MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

Penrith Lakes Business Park Pty Ltd

Penrith Lakes Employment Precinct

Flood Emergency Response Plan

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FLOOD EMERGENCY RESPONSE PLAN

for

Penrith Lakes Business Park Pty Ltd

by

Molino Stewart Pty Ltd
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1 INTRODUCTION

1.1 BACKGROUND

In January 2017, the NSW Government published the State Environmental Planning Policy (Penrith Lakes Scheme) Amendment 2017. Amongst other things, this zoned an area in the south of Penrith Lakes as Employment.

A development application is being submitted for a proposed subdivision of this land into light industrial lots.

The SEPP states that:

Development consent must not be granted for development on land zoned Employment unless the consent authority has considered the following:

…(b) an evacuation plan and procedures for early warnings that are prepared by an emergency services organisation and endorsed by the State Emergency Service as being appropriate for the development,

This Flood Emergency Response Plan (FERP) has been prepared by Molino Stewart Pty Ltd on behalf of Penrith Lakes Business Park Pty Ltd, the owners of the land at the time of the development application. The FERP, of which evacuation is only one aspect, sets out how the development will be prepared for flooding and what actions will be taken before, during and after a flood to manage the safety of those on site.

This FERP is an overarching plan for the whole precinct and provides a level of detail appropriate to planning and response at a precinct level. Each individual business and/or body corporate within the precinct will need to develop its own detailed FERP which is consistent with this precinct FERP.

1.2 SITE DETAILS

1.2.1 Locality

The site is located in Penrith and is situated between Castlereagh Road to the east and Nepean River to the west. The location of Penrith Lakes Business Park is shown in Figure 1.

The site covers approximately 46 hectares and is located within the NSW SES North Penrith (A) flood evacuation subsector within the Penrith flood evacuation sector.

1.2.2 Site Layout

Figure 2 shows the indicative layout plan for the proposed subdivision. It consists of a total of 100 lots ranging in size from 1,290m^2 to 12,594m^2. It will have road access from Lugard Street in the east and Old Castlereagh Road in the north. It will have an internal ring road network and swale drains which drain into the artificial wetland to the west.

1.2.3 Topography and Drainage

The precinct is situated in one of a series of floodplains formed by the topography within the Hawkesbury-Nepean valley. After exiting the Fairlight Gorge, the Nepean River expands into a wider channel with a broad floodplain at Regentville and then flows past Penrith on the east bank of the River and Emu Plains on the west bank. A sharp bend in the river and a narrowing of the channel downstream of Emu Plains creates a constriction which is responsible for the flooding of the Penrith and Emu Plains floodplain.

The precinct is on the outside of this bend at a level of around 26m AHD compared to the river normal river level which is at about 12m AHD. The precinct has been created by filling some low lying ground and it drains generally to the west into an artificial wetland which itself eventually drains in the Nepean River.

Boundary Creek enters the River from the east about 650m south of the precinct.

Figure 1: Location of the Penrith Lakes Employment Precinct

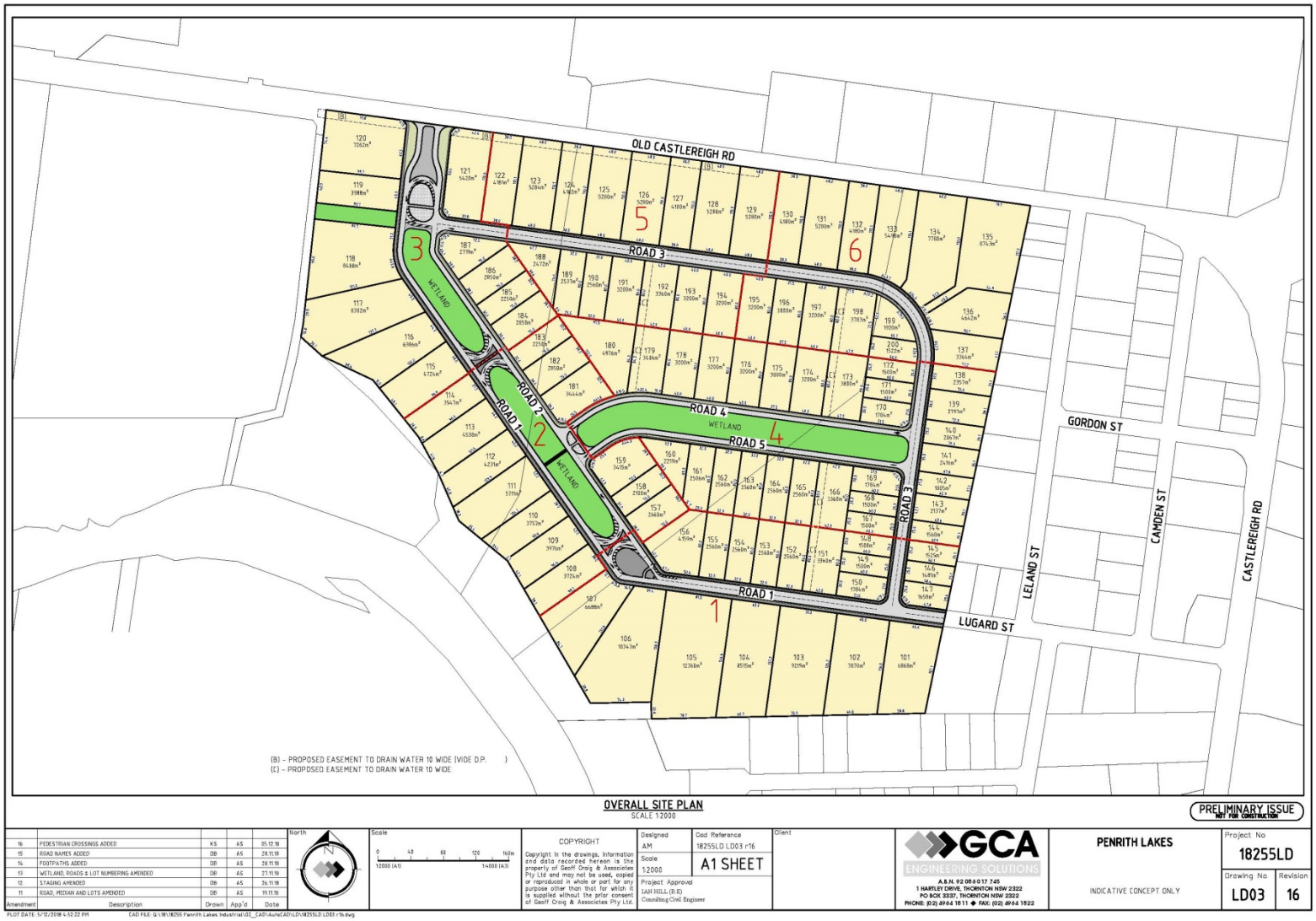

Figure 2: Indicative Layout Plan for the Penrith Lakes Employment Precinct

2 FLOOD RISKS

2.1 FLOOD GENERATING WEATHER

Coastal areas of eastern Australia mostly receive flooding rains from so-called "east coast lows" that develop from time to time over the adjacent Tasman Sea. These are intense depressions off the coast and can produce thunderstorm activity associated with troughs.

Depressions can develop at any time of year, but are most likely when sea surface temperatures are high and the air is humid. Therefore, these events usually occur in the summer months and over the first half of the year.

Flooding can also be a winter-spring phenomenon, associated with unusually frequent or active extra-tropical depressions and fronts. However some major events have occurred in the summer half-year as systems of tropical origin extend or move south. Flooding over inland areas is usually associated with southward-moving tropical systems, but in the cooler months, may occur when well-developed cloudbands extend across the interior from the oceans north and northwest of Australia.

All of the above weather can result in extended rainfall events which can cause flooding in the Nepean River or in Boundary Creek or both.

Flooding is more prevalent in a La Nina year when rainfall is significantly greater than the average rainfall.

Rainfall patterns are also dependant on weather patterns that occur throughout the year. Thunderstorms, which generally occur during the summer, can result in localised flooding, which could impact on the site.

Sydney has experienced severe thunderstorms in the past and because large expanses of the urban area are paved, much of the rainfall becomes flood run-off. This could result in localised flooding of Boundary Creek but is unlikely to be the cause of flooding in the Nepean River.

The Hawkesbury-Nepean Valley has been flooded in numerous large rainfall events, although there has not been a significant flood in the valley for more than 20 years. In summary, there are many different weather events which could cause flooding at the site and this could happen at any time of year.

2.2 FLOOD PROBABILITIES

Flood probability can be expressed in more than one way. For example a flood may be described as having a 1 in 100 year average recurrence interval (ARI). This means that over many thousands of years, a flood of this magnitude would occur on average once in 100 years. This does not mean that a flood of this size only occurs once every 100 years. It is possible to have floods of this size in consecutive years or even two in the same year. This happened in several locations in Queensland and Victoria in 2010 and 2011.

