WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

14 September 2023

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Director – Development, Retail and Mixed Use
Elanor Investors Group
Level 38, 259 George Street
Sydney NSW 2000

Via email: bmahchut@elanorinvestors.com

Dear Ben,

Our ref: 24050019_L02v02_Flood_Assessment_Report

# 24050019 Warrawong Plaza Planning Proposal – Flood Assessment Report

This letter sets out our findings regarding flood, flood evacuation and flood impact constraints on the proposed redevelopment at Warrawong Plaza (43-65 Cowper Street, Warrawong, Figure 1).

Elanor Investors Group (ASX: ENN) purchased the site in 2021/22 and intends to submit a Planning Proposal to amend the land use zoning from E2 Commercial Centre to MU1 Mixed use, amend the Height of Buildings Map from 24 m to allow building heights of up to 75 m and to introduce a site specific clause in the Local Environmental Plan which would allow for the redevelopment of the site in line with the principles of the Planning Proposal reflected in the Planning Proposal Report. The Proposal also seeks to allow for the redevelopment of the existing retail centre.

The following preliminary flood advice has been prepared with reference to the following documents:

- Flood Impact Assessment Report: Warrawong Plaza (Water Technology, 2023)
- Kully Bay Overland Flow Study (Rhelm, 2019)
- Lake Illawarra Floodplain Risk Management Study and Plan (Cardno, 2012)
- Lake Illawarra Flood Study (Lawson and Treloar, 2001)
- Illawarra Flood Emergency Sub Plan (NSW SES, 2022)
- Wollongong Local Environmental Plan (LEP) 2009
- Wollongong Development Control Plan (LEP) 2009
- State Environmental Planning Policy (Resilience and Hazards) 2021
- Ministerial directions under Section 9.1 of the Environmental Planning and Assessment Act as they relate to flooding.

## 1 THE PLANNING PROPOSAL

The Planning Proposal will seek consent for:

- *An amendment to the land use zoning of the Site (clause 2.1) from E2 Commercial Centre to MU1 Mixed Use*


*Figure 1: Site location*

- *An increase in the Height of Building Development Standard from 24 metres up to 75 metres (variable between 24m to 75m)*
- *An amendment to the Key Sites Map to identify 43-65 Cowper Street, Warrawong as "Area 11"*
- *The introduction of specific additional 'Local Provisions' in Part 7 of the WLEP 2009, through a Site-specific LEP clause 7.24 to allow for the mixed-use redevelopment of the existing retail centre at 43-65 Cowper Street, Warrawong, and references "Area 11" on the Key Sites Map*

The proposal will retain a minimum of 50,000 $m^2$ of Gross Floor Area for non-residential land uses and provide a public open space area with a minimum area of 3,000 $m^2$. The development will deliver approximately 1,300 dwellings.

The reference design includes largely commercial uses at ground level, including a retail core, large format food and beverage and other food and drink premises (Figure 2). The design also shows residential dwellings in a series of towers. A path running from Cowper Street to Northcliffe Drive would provide a through-site link while the existing driveway along the eastern margin of the site would be maintained.

The design includes 5 residential towers along the southern margin of the site, adjacent to Northcliffe Drive (Figure 3). The 2 easternmost towers (Buildings F and G) include only a lobby at ground level (Table 1), with the buildings raised and supported by columns (Figure 2) and all residential uses proposed for levels 1 and above.

**Table 1 Significant Levels for the Site**

| Location | Elevation (m AHD) |
|---|---|
| Retail areas – ground floor level | 6.0 |
| Retail areas – level 1 | 11.6 |
| Pub – ground floor level | 6.0 |
| Building C-2 – ground floor level | 6.0 |
| Buildings D and E – ground floor level | 6.5 |
| Building F – lobby level | Approx. 4.5 |
| Building F – level 1 | 9.6 |
| Building G – lobby level | Approx. 2.6 |
| Building G – level 1 | 6.5 |
| Basement level 1 | 2.3 – 2.5 |
| Basement level 2 | 0.7 |
| Cowper Street at basement entry | 5.865 |
| Northcliffe Dr at western basement entry | 3.5 |

Under the reference design, existing undercroft parking is proposed to be demolished and replaced with 2 levels of basement parking accessed via Cowper Street and Northcliffe Drive (Figure 4).


*Figure 2: Ground floor plan*


*Figure 3: Site roof floor plan*


*Figure 4: Basement level 1 floor plan*

# 2 FLOOD BEHAVIOUR

The site is impacted by both overland and lake flooding.

## 2.1 Overland Flooding

### 2.1.1 Flood Behaviour

In the following analysis overland flood levels for most events are given for existing conditions based on flood data from Rhelm (2019). Post-development modelling based on the reference design for the 1% AEP and PMF events has been undertaken by Water Technology (2023). Therefore, flood levels for the overland 1% AEP and PMF events have been provided for the post-development scenario, except where otherwise stated.

Parts of the subject site and adjoining roads would be impacted by overland flooding in the Kully Bay catchment in events as frequent as the 20% AEP flood (Table 2). Site ground levels generally slope downwards from north to south. Thus, in existing conditions overland flows are diverted westwards along Cowper Street and then southwards on King Street and south-westwards through the driveway and at-grade carpark along the border with the neighbouring property owned by the NSW Government (Land and Housing Site).

Hydraulic hazard is a standard way to measure the threat posed by floodwaters to people and property and it is based on the combination of maximum flood depth and velocity at any given location. Figure 5 shows the national hydraulic hazard classification and the threat to life and property associated with each hazard class from H1 (minimum hazard) to H6 (maximum hazard). In a 20% AEP overland event, H3 floodwaters over Northcliffe Road would generally cause stability issues for vehicles, children and the elderly.

In the 20% AEP event Northcliffe Road to the south of the site would flood to a depth of up to 0.8 m with a hydraulic hazard of H3. Much of the southern section of the site would have a hydraulic hazard of H2 or H3. The intersection of King Street and Cowper Street would flood by up to 0.5 m, but with a hydraulic hazard of H5 (Table 2). This hydraulic hazard is considered unsafe for vehicles and people and buildings are vulnerable to structural damage. Cowper Street east of the intersection with Taurus Avenue would be flooded with low hazard (H1) floodwaters, which generally do not cause stability issues for people or vehicles. Therefore, in an event of this magnitude the proposed development would be considered to be isolated by low hazard floodwaters.

Similarly, the proposed development would be isolated by low hazard floodwaters in all events up to and including the 5% AEP flood (Table 2). The Kully Bay Overland Flow Study (Rhelm, 2019) shows that in existing conditions floodwaters would start to accumulate against the northern margin of the shopping centre in the 5% AEP event. However, this is potentially because the Rhelm study assumed no floodwaters would flow through the existing buildings and so blocked them out in the flood model. This may not be realistic and floodwaters could potentially flow through the ground floor of the existing shopping centre in the 5% AEP event.

In overland flows of a 2% AEP magnitude or greater the site would be isolated by H2 or greater floodwaters on local roads. These could cause stability issues for small vehicles.

*Table 2: Overland flood behaviour*

| Design Flood | Variable | A. Intersection of King Street and Cowper Street | B. Intersection of Taurus Avenue and Cowper Street | C. Intersection of Northcliffe Drive and King Street | D. Northcliffe Drive (east of King Street) | Site Isolation (in the local catchment) |
|---|---|---|---|---|---|---|
| 20% AEP | Flood Level | 4.64 m AHD | 6.10 m AHD | 3.21 m AHD | 3.05 m AHD | Site isolated by low hazard floodwaters |
| | Flood Depth | 0.3 – 0.5 m | 0.07 m | 0.15 m | 0.83 m | |
| | Flow Velocity | 2 – 3 m/s | 0.25 m/s | 1 – 2 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H5 | H1 | H1 | H3 | |
| 10% AEP | Flood Level | 4.67 m AHD | 6.13 m AHD | 3.21 m AHD | 3.07 m AHD | Site isolated by low hazard floodwaters |
| | Flood Depth | 0.5 m | 0.15 m | 0.15 m | 0.78 m | |
| | Flow Velocity | 2 – 3 m/s | 0.6 m/s | 1.7 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H5 | H1 | H1 | H3 | |
| 5% AEP | Flood Level | 4.71 m AHD | 6.14 m AHD | 3.25 m AHD | 3.09 m AHD | Site isolated by low hazard floodwaters |
| | Flood Depth | 0.5 m | 0.15 m | 0.2 m | 0.87 m | |
| | Flow Velocity | 3.2 m/s | 0.7 m/s | 1.8 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H5 | H1 | H2 | H3 | |
| 2% AEP | Flood Level | 4.73 m AHD | 6.16 m AHD | 3.26 m AHD | 3.11 m AHD | Site isolated by low hazard floodwaters |
| | Flood Depth | 0.53 m | 0.15 m | 0.2 m | 0.9 m | |
| | Flow Velocity | 3.3 m/s | 1.9 m/s | 1.8 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H5 | H1 | H2 | H3 | |
| 1% AEP | Flood Level | 4.75 m AHD *(4.72 m AHD)* | 6.16 m AHD *(6.23 m AHD)* | 3.27 m AHD *(3.27 m AHD)* | 3.13 m AHD *(3.13 m AHD)* | Site isolated by low hazard floodwaters |
| | Flood Depth | 0.6 m | 0.2 m | 0.3 m | 0.9 m | |
| | Flow Velocity | 3.3 m/s | 2 m/s | 2 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H5 | H1 | H2 | H3 | |
| PMF | Flood Level | 5.16 m AHD *(5.13 m AHD)* | 6.41 m AHD *(6.55 m AHD)* | 3.46 m AHD *(3.47 m AHD)* | 3.35 m AHD *(3.39 m AHD)* | Site isolated by high hazard floodwaters |
| | Flood Depth | 1.2 m | 0.5 m | 0.4 m | 1.2m | |
| | Flow Velocity | 3.8 m/s | 3.5 m/s | 2.7 m/s | 0.3 m/s | |
| | Hydraulic Hazard | H6 | H5 | H5 | H3 | |

*Flood data from Rhelm, 2019). For the 1% AEP and PMF events post-development flood levels from Water Technology flood modelling have been provided in brackets below the existing conditions flood levels*

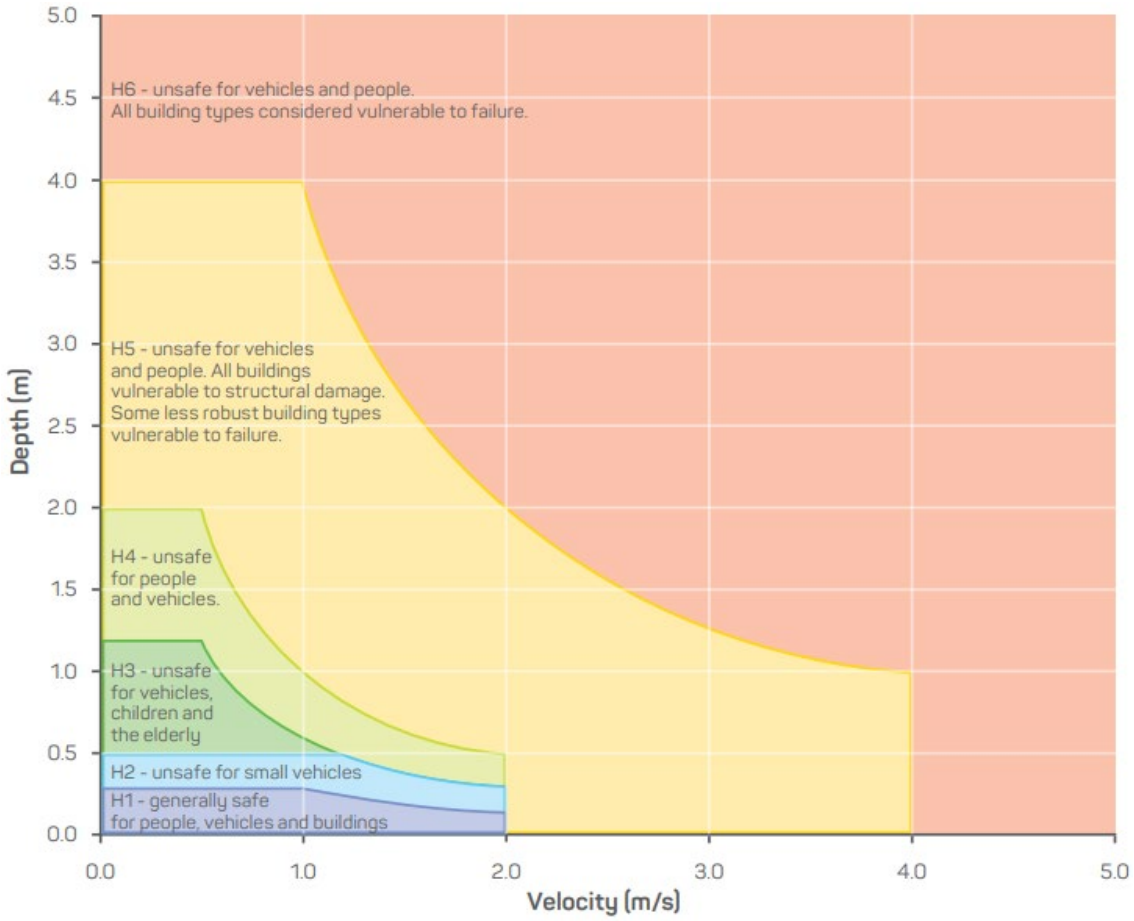


*Figure 5: Flood hazard vulnerability curves (Geoscience Australia, 2019)*

However, in events up to the 1% AEP flood, Cowper Street to the east of Taurus Avenue and Shellharbour Road north of Cowper Street would only be flooded with floodwaters up to H1, which are generally safe for emergency service vehicles. Therefore, emergency service vehicles would be able to access the north-eastern corner of the site and the Cowper Street basement access ramp via Mongomery Avenue and Cowper Street in events up to and including the 1% AEP event.

In the 1% AEP event, post-development flood levels around the site would range from 4.72 m AHD at Location A to 6.23 m AHD at Location B (Table 2, Figure 7) and 8.32 m AHD in the vicinity of the north-eastern corner of the Coles building in the reference design. The 1% AEP flood level at the north-eastern corner of the site would be 8.84 m AHD and at the south-eastern corner of the site would be 3.28 m AHD (Figure 7). The 1% AEP flood level in the eastern corner of the site would be 5.20 m AHD.

When climate change is taken into consideration (for the existing building footprint), the 1% AEP flood level in the year 2100 would be 0.01 – 0.05 m higher than the present-day 1% AEP flood level around most of the site (Figure 8) (Rhelm, 2019). Along the north-eastern margin of the existing building and along King Street adjacent to the north-western corner of the shopping centre flood levels would be increased by 0.05 – 0.1 m.

Overland PMF levels in post-development conditions would range from 6.55 m AHD at Location B to 5.13 m AHD at Location A and 3.47 m AHD at Location C (Table 2, Figure 9). The PMF level at the north-eastern corner of the site would be 8.88 m AHD, while at the south-eastern corner it would be 3.53 m AHD and in the eastern corner it would be 5.29 m AHD.

