Civil, Flooding and Stormwater

Macquarie Park Innovation Precinct

Stage 2

Prepared for Department of Planning, Housing and Infrastructure (DPHI) / 14 June 2024

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Your Partner in Engineering

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Draft	16.04.2024	ML, LC	JM	DRAFT FOR REVIEW
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1.0 Introduction

Taylor Thomson Whitting (TTW) have been engaged by the Department of Planning, Housing and Infrastructure (DPHI) to offer civil engineering and flooding advice for the proposed Master Plan covering the Macquarie Park Innovation Precinct (MPIP) Stage 2.

This report will assess the existing flood conditions, opportunities for the provision of watercourse restoration options including water quantity and quality devices, as well as the realignment of existing road networks and pedestrian pathways. Per requirements outlined by City of Ryde Council Development Control Plan (DCP) 2014, detailed flood planning levels for a range of development types have been outlined and suitable land uses within the Precinct identified. Information provided in this report aligns with the Macquarie Park Innovation Precinct's Place Strategy and the Strategic Infrastructure and Services Assessment (September 2022).

1.1 Background

In December 2023, the NSW Government announced the Transport Oriented Development Program – Part 1 Accelerated Precincts, a series of state-led priority rezonings located near Sydney metro stations and other key transport hubs. The state-led rezonings will provide planning support to optimise investment in transport infrastructure and increase housing close to existing transport hubs and new metro lines. The MPIP Place Strategy (Place Strategy) was finalised in September 2022 to guide and support detailed master planning of the neighbourhoods within Macquarie Park and subsequent rezonings. It provides a strategic framework to guide future development in the area, including approximately 20,000 additional jobs and up to 7,650 new dwellings and supporting infrastructure including improved public and active transport.

1.2 Stage 1 Neighbourhood Master Plan and Rezoning Package

The draft MPIP Stage 1 Master Plan rezoning package was exhibited from 9 November to 10 December 2023. It intends to deliver 3,060 new homes including 5-10 per cent affordable housing, up to 23,000 additional jobs or 5,040 homes through build-to-rent and 8 hectares of public and open space. It is currently being finalised by DPHI.

1.3 Stage 2 Neighbourhood Master Plan and Rezoning Package

The Department is now progressing the preparation of a rezoning package for the Stage 2 Neighbourhood Master Plan and Rezoning Plan, which seeks to rezone the following neighbourhoods identified in the Place Strategy:

- **Neighbourhood 1 – North Park – Ngalawala (Reciprocity)**: Ngalawala is characterised by its proximity to the Lane Cove National Park. It links from the rear of Macquarie Centre to Lane Cove Road and from the M2 Motorway southward to a series of incomplete connections that run parallel to Waterloo Road.
- **Neighbourhood 5 – Porters Creek – Burbigal (Morning):** Burbigal is bound by Lane Cove Road to the north, the Lane Cove National Park and M2 Motorway to the east and Wicks Road to the south. It offers key open space and connections to the natural environment through Fountain Garden, Halifax Street Park and Porters Creek.
- **Neighbourhood 6 – Wicks Road South – Garungul (Unbreakable):** Garungul is in the southwest of the investigation area, bound by Lane Cove Road to the north, Epping Road to the west, and Lachlan's Line to the south and east. Garungul is characterised by education, health and wellbeing activities, with Macquarie Park education precinct and walking connections links to North Ryde and Macquarie Park.
- **Neighbourhood 7 – North Ryde Riverside – Narrami Badu-Gumada (Connecting Water Spirit):** Narrami Badu-Gumada is the southernmost neighbourhood of Macquarie Park and is not directly connected to the rest of the investigation area. It is bound to the north by the North Ryde Metro Station, the M2 Motorway to the west, Delhi Road to the east and the Lane Cove National Park to the south.
- Stage 2 will also include the **eastern part of Neighbourhood 4 - Macquarie Living Station – Gari Nawi (Saltwater Canoe**). The remainder of Neighbourhood 4 is part of Stage 1 work.

2.0 Site Description

2.1 Site Location

The MPIP site is bounded by the M2 Motorway to the north and east, Epping Road to the south, and Shrimptons Creek to the west. The site area is approximately 185 hectares and is comprised of E2 Commercial Centre, E3 Productivity Support, and RE1 Public Recreation land use zone classifications. The MPIP Stage 2 site is shown in Figure 1, with key roads and properties presented in Figure 2 and Figure 3.

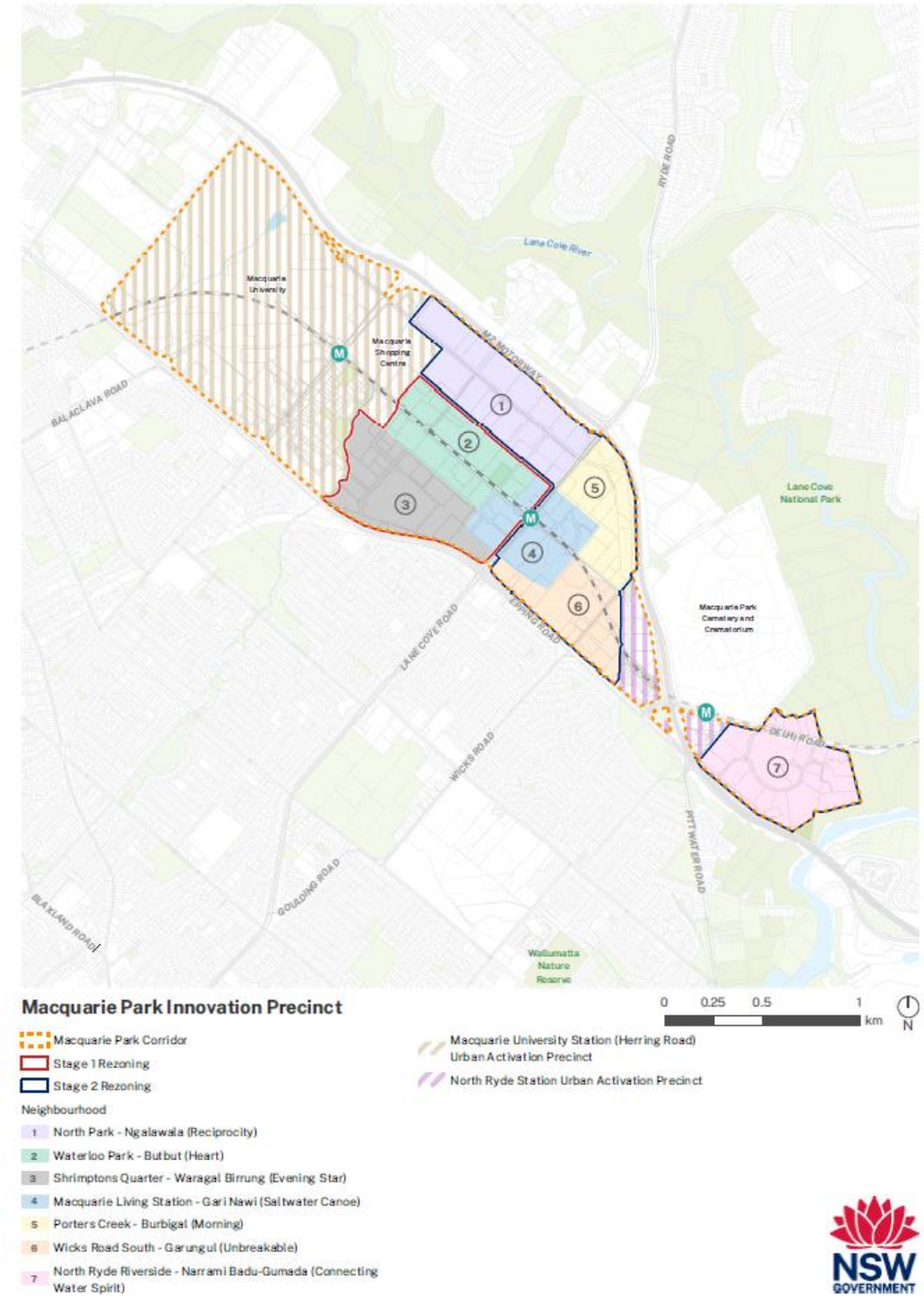


Figure 1: MPIP Site location and neighbourhoods

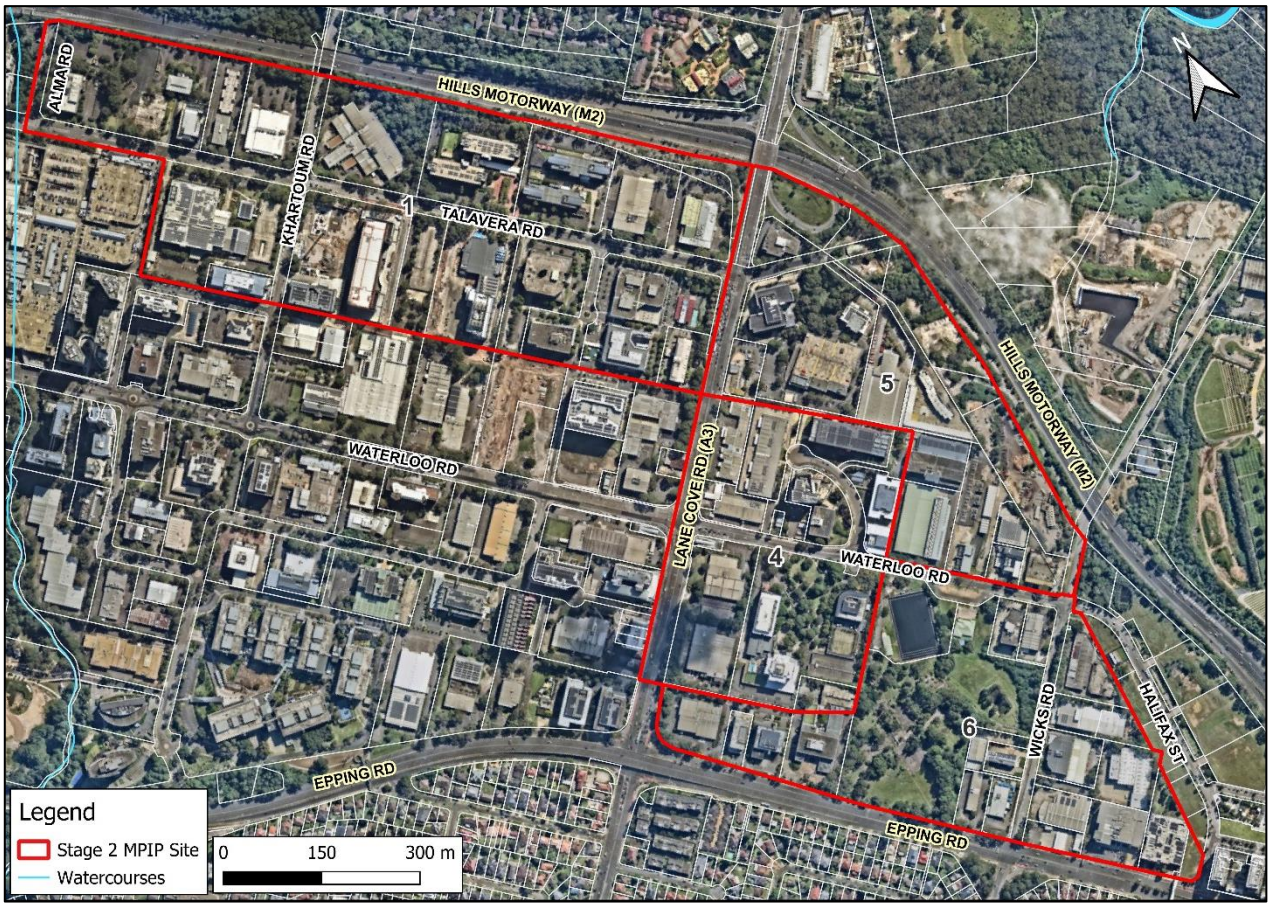


Figure 2: Map of the main Stage 2 area, showing key roads and properties. Source: Nearmap (dated 25th February 2024)

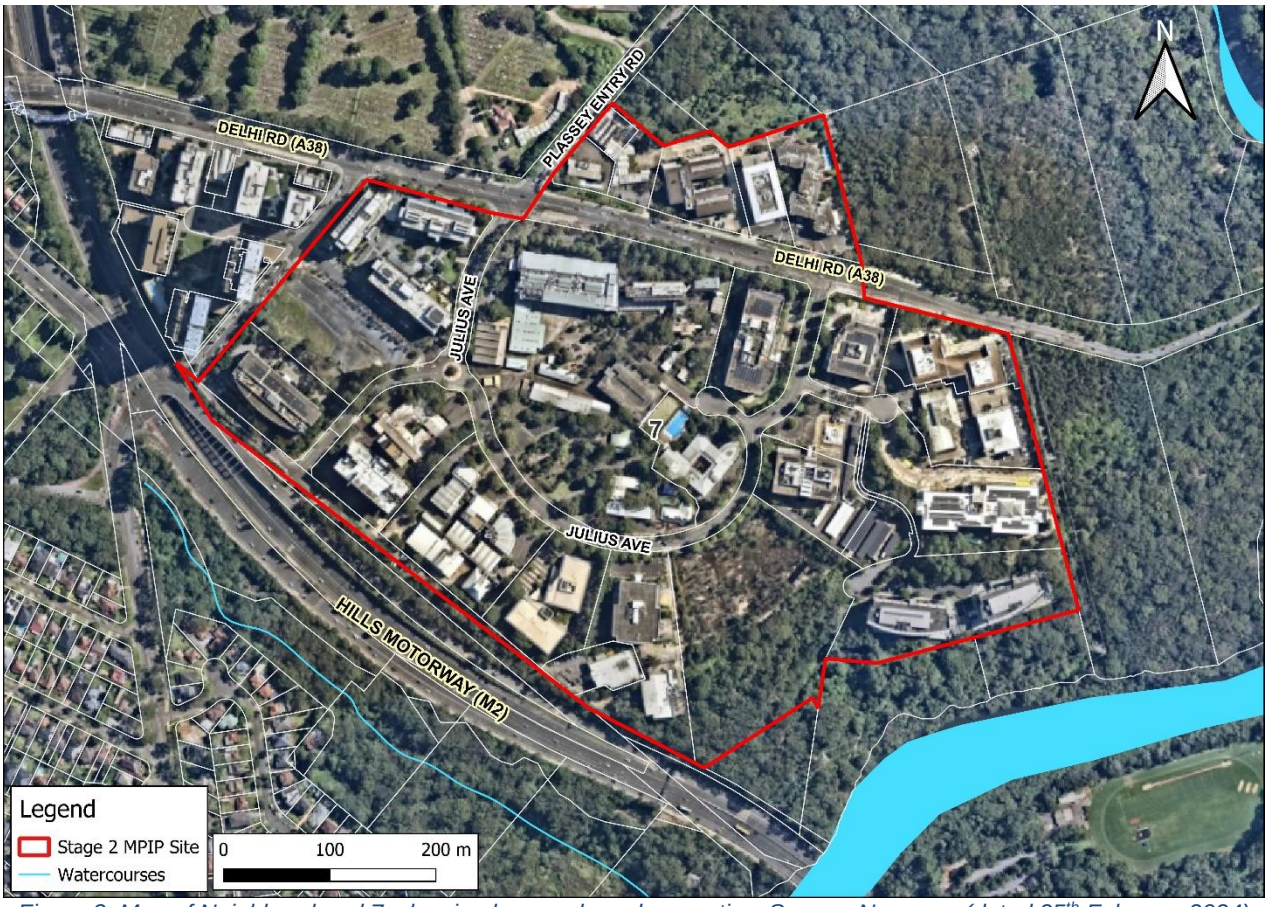


Figure 3: Map of Neighbourhood 7, showing key roads and properties. Source: Nearmap (dated 25th February 2024)

2.2 Site Topography

The bed elevation within the main western MPIP site boundary varies between a high of 75.4m AHD in Neighbourhood 6 and a low of 32.8m AHD in Neighbourhood 5. Elevation falls by approximately 42.6 m over an 845 m distance, with an average gradient of 5%. There is an overall slope from the southwest to the north-northeast towards Lane Cove River, as is evident in the Digital Elevation Model (DEM) of the site in Figure 4 and the cross-sectional profile in Figure 5.

Neighbourhood 7 slopes from a relatively flat region in the northwest towards the Lane Cove River in the southeast. Elevation varies between a high of approximately 60m AHD to a low of approximately 16m. A plateau has been excavated at 6-8 Julius St to 36m AHD. Along the section in Figure 6, elevation falls by 41.4m over a distance of 613m with an average gradient of 6.8%.

Further discussion of nearby waterways and overland flows across the site will be included in the draft design report.

