



Attachment 7 to Item 2.1.1.

Appendix 7 Detailed Evacuation Capability Assessment

Date of meeting: 18 April 2024

Location: Council Chambers or audio-visual link

Time: 12:30pm



22 August 2023

Matthew Causley
SEED Projects

Via email: matthew@seedprojects.com.au

Dear Matthew,

Our ref: 23020266_L01v02_Belmont_Park_Estate_NSW_ECA

Belmont Park Estate, Grose Wold – Detailed Evacuation Capability Assessment

1 BACKGROUND

Water Technology has been engaged by the Kavanagh Family to prepare a Detailed Evacuation Capability Assessment (ECA) for the Belmont Park Estate to review the suitability of the site for rezoning. This ECA will accompany a Scoping Proposal submission to Hawkesbury Council.

The development plans include rezoning of land above the extent of the 1% Annual Exceedance Probability (AEP) flood. As such, a risk-based assessment has been undertaken for the proposal, consistent with *Considering flooding in land use planning – Guideline July 2021* (NSW Department of Planning, Industry and Environment).

This Evacuation Capability Assessment has been prepared in accordance with Section E of the Hawkesbury City Council *Schedule of Flood Related Development Controls* (October 2020) and addresses the following requirements:

- *demonstrate the available route/s from the development to the Regional Flood Evacuation Route;*
- *determine the available time for evacuation;*
- *identify at what point and time the access route is cut off;*
- *identify whether the proposed development will be capable of self-evacuation or whether it will rely on emergency services to assist in the evacuation of occupants, such as seniors housing, residential care facilities, group homes, or correctional centres;*
- *determine whether evacuation from the site can be achieved within the Effective Warning Time; and*
- *demonstrate that evacuation of the site will not adversely impact on existing evacuation capabilities.*

2 SITE DETAILS

2.1 Location

The Belmont Park Estate is to involve the rezoning and associated subdivision for four large lots in Grose Wold. The subject site consists of 4 lots (1, 35, 61 and 63 Grose River Road). The site is located to the west of the Hawkesbury River, adjacent to the confluence of the Grose and Nepean Rivers. The site is approximately 120 ha in size with ground elevations around 5 to 80 m AHD. The part of the site adjacent to the Hawkesbury River is relatively low-lying (less than 15 m AHD). Steading Creek crosses the site from north to south-east. Phillip Charley Creek is located to the south of the site.

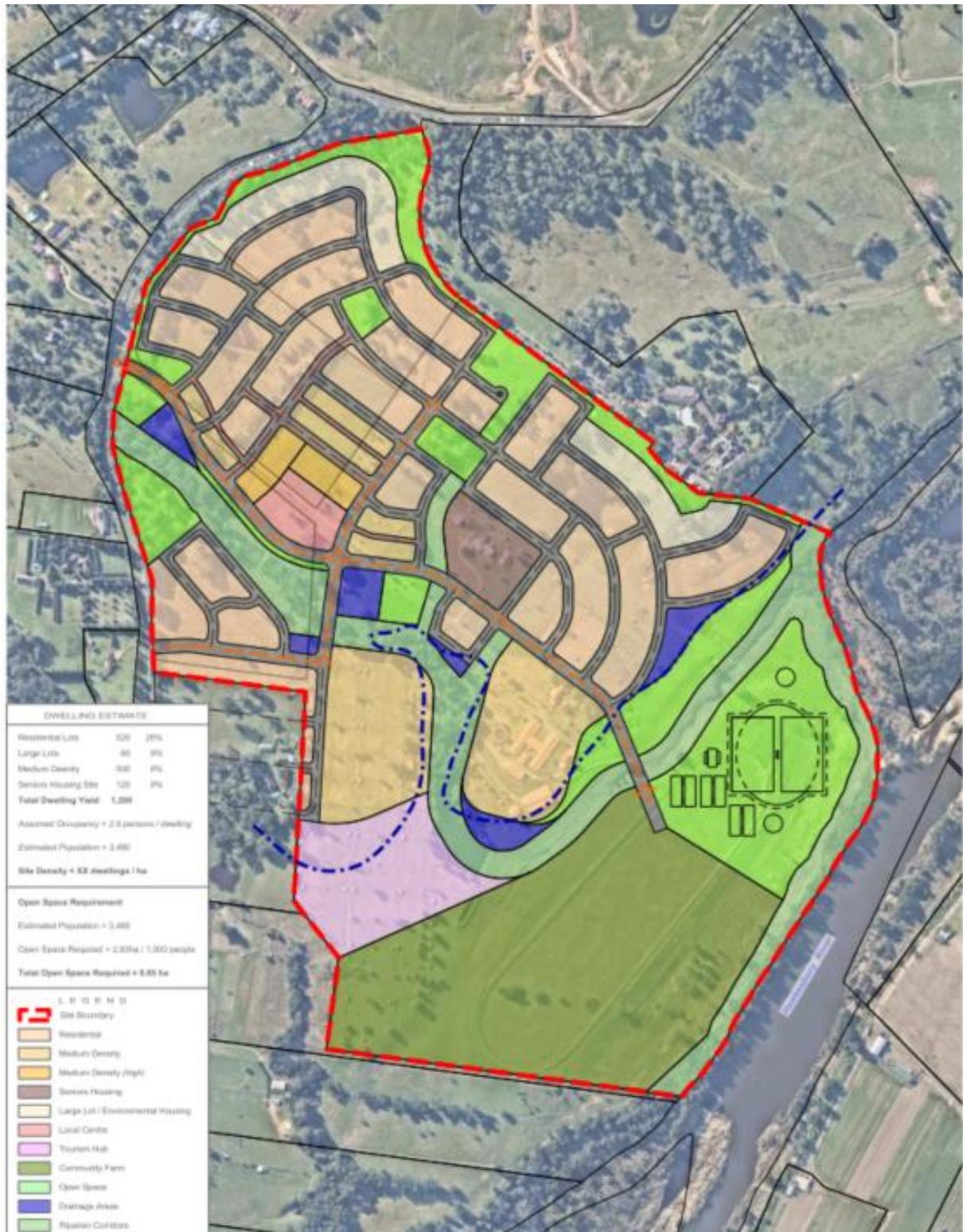


Figure 2-1 Study Area (as provided)



2.2 Development Details

The concept plan includes residential dwellings, a local centre, riparian corridors, drainage areas and a community farm adjacent to the river. The housing plan is to provide diverse housing typology estate with approximately 1,200 dwellings over a 10 to 20 year timeframe. This includes:

- 520 residential lots
- 60 large lots
- 500 medium density lots
- 120 seniors housing sites

All housing within the development is proposed to be on the relative high points on the site (above the 1% AEP flood level).