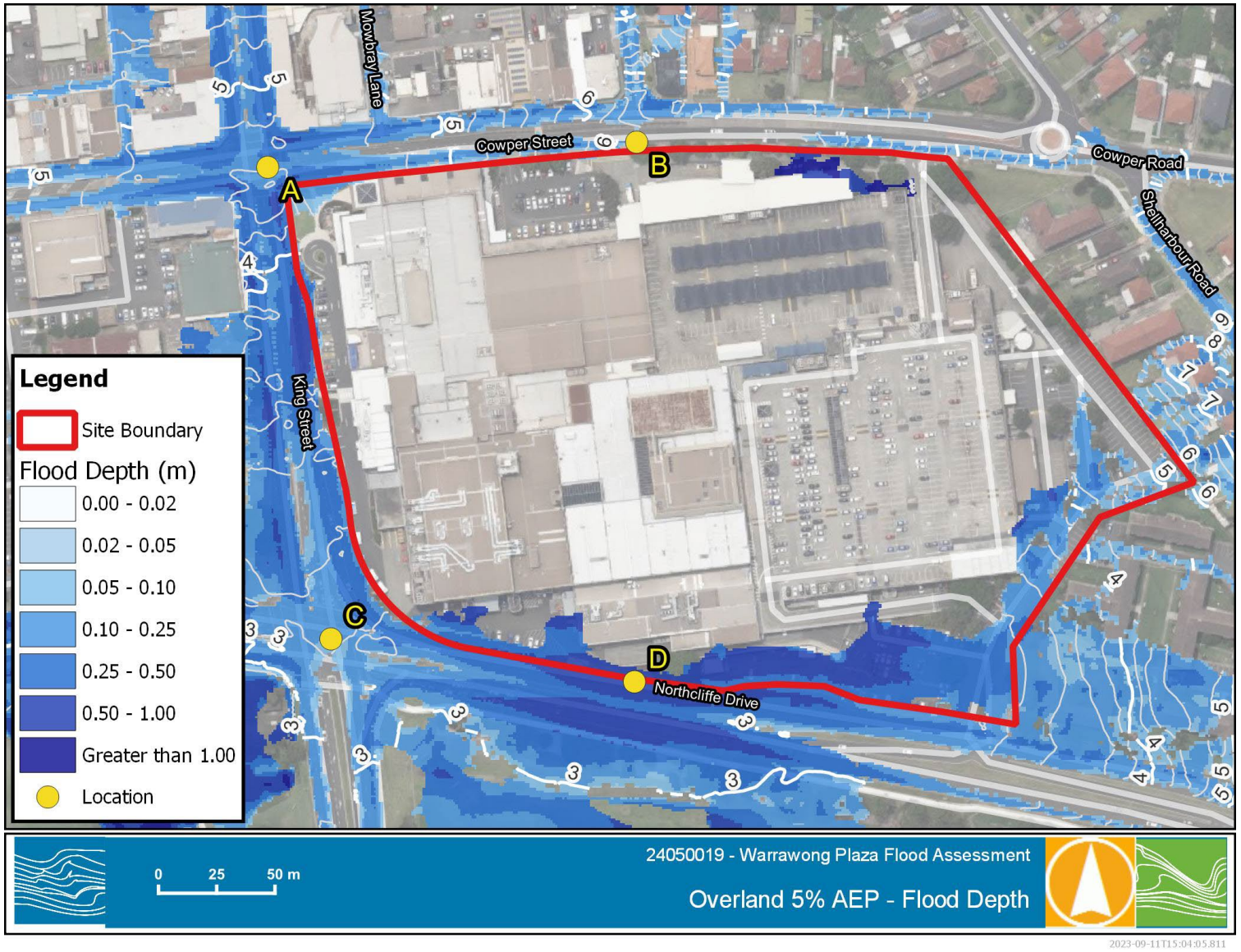


*Figure 6: Overland flood depths and flood levels in the 5% AEP event in existing conditions (Rhelm, 2019)*

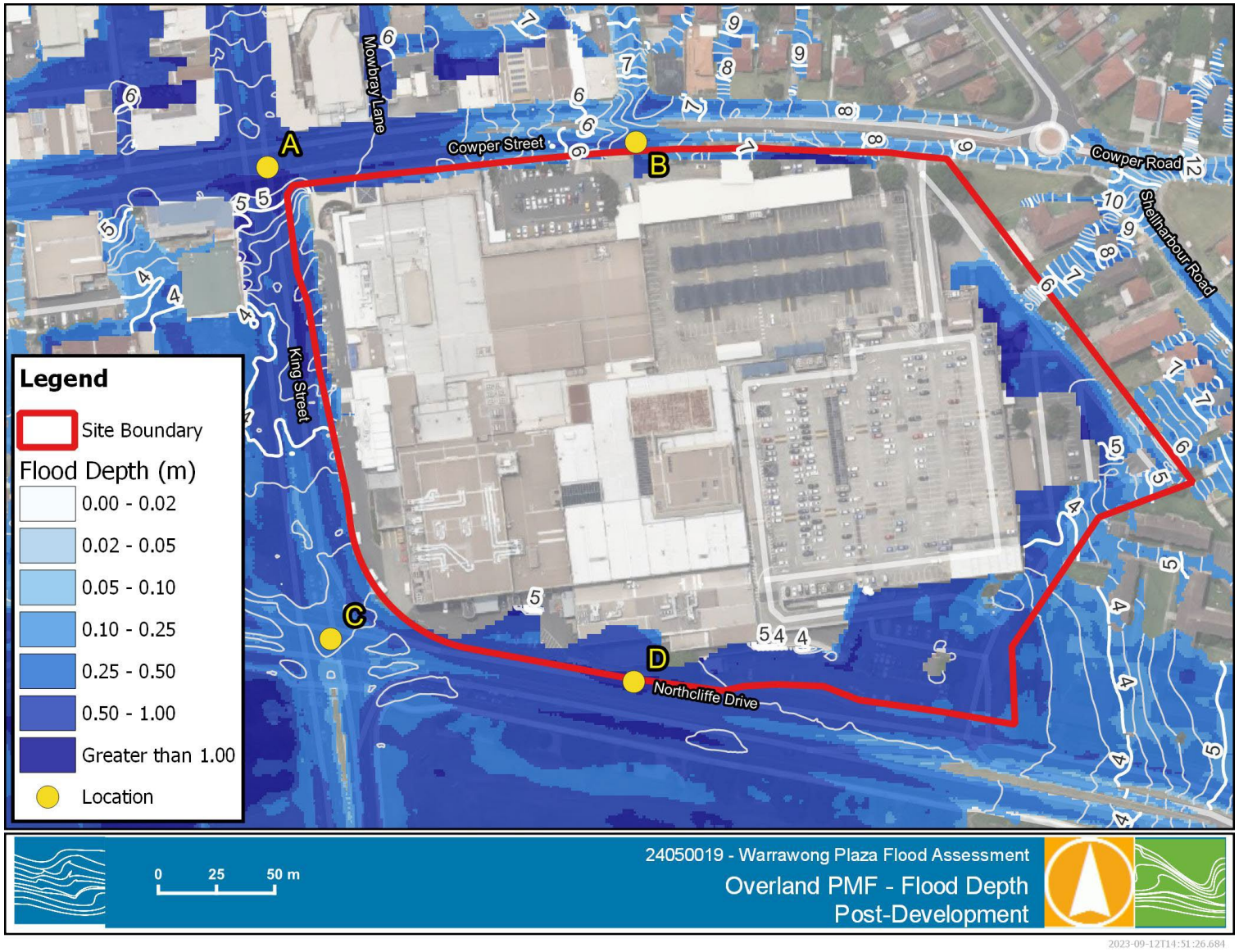


*Figure 7: Overland flood depths and flood levels in the 1% AEP event in post-development conditions (Water Technology, 2023)*

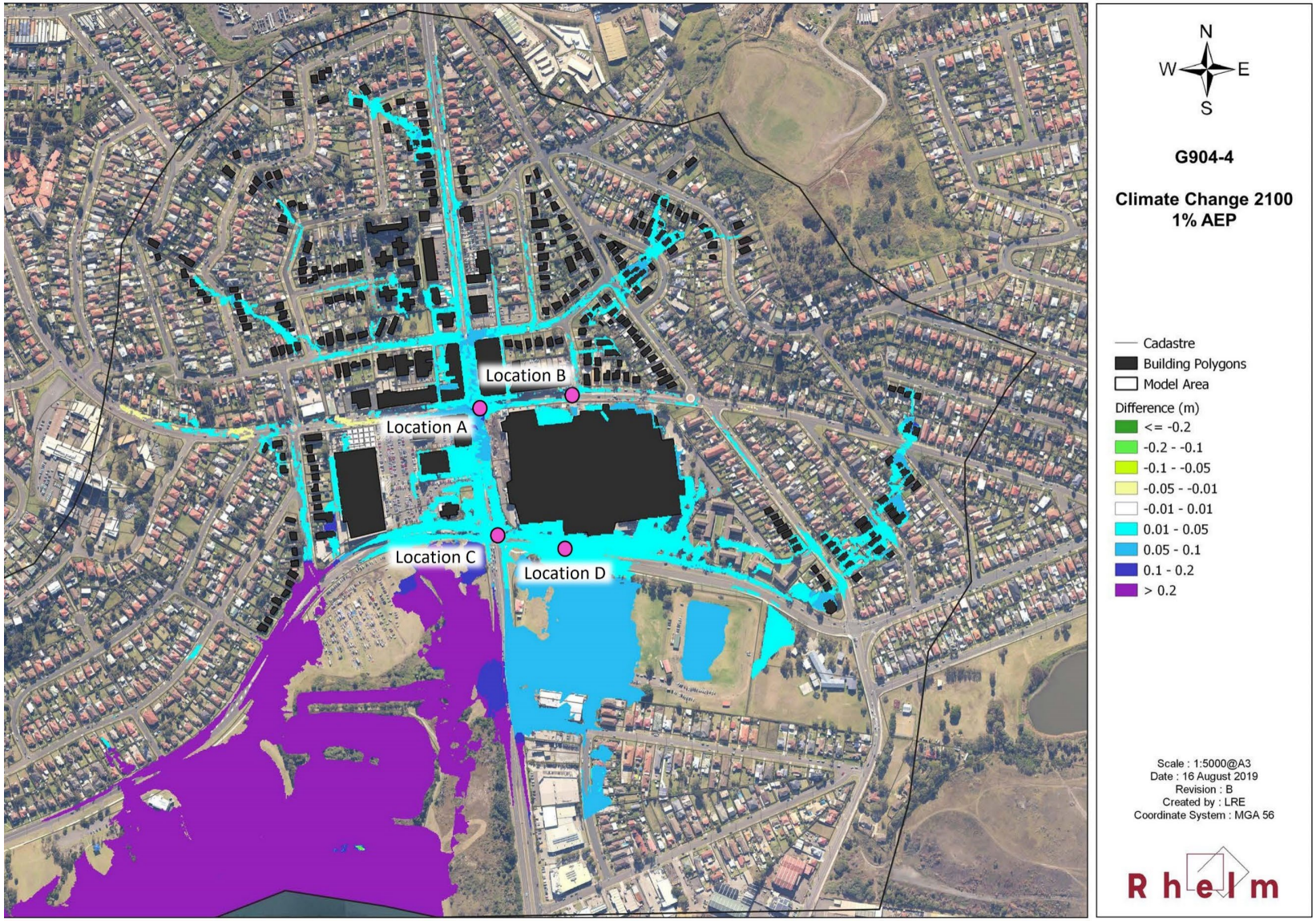


*Figure 8: Impact of climate change on 1% AEP overland flood levels for the year 2100 (Rhelm, 2019). Based on existing building footprint*

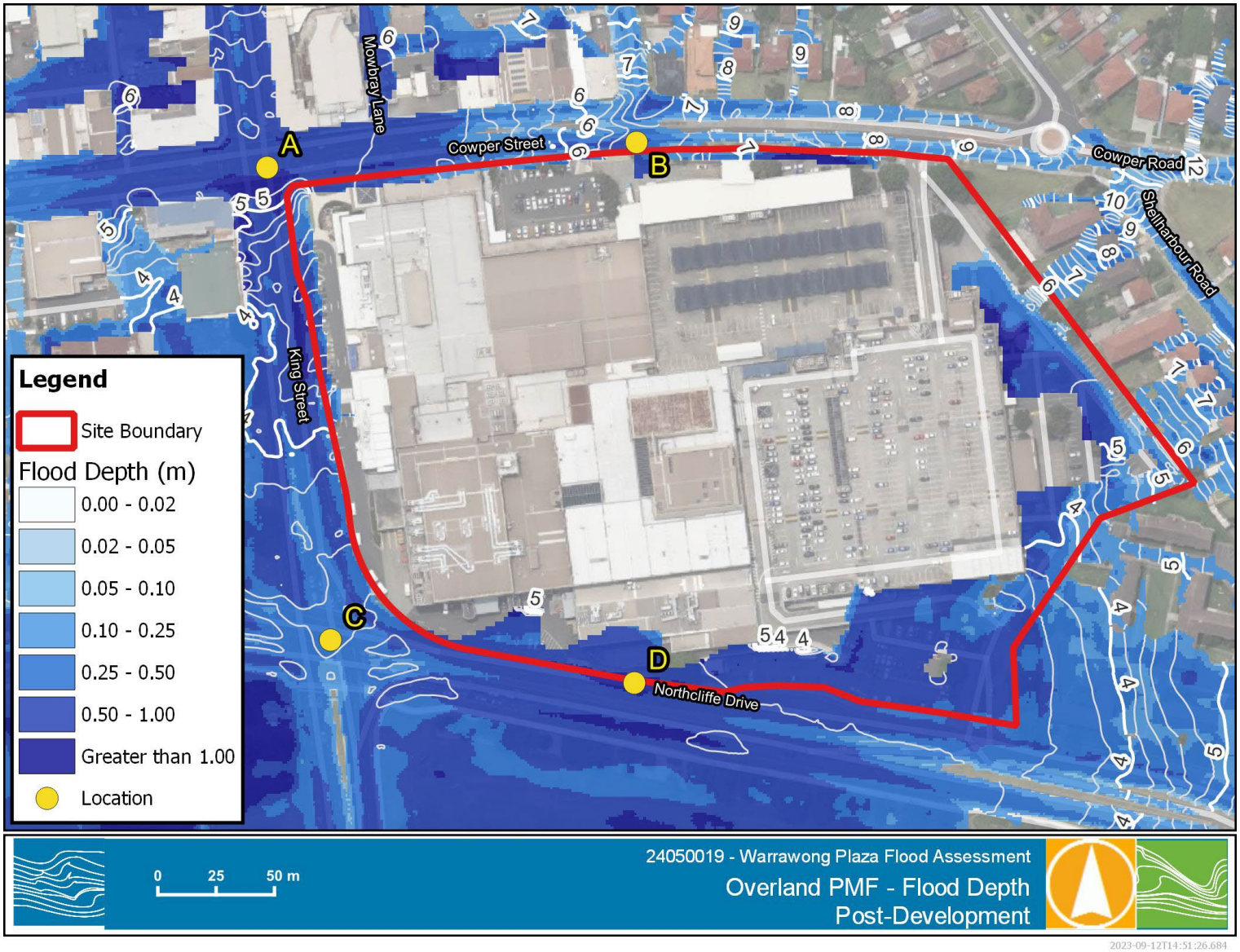


*Figure 9: Overland flood depths and flood levels in the PMF in post-development conditions (Water Technology, 2023)*