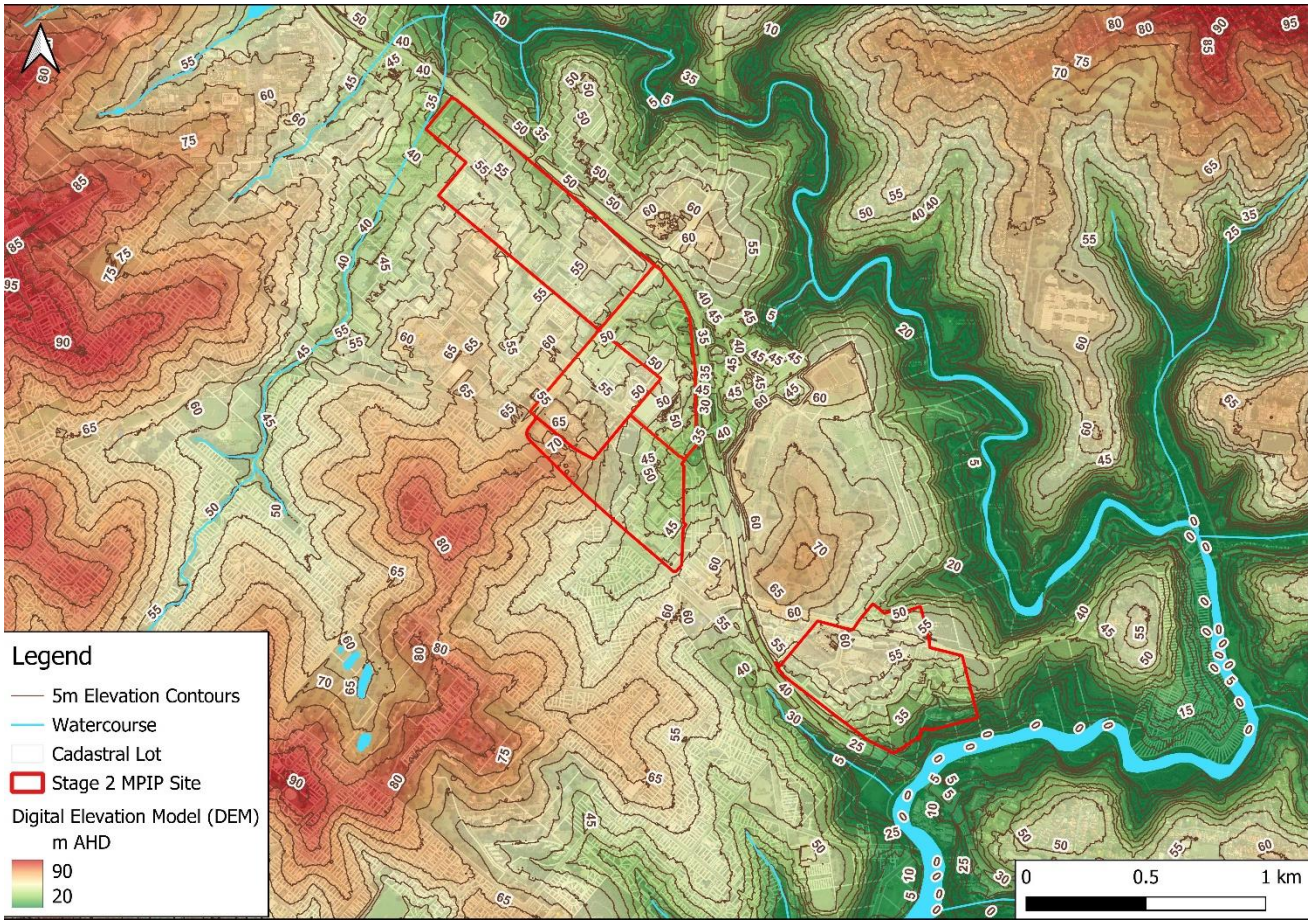


Figure 4: Topography of Stage 2 MPIP site and its surrounding area

Figure 5: Cross-sectional profile through the MPIP site from the southwest of the site to the northeast.

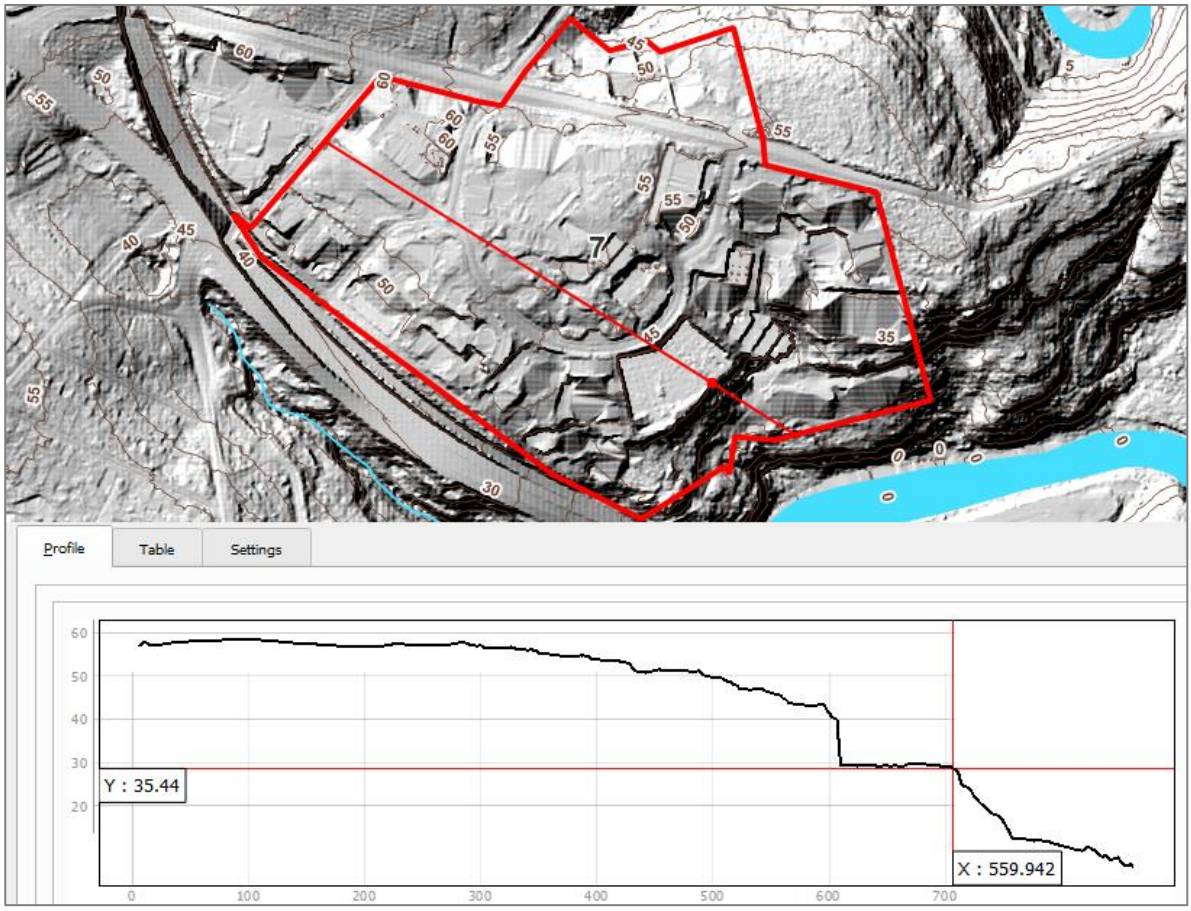


Figure 6: Cross-sectional profile through Neighbourhood 7 from the northwest to the southeast.

2.3 Existing Services

A Before You Dig Australia (BYDA) enquiry has been made to support the development of this master plan and ensure that the extent of known existing subterranean services have been satisfactorily identified to aid in future planning opportunities. Assets belonging to AARNet, Ausgrid, Aussie Broadband, City of Ryde Council, FibreconX, Jemena Gas North, NBN, Nextgen, Optus, Superloop, Sydney Metro, Sydney Water, Telstra, TPG, Transgrid, TfNSW, Verizon Business, and Vocal Communications have all been identified within proximity to the MPIP Stage 2 area.

The Sydney Metro line bisects the MPIP Stage 2 area from the south-east to the north-west and is predominantly situated beneath the existing Waterloo Road An overview of the alignment of this system is provided in Figure 7 below.

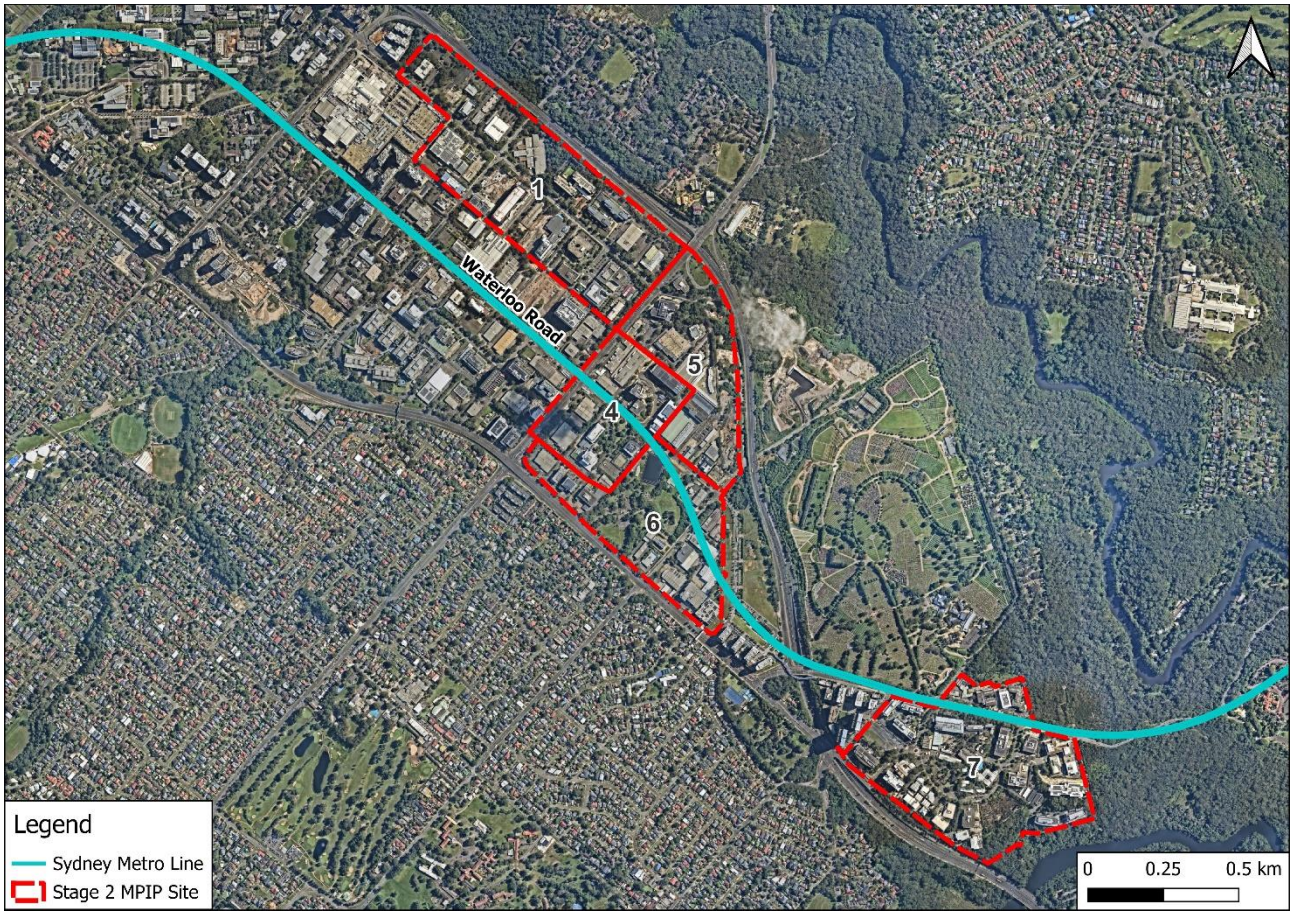


Figure 7: Extent of Sydney Metro Line though proposed site.

Telecommunication, sewerage, stormwater, gas, and electrical services are all prominent within the scope of works and are primarily associated within the public domain as interfacing with existing developments. This document has been prepared in consultation with the Macquarie Park Innovation Precinct – Utilities Report prepared by Arcadis during the Stage 1 scope of works which had identified and assessed existing utility services constraints, opportunities and capacity as part of the wider MPIP proposal. Information provided within this report has been considered applicable to the wider Precinct area covered within the Stage 2 scope of works. Please refer to the Utilities Report prepared by Arcadis for information regarding existing and proposed inground service assets.

2.4 Existing Flooding Conditions

The Macquarie Park Floodplain Risk Management Study and Plan was conducted by Bewsher Consulting on behalf of the City of Ryde. The study was published in 2011 and focused on catchments in the Macquarie Park Corridor. In 2023, an updated flood study of the entire LGA was conducted by WMA Water, which is currently available as a draft report. The City of Ryde Draft Flood Study (2023) updated the 2011 DRAINS hydrologic model and TUFLOW hydraulic model in accordance with the updated edition of Australian Rainfall and Runoff (ARR) 2019. In comparison to Bewsher (2010), the draft study uses updated software, more recent elevation data, updated hydraulic structures information, and a finer cell grid (2m in comparison to Bewsher's 3m). It should be noted that as this is still a draft report, these results are still subject to change.

The catchment map prepared by Bewsher (2011) (provided in Figure 8) shows that the majority of the MPIP Stage 2 area (Neighbourhoods 1, 4, 5 and 6) falls within the Porters Creek and Industrial Creek catchments, with the western tip of Neighbourhood 1 falling in the Shrimptons Creek catchment. Neighbourhood 7 in North Ryde falls entirely within the Lane Cove Catchment.

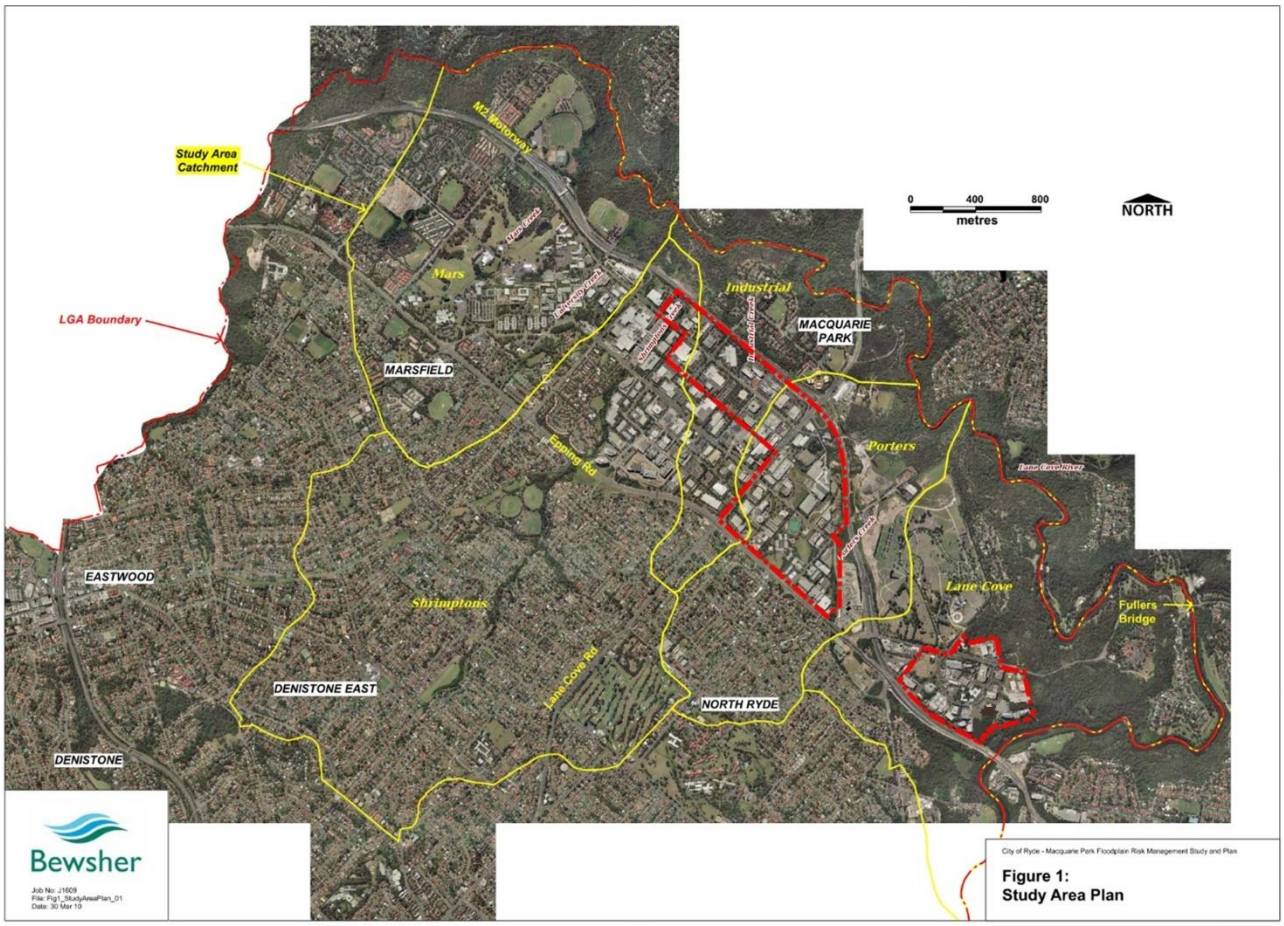


Figure 8: Map of Macquarie Park sub-catchments. Approximate study area has been highlighted. Source: Bewsher (2010)

Analysis of model outputs from the City of Ryde's Draft Flood Study (2023) indicates that the overall MPIP Stage 2 area is not subject to widespread inundation, with flooding largely confined to narrow creeks and floodways, depicted in the 1% AEP flood map in Figure 9. These creeks flow north-east, eventually draining into the Lane Cove River. Typically, flooding in affected areas is shallow but high velocity. The flood behaviour within the Stage 2 rezoning area is assessed further in Sections 2.4.1 and 2.4.2.

