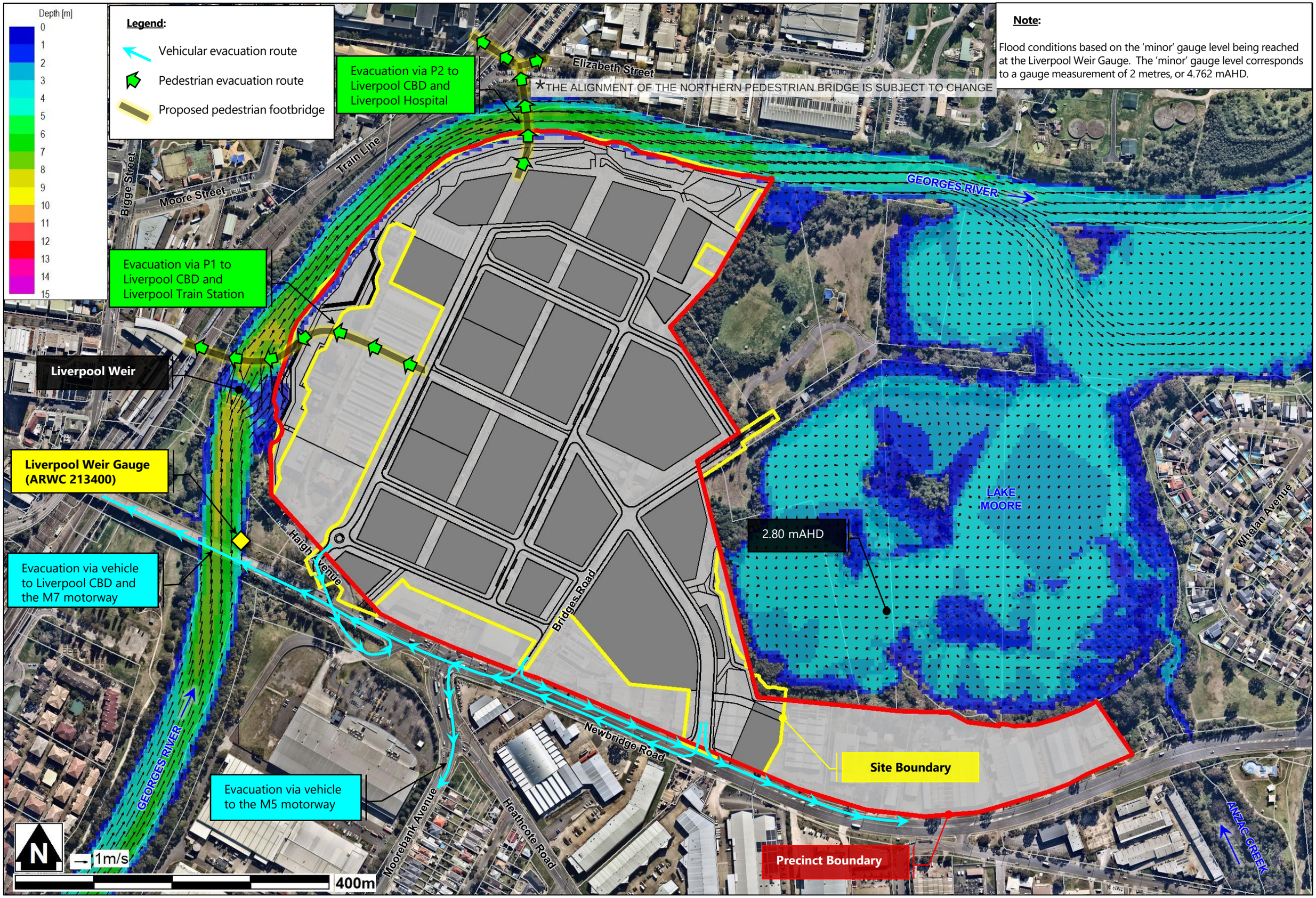
* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MINOR' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-5



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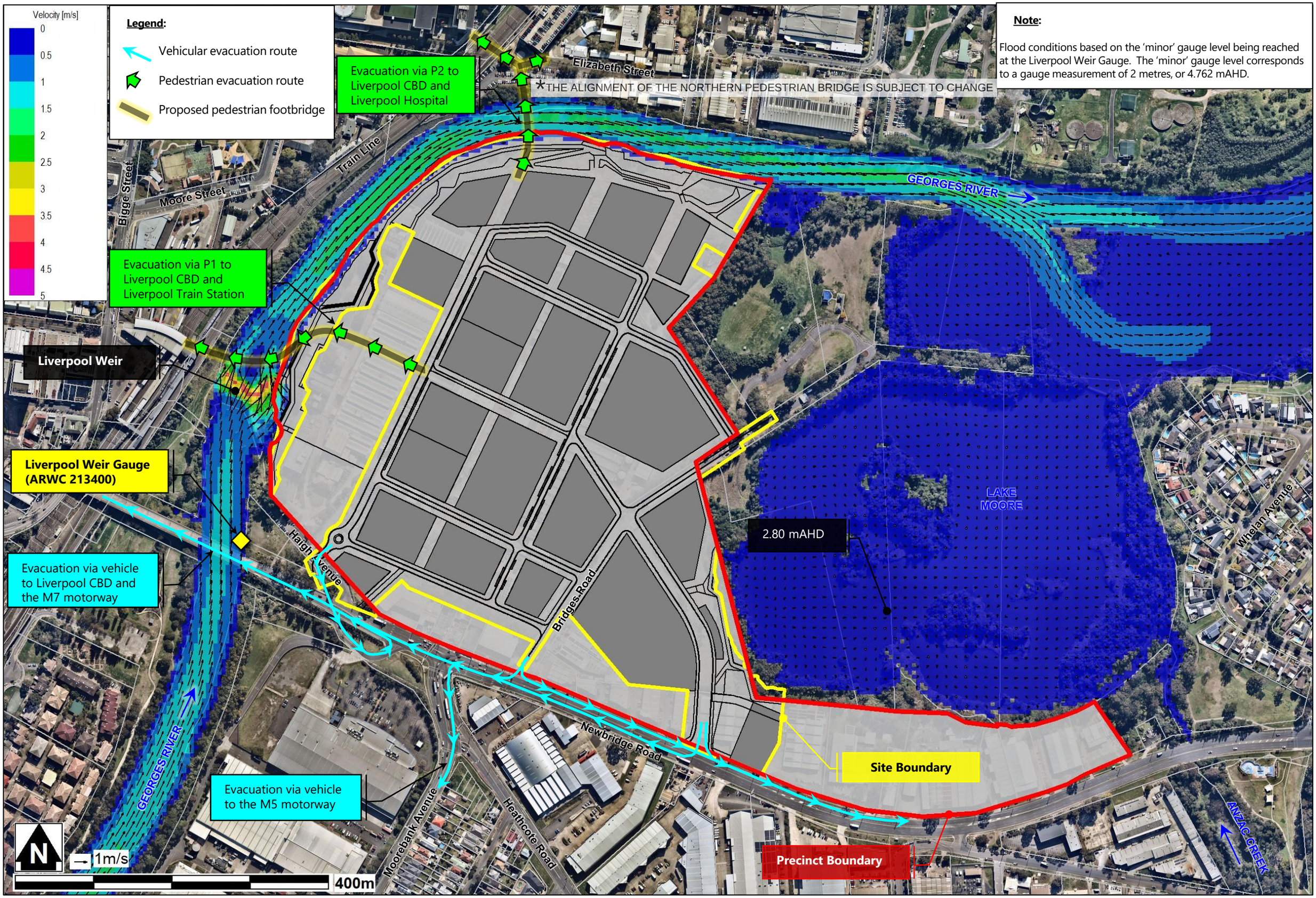
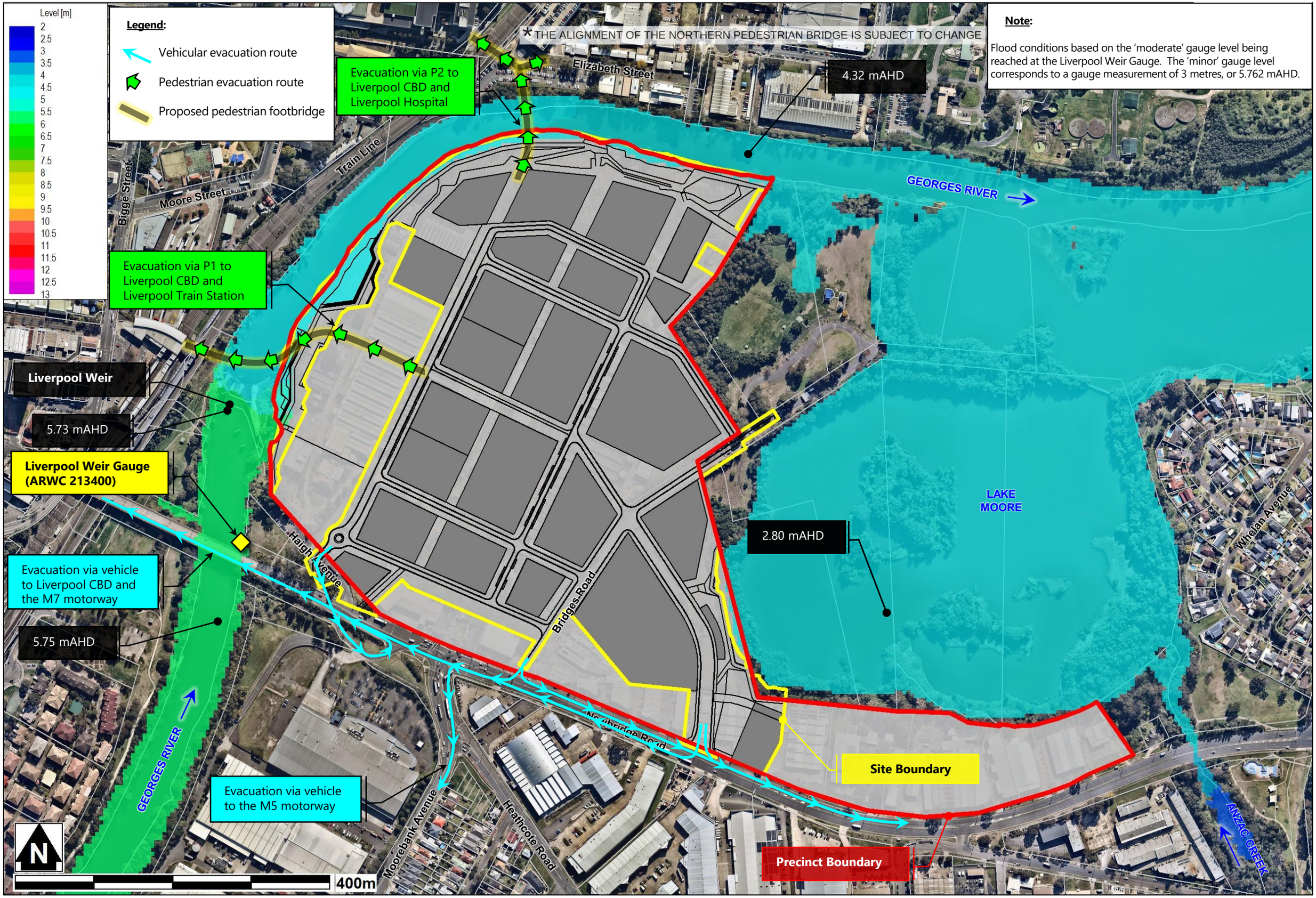
PREDICTED FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MINOR' LIVERPOOL WEIR GAUGE HEIGHT



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

PREDICTED FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS AT THE 'MINOR' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-7



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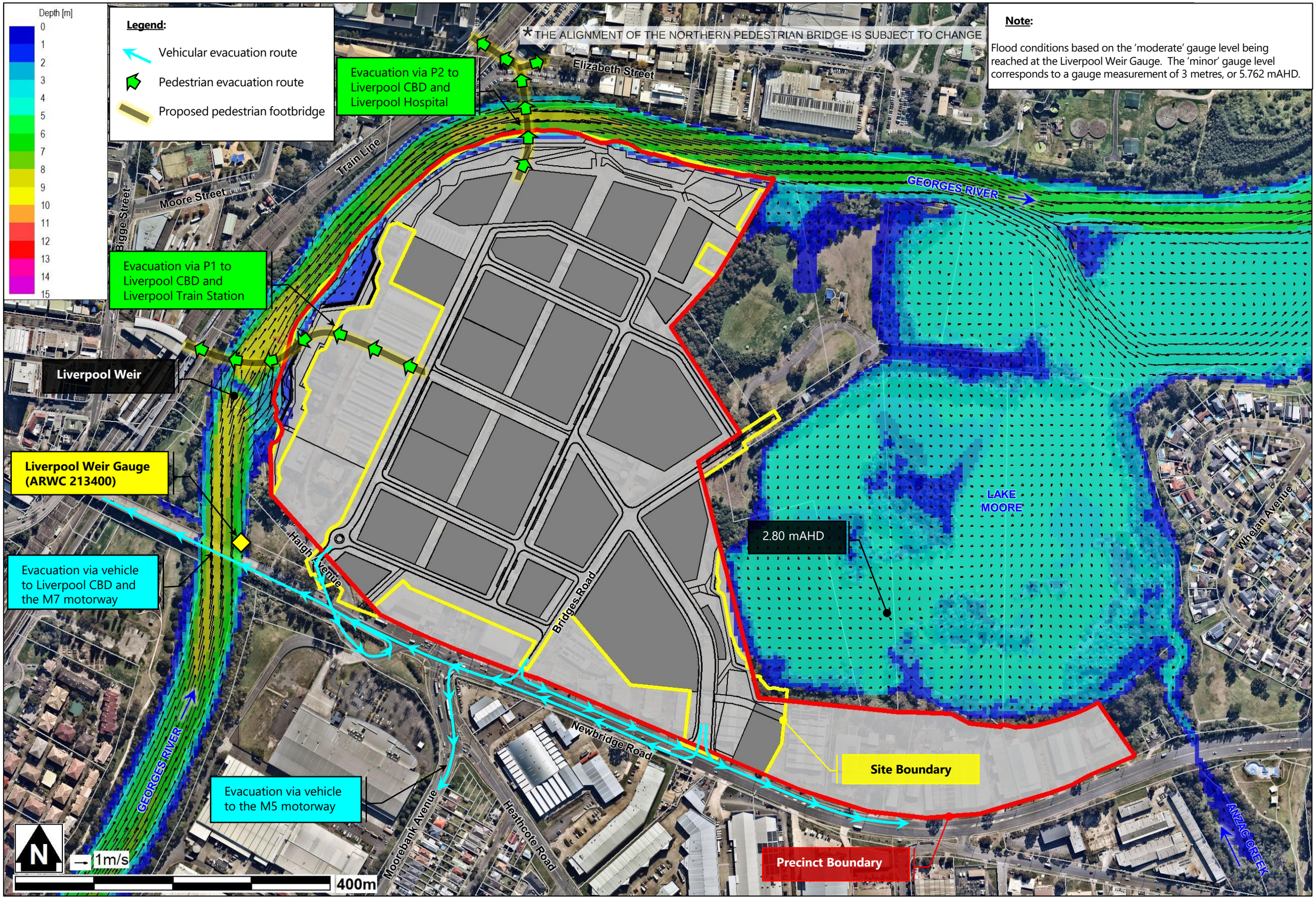
PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MODERATE' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-8



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* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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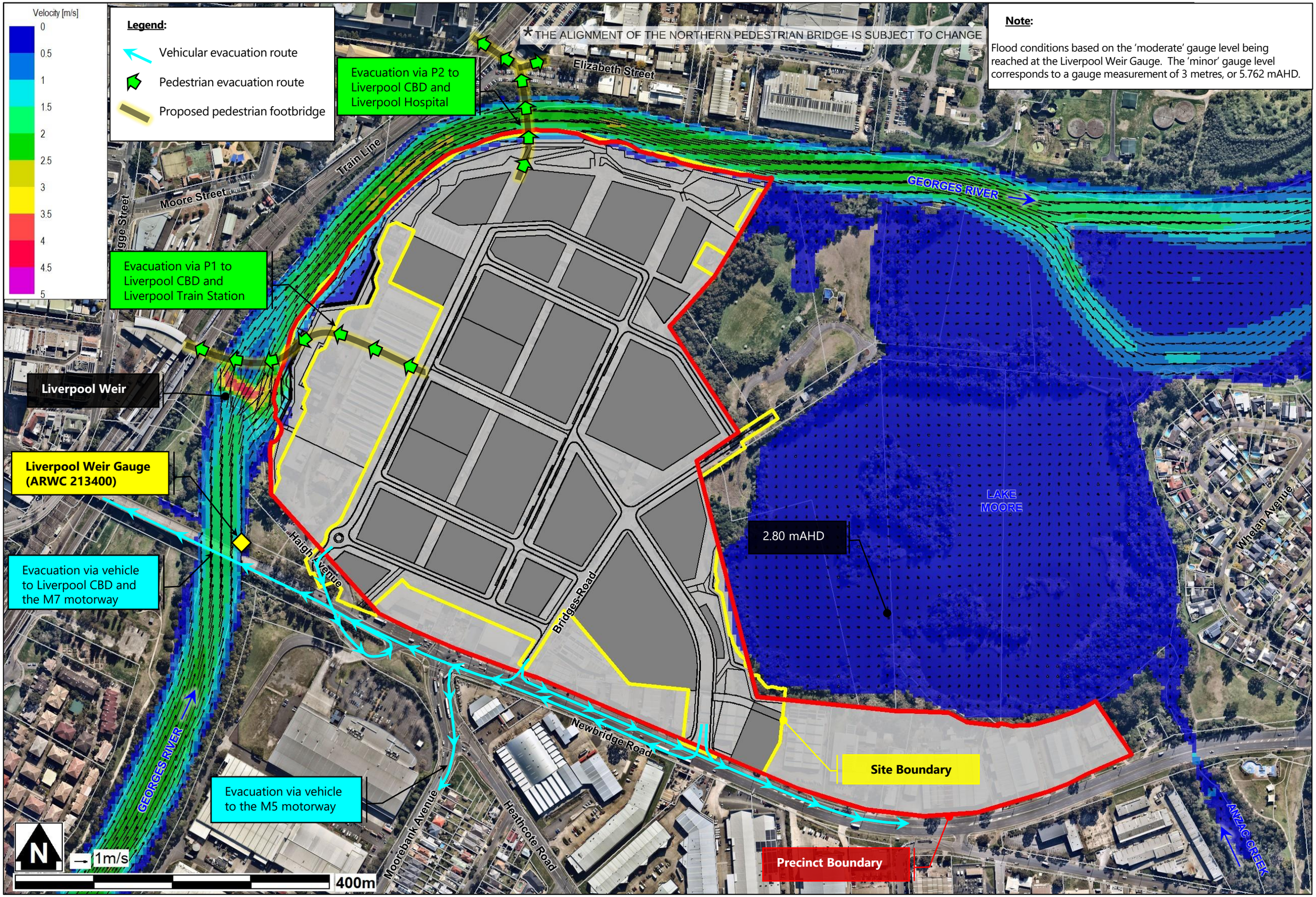
PREDICTED FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MODERATE' LIVERPOOL WEIR GAUGE HEIGHT



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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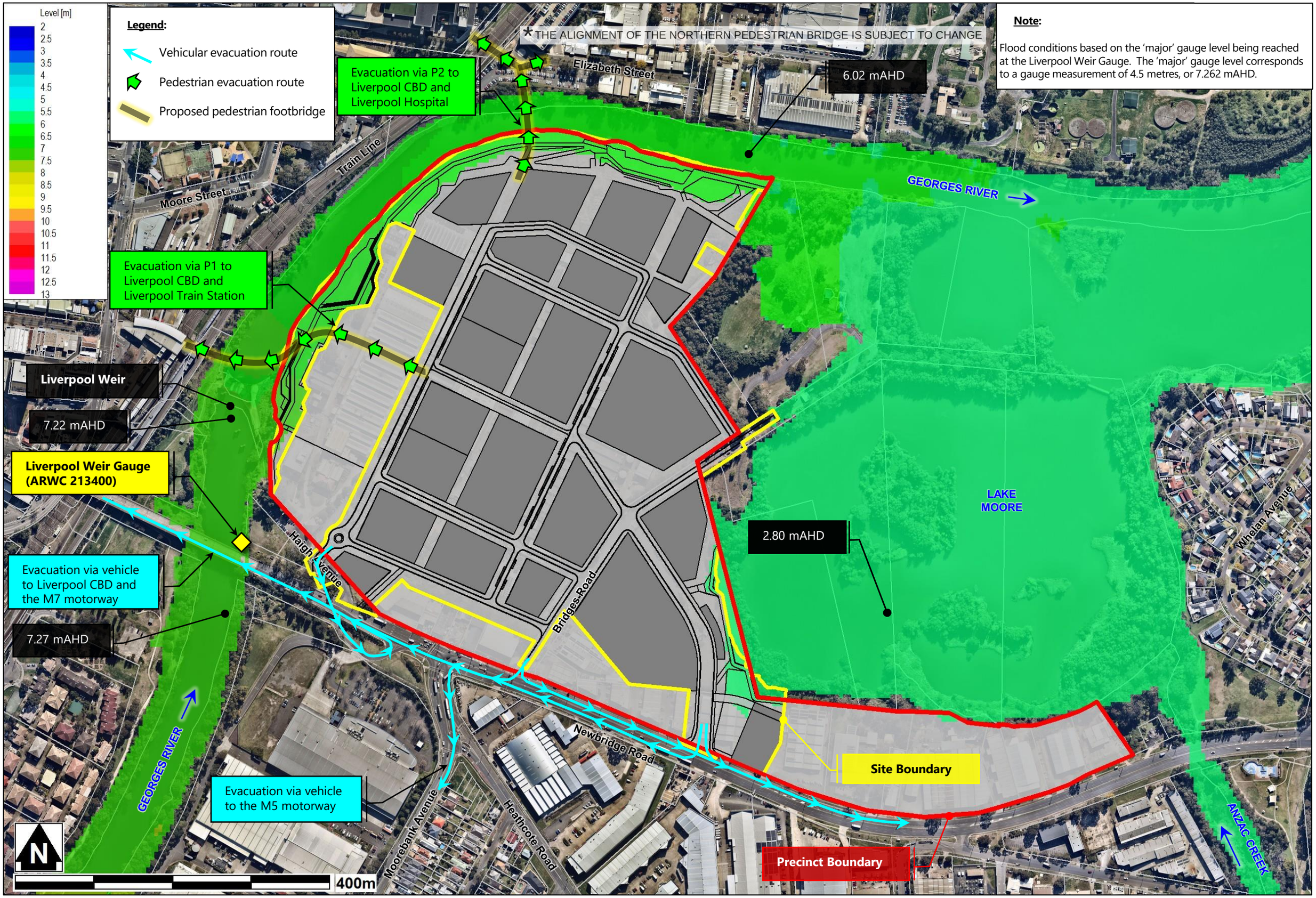
PREDICTED FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS AT THE 'MODERATE' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-10