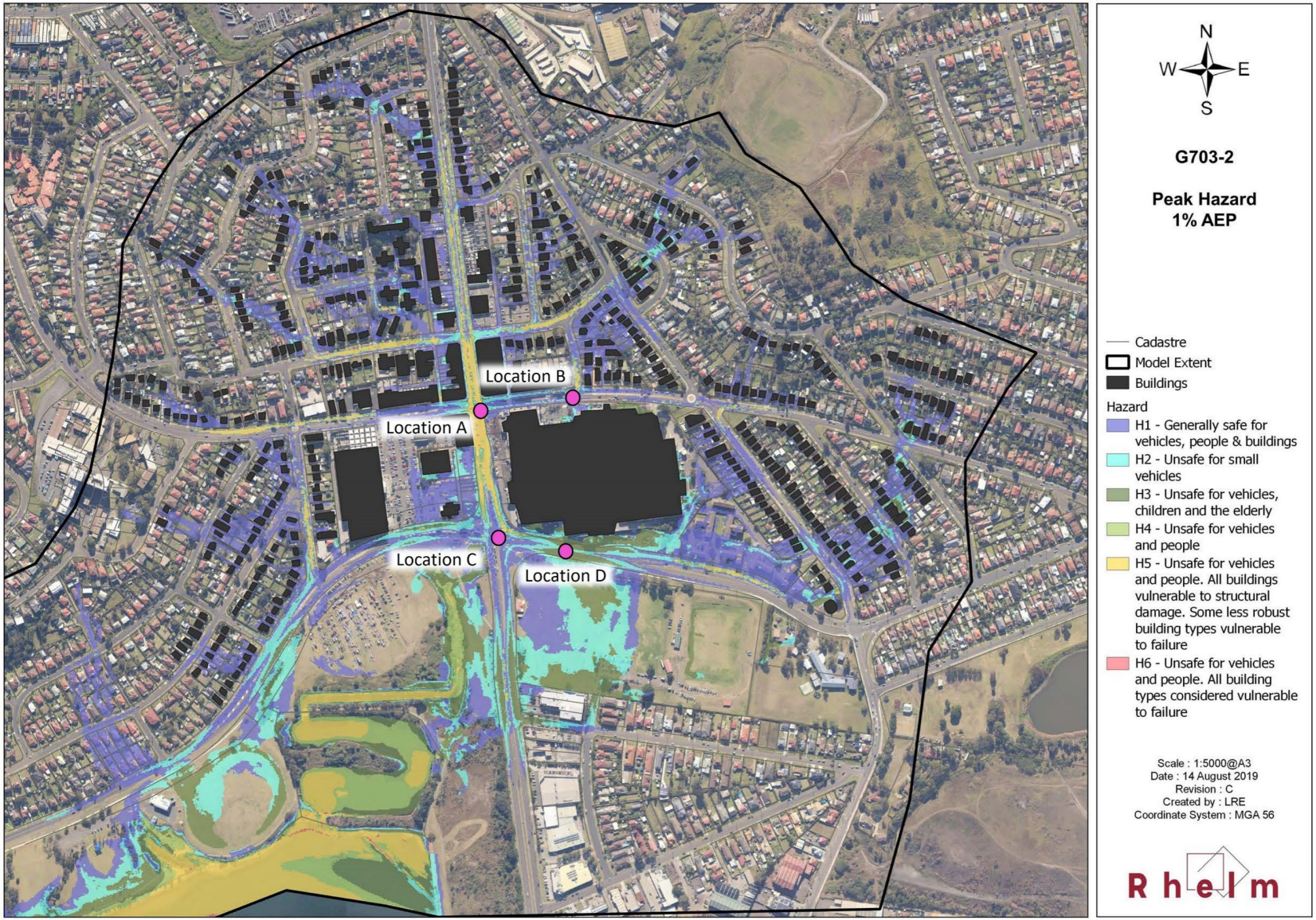


*Figure 10: Hydraulic hazard in the 1% AEP overland flood in existing conditions (Rhelm, 2019)*

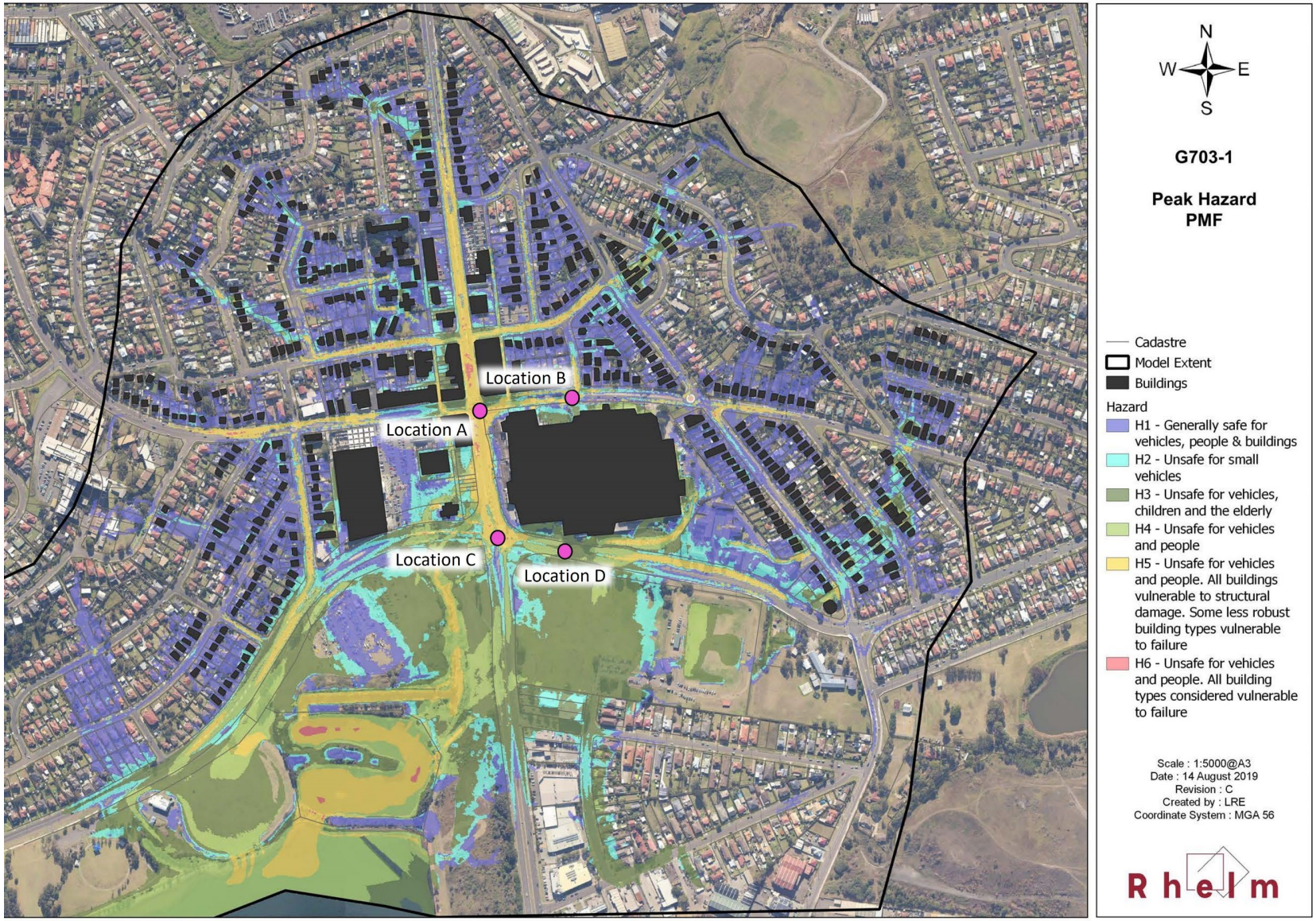


*Figure 11: Hydraulic hazard in the overland PMF in existing conditions (Rhelm, 2019)*

### 1.1.1 Rate of Rise and Duration

Overland flooding generally has a fast rate of rise. The Rhelm study found that in the design PMF all local roads (including Locations A, B and D) would flood within 30 minutes of the start of the rainfall event. Flooding at Location B (the intersection of Cowper Street and Taurus Avenue) would have a duration of 30 minutes, but King Street and Northcliffe Drive (Locations A, C and D) could be flooded for over 3 hours as the timing of flooding in these locations could be impacted by lake flooding.

## 2.2 Lake Flooding

### 2.2.1 Flood Behaviour

The site is located within the Lake Illawarra catchment and would be impacted by lake flooding in events larger than the present-day 1% AEP event (Table 3, Figure 12).

*Table 3: Lake flood levels*

| Design Flood | Variable | Southern section of site | Northcliffe Dr eastbound | Intersection of King St and Northcliffe Dr | Site Isolation (in the local catchment) |
|---|---|---|---|---|---|
| 50% AEP | Flood Level | 1.11 m AHD | 1.11 m AHD | 1.11 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 20% AEP | Flood Level | 1.40 m AHD | 1.40 m AHD | 1.40 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 10% AEP | Flood Level | 1.57 m AHD | 1.57 m AHD | 1.57 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 5% AEP | Flood Level | 1.81 m AHD | 1.81 m AHD | 1.81 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 2% AEP | Flood Level | 2.03 m AHD | 2.03 m AHD | 2.03 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 1% AEP (present) | Flood Level | 2.24 m AHD | 2.24 m AHD | 2.24 m AHD | Not isolated |
| | Flood Depth | Not flooded | Not flooded | Not flooded | |
| | Hydraulic Hazard | Not flooded | Not flooded | Not flooded | |
| 1% AEP (year 2050) | Flood Level | 2.63 m AHD | 2.63 m AHD | 2.63 m AHD | Not isolated |
| | Flood Depth | 0.45 m | 0.27 m | Not flooded | |
| | Hydraulic Hazard | min. H2 | min. H1 | Not flooded | |
| 1% AEP (year 2100) | Flood Level | 3.04 m AHD | 3.04 m AHD | 3.04 m AHD | Not isolated |
| | Flood Depth | 0.85 m | 0.81 m | 0.21 m | |
| | Hydraulic Hazard | min. H3 | min. H3 | min. H1 | |
| PMF | Flood Level | 3.24 m AHD | 3.24 m AHD | 3.24 m AHD | Not isolated |
| | Flood Depth | 1.05 m | 0.88 m | 0.41 m | |
| | Hydraulic Hazard | min. H3 | min. H3 | min. H2 | |

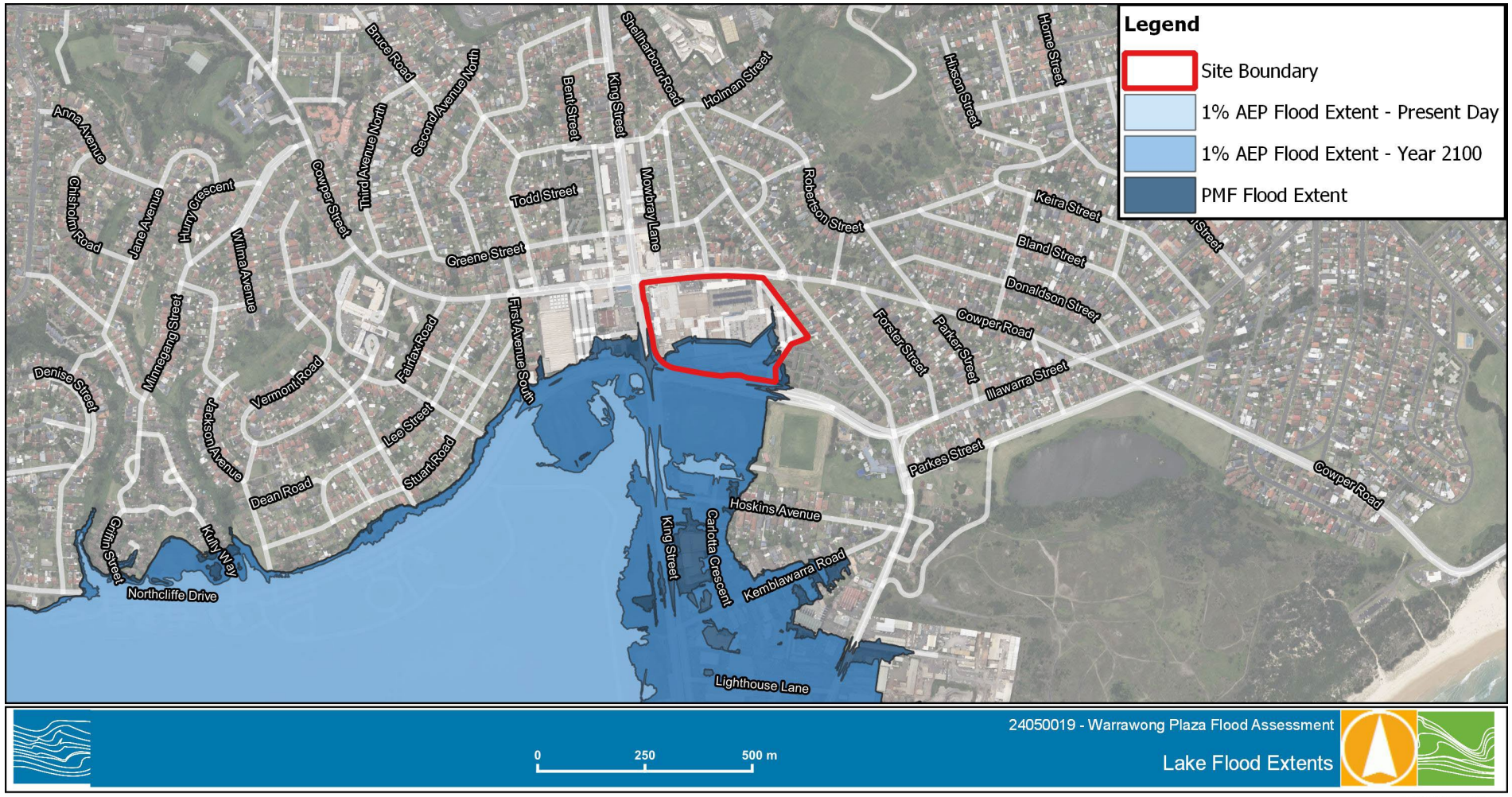


*Figure 12: Lake flood extents for the present-day 1% AEP, year 2100 1% AEP and PMF events. Flood extents based on contours of lake flood levels*

In the 1% AEP event the lake flood level would be 2.24 m AHD, which would flood sections of Northcliffe Drive to the west of King Street and would possibly flood part of King Street south of the site (Figure 12). However, the site itself would not experience inundation.

On the other hand, if climate change is taken into consideration the 1% AEP flood level in the year 2050 (0.55 m of sea level rise) would be 2.63 m AHD (Table 3). This would flood the southern section of the site by up to 0.45 m. Given the location of the site with regard to the lake, flood waters would have negligible velocity at the site. Therefore, the hydraulic hazard of the lake flood waters can be determined for various events with depth alone using the flood hazard vulnerability curves developed by Smith et al. (2014) (Figure 5). Thus, the southern section of the site would have a hydraulic hazard of H2 (based on a flood depth of 0.45 m). This may cause stability issues for small vehicles. The eastbound lanes on Northcliffe Drive south of the site would flood by up to 0.27 m, which would have a hydraulic hazard of H1.

In the 1% AEP event in the year 2100 (0.91 m of sea level rise) the flood level would be 3.04 m AHD, which would flood the southern section of the site (Figure 12) by 0.85 m and corresponds with a hydraulic hazard of H3 (Table 3). This would be unsafe for vehicles, children and the elderly. Northcliffe Drive would also be flooded by H3 floodwaters, while the intersection of King Street and Northcliffe Drive would have a hydraulic hazard of H1.

The lake PMF would have a flood level of 3.24 m AHD (Table 3), flooding the southern half of the site and Northcliffe Drive adjacent to the site (Figure 12). The southern part of King Street adjacent to the site would also be flooded. However, Cowper Street would not be impacted by lake floodwaters in any event up to and including the PMF. Therefore, the site would not be isolated by lake flooding alone.

### 1.1.1 Rate of Rise and Duration

Flooding of Lake Illawarra would have a relatively slow rate of rise given that the floodplain is large and flat. Rates of rise for the design PMF are not available. However, the *Lake Illawarra Flood Study* (Lawson and Treloar, 2001) indicates that the design 1% AEP lake flood would initially rise at a rate of 0.05 m/hr for approximately 16 hours, before increasing to a rate of 0.17 m/hr. It is possible that larger events would have faster rates of rise.