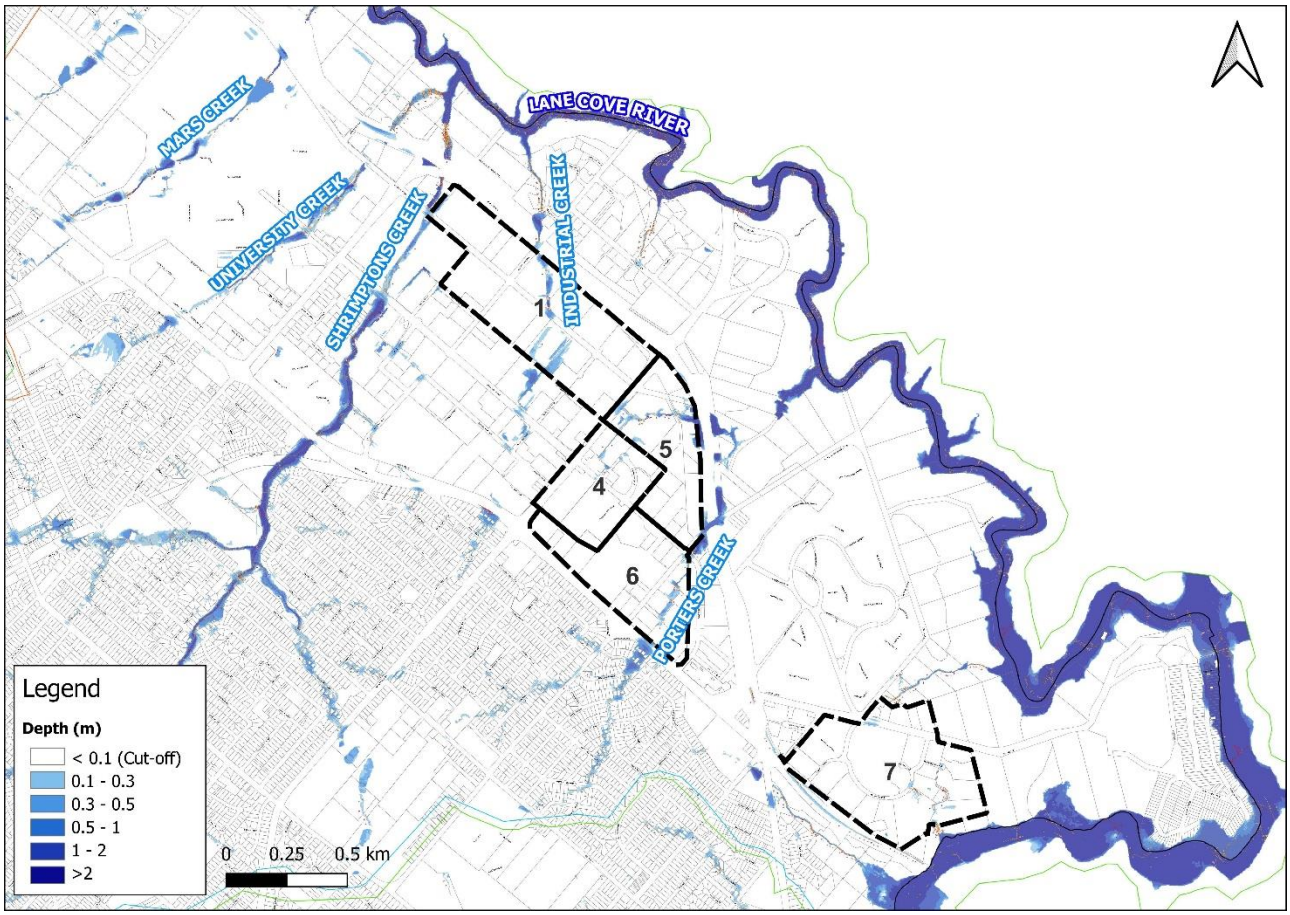


Figure 9: City of Ryde Draft Flood Study (2023) 1% AEP flood map

2.4.1 Flood Depths and Velocities

Overall, the 1% AEP flood extent is generally limited to the valley-like troughs of the natural creeks and floodways. Flood depth and velocity maps for the 1% AEP event are provided in Figure 10 and Figure 11, respectively. In the 1% AEP event, it is observed that:

- Neighbourhood 1 experiences flood depths up to 0.5 m along Alma Road in the northwest. Depths reach up to 1.0m at 40-52 Talavera Rd, with associated flood velocities exceeding 2.0m/s at some localised points. Flooding at 17-27 Talavera Rd is more extensive but less severe, with depths up to 0.5m to the east and velocities up to 1.0m/s to the west.
- Neighbourhood 4 develops a narrow channel of high-velocity flow around the west and south sides of 2 Eden Park Dr, with flood depths up to 0.5m and velocities exceeding 2.0m/s. Some localised areas on the east side may experience deeper (but lower velocity) flooding up to 1.0m in depth.
- Flooding in Neighbourhood 5 is similar, with a slightly wider channel of high-speed flow (up to 0.5m depth, over 2.0m/s) passing through 5 Talavera Rd. Some currently undeveloped areas around the M2 Motorway experience deeper, low velocity flooding up to 2.0m deep and 0.2m/s in velocity.
- Flooding in Neighbourhood 6 is limited to a few of properties along Wicks Rd, with depths up to 1.0m and velocities typically below 1.0m/s. Flood velocity can exceed 2.0m/s at some localised points.
- Neighbourhood 7 is mostly unaffected by flooding in this event, with some localised points experiencing minor flooding up to 0.3m in depth and generally below 0.25m/s in velocity.

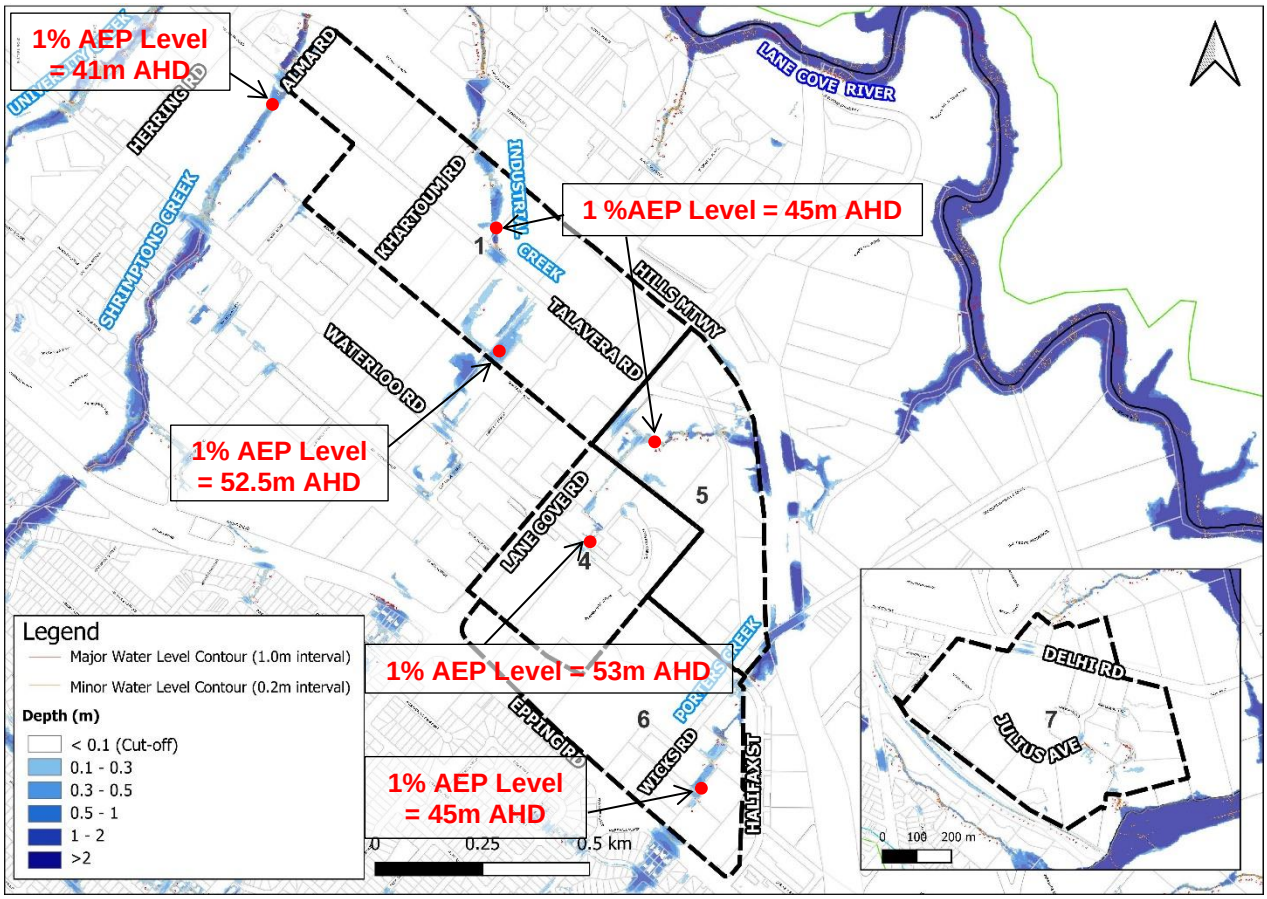


Figure 10: 1% AEP Flood levels and depths. Source: WMA Water (2023)

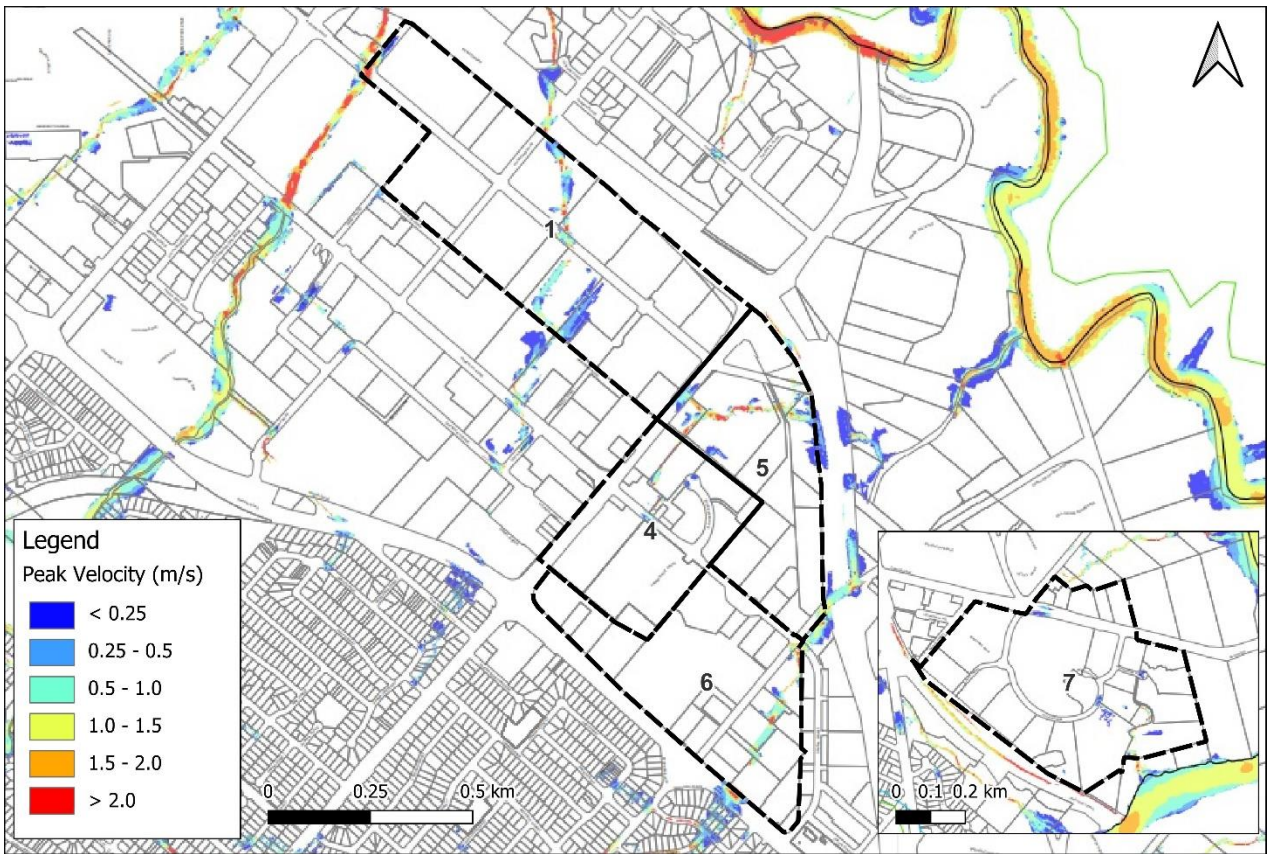


Figure 11: 1% AEP Flood Velocities. Source: WMA Water (2023)

Flood depth and velocity maps for the PMF event are provided in Figure 12 and Figure 13, respectively. Model results indicate the following:

- In the PMF, the western edge of Neighbourhood 1 becomes severely flooded at Alma Rd, with flood depths exceeding 2.0m and velocities exceeding 2.0m/s within the site boundary. Flooding is more extensive along Industrial Creek, extending into 15 Talavera Rd. Neighbourhood 4 remains largely unchanged, with flooding partially spreading along roads.
- The PMF event sees much more extensive flooding occur around the Hills Motorway (M2), connecting the floodways across Neighbourhoods 5 and 6. The intersection between Wicks and Halifax is now severely flooded, with depths exceeding 2.0m and velocities exceeding 2.0m/s. Flooding in Neighbourhood 6 now extends further south, reaching Epping Rd. Flood velocities in Neighbourhood 6 are also higher, exceeding 2.0 m/s.
- Flooding in Neighbourhood 7 is also more significant, with low-level flooding around (the currently undeveloped) 6-8 Julius Ave. Flood depths here reach up to 0.3m, with velocities reaching up to 0.25m/s. Flooding is more severe around 3 & 4 Richardson Pl, with depths up to 1.0m and velocities exceeding 2.0m/s.

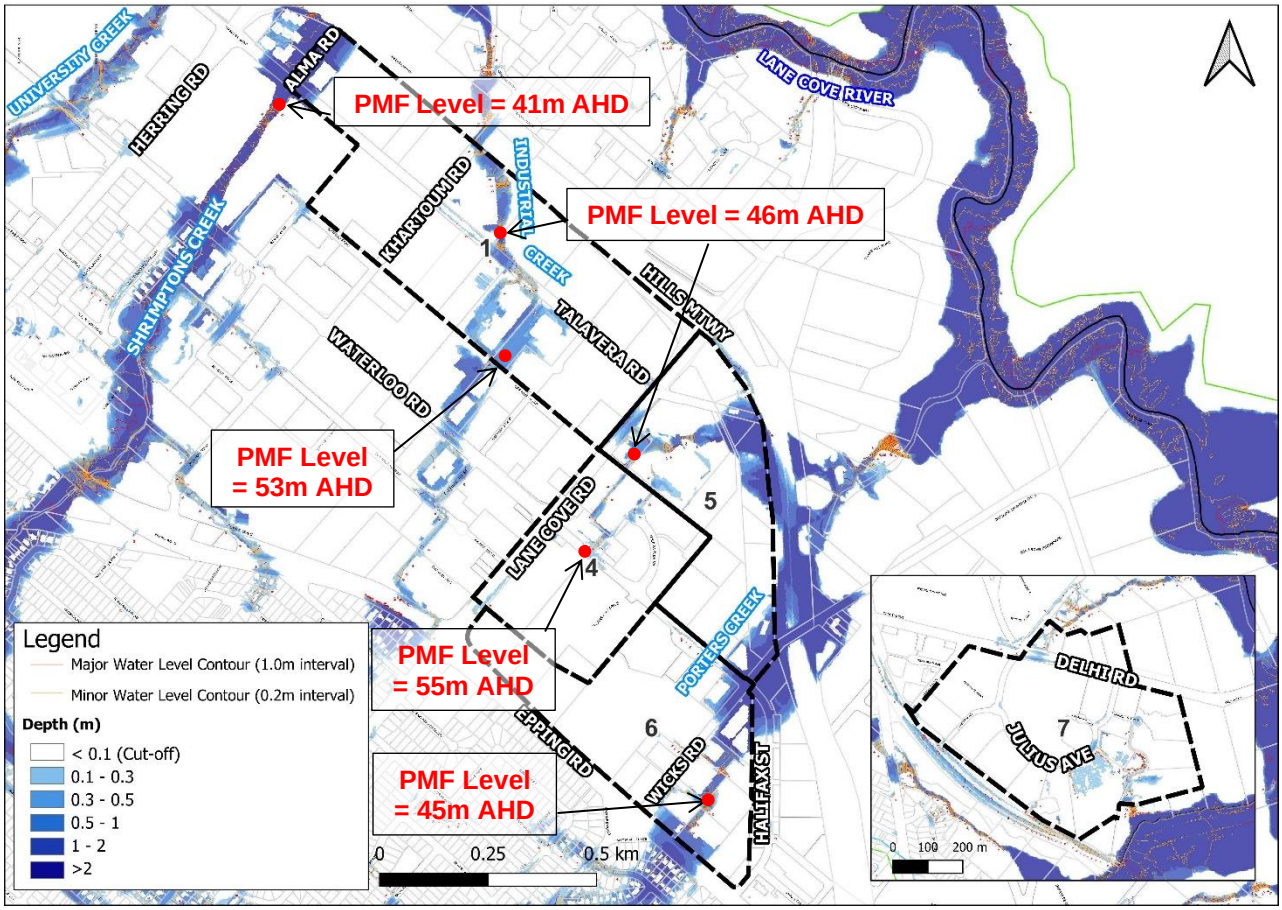


Figure 12: PMF levels and depths. Source: WMA Water (2023)