Another way of expressing flood probability is in terms of average exceedance probability (AEP). A 1 in 100 year ARI flood has roughly a 1 in 100 AEP. That is, each year and every year it has a 1 in 100 or 1% chance of being reached or exceeded. This is perhaps a more helpful way of thinking about flood probabilities.

This document will refer to flood probabilities in terms of chance per year. Each and every year a 1 in 100 chance per year flood has a 1 in 100 chance of being equalled or exceeded in that year.

A flood with a 1 in 100 chance per year has about a 1 in 2 chance of being reached or exceeded in the average person's lifetime, the same probability of tossing a coin and getting a head.

Bigger floods can and do occur. There were several floods with greater than a 1 in 100 chance per year experienced in Eastern Australia in early 2011. Some reached levels which have a 1 in 1,000 (0.01%) chance per year.

A flood with a 1 in 500 chance per year has about a 1 in 6 chance of being reached or exceeded in the average person's lifetime, the same as tossing a die and getting a 6.

The largest flood that can occur is referred to as the Probable Maximum Flood (PMF). Although it has a very low probability of occurring in any one year (1 in 10,000 chance per year or less), events approaching a PMF have been recorded.

Flooding may occur at any time of year and at any time of day. There is no seasonality associated with flooding in Sydney and an event could occur during hours of operation for commercial premises on the site.

2.3 FLOODING ON THE SITE

2.3.1 Nepean River

The largest flood on record in the Hawkesbury-Nepean valley occurred in 1867 when the river level reached 26.9 metres Australian Height Datum (AHD) at Victoria Bridge at Penrith. This flood is estimated to have about a 1 in 200 chance of occurrence in any year (more specifically, 1 in 170 chance per year at Penrith). A PMF event would reach a level of approximately 32.1 metres AHD at Victoria Bridge. Table 1 outlines the history of recorded floods in the valley.

Sediment within the Fairlight Gorge in the Nepean River upstream of Penrith shows that prior to European settlement at least one flood reached or exceeded the level of a flood with about a 1 in 500 chance per year level of 27.6 metres AHD at Penrith. The most recent floods in the Hawkesbury-Nepean Valley have ranged been 1 in 5 and 1 in 30 chance of occurrence flood levels.

To place these probabilities in context, some of the rivers in Victoria which flooded in 2011 experienced floods with a 1 in 200 chance per year level, while some catchments in Queensland experienced floods in 2011 that have been reported to have had about a 1 in 1,000 chance of occurrence per year.

Flood waters from the Nepean River would initially back up Boundary Creek, eventually flooding Castlereagh Road and cutting the evacuation route south of the site. As the water level continues to rise it would break the river banks and enter the existing industrial estate immediately south of the site.

Further flood rises would result in the water to the south eventually flowing around the east of the precinct and cutting off its access via Lugard Street. At the same time the water backing up in Boundary Creek would have crossed Andrews Road, cutting off that evacuation route. Once water overtops Lugard Street it would flow through the industrial estate to the north and cut Old Castlereagh Road which is at a lower level.

Eventually the river overtops the banks adjacent to the site and the whole site will be flooded.

2.3.2 Flood Levels

The Penrith gauge is just upstream of Victoria Bridge which itself is upstream of Penrith Weir. The precinct is 700m downstream of the weir. This means that the water level at the gauge is higher than the water level at the site but this difference diminishes as flood levels increase.

Table 1 shows the full range of flood levels which could affect the site. The table shows three levels. The first is the peak gauge level at Victoria Bridge for the corresponding flood probability (note that historically the gauge was set arbitrarily with a zero reading at 14.139m AHD). The second level is the corresponding peak height above sea level (m AHD) for that gauge reading. The third level is the peak level at the precinct which would be reached for a flood of that probability.

The 1 in 100 chance per year flood would reach a peak of 25.9m AHD at the gauge and about 25.4m AHD adjacent to the precinct. The entire Precinct is at or above 26.5m AHD and so would not be directly affected by the flood. However, as shown in Table 1 its evacuation route along Castlereagh Road would be cut by floodwaters backing up Boundary Creek. The road has a low point of 24.2m AHD at the creek crossing and would be covered by 1.2m of water. The neighbouring industrial estate immediately to the south of the precinct would be flooded.

Table 1: Flood history in the Hawkesbury-Nepean valley

Chance per year	Peak gauge level at Victoria Bridge (m)	Peak flood level at Victoria Bridge, Penrith (m AHD)	Peak flood level at the Precinct (m AHD)	Occurrence
1 in 5	6.3	20.4	19.9	1992, 1986, 1975, 1956, 1952 & 11 other times
1 in 10	7.8	21.9	20.7	
1 in 20	9.4	23.5	22.6	
1 in 30	9.8	23.9	23.1	1990, 1978, 1964, 1956 & 12 other times (8 times 1806-1819)
1 in 40	10.3	24.4	23.7	1961, 1799
1 in 50	10.7	24.8	24.1	
1 in 100	11.8	25.9	25.4	No record
1 in 200	12.4	26.5	26.0	1867
1 in 500	13.0	27.1	26.6	At least once before 1788
1 in 1,000	13.5	27.6	26.9	No record
PMF	17.4	31.5	31.1	No record

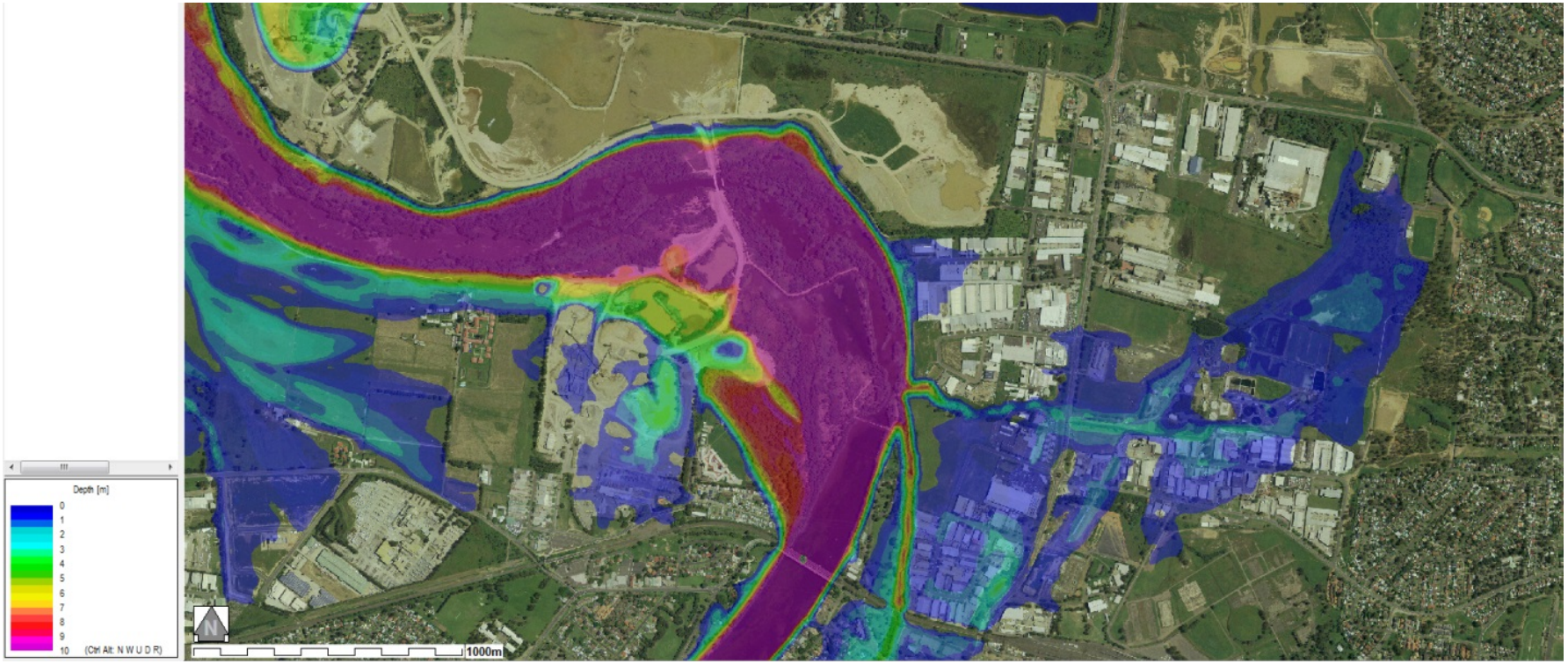

Figure 3: 1 in 100 chance per year flood depths

A flood would have to reach about the 1 in 1000 chance per year level of 26.9m AHD before the lowest parts of the site began to flood through water backing up into the internal drainage system and onto the lowest parts of roads by a couple of hundred millimetres.

The PMF peak level at the gauge is 31.5m AHD) and 31.1m at the precinct. The whole precinct would therefore be flooded to a depth of up to 4m.