The *Kully Bay Overland Flood Study* (Rhelm, 2019) indicates that in the overland PMF flood durations for King Street and Northcliffe Drive would exceed 3 hours, with duration governed by flooding of Lake Illawarra. This suggests that the southern section of the site may flood for in excess of 3 hours in a lake PMF. Further, the *Lake Illawarra Floodplain Risk Management Study* (Cardno, 2012) states that properties that would be flooded for more than 24 hours in the lake PMF are classified as high hazard and are generally below 1.7 m AHD. The subject site and Northcliffe Drive adjacent to the site are mapped as low hazard by the Cardno study and have a minimum elevation of 2.2 m AHD. Therefore, these areas would be flooded for less than 24 hours in the design PMF.

# 3 FLOOD CONSTRAINTS

## 3.1 Ministerial Directions 4.1 Flooding

Local planning directions have been issued by the Minister for Planning under Section 9.1(2) of the *Environmental Planning and Assessment Act* 1979. These directions apply to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that affects flood prone land.

The objectives of this direction are to:

- Ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and
- Ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.

Table 4 lists all the directions under Section 4.1 Flooding and implications for the proposed development. The directions make reference to the "flood planning area" which is defined as the area below the flood planning level (FPL). In Wollongong LEP, the flood planning level for residential and mixed use development is the 1% AEP flood plus 0.5 m. In the case of Lake Illawarra flooding the flood planning area is based on the projected 1% AEP flood level in 2100 and would cover the south parts of the site (Figure 13). However, other parts of the site would also be within the flood planning area because they are below a level 0.5 m above the 1% AEP overland flood levels (Figure 14). Note that the overland flood planning level is based on the existing 1% AEP flood levels because climate change is not likely to change these significantly.

While the flood planning area is defined as the area below the FPL, it is physically possible to have development within the flood planning area which is above the FPL. Figure 15 shows a 3D representation of the flood planning area. The FPL is a horizontal surface defined by the 1% AEP flood level + 0.5 freeboard. The green volume within the diagram is that part of the Warrawong Plaza building which is within the flood planning area but above the flood planning level. This is an important consideration in the interpretation of the ministerial directions and their intent.

**Table 4 Compliance table identifying flood-related planning directions and implications for the proposed development**

| Local planning direction | Section of report addressing issue |
|---|---|
| 1. A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, the Considering flooding in land use planning guideline 2021, and any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council. | This flood assessment report and the flood impact assessment have been prepared to be consistent with the NSW Flood Prone Land Policy, the principles of the Flood Risk Management Manual 2023 (which replaced the Floodplain Development Manual 2005), the Considering flooding in land use planning guideline 2021, the Lake Illawarra Floodplain Risk Management Strategy 2012 and the Kully Bay Overland Flow Study 2019. |

| Local planning direction | | Section of report addressing issue |
|---|---|---|
| 2. A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones. | | No such rezoning is proposed. |
| 3. A planning proposal must not contain provisions that apply to the flood planning area which: | (a) permit development in floodway areas, | The planning proposal does not contain provisions which would permit significant development in floodway areas within the flood planning area. The reference design includes only small lobby areas at ground level in the overland flow path at the south-eastern margin of the site within the flood planning area. All habitable development is proposed for above the FPL and also clear of any overland flows. |
| | (b) permit development that will result in significant flood impacts to other properties, | The future development of the site will need to be designed to ensure there are no significant flood impacts on other properties. The Flood Impact Assessment produced by Water Technology indicates that in the 1% AEP overland flood the reference design would not increase flood levels on neighbouring properties (Figure 16). There would be a slight increase in flood levels in the Cowper Street (up to 0.1 m) and King Street (up to 0.12 m) road reserves.<br>In the overland PMF the reference design would produce very little afflux on neighbouring properties (Figure 17). Flood levels in a car park on the neighbouring property to the east would increase by up to 0.1 m while properties on the northern side of Cowper Street might also experience flood level increases. However, the afflux produced by the reference design is not significant and could easily be reduced by adjusting the building footprint during the development design stage.<br>The Flood Impact Assessment also demonstrates that development on the site would have negligible impact on flood levels in Lake Illawarra. |

| Local planning direction | | Section of report addressing issue |
|---|---|---|
| | (c) permit development for the purposes of residential accommodation in high hazard areas, | The overland flow path through the existing at-grade carpark at the south-eastern margin of the site is a high hazard area in the overland PMF but not in the 1% AEP flood. No habitable development is proposed below the PMF level in the high hazard area in the flood planning area. |
| | (d) permit a significant increase in the development and/or dwelling density of that land, | The planning proposal does not permit an increase in dwelling density below the FPL in the flood planning area. |
| | (e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, | The proposed development does not include any of the mentioned uses. The intended uses will be commercial and residential. Were such developments proposed then it would only be consistent with this direction if they were to take place outside of the flood planning area. |
| | (f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent, | The rezoning will require the proposed development to obtain development consent. |
| | (g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or | No increases in government flood mitigation spending would be required for the proposed development. |
| | (h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event. | No hazardous industries or storage establishments are proposed for the site. |
| 4. A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which: | | Wollongong LEP does not adopt the Special Flood Considerations Clause 5.22 so this provision does not apply to the planning proposal. |

| Local planning direction | Section of report addressing issue |
|---|---|
| (5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council. | The planning proposal does not propose to change the current flood planning area which is consistent with the principles of the Flood Risk Management Manual 2023 (which replaced the Floodplain Development Manual 2005) and Floodplain Risk Management Studies adopted by Wollongong Council. |

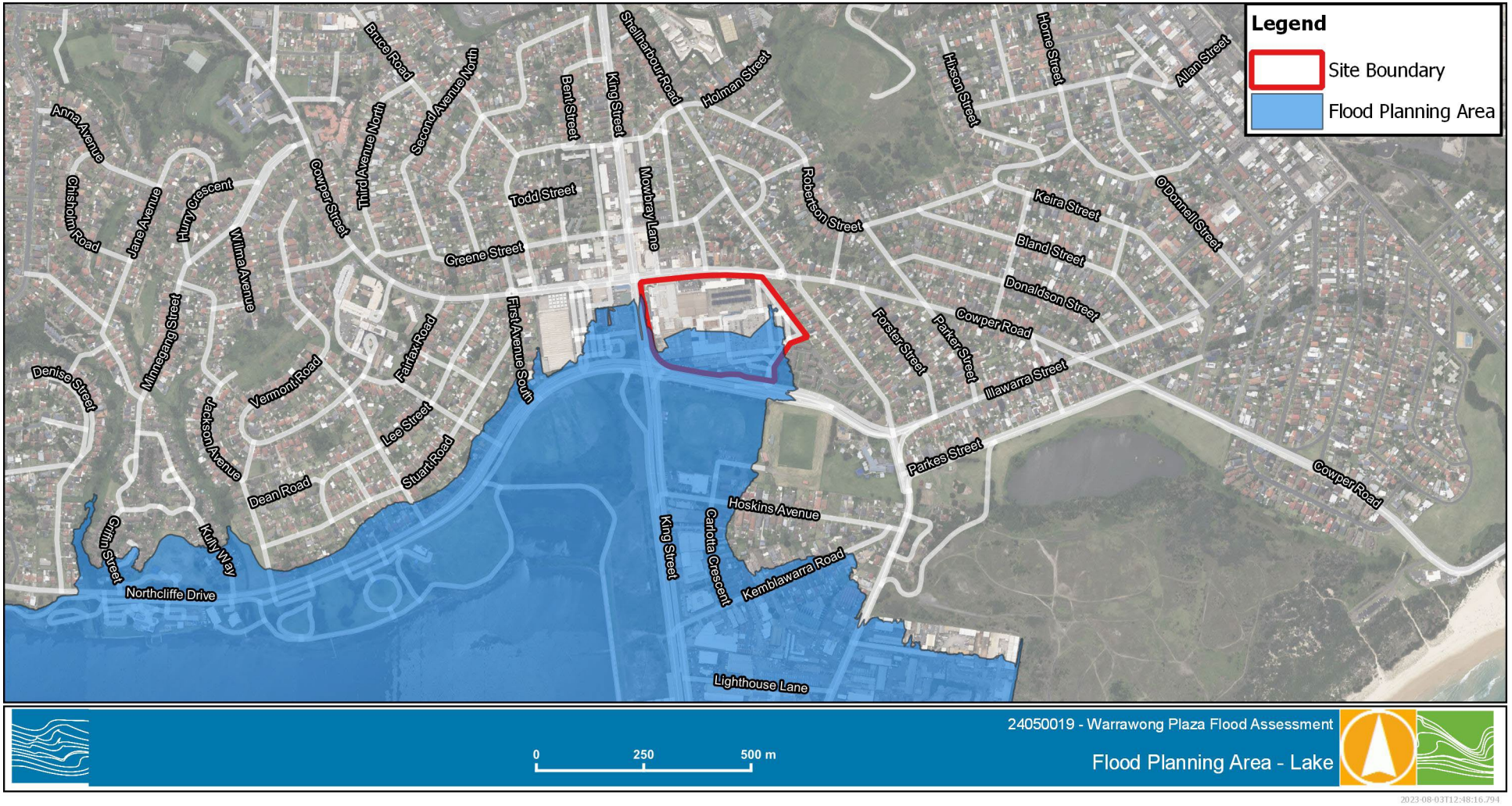


*Figure 13: Flood planning area in 2D based on lake flooding (1% AEP flood level in the year 2100 plus 0.5 m freeboard)*

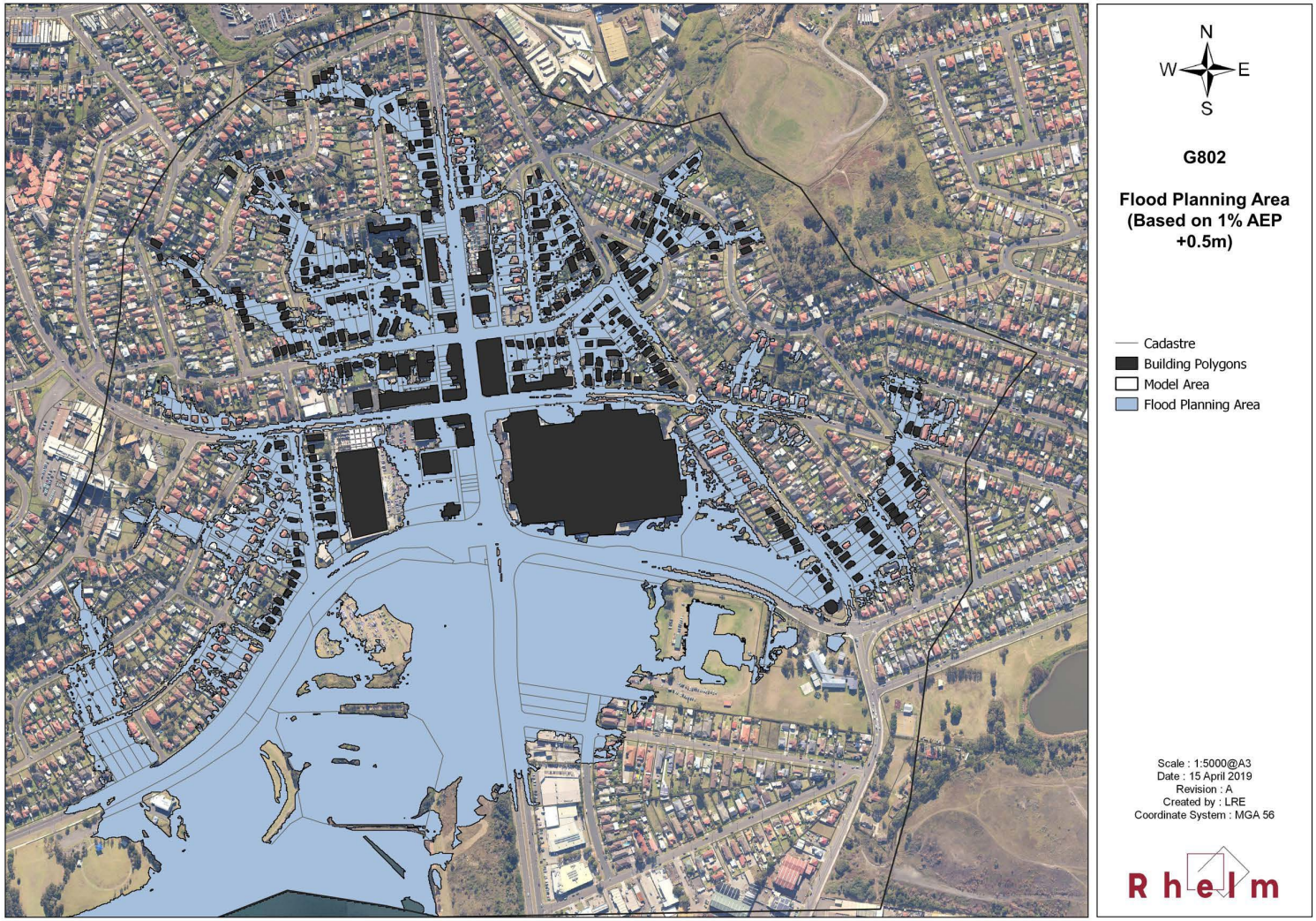


*Figure 14: Flood planning area in 2D based on overland flooding (current 1% AEP flood level plus 0.5 m freeboard) from Rhelm (2019)*

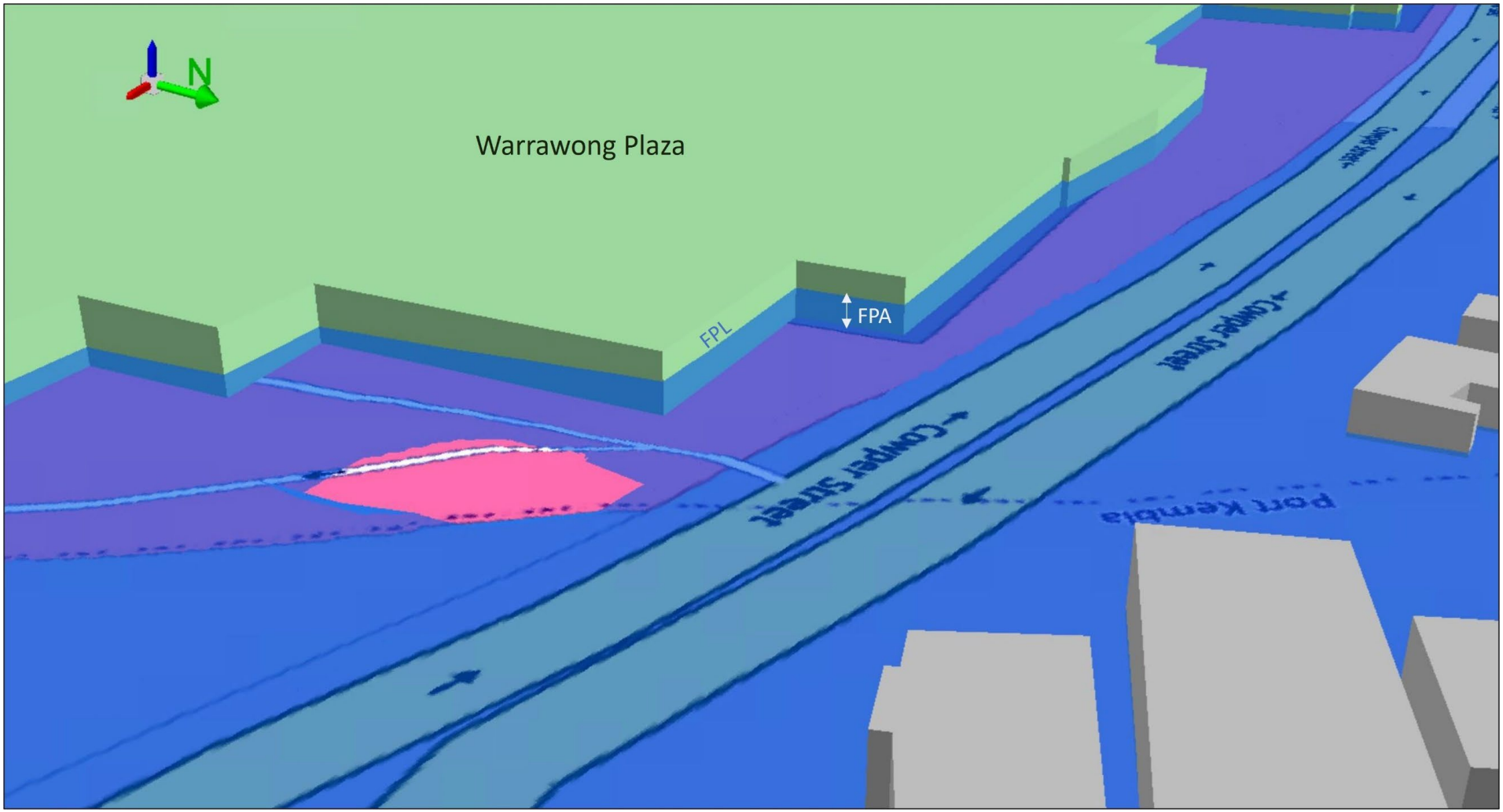


*Figure 15: 3D representation of the flood planning area (FPA) at the north-eastern corner of the existing building*