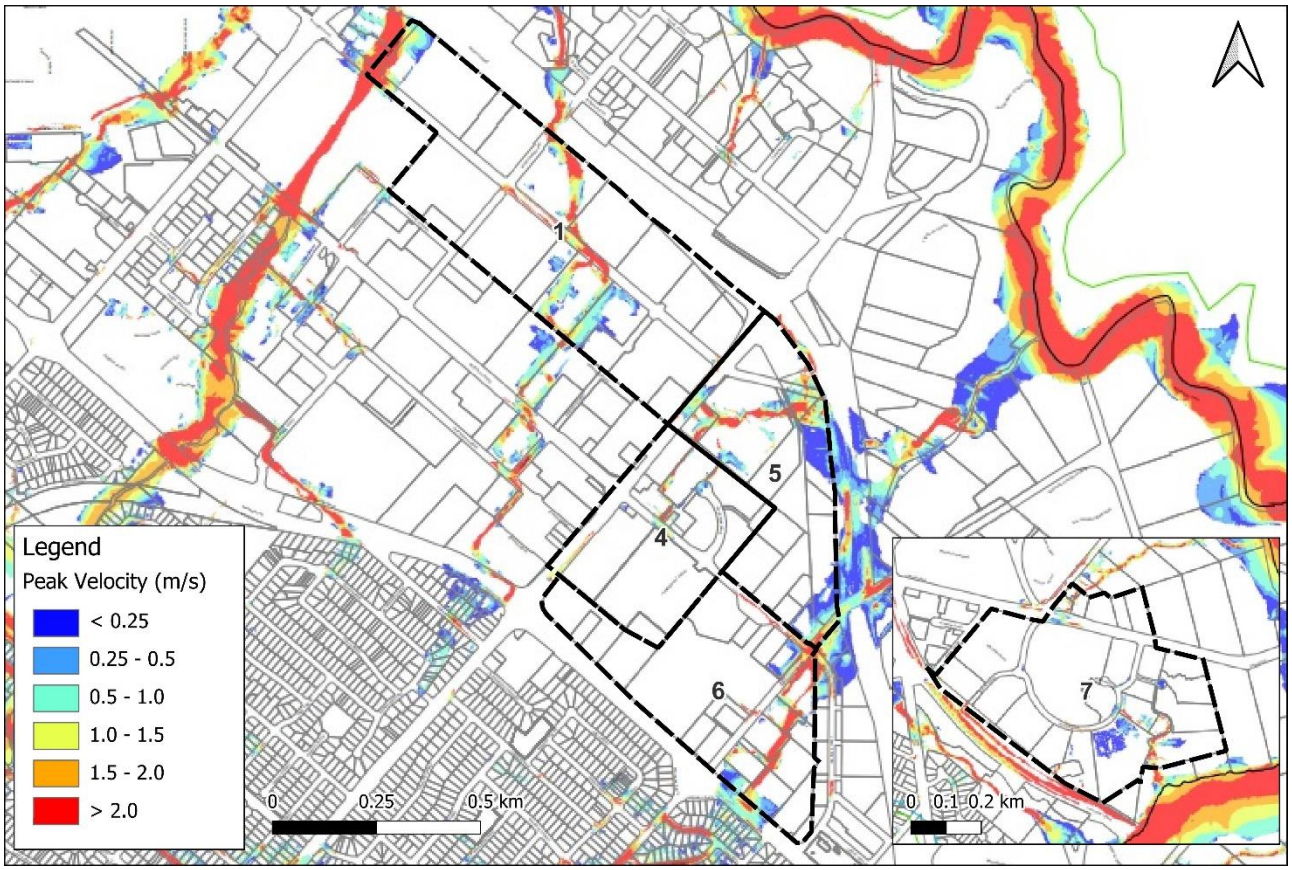


Figure 13: PMF Velocity Map. Source: WMA Water (2023)

2.4.2 Flood Hazard

The City of Ryde Draft Flood Study (2023) includes an assessment of flood hazard based on the hazard vulnerability curves set out by the Australian Emergency Management Institute. '*Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*', part of the Australian Disaster Resilience Handbook Collection (2017) presents a set of hazard curves which assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows.

This flood hazard vulnerability curve is shown in Figure 14, with six classes ranging from a level of H1 (generally safe for people, vehicles and buildings) to H6 (unsafe for vehicles and people, with all buildings considered vulnerable to failure).

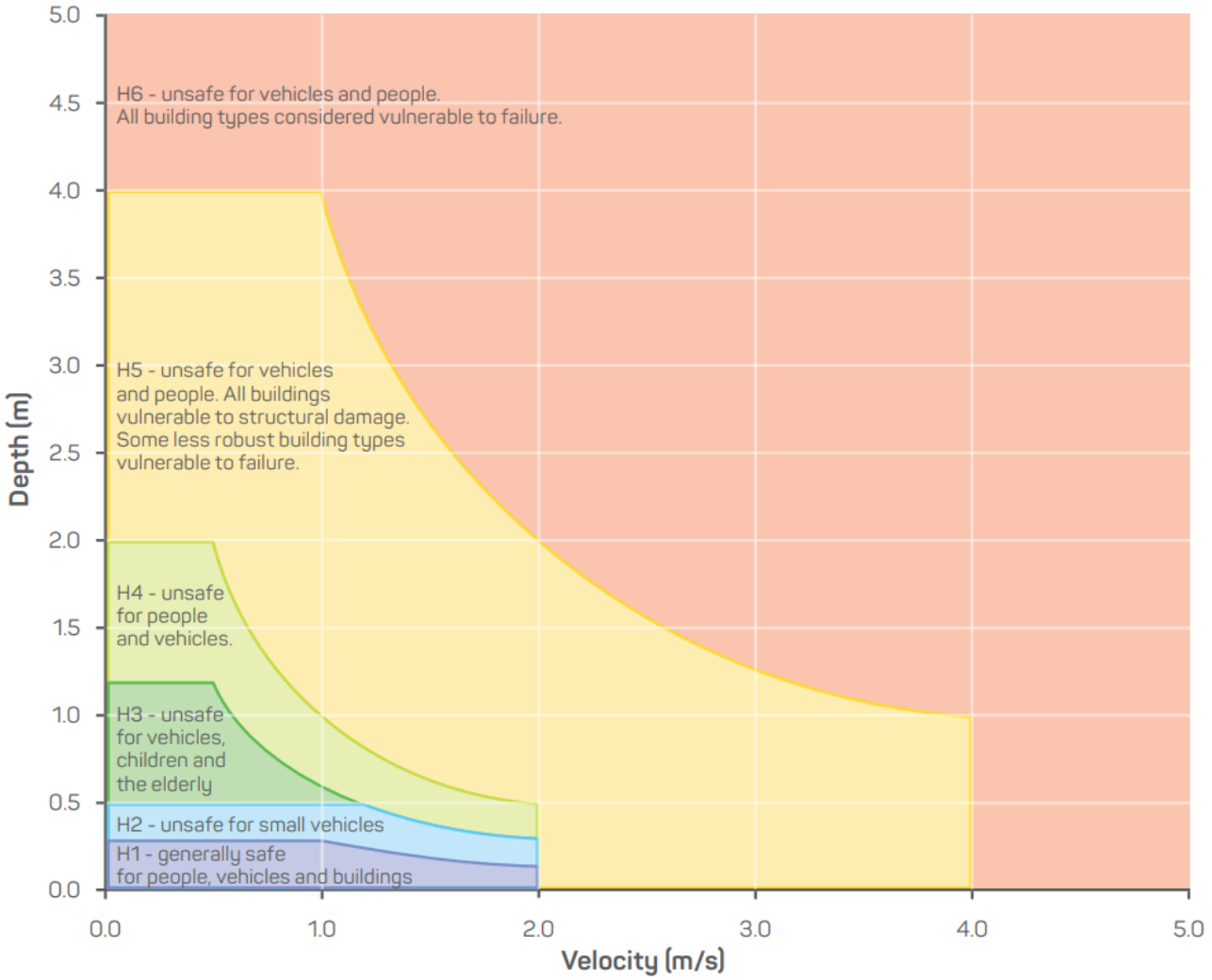


Figure 14: General Flood Hazard Vulnerability Curve. Source: AIDR (2017)

Figure 15 presents the flood hazard categorisation for the Macquarie Park region in the 1% AEP event, taken from the City of Ryde Draft Flood Study (2023). In the 1% AEP event, flood hazards are typically only high within high-velocity floodways. Modelling results for the 1% AEP indicate the following:

- Neighbourhood 1 experiences flood hazards up to hazard level H3 at 40-52 Talavera Rd, with some localised points reaching level H4. 17-23 Talavera Rd reaches up to hazard level H2 on the eastern boundary, with some localised points reaching level H3.
- Sections of Talavera Rd and Khartoum Rd reach up to hazard level H3 and H4 respectively, which renders them impassable to vehicular traffic and dangerous on foot. Alma Rd reaches hazard level H5 at its intersection with Talavera Rd, which cuts off westward access to and from Herring Rd and the M2.
- Flood hazards in Neighbourhood 4 are low, only reaching up to level H1 on Waterloo Rd and Eden Park Drive. No access or egress routes are notably impacted by flooding.
- In the 1% AEP event, the overland flow path running through Neighbourhood 5 is categorised as H5 hazard, unsafe for people and vehicles, with potential structural damage to all buildings.
- Neighbourhood 6 sees a wide range of flood hazard levels along the Porters Creek floodway, ranging from H1 to H5. However, the flood extent is limited, and does not impact any access routes, with the exception of Epping Road (which marks the southern border of the Neighbourhood) with flood hazard reaching H5 over one lane.
- Flood hazard in Neighbourhood 7 is low, categorised as H1.

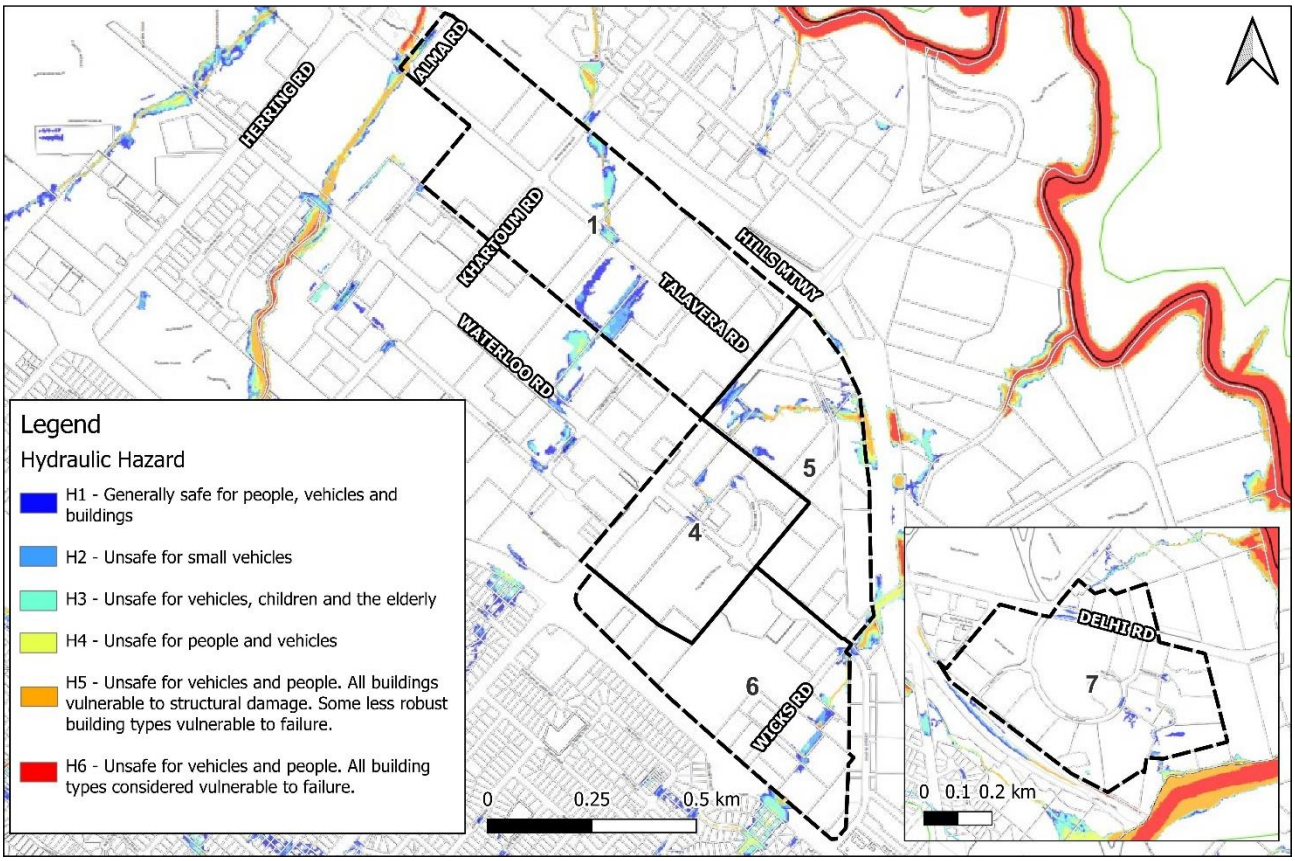


Figure 15: Hydraulic Hazard Categorisation for the 1% AEP event. Source: WMA Water (2023).

Figure 16 presents the flood hazard levels for the PMF event. The following observations have been made:

- Access through Khartoum Road and Talavera Road, especially at Alma Road, remains obstructed by flooding up to hazard level H6. 17-23 Talavera Road is now completely enclosed by floodwaters up to level H5, restricting access to this area.
- Flood hazard levels remain low in Neighbourhood 4, though access to 2 Eden Park Drive may be more difficult due to flood hazards up to level H5. Flooding at Waterloo Road reaches up to hazard level H3 at some localised points which could make it unsafe for vehicles to pass through.
- In Neighbourhood 5, flood hazards reach up to level H6 within the floodway and around the M2 Motorway. Buildings on the 5 Talavera Road estate are vulnerable to structural damage and failure. Lane Cove Road is completely cut off to people and vehicles, with flooding up to hazard level H4.
- The overland flow path along Porters Creek in Neighbourhood 6 increases from generally low hazard in the 1% AEP event to predominantly H6 hazard in the PMF, spreading over the intersection of Wicks and Halifax and a portion of the M2 Motorway. This cuts off northward access to Waterloo Road. Epping Road is cut off by flooding up to hazard level H5, blocking eastward access to Delhi Road and the M2 Motorway.
- Neighbourhood 7 sees flooding up to level H5, which could cause structural damage. Sections of Julius Avenue and Delhi Road experience localised flooding up to level H4 at some points, which is considered dangerous for vehicles and people.

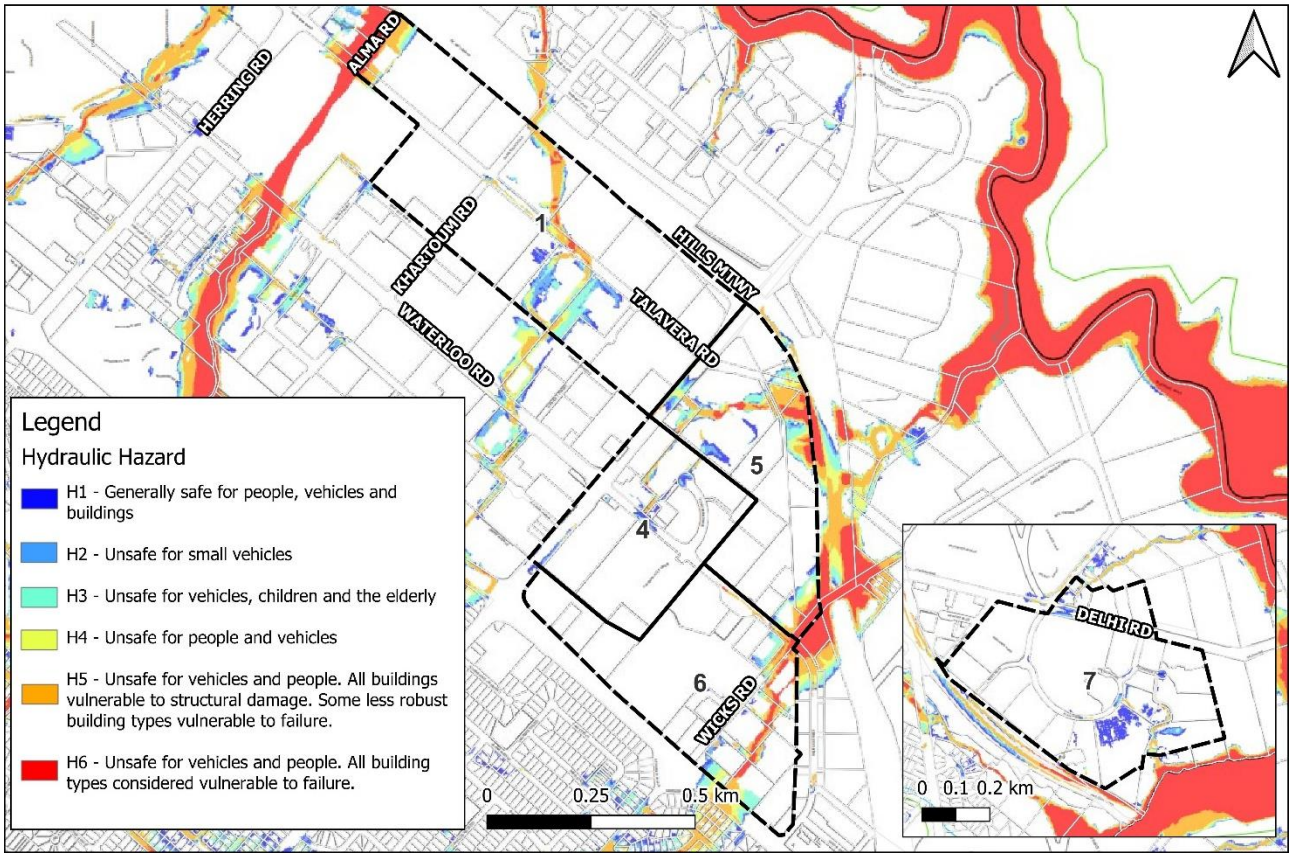


Figure 16: Hydraulic Hazard Categorisation for the PMF event. Source: WMA Water (2023).

3.0 Public Domain Works

Master planning of the precinct involves restructuring of existing transport routes to increase user amenity and promote active transport options. Works should include the integration of enhanced deep planting zones and areas, increased street planting, introduction of WSUD principles, and increased canopy cover. Where relevant, relocation of the kerbline will typically be associated with stormwater rectification works and when applicable could provide opportunity for the rectification and reconstruction of existing stormwater assets.