2.3.3 Rate of Flood Rise

The rate at which this water rises will vary depending on how big the flood is and how quickly the rain is falling. The NSW SES plans its vehicular evacuation of the Hawkesbury Nepean Valley around an average rate of rise of about 0.5m per hour and pedestrian evacuation around a rate of rise of about 1.5m per hour. Floods could rise more slowly than this but it is appropriate to plan around these rapid rates of rise as they are quite possible.

It should also be noted that the peak at the site will occur sometime after the flood has peaked at Victoria Bridge because of the time it takes the flood peak to travel downstream from the bridge.

2.3.4 Critical Levels

There are several levels associated with the Penrith Lakes Employment Precinct which are critical to the safety of people and the protection of property. They are:

- 24.2m AHD – the lowest point along Castlereagh Road which is the primary evacuation route for the site. All vehicles should leave the precinct before flooding reaches this level at Castlereagh Road.
- 25.4m AHD – the lowest point on Lugard Street. When flooding exceeds this level adjacent to the precinct, exiting the precinct by car or on foot in this direction becomes dangerous. Water would flow north from this point and cut Old Castlereagh Road which is at a lower level. Andrews Road would also be cut by water backing up Boundary Creek. Once this level is reached safe evacuation routes from the site are effectively cut.
- 26.7m AHD – the lowest point within the precinct. At this level floodwaters enter the precinct directly from the river via the internal drainage system.
- 30.5m AHD – the highest ground level within the precinct would flood.

Floor levels in each of the buildings within the precinct vary and details of those should be provided in each respective flood response plan. Some may have mezzanine floors or first floors which are above the reach of the PMF. An extreme flood could isolate the precinct for up to three days.

2.3.5 Emergency Response Classification

The NSW SES has developed a classification system for areas within floodplains which determines whether those who fail to evacuate by car:

- have safe walking access to a flood free area
- would be isolated and/or overwhelmed by rising floodwaters

The Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities (DECC, 2007) provides details of the classification system.

According to this classification system the precinct is a Low Flood Island (LFI). This is an area whose evacuation routes get cut before the area begins to flood but as floodwaters rise the whole area can be inundated.

3 EMERGENCY MANAGEMENT CONTEXT

3.1 NSW SES FLOOD EMERGENCY PLAN

The NSW SES flood response strategy for the Hawkesbury Nepean Valley is set out in its Hawkesbury Nepean Flood Emergency Sub Plan (2015). It involves evacuating all residential, business and other premises that are at risk of flooding and directing evacuees towards Sydney Olympic Park. It is expected that most evacuees will find their own temporary accommodation with friends and relatives or at commercial accommodation outside of the floodplain. Those who cannot will be assisted at Sydney Olympic Park.

To achieve orderly and timely evacuation, the NSW SES has divided the floodplain into sectors and subsectors with designated evacuation routes.

The Precinct is located within the North Penrith A subsector within the Penrith North Sector. This subsector includes the undeveloped land to the west of the precinct as well as the existing industrial estates to the east and south. Along with North Penrith B subsector, this subsector would evacuate south along Castlereagh Road before heading east along Coreen Avenue to The Northern Road. The subsectors and evacuation route are shown in Figure 4.

3.2 SES EVACUATION TIMELINE MODEL

The NSW SES has developed the Timeline Evacuation Model (TEM) as an empirical means of consistently estimating the ability of people to safely evacuate by motor vehicle from floodplains (Opper et al, 2009). 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 this 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.

The TEM was born out of the 1997 Hawkesbury-Nepean Floodplain Management Strategy, where the NSW SES applied conventional time line project management to the flood evacuation problem. It became apparent that this approach provided a clear and concise method for examining the evacuation process.

Since that time, the approach has been refined into a model that can be easily applied to different developments. The TEM has been used widely within NSW by both the NSW SES and consultants in evacuation planning, with the scale of the model ranging from small sub divisions to towns of tens of thousands of people.

The primary goal of the TEM is to compare the time required for evacuation with the time available for evacuation. This can be represented by the equation:

Surplus Time = Time Available – Time Required

or:

ST=TA-TR

Where the Time Available exceeds the Time Required there can be greater confidence that a community can evacuate safely by motor vehicle. Where the Time Required exceeds the Time Available it is unlikely that everyone will be able to evacuate safely by motor vehicle in all floods.

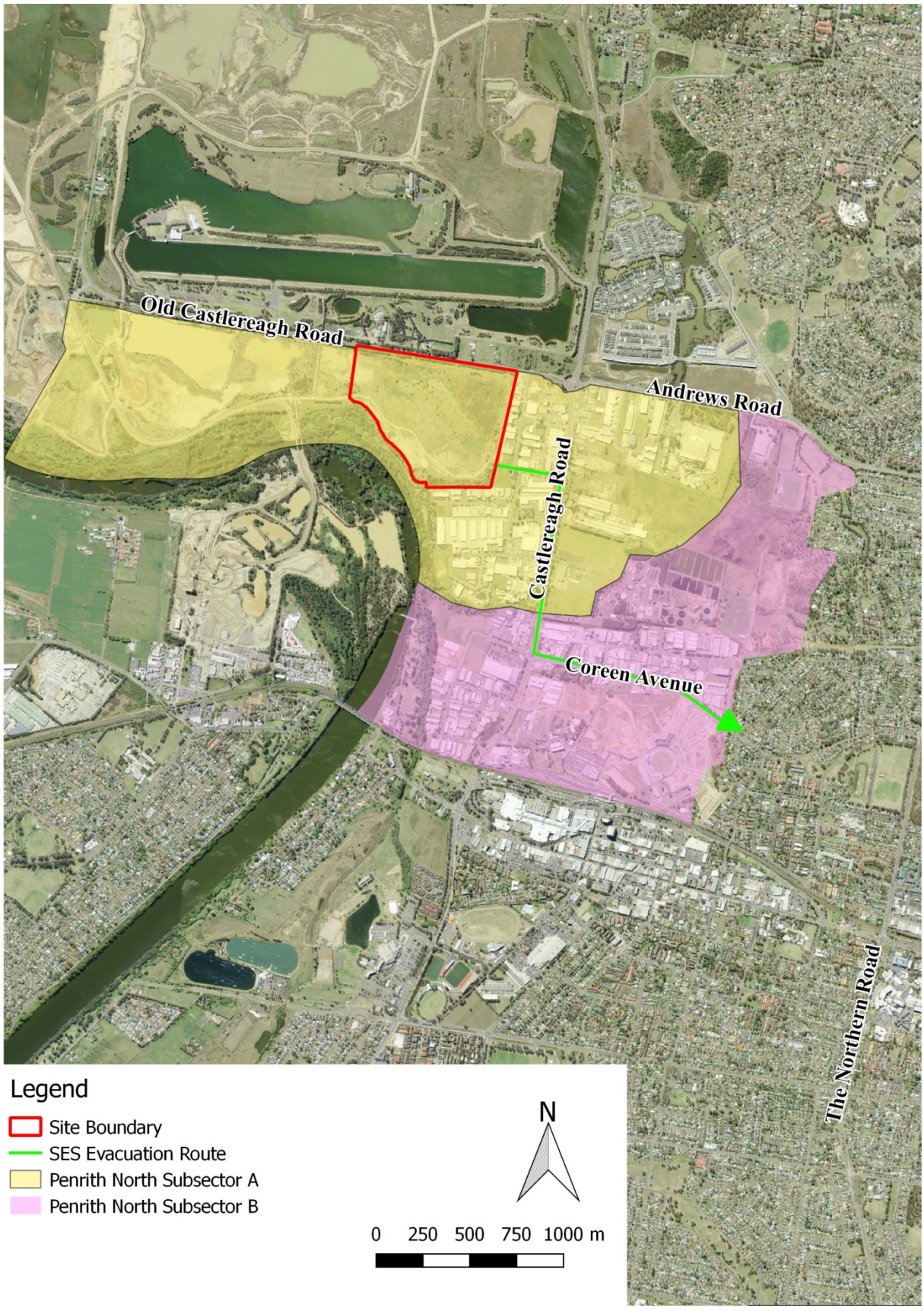

Figure 4: Evacuation subsectors and vehicle evacuation routes for the Penrith North Sector

3.2.1 Estimating the Time Required

The time required (TR) can be described by the equation

TR = WAF + WLF + TT + TSF

Where:

- **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. Therefore if an evacuation generates 1,200 vehicles and the evacuation route has one lane, then the travel time is two hours. If there are two lanes the travel time is reduced to one hour.
- **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. The NSW SES has developed a table of traffic safety factors, where the safety factor is proportional to the travel time, ranging from one hour to three and a half hours (Table 2).

The time needed to disseminate an evacuation order also needs to be considered. Generally, the NSW SES will broadcast the order by several means but will also initiate doorknocking of the target premises. The model assumes that the evacuation order is not received at a property until it is doorknocked and that at any one time there will be properties at different stages of the evacuation sequence.