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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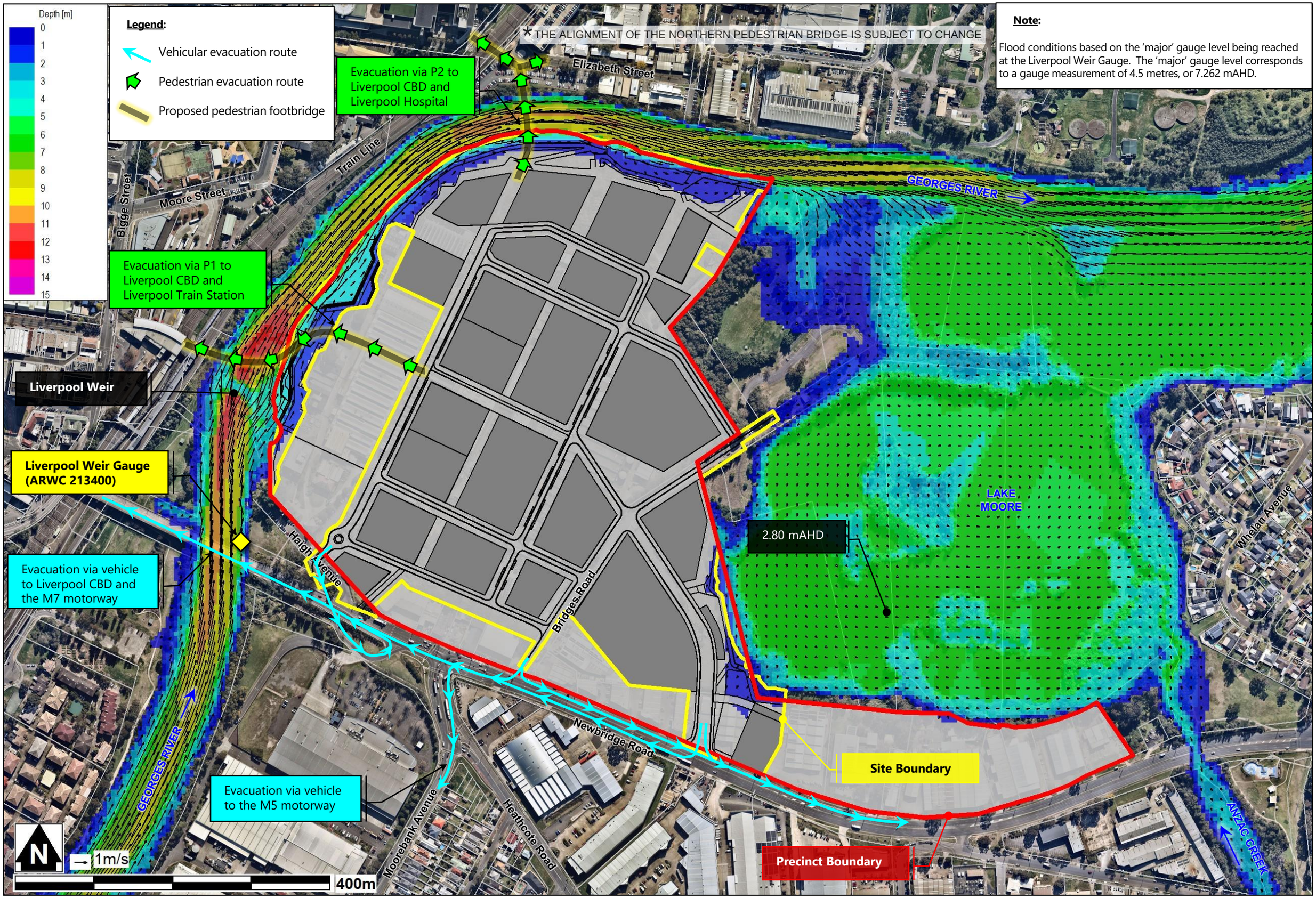
PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MAJOR' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-11



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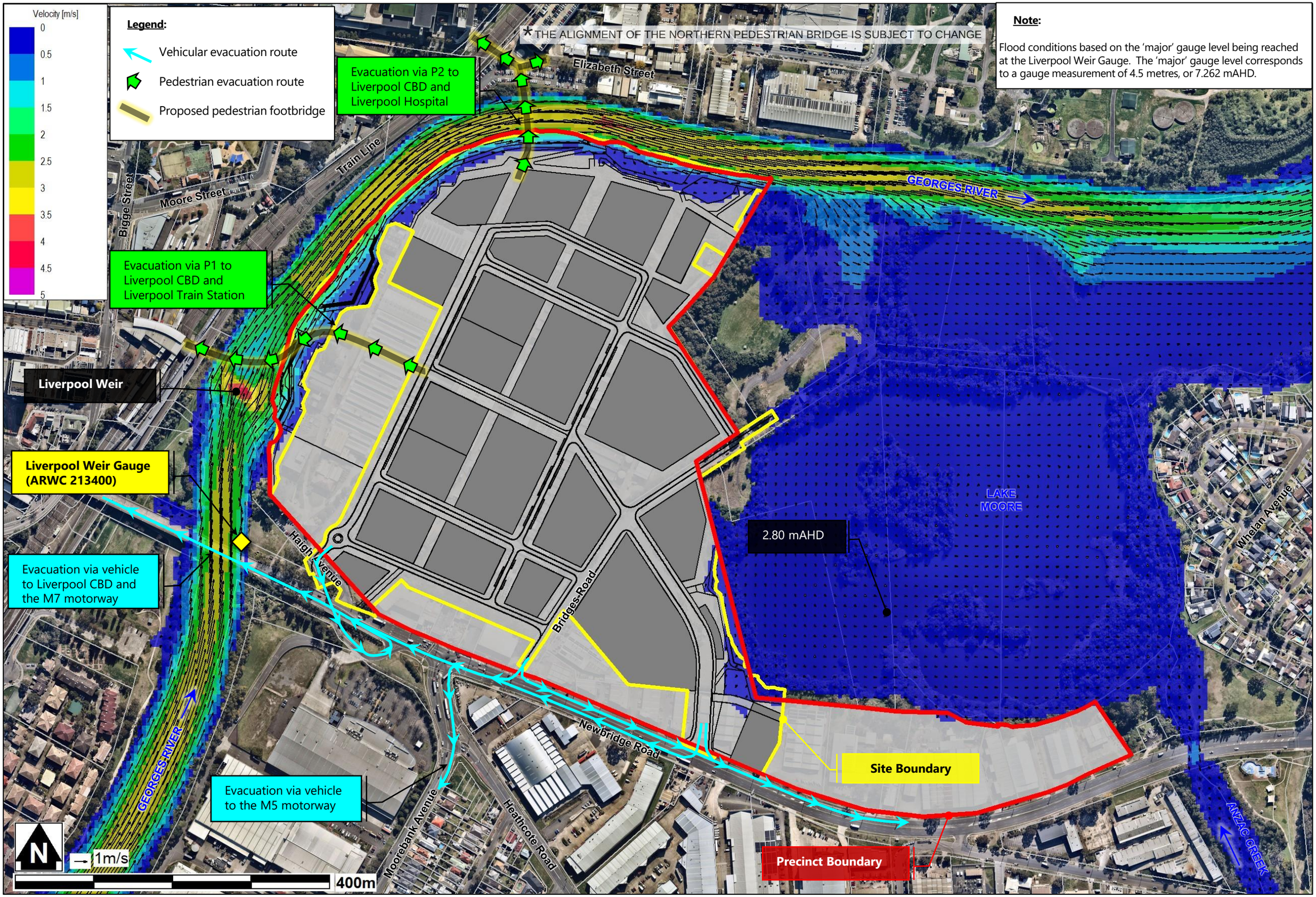
* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

PREDICTED FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS AT THE 'MAJOR' LIVERPOOL WEIR GAUGE HEIGHT

FIGURE 4-12



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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PREDICTED FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS AT THE 'MAJOR' LIVERPOOL WEIR GAUGE HEIGHT

Table 4-4 Flood Conditions for Liverpool Weir Gauge Warning Heights Exceeding the Major Level

	Inundation of Heritage Buildings near Liverpool Weir	Inundation of Vehicular Evacuation Routes V1, V2 & V3	Inundation spreads into south-east corner of the development	Inundation of Vehicular Evacuation Route V4 and Pedestrian Bridge P1 & P2
Liverpool Weir Gauge Height	5.80 metres	6.44 metres	7.09 metres	7.44 metres
Liverpool Weir Gauge Elevation	8.56 mAHD	9.20 mAHD	9.85 mAHD	10.20 mAHD
Flood Levels and Extents	**Figure 4-13**	**Figure 4-14**	**Figure 4-15**	**Figure 4-16**

*Note: Locations of Vehicular Evacuation Routes V1 to V4 and Pedestrian Evacuation Routes P1 to P2 are shown on **Figure 4-1***

Figure 4-13 shows that at a Liverpool Weir gauge height of 5.80 metres floodwaters would start to:

- Inundate the heritage buildings near Liverpool Weir and Pedestrian Footbridge P1. Footbridge P1 is however elevated and is not impacted until flooding nears a gauge height of 7.44 metres (*refer* **Figure 4-16**).

Figure 4-14 shows that at a Liverpool Weir gauge height of 6.44 metres floodwaters would start to:

- inundate the lower lying parts of Newbridge Road by backing up through the proposed overland flow route and/or via the local drainage network; and,
- break the banks of the Georges River upstream of Newbridge Road leading to the immanent inundation of Haigh Avenue and Heathcote Road and increased flooding along Newbridge Road.

As a result of the inundation discussed above, vehicular evacuation routes V1, V2 and V3 would be closed.

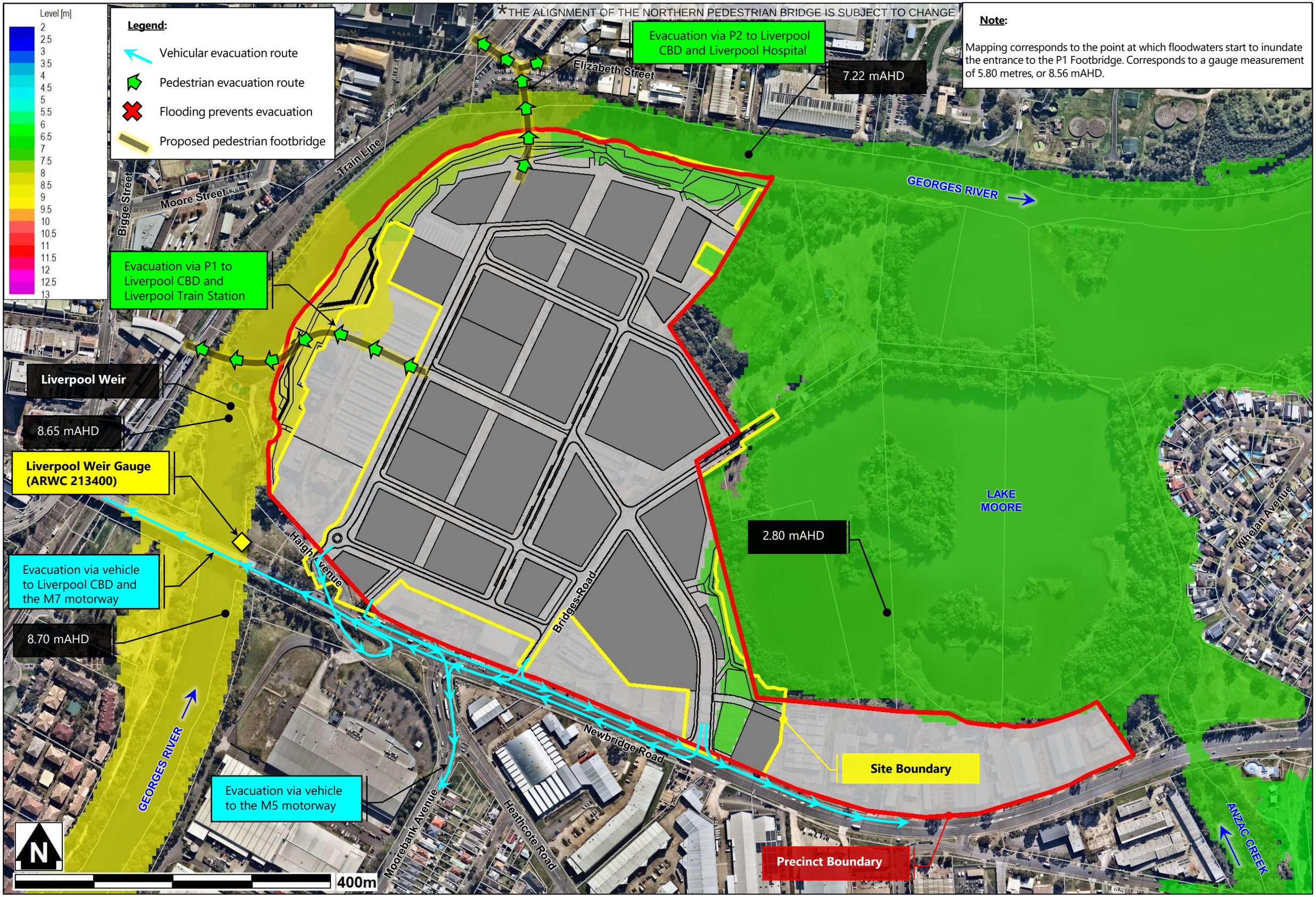
Figure 4-15 shows that at a Liverpool Weir gauge height of 7.09 metres floodwaters would:

- inundate the lower lying parts of Moore Point Precinct adjacent to Newbridge Road. This is predicted to result in floodwaters inundated parts of Bridges Road and part of the internal road network; and,
- inundate the heritage sites to the west of the Precinct.

At this point in time, vehicular evacuation route V3 would remain flood free providing ongoing access to the Liverpool CBD via Newbridge Road. Pedestrian Footbridge P1 and P2 would also remain flood free and be available for safe evacuation by foot.

Figure 4-16 shows that at a Liverpool Weir gauge height of 7.44 metres floodwaters would start to inundate the internal road network and development pads. Further evacuation of the Moore Point Precinct by vehicle or foot is not recommended until floodwaters recede below 7.44 metres at the Liverpool Weir gauge.

FIGURE 4-13



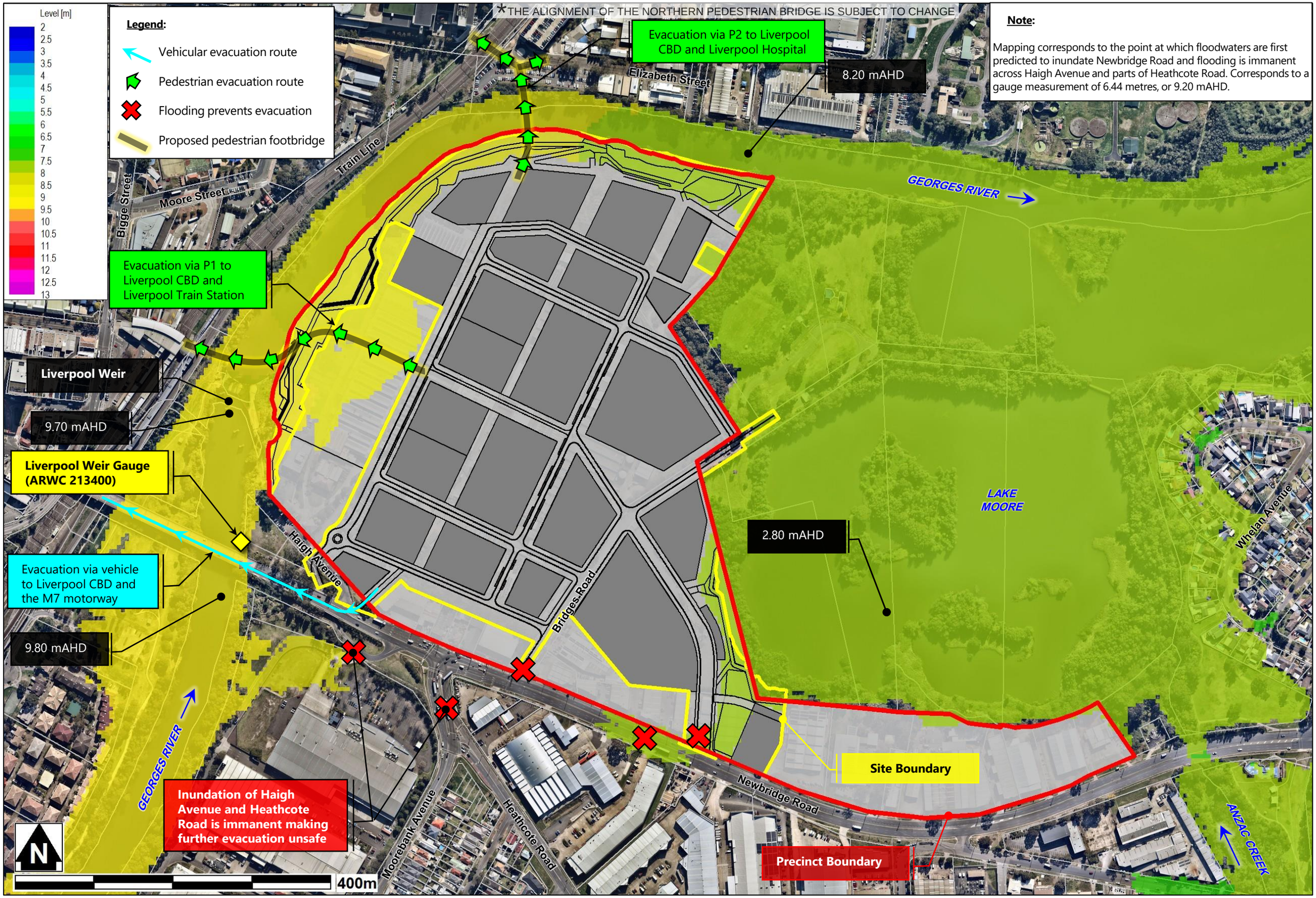
worley
DELIVERING SUSTAINABLE CHANGE

311012-00000 –Moore Point Precinct FIRA
210914_Moore Point Precinct.pptx

* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS AT THE POINT OF INITIAL FLOODING OF FOOTBRIDGE P1

FIGURE 4-14



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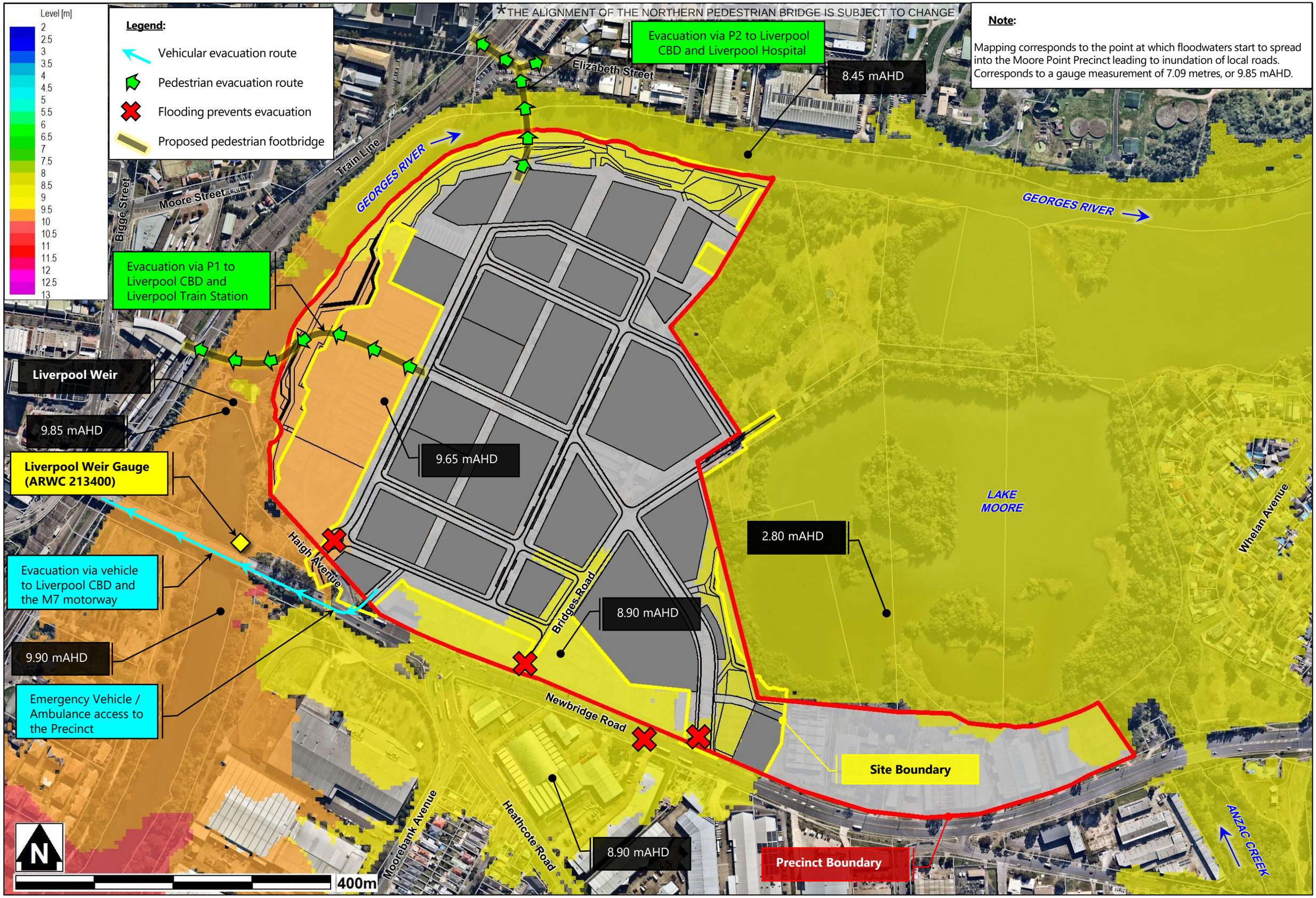
DELIVERING SUSTAINABLE CHANGE