3.1 Secondary Circulation Routes

The scope of the master plan report includes development of secondary circulation streets with an average width of 20.0m. Roadways typically have a wide carriageway with additional width for street parking. Surrounding developments vary but typically consist of large buildings or medium to high density residential buildings. There are existing in-ground services located within the street, however the majority of non-stormwater assets have been identified within the public realm and includes electrical, telecommunications, gas, water, and sewer lines and pits.

Changes proposed to Secondary Circulation routes as part of the Stage 2 scope of works includes:

- Blistering existing parking lanes with deep soil zones to accommodate additional large street tree cover.
- Increased footpath width where appropriate.
- Implementation of separate cycleway or shared path where appropriate.
- Incorporation of WSUD features incorporated in kerb and tree blisters.
- Upgraded paving, lighting, and signage.
- Realignment of existing kerblines will be associated with remediation works to the existing stormwater network and would provide additional opportunity for the enhancement of stormwater quantity and quality infrastructure.

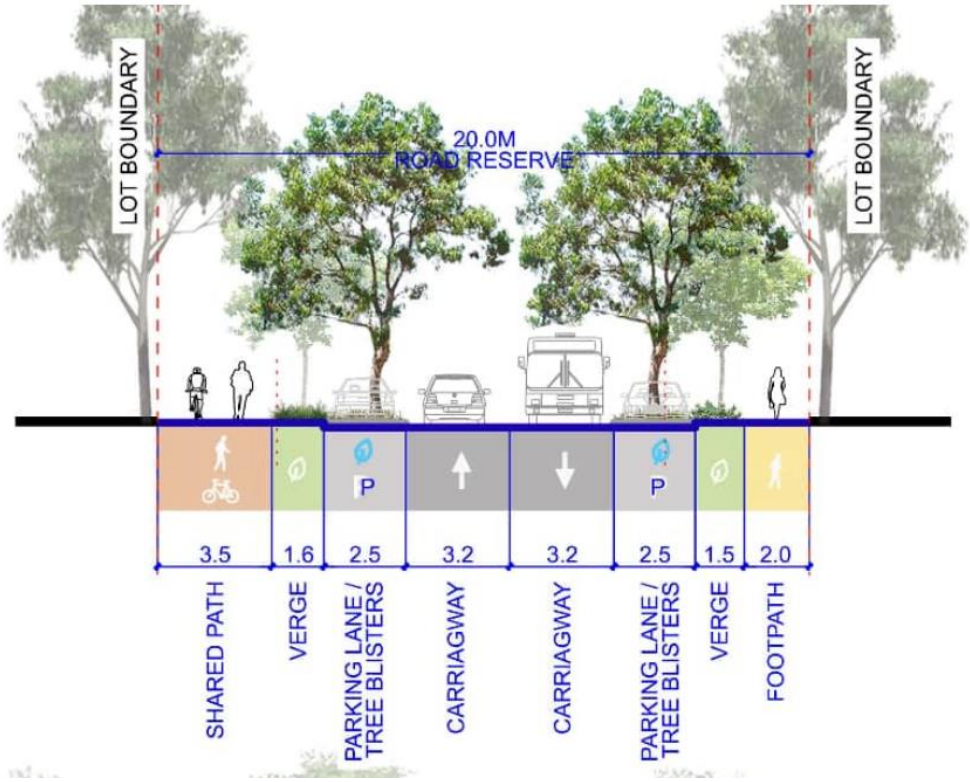


Figure 17: Proposed 20.0m Secondary Circulation Route Typical Cross-Section Type 1 (Wicks Rd / Talavera Rd)

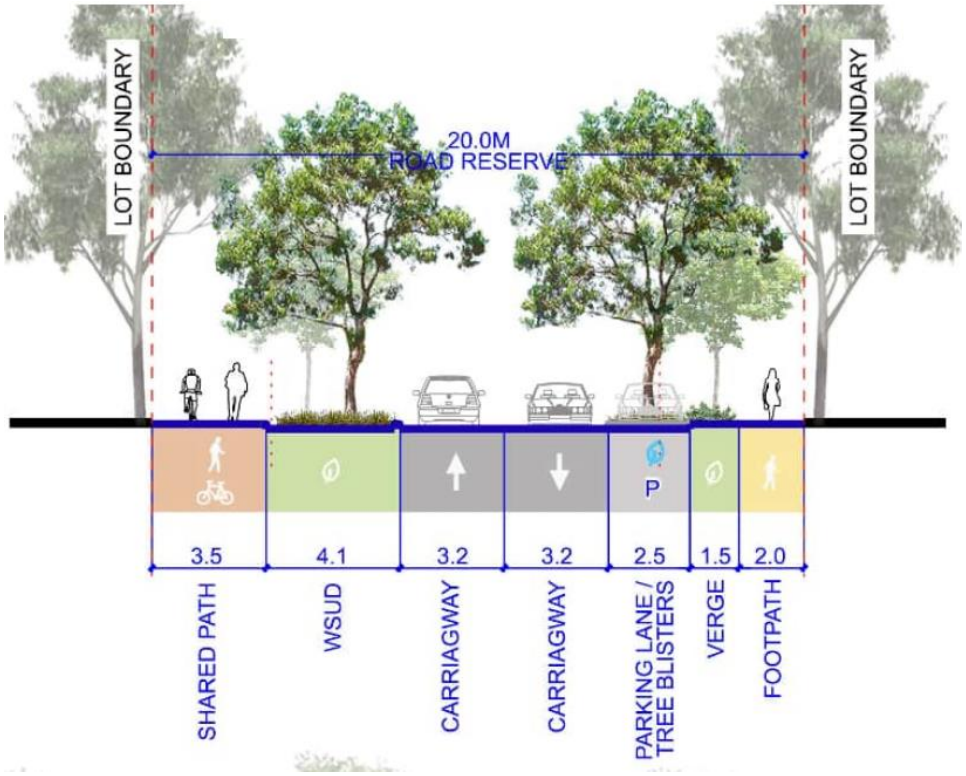


Figure 18: Proposed 20.0m Secondary Circulation Route Typical Cross-Section Type 2 (Wicks Rd / Talavera Rd)

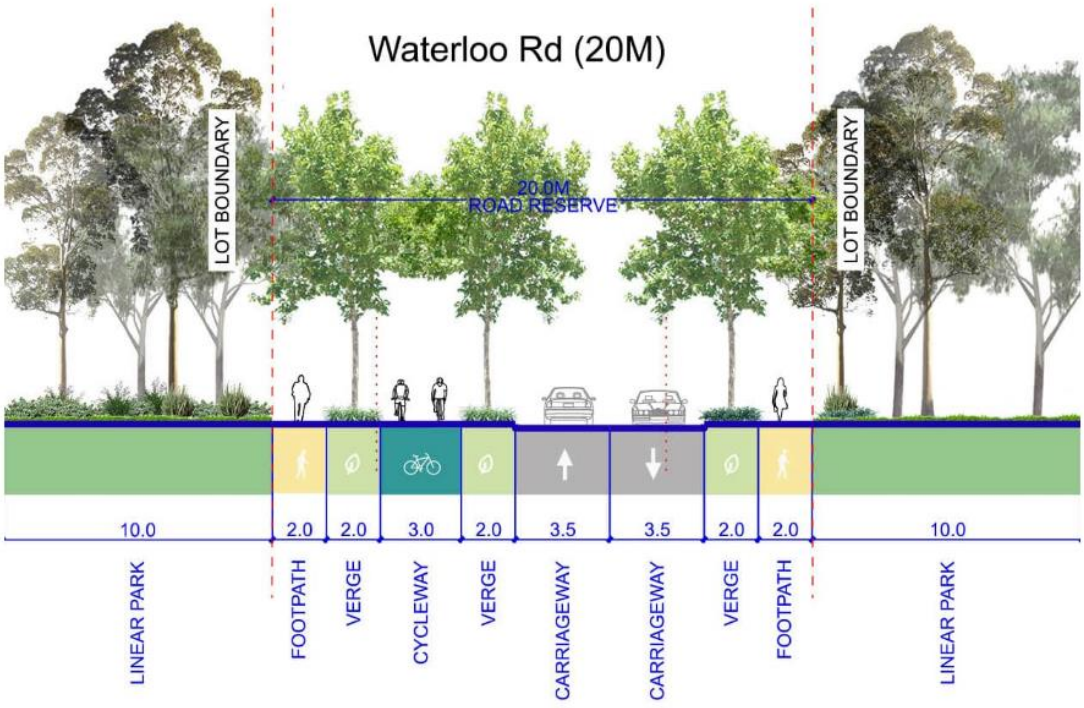


Figure 19: Waterloo Road Proposed 20.0m Secondary Circulation Route

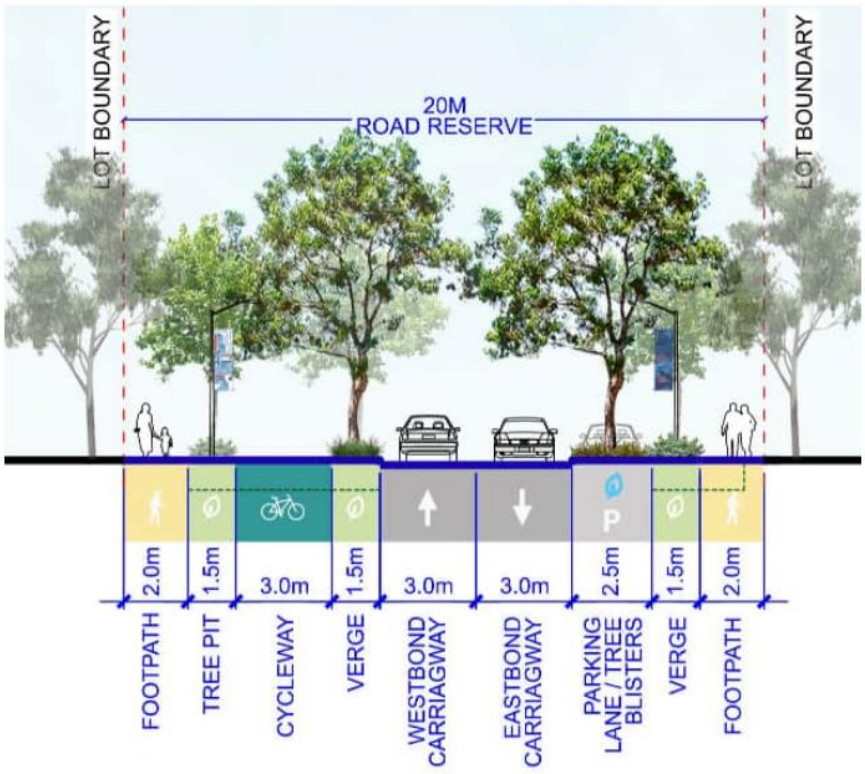


Figure 20: Proposed 20.0m Secondary Circulation Route with Cycleway Typical Cross-Section

3.2 Local Streets

The scope of the master plan report includes development of local streets with a width of 17.5m and 14.5m. Proposed works will prioritise pedestrian movements through the application of slow speed environments to encourage walkability. Proposed changes would include:

- Street parking to be implemented on one side of the laneway only.
- Blistering existing parking lanes with deep soil zones to accommodate additional large street tree cover.
- Incorporation of WSUD features incorporated in kerb and tree blisters.

As with the proposal for secondary circulation routes, the incorporation of street blistering to create WSUD deep planting zones is recommended to improve precinct stormwater quality and quantity discharge. Although less prominent on local streets, consideration of all existing in ground services including telecommunications, electrical, gas, sewer, water and stormwater lines and pits will need to be considered when identifying opportunities for deep planting zones and associated WSUD developments.

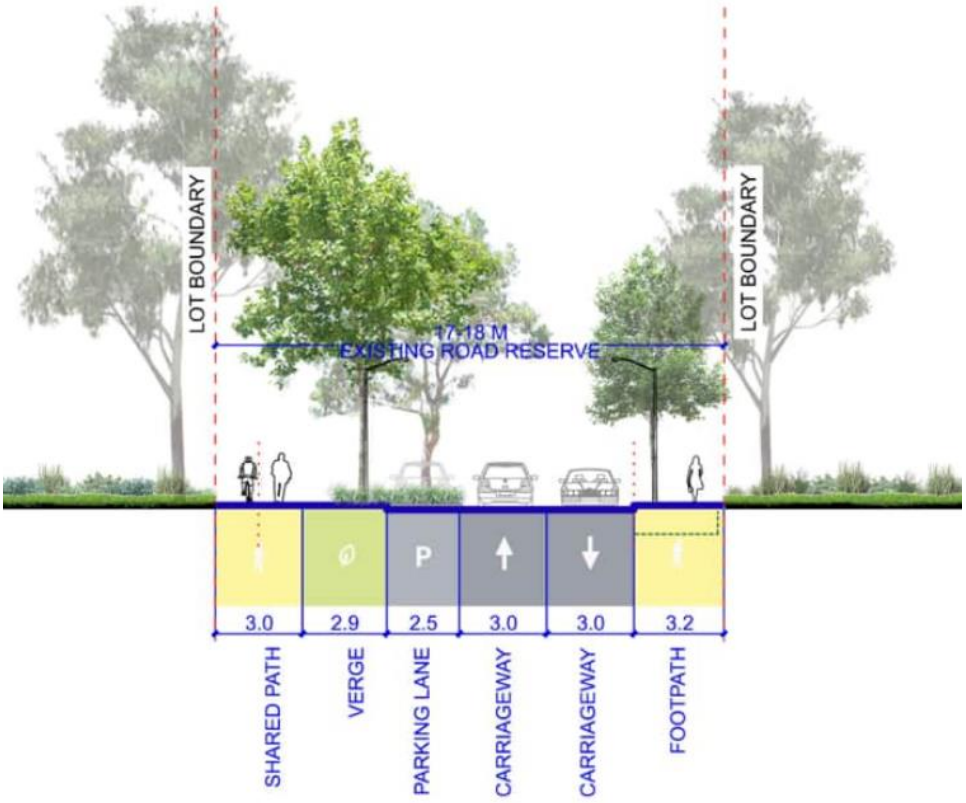


Figure 21: Section for Typical Proposed 17.5m Local Street (Julius Av)

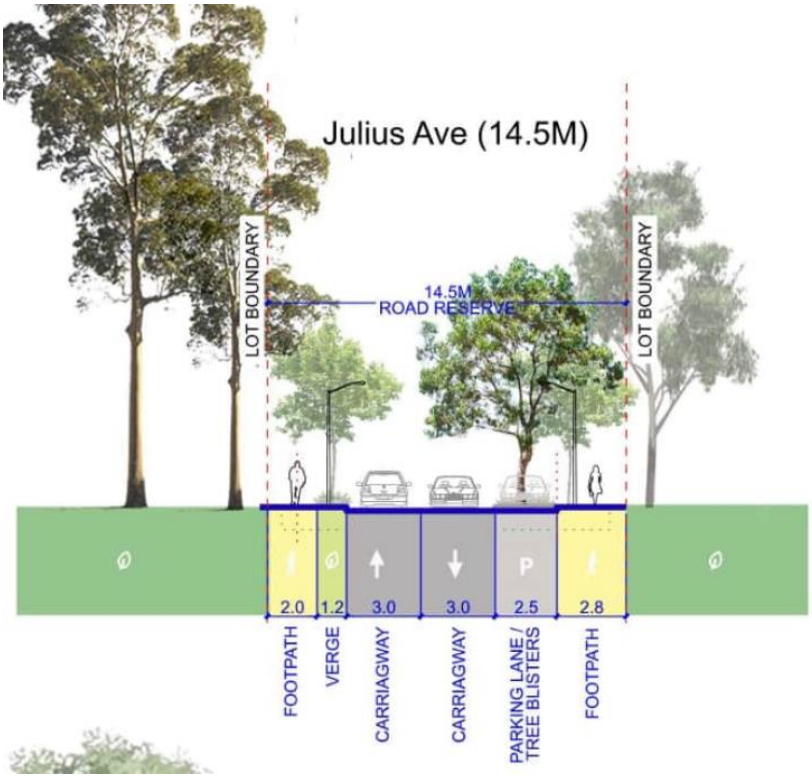


Figure 22: Section for Typical Proposed 14.5m Local Street (Julius Av)

3.3 Cycleways and Pedestrian Throughways

Where deemed appropriate, opportunities for the development of new pedestrian and cycleway links not trafficable by vehicles should be identified to allow vital connections for active transport within the Precinct. Key outcomes for the implementation of active transport links should prioritise the following development outcomes:

- Extension of the wider active transport network and links with separate cycleways.
- Connectivity to encourage active transport options through the precinct.
- Increased pedestrian amenity through application of tree-lined corridor with shaded canopy.

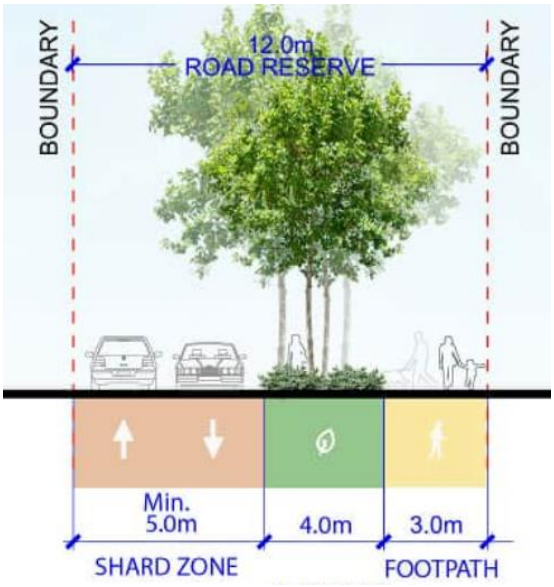


Figure 23: Proposed Typical 12.0m Through-Site Pedestrian and Shared Zone Link

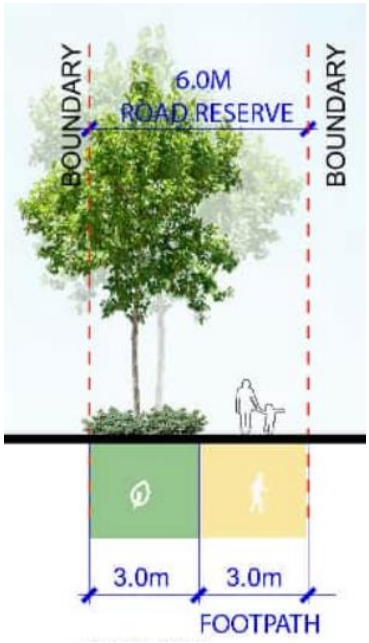


Figure 24: Proposed Typical 6.0m Through-Site Pedestrian Link

4.0 Watercourse Restoration

The identified MPIP zone covers several catchments for local tributaries of the Lane Cove River located to the north and east boundary of the identified study area. Key waterways identified within the scope of Stage 2 works includes Industrial Creek and Porters Creek as demonstrated in Figure 9.