The Hawkesbury City Council DCP requires 2 parking spaces per large dwelling (GFA more than 85m²), 1.5 parking spaces per medium dwelling (GFA 55m² to 85m²), 1 parking space per small dwelling (GFA less than 55m²), and 1 visitor space per 5 dwellings.

Based on the above, the site is expected to have a maximum of 1,630 total vehicles.

However, only approximately 530 dwellings are located below the extent of the Probable Maximum Flood (PMF) based on the site's Concept Plan. This means that only approximately 720 vehicles would need to evacuate in a PMF.

2.3 Access

The lots are to be accessible via two transport access points on Grose River Road.

The Grose River Bridge is currently under construction and is to include a roundabout upgrade to the Grose River Road / Grose Vale Road intersection from a priority-controlled to a roundabout. TfNSW, Hawkesbury City Council and Redbank Communities are currently in the process of extending Grose River Road, Grose Wold to Springwood Road, Yarramundi, which would include the Grose River Bridge over the Grose River. The Grose River Bridge will provide an alternative flood evacuation route south of the site with a higher level of flood immunity than that which currently exists. It is set to be above the 1% AEP (1 in 100 year) flood level. However, this will flood more frequently than the site itself is flooded, and therefore is not included in flood evacuation planning for the site.

3 FLOOD IMPACTS

3.1 Flooding on Site

Flood impacts to the site are detailed in the GRC Hydro Flood Report (February 2023). As summarised in this report, the site can be impacted by:

- Mainstream flooding from the Hawkesbury River
- Mainstream flooding from Steading Creek; and
- Overland flooding.

3.1.1 Hawkesbury River Flooding

The site can be impacted by mainstream flooding from the Hawkesbury River. Regarding flood data availability, it is noted that the State Government commissioned the recent Hawkesbury-Nepean Valley Regional Flood



Study prepared by WMAwater in 2019 for Infrastructure NSW. However, this is not a two-dimensional flood model. We have been advised by Infrastructure NSW that it will be finalising its two-dimensional flood model for the Hawkesbury Nepean River in late 2023, which builds off of the Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019). It is therefore not currently available for use in this work.

Flood levels as per the GRC Hydro Flood Report are provided in Table 3-1 and Figure 3-1. The Hawkesbury River flood levels were provided by Council except for the Probable Maximum Flood (PMF) which was extracted by GRC Hydro from the Hawkesbury-Nepean Valley Regional Flood Study (Infrastructure NSW, 2019). Flooding from the Hawkesbury-Nepean River can last for a few days in the PMF.

Table 3-1. Flood levels on site

Flood	Hawkesbury River Flood Levels (m AHD)	Impacts to the Site
20% AEP (1:5 year ARI)	12.8-12.9	The lowest parts of the site adjacent to the river and creeks are flooded. The proposed development is above the extent of flooding.
5% AEP (1:20 year ARI)	16.3	The lowest parts of the site adjacent to the river and creeks are flooded. The proposed development is above the extent of flooding.
1% AEP (1:100 year ARI)	18.1-18.2	Low parts of the site adjacent to the river and creeks are flooded. The proposed development is above the extent of flooding.
0.2% AEP (1:500 year ARI)	20.2	Low parts of the site adjacent to the river and creeks are flooded. Some of the proposed developed areas are under the flood extent.
PMF	27.1	The southern half of the site is flooded, with some proposed developed areas (i.e. residential areas, tourism hub and some internal roads) under the extent of flooding.