311012-00000 –Moore Point Precinct FIRA
210914_Moore Point Precinct.pptx

* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS AT THE POINT OF INITIAL FLOODING ALONG NEWBRIDGE ROAD



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DELIVERING SUSTAINABLE CHANGE

* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

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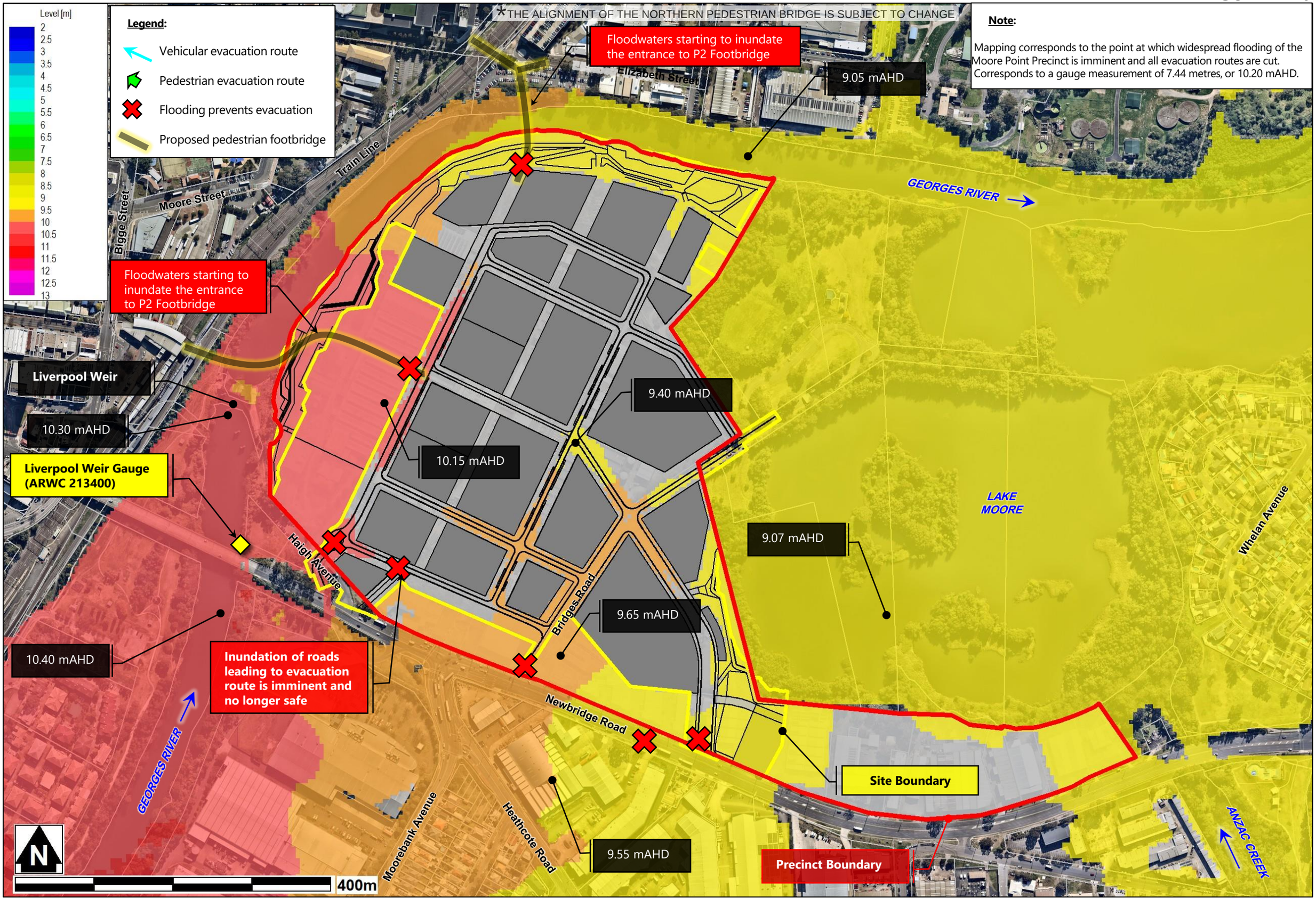
PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS ONCE FLOODWATERS SPREAD INTO THE PRECINCT

FIGURE 4-16



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners.

311012-00000 –Moore Point Precinct FIRA
210914_Moore Point Precinct.pptx

PREDICTED FLOOD LEVELS AND EXTENTS FOR POST-DEVELOPMENT CONDITIONS ONCE FLOODWATERS SPREAD INTO THE PRECINCT

4.5 Available Time for Flood Warning and Evacuation

Flood warning and evacuation times for the Georges River floodplain are documented in a report titled, '*Georges River Evacuation Modelling – Flood Evacuation Analysis*', which was prepared in 2022 by Molino Stewart for Liverpool City Council. Appendix C of the 2022 Molino Stewart Report states that there is 7.25 hours of available time for evacuation, or Surplus Time (TM), for the Moore Point Precinct. The report indicates that this time was determined based on the following approach and assumptions.

(i) There is a minimum of 12 hours of 'target warning lead time' available before a gauge height of 4 metres is reached at the Liverpool Weir Gauge as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019).

(ii) The available time for evacuation, or Surplus Time (TM), is determined based on the NSW SES Timeline Evacuation Model (TEM). The TEM requires that the following factors be taken into consideration and subtracted from the available evacuation time:

- Warning Acceptance Factor (WAF);
- Warning Lag Factor (WLF);
- Required Travel Time (TT); and,
- Travel Safety Factor (TSF).

The above factors combine to form a Delay Factor (DF).

(iii) The available time for evacuation (TM) of 7.25 hours is determined from the following calculation.

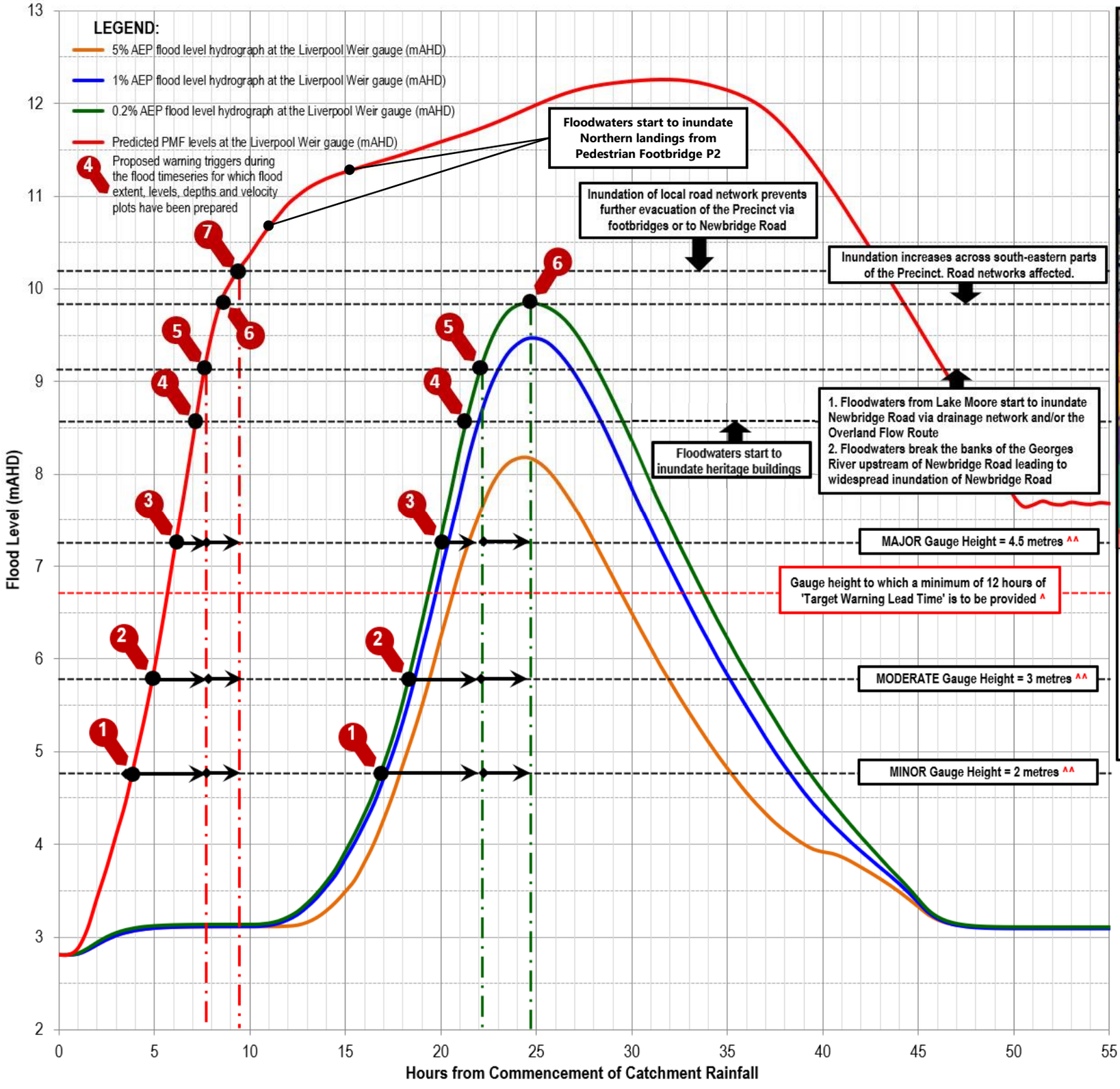
Available Time for Evacuation = Available Time (AT) less Delay Factor (DF)
= 12 hours less 4.75 hours
= 7.25 hours

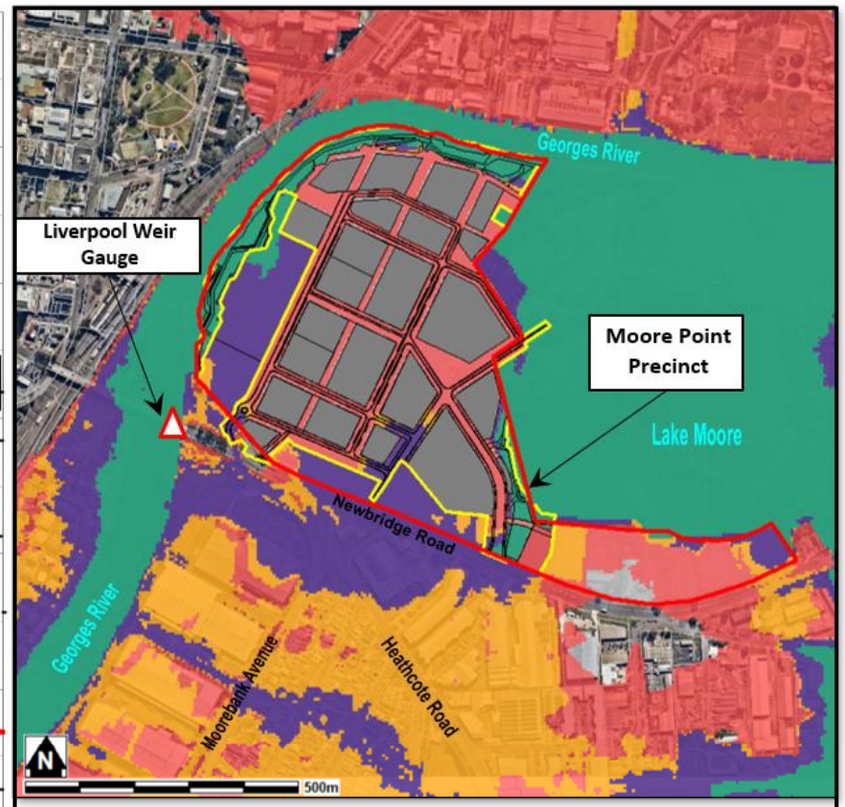
The logic for adopting 12 hours as the total available time is unclear from the 2022 Molino Stewart Report given that this corresponds to the warning time forecast to be available prior to flood levels reaching a gauge height of 4 metres. As shown in **Table 4-4** and **Figure 4-14**, inundation of Newbridge Road is not predicted until flood levels at the Liverpool Weir Gauge reach 6.44 metres, or 9.2 mAHD.

Flood level (or stage) hydrographs for the 5%, 1% and 1 in 500 AEP floods and the PMF are plotted on **Figure 4-17** for the Liverpool Weir gauge. Although the 1% AEP event is the flood used for planning purposes such as setting building floor levels, it is appropriate to use rarer floods up to and including the PMF when considering risk to life issues such as those that will involve evacuation. This is because the rate-of-rise in the extreme flood is often faster than for lesser events, such as the 1% AEP flood or 1 in 500 AEP event.

Accordingly, the flood warning times presented for the PMF are considered to represent a worst-case assessment; i.e., warning times would typically be longer for smaller or more frequent floods.

Included on **Figure 4-17** are markers which indicate the point in time along the 1 in 500 AEP and PMF flood level hydrographs at which inundation of the various evacuation routes first occurs. These markers are included to allow warning times to be calculated from each of the minor, moderate and major flood warning gauge heights. The elevation and importance of each of the markers is outlined in **Table 4-5**.





LEGEND:

- Location of the Liverpool Weir Gauge
- Predicted peak 5% AEP flood levels
- Predicted peak 1% AEP flood levels
- Predicted peak 1 in 500 AEP flood levels
- Predicted peak Probable Maximum Flood (PMF) levels

NOTES:

^ Available warning times include twelve (12) hours of minimum *'target warning lead time'* before a gauge height of 4 metres is reached as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019).

^^ Gauge zero for the Georges River at Liverpool Weir gauge is 2.762 mAHD

PREDICTED FLOOD WARNING TIMES AND NOMINATED EMERGENCY RESPONSE TRIGGERS BASED ON THE LIVERPOOL WEIR GAUGE

Table 4-5 Overview of Adopted Flood Markers

Adopted Markers (Refer **Figure 4-17**)	Corresponding Liverpool Weir Gauge Height & Elevation	Event Description
Marker No. 1	2.0 metres 4.762 mAHD	Flood levels at the Liverpool Weir gauge reach the 'Minor' gauge height.
Marker No. 2	3.0 metres 5.762 mAHD	Flood levels at the Liverpool Weir gauge reach the 'Moderate' gauge height.
Marker No. 3	4.5 metres 7.262 mAHD	Flood levels at the Liverpool Weir gauge reach the 'Major' gauge height.
Marker No. 4	5.8 metres 8.56 mAHD	Floodwaters first start to inundate the heritage buildings near the Liverpool Weir.
Marker No. 5	6.44 metres 9.20 mAHD	Floodwaters start to inundate the lower lying parts of Newbridge Road and inundation of Haigh Avenue and Moorebank Avenue is immanent. Vehicular Evacuation Routes V1, V2 and V3 are no longer viable.
Marker No. 6	7.09 metres 9.85 mAHD	Inundation of the south-east corner of the Moore Point Precinct increases. Evacuation Routes V4, P1 and P2 remain open.
Marker No. 7	7.44 metres 10.20 mAHD	Widespread flooding of the Moore Point Precinct internal road network is immanent with floodwaters encroaching from the west (near Liverpool Weir) and east. Vehicular evacuation via V4 and Pedestrian Evacuation via P1 and P2 are no longer viable.

The PMF stage hydrograph shows that there would be an additional 2 hours of evacuation time available between the time flood levels rise from 4 metres to 6.44 metres at the Liverpool Weir gauge (*refer* **Figure 4-17**).

Furthermore, Vehicular Evacuation Route V4 will allow evacuation to continue west along Newbridge Road up to a gauge height of 7.44 metres. This could enable evacuation to occur for a further 1.5 hours from initial inundation of Newbridge Road (*refer* **Figure 4-17**) or 3.5 hours from the time when flood levels are predicted to reach a height of 4 metres at the gauge.

The available time for evacuation of 7.25 hours determined by Molino Stewart (2022) is considered to be conservative based on the development layout currently proposed for the Moore Point Precinct and the assessment of evacuation route flooding included in **Section 4.3.3**.

4.6 Potential Triggers for Evacuation Management

Volume 3 of the '*Georges River and Woronora River Valley Flood Emergency Sub Plan*' was not available for review as it is currently in the preliminary stages of drafting. Evacuation and floodplain management triggers are typically outlined in Volume 3 of an Emergency Sub Plan and as such this information is not available for the Georges River floodplain for consideration in emergency response planning for the development.

Notwithstanding, it is common practice for the NSW SES to monitor river level gauges and assign triggers to various gauge heights. In that regard, the Georges River at Liverpool Weir gauge (ARWC No. 213400) is monitored by the SES and relied upon for issuing Minor, Moderate and Major flood warnings (*refer* **Section 4.2**).

In lieu of the information to be contained in Volume 3 of the sub plan, predicted flood warning and evacuation times have been assessed for each of the Minor, Moderate and major gauge heights at the Liverpool Weir gauge. The available warning and evacuation times are listed in **Table 4-6** and **Table 4-7** based on the predicted flood level hydrographs exported for the PMF event and the 1 in 500 AEP flood, respectively. Warning times are provided for the following four evacuation triggers or scenarios:

(1) Preparation and evacuation of the Moore Point Precinct is commenced at the start of the twelve (12) hours of minimum '*target warning lead time*' specified within the '*Provisions and Requirements for Flood Warning*' (*NSW SES, 2019*). The 12 hours of warning is adopted by Liverpool City Council (LCC) and agreed to by the NSW SES.

(2) Flood warning is based on the 12 hours target lead time (*refer Scenario 1 above*) and evacuation is not triggered until the 'Minor' gauge height is reached.

(3) Flood warning is based on the 12 hours target lead time (*refer Scenario 1 above*) and evacuation is not triggered until the 'Moderate' gauge height is reached.

(4) Flood warning is based on the 12 hours target lead time (*refer Scenario 1 above*) and evacuation is not triggered until the 'Major' gauge height is reached.