4.1.1 Existing Conditions

Extensive historic development of the Macquarie Park area has resulted in the majority of creek runs being developed and no longer appear open to the sky. Instead, the majority of the creek lines and runs through the identified MPIP catchment are routed in-ground via culvert or pipe prior to discharge at the north boundary of the proposed precinct. Alignments of these creek lines are heavily associated with flooding and overland flow routes within the wider precinct area as identified from the associated flood mapping. and it is recommended that watercourse restoration including increased deep soil pervious green spacing and bioretention be sited within close proximity to the existing developed creek run.

4.1.2 Identified Rectification Opportunities

Where possible, the restoration of a riparian zone and planting buffer should be prioritised along developed creek alignments and viable land purchased for development as regional bioretention to limit creek flows and pollutant loadings. Ideal siting of regional bioretention basins would include large pervious zoning with opportunities to integrate community and shared spacing including parks and sporting fields. Provided the developed nature of the precinct, however, it is to be acknowledged that the feasibility of this approach will be limited by costs associated with roadwork and service realignment as well as the need for land buyback required to establish such a zone along the majority of the creek runs. Despite this, introduction of regional WSUD infrastructure does form a critical component in rectifying the significant waterway degradation that has historically occurred as a result of significant development within the Precinct and should therefore be prioritised wherever feasible.

Although the alignment of Pages Creek lies external to the south-east boundary of the precinct, there will remain various opportunities to enforce positive water quality and quantity restoration through the application of Water Sensitive Urban Design principles. It is recommended that advice provided in Section 6.0 of this report including provision of OSD and pollutant reduction parameters be enforced to Neighbourhood 7 - North Ryde Riverside as this region drains to the regulated catchment area of Pages Creek and the wider Lane Cove River.

Shrimptons Creek located to the west boundary of the MPIP zone is heavily associated with the Stage 1 scope of works and has minimal to no identified catchment falling within the wider scope of Stage 2 works. However, where it is deemed relevant, coordination with previous advice proposed with the Stage 1 scope of works should be applied for all development or staging falling within proximity to Shrimptons Creek.

It is to be noted that although the findings of this report propose opportunities related to the restoration of existing watercourses through the identification of potential deep soil planting and bioretention zones, the intended purpose of this document will be to establish an overarching framework from which identified WSUD parameters can be legally enforced for future developments within the MPIP. It is therefore the responsibility of future developments to ensure compliance with the findings presented in this report and provide water quality and quantity reduction solutions specific to the various parameters of each site. Opportunities for deep planting and bioretention within the public domain should therefore be prioritised where possible as the introduction and potential augmentation of future regional bioretention zoning will be pivotal in meeting the overall wider precinct planning targets.

Opportunities for regional bioretention zoning integrated within the surrounding streetscape are identified in Figure 25.

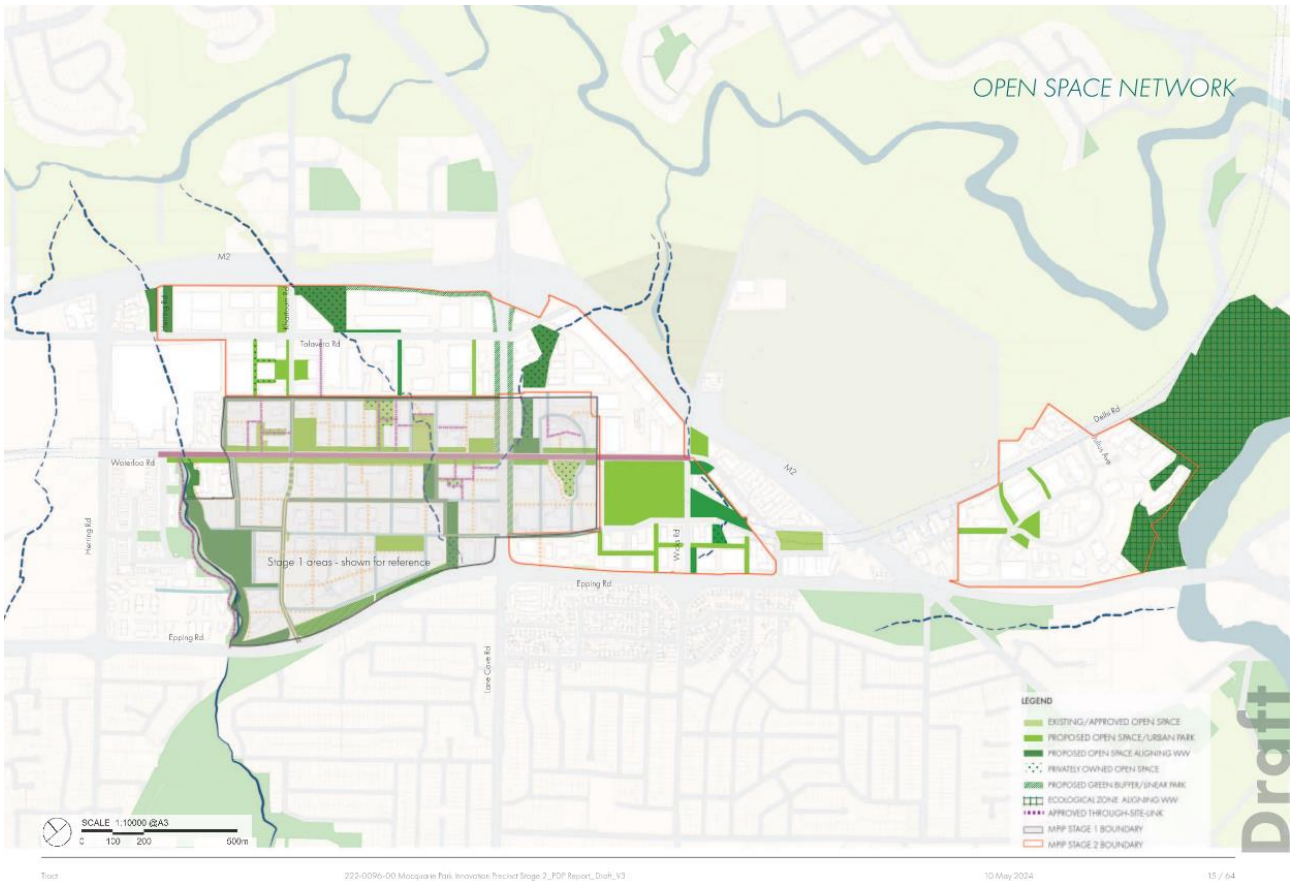


Figure 25: WSUD Location Opportunities with Respect to Developed Creek Lines

5.0 Flooding Design

5.1 DCP and LEP Flood Planning Requirements

All developments in the City of Ryde LGA must adhere to the Development Control Plan (DCP), published in 2014 (with amendments made in 2017), which provides planning and design guidelines to support the Local Environment Plan (LEP). Flooding and stormwater guidelines are covered in Part 8.2 of the DCP (Stormwater and Floodplain Management). This report covers these guidelines and recommends amendments in line with the Flood Risk management Manual (2023) as well as understanding and managing flood risk guidelines.

The objectives of the City of Ryde's DCP in relation to flooding are:

i. To ensure that development on land affected by flooding and overland flow is undertaken in a manner which provides for the safety of occupants of that development as well as minimise damage to private property, during such flooding events.

ii. To ensure essential services and land uses are designed with respect to potential flooding and overland flow risks.

iii. To ensure development does not exacerbate flooding on other properties.

iv. To ensure flood protection measures are sympathetic to the streetscape and relationship of the building to the street, do not have other adverse environmental impacts.

The stringency of flood-related development controls within the LGA is dependent on the land use type of the development alongside the flood risk categorisation of the site.

5.1.1 Land Use

Table 1 outlines the development categories within the City of Ryde DCP (2014), taken from Schedule 2 – Flooding and Overland Flow Development Categories.

Table 1: Land use categories identified within the City of Ryde DCP (2014)

Land Use Type	Description
Critical Uses and Facilities	Emergency services facilities, administration building or public administration building that may provide an important contribution to the notification or evacuation of the community during flood events (e.g. SES headquarters and Police Stations); Hospitals.
Sensitive Uses and Facilities	Development accommodating services or facilities which are essential to evacuation during periods of flooding or if effected would unreasonably affect the ability of the community to return to normal activities after flood events. Includes community facilities; telecommunication facilities; educational establishments; seniors housing; and public utility undertakings (including electricity generating works and utility installations)
Recreation and Non-Urban Development	This is comprised development normally exposed to the elements and is therefore present a considerably reduced potential for damage to private property. Includes animal boarding or training establishment; biosolid waste application; biosolids treatment facility; boat launching ramp; boat repair facility; boat shed; caravan park (with non- permanent occupants); charter and tourism boating facility; environmental facility; environmental protection works; extensive agriculture; extractive industry; information and education facility; horticulture; kiosk; landscape and garden supplies; marina; mine; mining; moveable dwelling; port facilities; public utility undertaking (other than critical uses or facilities); recreation area.

Retail, Commercial and Industrial Development	Development which is typically providing goods for sale or supply and other services. For such development, there is typically low exposure to personal safety (staff and patrons per square metre of the site is low) however there is a greater proportion for damage to property in terms of materials and goods. It is acknowledged that most development in this category would be more tolerant of inundation due to the nature of the business, particularly for industrial applications. Includes air transport facility; airport; amusement centre; brothel; bulky goods premises; business premises; caravan park; community facility (other than critical and sensitive uses and facilities); correctional centre; crematorium; depot; entertainment facility; exhibition village; food and drink premises; freight transport facility; function centre; funeral chapel; funeral home; hazardous industry; hazardous storage establishment; health care professional; health consulting rooms; health services facility; heavy industry; heliport; highway service centre; industrial retail outlet; industry; liquid fuel depot.
Residential Development	Development which permits a place of residence or temporary occupation for the general public. A majority of this is represented by single residential properties and thereby there is potential that the stormwater inundation or flooding could pose a danger to public safety and property damage. In most cases, the lower scope of works presents less opportunity for flood protection and there is greater repercussion to occupants resulting from flood events. Includes backpackers' accommodation; bed and breakfast accommodation; boarding house; caravan park; childcare centre; hostel; hotel or motel accommodation.
Concessional Development (residential alterations and additions, minor works or change of use)	Concessional development refers to minor works or change of use that does not considerably extend the serviceable life of the structure on site any further than, say, 25 years. Includes: • Additions to an existing dwelling (unless in Councils opinion the extent of alteration is such that the dwelling is effectively a new dwelling) • The construction of a non-habitable outbuilding; or • Rebuilt dwellings which substantially reduce the extent of flood risks compared with the existing situation.
Carparking Areas	Any development where parking is a component for consideration
Landform Development	Works not included in the above categories however involve minor alterations to the landform and have potential to affect the path of overland flow or conveyance of flood waters. Includes retaining walls, fencing, swimming pools.

5.1.2 Flood Risk Categorisation

The City of Ryde DCP categorises flood-affected areas into High, Medium and Low Flood Risk precincts, as well as an Overland Flow precinct. Flood risk level is a product of flood depth and velocity of flows. The precincts are outlined in Table 2.

Table 2: City of Ryde DCP Flood Risk Precincts

Flood Risk Precinct	Description
High Flood Risk	Areas where there is a potentially catastrophic damage to property, risk to life, evacuation problems or where development would significantly or adversely alter flood behaviour. Most development is restricted in these locations.
Medium Flood Risk	Areas whereby there would be potential flood damage or public safety is a concern but could be addressed by the application using appropriate measures.

Low Flood Risk	Land within the floodplain (i.e. within the extent of the probable maximum flood) but not identified as either High Flood Risk, Medium Flood Risk Precinct or as an Overland Flow Precinct.
Overland Flow Precinct	Areas identified as Overland Flow Precincts are distant from watercourses where shallow inundation (relative to major flooding) occurs following heavy rain. Typically, the depth of inundation will be less than 0.3 m to 0.5 m but more than 0.1 m to 0.2 m in a 100-year ARI event.

Although the DCP does not refer to a specific precinct map, the City of Ryde Draft Flood Study (2023) provides flood risk precinct mapping, depicted in Figure 26. However, this map does not include any overland flow precinct.

As shown in Figure 26, the majority of flood-affected areas are categorised as low to medium risk, though there are some small regions that fall within the High Flood Risk Precinct, including the overland flow path across Neighbourhood 5, and land adjacent to Alma Road in Neighbourhood 1, sourced from Shrimptons Creek.

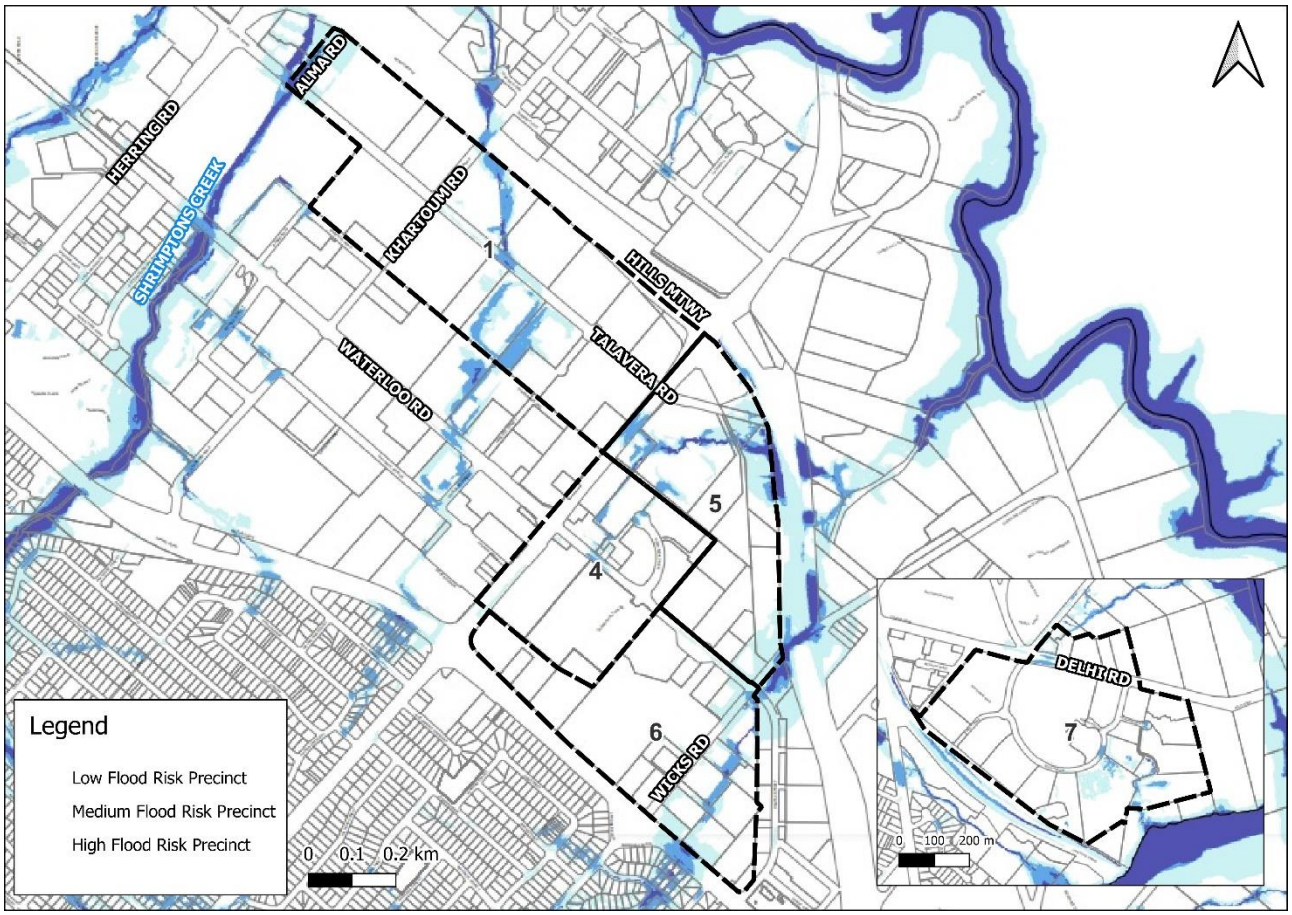


Figure 26: Flood Risk Precincts around the Stage 2 rezoning area (Source: City of Ryde Draft Flood Study, 2023)

5.1.3 Development Controls

As aforementioned, the applicable flood controls depend both on the level of flood risk, and the land use of the development. A summary of required floor levels and development permissibility is provided in Table 2. TTW has proposed updated restrictions (as marked in red) to the current DCP based on the NSW Flood Risk Management Manual, Managing Food Risk Guidance and Local Planning Directions.