However, this is only true if the number of door knocking teams available is equal to the number that would produce enough traffic to keep the evacuation route at full capacity. Should the number of door knocking teams available be less than this optimal number, then the travel time must be modified to account for this. If more door knockers are provided than the optimal number then the rate of traffic generation will exceed the road capacity and traffic queues will form until no more premises evacuate.

Table 2: Traffic Safety Factors

Travel Time TT (hrs)	Traffic Safety Factor TSF (hrs)
0 to 3	1.0
>3 to 6	1.5
>6 to 9	2.0
>9 to 12	2.5
>12 to 15	3.0
>15	3.5

3.2.2 Estimating Time Available

The time available is usually the time from when an Evacuation Order is issued by the NSW SES to when the lowest point on the evacuation route is cut by floodwaters. The ability to estimate this time for use in the TEM will be very dependent on the quality of available flood data, and the type of warning products which the Bureau of Meteorology (BoM) is able to provide.

In the case of the Nepean River, the Hawkesbury Nepean Flood Emergency Sub Plan (NSW SES, 2015) provides some guidance with regard to available warning times. The plan states that for floods forecast to exceed 11.3m AHD at Penrith, 8 hours warning is required. Discussions with the Bureau of Meteorology over the past 15 years have suggested that 7 hours is more realistic for the magnitude of flooding which would impact on Penrith Lakes Employment Precinct which involves flooding in excess of 24m AHD at Penrith.

The timing of such a forecast is called the Quantitative Precipitation Forecast (QPF) Limit and is the minimum time (in advance) that the flood height can be forecast with a high level of certainty. It uses gauging of rainfall and

upstream river levels. This forecasting is not simply forecasting the peak height but any particular height being reached or exceeded. A QPF limit of seven hours has been assumed in all of the evacuation planning and modelling around Penrith.

Any flood can be represented by a hydrograph at specified points along a river. A hydrograph plots how the water level goes up and down over time. Because the TEM is interested in the minimum time which is likely to be available, and there will be limited data about the possible rates of rise of floods, the PMF hydrograph is usually used for these steps.

This does not mean that the TEM is only estimating the time available in a PMF. Modelled design floods and even records of actual floods only represent one possible rate of rise for a flood to reach a particular peak. Floods with peaks smaller than a PMF could rise at rates approaching that of a PMF, particularly in the range in which evacuation needs to take place which is often well below the flood peak.

3.2.3 Other Considerations

In keeping with the principles of the NSW Floodplain Development Manual (DECC, 2005), the results of the TEM calculations must be considered within a risk framework and merits based decisions need to be made as to the appropriateness or otherwise of modelled evacuation arrangements for existing and proposed developments.

The following highlight some of the issues which need to be considered beyond the results provided by the TEM.

- **Traffic Convergence:** While each community, development or precinct must be evaluated individually to determine whether full evacuation is possible, it must be recognised that the evacuation traffic from several locations may be directed to the same road and therefore the potential for traffic convergence to affect completion of the evacuation must be considered.
- **Safety Margins:** Any surplus time calculated through the timeline evacuation modelling can be considered to be a safety margin should any of the model assumptions prove to be non-conservative.
- **Consequences of Evacuation Failure:** There are many reasons why vehicular evacuation may fail. It therefore must be acknowledged that some, or all, of the evacuees will be unable to evacuate by motor vehicle. The probability and consequences of such a failure must come into consideration when determining the appropriateness of a new development. The Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities (DECC, 2007) provides some guidance in this regard. The classification system determines whether those who fail to evacuate by car:
  - have safe walking access to a flood free area
  - would be isolated and/or overwhelmed by rising floodwaters
- **Sensitivity of Variables:** Default values for many of the variables used in the TEM have been determined by the NSW SES. It is expected that any application of the TEM will utilise these default values, except where it can be clearly justified to use alternative values. Other variables will be derived from available flood modelling, census data, council records and development details. There may need to be assumptions made in selecting values from this data for use in the TEM. The sensitivity of the TEM to these assumptions should be tested to ensure that any conclusions drawn from using the model are robust.

3.3 ALTERNATIVES TO TEM

The NSW SES recognises that evacuation of a development may not necessarily occur in isolation as other nearby developments may also have to evacuate at the same time. The TEM makes provision for estimating how converging evacuation traffic may impact on the ability of developments to evacuate simultaneously. However, the TEM is not set up to consider more than two converging traffic streams and in the Hawkesbury Nepean floodplain there are multiple subsectors evacuating onto shared evacuation routes.

This means that more sophisticated modelling that accounts for traffic convergence in more detail is required. This would allow consideration on what impact other existing evacuating traffic from the Hawkesbury Nepean floodplain would have on the safe evacuation of Penrith Lakes and vice versa.

Furthermore, the TEM is coarse in that it analyses towns, precincts, subsectors or sectors as a single block and provides no sense of what is happening to evacuation traffic on the roads within the spatial unit which is evacuating.

In recent years more sophisticated models for the estimation of loss of life in any flood event have been created. One of the most advanced of these was developed by British Columbia Hydro in Canada and commercialised as the Life Safety Model (LSM) by HR Wallingford in the UK.

HR Wallingford, under licence from British Columbia Hydro, has developed the LSM into a dynamic model that represents:

- the rise and spread of floodwaters
- the receipt of warning messages
- the response of occupants to the warning
- evacuation traffic flow
- the fate of those who fail to evacuate before the arrival of floodwaters.

It models the evacuation and fate of each individual household based on their exact spatial location and the available road network over time. Time series output from the model can be viewed as animations as well as in tables.

The Hawkesbury Nepean Valley Flood Management Taskforce is currently developing a dynamic evacuation model for the Hawkesbury Nepean Valley. However, Molino Stewart has already created one for analysing evacuation modelling of Penrith Lakes. This uses inputs and assumptions provided by the Taskforce and NSW SES and appears to give results consistent with the Taskforce's preliminary modelling. The Taskforce's estimates of vehicle numbers in 2041 have been used which accounts for significant infill development across the floodplain.

This model has been used to evaluate evacuation for the Penrith Lakes Employment Land.

3.4 EVACUATION MODELLING RESULTS

According to our evacuation modelling of the region, the first of the premises in the Penrith North Sector would be doorknocked at time=9 hours on the timeline within the model and they are showing as being aware in the model extract (Figure 5). An evacuation order would be broadcast to everyone simultaneously but the NSWSES Timeline Evacuation Modelling assumes that door knocking will be used to confirm everyone has got the message, understood it and is responding appropriately.

By t=11 everyone is aware of the need to evacuate and the first vehicle from the North Penrith A Subsector is on Castlereagh Road (Figure 6). At t=12:30 nearly all of the premises have evacuated and the traffic queue on Castlereagh Road is dissipating (Figure 7). Within another 10 minutes everyone has left the subsector and passed the low point at Boundary Creek

The flooding will not cross the road until t=16. This means that there is 3.5 hours surplus time to evacuate. However, the NSWSES Timeline Evacuation Model requires an allowance for traffic accidents, breakdowns, trees and power lines across the road etc. For an evacuation which theoretically will have vehicles on the evacuation route for 1.5hours, a traffic safety factor of 1.0 hours needs to be allowed. This would reduce the surplus time to 2.5hours.

The NSWSES timeline evacuation model requires that evacuation be modelled on the assumption that the road capacity is only 600 vehicles per hour per lane of evacuating traffic. Since Coreen Avenue is only a single lane the evacuation route capacity for the subsector is 600 vehicles per hour. In 2.5 hours 1,500 vehicles would be able to evacuate. The proposed Penrith Lakes Employment Precinct's 100 lot subdivision is not going to generate anywhere near 1,500 vehicles.

In a flood rising as fast as the 72hr PMF, Boundary Creek is likely to cross the road when the water level is 24.4m AHD at the Penrith Gauge (i.e. 10.3m gauge reading). The Bureau of Meteorology defines major flooding at Penrith as a 10.4m gauge reading (24.5m AHD).

The NSWSES is likely to issue an evacuation order for the North Penrith A Subsector, including Penrith Lakes Employment Precinct when there is a quantified flood forecast at the Penrith Gauge of 10.4m or a generalised Major Flood warning. This has somewhere between a 1 in 40 (10.3m) and 1 in 50 (10.7m) chance of occurrence in any year.

There will be ample time for the site to evacuate along with other subsector traffic and it is not likely to be any significant impacts on other regional traffic evacuation.