Table 4-6 Flood Warning and Evacuation Times Based on the Rate of Rise Predicted for the PMF Event and Various Triggers

Evacuation Route Options (Refer **Figure 4-1**)	**Utilisation of all of the 12 hours of minimum 'target warning lead time'^**	**Liverpool Weir Gauge Triggers**		
		From the 'Minor' Gauge Height	**From the 'Moderate' Gauge Height**	**From the 'Major' Gauge Height**
Vehicular Connection V1: Bridges Road connection to Newbridge Road	14.0 hrs Evacuation and Warning	4.0 hrs Evacuation 10.0 hrs Warning	2.5 hrs Evacuation 11.5 hrs Warning	1.5 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V2: Anchor Place connection to Newbridge Road	14.0 hrs Evacuation and Warning	4.0 hrs Evacuation 10.0 hrs Warning	2.5 hrs Evacuation 11.5 hrs Warning	1.5 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V3: Connection to Haigh Avenue	14.0 hrs Evacuation and Warning	4.0 hrs Evacuation 10.0 hrs Warning	2.5 hrs Evacuation 11.5 hrs Warning	1.5 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V4: Connection to Newbridge Road, west of Bridges Road	15.5 hrs Evacuation and Warning	5.5 hrs Evacuation 10.0 hrs Warning	4.0 hrs Evacuation 11.5 hrs Warning	3.0 hrs Evacuation 12.5 hrs Warning
Pedestrian Connection P1: Connection to Liverpool CBD via Liverpool Train Station	15.5 hrs Evacuation and Warning	5.5 hrs Evacuation 10.0 hrs Warning	4.0 hrs Evacuation 11.5 hrs Warning	3.0 hrs Evacuation 12.5 hrs Warning
Pedestrian Connection P2: Connection to Liverpool CBD and Liverpool Hospital via Elizabeth St	15.5 hrs Evacuation and Warning	5.5 hrs Evacuation 10.0 hrs Warning	4.0 hrs Evacuation 11.5 hrs Warning	3.0 hrs Evacuation 12.5 hrs Warning

^ Available warning times include twelve (12) hours of minimum '*target warning lead time*' before a gauge height of 4 metres is reached as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019).

Table 4-7 Flood Warning and Evacuation Times Based on the Rate of Rise Predicted for the 1 in 500 AEP Event and Various Triggers

Evacuation Route Options (Refer **Figure 4-1**)	Utilisation of all of the 12 hours of minimum 'target warning lead time'^	Liverpool Weir Gauge Triggers		
		From the 'Minor' Gauge Height	From the 'Moderate' Gauge Height	From the 'Major' Gauge Height
Vehicular Connection V1: Bridges Road connection to Newbridge Road	14.5 hrs Evacuation and Warning	5.0 hrs Evacuation 9.5 hrs Warning	3.5 hrs Evacuation 11.0 hrs Warning	2.0 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V2: Anchor Place connection to Newbridge Road	14.5 hrs Evacuation and Warning	5.0 hrs Evacuation 9.5 hrs Warning	3.5 hrs Evacuation 11.0 hrs Warning	2.0 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V3: Connection to Haigh Avenue	14.5 hrs Evacuation and Warning	5.0 hrs Evacuation 9.5 hrs Warning	3.5 hrs Evacuation 11.0 hrs Warning	2.0 hrs Evacuation 12.5 hrs Warning
Vehicular Connection V4: Connection to Newbridge Road, west of Bridges Road	19.0 hrs Evacuation and Warning	8.0 hrs Evacuation 11.0 hrs Warning	6.0 hrs Evacuation 13.0 hrs Warning	4.5 hrs Evacuation 14.5 hrs Warning
Pedestrian Connection P1: Connection to Liverpool CBD via Liverpool Train Station	19.0 hrs Evacuation and Warning	8.0 hrs Evacuation 11.0 hrs Warning	6.0 hrs Evacuation 13.0 hrs Warning	4.5 hrs Evacuation 14.5 hrs Warning
Pedestrian Connection P2: Connection to Liverpool CBD and Liverpool Hospital via Elizabeth Street	19.0 hrs Evacuation and Warning	8.0 hrs Evacuation 11.0 hrs Warning	6.0 hrs Evacuation 13.0 hrs Warning	4.5 hrs Evacuation 14.5 hrs Warning

^ Available warning times include twelve (12) hours of minimum '*target warning lead time*' before a gauge height of 4 metres is reached as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019).

Table 4-6 indicates that during a Georges River PMF event there would be between 13.5 and 15.5 hours of combined warning and evacuation time available. The length of available warning and evacuation time is dependent on which evacuation options are taken. In that regard, evacuation via Vehicular Route V4 and Pedestrian Footbridges P1 and P2 provide the maximum warning and evacuation time.

Available warning times for a 1 in 500 AEP event have also been assessed and are presented in **Table 4-7** based on the flood level hydrograph superimposed on **Figure 4-17**. As shown, the 1 in 500 AEP flood level hydrograph has a more gradual rate-of-rise leading to longer warning times for evacuation to be completed. The warning times presented in **Table 4-7** confirm this with between 14.0 and 19.0 hours of combined warning and evacuation time available. This is up to 3.5 hours longer than predicted for the PMF event.

Tables 4-6 and **4-7** show that the quantum of available warning and evacuation time will not change regardless of the evacuation triggers nominated. In that regard, selection of a Moderate gauge height over Minor will only result in less time for dedicated evacuation whilst providing increased flood warning time. However, it is expected that evacuation of the Moore Point Precinct will actively occur during the warning phase regardless of an official trigger height being reached. The rate of evacuation would however be lower than during the later stages of the flood event when evacuation has been triggered.

4.7 Evacuation Strategy

The proposed approach for managing the potential flood risk at the Moore Point Precinct is based on:

a) minimising the potential for flooding of the Georges River to impact on the development and its occupants,

b) utilising technology and other means for information dissemination,

c) utilising early warning triggers such as severe weather warnings to commence systems maintenance and preparation of the site and people;

d) maximising the capacity for future residents and workers to safely evacuate the precinct either by vehicle (up to a maximum of 5,500) or by foot, during the onset of major flooding that would cause the precinct to be isolated for more than 6 hours., and recommendations made by the flood advisory panel and flood enquiry.

The key aspects of the Strategy are as follows.

- Design of the landform for the development that delivers residential and commercial precincts that are at an elevation above the predicted peak level of the 1 in 500 AEP flood and which have building footprints set at or above the Flood Planning Level (FPL) for the site as determined by Liverpool City Council.
- Design of a graded landform that delivers an internal road network with minimum road elevations that allow for up to 12 hours warning time before evacuation needs to be triggered should the prospect of flooding of the Georges River lead to the potential for floodwaters to reach elevations above the FPL; that is above the 1% AEP flood level plus 0.5 m (10.1 mAHD), which is a level higher than the predicted 1 in 500 AEP flood level for the Precinct.
- Provision of buildings with minimum habitable floor levels set at or above the predicted peak level of the Probable Maximum Flood (PMF) (12.2 mAHD).
- Construction of a built form, internal road network and pedestrian routes that delivers the opportunity for a phased approach to emergency response management during the onset of a flood rarer than the 1 in 500 AEP event.
- Construction of a vehicular evacuation route that could provide emergency vehicle access to and from the Precinct during events up to and including the 1 in 500 AEP event. Vehicular Connection V4 has been designed to meet this criteria. Pedestrian Footbridges P1 and P2 therefore do not need to meet this criteria and instead provide a similar level of flood immunity for pedestrian access only.
- Ensuring procedures are in place that include maintenance and reviews during normal weather conditions, site and systems preparation following early warning, and evacuation management during a flood (*refer* **Section 6**).

An assessment of the above strategy for managing flood risk is provided in the following sections. The assessment seeks to evaluate the capacity of vehicular and pedestrian evacuation options based on the available flood warning times identified in **Section 4.4**. Shelter-in-place as a failsafe measure is also discussed.

4.8 Evacuation of Residents by Car

The 2022 Flood Evacuation Analysis undertaken by Molino Stewart determined the road network may have capacity for approximately 5,500 vehicles evacuating from Moore Point. This modelling was based on Scenario B which included a range of road upgrades that are forecast for the Liverpool LGA and within the evacuation area. The estimated 5,500 vehicle capacity is considered conservative on the basis that it does include evacuation along the proposed Vehicular Connection V4 to Newbridge Road. As shown in **Table 4-2** and **Figure 4-16**, Vehicular Evacuation Route V4 will provides a connection to Newbridge Road that is above the predicted peak flood level for a 1 in 500 AEP event, or to a height of 7.44 metres at the Liverpool Weir Gauge. Inclusion of Route V4 would allow evacuation to continue for at least 3 hours beyond that modelled as part of the 2022 Molino Stewart Report. This would increase the total number of vehicles that could evacuate the site by between 1,800 and 3,600, depending on whether one or two lanes are used for evacuation, respectively.

Accordingly, it is estimated that between 7,300 and 9,100 vehicles could safely evacuate from the Moore Point Precinct in the event of a PMF in the Georges River catchment.

A total of 10,500 vehicles spaces is planned for the Moore Point Precinct. Therefore, if the additional carrying capacity afforded by Route V4 is assumed, there could be between 5,200 and 3,400 vehicles that are not able to leave the precinct in the available warning time during the onset of a PMF.

However, this scenario assumes that 100% of spaces are occupied at the time evacuation is triggered. This assumption is extremely conservative as the parking space occupancy rate at any point in time would never be 100% based on the daily movements of people for work or leisure and/or holidays (*refer* **Table 4-1**).

It is important to note that the owners of the vehicles that cannot be evacuated in the available time post an evacuation order would be able to evacuate via the two footbridges that will connect the site to the Liverpool CBD. Movements onwards from the Liverpool CBD will be discussed with Council and State Government to identify options for relocation to evacuation centres and/or implementation of new temporary refuge alternatives. Accordingly, vehicular evacuation is not the sole mechanism for mitigating flood risk for the Moore Point Precinct.

Discussion Regarding Conservative Assumptions

The following are considered to be important points that are not considered as part of the 2022 Molino Stewart modelling and which could lead to an increase in the vehicular evacuation capacity

Evacuation Rate from Vehicular Route V4

The adopted vehicular evacuation rate of 600 vehicles per hour per lane is considered conservative for Vehicular Evacuation Route V4 over the course of its use following inundation of Newbridge Road. A higher rate of up to 1,200 vehicles per lane per hour could be more appropriate given there would be no external traffic along Newbridge Road for vehicles evacuating the site to contest with.

Available Time for Evacuation

As discussed in **Section 4.4**, it is not clear from the Molino Stewart report if the evacuation modelling for Scenario B included all available evacuation time up to inundation of Newbridge Road. This confusion is based on Appendix C of the 2022 Flood Evacuation Analysis indicating that there is 7.25 hours of time for evacuation (*termed 'surplus time' in the report*) based on the forecast 12 hours of 'target warning lead time' less the required time for mobilisation and decision making in accordance with the NSW SES Timeline Evacuation Model (TEM).

As discussed in **Section 4.4**, the 12 hours of '*target warning lead time*' is up to a gauge height of 4 metres, which is 2.44 metres below the gauge height predicted to align with the initial inundation of Newbridge Road. The stage hydrographs presented in **Figure 4-17** indicate that that there would be approximately 2 hours of time between gauge heights of 4 and 6.44 metres.

4.9 Evacuation of Residents by Foot

The Moore Point Precinct has been designed to incorporate two pedestrian footbridges that cross the Georges River and provide access to the Liverpool CBD and Liverpool Train Station. Both footbridges have been designed to have deck levels above the 1 in 500 AEP event and with rising access to the Liverpool CBD.

As shown in **Figures 4-13** to **4-16**, Footbridges P1 and P2 will remain accessible during floods up to and including the 1 in 500 AEP event or a Liverpool Weir gauge height of 7.44 metres.

The analysis of potential triggers for evacuation presented in **Section 4.5** shows that there would be up to 15.5 hours of warning and evacuation time available for pedestrian bridges P1 and P2 during a PMF event (*refer* **Table 4-6**). Adopting the 'Minor' gauge height as a trigger for evacuation would result in 10 hours of warning and 5.5 hours of evacuation time for pedestrian bridges P1 and P2.

Based on the available warning and evacuation times, and direct access to the Liverpool CBD and Liverpool Train Station, it is reasonable to expect that evacuation by foot will be an attractive option for residents of the Moore Point Precinct. This recognises that this mode of transport would already be familiar to residents and require them to walk less than one (1) kilometre to reach land that is above the predicted peak level of the PMF.

Based on a maximum walking distance of 1.0 kilometre and application of the average walking speed of 2km/hr adopted by the NSW SES, it would take up to 30 minutes for someone to evacuate the Moore Point Precinct by foot. With at least 5.5 hours (*refer* **Table 4-6**) of dedicated evacuation time being available there would be sufficient time for residents and visitors to evacuate by foot from any location within the Precinct.

The above evacuation timeframes are supported by a 'Pedestrian Volume Assessment' completed by BG&E in April 2024 (*refer* **Appendix B**). The BG&E assessment calculated that a crowd of 5,533 people could cross one of the pedestrian footbridges within a total timeframe of 42.5 minutes. Accordingly, once both footbridges are constructed approximately 11,000 people could evacuate the site to the Liverpool CBD in less than 1 hour.

With 5.5 hours evacuation time available from receipt of a Minor flood warning there would be an abundance of time available for pedestrians to evacuate in a calm manner. The additional time provides an allowance for wet weather and other factors which may result in a slower pedestrian pace than the adopted average of 2 m/s. It is also noted that both footbridges would remain a viable evacuation option for at least 1.5 hours from initial inundation of Newbridge Road.

Pedestrian Footbridge P2 'lands' on the Liverpool CBD side at locations that are at risk of flooding during the late stages of a PMF event. As shown in **Figure 4-17**, the two proposed exits and their surrounds are predicted to be inundated between 2 and 5 hours after the footbridge would be closed due to inundation on the Moore Point side. The exit to the east of the railway would be inundated first approximately 2 hours after bridge closure, followed by the exit to the west of the railway a further 3 hours later. There will therefore be sufficient time for all pedestrians to be relocated to flood free land prior to the arrival of floodwaters.

Accordingly, it is evident that any residents unable to evacuate by vehicle, or who chose not to, will have sufficient warning and evacuation time to evacuate the Precinct to high ground by foot.

4.10 Shelter-in-Place

Section 4.7 and **Section 4.8** show that evacuation by vehicle or foot are two viable options for the Moore Point Precinct. Past flood events throughout NSW have shown that residents may still choose to shelter-in-place despite there being viable options for evacuation and sufficient warning time. To minimise the risks associated with this the Precinct has been designed to be above the predicted peak flood level for a 1 in 500 AEP event, and all floor levels for residential apartments are to be above the predicted peak level of the PMF. Accordingly, any residents and visitors that choose to remain will have adequate options for sheltering in place at locations that are above the predicted peak level of the PMF.

The following best practice design elements have been incorporated into the development proposal to ensure shelter in place will be as safe as possible for anyone who chooses not to evacuate as instructed.

- Back up infrastructure to be provided in areas above the predicted peak flood levels for a PMF event to enable residents to 'shelter in place' for the duration of the flood event.
- Communal and gathering areas to be provided within buildings above the level of a major flood event.
- 'Shelter in place' provisions will ensure residents have access to power, water and sewage services.
- Buildings be designed to accommodate potential flood and debris loading so floodwaters do not contribute to structural failure.
- Provision of multi-lingual PA system to all floors of medium and high-density residential buildings to ensure announcements/warnings are conveyed to the entire community whilst the precinct is under isolation.

The stage hydrographs presented in **Figure 4-17** indicate that during a PMF event, flood levels could remain above the peak level for a 1 in 500 AEP event for approximately 35 hours. Access to Footbridges P1 and P2 would be possible once flood levels recede below the level of a 1 in 500 AEP event.

4.11 Evacuation Forecasts – Final Development

The analysis presented in the preceding sections is reproduced in **Table 4-7** on the following page for the final development that is forecast to be completed in 2056.

The analysis indicates that 12,100 people could evacuate the site by vehicle. Up to 17,300 people would remain on site and would evacuate by foot via the two proposed footbridges (P1 and P2). The flood warning time analysis shows that vehicular and pedestrian evacuation could both be completed safely within the time available.

With respect to pedestrian evacuation, there is predicted to be over 3.5 hours of excess time based on the Minor gauge at being adopted as an evacuation trigger. This indicates that pedestrian evacuation could be staggered over a longer time period to reduce the potential for large crowds to arrive at the Liverpool CBD over a relatively short period of time.

No one would therefore be required to shelter in place during the event. This supports the flood emergency response strategy which relies on vehicular and pedestrian evacuation from the Precinct with the provision of shelter-in-place as a back-up strategy should it be required.

Table 4-7 Overview of Evacuation Figures for the Final Development (2056)

Evacuation Information	Stage 3 / Final Development (2056)
Available Evacuation Options	Vehicular V1, V2, V3 & V4 Pedestrian P1 & P2
Evacuation Capacity - Vehicles	
- No road upgrades (external or internal)	Not Specified^
- With external road upgrades taken into consideration within the Molino Stewart traffic modelling (2022)	5,500
- With internal site upgrades, i.e., additional connections to Newbridge Road.	5,500^^
Evacuation Capacity - Pedestrians	
- Excess residential & commercial population	11,000 per hour ^^^
Evacuation – Cars and People	
- Vehicles (Residential/Commercial/Visitors)	
Total that can be evacuated	5,500
Total remaining on site	4,959
- People via cars (Residential/Commercial/Visitors)	
Total that can be evacuated by car	12,100#
Residual People	17,300
- People via footbridges (Residential/Commercial/Visitors)	
Time required to evacuate residual	<2.0 hrs (*3.5hrs Excess Time*)
People Unable to Evacuate	0

^ The Molino Stewart report (2022) does not state whether there is any excess evacuation capacity from the site under existing conditions, i.e., no internal or external road upgrades.

^^ The Molino Stewart traffic modelling (2022) does not take into consideration any of the upgrades proposed within the site. In that regard, the proposed development includes construction of Vehicular Connections V1, V2, V3 and V4 to Newbridge Road. There is potential for these upgrades to increase evacuation capacity based on the Traffic Modelling (2022) assuming only one connection exists as is under pre-development conditions. Vehicular Connection V4 will also allow vehicles to continue evacuating to the Liverpool City Centre once Newbridge Road is inundated. This could also increase the evacuation capacity from the site. However, without revised traffic modelling a conservative approach is adopted that assumes these upgrades will have no impact on evacuation capacity.

^^^ Evacuation rate along pedestrian footbridges is based on modelling undertaken by BG&E (2024) that showed 5,533 people could cross each footbridge within 43 minutes. This was based on a conservative walking speed of 2km/hr.

Average people per vehicle rates are based on Demographics Research conducted for the Moore Point Precinct by Mecone in September 2020. The research identified the following average household sizes to be applied to various stages of the development:

- 2026 – 1.9 people / apartment / vehicle
- 2041 – 2.1 people / apartment / vehicle
- 2051 – 2.2 people / apartment / vehicle

-

5 Evacuation During Intermediate Stages of Development

5.1 Staging Plan

Development of the Moore Point Precinct will be staged to deliver 10,700 new dwellings over 30 years. It will also deliver more than 328,516 m^2 of commercial floor area. The Precinct is to be developed across three distinct time horizons as follows:

- 2025-2036;
- 2036-2046; and,
- 2046-2056.

The proposed staging of development will allow for the progressive delivery of transport infrastructure that has been identified by the *Liverpool Collaboration Area Strategic Transport Infrastructure Assessment* (2020) as being required to address existing network issues and support growth in the Liverpool LGA.

The proposed staging will occur according to the details listed in **Table 5-1** and shown in **Figure 5-1**.

Table 5-1 Proposed staging of the Moore Point Precinct showing the timing for delivery of infrastructure, commercial floor space and housing

Time Period	Infrastructure Delivery	Triggered at:
2026 – 2036	▪ Stage 1 signalised upgrade of Newbridge Road/ Anchor Place intersection to enable occupation of initial Moore Point Development	▪ Residential: Between 0 and 4237 dwellings ▪ Commercial: Between 0 sqm and 109,478 sqm of floor space
2036 – 2056	▪ Newbridge Road/Moorebank Avenue/Bridges Road intersection upgrade ▪ Stage 2 signalised upgrade of Newbridge Road/Anchor Place intersection	▪ Residential: Between 4237 and 10,742 dwellings ▪ Commercial: Between 109,478 sqm and 328,516 sqm of floor space

As shown in **Figure 5-1**, the construction of Vehicular Connections V1 to V4 and Pedestrian Bridges P1 & P2 will occur incrementally throughout Stages 1 to 3. The proposed construction stages for each evacuation option, forecast numbers of people and vehicle parking spaces are outlined in **Table 5-2**.