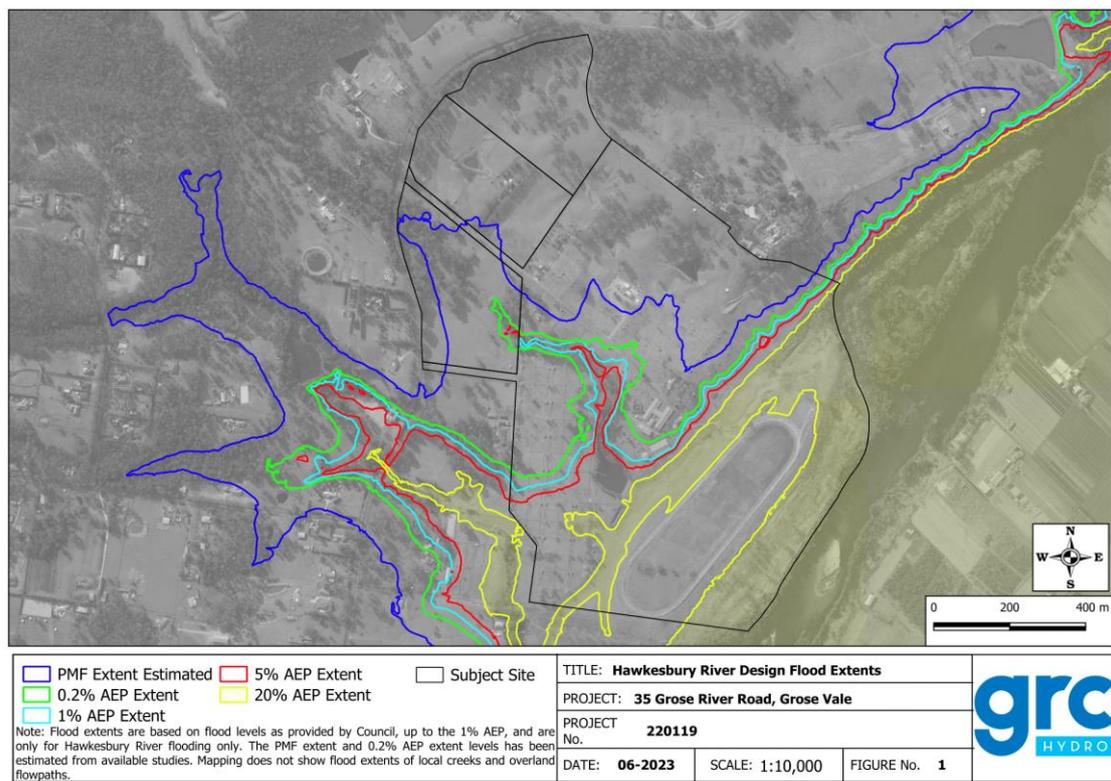


Figure 3-1 Hawkesbury River Flood Extents (GRC Hydro, 2023)



3.1.2 Steading Creek and Overland Flow Flooding

Steading Creek has a small catchment of approximately 2 km² and can experience flooding following heavy localised rain events. This flooding would typically only last two hours at most. It can flood separately or at the same time as Hawkesbury River.

Overland flooding can also occur on site as the result of heavy rainfall. The site has overland flow paths that are subject to short-duration flooding, typically less than two hours.

Creek and overland flow flooding have been modelled by GRC Hydro (Figure 3-2). This flood modelling assumes no coincidence with Hawkesbury River flooding (and would be superseded by any coincident Hawkesbury River flooding). There are four flow paths crossing the site that flow into the creek, and modelling of the 1% AEP and PMF show that flooding is largely confined to the creek and flow paths.

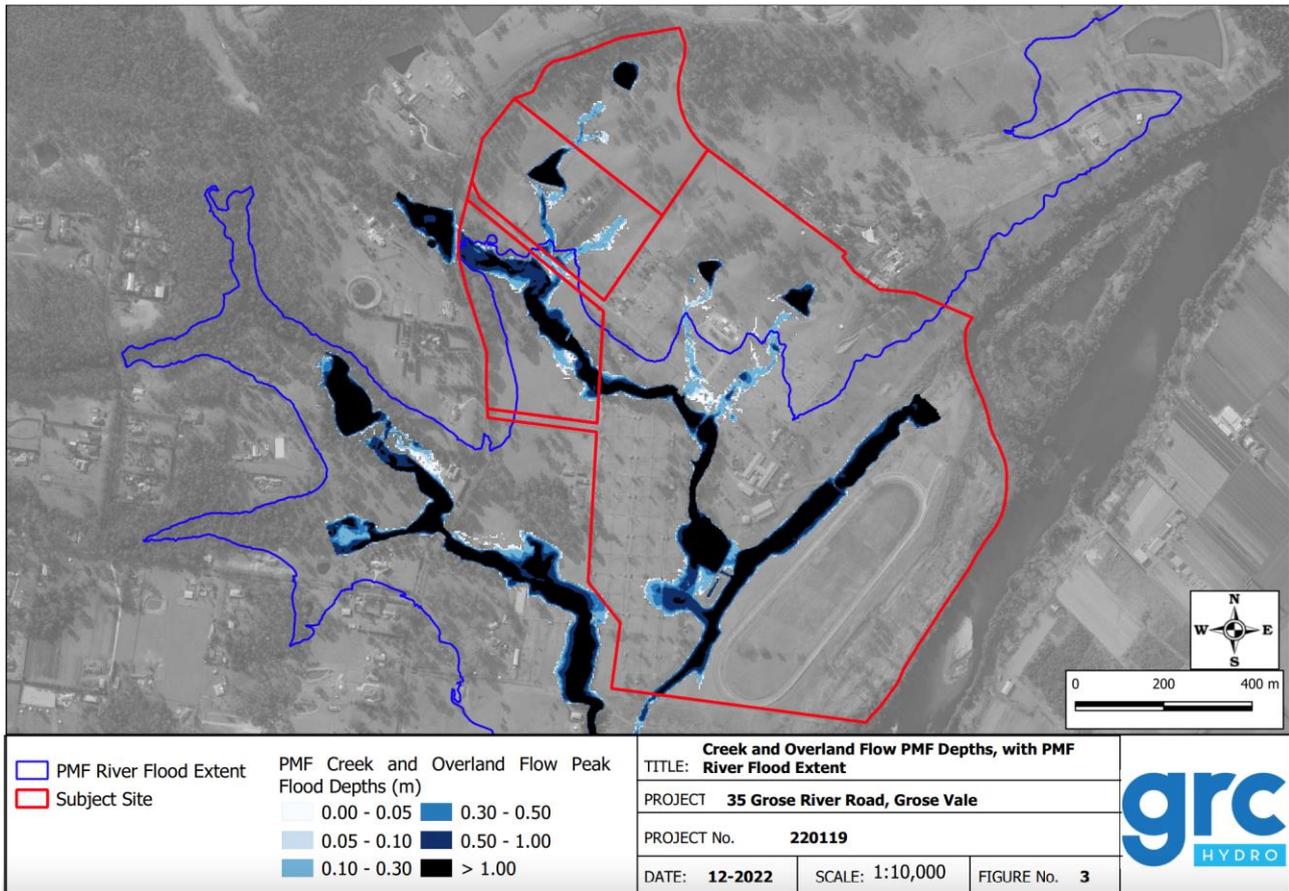


Figure 3-2 Creek and Overland PMF Extent (GRC Hydro, 2023)

3.2 Access to Site

Internally, the site has roads with rising grade to land above the PMF (Figure 3-3).

The site is accessed via Grose River Road and Grose Vale Road. This area has rising road access to land above the extent of the Hawkesbury River PMF; this means that the area will not be isolated by rising floodwaters from the river and is not a high or low flood island.