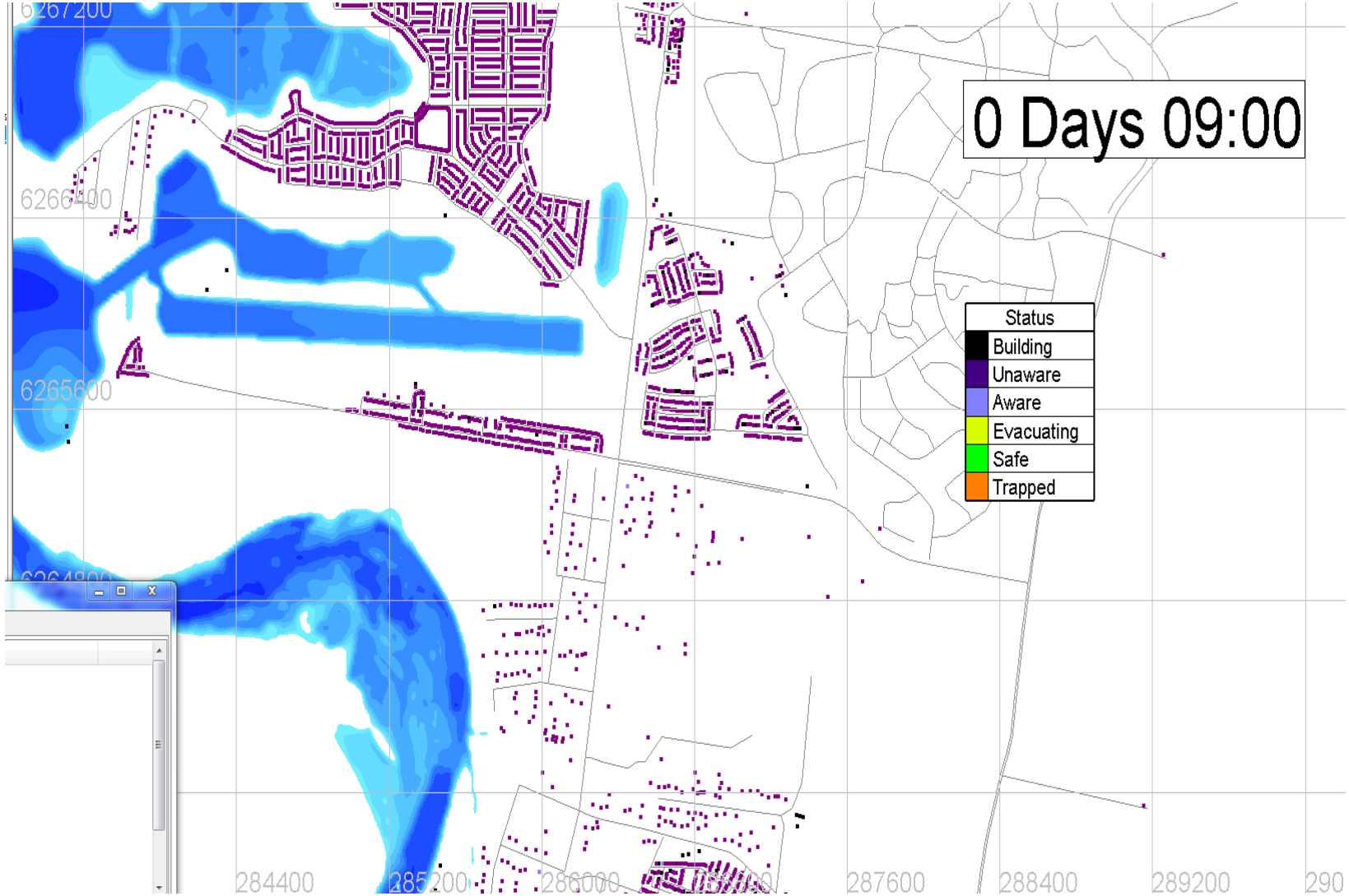

Figure 5: Evacuation modelling at t=9.0 hrs

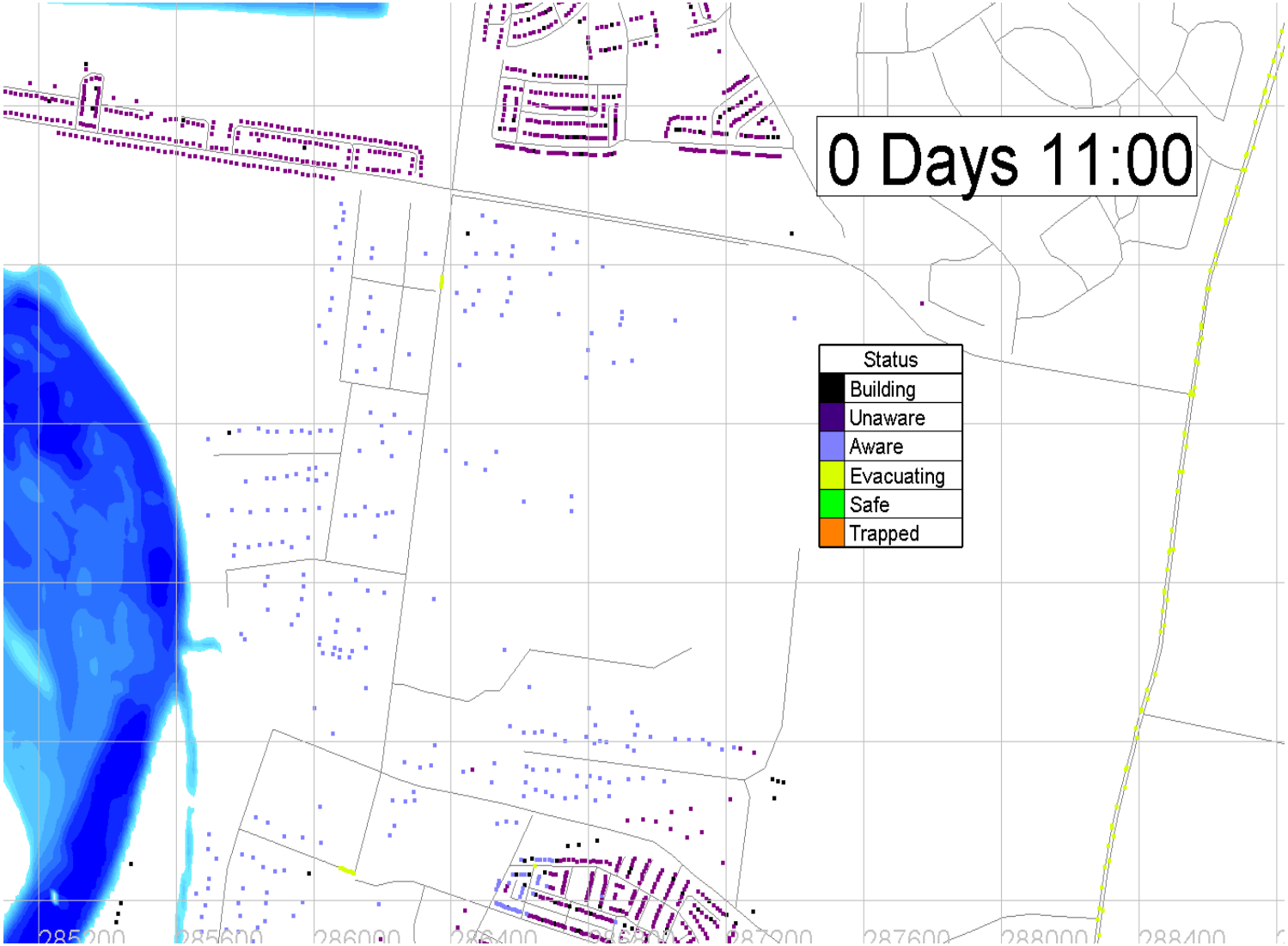

Figure 6: Evacuation modelling at t=11.0 hrs

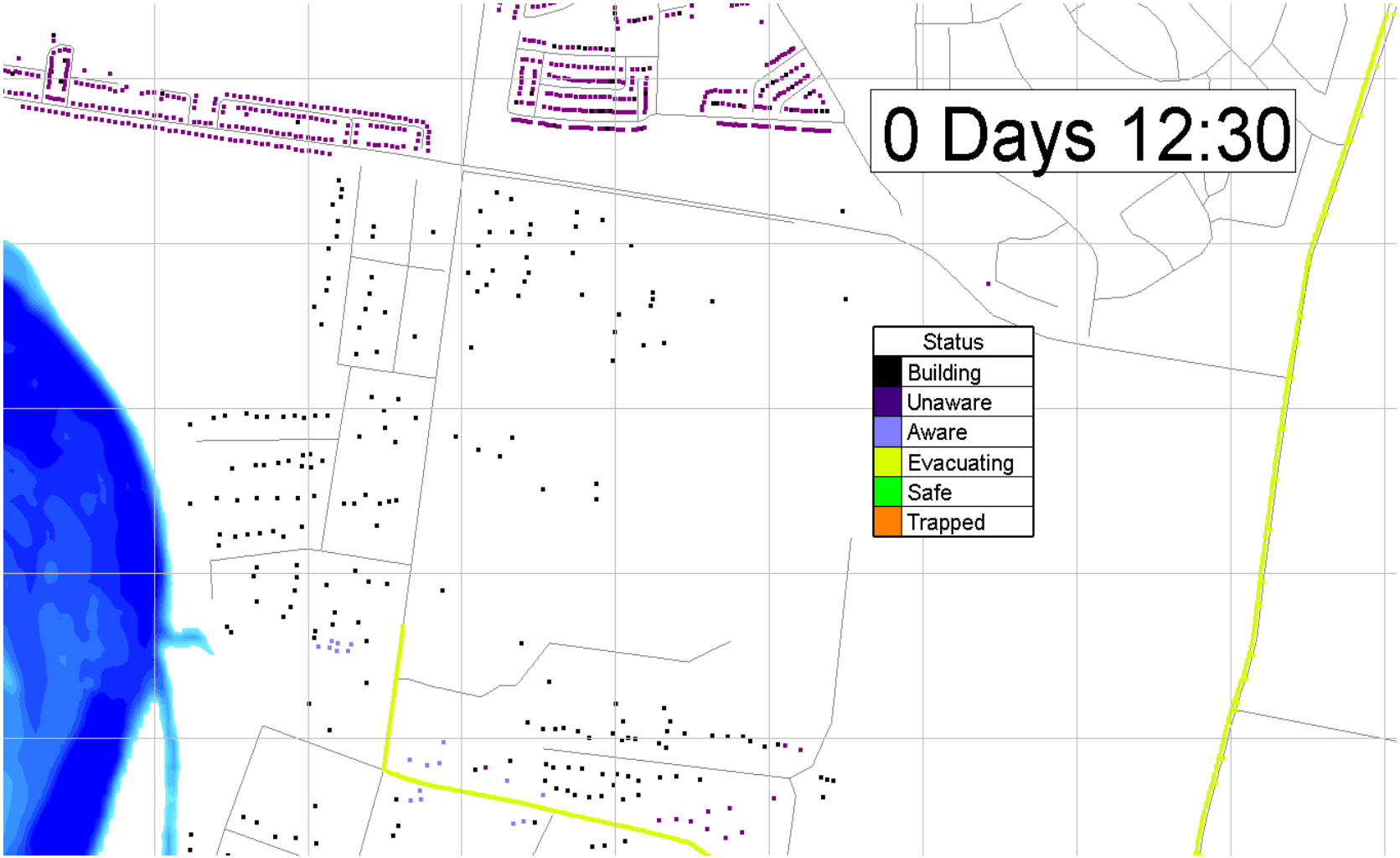

Figure 7: Evacuation modelling at t=12.5 hrs

4 PRECINCT FERP

4.1 EMERGENCY RESPONSE PHILOSOPHY

This FERP recognises that protection of life is of critical and primary importance.

The protection of all lives is the first priority, the comfort of workers and customers is second, the protection of property is third and the continuity of business operations, while of lesser priority, should not be overlooked.

While this FERP recognises the need for developers, owners and operations managers at premises within the precinct to consider financial implications, this will not be consciously done to the detriment of protecting life. It is incumbent on the developers, owners and operations managers to take all necessary measures outside of this FERP to manage the financial risks which flooding poses to their property and assets.

Therefore the proposed response to a flood is the evacuation of the entire precinct. The FERP for the Penrith Lakes Employment Precinct must be consistent with the NSW SES Flood Emergency Plan for the Hawkesbury Nepean Valley and the Penrith area in particular.

4.2 EVACUATION

Because the precinct is a low flood island it is imperative that it is evacuated before its evacuation routes are cut by flooding. The NSW SES nominated primary evacuation route for the precinct is south on Castlereagh Road then east on Coreen Avenue. Should Castlereagh Road be closed at Boundary Creek due to flooding then it would be possible to head north on Boundary Road and east on Andrews Road. This route should not be used as a primary evacuation route as it will be needed for the evacuation of the Penrith Lakes residential areas should they proceed. The secondary route may remain open for about six hours longer than the primary evacuation route.