Table 5-2 Forecast People, Vehicles and Evacuation Options During Construction Stages

	Forecast Population	Forecast Vehicle Spaces	Available Evacuation Options (refer **Figure 4-1**)
Stage 1 (2026 – 2036)	11,112	4,575	Vehicular Connection V1 – Bridges Road Vehicular Connection V2 – Anchor Place Pedestrian Footbridge P1
Stage 2 (2036 – 2046)	20,156 (+9,044)	8,198 (+3,623)	Vehicular Connection V3 – Haigh Avenue Pedestrian Footbridge P2 (*plus those above*)
Stage 3 (2046 – 2056)	29,402 (+9,246)	10,459 (+2,261)	Vehicular Connection V4 (*plus those above*)

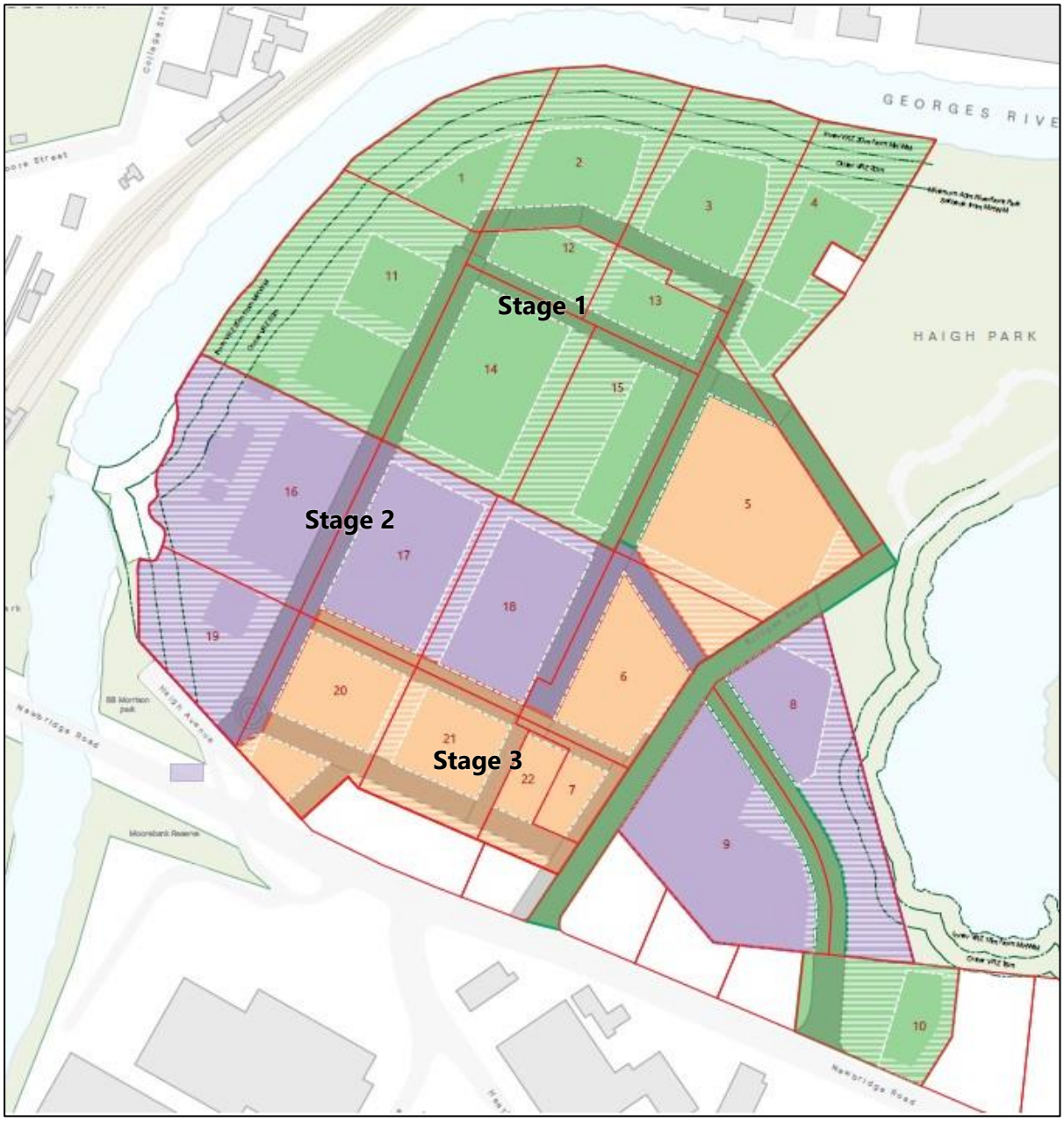


Figure 5-1 Proposed Staging for Delivery of the Moore Point Precinct
Source: *SJB Architecture*

5.2 Evacuation Capacity During Intermediate Stages

The staged delivery of the Moore Point Precinct requires evacuation capacities to be reviewed to take into consideration reduced vehicle and population numbers. It is also necessary to consider changes to evacuation routes which would have an impact on the capacity for vehicles to reach Newbridge Road and evacuate onwards from the Precinct.

As discussed in **Section 4.7**, the assessment of vehicular evacuation for the ultimate development scenario estimated that between 7,300 and 9,100 vehicles could evacuate from the Moore Point Precinct in the event of a PMF in the Georges River catchment. These numbers are arrived at based on the following two components:

- The 2022 Flood Evacuation Analysis undertaken by Molino Stewart determined the road network may have capacity for approximately 5,500 vehicles evacuating from Moore Point, and
- Construction of Vehicular Route V4 would allow evacuation to continue for approximately 2 hours following inundation of Newbridge Road. Route V4 is estimated to allow between 1,800 and 3,600 vehicles to evacuate on top of those identified by the 2022 Flood Evacuation Analysis.

The capacity for vehicular evacuation to occur during Stages 1 and 2 of development are discussed below.

5.2.1 Stage 1 (2026 to 2036)

Evacuation Routes V1 (Bridges Road) and V2 (Anchor Place) and Pedestrian Footbridge P2 are proposed to be available during Stage 1 of the development.

All 5,500 vehicles predicted by the 2022 Flood Evacuation Analysis could evacuate Stage 1 of the development if required. With 4,575 total vehicle spaces predicted during Stage 1 it follows that all vehicles will be able to evacuate.

Those that chose not to evacuate by vehicle or cannot, will be able to walk to flood free land in the Liverpool CBD via Pedestrian Bridge P2. The analysis presented in **Section 4.9**, shows that there is sufficient time for pedestrian evacuation to occur based on the Minor gauge height being adopted to trigger evacuation.

After consideration of vehicular evacuation there is forecast to be up to 2,000 people during Stage 1 that would remain on site and would rely on pedestrian evacuation. Pedestrian modelling for the proposed footbridges undertaken by BG&E indicates that this total population could evacuate over Pedestrian Footbridge P2 within less than 30 min. This would mean that there is approximately 5 hours of excess time over which pedestrian evacuation could be staggered to spread out the influx of people arriving by foot into the Liverpool CBD.

Anyone who chooses to remain on site would need to shelter-in-place within apartments or nominated communal gathering area located above the peak PMF level, and visitors at areas.

5.2.2 Stage 2 (2036 to 2046)

Evacuation Routes V1 (Bridges Road), V2 (Anchor Place) and V3 (Haigh Avenue) and Pedestrian Footbridge P1 and P2 are all proposed to be available during Stage 2 of the development. There is adequate capacity within the Precinct for vehicles to reach Newbridge Road and evacuate onwards. Accordingly, the capacity constraints along Bridges Road present during Stage 1 (refer **Section 5.2.1**) would no longer be an issue.

It is therefore expected that all 5,500 vehicles predicted by the 2022 Flood Evacuation Analysis could evacuate Stage 2 of the development. With 7,338 total vehicle spaces predicted during Stage 2 it follows that approximately 2,700 vehicles may not be able to evacuate.

With at least one of the proposed footbridges to be completed prior to the commencement of Stage 2 it follows that anyone remaining within the Precinct will have enough time to evacuate by foot via the pedestrian footbridge. After consideration of vehicular evacuation there is forecast to be up to 9,200 people during Stage 2 that would remain on site and would rely on pedestrian evacuation. Pedestrian modelling for the proposed footbridges undertaken by BG&E indicates that this total population could evacuate over Pedestrian Footbridge P2 within less than 2 hours. This evacuation timeframe could reduce to less than 1 hour if Pedestrian Footbridge P1 is also available.

The above evacuation timeframes indicate that there is at least 3.5 hours of excess time over which pedestrian evacuation could be staggered to spread out the influx of people arriving by foot into the Liverpool CBD.

Shelter-in-place would therefore not be a requirement during Stage 2 and onwards unless chosen by individuals.

5.3 Evacuation Forecasts – Intermediate and Final Stages

The analysis presented in the preceding sections is reproduced in **Table 5-3** on the following page for the two proposed intermediate stages of development and the final development.

The analysis indicates that Stage 1, Stage 2 and the final development could all be evacuated based on vehicular and pedestrian evacuation. The flood warning time analysis shows that the vehicular evacuation and evacuation by foot could both be completed safely within the time available. No one would therefore be required to shelter in place during the event. This supports the proposed flood emergency response strategy that relies on vehicular and pedestrian evacuation whilst ensuring shelter in place is used only as a failsafe.

Table 5-3 Overview of Evacuation Figures During Intermediate and Final Stages

Evacuation Information	Stage 1 (2036)	Stage 2 (2046)	Stage 3 / Final Development (2056)
Available Evacuation Options	Vehicular V1 & V2 Pedestrian P2	Vehicular V1, V2 & V3 Pedestrian P2	Vehicular V1, V2, V3 & V4 Pedestrian P1 & P2
Evacuation Capacity - Vehicles			
- No road upgrades (external or internal)	Not specified^	Not Specified^	Not Specified^
- With external road upgrades taken into consideration within the Molino Stewart traffic modelling (2022)	5,500 (All Vehicles)	5,500	5,500
- With internal site upgrades, i.e., additional connections to Newbridge Road.	5,500 ^^	5,500 ^^	5,500^^
Evacuation Capacity - Pedestrians			
- Excess residential & commercial population	5,500 per hour ^^^	5,500 per hour ^^^	11,000 per hour ^^^
Evacuation – Cars and People			
- Vehicles (Residential/Commercial/Visitors)			
Total that can be evacuated	4,575	5,500	5,500
Total remaining on site	0	2,698	4,959
- People via cars (Residential/Commercial/Visitors)			
Total that can be evacuated by car	8,692#	11,550#	12,100#
Residual People	2,420	8,606	17,300
- People via footbridges (Residential/Commercial/Visitors)			
Time required to evacuate residual	<0.5 hrs *(5.0hrs Excess Time)*	<2.0 hrs *(3.5hrs Excess Time)*	<2.0 hrs *(3.5hrs Excess Time)*
Unable to Evacuate	0	0	0

^ The Molino Stewart report (2022) does not state whether there is any excess evacuation capacity from the site under existing conditions, i.e., no internal or external road upgrades.

^^ The Molino Stewart traffic modelling (2022) does not take into consideration any of the upgrades proposed within the site. In that regard, the proposed development includes construction of Vehicular Connections V1, V2, V3 and V4 to Newbridge Road. There is potential for these upgrades to increase evacuation capacity based on the Traffic Modelling (2022) assuming only one connection exists as is under pre-development conditions. Vehicular Connection V4 will also allow vehicles to continue evacuating to the Liverpool City Centre once Newbridge Road is inundated. This could also increase the evacuation capacity from the site. However, without revised traffic modelling a conservative approach is adopted that assumes these upgrades will have no impact on evacuation capacity.

^^^ Evacuation rate along pedestrian footbridges is based on modelling undertaken by BG&E (2024) that showed 5,533 people could cross each footbridge within 43 minutes. This was based on a conservative walking speed of 2km/hr.

Average people per vehicle rates are based on Demographics Research conducted for the Moore Point Precinct by Mecone in September 2020. The research identified the following average household sizes to be applied to various stages of the development:

- 2026 – 1.9 people / apartment / vehicle
- 2041 – 2.1 people / apartment / vehicle
- 2051 – 2.2 people / apartment / vehicle

6 Flood Emergency Response Procedures

As discussed in **Section 4.6**, the proposed approach for managing the potential flood risk at the Moore Point Precinct is based on:

- minimising the potential for flooding of the Georges River to impact on the development and its occupants,
- utilising technology and other means for information dissemination,
- utilising early warning triggers such as severe weather warnings to commence systems maintenance and preparation of the site and people; and
- maximising the capacity for future residents and workers to safely evacuate the precinct either by vehicle (up to a maximum of 5,500) or by foot, during the onset of major flooding that would cause the precinct to be isolated for more than 6 hours.

The preceding sections of this report in combination with the *Moore Point Precinct Flood Impact Assessment* (*2024*) have shown that the development can be designed such that point a) above is possible. This is achieved based on a combination of raising the site and implementation of mitigation measures including foreshore regrading and construction of an overland flow path.

Section 4 and **Section 5** have also shown that the development can be configured such that there would be four vehicular connections to Newbridge Road that could be utilised for evacuation. Vehicular evacuation would therefore not be constrained within the site but rather by the external road network. The outcomes of traffic modelling completed by Molino Stewart (2022) were therefore adopted that predict the external road network could have capacity for up to 5,500 additional vehicles from the site.

The following sections outline the flood emergency response procedures and systems that are to be put in place to:

(i) ensure systems are in place to regularly monitor for flood warnings,

(ii) ensure systems and technology to be used to aid evacuation and the dissemination of information are maintained and available,

(iii) infrastructure such as back-up power generators are maintained,

(iv) contact details are up to date, including the NSW SES, Bureau of Meteorology (BOM), onsite residential building and business contacts, maintenance contractors and traffic management,

(v) systems are in place to ensure vehicular evacuation is capped at 5,500 vehicles, and

(vi) evacuation by foot is triggered and managed to allow for sufficient time for all remaining people to evacuate safely.

6.1 Flood Warden

A flood warden is to be appointed at all times for the management and monitoring of flood risks along the Georges River. The flood warden is to be suitably qualified, trained and have the resources available to monitor flooding in a timely manner.

It is possible that more than one flood warden could be appointed pending the final time requirements for the role and practicalities of managing the flooding across the entire precinct versus into discrete zones or precincts.

In general, and as discussed above, the flood warden will be responsible for the following actions:

- Maintaining the evacuation plan for the Precinct in consultation with the NSW SES.
- Keeping in contact with the NSW SES and Liverpool City Council to understand any developments or changes to emergency response management across the Georges River catchment.
- Ensuring maintenance of backup equipment used for emergency response such as back-up power generators, PA systems etc.
- Keeping emergency contact details up to date – NSW SES, Bureau of Meteorology (BOM), onsite building and business contacts, maintenance contractors and traffic management.
- Actioning the emergency response plan once a flood watch or flood warning has been issued.
- Organising personnel to assist with onsite pedestrian evacuation movements and to control vehicular evacuation to ensure vehicular evacuation is capped at 5,500 in total.
- Overseeing flood recovery.

The flood warden is also responsible for ensuring the flood emergency response plan and associated protocols are reviewed following every flood event. This is to include flood events that did not require evacuation but did trigger early warning and preparation activities. Reviews are also to consider advancements in technology (*refer* **Section 6.3.3**) that could be used to improve communication and monitoring.

The flood warden is to follow the flood emergency response plan unless advised otherwise by the NSW SES. The NSW SES is to be invited periodically to provide input to the Precinct FERP to minimise any conflicts and contradictions with the NSW SES Local Sub-Plan.

6.2 Early Warning and Monitoring

A Georges River flood event sufficient to trigger evacuation procedures will typically require severe weather that includes high intensity and long duration rainfall over the upper Georges River catchment, such as an east coast low. In that regard, flash flooding or short duration high intensity rainfall bursts would not be sufficient to generate increases flows along the Georges River that would cause inundation of the site and the nominated evacuation routes.

The flood warden is to routinely monitor the following sources for any forecast flooding in the Georges River catchment:

- Bureau of Meteorology Warnings - http://www.bom.gov.au/nsw/warnings/
- NSW SES 'Hazards Near Me' App - https://www.ses.nsw.gov.au/about-us/our-warnings/
- SES Warnings and News: http://www.ses.nsw.gov.au/news/

As discussed above, it is expected that there will be advanced warning of flooding along the Georges River that would be of a sufficient magnitude to require evacuation of the Moore Point Precinct, that is, a flood that is forecast to exceed a 1% AEP event. The Bureau of Meteorology (BOM) operates a Flood Warning Service Program that aims to provide effective flood forecasting and warning services for most major rivers in Australia. For the larger river systems the BOM aims to issue early warnings of forecast flooding by way of a **Flood Watch** or **Flood Warning**.

The BOM website includes the following for descriptions for a Flood Watch and Flood Warning:

*A **Flood Watch** is generally issued up to **four days** in advance of the expected onset of flooding. A Flood Watch can be issued before, during and after the rainfall has occurred, depending on the level of maturity of the flood warning systems and services, and flood impact information made available from the local emergency services or state agency.*

*A **Flood Warning** is issued when the Bureau is more certain that flooding is expected, often when rainfall has started to fall. Flood Warnings are more targeted and are issued for specific catchments or even sub-catchments in some of the larger river basins. Flood Warnings will generally include specific predictions of the severity of expected flooding.*

Source: http://www.bom.gov.au/water/floods/floodWarningServices.shtml

It is likely for a large catchment such as the Georges River that a flood watch would be issued in advance of a significant flood event and that this could be up to four days in advance of the flooding (*refer above*).

If any of the above flood warnings are issued by the BOM for the Georges River, the flood warden is to actively monitor SES warnings and gauge levels at the Georges River at Liverpool Weir gauge. The link to real-time river height data for this gauge in chart and table format is provided below.

- Table Format: http://www.bom.gov.au/fwo/IDN60233/IDN60233.566054.tbl.shtml
- Chart Format: http://www.bom.gov.au/fwo/IDN60233/IDN60233.566054.plt.shtml

The Minor, Moderate and Major gauge heights that are to be monitored are outlined in **Section 4.2**. A range of actions will be triggered at these gauge heights and as such need to be closely monitored.

6.3 Technology and Site Preparation Procedures to Assist Evacuation

The proposed density and confinement of development across the Moore Point Precinct provides an opportunity for technology and systems to be implemented that could assist to:

- inform the community of any forecast flood events,
- prepare them for what to expect, i.e., timing and severity of forecast flooding, and
- guide them on the emergency response procedures in place for the precinct.

The following systems, both technology and people based, are proposed to be implemented into the emergency response procedures for the Moore Point Precinct. It is recognised that the proposed technology and systems could become obsolete over the course of the 30-year development. Regardless, any technological advancements that lead to new alternatives would be expected to improve and make easier the superseded method.

6.3.1 Multi-Lingual Public Address (PA) System

A multi-lingual PA system is proposed to be incorporated into each of the buildings for the dissemination of emergency response notifications. This would allow information to be quickly distributed to the community and would negate the need for time and resource intensive doorknocking.

For flood emergency response and during the various stages of a flood event, the following examples of announcements are proposed. It is noted that each stage of announcements will only be required if flooding is forecast to continue rising and is forecast to reach a sufficient height that would lead to inundation of the Precinct. In that regard, each stage of announcements may not be required.

Upon Receipt of a Flood Watch and advice from the NSW SES

- Announcement to inform the community that a flood watch has been issued for the Georges River signalling that flooding along the Georges River is forecast to occur in the coming days (*note: can be more specific if the flood watch includes information on timing*).
- Invite residents to collect a leaflet located on the ground floor of all buildings.
- Further information to be provided closer to the event.

Upon Receipt of a Flood Warning and advice from the NSW SES

- Announcement to inform the community that a flood levels along the Georges River are forecast to rise from **X** date/day and that emergency response procedures will be in place once river levels reach the Minor gauge height at the Liverpool Weir.
- Evacuation via vehicle or the pedestrian bridges is recommended and will be managed by evacuation specialists located at all vehicular and pedestrian exists.
- Invite residents to collect a leaflet located on the ground floor of all buildings.
- Further information to be provided once emergency response procedures are triggered.

Upon Flood Reaching the Minor Guage Height at Liverpool Weir

- Announcement to inform the community that evacuation procedures are in effect and that pedestrian or vehicular evacuation is to commence.
- Inform the community that access to the foreshore and heritage buildings will no longer be permitted.
- Refer to the leaflet provided which will have included information on evacuation routes, forecast timings for each mode of evacuation, and limitations of vehicular evacuation.

Upon Flood Reaching the Major Guage Height at Liverpool Weir

- Announcement to inform the community that floodwaters are forecast to inundate Newbridge Road within **X** hours. Management of vehicular evacuation is in place with no further vehicles permitted to join queues at the Bridges Road, Anchor Place and Haigh Avenue.
- Further evacuation is to occur via the footbridge into the Liverpool CBD.

Prior to Floodwaters Inundating the Precinct

- Announcement that floodwaters could inundate the Precinct within one (1) hour and evacuation via the footbridges will no longer be possible.
- Shelter in place will be a requirement for anyone that is not actively in the process of evacuating.

6.3.2 Information Leaflets or Website

Evacuation specific information is to be distributed via leaflets or website to provide critical information to the community ahead of a forecast flood event. This is to include forecasts for the potential flood event, relevant sources of information such as the NSW SES and to provide information on how evacuation is to occur, should it be required. Information templates are to be prepared in advance so that only event specific information needs to be added prior to printing.

It is envisaged that only one version of the leaflet (or similar) will be required and that further specific information would be available via a website for which the link will be provided. The leaflet (or similar) will be focused on outlining information such as:

- The flood risk and potential stages of flooding, including:
  - That initial inundation would occur along the foreshore and heritage buildings and as a result access to these areas will be restricted first.
  - Inundation of Newbridge Road and parts of Bridges Road, Haigh Avenue and Anchor Place could occur prior to inundation of the Precinct itself.
  - Evacuation via the two pedestrian bridges will be possible during the early stages of the flood event and following closure of Newbridge Road. Evacuation is to be completed prior to inundation of the footbridge entrances.
- The capacity for vehicular evacuation is limited and will be restricted to medical emergencies once the permitted capacity is reached. The capacity for vehicular evacuation is in the order of 55% of all forecast vehicles within the Precinct.
- Vehicular evacuation for medical emergencies and registered households is to be undertaken initially via Haigh Avenue and then the unnamed Vehicular Connection V4.
- There is ample capacity for evacuation of the entire Precinct via the P1 and P2 footbridges. It is recommended evacuation be completed prior to the Major gauge height being reached at Liverpool Weir.
- Evacuation by foot and vehicle can be 'cut' during significant flood events in the order of a 1 in 500 AEP flood. Failure to evacuate could result in residence having to 'shelter-in-place' within their apartments until floodwaters recede to a safe level.
- Personnel will be available onsite to answer questions at designated locations.