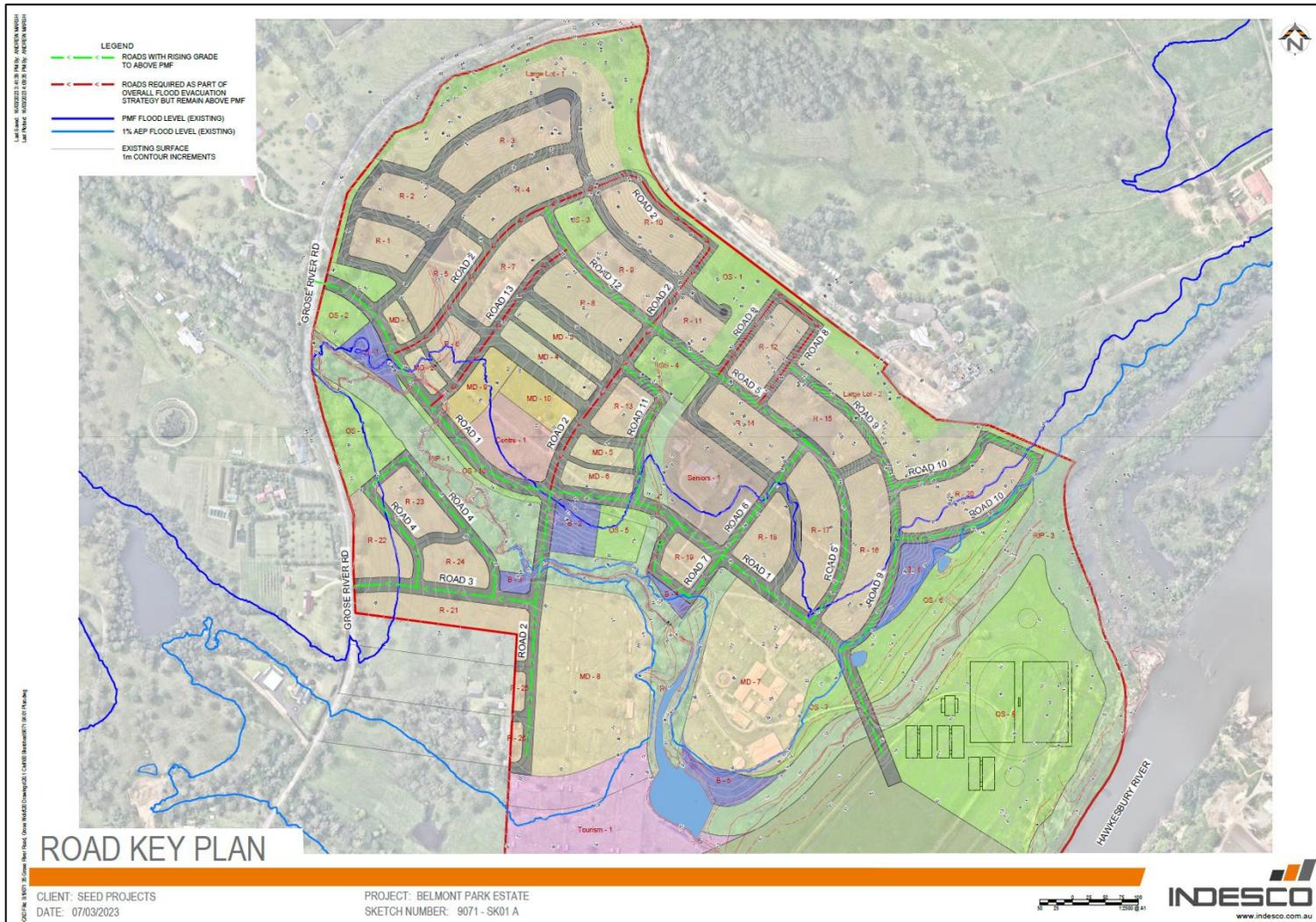


Figure 3-3 Site Internal Road Plan (INDESCO, 2023)



4 HAWKESBURY RIVER FLOOD EVACUATION TIMING AND CONSIDERATIONS

The NSW SES uses the Timeline Evacuation Model (TEM) as a tool to estimate the ability of people to safely evacuate by motor vehicle from a floodplain. It takes into account the time people take to accept a warning, act upon the warning and travel along an evacuation route which may face delays due to incidents along the route. It then compares the estimated “Time Required” with the estimated “Time Available”. The Time Available is derived from information about warning times, flood travel times and flood rates of rise.

This can be represented as: **Surplus Time = Time Available – Time Required**

These components are assessed below.

4.1 Time Available to Evacuate

The time available to evacuate is based on the availability of suitable flood warnings and triggers. This includes warnings issued by the Bureau of Meteorology.

The closest flood gauge to the site that can provide information regarding flood levels and warnings on the Hawkesbury River is the [North Richmond Gauge](#).

The flood classification levels for the Hawkesbury-Nepean River at the North Richmond (WPS) gauge are:

- Minor flood level: 3.8 m AHD
- Moderate flood level: 7.9 m AHD
- Major flood level: 10.5 m AHD

The *Provision of and Requirements for Flood Warning* (NSW SES, 2019) states that there will be the following quantitative flood warnings available for the North Richmond (WPS) gauge:

- 6 hours of warning for a trigger height of 16 m AHD
- 15 hours of warning for a trigger height of 18 m AHD

The proposed developed parts of the site are not impacted by Hawkesbury-Nepean River flooding until events exceeding the 1% AEP flood level (18.1 m AHD). **Therefore, the Bureau of Meteorology will provide 15 hours of warning for a flood that would impact the site.**

In addition to the 15 hours of warning time, there would be additional time between floodwaters reaching the lowest levels of the site and floodwaters rising to their peak levels which would start to impact the developed parts of the site and its roads.

It is noted that there would not be any flood warning available for nearby local creeks or overland flow. Therefore, if creeks are flooding independently or earlier than the Hawkesbury River, the above 15 hours of flood warning does not apply. However, this flooding would be short duration and would reach lower levels than riverine flooding.