The secondary evacuation route is also recommended as the pedestrian evacuation route as it provides the shortest route from the precinct to flood free land and will remain open the longest. It is about a 2.5km from most locations in the precinct to the section of Andrews Road which is above the reach of the PMF. This would take about 30 minutes to walk at a brisk walking pace or about one hour at a strolling pace.

The evacuation routes are shown in Figure 8.

4.3 ROLES AND RESPONSIBILITIES

This FERP is an overarching FERP for the precinct which provides important information on flood levels, flood warnings, evacuation triggers, evacuation routes and actions to take before during and after a flood. Each of the businesses within the precinct will need to development their own FERP which is consistent with the overarching FERP but which deals with the specifics of their business.

Each of the premises in the Precinct will have a management structure, either individual business management or strata management. The specific roles and responsibilities within each business or body corporate with regard to flood emergency response will need to be determined by each of those organisations.

Each of these premises will need to have someone who is responsible for maintaining and implementing their FERP such as monitoring river heights, ensuring basic measures are in place and issuing the necessary warnings when the river reaches the relevant trigger levels (see Section 3.6.3b).

For each individual building FERP this management structure must be identified, documented and flood responsibilities allocated to personnel with appropriate seniority.

No reliance will be placed upon the New South Wales State Emergency Service or Penrith City Council's emergency resources in the development or implementation of individual FERPs.

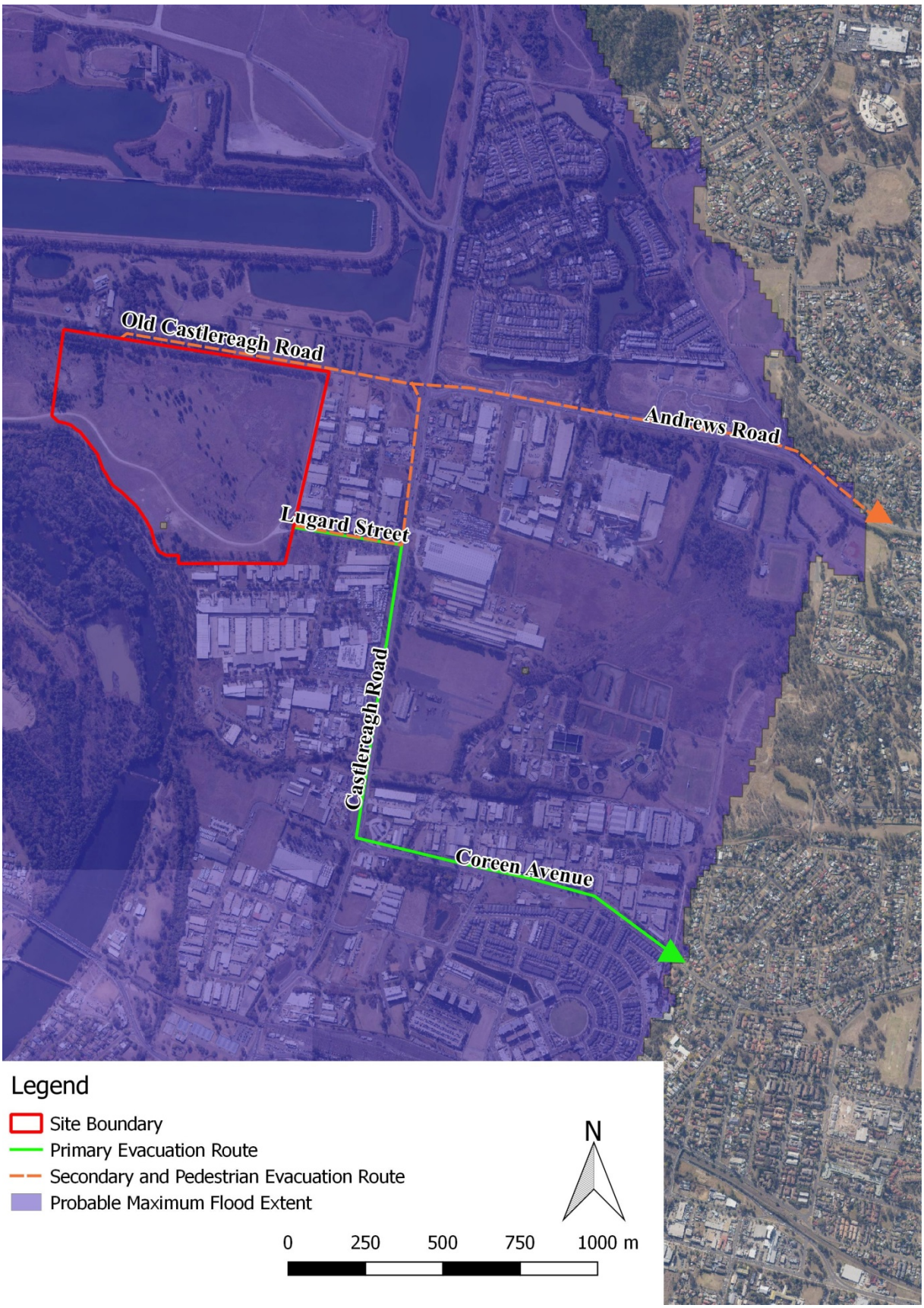

Figure 8: Evacuation Routes

4.4 FORECASTS AND WARNINGS

4.4.1 Bureau of Meteorology

Monitoring the weather forecasts and warnings will be an integral step in managing the flood risk of the Penrith Lakes Employment Precinct. This will be critical to being able to evacuate the site before flooding cuts evacuation routes.