*Figure 16: Afflux in 1% AEP overland flood based on the reference design (Water Technology, 2023)*

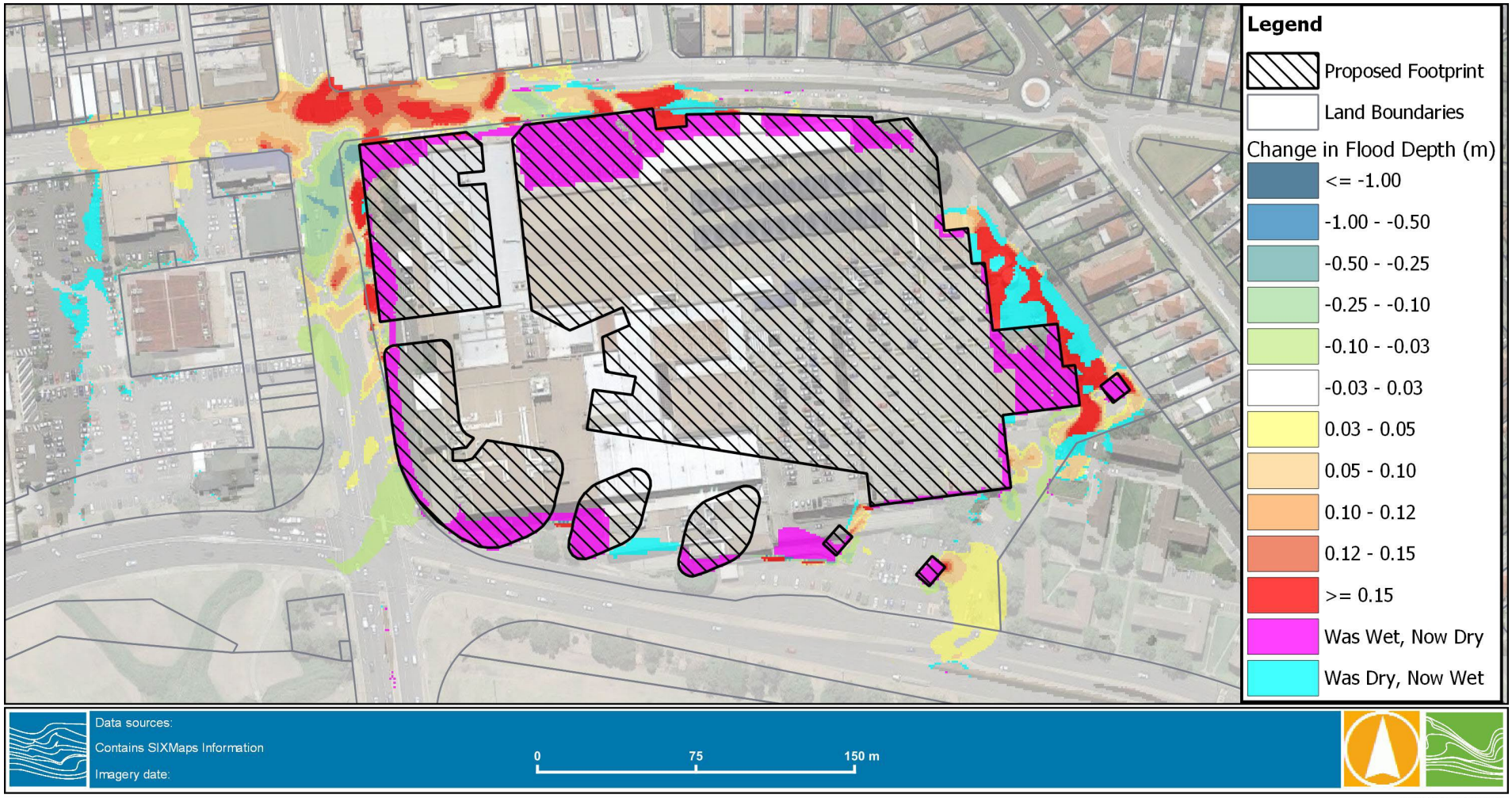


*Figure 17: Afflux in the overland PMF based on the reference design (Water Technology, 2023)*

## 3.2 Wollongong Local Environmental Plan 2009

In the Wollongong Local Environmental Plan 2009 (LEP 2009) the site is zoned as E2 – Commercial centre. The planning proposal proposes that the site be rezoned to MU1 Mixed Use to allow for both residential and commercial use and to better align with the proposed development of the site.

Clause 5.21 outlines the flood planning controls that apply for developments within the LGA. Table 5 below outlines the provisions made in Clauses 2 and 3 of Sections 5.21 of the LEP 2009, and how these clauses will need to be considered for the proposed development to comply with the LEP provisions.

**Table 5 Compliance table identifying flood-related issues in Wollongong LEP 2009**

| Flood planning controls | | Section of report addressing issue |
|---|---|---|
| 5.21.2. Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development | (a) is compatible with the flood function and behaviour on the land, and | Most of the site is classified as being within the Medium Flood Risk Precinct (FRP), in which commercial, industrial and residential development is permitted. The reference design has been developed with reference to the applicable development controls in the Wollongong Development Control Plan 2009, as discussed in Section 3.3 of this report. Future designs of the proposed development will need to similarly be designed to be compatible with the flood function and behaviour on the land.<br>The overland flow path along the south-eastern margin of the site is a floodway and therefore is in the High Flood Risk Precinct (FRP). All residential areas in Buildings F and G would be raised above the PMF level and therefore would not be located in the floodway or the High FRP. In addition, the raised residential areas would be above the FPL. |

| Flood planning controls | | Section of report addressing issue |
|---|---|---|
| | (b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and | The future development of the site will need to be designed to ensure there are no significant flood impacts on other properties. The Flood Impact Assessment produced by Water Technology indicates that in the 1% AEP overland flood the reference design would not increase flood levels on neighbouring properties (Figure 16). There would be a slight increase in flood levels in the Cowper Street (up to 0.1 m) and King Street (up to 0.12 m) road reserves.<br>In the overland PMF the reference design would produce very little afflux on neighbouring properties (Figure 17). Flood levels in a car park on the neighbouring property to the east would increase by up to 0.1 m while properties on the northern side of Cowper Street might also experience flood level increases. However, the afflux produced by the reference design is not significant and could easily be reduced by adjusting the building footprint during the development design stage.<br>The Flood Impact Assessment also demonstrates that development on the site would have negligible impact on flood levels in Lake Illawarra. |
| | (c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and | As discussed in Section 4 of this report, evacuation of the site is not required in response to lake flooding and would be inappropriate in response to overland flooding. The proposed flood emergency response strategy is for site occupants to shelter in place in response to overland flooding. No specific response strategy is required in response to lake flooding beyond closing exits onto Northcliffe Drive to prevent people from exiting the development onto a flooded road. Site occupants would be able to enter and exit the site as per usual via Cowper Street during lake flooding. Therefore, the proposed development will not adversely affect the safe occupation and efficient evacuation of the site, nor would it exceed the capacity of existing evacuation routes. |

| Flood planning controls | | Section of report addressing issue |
|---|---|---|
| | (d) incorporates appropriate measures to manage risk to life in the event of a flood, and | The development will need to adopt flood risk mitigation measures as discussed in Section 5 of this report. This includes having a Flood Emergency Response Strategy prepared for the site. |
| | (e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. | The current development has no existing ecological values and the site is not located adjacent to any waterways or waterbodies. Therefore, the proposed development will not destroy riparian vegetation or reduce the stability of the creek banks. |
| 5.21.3. In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters | (a) the impact of the development on projected changes to flood behaviour as a result of climate change, | The impact of the development on flood behaviour in climate change conditions will need to be considered for overland flooding. This should be undertaken during the development design phase for proposed development. The impacts for lake flooding are discussed in Section 5 of this report. |
| | (b) the intended design and scale of buildings resulting from the development, | The reference design includes commercial and residential uses at ground level. Residential units will be in use at all times but will need to be at or above the FPL, which is above the PMF level across most of the site. |
| | (c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood, | The development will need to adopt measures to manage risk to life as discussed in Section 5 of this report. This includes having a Flood Emergency Response Strategy prepared for the site. |
| | (d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion | It will not be possible to modify, relocate or remove the proposed buildings as a response measure to flooding. The site is not subject to coastal erosion. |

## 3.3 Wollongong Development Control Plan 2009

Chapter E13 of the Wollongong Development Control Plan 2009 (DCP 2009) uses land use categories and flood risk precincts to apply development controls in flood prone land.

The proposed development would be mixed use of commercial and residential, which Chapter E13, Appendix A of DCP 2009 classifies as Land Use "Commercial or Industrial".

The development controls applicable to development on flood prone land are identified in Chapter E13 Appendix C Schedules 1 – 10. The sections of the site located within the Lake Illawarra floodplain (i.e. within the lake PMF extent, Figure 12) are subject to the controls set out in Schedule 9 – Lake Illawarra Floodplain, while the parts of the site impacted by overland flooding are subject to development controls identified in Schedule 1- All other floodplains.

Schedule 9 specifies that all development in the lake floodplain other than concessional development must use the 1% AEP including High Sea Level Rise (0.91 m – 2100). Schedule 10 does not include a requirement for considering climate change for the overland floodplain.

Figure 18 shows Council's mapping of the flood risk precincts (FRPs) on site. The site is mapped as mainly being within the Medium FRP as per the Constraints and Planning DCPs layers in Council's online mapping portal. Small fragments of the site are within the Low FRP according to this mapping, while the northern, eastern and western boundaries are outside the mapped FRPs.

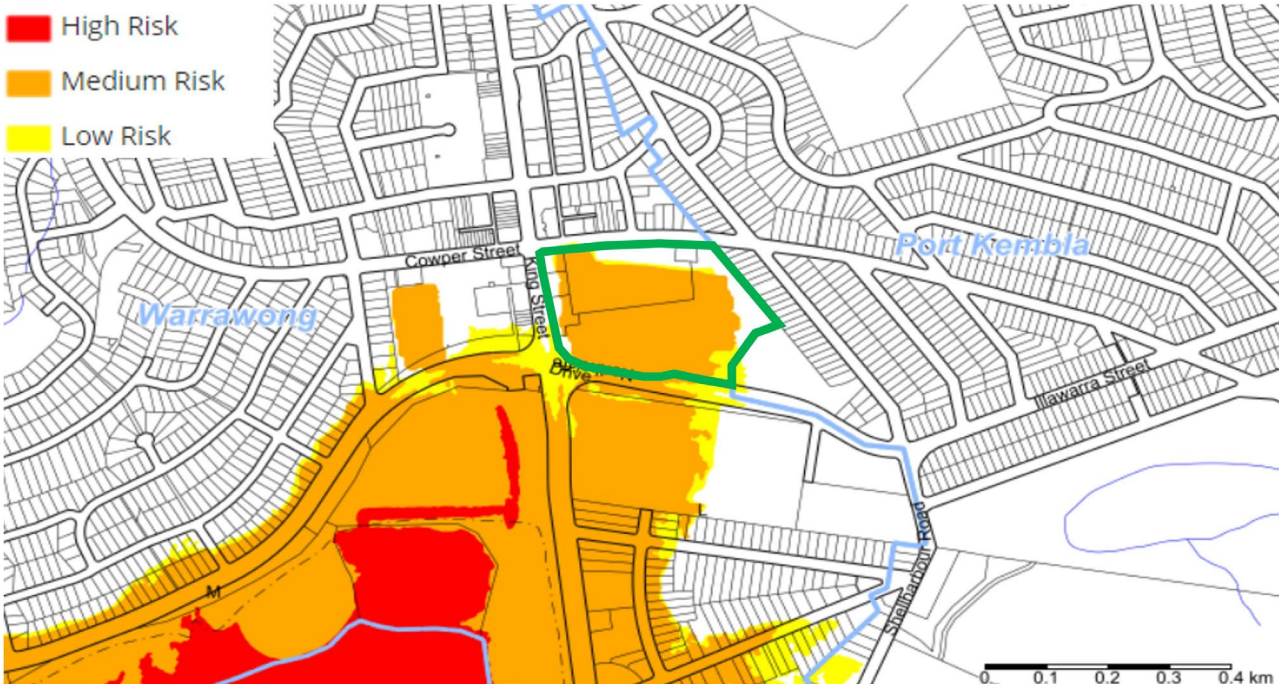


*Figure 18: Flood Risk Precinct mapping by Wollongong Council*

The DCP 2009 defines the Medium FRP as including areas below the 1% AEP flood level plus 0.5 m that would have H3 or lower hydraulic hazard during a 1% AEP flood, are not a floodway and are not within 10 m of the top of a watercourse bank. On the other hand, the Low FRP is all areas within the floodplain (i.e. within the PMF extent) that are not within the Medium or High FRPs. If these definitions are applied to the Lake Illawarra floodplain:

- The site is located on the edge of the lake and is not within a floodway, which the *Flood Risk Management Manual* (DPE, 2023) defines as

  > *Areas of the floodplain which generally convey a significant discharge of water during floods and are sensitive to changes that impact flow conveyance. They often align with naturally defined channels or form elsewhere in the floodplain.*

- The site is not within 10 m from the top of the lake bank
- In the 1% AEP lake flood in 2100 the maximum hydraulic hazard on site is H3

Therefore, the Medium FRP should be the part of the site below the 1% AEP flood level for the year 2100 plus 0.5 m. The Low FRP on site would be the area between the PMF extent and the 1% AEP flood extent for the year 2100 plus 0.5 m. However, the 1% AEP (2100) flood level is 3.04 while the PMF level is 3.24 m AHD, which means the PMF is below the 1% AEP (2100) flood level plus 0.5 m (3.54 m AHD). Therefore, no part of the site should be within the Low FRP based on lake flooding.

The *Lake Illawarra Floodplain Risk Management Study* (Cardno, 2012) maps the 1% AEP lake flood in the year 2100 as extending almost to the northern margin of the site. However, when lake flood levels from the Cardno study are mapped using a 1 m resolution digital elevation model from Spatial Services produced in 2021 the 1% AEP event in year 2100 only impacts the southern section of the site. Therefore, Council's FRP boundaries, which are based on the 2012 mapping of the flood extents (Figure 19), do not precisely fit with the DCP's definitions of the FRPs. Figure 20 shows the FRPs that would apply to the site based on the DCP 2009 definitions of the FRPs. The southern section of the site would belong within the Medium FRP.

If the DCP 2009 definitions for the FRPs are applied to the overland floodplain:

- The overland flow path through the on-grade carpark along the site's south-eastern border with the neighbouring property owned by the NSW government may be considered a floodway. Therefore, this flow path would belong in the High FRP
- As above, the site is not within 10 m of the top of a watercourse bank
- In the 1% AEP overland flood the maximum hydraulic hazard on site is H3

Therefore, all areas on site affected by the 1% AEP overland flow (Figure 7) would be classified as within the Medium FRP. This includes to the south of the existing building, and several locations around the perimeter of the site. The flow path to the south-east would be in the High FRP. The Low FRP would cover almost all of the remainder of the site that is not within the footprint of the existing building.