4.2 Time Required to Evacuate

Based on the NSW TEM, the time required to evacuate is based on:

- **Warning Acceptance Factor (WAF)** accounts for the delay between receiving an evacuation order and acting upon it. The NSW SES recommends a value of **one hour**.



- **Warning Lag Factor (WLF)** is an allowance for the time taken by occupants to prepare for evacuation. The NSW SES recommends a value of **one hour**.
- **Travel Time (TT)** is defined as the number of hours taken for all of the evacuating vehicles to pass a point given the road capacity. The NSW SES recommends an assumed road capacity of 600 vehicles per hour per lane.
 - If only the dwellings under the extent of the PMF evacuate, there would be approximately 720 vehicles evacuating. In this case, it would take approximately **1.2 hours** of travel time to complete evacuation. In the event that the entire site evacuates, it could take a maximum of almost 3 hours of travel time to evacuate the site.
- **Traffic Safety Factor (TSF)** is added to the travel time to account for any delays that occur along the evacuation route. This includes potential for incidents such as vehicle accidents or breakdowns, fallen trees or power lines or water across the road. For travel time between 0 to 3 hours, the NSW SES guidance sets a Traffic Safety Factor of **one hour**.

Given the above considerations, it is recommended that flood evacuation planning for this site allows for **4.2 hours to evacuate** the parts of the site under the extent of the PMF following an evacuation order being issued. If the entire site evacuates, it would require approximately 6 hours.

4.3 Evacuation Considerations

The following evacuation considerations must be taken into account:

- The access routes for the site are cut off after low parts of the site adjacent to the river and creeks already start to flood. The site does not become a low or high flood island.
- A Flood Emergency Response Plan can be developed for the site that details the triggers for evacuation. In addition to setting a specific Hawkesbury River level as an evacuation trigger (the level at which the first developed area floods), this can include additional visual triggers, such as floodwaters reaching a specific point on the site.
- The evacuation timing calculations above show that the site has over 15 hours of warning time for a flood that would require evacuation from the site. This accounts for both the Bureau's provision of 15 hours of warning time, plus the additional time it takes for the flood levels to reach the developed parts of the site. If the maximum number of vehicles on site were to all need to evacuate at once, it would take almost 6 hours to do so. Therefore, even in the worst case scenario, there would be sufficient time for the site to fully evacuate.
- However, only the southern part of the site is under the Hawkesbury River PMF. The northern part of the site would not necessarily have to evacuate immediately due to direct flood risk. Therefore, the above assessment overestimates the number of vehicles that would be evacuating at the same time. If only the part of the site under the extent of the PMF evacuates, it would take approximately 4.2 hours. This is less than the 15 hours of time available to evacuate.
- The lowest parts of the site under the PMF would only need to evacuate in an event exceeding the 1% AEP (1:100 year ARI) flood level of 18.1 m AHD.
- If flood levels on the Hawkesbury River exceed 14.5 m, all electrical supply west of the Hawkesbury River is likely to be shut off (Hawkesbury-Nepean Valley Flood Plan, 2020-1.0). If this occurs, it is likely that all site occupants will need to eventually evacuate due to lack of services, which could last for weeks. However, there would be no urgency on this evacuation. As the site has rising road access to flood-free land, the parts of the site above the PMF would have as much time as they need to leave due to the lack of electricity/ services.



- Based on this assessment, the proposed development will be capable of self-evacuation and would not rely on emergency services to assist in the evacuation of occupants.

5 EVACUATION DESTINATION

As per the NSW SES's published flood evacuation route mapping shown in Figure 5-1, in the event of a flood evacuation, site occupants would travel to the west, and would not cross the Hawkesbury River to the east. The western evacuation route is the shortest route out of the floodplain and avoids merging with existing flood evacuation traffic to the east. It is noted that North Richmond is not included in the Regional Evacuation Route Map (Map 1 within Chapter 4, Volume 3 of the Hawkesbury-Nepean Flood Plan, NSW SES September 2015) cited in the Hawkesbury City Council *Schedule of Flood Related Development Controls*.