6.3.3 Advancements in Technology

With the final stages of the Moore Point Precinct not forecast to be completed until 2056 and with the current trajectory of technological advancement, there is a very high likelihood that paper leaflets will be superseded by technological options. Even today, options such as text messaging, e-mail distributions, websites, or in-app popups and notifications are possible and widely accepted.

Distribution of the information outlined in **Section 6.3.2** via technology would have the potential to provide the community with the same information but with greater flexibility to provide updates and easily accessible links. It is envisaged this distribution method will dominate by the time Stage 1 of the development is completed.

6.4 Emergency Response Triggers and Actions

A checklist of actions that is to be followed by the flood warden in the event that an early warning trigger is received is included within **Appendix A**.

7 Alignment with Gateway Determination Recommendations

The Moore Point Planning Proposal (PP-2022-1602) was lodged with the NSW Department of Planning and Environment (now the NSW Department of Planning, Housing and Infrastructure) for Gateway Determination in May 2022. The Gateway Determination was issued on 3rd April 2023. Section 5.4.4 of the Gateway Determination addresses flooding and includes comments and advice from the DPE's Technical Advisory Group (TAG), the DPE's Flood Planning Advisory Panel, as well as representatives from the Department's planning section.

The Gateway Determination outlined a list of conditions that were required prior to rezoning of the Moore Point Precinct via an amendment to the Liverpool Local Environmental Plan 2008. The conditions that are applicable to flooding are outlined below. Commentary has been included to indicate where and how these conditions have been met as part of the updated Moore Point Precinct development proposal.

a) *Further modelling and hazard mapping for the 1 in 100, 1 in 5000 and PMF events which must consider climate change impacts and be calibrated with the most recent flood events. The modelling must support an updated Urban Design Report and revised master plan for the site, including the proposed location of any public space and the evacuation plan discussed below.*

The additional information requested by this condition of the Determination has been provided in an updated Flood Impact Assessment (FIA) report titled '*Moore Point Precinct – Flood Impact Assessment*', dated January 2024. In that regard, the updated FIA report documents the results of modelling of the 1 in 5000 AEP event and a climate change scenario for a revised development layout that includes the following changes.

- All developable areas and internal roads have been raised to be above the predicted peak 1 in 500 AEP flood level. This increases the flood immunity of the development and allows evacuation to occur by vehicle to Newbridge Road and by foot over two footbridges during floods up to and including the 1 in 500 AEP event.
- Modification of the mitigation strategy to replace the proposed flood mitigation levee with an overland flow path. As discussed in Section 4.2 of the 2024 FIA report, the overland flow route is proposed to be located between Newbridge Road and Lake Moore to allow floodwaters approaching from the south-west to escape to Lake Moore (*refer* **Plate 6.1**).

Modelling undertaken as part of the 2024 FIA report found that the modified mitigation strategy will result in an overall benefit when compared to the original flood mitigation levee option and when compared to existing conditions. The 2024 FIA report makes the following conclusions with regard to the modified development and mitigation strategy:

"*The reduction in flood levels upstream of Newbridge Road during a 1% AEP event is predicted to benefit over fifty (50) residential properties, consisting of both apartment buildings to the west of the Georges River and residential properties to the east of Moorebank Avenue. Approximately ten (10) industrial/commercial properties would also benefit from the reduction in flood levels predicted upstream of Newbridge Road.*"

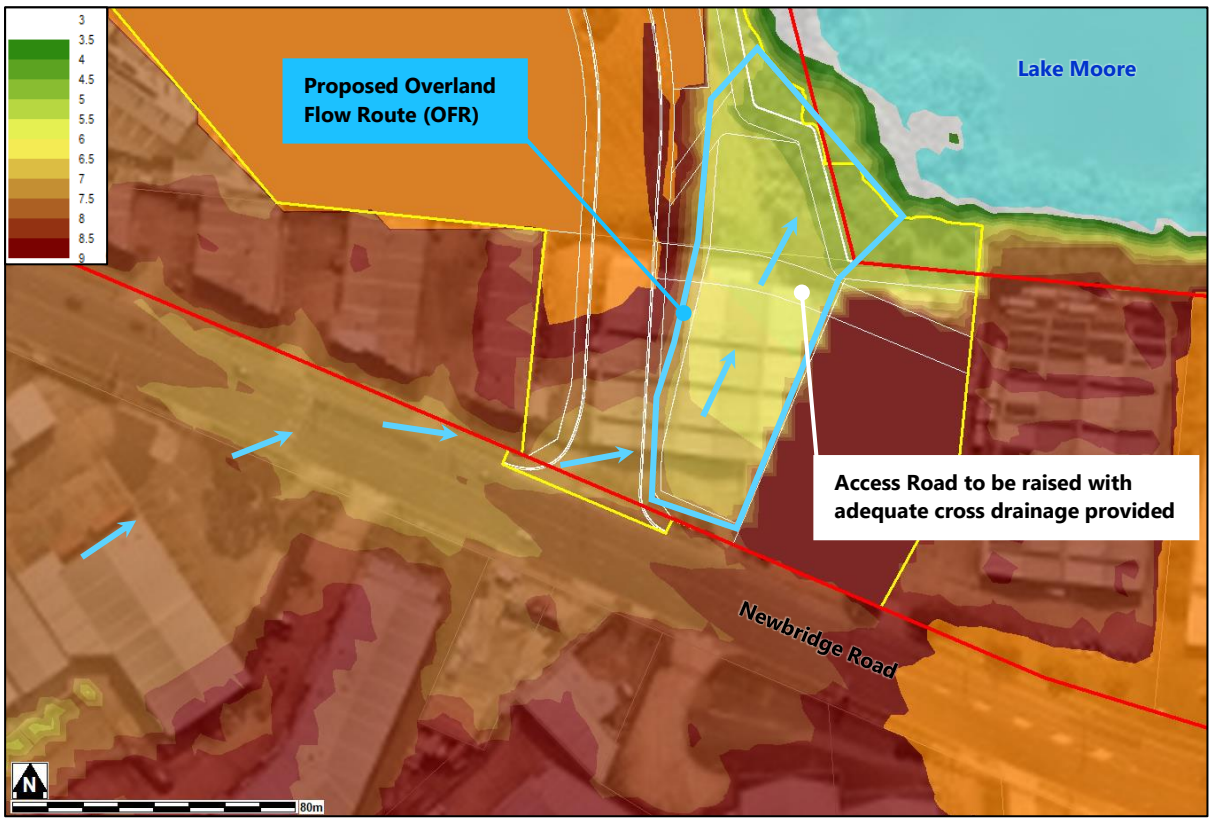


Plate 6.1 Topography along the Proposed Overland Flow Route Relative to the 'sag' along Newbridge Road

"The reduction in flood levels upstream of Newbridge Road during a 1 in 500 AEP event is predicted to benefit over two hundred (200) residential properties, consisting of both apartment buildings to the west of the Georges River and residential properties to the east of Moorebank Avenue, with reduced peak flood levels of up to 0.13 metres. Over twenty (20) industrial/commercial properties would also benefit with flood levels predicted to reduce by between 0.02 and 0.26 metres."

b) Provide an amended Evacuation plan. The Evacuation Plan is to identify critical infrastructure upgrades required for evacuation purposes, and provide a detailed staging and delivery plan, including dwelling thresholds for the delivery of infrastructure. At least one pedestrian bridge and the levee are to for part of Stage 1.

i. the Evacuation Plan, must determine (in consultation with the Department and agencies) the flood level for the three pedestrian bridges and demonstrate how the residents will evacuate, and the site be accessed where required in a 1 in 100 event, 1 in 500 event, 1 in 5000 event and in a PMF event.

ii. The Evacuation Plan must provide a strategy for emergency vehicle access to at least one of the proposed bridges.

iii. Evidence that the proposed pedestrian bridges required for the purpose of evacuation can be secured at the appropriate stage of the development, the funding and delivery strategy, including the identification the owners of land where the bridges are located and in principle support from those landowners.

This Flood Emergency Response Plan (FERP) has been prepared to serve as the 'amended Evacuation Plan' that is requested for the Moore Point Precinct by this Gateway Determination condition. The three points above are discussed further with reference to this FERP.

i. As discussed in this FERP, two Pedestrian Footbridges P1 and P2 are proposed to be constructed as part of the Moore Point Precinct. Both footbridges will be constructed to be upwardly grading towards the Liverpool CBD and with minimum bridge deck elevations set to be above the 1 in 500 AEP flood level. Accordingly, both Pedestrian Footbridge P1 and P2 will be accessible from within the Precinct for evacuation during floods up to and including the 1 in 500 AEP event.

   Once flooding at the site exceeds a 1 in 500 AEP event, the footbridges will no longer be accessible and shelter in place will be required for anyone remaining on site. For those remaining, residents will be able to shelter above the level of the Probable Maximum Flood (PMF) either within their apartments or at dedicated communal areas within the apartment complexes. Visitors to the site will also be able to shelter within buildings at the designated communal areas. Further information on the proposed shelter in place strategy is provided in **Section 4.9**.

ii. The development proposal has been updated to include a new vehicular connection to Newbridge Road that is above the predicted peak 1 in 500 AEP flood level. This is in place of previous plans which proposed vehicular emergency vehicle access via one of the footbridge crossings. Accordingly, emergency vehicle access via the footbridges is no longer required.

   As shown in **Figure 4-1**, Vehicular Connection V4 joins Newbridge Road to the east of Haigh Avenue and is predicted to be accessible while flood levels in the Georges River at the Liverpool Weir gauge do not exceed 10.2 mAHD; i.e., a gauge height of 7.44 metres (*refer* **Figure 4-15** *and* **Figure 4-16**). This means that evacuation is possible until flooding of the Georges River reaches the magnitude of a 1 in 500 AEP event.

   Note that emergency services could also access the Precinct via the footbridges by alternate means such as by foot, bike and/or cart.

   a. Strategic planning around the delivery and construction of the footbridges is outside of the scope of this FERP.

c) Provide further detail on how critical infrastructure will be provided above the PMF for all residents (including if wider network upgrades are required).

Details of the infrastructure proposed to be provided to ensure shelter in place can be relied upon as a failsafe measure are outlined in **Section 4.9** and re-iterated below.

- Back up infrastructure to be provided in areas above the predicted peak flood levels for a PMF event to enable residents to 'shelter in place' for the duration of the flood event.
- Communal and gathering areas to be provided within buildings above the level of a major flood event.
- 'Shelter in place' provisions will ensure residents have access to power, water and sewage services.
- Buildings be designed to accommodate potential flood and debris loading so floodwaters do not contribute to structural failure.

- Provision of multi-lingual PA system to all floors of medium and high-density residential buildings to ensure announcements/warnings are conveyed to the entire community over the course of the event.

d) Provide further detail on the proposed levee including:

a. a plan showing its exact location

b. size

c. material

d. evidence of Council's support and consent for the levee (as owners of the proposed site)

e. how safely will be addressed.

As discussed above in response to Condition b) and outlined in the 2024 FIA report, the mitigation strategy for the development has been changed to no longer require the flood mitigation levee. Modelling documented in the 2024 FIA report confirms that a similar, if not better flooding outcome, can be achieved by incorporating an overland flow path within the development for the carriage of flows that overtop the eastern bank of the Georges River upstream of the Newbridge Road crossing. As discussed in Section 4.2 of the 2024 FIA report, the overland flow route is proposed to be located between Newbridge Road and Lake Moore to allow floodwaters approaching from the south-west to escape to Lake Moore and not impact on the development (*refer* **Plate 6.1**).

e) Provide a bulk earthworks/cut and fill plan and a fill strategy to demonstrate the elevation of all building pads will be above the 1 in 100 level plus 0.5 metres freeboard. The internal roads must be above the 1 in 100 level with rising egress to the evacuation routes.

A detailed bulk earthworks plan has been prepared for the development by Northrop and is included with the revised planning proposal package.

The proposed redevelopment of the site involves filling to raise those areas of the precinct proposed for residential land uses to the flood planning level (1% AEP plus 0.5 m) which is at least 0.1 m above the predicted peak level of the 1 in 500 AEP flood. This will ensure that the majority of the proposed development will remain "flood free" during floods up to and including the 1 in 500 AEP event.

Flooding of the developed site in a 1 in 500 AEP flood will be limited to lower lying areas that adjoin Newbridge Road. Evacuation via the proposed Vehicular Connections V1 to V3 (*refer* **Figure 4-1**) will not be upwardly grading due to the existing elevations along Newbridge Road at the points of connection. Notwithstanding, Vehicular Evacuation Route V4 and Pedestrian Bridges P1 and P2 will be upwardly grading to land that is above the PMF and within the Liverpool CBD.

f) Sections at various locations along the river to show levels (current and proposed) and relationships between river, embankment and future buildings; and

Sections along the Georges River have been extracted from the flood modelling and bulk earthworks plan for various locations along the river frontage. These cross-sections are included in the planning package.

g) The modelling and evacuation strategy must be submitted to the Department to enable an independent peer review.

It is understood that this FERP is to be submitted to the Department for independent peer review.

Section 5.4.4.2 of the gateway determination relates specifically to flood evacuation and emergency response. **Table 6-1** highlights where the proposed flood emergency response strategy and plan is aligned with the recommendations of the gateway determination.

Table 6-1 Alignment of Proposed Flood Emergency Response Plan for Moore Point with elements of the Gateway Determination Received on 3rd April 2023

Gateway Determination Advisory Panel Advice (Section 5.4.4.2 – Flood Evacuation)	Flood Risk Measures of proposed Redevelopment of Moore Point Precinct
Pedestrian Footbridges: ▪ **Further details provided on the pedestrian bridges to ensure all bridges would be located at a level that has been established in consideration of the 1 in 100, 1 in 5000 and PMF events (consistent with Flood Inquiry recommendation 18) and designed with a width that allows emergency vehicle access to the development.** ▪ Further flood modelling should inform the access levels and relationships with the road network. Gateway conditions should be provided to ensure pedestrian bridges will meet certain conditions, including at least one bridge being capable of carrying an emergency vehicle.	▪ Two pedestrian bridges are proposed within the development to allow evacuation from the precinct by foot to Liverpool CBD, Liverpool Innovation Precinct and Liverpool Train Station. ▪ As shown in **Figure 4-1** and outlined in **Table 4-2**, Pedestrian Footbridges P1 and P2 are proposed to be above the predicted peak 1 in 500 AEP flood level. ▪ Both Pedestrian Footbridges P1 and P2 are to be 'continually rising' when accessed from the Precinct. ▪ Emergency vehicle access is proposed to be provided via Vehicular Connection V4 (*refer* **Figure 4-1**) in lieu of one of the proposed footbridges. This route is accessible via Newbridge Road during floods up to and including a 1 in 500 AEP event.
Future residential towers be provided with back-up infrastructure above the PMF to ensure essential services are available for the duration of any flood events and are also provided with communal and gathering areas within building above major flood levels.	▪ Back up infrastructure to be provided in areas above flood levels to enable residents 'shelter in place' for the duration of the flood event ▪ "Shelter in place' provisions will ensure residents have access to power, water and sewage services ▪ Communal and gathering areas to be provided within buildings will be above the level of a major flood event
A pedestrian footbridge should be delivered in the first stage of the Precinct's development.	At least one pedestrian footbridge is to be constructed during Stage 1 of the development.

8 Conclusions

This Flood Emergency Response Plan (FERP) for the Moore Point Precinct has been developed with reference to contemporary research, practical application through lessons learnt in real flood scenarios and consideration of the findings of the 2022 NSW Flood Inquiry. It has also been prepared with the objective of addressing the flood advisory panel recommendations detailed in the 2023 Gateway Determination.

The FERP is based on the strategies documented in the '*Moore Point Precinct, Liverpool – Flood Emergency Response Strategy*' (November 2022). Analysis completed for the FERP indicates that these strategies can be implemented to ensure the flood risks to future residents of and visitors to the Moore Point development, will be minimal. As outlined in **Section 4.5**, the FERP relies on a phased approach involving vehicular evacuation, evacuation by foot and shelter in place. The analysis shows the following.

(iv) There are four (4) potential vehicular routes which provide opportunity for access from the development to Newbridge Road during the onset of major flooding of the Georges River (*refer Vehicular Connections V1 to V4 as shown in* **Figure 4-1**). The flood immunity of each route is as follows:

a. Vehicular Connections V1 to V3 all offer the same level of flood immunity which corresponds to a flood that reaches a gauge height of 6.44 metres (*9.2 mAHD*) at the Liverpool Weir Gauge (*refer* **Table 4-2**). This corresponds to a flood immunity that is between a 2% and 1% AEP flood.

b. Access to Vehicular Connection V4 is not predicted to be 'cut' until river water levels reach a gauge height of 7.44 metres (*10.2 mAHD*). This corresponds to a level of flood immunity that exceeds the 1 in 500 AEP event (*refer* **Table 4-2**).

(v) Two pedestrian footbridges are proposed as part of the development. These will connect the Moore Point Precinct to the Liverpool CBD and to Liverpool Train Station (*refer* **Figure 4-1**). As indicated in **Table 4-2**, access to Pedestrian Footbridges P1 and P2 is not predicted to be 'cut' until river water levels reach a gauge height of 7.44 metres (*10.2 mAHD*) indicating that both pedestrian footbridges will not begin to experience any form of inundation until flooding of the Georges River approaches the magnitude of the 1 in 500 AEP event (*refer* **Table 4-2**).

Both pedestrian footbridges will be designed to be upwardly grading from the development site.

(vi) Emergency vehicle access is proposed to be provided via Newbridge Road and Vehicular Connection V4. As discussed above, this will allow ambulances and other emergency vehicles to access the site during floods up to and including a 1 in 500 AEP event. Emergency vehicle access via the footbridges will not be required.

(vii) The 2022 Molino Stewart Report states that there is 7.25 hours of available evacuation time for the Moore Point Precinct. This is based on the forecast 12 hours of '*target warning lead time*' less the required time for mobilisation and decision making in accordance with the NSW SES Timeline Evacuation Model (TEM).

The 7.25 hours of evacuation time is considered to be conservative as it appears to only include the time available before a height of 4 metres is reached on the Georges River at the Liverpool Weir gauge. As Newbridge Road is not predicted to be cut by floodwaters until river water levels

reach a gauge height of 6.44 metres, there could be up to 2 hours of additional evacuation time available (*refer* **Table 4-2**).

In addition, the available warning time for the Precinct does not take into consideration Vehicular Evacuation Route V4 which will allow evacuation to continue west along Newbridge Road during flooding up until river water levels reach a gauge height of 7.44 metres. This could allow evacuation to occur for a further 1.5 hours from initial inundation of Newbridge Road (*refer* **Figure 4-17**) or 3.5 hours from the time when flood levels are predicted to reach a height of 4 metres on the gauge.

It could be argued that Vehicular Connection V4 could lead to an increase in the 5,500 maximum vehicle capacity identified by Molino Stewart (2022). This is based on Connection V4 allowing vehicles to continue to evacuate along Newbridge Road after the low point is inundated. This would mean that while Newbridge Road is closed to everyone else, the Precinct could continue to use it to evacuate to the Liverpool CBD. It is estimated Vehicular Connection V4 could increase the vehicular evacuation capacity for the Precinct from 5,500 vehicles to between 7,300 and 9,100 vehicles.

Notwithstanding, the 7.25 hours of available evacuation time documented in the 2022 Molino Stewart Report is considered more than adequate for the Precinct to be evacuated safely via the available vehicular routes and footbridges.

(viii) An analysis of available warning times for potential evacuation triggers was undertaken based on an assessment of the rate-of-rise of flood levels at the Liverpool Weir gauge for the Probable Maximum Flood (PMF) and for the 1 in 500 AEP flood. Flood level (or stage) hydrographs for the 5%, 1% and 1 in 500 AEP floods and the PMF are plotted in **Figure 4-17** for the Liverpool Weir Gauge. Markers indicating the point in time along the 1 in 500 AEP and PMF flood level hydrographs when inundation of the various evacuation routes first occurs is superimposed on the figure.

All flood warning times include twelve (12) hours of minimum 'target warning lead time' before a gauge height of 4 metres is reached as per the '*Provisions of and Requirements for Flood Warning*' (NSW SES, 2019). The analysis found that the following flood warning and evacuation times would be available for the Moore Point Precinct.

- There would be between 13.5 and 15.5 hours of combined warning and evacuation time available during a PMF event (*refer* **Table 4-6**).
- Warning and evacuation times would range between 14 and 19 hours during a 1 in 500 AEP event (*refer* **Table 4-7**).
- The length of available time varies depending on the method of evacuation and the specific route chosen.