For the purposes of this analysis, we have conservatively assumed that the development controls for the High FRP apply to the south-eastern overland flow path, while development controls for the Medium FRP apply to the remainder of the site.

The prescribed controls in Schedules 9 and 10 are identical apart from a difference in controls for flood affectation (highlighted in Table 6 and Table 7) and the absence of a clause about sea level rise in Schedule 10 (relating to the overland floodplain).

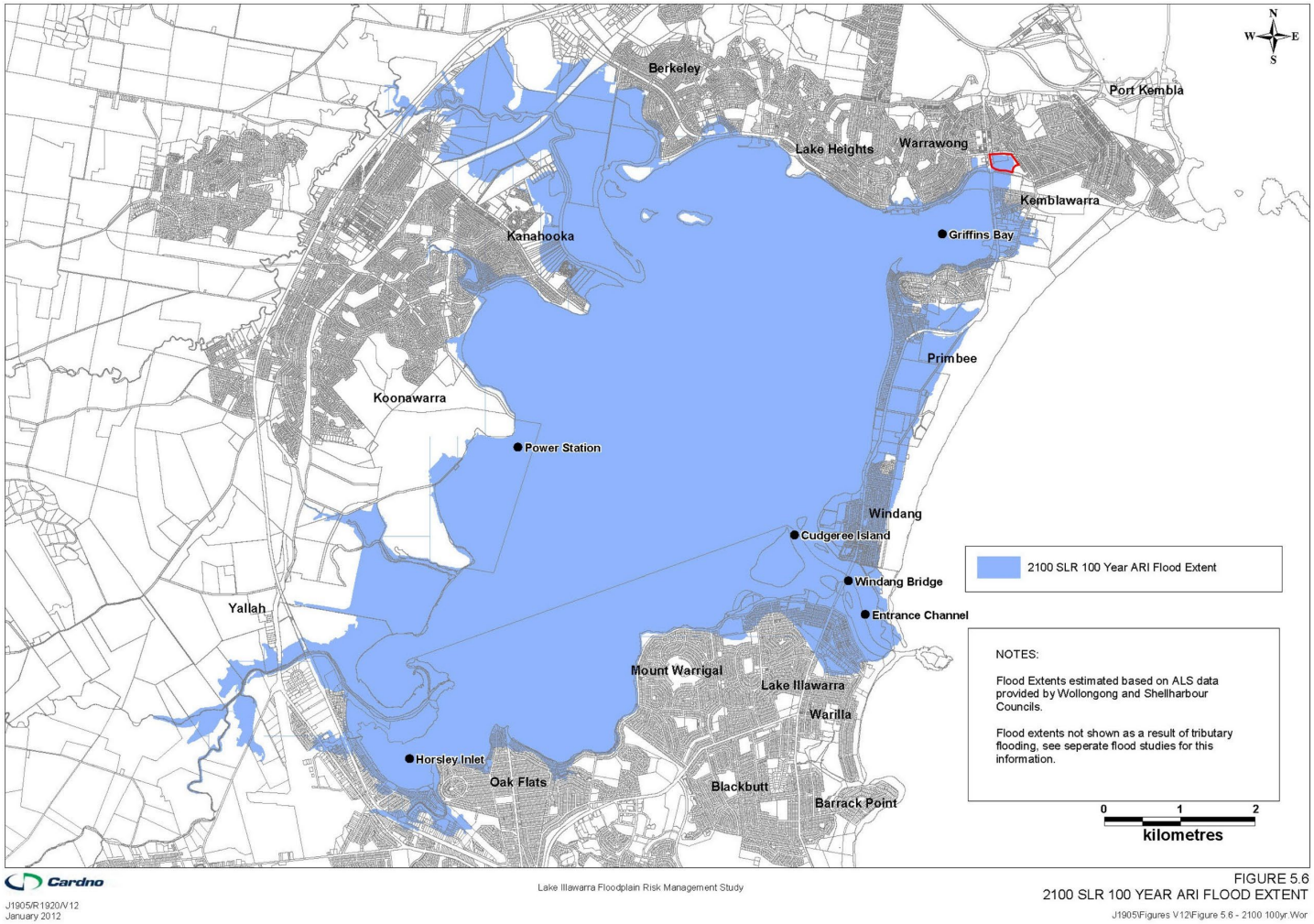


*Figure 19: Flood extent of the lake 1% AEP event in the year 2100 (Cardno, 2012)*

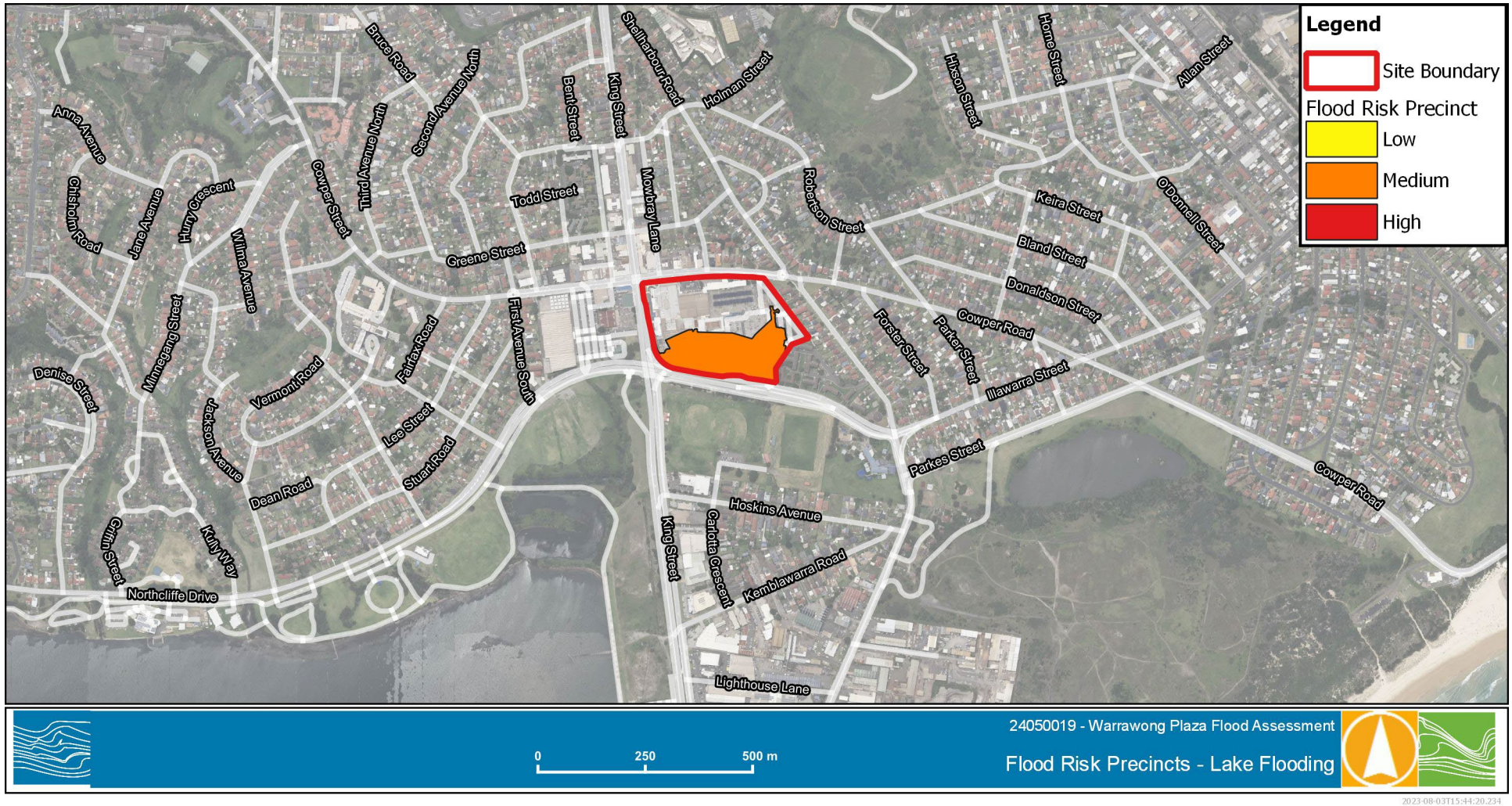


*Figure 20: Flood Risk Precincts (for the subject site only) based on FRP definitions from the DCP 2009, 2021 topography and lake flood levels*

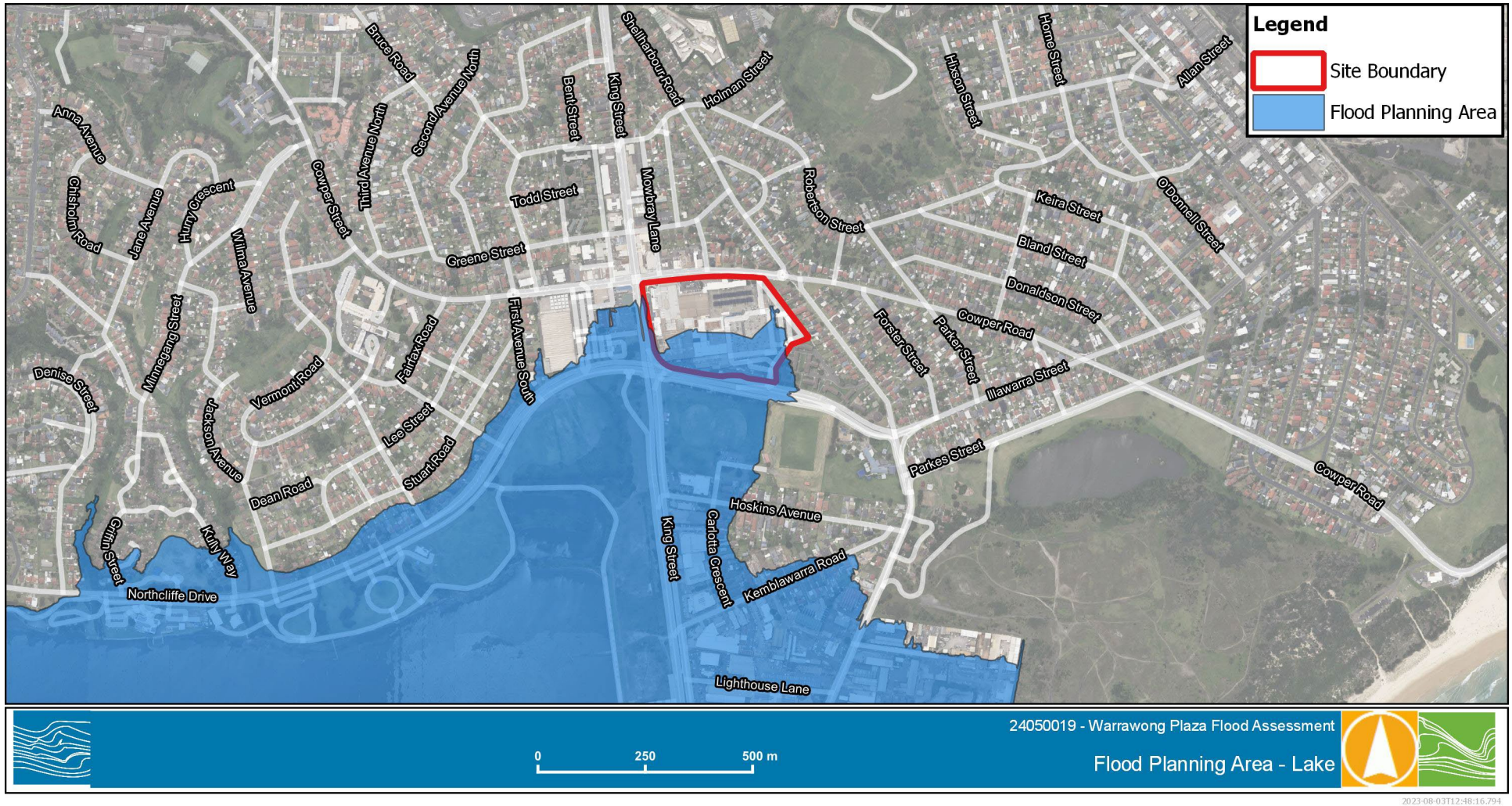


*Figure 21: Flood planning area. Area based on the contour of the 1% AEP flood level in the year 2100 (3.04 m AHD) plus 0.5 m freeboard (3.54 m AHD)*

### Permitted Development

Both Schedule 9 (Table 6) and Schedule 10 (Table 7) specify that commercial and industrial (as well as residential) development is not permitted within the High FRP. Therefore, mixed-use development would not be permitted within the overland flow path that currently flows through the at-grade carpark at the south-eastern boundary of the site.

*Table 6: Prescribed controls for Lake Illawarra floodplain. Numbers refer to controls in Wollongong DCP 2009, Chapter E13, Appendix C, Schedule 9*

| | Flood Risk Precincts (FRP's) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Flood Risk | | | | | | | | Medium Flood Risk | | | | | | | High Flood Risk (& Interim Riverine Corridor) | | | | | |
| Planning Consideration | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development |
| Floor Level | | 3 | | | | | | | | | | 2,6 or 7 | 2 or 5 | 2 | 1 | 2,4 6 | | | | | | | 1 | 2,4 6 |
| Building Components | | 2 | | 2 | | | | | | | | 2 | 1 | 2 | 1 | 1 | | | | | | | 1 | 1 |
| Structural Soundness | | 3 | | 3 | | 3 | | | | | | 3 | 2 | 3 | 2 | 2 | | | | | | | 1 | 1 |
| Flood Affectation | | 2,3 | | | 2,3 | 2,3 | | | | | | 2,3 | 2,3 | 2,3 | 2,3 | 2 | | | | | | | 1,3 | 1,3 |
| Evacuation | | 2,4 | | 3,4 | 4 | 3,4 | | | | | | 3,4 | 1,4 | 3,4 | 3,4 | | | | | | | | 1 | |
| Management & Design | | 4,5 | | | | | | | | | | | 2,3 5 | 2,3 5 | 2,3 5 | 2,3 5 | | | | | | | 2,3 5 | 2,3 5 |

Not Relevant | Unsuitable Land Use | Concessional development to use the 1% AEP including Medium Sea Level Rise (0.4m - 2050), all other development to use the 1% AEP including High Sea Level Rise (0.91m - 2100).

Commercial and industrial development is permitted in the Medium FRP for both floodplains, subject to development controls.

In the reference design Buildings F and G are raised on columns so that all residential areas are above both the FPL and the PMF level. Therefore, only the lobby areas on the ground floor would be located within the flow path.

### Floor Level

*Control 2*

All habitable floor levels are to be equal to or greater than the 1% AEP flood level plus 0.5 m freeboard. In the Lake Illawarra floodplain (Table 6) the 1% AEP flood level referred to is the 1% AEP lake flood in the year 2100, while in the overland floodplain (Table 7) the present-day 1% AEP flood level is referred to. The minimum floor level for habitable spaces are displayed for various locations around the site in Table 8.

When comparing these flood levels, the post-development overland flood level is the higher of the 2 across the site (Table 8). Therefore, the overland flood levels will be used to set the flood planning level (FPL) and minimum floor levels for each of these locations. The northeastern corner is the highest point of the site with an overland 1% AEP flood level of 8.84 m AHD (Table 8), which would have a FPL of 9.34 m AHD for this corner of the development. The southeastern corner of the site would have a 1% AEP flood level of 3.28 m AHD, which would result in a FPL of 3.78 m AHD for development in this vicinity. At the north-western corner of the site (near Location A) the minimum habitable floor level would be 5.22 m AHD, while at the south-western corner (near Location C) it would be 3.77 m AHD (Table 8).