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April 2022

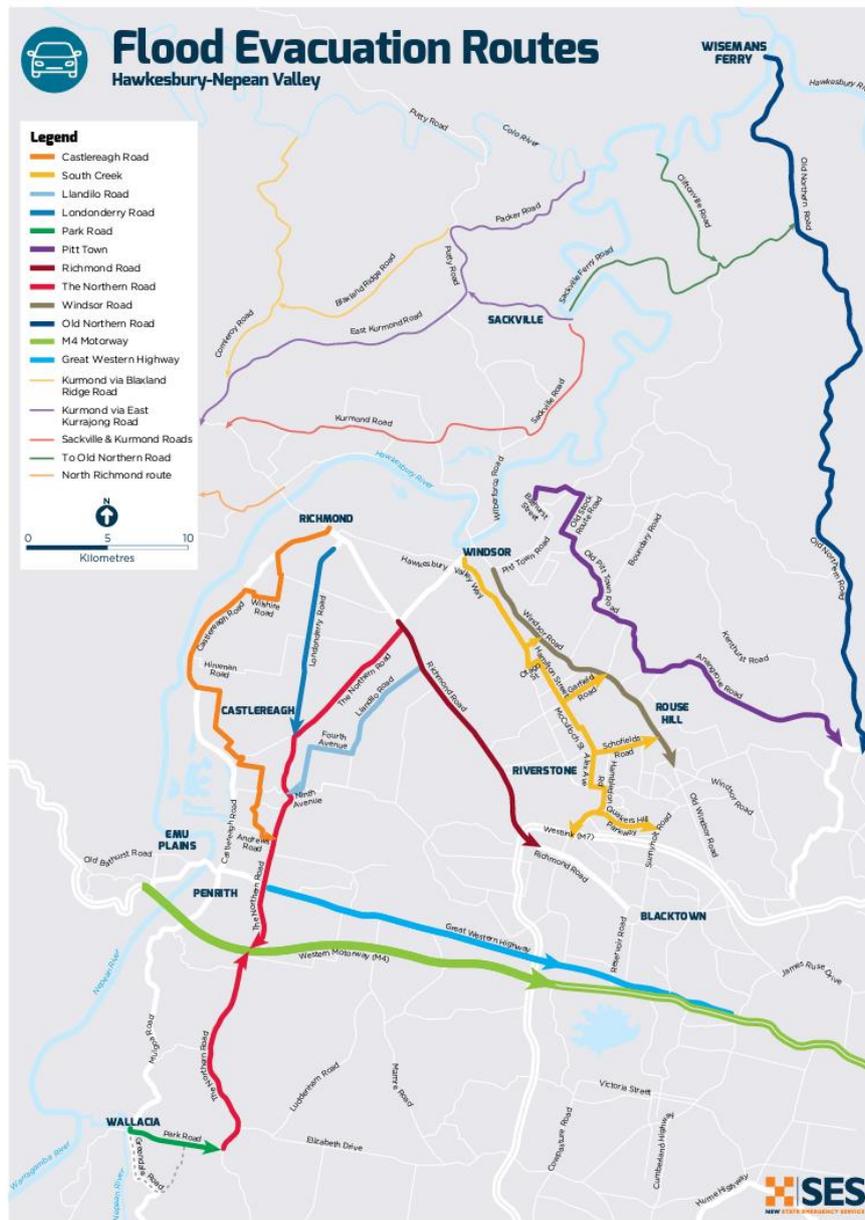


Figure 5-1 NSW SES Flood Evacuation Routes (April 2022)



This site would evacuate with North Richmond along the “North Richmond” route shown in Figure 5-1. This involves traveling down Grose Vale Road to the west towards Bells Line of Road through Kurrajong. Essential services are available in this immediate area above the extent of flooding.

From Bells Line of Road, site occupants would have the option of traveling west (i.e. towards Lithgow) or southwest to the Blue Mountains (via the Darling Causeway). Travel towards Sydney to the east on the M4 would also be possible via the Blue Mountains, although this would not be advised due to the amount of evacuation traffic that would already be on the roads traveling to the east.

A local SES nominated Evacuation Centre is Colo High School in north Richmond (218 Bells Line of Road), which is just above the extent of the PMF in North Richmond. There is a flood-free route from the site to this evacuation centre via Grose Vale Road to Bells Line of Road and then traveling east to the school (Figure 5-2). North Richmond Community Centre (which is slightly further down Bells Line of Road) has been used for flood evacuation in recent years, however, this is beneath the extent of the PMF and is unlikely to be used in an event that requires evacuation from the site.

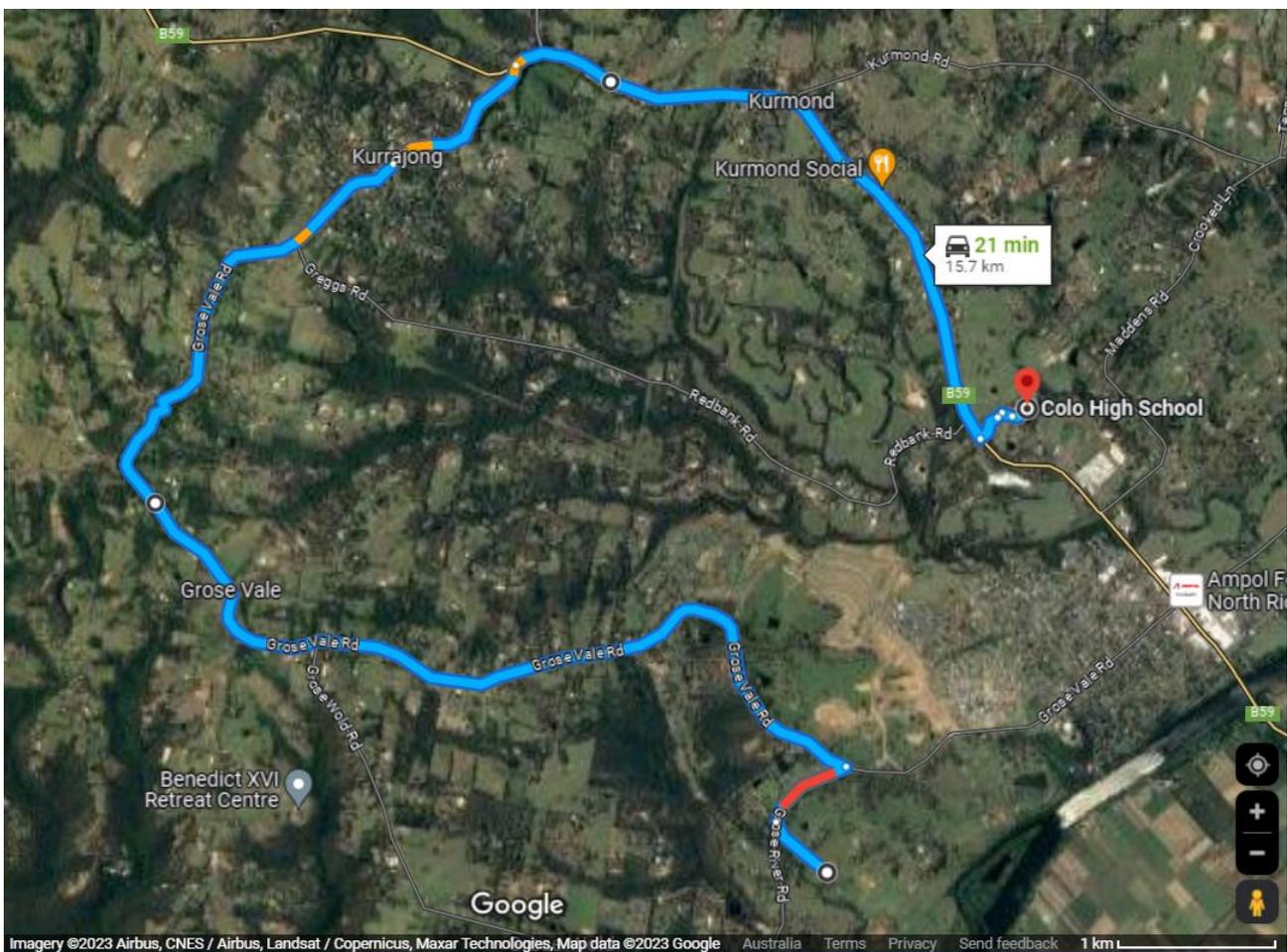


Figure 5-2 Route from the Site to Colo High School Evacuation Centre



6 EVACUATION ROUTE CAPACITY

From the site, there is a flood-free evacuation route to extensive areas above the PMF to the west and north-west by traveling north on Grose River Road and north/ west on Grose Vale Road (Figure 6-1).