Table 3: Summary of required floor levels development permissibility

Land Use Category	Flood Planning Level	Not permitted at:
Critical Uses and Facilities	Probable Maximum Flood	Low/Medium/High Risk May be permissible in lots identified as Overland Flow Precincts, provided they are not subject to major overland flows.
Sensitive Uses and Facilities	Probable Maximum Flood	Low, Medium or High Risk
Recreation/Non-Urban	1% AEP + freeboard (refer to Table 4 for freeboard requirements. Considered as non-habitable residential)	-
Industrial/Commercial	1% AEP + 300mm	Medium/High Flood Risk
Residential	Habitable Floors: 1% AEP + 300mm (for Low Risk and Overland Flow Precincts) 1% AEP + 500mm (if close to Medium and High Risk Precincts)	Medium/High Flood Risk
Open Parking	1% AEP	-
Enclosed Parking	1% AEP + 150mm freeboard	-
Basement Parking	Crest at PMF	-

Table 4 specifies minimum freeboard requirements based on type of overland flow and category of the development to ensure that such development is not subject to stormwater inundation or nuisance flooding, taken from Table 2.1 of the Stormwater Management Technical Manual (City of Ryde DCP, 2014).

Table 4: Freeboard Requirements (Source: City of Ryde DCP – Part 8.2: Stormwater Management Technical Manual)

Drainage System/ Overland Flow	Residential			Industrial/ Commercial	
	Land Level [b]	Habitable Floor Level	Non-Habitable Level [c]	Land Level [b]	Floor Level
Surface Drainage/ adjoining ground level [a]	-	.15m	-	-	.15m
Public drainage infrastructure, creeks and open channels	0.5m	0.5m	0.1m	0.3m	0.3m
Flooding and Overland Flow (Overland Flow Precincts and Low Risk)	N/A	0.3m	0.15m	N/A	0.3m

Flooding and Overland Flow (Medium Risk and greater)	N/A	0.5m	0.3m	N/A	-
Onsite Detention [(d)]	N/A	0.2m	0.1m	N/A	0.2m
Road Drainage **Minor Systems (Gutter and pipe flow)**		0.15m below top of grate			
Road Drainage		Refer to Figure 2-1.			
Detention Basins [(4)]		The top water level shall be designed to be 0.5m below top of embankment (100yr ARI)			

5.2 Flood Response

Although much of the developable site (i.e. not inundated by flood) is clear of flooding it should be noted that some of the neighbourhoods/specific areas within the neighbourhoods may be cut off by creek or, what is ore largely seen, overland flow paths running across the subject areas. This will mean that each development that has these constrictions will need to have an emergency repose plan prepared in line with Council and NSW SES guidelines. Most of the neighbourhoods are impacted by overland flows or small creek/stream flows running through them and, as such response and inundation times are likely to be short. This may mean that plans will need to accommodate for a quick catchment response (an hour to a few hours) but are unlikely to need to make provision for a long-term refuge (i.e. hour to hours). Hydraulic models could not be made available to TTW and these response times would need to be verified through hydraulic modelling. Areas above the PMF are available in all neighbourhoods. This isolation is discussed in the following section for each neighbourhood but site specific studies would need to be carried out for each development.

5.3 Suitable Land Uses

Based on the existing flood behaviour (from the Draft Flood Study mapping) alongside the flood controls outlined in the City of Ryde DCP (2014), TTW have conducted an assessment of the suitable land uses for each neighbourhood.

5.3.1 Neighbourhood 1 – North Park – Ngalawala (Reciprocity)

The North Park region is characterised by its close proximity to the Lane Cove National Park (to the north). The current land use is predominantly industrial and commercial. Large expanses of the neighbourhood are flood-free and suitable for all land use types. However, it is important to consider access (particularly for critical or sensitive land uses). Creek flooding cuts off access through Talavera Rd (the main access road in this neighbourhood) at several sections, even in the 1% AEP event. Alternative routes into and out of the neighbourhood are available via Khartoum Rd and Lane Cove Rd in the 1% AEP event, though the area

becomes isolated by high hazard flows across these key roads in the PMF.

The neighbourhood can be described as a High Trapped Perimeter Area. These are potentially inhabitable areas that become isolated by floodwater and property and may be inundated. However, there is an opportunity for people to retreat to higher ground above the PMF within the area and therefore the direct risk to life is limited. The area will require resupply by boat or air if not evacuated before the road is cut. If it will not be possible to provide adequate support during the period of isolation, evacuation will have to take place before isolation occurs (Australian Institute for Disaster Resilience, 2017).

The majority of flood-affected land in this neighbourhood is classified as low to medium risk, suitable for the following land uses:

- Recreation/non-urban
- Industrial/Commercial
- Residential

Any development within these flood risk precincts is subject to the controls set out in Table 3 and Table 4, including minimum required FFLs based on the 1% AEP level plus freeboard. As Alma Road is affected by flooding in the PMF and lies within the low/medium/high flood risk precinct, critical facilities are not recommended at this area close to Shrimptons Creek.

5.3.2 Neighbourhood 4 – Macquarie Living Station – Gari Nawi (Saltwater Canoe)

Neighbourhood 4 (Gari Nawi) is affected by some minor, generally low hazard flows (H1-H2 in the PMF) along Waterloo Road in the centre of the neighbourhood, which flow northwards around the existing buildings. Flood-affected areas mostly fall under the low and medium risk precincts, which can permit residential, industrial and recreational land uses with appropriate flood controls.

The properties south of Waterloo Rd are largely unaffected by flooding and are suitable for all land use types. Access to the rest of Macquarie Park is possible via Lane Cove Rd (heading south) in the PMF.

5.3.3 Neighbourhood 5 – Porter's Creek – Burbigal (Morning)

Neighbourhood 5 (Burbigal) is currently dominated by commercial and industrial land uses. It offers open space and connections to the natural environment through Fountain Garden, Porters Creek and the adjacent Halifax Street Park. Recreation and non-urban land uses are permitted within this precinct, including sports fields and parks. Floor levels of habitable and non-habitable areas must comply with the freeboard requirements as stated in Table 4.

Site access to the north is limited, as the floodway cuts off access through Lane Cove Rd with flooding up to hazard level H4. However, access to the south via Lane Cove Rd remains good, even during the PMF event.

5.3.4 Neighbourhood 6 – Wicks Road South – Garungul (Unbreakable)

Neighbourhood 6 (Garungul) is characterised by education and health and wellbeing activities, with Macquarie Park education precinct and walking connections to North Ryde and Macquarie Park.

Health and education facilities are considered critical and sensitive land use types and must be located above the PMF. Considering the Porters Creek floodway cutting across the east of the neighbourhood, these facilities should be situated to the west of the neighbourhood.

However, it should also be noted that even if these facilities are situated outside the PMF extent, a number of access roads are significantly flooded. Epping Road (which marks the southern boundary of the neighbourhood) is flooded up to a H5 hazard level at the intersection with Wicks Road during the PMF, and Waterloo Road (which marks the northern boundary of the neighbourhood) reaches a hazard level of H6 east of Lane Cove Rd. It is particularly important that critical services (including hospitals) and sensitive facilities (including schools) are readily accessible in flood events, for both emergency access and evacuation. If land within this neighbourhood is acquired for these purposes, further assessment of accessibility during design

flood events is recommended.

5.3.5 Neighbourhood 7 – North Ryde Riverside – Narrami Badu-Gumada (Connecting Water Spirit)

Currently, Neighbourhood 7 (Narrami Badu-Gumada) is predominantly made up of commercial and industrial land use developments. It is minimally flood affected, with predominantly low flood hazards even in the PMF (with the exception of a narrow overland flow path draining directly into the Lane Cove River). The flood-affected areas are currently undeveloped and categorised as low to medium flood risk, which are appropriate for the following land uses:

- Recreation/non-urban
- Industrial/Commercial
- Residential

Any development within these flood risk precincts must comply with the relevant flood controls.

6.0 Stormwater

The overall MPIP Stage 2 area is considered as highly developed and is therefore comprised of predominately impervious surfacing including pavement, roofing, and roadways. These existing conditions increase the rate in which stormwater is shed to local watercourses leading to inundation of existing systems as well as increasing the accumulation of anthropogenic pollutant loads that will become entrained within overland flow.

6.1 Stormwater Quantity

The City of Ryde DCP (2014), Part 8.2: stormwater Management Technical Manual stipulates that any proposed development within the LGA will require provision of Onsite Stormwater Detention (OSD) prior to discharge from the site to an existing Council system or alternative point of connection deemed appropriate to the development type, rate, and topography. Provision of OSD within the wider MPIP Stage 2 works will aid with the identified aims of restricting inundation of the existing local watercourses and aid in reducing the impacts of flooding to downstream developments.

6.1.1 Onsite Stormwater Detention (OSD)

Section 1.4.2 of the City of Ryde Council stormwater management technical manual outlines that the following general OSD requirements be applicable to all new developments:

- The OSD system should be located prior to the point of discharge, generally in the lowest point of the site and located in a common area to facilitate access. This can possibly include a car park, open space area or even roof top areas where no underground storage is possible.
- As much as possible of the site area is to drain through the OSD system(s). A portion of the impervious area may discharge directly to Council's system if it cannot be drained to the storage facility, provided the PSD is reduced and SSR is increased to compensate for the smaller catchment.
- The maximum desirable extent of impervious area bypassing the OSD system is 25% of the total impervious site area.
- Where it is proposed for the site to discharge to the kerb and gutter, the PSD shall be restricted to 30 L/s.
- A positive covenant must be executed and registered against the title of the lots containing OSD systems to require maintenance of the system. This positive covenant must be on any linen plans for subdivision of the development. If no subdivision is proposed, the covenant shall be prepared prior to finalisation of the development.

Where development does not fit the criteria for the simplified design method above, application of Council's detailed design method outlined in Section 1.4.4 of the City of Ryde Council stormwater management technical manual outlines should be employed for use within the wider MPIP:

- OSD design must ensure the level of stormwater discharged from the area of development must not exceed the peak stormwater discharge arising from the post-developed works during a 5-year ARI storm event.
- To restrict post development flows to pre-development levels a detention basin for the design storms will be required to be modelled.
- In cases where the site proposes discharge to the kerb and gutter, the point of discharge is to be limited to 30 L/s.
- If the rate of discharge from the outlet of the OSD system is affected by tail water conditions from the receiving system, then full hydraulic calculations will be required in accordance with Section 5 of the manual.

It is proposed that post-development stormwater flows for all major storms up to and including the major design 1%AEP storm event be restricted to the existing pre-development rates for all development land subject to the site-specific requirements of the MPIP. This rate is consistent with the existing requirements of the City of Ryde Council DCP and ensures that future development will not inundate existing stormwater assets.

Although integration of WSUD devices with OSD and water retention strategies is recommended from a design and maintenance perspective, it is recognised that this may be excluded by site specific topographic and

drainage conditions. It should therefore be the responsibility of future development consultants to evaluate the benefits and restrictions of a combined water quality and quantity system accounting for the specific development conditions of each site.

6.1.2 Stormwater Detention and Reuse

Incorporation of potable water conservation measures including rainwater harvesting through retention and reuse is recommended to be encouraged for all new developments sited within the future MPIP. Section 4.3 of the City of Ryde Council WSUD Guidelines outlines that the following general RWT requirements are applicable to all new developments:

- All rainwater tanks should be fitted with 'first flush diverters'. These are simple mechanical devices that divert the first portion of runoff volume (that typically carries more debris and contaminants) away from the tank. After the first flush diversion, water passes directly into the tank.
- Tanks can be fitted with potable water top-up devices, to ensure there will always be some water in the tank, even in periods of no or little rainfall.
- Where there is potable water top-up, a backflow prevention device is required to prevent rainwater from entering the potable supply system.
- Collected roof runoff water is suitable for direct use for outdoor irrigation or toilet flushing with no additional treatment. Tank water can also be used in hot water systems, where a storage temperature of 60°C will effectively destroy most pathogens in a short amount of time. The relevant Australian Standard (AS/NZS 3500 Part 4.2) requires hot water to be stored at a minimum of 60°C and then mixed with cold water to be delivered at 50°C.

Where introduction of stormwater harvesting is proposed, sizing and reuse requirements are to be designed to accommodate site specific hydraulic loading and rainfall requirements on a development-by-development basis utilising the existing Council requirements outlined in Section 3.3 and Section 3.4 of City of Ryde Council WSUD Guidelines. Potential reuse opportunities for stormwater harvesting schemes are highlighted by Council and presented in the below matrix.

Table 5: City of Ryde Council Water Reuse Application Matrix

Source	Reuse Options							
	Garden and Lawn	All toilets	Laundry	All hot water	Cold water in showers, baths, hand basins, etc	Cooling towers	Ornamental water features	Public open space[1]
Potable	✓	✓	✓	✓	✓	✓	✓	✓
Rainwater	✓	✓	✓	✓		✓	✓	✓
Treated stormwater	✓	✓	✓			✓	✓	✓
Treated greywater[2]	✓	✓	✓					✓
Untreated greywater[3]	✓							
Reticulated recycled water	✓	✓	✓			✓	✓	✓

Note 1: Water uses in public open space may include irrigation and street cleaning.
Note 2: Advanced treatment of greywater is required before reuse in toilet flushing, laundry and surface irrigation. Treatment needs to include filtration and disinfection.
Note 3: Untreated greywater can be used for subsurface irrigation; further guidance is given by DEUS (2007)

6.2 Stormwater Quality

Stormwater quality target discussions during the preliminary planning stage of the MPIP design requirements have outlined that compliance with the pollutant reduction targets provided in Section 8.2: Stormwater Management Technical Manual of the City of Ryde Council DCP is not satisfactory for incorporation into the wider MPIP. Concerns regarding the pollutant reduction targets were primarily associated with the desire for portions of the external Lane Cove River to become designated swimming zones and will consequently require the enforcement of more stringent pollution reduction targets than those presented by the existing Council rate.

6.2.1 Water Sensitive Urban Design (WSUD)

WSUD opportunities for the precinct are summarised in Table 6 below and remain consistent with the information provided within the wider City of Ryde DCP. Zoning for the implementation of precinct wide water quality measures, primarily bioretention systems and constructed wetlands will need to be adopted early to ensure that land can be reclaimed by Council for the purpose of zoning and constructing the necessary area of works. It is advised that adopted WSUD strategies employed within the wider public domain will primarily be associated with deep planting, infiltration, and bioretention zoning with particular emphasis on locations associated with the existing developed creek lines of Industrial Creek and Porters Creek.

Table 6: Summary of Physical Constraints Affecting WSUD Measures

WSUD Measure	Steep site	Shallow bedrock	Acid Sulfate Soils	Low permeability soil (eg. Clay)	High permeability soil (eg. sand)	High water table	High sediment input	Land availability
Swales and buffer strips	C	D	D	✓	✓	D	D	C
Bioretention Swales	C	C	C	✓	✓	C	D	C
Sedimentation basins	C	✓	✓	✓	✓	D	✓	C
Bioretention basins	C	D	D	✓	✓	C	C	C
Constructed wetlands	C	D	C	✓	D	D	D	C
Infiltration measures	C	C	C	C	✓	C	C	C
Sand filters	D	✓	✓	✓	✓	D	C	✓
Aquifer storage and recovery	C	C	C	C	✓	C	C	C

C – Constraint may preclude use; D – Constraint may be overcome through appropriate design;
✓ - Generally not a constraint

6.2.2 MUSIC Modelling

Water quality reduction targets are to be enforced for all new developments sited within the Precinct Masterplan in accordance with the Council's existing LEP requirements and objectives. Catchment specific pollutant reduction targets have been prepared for adoption for future development within the district through the preparation of a Model for Urban Stormwater Improvement Conceptualisation (MUSIC). It is intended that the annual pollutant reduction rates presented within this report will supersede the default overarching rates provided within the Council's DCP for development sited with the Precinct Masterplan.

The design intent regarding enforcement of legislative water quality reduction targets is the improvement of post-development stormwater discharge pollutant loading to pre-developed conditions. Modelling presented within this report has therefore adopted rates and requirements provided in the Neutral or Beneficial Effect on Water Quality Assessment Guideline (NorBE) as prepared by the Sydney Catchment Authority. Adoption of these guidelines is enforced for use on developments sited within Sydney drinking water catchments pending input from local authorities or guidelines and has thus been deemed appropriate for adoption within this Masterplan. Where appropriate, design with the Masterplan MUSIC model has been prepared in correspondence with the process and parameters provided in the eWater MUSIC Modelling Guidelines (2018) as recommended by Council's Water Sensitive Urban Design Guidelines.

Post-development site conditions have been prepared in accordance with the general land use catchment mapping outlined as part of the Masterplan for the wider precinct. Pollutant load production is determined by the post-development land use and will vary between sites pending final catchment areas for roof, roadway, and the pervious to impervious landscaping split. As the exact catchment split for future development proposals is impossible to know within context of the Master planning scope, precinct modelling has instead utilised lumped catchment stochastic pollutant loading values provided in Table 3.8 of the MUSIC Modelling Guidelines (2018) which models the combined pollutant generation for a series of surfaces utilising overarching development types. The following lumped catchment development types have been identified as applicable to the Precinct Masterplan and modelled as source nodes for analysis within the prepared MUSIC model.

- Commercial / Industrial Catchments refers to land identified for current or future commercial or industrial developments. Such development types will typically consist of high percentages of impervious site area including roofing and paving associated with vehicular movements and therefore result in higher GP, TSS, TP, and TN loads than other development types. Due to the high percentage of impervious site area a total impervious site area of 90% has been adopted in line with Table 3.7 of the MUSIC Modelling Guidelines (2018). Due to significant existing development within the precinct, commercial and industrial land usage will form a significant percentage of site catchment (64.2%) area under post-development conditions.

  It is to be noted that although no distinction between commercial or industrial land usage has been identified within the Masterplan, a 50-50 split has been inferred for adoption within MUSIC modelling due to minor variances in stochastic pollutant generation rates between the two development types. Where appropriate, it is considered the responsibility of future land developers to identify the intended land use type of future development and ensure that site usage aligns with the necessary commercial or industrial usage.