*Table 7: Prescribed controls for all other floodplains. Numbers refer to controls in Wollongong DCP 2009, Chapter E13, Appendix C, Schedule 10*

| | Flood Risk Precincts (FRP's) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Flood Risk | | | | | | | | Medium Flood Risk | | | | | | | | High Flood Risk (& Interim Riverine Corridor) | | | | | | | |
| **Planning Consideration** | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development | Essential Community Facilities | Critical Utilities | Subdivision | Residential | Commercial & Industrial | Tourist Related Development | Recreation & Non-Urban | Concessional Development |
| Floor Level | | 3 | | | | | | | | | | 2, 7 | 2 or 5 | 2 | 1 | 2,4 6 | | | | | | | 1 | 2,4 6 |
| Building Components | | 2 | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | | | | | | | 1 | 1 |
| Structural Soundness | | 3 | | 2 | | 3 | | | | | | 2 | 2 | 3 | 2 | 2 | | | | | | | 1 | 1 |
| Flood Affectation | | 2 | 2 | | 2 | 2 | | | | | 1 | 1 or 2 | 1 | 1 | 1 | 2 | | | | | | | 1 | 1 |
| Evacuation | | 2, 4 | 5 | 3, 4 | 4 | 3, 4 | | | | | 5 | 3,4 | 1,4 | 3,4 | 1 | | | | | | | | 1 | |
| Management & Design | | 4, 5 | 1 | | | | | | | | 1 | | 2,3 5 | 2,3 5 | 2,3 5 | 2,3 5 | | | | | | | 2,3 5 | 2,3 5 |
| Not Relevant | | Unsuitable Land Use | | | | | | | | | | | | | | | | | | | | | | |

To strictly comply with Control 2, the ground floor level would need to be at or above 9.34 m AHD in the north-eastern corner of the site, grading down to 3.77 m AHD in the south-western corner. In the reference design most buildings have a ground floor level of 6.0 m AHD (Table 1), which is the existing ground floor level. Across the site, the ground floor would be at or above the FPL in all locations except in the north-eastern section. In this area the large retail areas would have a ground floor level at 6 m AHD, below the FPL, but would actually be below the ground level in this location and not have any openings on the northeastern façade which would be below the FPL. The Level 1 floor level would be at 11.6 m AHD which would be well above the FPL and could have openings to Cowper St if required. The food and beverage outlet and the corridors off Cowper Street leading to residential lobbies will rise internally from the existing Cowper Street footpath level to the FPL.

*Table 8: Flood levels, minimum floor levels/FPLs and basement car parking controls across the site.*

| Location (refer to Table 2) | 1% AEP Flood Level in 2100 (lake) | Post-Development 1% AEP Flood Level (overland) | Minimum Floor Level: habitable; and FPL | Basement car park minimum levels for vehicular access, doors and ventilation points |
|---|---|---|---|---|
| A. Intersection of King Street and Cowper Street | Not flooded | 4.72 m AHD | 5.22 m AHD | 4.92 m AHD |
| B. Intersection of Taurus Avenue and Cowper Street | Not flooded | 6.23 m AHD | 6.73 m AHD | 6.43 m AHD |
| C. Intersection of Northcliffe Drive and King Street | 3.04 m AHD | 3.27 m AHD | 3.77 m AHD | 3.47 m AHD |
| D. Northcliffe Drive (east of King Street) | 3.04 m AHD | 3.13 m AHD | 3.63 m AHD | 3.33 m AHD |
| Northeast corner of the site | Not flooded | 8.84 m AHD | 9.34 m AHD | 9.04 m AHD |
| Southeast corner of the site | 3.04 m AHD | 3.28m AHD | 3.78 m AHD | 3.48 m AHD |
| Eastern corner of the site | Not flooded | 5.20 m AHD | 5.70 m AHD | 5.40 m AHD |

*Control 5*

Floor levels of shops are to be as close to the FPL (the applicable 1% AEP flood level for the floodplain plus 0.5 m freeboard) as practical. The FPLs for various locations around the site are shown in the fourth column of Table 8. Shops that are below the FPL (i.e., shops in the north-eastern section of the site) must have at least 30% of the total floor area above the FPL. This could be achieved in future development by building the new premises with part of the ground floor at street level with internal stairs and ramps up to the FPL. In the reference design the food and beverage outlet and the corridors leading to residential lobbies in the north-eastern corner of the site will have floor levels that ramp up internally from the existing Cowper Street footpath level to the FPL.

Alternatively, the DCP 2009 allows more than 30% of the premises to be below the FPL if the area below the FPL is flood proofed. In order to achieve flood proofing via passive flood protection measures, the large retail areas in the north-eastern section of the future development will need to be designed without any points of access (e.g., entrances, fire exits, openable windows, vents) below the FPL along Cowper Street. The reference design does not include any external access points to the large retail areas, ALDI and Coles along their northern margins.

### Building Components and Method

*Control 1*

All building components below the FPL will need to be of flood compatible materials. That is, all building components below the FPLs specified in Table 8 must be constructed of flood compatible materials. Concrete, masonry, metal, glass and tiles would meet this requirement. Materials made from wood, materials that corrode and fragile or brittle materials are not included.

The full list of flood compatible building components specified in the DCP 2009 is included in Appendix A.

All electrical wiring, power outlets, switches etc should as far as possible be located above the FPL, and if installed below the FPL needs to be suitable for continuous submergence in water. Safety switches must be installed. The main power service must be located above the relevant FPL and should be easy to disconnect.

Further detail regarding controls for electrical and mechanical equipment is available in Appendix A of this report.

### Structural Soundness

*Control 1*

An engineer's report will be needed to show that any structure can withstand the forces of floodwater, debris and buoyancy up to the FPL. The type of construction proposed should easily meet this requirement.

### Flood Affectation

*Schedule 9 – Control 2*

For the parts of the development within the extent of the lake PMF, the impact of the development on flooding elsewhere will need to be considered. The potential impacts of the development on lake flooding are minimal as discussed in the Water Technology Flood Impact Assessment report.

*Schedule 9 – Control 3*

Filling is not permitted within active flow areas in the stream network feeding Lake Illawarra. Fill therefore would not be permitted in the overland flow path along the south-eastern boundary of the site. The reference design does not include fill in this overland flow path.

However, filling within the footprint of the existing building would be permitted, as would filling outside of the existing building footprint if it could be demonstrated that there would be no loss of flood storage in lake floods up to and including the PMF.

*Schedule 10 – Control 1*

For the parts of the site impacted by overland flooding, an engineer's report will be required to certify that the development does not worsen flood affectation elsewhere.

The Flood Impact Assessment produced by Water Technology indicates that in the 1% AEP overland flood the reference design would not increase flood levels on neighbouring properties (Figure 16). There would be a slight increase in flood levels in the Cowper Street (up to 0.1 m) and King Street (up to 0.12 m) road reserves.

In the overland PMF the reference design would produce very little afflux on neighbouring properties (Figure 17). Flood levels in a car park on the neighbouring property to the east would increase by up to 0.1 m while properties on the northern side of Cowper Street might also experience flood level increases. However, the afflux produced by the reference design is not significant and could easily be reduced by adjusting the building footprint during the development design stage. Any alterations to the design would need to be incorporated into updated flood modelling informing an updated engineer's report.

Table 9 provides permissible impacts for various development types for flood events up to the 1% AEP flood. Future development of the site will need to take these into consideration when assessing the impact of the proposed development on flood behaviour.

*Table 9: Permissible flood impacts (Chapter E13 Table 2 of the DCP 2009)*

| Development/ Project Type | Allowable Impact (mm) | | | | | |
|---|---|---|---|---|---|---|
| | Critical Uses and Facilities | Sensitive Uses and Facilities | Residential | Commercial or Industrial | Tourist Related Development | Recreation or Non-urban Uses |
| Individual Property | 10 | 10 | 20 | 20 | 20 | 20 |
| Multi Lot Subdivision | 10 | 10 | 20 | 50 | 50 | 50 |
| Government Infrastructure Projects | 20 | 20 | 100 | 150 | 150 | 150 |

New development must not increase the frequency of over floor flooding for residential, commercial or industrial buildings in a 20% AEP, 1% AEP or PMF event. Additionally, new development must not cause additional lots to be impacted by the 1% AEP or PMF event. It should be simple to adjust the ground floor plans and ground levels of the reference design to minimise the impacts of the development on flood behaviour.

The DCP 2009 also specifies that flood impacts of a proposed development in the PMF will be assessed on merit taking into consideration:

- Impacts to evacuation routes and onsite refuge service levels
- Additional flood affected allotments
- Flood warning times
- Changes to above yard and above floor flooding

These impacts will also need to be considered once post-development flood modelling has been undertaken for the final design for future development on the site. However, the modelling post-development flood modelling undertaken based on the reference design indicates that flooding of additional allotments can be minimised, while flood warning times are unlikely to be significantly affected given how little warning time there is already available for overland flooding. The reference design will be able to be adjusted to minimise changes to above yard or above floor flooding on neighbouring properties and to flood levels on Cowper Street.The proposed internal link route from Cowper St to Northcliffe Drive may be a good route to use to direct overland flows through the site and reduce the impact on flood behaviour. This would ensure that water does not flow through the new buildings and is likely to prevent the development from making flooding worse for the premises across the road in Cowper Street. Finished ground levels along this route would need to be adjusted in order to allow overland flow through the site.

### Evacuation

*Schedule 9 - Control 1*

Reliable access or refuge during a 1% AEP flood will be required for the part of the site within the lake floodplain. During a lake 1% AEP flood in the year 2100 both pedestrian and vehicular access to the site would be possible via Cowper Street, which would not be impacted by lake flooding. Further, it would be possible for site occupants to shelter within the proposed buildings if necessary. This is discussed further in Section 5 of this report.

The proposed development should not have any difficulty complying with this development control.

*Schedule 10 – Control 1*

For overlanding flooding, reliable access for pedestrians is required during a 1% AEP event. In the 1% AEP overland flood, there would be a reliable pedestrian access route from the north-eastern section of the site east along Cowper Street and north onto Shellharbour Road, past Montgomery Avenue. This route would be flooded by H1 floodwaters in sections (Figure 10), which generally do not cause stability issues for pedestrians and vehicles. Pedestrian access to the site in the 1% AEP overland flood is therefore possible although the short duration of overland flooding should mean that access could be delayed until there is no flooding on this route.

*Schedules 9 and 10 – Control 4*

The proposed development will need to be consistent with the Illawarra Flood Emergency Sub Plan (NSW SES, 2022). The Flood Emergency Response Strategy prepared for the site by Water Technology (Section 5) is consistent with this plan. Any Flood Emergency Response Plan prepared for future development will also need to comply with the NSW SES Sub Plan.

### Management and Design

*Control 2*

A Site Emergency Response Flood Plan will be required if any floor levels are below the FPL. Given that basement parking is proposed, which is below the FPL, a plan will be required. The Flood Emergency Response Strategy (Section 5) demonstrates that flood emergency response can be managed at the site but a Site Emergency Response Flood Plan (i.e., a Flood Emergency Response Plan) which addresses design specifics will be needed to accompany the development application.

*Control 3*

It must be demonstrated that there is space in the proposed development to store goods above the 1% AEP flood level plus 0.5m freeboard (i.e. above the FPL). This control should be simple to comply with.

*Control 5*

No materials that could cause pollution or otherwise be hazardous during a flood are to be stored outside the building below the FPL. This would include materials or items that could be hazardous if carried away by floodwaters, or chemicals and other substances that may pollute the water and environment. Waste collection facilities therefore may not be able to be located outside below the FPL.

### Car Parking

*Car Parking*

Flood related requirements and prescriptive standards for parking are outlined in Section 6.5 of Chapter 13E of the DCP 2009. The proposed development does not include plans for open car parking or garages. Therefore, development controls 6.5.3 a, b and c would not apply to the development as currently proposed. Should it be decided that the development should include open car parking control 6.5.3a would need to be complied with.

*Control 6.5.3a*

> *a. Open car parking – open car parking subject to inundation should be designed giving regard to vehicle stability in terms of depths and velocity during inundation by floodwaters, ensuring that each car parking space is within hydraulic hazard category H1 in Figure 3 during a 1 % AEP flood.*

This would suggest that open car parking would be permitted in most areas around the western and north-western margins of the site.

*Control 6.5.3d*

> *d. Basement car parks are to be protected from inundation during a 1 % AEP flood, ensuring all vehicular access, doors and ventilation points are a minimum of 0.2 metres above the 1 % AEP flood level.*

The relevant levels for this are included in Table 8. They have been calculated assuming that the 1% AEP overland flood is the relevant flood level for parts of the site in the overland floodplain, and the 1% AEP lake flood in the year 2100 is the relevant flood level for parts of the site within the lake floodplain.

Based on flood levels in post-development conditions, basement access from Cowper Street in the vicinity of Taurus Avenue would need to be protected up to 6.43 m AHD, while access via the driveway off Northcliffe Drive would need to be protected up to 3.33 m AHD. This basement protection is achieved by the basement entry ramp crests in the reference design.

Council has indicated that it will not support active measures (e.g., flood gates across driveways, flood doors across stairwell or liftwell openings) given the redevelopment proposed. Basement protection from floodwaters must therefore be achieved by passive measures (e.g., floor levels, ramp crests).

### Fencing

If any fencing were to be constructed on the outside of the proposed development it must adhere to the flood related requirements and prescriptive standards outlined in Section 6.6 Chapter E13 of the DCP.

*Control 6.6.3a*

> *a. Fencing within a floodway or High FRP will not be permissible except for security/ permeable/ open type/safety fences of a type approved by Council.*

New fencing would not be permitted within the overland flow path through the existing on-grade carpark at the south-eastern margin of the site, unless it was security/ permeable/ open type/ safety fencing.

*Control 6.6.3b*

> *b. Council requires a Development Application for all new solid (non-porous) and continuous fences above 0.6m high, in the High and Medium FRP's.*

All solid and continuous fences above 0.6 m high proposed for the site would require development approval.

*Control 6.6.3c*

The applicant must show that the fence will not impede flow of flood water, and it must be of pool fence type, bricks or other masonry, or as prescribed by Council.

### Filling of the Floodplain

*Control 1*

In general, filling of the floodplain is not permitted. However, if the catchment has a flood risk management plan (FRMP) in place which allows it, or a report by a suitably qualified engineer as part of a flood study stating that filling will not increase flood affectation elsewhere, taking into account cumulative impacts, filling can be permitted.

In the reference design fill up to 6 m AHD is proposed along much of the southern margin of the site. Post-development modelling of overland flows indicates that this would not significantly increase flood affectation elsewhere in the 1% AEP event (Figure 16).

*Control 2*

If fill is proposed an analysis must be undertaken taking into consideration the cumulative impacts of developments in the same floodplain. It must consider the effect of similar filling of developable sites in the area on flood levels.

Any future development proposing fill will need to consider the cumulative impact of fill on flood behaviour.

*Control 3*

The analysis described in Control 2 would need to form part of a flood study.

*Control 4*

Filling may be permitted if it is offset by cut in an adjacent area with similar flood function that is lower in the floodplain so there is no net increase of fill in the floodplain. Cut and fill drawings and volume calculations would need to be provided.

The fill indicated in the reference design is located near the southern margin of the site and it would therefore be difficult to offset with cut lower in the floodplain. Cut and fill plans will need to be adjusted for future development to ensure that fill is appropriately offset by cut.

*Control 5*

Filling above the 1% AEP flood level may be permitted, but it would require demonstrating that there would be no adverse impacts on flood behaviour in events larger than the 1% AEP flood.