The Bureau of Meteorology (BoM) has forecast rainfall maps which can be used to estimate the amount of rain expected to fall over the next eight and four days, as well as the next 24 hours. This information is available at: www.bom.gov.au/jsp/watl/rainfall/pme.jsp.

NSW Weather Warnings are issued by the Bureau of Meteorology and can be found at the following link: www.bom.gov.au/nsw/warnings/.

The Bureau will also provide specific warnings for flooding in the Nepean River.

There are five potential warnings of relevance to the precinct which operators and managers will need to be alert to. They are:

- Severe Weather Warnings for the Sydney Metropolitan Area or Western Sydney – these are an alert to possible flooding in Boundary Creek
- Flash Flood Warnings for the Sydney Metropolitan Area or Western Sydney – these are an alert to possible flooding in Boundary Creek.
- A Flood Watch for the Nepean River – this is a heads up that flood producing rainfall is forecast within the catchment and flooding may eventuate
- A General Flood Warning for the Nepean River – this is a warning that minor, moderate or major flooding is expected on the Nepean River but it is too early to forecast specific levels
- A Quantified Flood Warning for the Nepean River at Penrith. This will include a forecast flood height and the time at which that height is expected to be reached. It may also include information on whether further flood rises are expected, whether that forecast is expected to peak or whether the river level is falling.

The Bureau of Meteorology also has rainfall and river gauges which show the amount of rainfall that has fallen in the previous 24 hour period and stream gauges which indicate water heights. These can be monitored at: www.bom.gov.au/australia/flood/.

There are several gauges in the region that are relevant to flood prediction and warning. The most relevant for the precinct is the Penrith gauge at Victoria Bridge and flood response actions for the Precinct should principally be determined by forecasts related to this gauge.

Gauge readings at Warragamba Dam, Camden Weir and Wallacia Weir will be indicative of flood behaviour upstream of Penrith and would be indicative of expected flood behaviour at Penrith some hours later. The data on the website is updated every hour or so.

The radar service on the BoM website also shows current rainfall location and intensities. The radar station to be used for the site would be the Sydney radar at:

http://www.bom.gov.au/products/IDR713.loop.shtml.

It also needs to be remembered that it is the forecast level at the Penrith gauge, not the observed level at the gauge, which needs to be used to trigger evacuation of the Precinct because it is the time it takes to reach the forecast level which is needed to effect evacuation.

4.4.2 Alerts and Responses

Level 1 Alert: Basic preparedness – Bureau of Meteorology issues either a:

- Severe Weather Warning for the Sydney Metropolitan Area or Western Sydney
- Flash Flood Warning for the Sydney Metropolitan Area or Western Sydney

Level 2 Alert: Prepare for potential closure of Precinct – Bureau of Meteorology issues either a:

- Flood Watch for the Nepean River

- Generalised Minor Flood Warning for the Nepean River:

Level 3 Alert: Prepare for closure of premises

Bureau of Meteorology issues either a:

- Generalised Moderate Flood Warning for the Nepean River
- Forecast that the river level at Penrith will exceed 8m (22.1m AHD).

Level 4 Alert: Close premises and evacuate

Bureau of Meteorology issues either a:

- Generalised Major Flood Warning for the Nepean River
- Forecast that the river level at Penrith will exceed 10.4m (24.5m AHD).

OR

The NSW SES issues an evacuation order

4.4.3 Closure and Evacuation Procedures

Flooding can occur at any time of any day and it is unlikely that many, if any, of the premises within the precinct will be open 24hrs per day, seven days per week. In fact, most business premises are closed for 60-70% of the time.

It will therefore be important that FERPs for individual businesses acknowledge their operating hours and have different responses for when they are open compared to when they are closed.

It is also noted that premises may close between a Level 2 alert being issued and a Level 3 alert being issued. It may be prudent to close the premises at the end of the day when a Level 2 alert is issued and not reopen until it is clear that major flooding is not likely to occur.

While this FERP documents that there is likely to be several hours between when an evacuation order is given and when the evacuation route is cut, delaying evacuation should be avoided. The evacuation planning is done on the assumption that everyone will start leaving when the evacuation order is given. If everyone delays their evacuation until the business would otherwise be closing for the day there may be insufficient time for everyone in the subsector to safely evacuate.

If individual business FERPs include procedures for protecting property from flood damage (e.g. moving plant, equipment and stock off site or into higher parts of the building) these should be triggered at a Level 2 alert and not at the Level 3 alert.

If people fail to evacuate from buildings by vehicle or on foot before the precinct is isolated, they should contact NSW SES then stay within the highest part of the building until and the all clear has been given. Sheltering on site should only be a last resort if evacuation has failed because the precinct could be isolated for up to three days, there is unlikely to be power, telecommunications or safe water supply and flood depths and velocities could cause buildings to fail.

5 MANAGEMENT ACTIONS

The management actions listed below are also provided in a Flood Actions Checklist in Appendix A. This is a generic list for the precinct and should be edited and supplemented to reflect the specific needs of each premises.

5.1 BEFORE A FLOOD

Trigger for action: Always

- All management, staff, and temporary employees likely to be in the Precinct at any time will be made aware of the possibility of flooding and the emergency procedures to be followed if a flood were to occur. This will be done by including flood procedures during staff inductions.
- Each development will develop and maintain detailed emergency procedures consistent with this precinct FERP and that takes into account any additional risks associated with the particular development.
- The procedures will also include clear responsibilities for management and staff in the event of a flood, and back up resources should key personnel not be present.
- The business management will maintain an emergency contacts list to advise the various emergency services and essential staff of the actions in train on the site. A suggested format for these details and other necessary contact details is provided in Appendix B – this will need to be completed by each business.
- A staff contact list will be created for each business and kept up-to-date in electronic AND hard copy format in the business offices on site.
- Management will appoint a staff member to monitor weather forecasts, current and predicted rainfall, flood warnings and the local gauge readings to ensure that any design features or equipment required to implement the FERP are in working order. They may delegate some duties to other staff and must have provision for suitable back-ups.

5.2 WHEN A FLOOD IS LIKELY

***Trigger for action:* When the Bureau of Meteorology issues severe weather warnings or flash flooding warnings for the Sydney Metropolitan area or Western Sydney, a Level 1 Alert for basic preparedness should be raised.**

The manager or delegate responsible will ensure that:

- there is a hard copy of the FERP on site
- all emergency contact details within the FERP are up to date
- all staff have been trained in the flood emergency procedures
- contact details are available for:
  - all staff who will be rostered on for the next week; and
  - all clients or customers that have appointments for the next week.
  - All deliveries which are expected in the next week
- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every four hours and advise management accordingly.

Trigger for action: When the Bureau of Meteorology issues either a Flood Watch for the Nepean River or a Minor flood warning for the Nepean River at Penrith, a Level 2 Alert should be raised and preparations made for possible closure of the Precinct.

The manager or delegate responsible will ensure that:

- there is a hard copy of the FERP on site
- all emergency contact details within the FERP are up to date
- all staff have been trained in the flood emergency procedures
- contact details are available for:
  - all staff who will be rostered on for the next week; and
  - all clients or customers that have appointments for the next week.

  - All deliveries which are expected in the next week

- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every two hours and advise management accordingly.

Trigger for action: When the Bureau of Meteorology issues either a Moderate Flood Warning for the Nepean River or forecasts that the river level at Penrith will exceed 8m (22.1m AHD) a Level 3 Alert should be raised.

The manager or delegate responsible will ensure that:

- staff that are rostered on for that week are notified of the possibility of flooding and reminded of actions and procedures to follow should evacuation be required.
- all organisations/patrons booked to use any facility within the Precinct are notified of the possibility of its closure should floodwaters continue to rise.
- consideration is given to cancelling appointments and deliveries and closing the business until flood threat has passed
- any movable objects owned by each development which are external to the building are either secured to prevent them from floating away or are brought inside the building. This includes objects such as garbage bins or external tables and chairs.
- consideration is given to take any actions necessary to protect assets from flood damage such as moving high value items from flood prone areas to the mezzanine or first floor of buildings if they exist.
- forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every two hours and advise management accordingly.