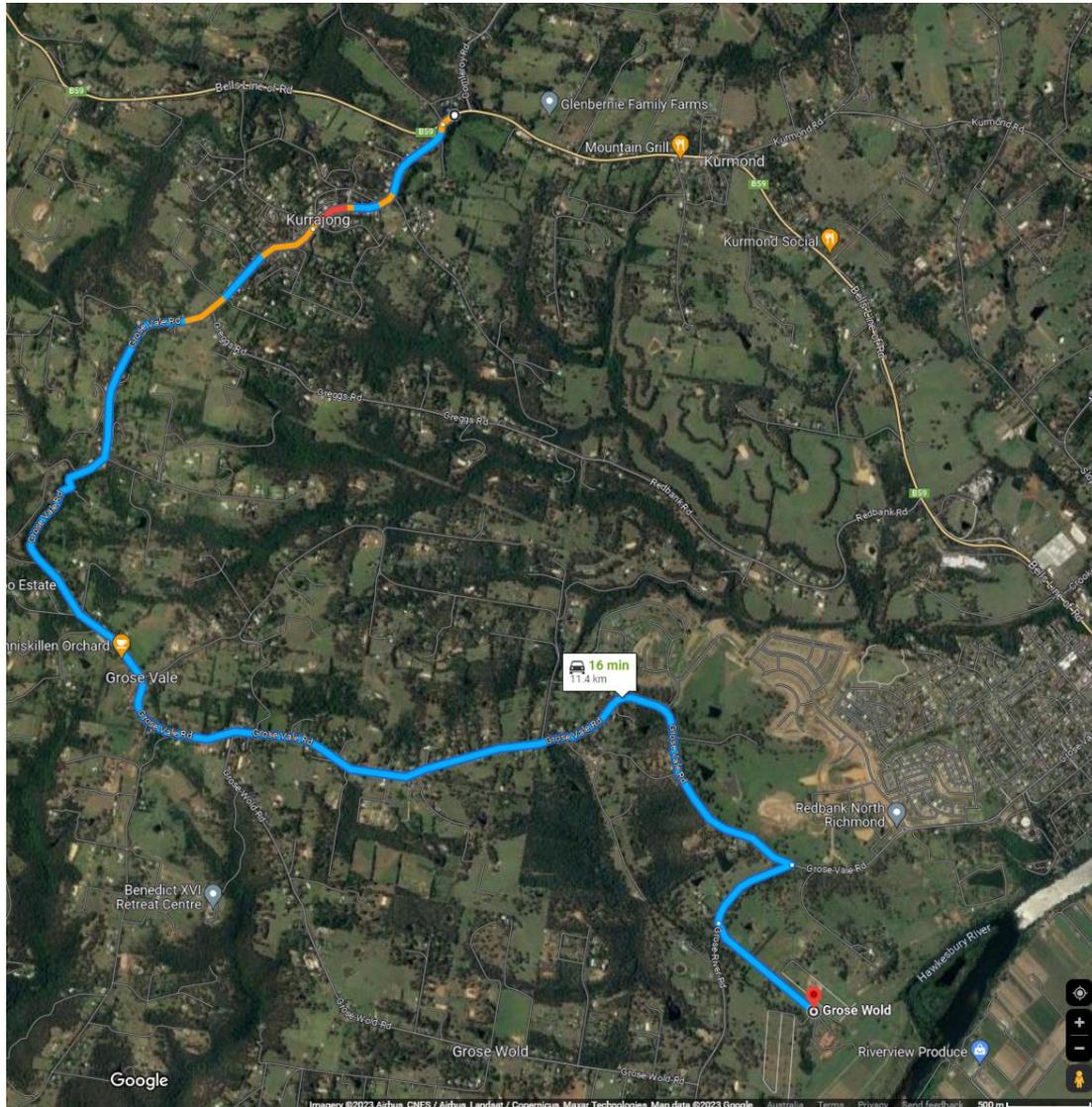


Figure 6-1 Evacuation Route

The proposed development must also consider its impact on existing evacuation traffic to ensure it does not strain the evacuation capacity of the local roads and therefore put the existing population at risk.

Based on 2021 Australian Bureau of Statistics (ABS) Census data, there are estimated to be fewer than 975 dwellings beneath the extent of the Hawkesbury River PMF in North Richmond. This includes the areas beneath the extent of flooding in Figure 6-2. It is noted that this is an overestimation due to the resolution of available Census data (i.e. dwelling counts at the Mesh Block level have been used).

In the 2021 Census, dwellings in Grose Wold had an average of 3 vehicles per dwelling. This would result in a maximum number of 2,925 vehicles that would evacuate from a Hawkesbury River PMF from North Richmond. In the unlikely event that all of these vehicles from North Richmond would travel south and west



away from rising floodwaters onto Grose Vale Road (i.e. the shared evacuation route with the subject site), it would take almost 5 hours of Travel Time plus 1.5 hours of Traffic Safety Factor based on the NSW SES TEM assumptions set out in Section 4. This would result in 6.5 hours required to evacuate this area.

Therefore, if the existing North Richmond evacuation traffic requires at most 6.5 hours to fully evacuate and the site requires 4.2 hours to evacuate the areas under the PMF, this would result in a total of 10.7 hours of evacuation time required.

This total (which is an overestimate based on the above assumptions) is less than the 15 hours of warning time available prior to the level of flooding that would require evacuation from the site. This demonstrates that the proposed development would not adversely impact on existing evacuation capabilities.