It is expected that once Volume 3 of the '*Georges River and Woronora River Valley Flood Emergency Sub Plan*' is completed there will be clearer guidance on emergency response planning and SES adopted triggers for evacuation management.

(ix) The capacity for the Moore Point Precinct to be evacuated via the proposed vehicular and pedestrian routes has been assessed and documented in **Table 4.7**. The assessment was based on applying the 5,500 maximum vehicle capacity determined by Molino Stewart (2022). The following was determined for the final development scenario in 2056.

a. It is estimated that 10,500 vehicles could be "in the precinct" prior to the onset of major flooding. However, many vehicle owners may choose to heed advice associated with a Flood Watch which in all likelihood would be issued by BOM up to three (3) days prior to an event of this magnitude and may relocate their vehicles in advance.

b. 12,100 people would evacuate the site via the 5,500 vehicles determined to be the capacity of the transport network allocated to the Moore Point Precinct.

c. The remaining 17,300 people would evacuate from the site via pedestrian Footbridges P1 or P2.

d. 17,300 people could be evacuated via the two footbridges within less than 2 hours.

e. Evacuation over the footbridges could be staggered based on their being 3.5 hours of additional time for evacuation, when based on use of the Minor flood warning being used as a trigger for evacuation.

As there is capacity to safely evacuate all of the population from the Precinct within the available time, it follows that shelter-in-place will only serve as a back-up strategy should it be required. As a risk mitigation measure, all habitable floors and back-up infrastructure will be positioned at or above an elevation of 12.2 mAHD which corresponds to the predicted peak level of the PMF (refer **Section 4.9**).

Construction of the Moore Point Precinct is proposed to occur over three stages between 2026 and 2056. Evacuation during intermediate stages 1 and 2 was also assessed as part of this FERP. The key findings are documented below.

(x) Stage 1 of the development is to be completed between 2026 and 2036. As shown in **Figure 5-1**, Stage 1 would include Vehicular Connection V1 (*Bridges Road*) and V2 (*Anchor Place*) which are both predicted to be 'cut' once floodwaters reach a height of 6.44 metres (*9.2 mAHD*) at the Liverpool Weir Gauge. Pedestrian Footbridge P2 will be constructed as part of Stage 1 and will provide a pedestrian evacuation route during floods up to and including the 1 in 500 AEP event; or up to a gauge height of 7.44 metres (*10.2 mAHD*).

As shown in **Table 5-3**, it is expected that all 5,500 vehicles predicted by the 2022 Molino Stewart Report could evacuate Stage 1 of the development. This exceeds the number of vehicle spaces that will be provided as part of Stage 1 by 925 spaces (*refer* **Table 5.3**). Accordingly, all vehicles predicted to be on-site once Stage 1 is completed will be able to evacuate during the onset of major flooding of the Georges River.

The 2,420 people that will not be able to leave the precinct via vehicle (*because they won't own one*) will be able to walk to flood free land in the Liverpool CBD via Pedestrian Bridge P2 (*refer* **Table 5.3**). Based on the evacuation timeframes determined by BG&E (refer **Appendix B**) it is estimated this number of people could evacuate in less than 30 minutes. As the available evacuation time is 5.5 hours, there is potential for pedestrian evacuation of these people to be staggered to allow a more gradual influx of people into the Liverpool CBD.

(xi) Evacuation Routes V1 (Bridges Road), V2 (Anchor Place) and V3 (Haigh Avenue) and Pedestrian Footbridge P1 and P2 are all proposed to be available during Stage 2 of the development (2036 to 2046) (refer **Figure 5-1**). There would be no constraints preventing all 5,500 vehicles determined to be the capacity of the transport network allocated to the Moore Point Precinct by the 2022 Molino Stewart Report to evacuate once Stage 2 of the development is completed (2046).

The analysis indicates that 8,189 total vehicle parking spaces will be provided by the end of development of Stage 2 (refer **Table 5-3**). Therefore, it follows that in 2046 there could be up to 2,689 vehicles that remain in the precinct during a PMF event.

As one of the proposed footbridges will be completed prior to the commencement of Stage 2 it follows that the remaining population (after vehicular evacuation) will be able to evacuate by foot. As shown in **Table 5-3**, the remaining 8,606 people could evacuate by foot within a 2 hour period. As above, there is approximately 3.5 hours excess time for evacuation by foot into the Liverpool CBD. Evacuation by foot could therefore be staggered.

(xii) Anyone remaining onsite during Stage 1 and Stage 2 will be required to shelter in place within their apartments and/or nominated communal gathering areas.

Flood emergency response management procedures have also been determined for the proposed development to show how flood risks and evacuation would be managed. The procedures have been determined with the objective of:

- utilising technology and other means for information dissemination;
- utilising early warning triggers such as severe weather warnings to commence systems maintenance and preparation of the site and people;
- maximising the capacity for future residents and workers to safely evacuate the precinct either by vehicle (up to a maximum of 5,500) or by foot, during the onset of major flooding that would cause the precinct to be isolated for more than 6 hours; and,
- addressing the recommendations made by the flood advisory panel and the 2022 NSW flood inquiry.

A preliminary '*Emergency Response Plan - Actions and Checklist*' has been prepared for the development and included as **Appendix B**.

9 References

- Advisian Pty Ltd & Risk-e Business Consultants (*February 2022*), *'Moore Point Precinct, Liverpool – Review of Molino Stewart's Georges River Flood Evacuation Analysis Report'*; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd
- Advisian Pty Ltd (*July 2022*), '*Moore Point Precinct, Liverpool - Flood Impact Assessment*'; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd
- Advisian Pty Ltd & Risk-e Business Consultants (*November 2022*), '*Moore Point Precinct, Liverpool – Flood Emergency Response Strategy*'; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd
- Advisian Pty Ltd (*January 2024*), '*Moore Point Precinct, Liverpool - Flood Impact Assessment*'; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd
- Advisian Pty Ltd (*February 2024*), '*Moore Point Precinct, Liverpool – Flood Emergency Response Plan*'; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd
- Aurecon (*2020*) *'Liverpool Collaboration Area – Strategic Transport Infrastructure Assessment*'; prepared for Leamac Property Group & Coronation Property Co. Pty Ltd)
- Australian Bureau Statics data https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC12361?opendocument
- Australian Institute for Disaster Resilience *'Australian Disaster Resilience Handbook - Flood Preparedness'* https://knowledge.aidr.org.au/resources/handbook-flood-planning
- Australian Institute for Disaster Resilience (*2017*), *'Australian Disaster Resilience Handbook 7 - Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia'*; © Commonwealth of Australia 2017 third edition.
- Australian Transport Research Forum (*2013*) *'An Overview on Multimodal Emergency Evacuation in an Urban Network'* https://www.australasiantransportresearchforum.org.au/sites/default/files/2013_shiwakoti_liu_hopkins_young.pdf
- 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.
- Bewsher Consulting (*1997*), *'Georges River Flood Model Study'*
- Bewsher Consulting (*2004*), *'Georges River Floodplain Risk Management Study and Plan'*, prepared for Georges River Floodplain Management Committee
- BMT Australia Pty Ltd (*2020*), *'Georges River Flood Study'*, prepared for Canterbury Bankstown Council and Liverpool City Council.
- Federal Emergency Management Agency, U.S. Department of Homeland Security (*2019*), *'Guidelines for design of structures for vertical evacuation from tsunamis'* https://www.fema.gov/sites/default/files/2020-08/fema_earthquakes_guidelines-for-design-of-structures-for-vertical-evacuation-from-tsunamis-fema-p-646.pdf
- Greater Sydney Commission (*2018*), *'Collaboration Area – Liverpool Place Strategy'*
- International Tsunami Information Centre (www.itic.ioc-unesco.org) *'Vertical Evacuation Guidance'* http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=2070&Itemid=2927

- J Wyndham Prince (*2016*), *'Liverpool Waterfront Water Cycle and Flood Management Strategy'*, prepared for Leamac and Coronation Joint Venture Pty Ltd
- Liverpool City Council (*2008*), *'Liverpool Development Control Plan 2008'*, amended 1st February 2021.
- Liverpool City Council (*2020*), *'Connected Liverpool 2040 – Liverpool's Local Strategic Planning Statement – A Land Use Vision to 2040'*.
- Liverpool Collaboration Area Flood Evacuation Study (*2021*)- Minutes of meeting held on 22nd April 2021
- Molino Stewart Pty Ltd (*2022*), *'Georges River Evacuation Modelling – Flood Evacuation Analysis'*; prepared for Liverpool City Council.
- Molino Stewart Pty Ltd (*2019*), *Update of Parramatta Floodplain Risk Management Plans* (Draft) prepared for City of Parramatta Council; refer page 32
- Newgate Research (June 2018) *'Flood Evacuation Social Research'*
- NSW Evacuation Management Guidelines https://www.opengov.nsw.gov.au/publications/19473;jsessionid=20A3FCC8468B9124088D4056F9FD72FD
- NSW Government (*2005*), *'Floodplain Development Manual: the management of flood liable land'*; ISBN 0 7347 5476 0
- NSW State Emergency Services (*2019*) *'Provision of and Requirements for Flood Warning'*
- NSW State Emergency Management plan https://www.nsw.gov.au/sites/default/files/2021-04/state-emergency-management-plan-emplan.pdf
- NSW State Flood Plan (2021) https://www.nsw.gov.au/sites/default/files/2021-04/emergency-management-subplan-flood.pdf
- Pannier, Rodolphe *(2016) 'Ensuring safety of people in case of severe floods: feasibility and relevance of vertical evacuation strategies in high population density areas'* https://www.e3s-conferences.org/articles/e3sconf/abs/2016/02/e3sconf_flood2016_19004/e3sconf_flood2016_19004.html
- Public Works Department (*1991*), *'Georges River Flood Study'*
- Radboud University, Netherlands (2013) *'Evacuation during flooding: Higher ground is often better than fleeing'* https://www.sciencedaily.com/releases/2013/09/130924091534.htm
- Tsunami Evacuation: Lessons from the Great East Japan earthquake and tsunami of March 11th 2011 https://www.alnap.org/help-library/tsunami-evacuation-lessons-from-the-great-east-japan-earthquake-and-tsunami-of-march
- Wellington Region Emergency Management Office (www.wremo.nz). Tsunamis – Vertical Evacuation advice https://www.wremo.nz/hazards/tsunamis/vertical-evacuation/

IMPORTANT: Do not delete this section break

Appendix A

Emergency Response Checklist and Triggers

TABLE A1 PRELIMINARY EMERGENCY RESPONSE TRIGGERS, ACTIONS AND CHECKLIST

Person Responsible	Trigger Observed	Task	Check List
Flood Warden *Insert Name*	**Flood/Weather Warning** from BOM Expected time to next trigger: **12-36 hours**	The following actions are based on the flood/weather warning predicting that the flood is at least two (2) days away from commencing. ▪ Check maintenance logs for critical infrastructure such as emergency back-up power generators and PA systems. If maintenance undertaken over 3 months ago then request maintenance. ▪ Notify other flood wardens (if applicable) and contact NSW SES to confirm flood risks. ▪ Announcement over PA system to inform the community that a flood watch has been issued for the Georges River signalling that flooding along the Georges River is forecast to occur in the coming days (*note: can be more specific if the flood watch includes information on timing*). ▪ Obtain latest template for the information leaflet and incorporate event specific information. Leaflet is to be printed and distributed to buildings/business approximately one (1) day prior to flooding commencing. ▪ Contact personnel required for onsite management, including traffic management for road exits and pedestrian bridges. ▪ Actively monitor flood levels at the Georges River at Liverpool Weir Gauge: *Table Format:* http://www.bom.gov.au/fwo/IDN60233/IDN60233.566054.tbl.shtml *Chart Format:* http://www.bom.gov.au/fwo/IDN60233/IDN60233.566054.plt.shtml	Y / N
Flood Warden	**Flood Warning** from BOM Expected time to next trigger: **12-24 hours**	Receipt of a Flood Warning is an indication that there is greater certainty that a flood along the Georges River will occur. At this stage, there would be a forecast of the severity of the event which would be expressed as a forecast height at the Liverpool Weir gauge and/or what flood warning height would be reached or exceed, i.e., forecast to exceed Major flooding at Liverpool Weir Gauge. If the Flood Warning forecasts that the event is to exceed the Major gauge height at Liverpool Weir, the following actions are to be taken: ▪ Ensure onsite personnel are available and notified that they will be required onsite within 12-24 hours. ▪ Print information leaflets and distribute to buildings and businesses. Information leaflet to include latest forecasts including height and timing. ▪ Announce via PA system that a Flood Warning has been issued and that a flood is forecast to occur within **X** days. Inform residents and workers to collect information leaflets. ▪ Liaise with businesses to ensure they are aware of the flood risks and are prepared to reduce staff commitments in the lead up to the event. Advise that business closures are recommended, if possible. This is to be enforced for the heritage buildings. Next Steps: Continue to monitor flood levels at the Liverpool Gauge and await any instructions from the NSW SES.	Y / N

Flood Warden	**Minor Flood Level** of 2.0 metres is reached at Liverpool Weir Gauge Expected time to next trigger: **1 - 2 hours**	Once flood levels reach the Minor gauge height of 2 metres, and if forecasts still predict flooding to exceed Major (4.5m height) and continue to over 6 metres (8.7 mAHD), then evacuation is to be triggered and the following actions are to be taken: ▪ Confirm forecasts with the NSW SES. ▪ Ensure personnel are onsite to manage traffic at all vehicular and pedestrian exists. ▪ Announcement over the PA system that evacuation has been triggered and that personnel will be onsite to assist with traffic management at all vehicular and pedestrian exits. ▪ Personnel at vehicular exists to record traffic movements out of the site. Recorded traffic movements are to be monitored twice hourly for the first two (2) hours to track progress and remaining permissible movements (noting that vehicular evacuation is to be capped at 5,500 vehicles). ▪ Personnel to be located at Pedestrian Bridges on the Precinct and Liverpool CBD sides. Pedestrians arriving to the Liverpool CBD to be directed onwards to a pre-determined flood refuge. Next Steps: Continue to monitor flood levels at the Liverpool Gauge and await any instructions from the NSW SES.	Y / N
Flood Warden	**Moderate Flood Level** of 3.0 metres is reached at Liverpool Weir Gauge Expected time to next trigger: **1 - 2 hours**	Once flood levels reach the Moderate gauge height of 3 metres, and if forecasts still predict flooding to exceed Major (4.5m height) and continue to over 6 metres (8.7 mAHD), then evacuation is to continue, and the following actions are to be taken: ▪ Confirm forecasts with the NSW SES ▪ Ensure vehicular movements are being tracked. The permissible 5,500 vehicle movements would likely be reached within 1-2 hours, which could align with flood levels reaching the Major gauge height. ▪ Announcement over the PA system that evacuation is to continue and that the foreshore and heritage buildings are to be restricted to the public. Next Steps: Continue to monitor flood levels at the Liverpool Gauge and await any instructions from the NSW SES.	Y / N
Flood Warden	**Major Flood Level** of 4.5 metres is reached at Liverpool Weir Gauge Expected time to next trigger: **1 - 2 hours**	Once flood levels reach the Major gauge height of 4.5 metres, and if forecasts still predict flooding to continue to over 6 metres (8.7 mAHD), then evacuation is to continue, and the following actions are to be taken: ▪ Confirm forecasts with the NSW SES ▪ Announcement over PA system that vehicular evacuation is nearing capacity and that vehicles could be prevented from leaving the site within 1 hour. Inundation of Newbridge Road and lower lying land that fronts Newbridge Road and Bridges Road could be impacted. ▪ Vehicular movements would be approaching 5,500 and inundation of Newbridge Road could occur within 1-2 hours. Traffic managers are to be instructed to prepare to turn traffic away at a safe location that is away from the exits to Newbridge Road, i.e., turned away within the site. ▪ Any vehicles that are turned away are to be instructed to return vehicles to their respective packing spots or to a designated parking location for visitors/workers. ▪ Evacuation to continue over the footbridges. Next Steps: Monitor for inundation of heritage buildings and Newbridge Road forecast to occur around a gauge height of 5.8 and 6.3 metres, respectively.	Y / N

Flood Warden	Floodwaters start to inundate Newbridge Road corresponding to a gauge height of 6.3 metres. Expected time to next trigger: **1 - 3 hours**	Once floodwaters start to inundate Newbridge Road vehicular evacuation is to be blocked to Vehicular Connections V1, V2 and V3. If forecasts are predicting that flood levels will continue to rise and peak above 7.5 metres at Liverpool Weir, then the following actions are to be taken. ▪ Confirm forecasts with the NSW SES ▪ If 5,500 vehicles have already evacuated, then an announcement is to be made over the PA system that vehicular evacuation is no longer possible and evacuation by foot is required. ▪ If there is still capacity for more vehicles to leave the site, then it is to be announced that evacuation could continue via Vehicular Connection V4. Traffic management will be required at this location to direct vehicles west and over the Newbridge Road Bridge. ▪ Evacuation over footbridges to continue and be closely monitored on the Liverpool and Moore Point sides. ▪ Ensure all evacuation is complete prior to a height of 7.5 metres being recorded at the Liverpool Weir gauge. Next Steps: Monitor flood levels at the Liverpool Weir gauge to ensure evacuation is complete before a gauge height of 7.5 metres is recorded. Floodwaters could start to inundate the internal road network at this point	Y / N
Flood Warden	Gauge height of 7.0 metres recorded indicating approximately 1.0 hour before widespread inundation of local roads. Expected time to next trigger: **1 hour**	If flooding at the Liverpool Weir reaches a gauge height of 7.0 metres the Flood Warden is to act on the basis that widespread inundation of the Precinct could occur within 1 hour. Pedestrian evacuation is to be winded down and if anyone remains within the Precinct they are to shelter in place within their apartment or within one of the designated communal floors. Shelter in place is to be announced over the PA system with no further evacuation to be undertaken. Next Steps: Maintain communication with the NSW SES and continue to monitor flood levels at the Liverpool Weir gauge to identify the peak and monitor falling flood levels.	
Flood Warden	**Flood Recovery**	Flood recovery at the site can commence once floodwaters drop below the minor gauge level of 7.0 metres at the Liverpool Weir gauge. Recovery procedures must be undertaken in accordance with the Flood Response Plan.	Y / N

Date Completed: .....

Time Completed: .....

Signature of Responsible: .....

Appendix B

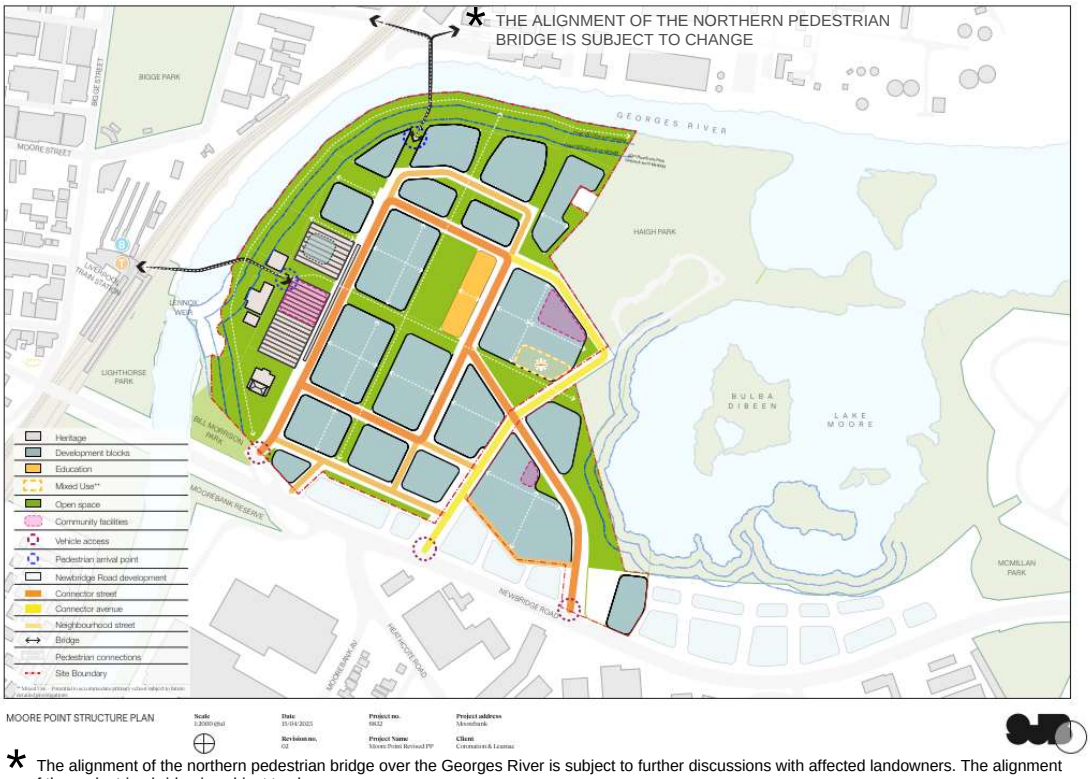
Pedestrian Volume Assessment (BG&E, 2024)

Technical Note – Moore Point Bridge Concept – Pedestrian Volume Assessment

Project Number	**S23202**
Client	**Coronation**
Date	**23 April 2024**
Document Number	**S23202-TN-001**
Revision	**03**
Prepared By	**Jack Sandell, Associate Traffic Modeller**
Reviewed By	**Deborah Hutchison, Traffic and Transport Planning Lead, QLD**
Approved By	**Adrian Benoy, Senior Bridge Engineer**

1 Introduction

This technical note summarises the pedestrian study undertaken for the proposed Moore Point bridges. A new mixed-use development is proposed at Moore Point, west of Liverpool, NSW. Two pedestrian bridges are proposed over the Georges River as part of this development. One bridge (referred to as A3) connects into Liverpool Station and the other (referred to as C2) connects into Elizabeth Street. The locations are shown in Figure 1.