5.3 DURING A FLOOD

Trigger for action: When the Bureau of Meteorology issues either a Major Flood Warning for the Nepean River or forecasts that the river level at Penrith will exceed 10.4m (24.5m AHD) OR The NSW SES issues an evacuation order a Level 4 Alert should be raised

The manager or delegate responsible will:

- Advise staff that are not on the premises that the business is expected to be isolated by flooding and is closing and for them not to come to work until further notice.
- cancel all appointments and deliveries until the flood threat has passed
- direct staff on site to leave and proceed to their homes via Castlereagh Road and Coreen Avenue.
- direct staff on site who are not able to travel to their homes are directed to travel to the Sydney Olympic Precinct at Homebush.
- direct anyone present who does not have private transport are to travel with those who do have private transport.
- sweep the site following evacuation to ensure that all have left the site, all floatable infrastructure is safely and securely stored and power, water and other utilities turned off as necessary.

Trigger for action: When Castlereagh Road is cut by flooding at Boundary Creek

- evacuate north on Castlereagh Road to Andrews Road

Trigger for action: When vehicular evacuation is not possible

- evacuate on foot to Andrews Road

Trigger for action: When floodwaters are over Lugard Street

- shelter in the building until flooding has passed
- contact NSW SES on 132 500 (if possible) and advise of your situation

5.4 AFTER A FLOOD

Trigger for action: When emergency services give the all clear to return

- No owners, tenants or staff will be allowed to return to the site while flooding is still occurring or has recently occurred.
- Owners, tenants and staff can return to the site only after the all clear has been given by emergency services or Council.
- Where necessary, the site will be appropriately cleaned and utilities checked by professionals before any re-use of the site.
- A hazard assessment will be undertaken, safe work methods statements prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods:
  - Slips, trips and falls;
  - Sharp debris;
  - Venomous animals; and
  - Contaminated water and sediments.
- A de-brief will be held with business owners and operators in the precinct and may involve emergency services and/or Council staff. The flood event and response procedures, including the use of the FERP, will be reviewed to identify changes required or considered beneficial to the operation of the plan.
- Changes may be made to the FERP and the requirements for future emergency evacuation should the review identify any improvements which may be made.

APPENDIX A – FLOOD ACTIONS CHECKLIST

Stage	Trigger for action	Action	Who is responsible	What is needed
Before A Flood				
	Always	All management, staff, and temporary employees likely to be in the Precinct at any time will be made aware of the possibility of flooding and the emergency procedures to be followed if a flood were to occur. This will be done by including flood procedures during staff inductions.	Business Manager	Up-to-date induction procedures with flooding information
		Each development will develop and maintain detailed emergency procedures consistent with this precinct FERP and that takes into account any additional risks associated with the particular development.	Business Manager	Emergency procedures
		The procedures will also include clear responsibilities for management and staff in the event of a flood, and back up resources should key personnel not be present.	Business Manager	Emergency procedures
		The business management will maintain an emergency contacts list to advise the various emergency services and essential staff of the actions in train on the site. A suggested format for these details and other necessary contact details is provided in Appendix B – this will need to be completed by each business.	Business Manager	Hard and soft copies of contact details
		A staff contact list will be created for each business and kept up-to-date in electronic AND hard copy format in the business offices on site.	Business Manager	Hard and soft copies of staff contact details
		Management will appoint a staff member to monitor weather forecasts, current and predicted rainfall, flood warnings and the local gauge readings to ensure that any design features or equipment required to implement the FERP are in working order. They may delegate some duties to other staff and must have provision for suitable back-ups.	Business Manager & appointed Flood Wardens	Staff members designated as Flood Wardens

When a Flood is Likely				
	Level 1 Alert: When the Bureau of Meteorology issues severe weather warnings or flash flood warnings for Western Sydney	Check there is a hard copy of the FERP on site	Business Manager	FERP
		Check that emergency contact details within the plan are up-to-date	Business Manager	emergency contacts
		Ensure all staff have been trained in flood emergency procedures.	Business Manager	A list of staff and their responsibilities and training for those staff members
		Check that contact details are available for: • all staff who will be rostered on for the next week; and • all clients or customers that have appointments for the next week. • All deliveries which are expected in the next week •	Business Manager	Contact details
		Nominated staff who are responsible for forecast monitoring will monitor weather forecasts, warnings, rainfall/stream gauges and onsite conditions at least every **four** hours and advise management accordingly.	Business Manager	Internet access
	Level 2 Alert: When the Bureau of Meteorology issues a Flood Watch or minor flood warning for Nepean River at Penrith	All of the above for Level 1 Alert	Business Manager	As above
		Nominated staff who are responsible for forecast monitoring will monitor weather forecasts, warnings, rainfall/stream gauges and onsite conditions at least every **two** hours and advise management accordingly.	Business Manager & appointed Flood Wardens	Internet access

	Level 3 Alert: When the Bureau of Meteorology issues a moderate flood warning for Nepean River or forecasts the river gauge level to exceed 8m (22.1m AHD)	staff that are rostered on for that week are notified of the possibility of flooding and reminded of actions and procedures to follow should evacuation be required.	Business Manager or appointed Flood Wardens	Contact details
		all organisations/patrons booked to use any facility within the Precinct are notified of the possibility of its closure should floodwaters continue to rise.	Business Manager or appointed Flood Wardens	Contact details
		consideration is given to cancelling appointments and deliveries and closing the business until flood threat has passed	Business Manager or appointed Flood Wardens	Contact details
		any movable objects owned by each development which are external to the building are either secured to prevent them from floating away or are brought inside the building. This includes objects such as garbage bins or external tables and chairs.	Business Manager or appointed Flood Wardens	Means of securing floating objects
		consideration is given to take any actions necessary to protect assets from flood damage such as moving high value items from flood prone areas to the mezzanine or first floor of buildings if they exist.	Business Manager or appointed Flood Wardens	Location above flood level
		forecasts, warnings and rainfall/stream gauges and local conditions on the site are monitored at least every **two** hours and advise management accordingly.	Business Manager & appointed Flood Wardens	Internet access

During a Flood				
	Trigger Level 4: When the Penrith gauge level is forecast to exceed 10.4m (24.5m AHD) or a major flood warning for Nepean River is issued	Advise staff that are not on the premises that the business is expected to be isolated by flooding and is closing and for them not to come to work until further notice.	Business Manager or appointed Flood Wardens	Contact details
		cancel all appointments and deliveries until the flood threat has passed	Business Manager or appointed Flood Wardens	Contact details
		direct staff on site to leave and proceed to their homes via Castlereagh Road and Coreen Avenue.	Business Manager or appointed Flood Wardens	FERP
		direct staff on site who are not able to travel to their homes are directed to travel to the Sydney Olympic Precinct at Homebush.	Business Manager or appointed Flood Wardens	FERP
		direct anyone present who does not have private transport are to travel with those who do have private transport.	Business Manager or appointed Flood Wardens	FERP
	*When **Castlereagh Road is cut** by flooding at Boundary Creek*	evacuate north on Castlereagh Road to Andrews Road	Business Manager or appointed Flood Wardens	FERP

	When vehicular evacuation is not possible	evacuate on foot to Andrews Road	Business Manager or appointed Flood Wardens	FERP
	When ***floodwaters are over Lugard Street***	shelter in the building until flooding has passed	Business Manager or appointed Flood Wardens	FERP
		contact NSW SES on 132 500 (if possible) and advise of your situation	Business Manager or appointed Flood Wardens	FERP
After a Flood				
	When emergency services give the all clear to return	No owners, tenants or staff will be allowed to return to the site while flooding is still occurring or has recently occurred.	Business Manager or Strata Manager	N/A
		Owners, tenants and staff can return to the site only after the all clear has been given by emergency services or Council.	Business Manager or Strata Manager	Contact details for owners, tenants and staff
		Where necessary, the site will need to be appropriately cleaned and utilities checked by licensed professionals before the site can be re-opened due to WH&S issues.	Business Manager or Strata Manager	Utilities contacts

		A hazard assessment will be undertaken, safe work methods statements prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods: • Slips, trips and falls • Sharp debris • Venomous animals • Contaminated water and sediments	Business Manager or Strata Manager	WHS representative to perform assessment with correct SWMS and PPE.
		A de-brief will be held with business owners and operators in the precinct and may involve emergency services and/or Council staff. The flood event and response procedures, including the use of the FERP, will be reviewed to identify changes required or considered beneficial to the operation of the plan.	Business Manager or Strata Manager	FERP and information on what occurred
		Changes may be made to the Plan and the requirements for future emergency evacuation should the review identify any improvements which may be made.	Business Manager or Strata Manager	FERP

APPENDIX B – EMERGENCY CONTACTS LIST

Name	Organisation	Role	Contact
	Body Corporate	Site Manager	???
	Business subject of FERP	General Manager	???
	Emergency Services	Fire/ambulance/police	000
	State Emergency Service	SES Local Controller	132 500
	Bureau of Meteorology	NSW Flood Warning Centre	(02) 9296 1511
	Nepean Hospital	Emergency Department	(02) 4734 2000
	Endeavour Energy	Electricity Supply	131 003
	Sydney Water	Water & Sewerage	13 20 90
	???	Telecommunications	???
	???	Waste Disposal	???