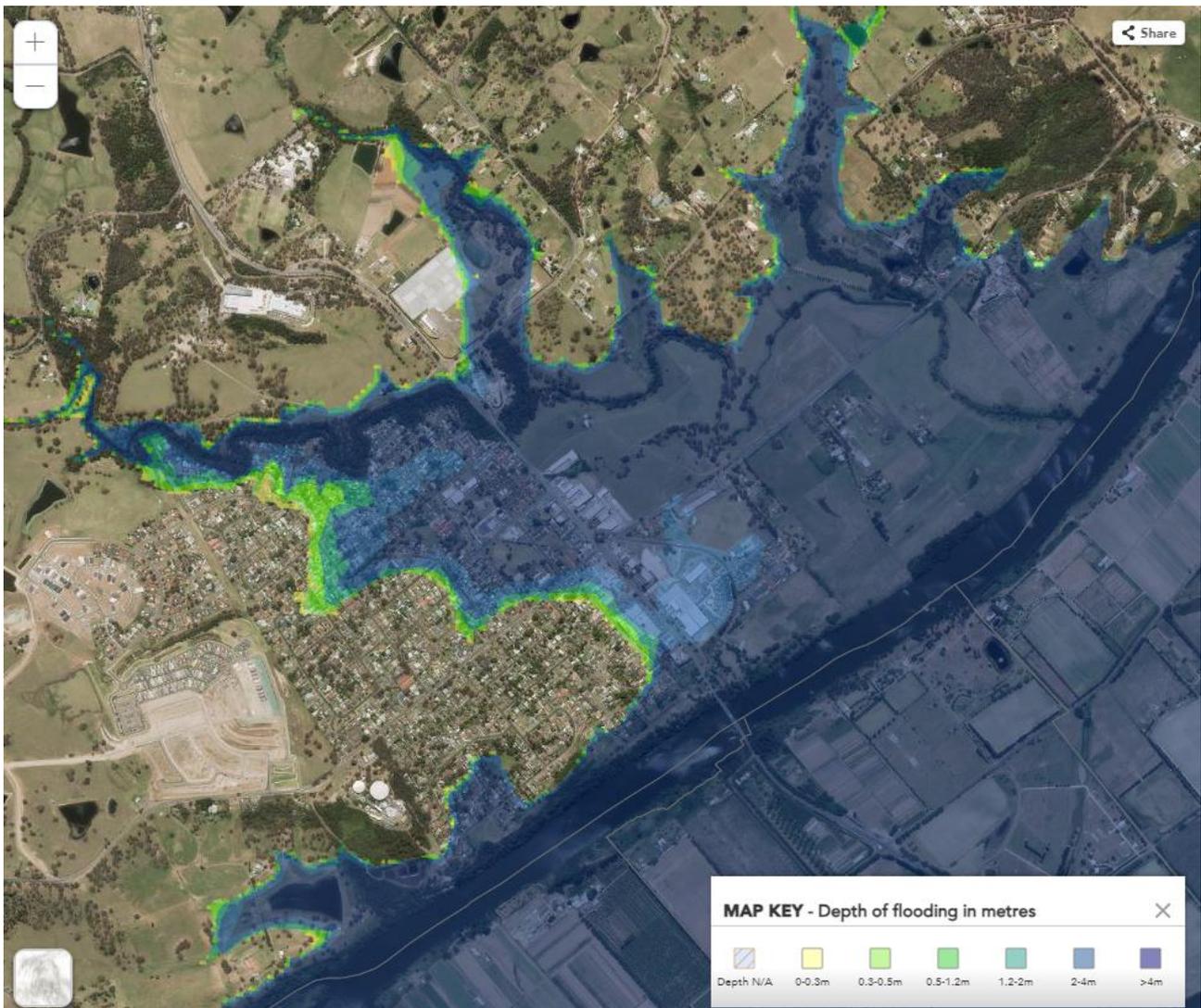


Figure 6-2 Hawkesbury River PMF extent in North Richmond (NSW SES: <https://www.ses.nsw.gov.au/hawkesbury-nepean-floods>)

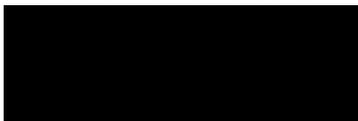


7 CONCLUSIONS

Based on the above assessment:

- The lowest parts of the site under the PMF would only need to evacuate in an event exceeding the 1% AEP (1:100 year ARI) flood level of 18.1 m AHD.
- The site has over 15 hours of warning time for a flood that would require evacuation from the site.
- Based on the NSW SES Timeline Evacuation Model (TEM) assumptions, if the part of the site under the extent of the PMF evacuates, it would take approximately 4.2 hours. Even in the worst case scenario where all vehicles on site evacuate, there would be sufficient time for the site to fully evacuate.
- The access routes for the site are cut only off after the lowest parts of the site adjacent to the river and creeks have already started to flood. The site does not become a low or high flood island.
- Based on this assessment, the proposed development will be capable of timely self-evacuation and would not rely on emergency services to assist in the evacuation of occupants.
- A Flood Emergency Response Plan can be developed for the site that details the triggers for evacuation and flood emergency response. In addition to Hawkesbury River levels, this can include additional visual triggers for flood emergency response, such as floodwaters reaching a specific point on the site.
- There is capacity on the local evacuation routes even accounting for a complete evacuation of North Richmond at the same time as the evacuation of the site. This is based on the unlikely scenario of a complete evacuation of North Richmond and an evacuation of the part of the site under the PMF, requiring approximately 10.7 hours. This is less than the 15 hours of warning time available prior to the level of flooding that would require evacuation from the site. It is noted that even if the entire site evacuates, the time required to evacuate does not exceed the time available, and there is still sufficient capacity on the road. This demonstrates that the proposed development would not adversely impact on existing evacuation capabilities.
- The site would evacuate via Grose Vale Road which is a flood free route to the Colo High School evacuation centre.

Yours sincerely



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