* The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners. The alignment of the pedestrian bridge is subject to change

Figure 1 Moore Point Development and bridge locations

BG&E Pty Limited
Level 2, 8 Windmill Street, Millers Point NSW 2000 Australia
sydney@bgeeng.com
+61 2 9770 3300

ABN 67 150 804 603

The pedestrian study assesses the time taken for a flood evacuation across the two proposed pedestrian bridges, and the maximum number of people on each bridge at any one time.

2 Available Data

The data in Table 1 has been used to undertake the assessment of the bridges. Pedestrian capacities and assumptions have been sourced from:

- NFPA (National Fire Protection Association) 130 standard for Fixed Guideway Transit and Passenger Rail Systems, 2023.
- John J Fruin, Pedestrian Planning and Design, 1971.

Information on bridge dimensions have been sourced from:

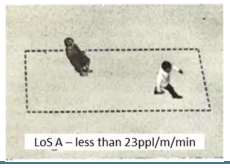
- Moore Point bridges concept design structural drawing package Revision B.

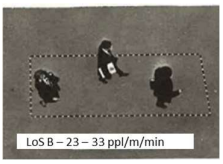
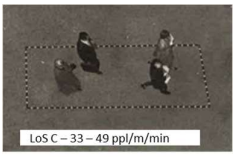
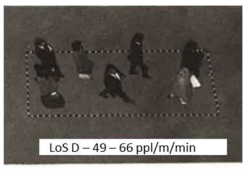
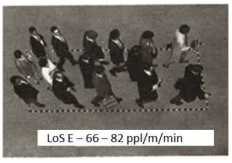
Table 1 Available data

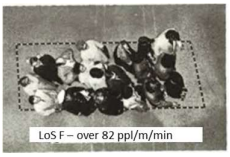
Data	Value	Source	Comment
Total People	11,066	Provided by Client	
Wheelchair users	57	Provided by Client	This represents 0.5% of the entire crowd.
Bridge Split	50%	Provided by Client	
Min Walking speed	2km/h	Provided by Client	This number is 12% lower than the NFPA 130 guidelines and has been lowered to account for wet weather and people carrying of luggage.
Bridge Capacity	66 people/m/min (LoS D)	John J Fruin, Pedestrian Planning and Design, 1971. These capacities are shown in greater detail in Table 2	NFPA 130 guidelines, 2023 recommends LoS E for a fire evacuation. This has been lowered to D to account for wet weather and people carrying of luggage.
Edge factor	0.3 m	Taken from NFPA 130, 2023	This represents people walking an appropriate distance from the wall/railing.
Bridge width A3	3.5 m	Taken from drawing BR-A303	Measured between hand railings
Bridge Width C2	3.5 m	Taken from drawing BR-C103	Measured between hand railings
Bridge length A3	300.1 m	Taken from drawing BR-A301	
Bridge length C2	467.3 m	Taken from drawing BR-C202	This represents the longest route.

Table 2 shows a description of the Levels of Service (LoS) and standard design densities for pedestrian walkways taken from *John J Fruin, Pedestrian Planning and Design, 1971*.

Table 2 Level of Service (LoS) descriptions for interchange walkways

LoS	Average Flow Rate (people/m/min)	Average Density (m^2/person)	Description	Image
A	23 or less	3.3 or more	At LoS A sufficient area is provided for pedestrians to select freely their own walking speed, to bypass slower pedestrians, and to avoid crossing conflicts with others. Designs consistent with this LoS would include public buildings or plazas without severe peaking characteristics or space restrictions.	

LoS	Average Flow Rate (people/m/min)	Average Density (m^2/person)	Description	Image
B	23-33	2.3-3.3	At LoS B sufficient space is available to select normal walking speed and to bypass other pedestrians in primarily unidirectional flows. Where reverse direction or pedestrian crossing movements exist, minor conflicts will occur, slightly lowering mean pedestrian speeds and potential volumes. Designs consistent with this LoS would represent a reasonably high type of design for transportation terminals and buildings in which recurrent, but not severe, peaks are likely to occur.	
C	33-49	1.4-2.3	At LoS C freedom to select individual walking speed and freely pass other pedestrians is restricted. Where pedestrian cross movements and reverse flows exist, there is a high probability of conflict requiring frequent adjustment of speed and direction to avoid contact. Designs consistent with this LoS would represent reasonably fluid flow; however, considerable friction and interaction between pedestrians are likely to occur, particularly in multidirectional flow situations. Examples of this type of design would be heavily used transportation terminals, public buildings, or open spaces where severe peaking, combined with space restrictions, limit design flexibility.	
D	49-66	0.9-1.4	At LoS D the majority of persons would have their normal walking speeds restricted and reduced due to difficulties in bypassing slower moving pedestrians and avoiding conflicts. Pedestrians involved in reverse-flow and crossing movements would be severely restricted, with the occurrence of multiple conflicts. Designs at this LoS would be representative of the most crowded public areas, where it is necessary to continually alter walking stride and direction to maintain reasonable forward progress. At this LoS there is some probability of intermittently reaching critical density, causing momentary stoppages of flow. Designs consistent with this LoS would represent only the most crowded public areas.	
E	66-82	0.5-0.9	At LoS E virtually all pedestrians would have their normal walking speeds restricted requiring frequent adjustments of gait. At the lower end of the range, forward progress would only be made by shuffling. Insufficient area would be available to bypass slower moving pedestrians. Extreme difficulties would be experienced by pedestrians attempting reverse-flow and crossflow movements. The design volume in this range would approach the maximum attainable capacity of the walkway, with the result of frequent stoppages and interruptions of flow. Design in this range should only be employed for short peaks in the most crowded areas. This design level would occur naturally with a bulk arrival traffic pattern that immediately exceeds available capacity, and this is the only design situation for which it would be recommended. Examples would include sports stadium design or rail transit facilities where there may be a large, short-term exiting of passengers from a train. When this LoS is assumed for these design conditions, the adequacy of pedestrian holding areas at critical design sections and all supplementary pedestrian facilities must be carefully evaluated.	

LoS	Average Flow Rate (people/m/min)	Average Density (m^2/person)	Description	Image
F	Variable	0.5 or less	At LoS F all pedestrian walking speeds are extremely restricted, and forward progress can only be made by shuffling. There would be frequent unavoidable contact with other pedestrians and reverse or crossing movements would be virtually impossible. Traffic flow would be sporadic with forward progress based on movement of those in front. This LoS is representative of a loss of control and a complete breakdown in traffic flow. Pedestrian areas in this range are more representative of a queuing than a traffic flow situation, and this LoS is not recommended for walkway design.	

3 Analysis and Results

3.1 Methodology

The methodology to assess the time taken to cross the bridges has calculated the:

- Volume of people crossing each bridge.
- The capacity of each bridge and how long it will take people to enter onto the bridge.
- The time taken for the final person in the queue to walk across.
- The maximum number of people on the bridge.

The time taken to cross the bridge is how long it will take the entire crowd to enter the bridge plus the time taken for the final person in the queue to exit the bridge. It is assumed that wheelchair users will be able to use the bridge and ramps with the rest of the crowds, however, will require alternate means of egress at any sets of stairs.

The maximum number of people on the bridge has been calculated by assuming the maximum flow rate operates continuously and then multiplies this density by the usable area of the bridge.

The evacuation will likely take place as a phased operation over a 5-hour period with SMS alerts and other communications methods directing pedestrians to the correct bridge. However, this assessment measures the time taken for all pedestrians to cross the bridge in a single continuous flow to assess the minimum time to cross and the maximum volume of pedestrians expected to use the bridge.

No assessment of the capacity or viability of routes within the site to the bridges has been undertaken as part of this study or of the locations on the Liverpool side of the bridge or inside Liverpool Station. This will be looked at further as part of the development of the evacuation plan.

3.2 Bridge A3

The volume of pedestrians to each bridge has been split evenly with 5,533 going to each (as per client advice). It has been assumed that 28 people are wheelchair users on Bridge A3 (as per client advice), which represents 0.5% of bridge users.

Bridge A3 crosses the river from Moore Point and connects into Liverpool Station. From Liverpool Station, evacuees will have the opportunity to use other modes of transport to reach a safe place.

The bridge is 3.5m wide between the railings. Subtracting an edge factor of 0.3m from each side, representing people standing an appropriate distance away from each wall (NFPA 130, 2023), results in a usable width of 2.9 meters. These widths are shown in Figure 2.

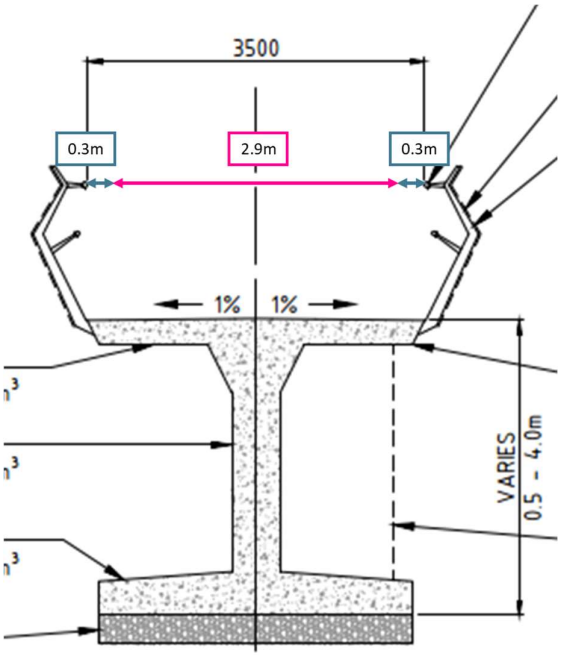


Figure 2 Bridge A3 cross section showing the edge factors and usable width

The bridge has a capacity of 66 people/m/min (walkway LoS D, Fruin 1971). Multiplying this by the usable width of the bridge results in a capacity of 191.4 people per minute. This means it will take the 5,533-person crowd 28:54 minutes for people to enter onto the bridge. It is assumed the arrival rate to the bridge will be managed to prevent a large queue of over 5,000 people at the base of the bridge and to prevent people having to wait the entire 28:54 minutes at a single point.

The bridge has a span of 300.1m, as shown in Figure 3. The slowest person, walking at 2km/h, will take 9:00 minutes to walk this distance. Therefore, to have everyone cross the bridge will take **37:54 minutes** (28:54 minutes for people to access the bridge plus 9:00 minutes for the final person to cross the bridge).

Care will need to be taken when directing this many people into Liverpool Station to ensure a single set of stairs or waiting area is not overloaded with people and to ensure the crowd is safely directed to appropriate waiting areas or alternate means of transport.

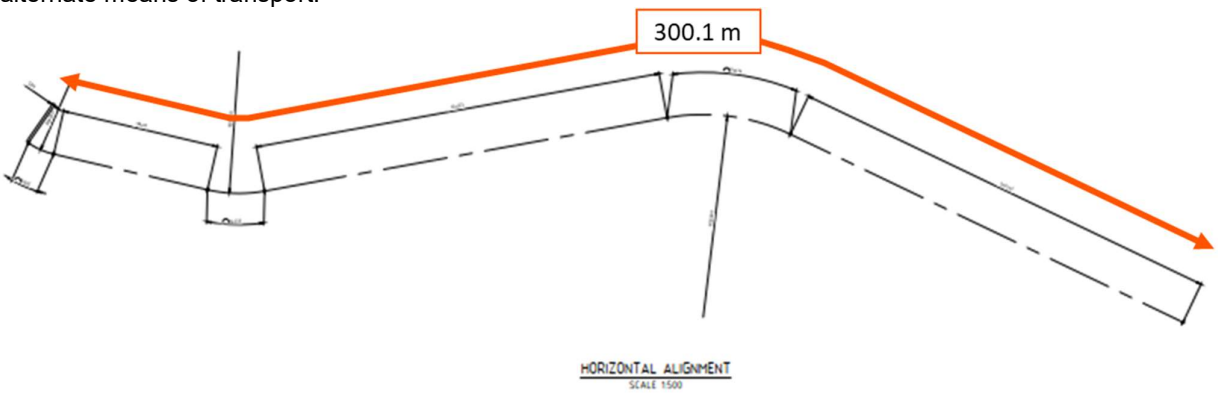


Figure 3 Bridge A3 length

When pedestrians walk at the continuous flow of 191.4 people per minute, the bridge will have a **maximum load of 967 people**.

If people choose to walk at lower density, at LoS A, a design level more typical of public building or outdoor plazas, it will take 1:22:57 hours for people to enter onto the bridge, 1:31:57 minutes for the entire crowd to cross and the bridge will carry a maximum load of 264 people.

3.3 Bridge C2

The volume of pedestrians to each bridge has been split evenly with 5,533 going to each (as per client advice). It has been assumed that 29 people are wheelchair users on Bridge C2 (as per client advice), this represents 0.5% of the crowd.

Bridge C2 crosses the river from Moore Point and connects into Elizabeth Street, both on the eastern and western sides of the train line. For this assessment, it is assumed that evacuees will be directed to the western side of Elizabeth Street to calculate both the longest time and the maximum load of pedestrians. The bridge is 3.5m wide between the railings. Subtracting an edge factor of 0.3m from each side, representing people standing an appropriate distance away from each wall (NFPA 130, 2023), results in a usable width of 2.9 meters. These widths are shown in Figure 4.

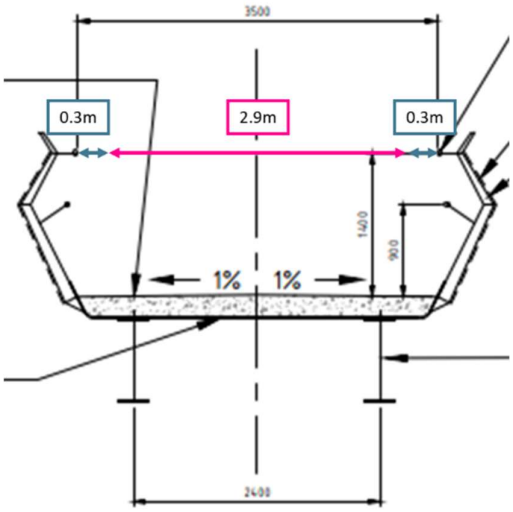
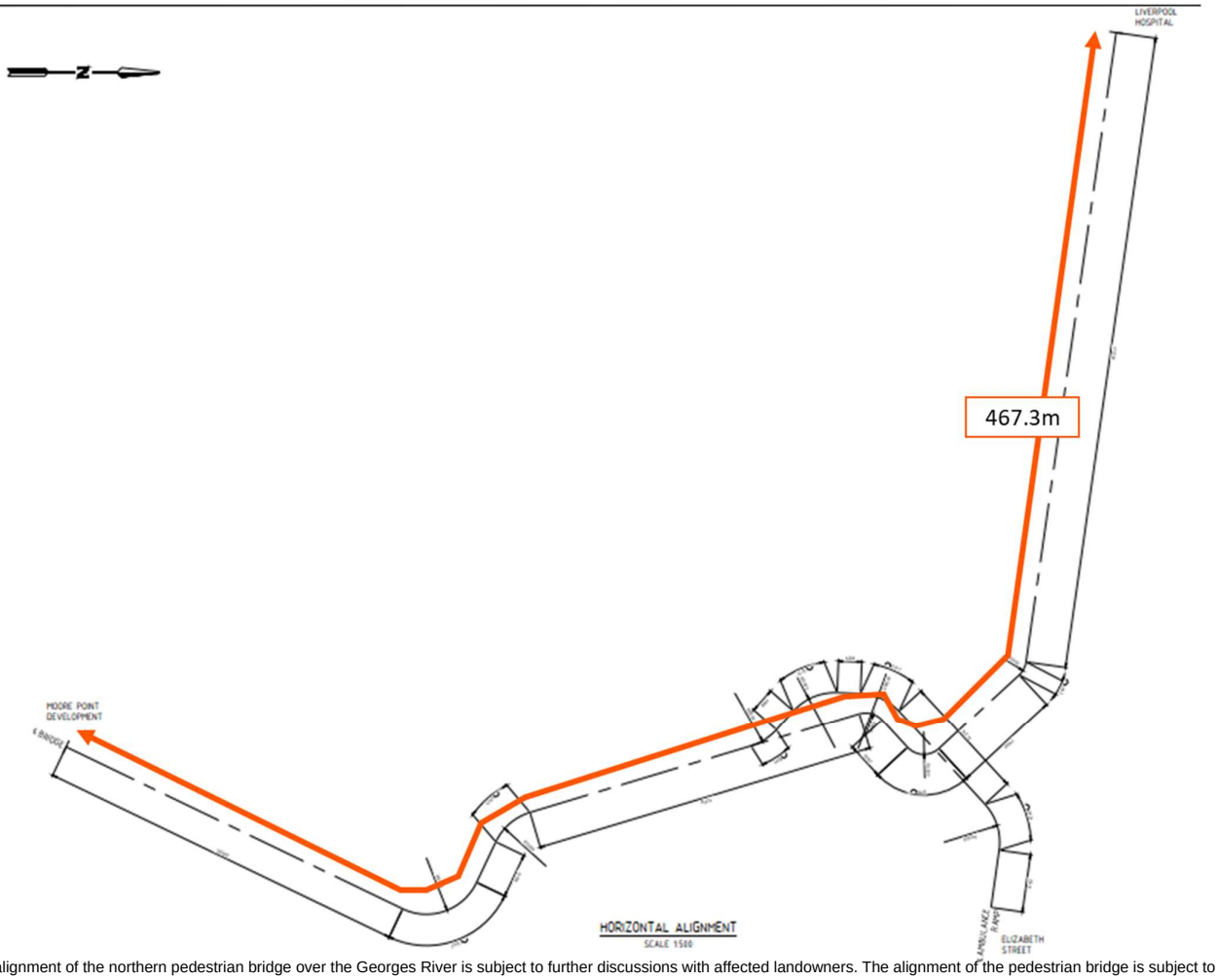


Figure 4 Bridge C2 cross section showing width, edge factors and usable width

The bridge has a capacity of 66 people/m/min (walkway LoS D, Fruin 1971). Multiplying this by the usable width of the bridge results in a capacity of 191.4 people per minute. This means it will take the 5,533-person crowd 28:54 minutes for people to enter onto the bridge. It is assumed the arrival rate to the bridge will be managed to prevent a large queue of over 5,000 people at the base of the bridge and to prevent people having to wait the entire 28:54 minutes at a single point.

The bridge has a span of 467.3m, shown in Figure 3. The slowest person, walking at 2km/h, will take 14:01 minutes to walk this distance. Therefore, to have everyone cross the bridge will take **42:55 minutes** (28:54 minutes for people to access the bridge plus 14:01 minutes for the final person to cross the bridge).



The alignment of the northern pedestrian bridge over the Georges River is subject to further discussions with affected landowners. The alignment of the pedestrian bridge is subject to change

Figure 5 Bridge C2 length

As the bridge connects into Elizabeth Street via ramps, wheelchair users will be free to use the same egress route as the rest of the crowd.

When pedestrians walk at the continuous flow of 191.4 people per minute, the bridge will have a **maximum load of 1,506 people**.

If people choose to walk at lower density, at LoS A, a design level more typical of public building or outdoor plazas, it will take 1:22:57 hours for people to enter onto the bridge, 1:36:58 minutes for the entire crowd to cross and the bridge will carry a maximum load of 411 people.

3.4 Structural Design Criteria

The structural design criteria adopted for the concept designs (all bridges) includes pedestrian crowd loading of 5kPa (kilopascal) as per AS5100.2-2017 clause 8.1(b). As per the standard an additional Ultimate Limit State Load Factor of 1.5 is applied to this loading, (i.e. additional 50%).

Therefore, the minimum pedestrian crowd loading which the designs can tolerate, structurally, is 1.5 x 5.0 = 7.5kPa. This is equivalent to approximately 750kg crowd weight in every square metre over the entire bridge deck area.

Assuming an average weight per pedestrian of 70kg (a value commonly selected for bridge vibration studies) the design crowd loading is approximately 10 people in every square metre (0.10m^2/person) over the entire bridge deck. This is almost 10 times denser crowding than the estimated maximum pedestrian evacuation volumes on the bridges and hence there are no structural issues associated with the predicted evacuation crowd loading.

4 Conclusions

The following conclusions have been reached from the study:

- Bridge A3 will take 37:54 minutes to clear the crowd and is expected to carry a maximum load of 967 people.
- Bridge C2 will take 42:55 minutes to clear the crowd and is expected to carry a maximum load of 1,506 people.

The times are assumed to be able to be managed effectively during the 5-hour phased evacuation period and have pedestrian volumes lower than the design load of the bridges.