The reference design includes fill above the 1% AEP lake and overland flood levels. In the overland PMF the reference design would produce very little afflux on neighbouring properties (Figure 17). Flood levels in a car park on the neighbouring property to the east would increase by up to 0.1 m while properties on the northern side of Cowper Street might also experience flood level increases. However, the afflux produced by the reference design is not significant and could easily be reduced by adjusting the building footprint during the design stage. Any alterations to the design would need to be incorporated into updated flood modelling to demonstrate the impact on flood behaviour.

#### Other Considerations

The proposal should not have a significant direct or cumulative detrimental impact on the natural environment, including the water quality, riparian vegetation, estuaries, wetlands and ecosystems. Some of the controls of the DCP 2009 outlined above are designed to safeguard this. Additional safeguards must be implemented to ensure the detrimental impacts are avoided, mitigated and minimised as far as possible.

## 3.4 Constraints on Basement Carpark

The *Kully Bay Overland Flow Study* (Rhelm, 2019) shows that a culvert runs through the centre of the site in a north-south alignment, in addition to a second culvert and pipes in the south-western corner of the site (Figure 22). The dimensions and depths of these culverts will need to be confirmed at a later stage of development. It is likely the north-south culvert will intersect the proposed basement levels. This means that on at least one basement level it may not be possible to have a fully connected car park.


Figure 22: Drainage network incorporated into TUFLOW model for the Kelly Bay overland Flow Study (Rhelm, 2019)

# 4 EVACUATION CAPABILITY

The first step to developing a flood emergency response strategy is to assess whether a safe evacuation of the site can be obtained under all circumstances. Namely, evacuation to a location outside the floodplain must be possible in the worst-case scenario of a flood rising as fast as the PMF, when the site is at full capacity. If evacuation is possible in the worst-case scenario, it is possible in all scenarios. This is the reason why the PMF is adopted as the industry-standard event when considering risk to life and flood emergency response.

There are 3 water level gauges located in Lake Illawarra, which are owned by Manly Hydraulics Laboratory and were installed for floodplain management purposes. Cardno (2012) states that a warning time of 12 hours is likely to be available for lake flooding before flooding rises to a level of concern. On the other hand, overland flooding has a fast rate of rise and can occur with little or no warning.

## 4.1 Evacuation

During lake flooding the site will have at least 12 hours of lead warning time before the southern margin of the site is impacted. However, Cowper Street is unaffected by lake flooding in all events up to the PMF. Therefore, the vehicular access points to the basement and to the eastern driveway located along Cowper Street ensure that access to the site is maintained during lake flooding. As flood-free vehicular access to the basement carpark is available and all habitable floor levels are above the lake PMF (3.24 m AHD), there would be no need to evacuate the site in response to lake flooding. The site can operate almost as per normal.

However, during overland flooding the local roads adjoining the site can be flooded within 30 minutes of the start of the rainfall event and can occur with little or no warning. The NSWSES Timeline Evacuation Model (Opper et al., 2009) requires that the calculated evacuation time includes:

- One hour of “warning acceptance factor” (time required for residents to make a decision to evacuate after an evacuation order has been communicated to them)
- One hour of “warning lag factor” (time required for site occupants to gather their belongings and leave)
- A standard vehicular evacuation rate of 600 cars per lane per hour
- One hour of Traffic Safety Factor (to account for delays due to road congestion and accidents).

The warning acceptance factor, warning lag factor and traffic safety factor tally to 3 hours, which significantly exceeds the 0 – 30 minutes of lead warning time that may be available for overland flooding. The time required for vehicles to actually leave the site should be added to the 3 hours to find the total time required to evacuate the site by vehicle.

Pedestrians evacuating the site would need to head east on Cowper Street and then north onto Shellharbour Road, walking 400 m to reach land beyond the reach of the overland PMF. At a very slow walking pace of 2 km/hr it would take 12 minutes to walk this distance. However, the warning acceptance factor and warning lag factor also apply, meaning that it would require 2 hours and 12 minutes to evacuate the site on foot. This is again in excess of the time that would be available ahead of overland flooding.

**As shown above, there is insufficient time to evacuate the site before local roads are cut by overland flooding**, both in existing and post-development conditions.

## 4.2 Shelter in Place

Shelter in Place (SIP) is a flood emergency response strategy that may be adopted when there is an appropriate refuge on site above the PMF level. The Wollongong DCP permits sheltering in place above the 1% AEP flood level.

The NSW Department of Planning and Environment (DPE) has released a draft shelter-in-place guideline (2022), which suggests that SIP can be the most appropriate flood emergency response strategy when off-site evacuation cannot be achieved and where flooding can occur with little notice. However, the guidelines suggest that this is only suitable for existing development and not for new development or intensification.

The site is subject to flash flooding with little lead warning time and evacuation off-site is not possible in the worst-case scenario of a flood rising as fast as the PMF. While the draft guideline recommends against SIP for new development, it also suggests that SIP should only be used if the duration of flood inundation is less than 6 hours. Given that the site would only be isolated for approximately 30 minutes by H1 hazard flooding in an overland PMF, sheltering in place could be suggested as an appropriate flood emergency response for the proposed development.

In the reference design all commercial and residential units are located on the ground floor or above. The ground floor is either above the PMF level or protected up to the FPL (which is above the PMF level) across most of the site. Therefore, site occupants would be able to shelter above floodwaters on the ground floor or above. In Buildings F and G site occupants would need to shelter on Levels 1 or above, which are above the PMF.

Given that most overland flooding would only isolate the site for 30 minutes, most site occupants will be able to shelter where they are (i.e., in the shops or in their apartments) until flooding has receded from local roads. Occupants of the basement levels will not be able to shelter in the basement unless the basement is passively protected from all flooding, including all basement ramp entries, vents, liftwells and stairwells. Were the basement to flood occupants will need to evacuate vertically to the ground floor or above. They will not be able to shelter in the basement.

It should be noted that if sections of the ground floor are placed at street level, as permitted by the DCP 2009, occupants of the areas below the PMF level will need to evacuate to higher areas within the development.

The reference design includes a number of essential services, such as food and beverage outlets and pharmacy and medical services. It would therefore be well supplied in the event of short-duration overland flooding isolating the site.

# 5 FLOOD EMERGENCY RESPONSE STRATEGY

Based on the current plans for the proposed development and the flood-related development controls applicable to the development, the proposed flood emergency response strategy is for site occupants to shelter in place on the ground floor or above in response to overland flooding (triggered by the observation of floodwaters in local streets).

There would be no need for site occupants to evacuate or to shelter in response to lake flooding as long as flood-free vehicular access to the basement carpark is maintained. Any exit onto Northcliffe Drive would need to be closed to prevent vehicles or pedestrians exiting into lake floodwaters.

## 5.1 Basement Flood Protection

The DCP 2009 only requires that the basement car park be protected up to the 1% AEP flood level plus 0.2 m freeboard. However, given that overland flooding can occur with little or no warning we would advise that the basement should be protected up to the PMF level by passive measures to manage risk to life. Should floodwaters enter the basement, they would pour in and pose a risk to any site occupants on these levels. Therefore, it is preferable to protect the basement from all flooding.

To comply with the relevant development controls, the habitable floor levels (the FPL) will need to be above the PMF level at all locations around the site or flood-proofed up to the PMF level by passive measures (Table

10). Therefore, no additional protection of liftwells or stairwells will be required. If sections of the ground floor are placed at street level, as permitted by the DCP 2009, we advise that any stairwells or liftwells that access the basement be located at the PMF level or above (they will also need to be at or above the 1% AEP flood level plus 0.2 m freeboard). Any liftwells or stairways located in the lobbies of Buildings F and G that provide access to the basement will need to be protected from the ingress of floodwaters up to the PMF level (approximately 3.60 m AHD). If Council does not support active flood protection measures such as flood doors and other flood barriers, these lifts may not be able to provide direct access to the basement levels.

*Table 10: Comparison of PMF level, FPL and basement protection levels around the site*

| **Location (refer to** Table 2**)** | **Post-Development Overland PMF Level** | **Minimum Floor Level: habitable; and FPL** | **Basement car park minimum levels for vehicular access, doors and ventilation points** |
|---|---|---|---|
| A. Intersection of King Street and Cowper Street | 5.13 m AHD | 5.22 m AHD | 4.92 m AHD |
| B. Intersection of Taurus Avenue and Cowper Street | 6.55 m AHD | 6.73 m AHD | 6.43 m AHD |
| C. Intersection of Northcliffe Drive and King Street | 3.47 m AHD | 3.77 m AHD | 3.47 m AHD |
| D. Northcliffe Drive (east of King Street) | 3.39 m AHD | 3.63 m AHD | 3.33 m AHD |
| Northeast corner of the site | 8.88 m AHD | 9.34 m AHD | 9.04 m AHD |
| Southeast corner of the site | 3.53 m AHD | 3.78 m AHD | 3.48 m AHD |
| Eastern corner of the site | 5.29 m AHD | 5.70 m AHD | 5.40 m AHD |

In many locations around the site the basement protection level required by the DCP 2009 would already protect the basement from the PMF (Table 10). However, the Cowper Street driveway accessing the basement would need to be protected up to an additional 0.12 m to appropriately manage flood risk to life and an additional 0.06 m of protection would be required at the Northcliffe Drive basement entry. This additional protection is achieved by the basement ramp crests in the reference design.

As overland flooding can occur with no warning time, it is advisable that the driveway entrances to the basement be protected up to the PMF level by passive measures, including ramp crest levels at or above the PMF. If the basement is protected from floodwaters up to the PMF solely by passive measures it would not be necessary to evacuate the basement levels in response to overland flooding. In addition, Council has indicated that active flood protection measures would not be supported. In the reference design the basement ramp crests protect from floodwaters up to the PMF level.

## 5.2 Other Structural/Engineering Design Features

- To ensure that all parts of the proposed development remain accessible during a lake flood, the buildings on site will need to be interconnected above overland PMF levels. This may take the form of raised, covered walkways. The residential towers along the southern margin of the site will need to be connected with the other buildings above overland PMF levels.
- A flood alarm system is recommended for the site. Although the flood sensor location should be confirmed once post-development flood modelling has been undertaken for the final development design, it is likely that it should be placed along Cowper Street. Once the sensor has been activated, it should trigger a public address system announcement that local roads are impacted by flooding and that all site occupants should remain on site until floodwaters have receded.
- A public address system audible in all parts of the development during intense weather conditions will be required to communicate flood response instructions to site occupants.

## 5.3 Operational Measures

The following operational measures should be adopted:

- The Site Manager, Building Manager or similar should be nominated as Chief Flood Warden
- A number of Flood Wardens should be nominated from amongst staff and potentially amongst residents. There should be a number of Flood Wardens on site at all times
- Flood emergency response drills should be carried out annually
- Given that basement parking below the FPL is proposed, the development will require a Site Emergency Response Flood plan to be prepared.

### 5.4 Governance Arrangements

The following roles and responsibilities are generally appropriate for similar development types:

- NSW SES is the lead combat agency for flooding in NSW. Any flood response directive issued by the NSW SES must be followed
- The development owners are responsible for:
  - Ensuring flood management measures, the public address system and the flood alarm system are maintained
  - Ensuring the Flood Emergency Response Plan is up-to-date and regularly reviewed
  - Ensuring a Chief Flood Warden and Flood Wardens are nominated and subscribed to appropriate weather apps
  - Post-flood clean-up and recovery
  - Ensuring there are sufficient financial, human and other resources to maintain and implement the flood emergency response strategy.
- The Chief Flood Warden is responsible for the below actions. The duties and responsibilities of Chief Flood Warden can be delegated to others.
  - Ensuring tenants and residents are aware of the flood risk and are appropriately trained
  - Organising annual flood emergency response drills
  - Organising the testing and maintenance of equipment and other flood risk mitigation measures
  - Monitoring weather forecasts and flood warnings
  - Implementing the flood emergency response strategy in the event of a flood.
- The Flood Wardens are responsible for:
  - Implementing the flood emergency response strategy under the direction of the Chief Flood Warden.
- Site occupants are responsible for:
  - Following the directions of staff and Flood Wardens during a flood emergency.

## 6 CONCLUSION

This letter has set out the results of our assessment regarding flood management considerations for redevelopment of the Warrawong Plaza based on the current planning instruments applicable to the site. It has described the areas where the reference design complies with the applicable controls, indicated where there are potential issues in satisfying the above requirements and the possible options that can be incorporated into the future development design to comply with the above provisions. It also sets out our advice regarding flood evacuation and flood emergency response. A separate Flood Impact Assessment report

provides further details as to how the impacts on lake and overland flooding referred to in this report have been determined.

There do not appear to be any impediments to the proposed development in relation to flood risk management providing that the development footprint, floor levels and other design features take into account local flood behaviour. Design solutions to meet existing flood related development controls should be achievable.

Yours sincerely

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**WATER TECHNOLOGY PTY LTD**

Water Technology pays respect to all First Nations peoples, their cultures and to their Elders, past and present.

# APPENDIX A: FLOOD COMPATIBLE MATERIALS

This appendix lists the flood compatible material requirements as listed in Chapter E13, Appendix B of the Wollongong DCP 2009.

| BUILDING COMPONENT | FLOOD COMPATIBLE MATERIAL |
|---|---|
| **Flooring and Sub-floor Structure** | • Concrete slab-on-ground monolith construction.<br>• Suspended reinforced concrete slab. |
| **Floor Covering** | • Clay tiles.<br>• Concrete, precast or in situ.<br>• Concrete tiles.<br>• Epoxy, formed-in-place.<br>• Mastic flooring, formed-in-place.<br>• Rubber sheets or tiles with chemical-set adhesives.<br>• Silicone floors formed-in-place.<br>• Vinyl sheets or tiles with chemical-set adhesive.<br>• Ceramic tiles, fixed with mortar or chemical-set adhesive.<br>• Asphalt tiles, fixed with water resistant adhesive. |
| **Wall Structure** | • Solid brickwork, blockwork, reinforced, concrete or mass concrete. |
| **Roofing Structure** (for Situations Where the Relevant Flood Level is Above the Ceiling) | • Reinforced concrete construction.<br>• Galvanised metal construction. |
| **Doors** | • Solid panel with water proof adhesives.<br>• Flush door with marine ply filled with closed cell foam.<br>• Painted metal construction.<br>• Aluminium or galvanised steel frame. |
| **Wall and Ceiling Linings** | • Fibro-cement board.<br>• Brick, face or glazed.<br>• Clay tile glazed in waterproof mortar.<br>• Concrete. |

| BUILDING COMPONENT | FLOOD COMPATIBLE MATERIAL |
|---|---|
| | • Concrete block.<br>• Steel with waterproof applications.<br>• Stone, natural solid or veneer, waterproof grout.<br>• Glass blocks.<br>• Glass.<br>• Plastic sheeting or wall with waterproof adhesive. |
| **Insulation**<br><br>**Windows** | • Foam (closed cell types).<br><br>• Aluminium frame with stainless steel rollers or similar corrosion and water resistant material. |
| **Nails, Bolts, Hinges and Fittings** | • Brass, nylon or stainless steel.<br>• Removable pin hinges.<br>• Hot dipped galvanised steel wire nails or similar. |
| **Electrical and Mechanical Equipment** | For dwellings constructed on land to which this chapter applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.<br>• Main power supply<br>Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the relevant flood level. Means shall be available to easily disconnect the dwelling from the main power supply.<br>• Wiring<br>All wiring, power outlets, switches, etc., should, to the maximum extent possible, be located above the relevant flood level. All electrical wiring installed below the relevant flood level should be suitable for continuous submergence in water and should contain no fibrous components. Earth core leakage systems (or safety switches) are to be installed. Only submersible-type splices should be used below the relevant flood level. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.<br>• Equipment<br>All equipment installed below or partially below the relevant flood level should be capable of disconnection by a single plug and socket assembly.<br>• Reconnection |

| BUILDING COMPONENT | FLOOD COMPATIBLE MATERIAL |
|---|---|
| | • Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection. |