- Residential Catchments refers to land utilised for low, medium, and high-density housing. Typical impervious to pervious site split will vary pending the density of housing and is currently undefined within the Masterplan. Table 3.7 of the MUSIC Modelling Guidelines (2018) defines impervious fraction rates for various housing densities defined as dwellings per hectare. Modelling within the prepared MUSIC model has assumed an impervious fraction percentage of 80% and is representative of variable dwelling density ranging between 40 to 80 per hectare for all combined residential zones within the wider precinct.

- Roadways refers to public domain areas associated with the Council streetscape but also covers land not typically traversable by vehicles including pedestrian footpaths and laneways. A site split of 70% impervious area has been modelled per recommendations provided in Table 3.7 of the MUSIC Modelling Guidelines and is representative of proposed street tree planting, kerb blistering, and introduction of deep soil planting as outlined within Section 3.0 of this report.

- Landscaping refers to land identified as possessing significant pervious land usage post development and will include community land usage such as sporting fields and parks, as well as riparian zones. A maximum site catchment split of 20% has been adopted for modelling to account for minimal paving and hardscaped finishes in accordance with Table 3.7 of the MUSIC Modelling Guidelines.

The Precinct masterplan demonstrating the proposed land use catchment split is provided in Figure 27 below. A summary of the split between the Neighbourhoods is provided in Table 7 and demonstrates the final split between the four catchment types adopted for modelling in MUSIC as defined above.

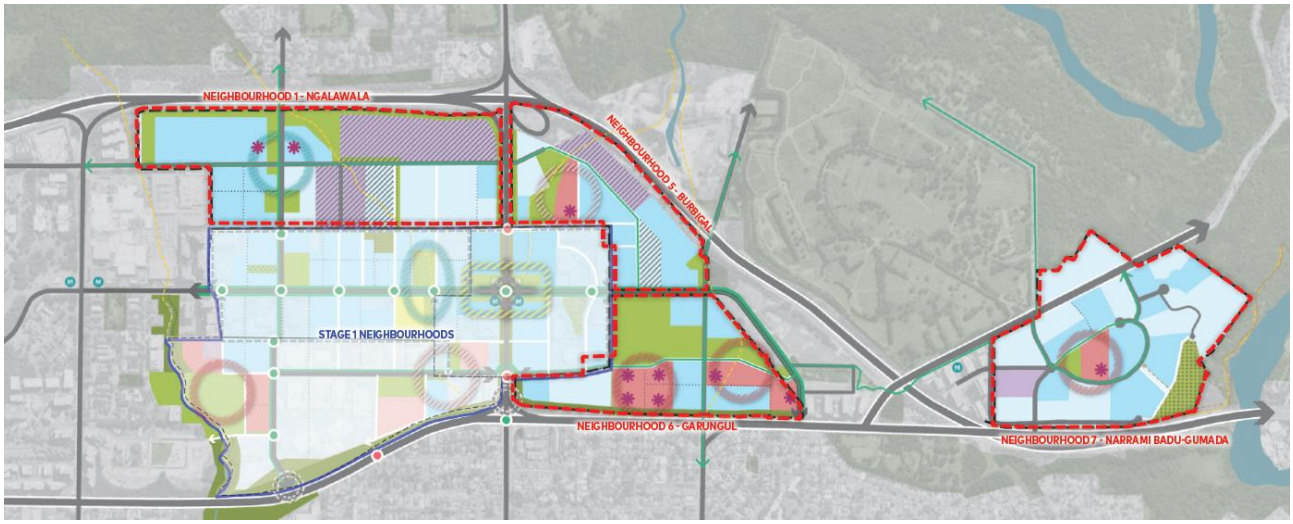


Figure 27: Land Usage Catchment Areas Proposed as Part of the Masterplan

Table 7: Land Use Catchment Areas Defined by Development Type and Neighbourhood

NEIGHBOURHOOD	COMMERCIAL / INDUSTRIAL (Ha)	RESIDENTIAL (Ha)	ROADWAY (Ha)	LANDSCAPE (Ha)	SUM TOTAL (Ha)
1	26.3	0	2.5	6.0	34.9
Stage 1	45.8	4.5	16.8	10.9	77.9
5	13.8	1.1	1.0	2.2	18.1
6	6.9	4.4	0.7	7.5	19.4
7	23.7	1.2	4.1	2.2	31.2
Sum Masterplan	116.5	11.1	25.2	28.8	181.5
	64.2%	6.1%	13.9%	15.9%	100.0%

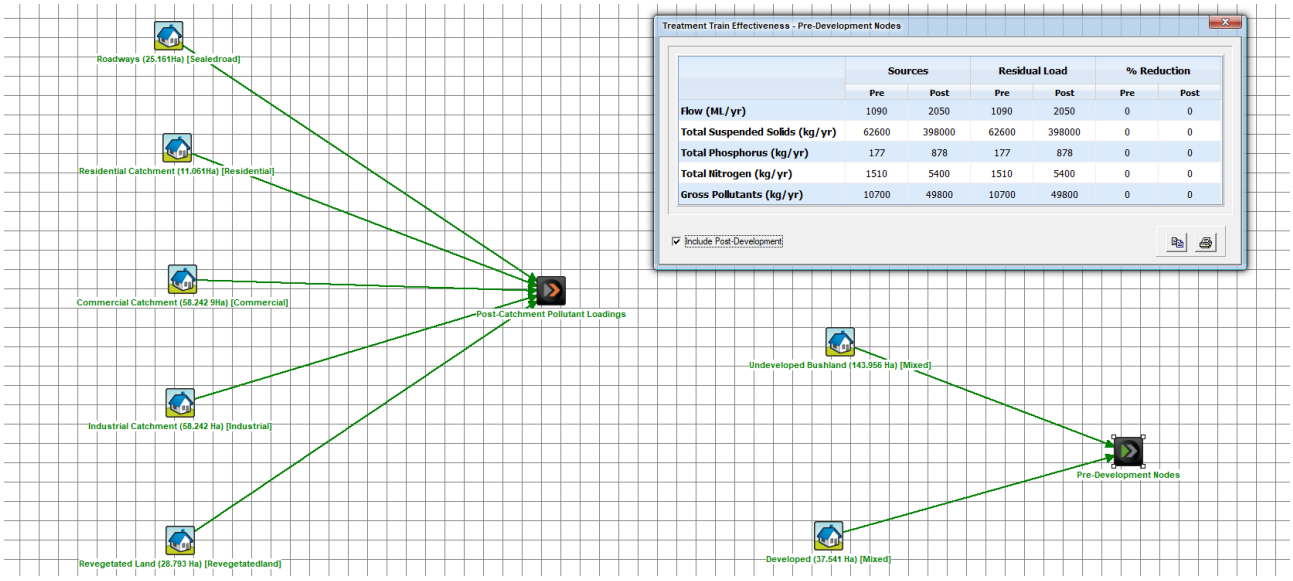
In order to obtain pollutant reduction targets expressed as a percentage reduction, a pre-development node was modelled to predict the existing annual pollutant loads for the overall Masterplan area as required for NorBE assessment. However, due to the significant developed extent associated with the existing site, it was deemed that reduction of post-development pollutant production loads to current rates was inappropriate in meeting the Masterplan objective for discharge to the neighbouring Lane Cove River. Likewise, modelling post-development conditions to meet undeveloped bushland (greenfield) rates is noted to be excessive at a 99.9% Total Nitrogen reduction rate which is not achievable for the majority of future development types both proposed and existing within the Precinct.

Instead, it has been proposed that the majority of site be modelled as undeveloped bushland with the remainder of site modelled as rural residential zoning. Adoption of these rates will significantly exceed the minimum requirements needed for NorBE assessment and is therefore representative of a best case outcome for the precinct stormwater quality discharge. The following Neighbourhoods have been modelled as native bushland, noting that the remainder were modelled as rural residential catchments:

- Neighbourhood 1,
- Neighbourhoods associated with Stage 1, and
- Neighbourhood 7.

Where a development is proposed to discharge to a regulated catchment including local waterway or riparian corridor as outlined in the Foreshores and Waterways Area regulated catchment map, water quality will instead be required to be reduced to a rate that is neutral or beneficial when compared to undeveloped conditions in accordance with Chapter 6 of the *State Environmental Planning Policy (Biodiversity and Conservation) 2021*.

A screenshot of the modelled pre-development and post-developed catchments with node types and areas within MUSIC is provided in the Figure 28 below.



	Sources		Residual Load		% Reduction	
	Pre	Post	Pre	Post	Pre	Post
Flow (ML/yr)	1090	2050	1090	2050	0	0
Total Suspended Solids (kg/yr)	62600	398000	62600	398000	0	0
Total Phosphorus (kg/yr)	177	878	177	878	0	0
Total Nitrogen (kg/yr)	1510	5400	1510	5400	0	0
Gross Pollutants (kg/yr)	10700	49800	10700	49800	0	0

Figure 28: MUSIC Model Schematic of Pre vs Post-Development Source Nodes and Annual Pollutant Loads (kg/yr)

A comparison of post-development to pre-development pollutant nodes is provided in Table 8 and identifies the annual pollutant reduction rates that should be implemented for future development located within the Precinct Masterplan. Where MUSIC modelled pollutant reduction targets are exceeded by Council's regular DCP rate or Greenstar C target, the adoption of those rates has instead been recommended. Findings from this report align with other NSW precinct master planning strategies including Mamre Road Precinct DCP 2021 and Aerotropolis DCP 2022.

Table 8: Annual Pollutant Load Production Loads and Investigated Catchment Pollutant Reduction Parameters

Pollutant Target	Pre-Development Pollutant Loads (bushland) (kg/yr)	Post-Development Pollutant Loads (masterplan) (kg/yr)	MUSIC Modelling Reduction (%)	Council DCP Reduction (%)	Greenstar C Maximum Reduction (%)	Maximum Annual Pollutant Reduction Rate (%)
Gross Pollutants (GP)	10,700	49,800	80%	90%	95%	95%
Total Suspended Solids (TSS)	62,600	398,000	85%	85%	90%	90%
Total Phosphorus (TP)	177	878	80%	65%	70%	80%
Total Nitrogen (TN)	1,510	5,400	70%	45%	60%	70%

It is to be noted that the identified 80% TP and 70% TN reduction rates exceed the maximum achievable Greenstar pollutant reduction targets and the provided reduction rates are therefore indicative of exceptional standards regarding traditional WSUD design. This report acknowledges that adoption of the proposed pollutant reduction targets as modelled in MUSIC will be highly restrictive for the majority of new developments located within the precinct zoning without the capability or appropriate topographic limitations necessary to accommodate bioretention or constructed wetland systems. It is therefore vital that consideration of any potentially viable pervious land downstream of the Precinct and adjacent to the existing developed creek lines including Industrial Creek and Porters Creek be investigated and integrated by Council within a precinct wide stormwater quality scheme as identified in Section 4.0 – Water Restoration of this report.

It is therefore recommended that the maximum Greenstar pollutant reduction targets should be adopted within the proposed master planning area as identified in Table 9 and, where applicable, introduction of deep planting zones and bioretention within the public domain to augment site specific stormwater treatment trains for new development works. As previously discussed, achievement of Greenstar C pollutant reduction targets is typically considered indicative of exceptional standards regarding traditional WSUD design and should therefore be deemed appropriate for integration within the proposed masterplan area.

Table 9: Recommended Masterplan Annual Pollutant Reduction Targets

POLLUTANT TYPE	ANNUAL POLLUTANT REDUCTION TARGET
Gross Pollutants (GP)	95% reduction (minimum) in mean annual loads.
Total Suspended Solids (TSS)	90% reduction (minimum) in mean annual loads.
Total Phosphorus (TP)	70% reduction (minimum) in mean annual loads.
Total Nitrogen (TN)	60% reduction (minimum) in mean annual loads.
Total Petroleum Hydrocarbons	90% reduction (minimum) in mean annual loads.
Free Oils	98% reduction (minimum) in mean annual loads.

It is noted by this report that the treatment of Total Petroleum Hydrocarbons (TPH) and free oils is not possible utilising MUSIC. However, demonstration that these targets can be satisfied forms a requirement for Greenstar C compliance and should therefore be considered for inclusion in the overall annual pollutant reduction target requirements aimed at reducing the pollutant loading to the neighbouring Lane Cove River. Treatment of TPH and free oils is recommended to occur through a combination of the following devices:

- Impermeable baffle located within an OSD system or diversion pit to cater for major storm event flows.
- Bioretention and biofiltration systems including planted buffer zones and constructed wetlands.
- Gross Pollutant Trap (GPT) pit inserts with oil / hydrocarbon absorbent material or approved equivalent.

7.0 Summary of Policy Recommendations

The following provisions identified from findings presented within this report should be adopted for integration into the Design Guide for the MPIP:

- Portions of the MPIP Stage 2 area is flood affected. Flood planning levels are defined by City of Ryde Council in the DCP (2014) and associated Stormwater Technical Manual (2014). Where applicable, flood levels are to be taken as the 1% AEP event plus an applicable freeboard as discussed in Section 5.1.3 of this report. Several development types including Critical and Sensitive Uses and Facilities as well as entrance to basement carparking will require protection against the PMF. A summary of flood planning levels is provided below. Please refer to Section 5.0 of this report for more detailed flood planning advice.

  All minimum floor planning levels and associated freeboards will need to align with the values provided in Table 3 and replicated below.

Table 10: MPIP Recommended Land Use Category Flood Planning Levels and Minimum Flood Zoning Requirements

Land Use Category	Flood Planning Level	Not permitted at:
Critical Uses and Facilities	Probable Maximum Flood	Low/Medium/High Risk May be permissible in lots identified as Overland Flow Precincts, provided they are not subject to major overland flows.
Sensitive Uses and Facilities	Probable Maximum Flood	Low Medium or High Risk
Recreation/Non-Urban	1% AEP + freeboard (refer to Table 4 for freeboard requirements. Considered as non-habitable residential)	-
Industrial/Commercial	1% AEP + 300mm	Medium/High Flood Risk
Residential	Habitable Floors: ▪ 1% AEP + 300mm (for Low Risk and Overland Flow Precincts) ▪ 1% AEP + 500mm (for Medium and High Risk Precincts)	Medium/High Flood Risk
Open Parking	1% AEP	-
Enclosed Parking	1% AEP + 150mm freeboard	-
Basement Parking	Crest at PMF	-

Red = Proposed changes to current DCP

- A review of the existing flood behaviour and mapping was performed to determine the suitability of various development types for flood affected properties identified within the respective Precinct neighbourhood.
    - Neighbourhood 1 – North Park – Ngalawala (Reciprocity) This Neighbourhood is proposed to consist of predominantly a business and technology core with largely commercial land use areas and has been identified as a High Trapped Perimeter Area due to creek flooding cutting egress routes via Talavera Rd at several sections during the 1%AEP. Other egress routes available at Khartoum Rd and Lane Cove Road are traversable during the 1%AEP but become high hazard flows during the PMF. Despite this the majority of flood-affected land within the neighbourhood is classified as low to medium risk and is deemed suitable for recreation/non-urban, industrial & commercial, and residential development types.

- Neighbourhood 4 – Macquarie Living Station – Gari Nawi (Saltwater Canoe) is affected by low hazard flows associated with Waterloo Rd and results in areas of low and medium flood risk appropriate for recreational, residential and industrial land use. Properties south of Waterloo Rd are notably flood unaffected and are considered appropriate for all development types.
- Neighbourhood 5 – Porter's Creek -Burbigal (Morning) currently consists of predominantly commercial and industrial land usage. Site access to the North of Lane Cove Rd is cut off at flooding hazard level H4 flows, however access south is maintained during the PMF. Recreation and non-urban land usage including sports fields and parks are permitted within this precinct. Incorporation of bioretention and regional detention basins within these recreational areas is recommended to promote waterway restoration works.
- Neighbourhood 6 – Wicks Road South – Garungul (Unbreakable) is flood affected to the east of the site associated with Porters Creek and south of the site associated with Epping Road. Any critical and sensitive use facilities require siting outside of the PMF extent and are therefore recommended to the west of the neighbourhood. It is recommended that should land within this neighbourhood be acquired, further assessment of accessibility during design should be performed.
- Neighbourhood 7 – North Ryde Riverside – Narrami Badu-Gumada (Connecting Water Spirit) is comprised of existing commercial and industrial land use and is minimally affected by flooding. Flood affected areas are predominately low to medium flood risk and are considered appropriate for recreation/non-urban, industrial & commercial, and residential development types.

- OSD is recommended for adoption for all future development within the MPIP in accordance with existing rates provided in the City of Ryde DCP, 2014.
- Incorporation of rainwater harvesting, and reuse schemes should be encouraged for all new development and rectification works. Where introduction of rainwater reuse is proposed, the design process should incorporate the existing reuse calculation and sizing rates outlined in the City of Ryde Council WSUD Guidelines, 2015.
- Catchment specific annual pollutant reduction targets have been proposed to accommodate restoration of the neighbouring Lane Cove River following rainfall events as part of the Master planning legislative framework. Adoption of these rates was modelled within MUSIC to ensure compliance with NorBE rates applicable for Sydney Water drinking catchments and is considered appropriate for adoption with catchments draining to the Lane Cove River. GP, TSS, TP and TN annual pollutant reduction rates should be implemented as 95%, 90%, 70% and 65% respectively as recommended by this report. Further incorporation for Total Petroleum Hydrocarbons and Free Oils to 90% and 98% respectively should also be accommodated into future planning requirements. Where applicable, treatment of heavy metals should be investigated for large scale industrial use development proposals.
- Opportunities for watercourse restoration and WSUD strategies have been identified within various public domain areas, especially when in proximity to the existing natural and developed creek lines and should consist of deep soil planting, bioretention, and extended tree canopy cover.

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