North Penrith

18/10/10

Regional Flooding Assessment

Summary

The North Penrith site is located immediately north of the Penrith railway station and is being redeveloped for around 1000 residences. The development will consist of a range of residential densities from detached to apartment type dwellings. The Concept Plan layout is presented in **Figure 1**.

This report has been prepared to support a Concept Plan and Stage 1 Project Application for the redevelopment. The Director General Requirements (DGRs) were issued on the 2nd July 2010.

Objectives

This report addresses points (7) and (8) under Section 6 in the DGR's headed *"Drainage, Stormwater and Groundwater management".* These requirements are:

> *(7) The EA shall provide an assessment of the full range of flood risks to people, property, infrastructure, and utilities from Nepean River and local flooding related to the proposal. This will be conducted in accordance with the NSW Government's Flood Prone Land Policy as set out in the Floodplain Development Manual 2005 and Section 117 Direction (4:3 Flood Prone Land and relevant Section 117 Planning Circulars).*
>
> *(8) The EA shall address development controls needed to reduce property damage to socially acceptable and sustainable levels and any flood evacuation infrastructure upgrades required for the proposed development, ensuring that flood evacuation of existing communities is not compromised by the proposed development.*

The objective of this assessment is to establish how the proposed development conforms to the NSW government Floodprone Land Policy, whether the proposed development can integrate into the SES regional evacuation strategy and how the development will manage the structural damage risk.

Methods and findings

Risk to Structural Damage

The Hawkesbury Nepean Floodplain Management Steering Committee formulated an assessment methodology for reviewing the acceptability of the risk to major structural damage from severe flooding events. The methodology is detailed in *"Managing Flood Risk Through Planning Opportunities"* (2006). This methodology was adopted and the flood risk was estimated in terms of exposure, hazard and vulnerability for the 100yr, 200yr, 500yr, 1000yr and the PMF flood events.

The findings were that the proposed development had a low to nil risk of major structural damage.

Risk to Personal Safety

The extent of flooding over the site was examined and it was evident that the site was on the edge of the floodplain with about 25% of its area above the Probable Maximum Flood (PMF). As such, there was a fail safe evacuation route to higher ground in the event of any flood.

The site is so located that there is ready access to The Northern Road which forms part of the SES regional flood evacuation plan for the Penrith area. An examination of the population and travel times in the local area of the site indicated that there was ample time for evacuation and the proposed development would not adversely impact on the evacuation of adjacent areas.

Flood Policy

The objectives of the Floodplain Development Manual and the Section 117 Direction on flooding are to minimize flood risk to damages and personal safety.

The risk to flood damages is minimized by adopting, as recommended in the Manual, a habitable floor at the flood planning level. The risk to personal safety is minimized by adopting a minimum finished ground level at the 100yr ARI flood level and ensuring that the development can be integrated into the SES regional flood evacuation strategy without adverse impact on the evacuation of other adjacent existing developments. The integration with this strategy has been demonstrated in **Section S2.2**.

The Section 117 Direction

The directive does not permit rezoning of land within flood planning areas from Special Use to Residential unless the inconsistency is of a minor significance (Clause 9 [b]). The proposed project rezoning is considered allowable under this directive because the potential impacts in terms of adverse effects on flooding in existing developments are of minor significance. The classification of minor significance is because:

- The area involved on the site is minor and the development would result in this flood affected planning area on the site being smaller;
- The minor flooding on the site is a backwater effect and as such, filling of this minor area would have no significant adverse impacts on flood behavior; and
- As the flooding up to flood planning levels is backwater flooding, there are no cumulative flooding impacts caused by the proposed development.

Conclusions

The conclusions with respect to regional flooding are that the development:

- Will be in accord with the government's Flood Prone Land Policy as it will minimize the risk for flood damages and risk to personal safety;
- Complies with the Section 117 Direction with respect to flooding as it represents an inconsistency of minor significance;
- The risks to major structural damage to property, infrastructure and utilities are within socially acceptable and sustainable levels;

- Can be integrated into the SES regional evacuation strategy without any adverse impact on the evacuation of adjacent areas or requiring significant government expenditure on infrastructure upgrades; and
- It has a fail safe evacuation route for vehicles and pedestrians within and adjacent to the site above the PMF levels.

Recommendations

The recommendations with respect to regional flooding for the development are:

- In remodeling the site to drain the site, the final ground surfaces should be at or above the regional 100yr ARI flood level of RL 25.4mAHD; and
- The minimum habitable floor level should be RL 25.9mAHD (100yr ARI flood level plus 500mm freeboard).

Contents

1. Objectives of assessment

The objective of this assessment is to establish how the proposed development conforms to the NSW government Floodprone Land Policy, whether the proposed development can integrate into the SES regional evacuation strategy and how the development would manage the structural damage risk.

There have been a number of previous comprehensive investigations & development control plans prepared for redevelopment of this site which have included review of the regional flooding issues and formulation of strategies for dealing with floods rarer than the 100yr ARI event for the Hawkesbury-Nepean River. These have been useful background and demonstrate that this proposed development has been evident for planning purposes for more than 9 years.

2. Site analysis

The Concept Plan layout is presented in **Figure 1**. The Stage 1 area incorporates the main entrance off Coreen Avenue and a loop road system that circumnavigates the oval before returning to Coreen Ave. to the North. The approximate number of dwellings in Stage 1 would be 178.

Vehicular access to the ultimate development will be available at four locations including two access points from Coreen Avenue to the north, to The Crescent at the east and Castlereagh Road to the west.

Ready pedestrian access will be available to Penrith Station and the Penrith City Centre adjacent to the southern boundary of the site.

Some filling of the site will be undertaken to provide sufficient grade on the development to effectively drain runoff from the site to a central water feature which will direct runoff to the proposed wetland at the western end. The site will then drain to the existing trunk drainage system which directs runoff from the north western corner of the site to Boundary Creek in the north and then to the Nepean River. It is expected that the north western corner will be filled to remove the minor drainage channel in this area. This fill depth will be up to 1.5m in the lowest areas (minor channel) but generally 0.5-1m (refer to **Figure 2**). This will be raised to a minimum to match the 100yr ARI flood level (RL 25.40m AHD). This will reduce the flood hazard over the site to achieve acceptable risks to personal safety and property damage especially in floods rarer than the 100yr ARI event.

Habitable floor levels will have a minimum level of RL 25.9m AHD which incorporates a freeboard of 500mm above the 100yr ARI flood level. The roads will have a minimum level of RL 25.60m AHD.

The project with these design initiatives will comply with the objectives of the NSW government Flood Prone Land Policy and the Floodplain Development Manual 2005.

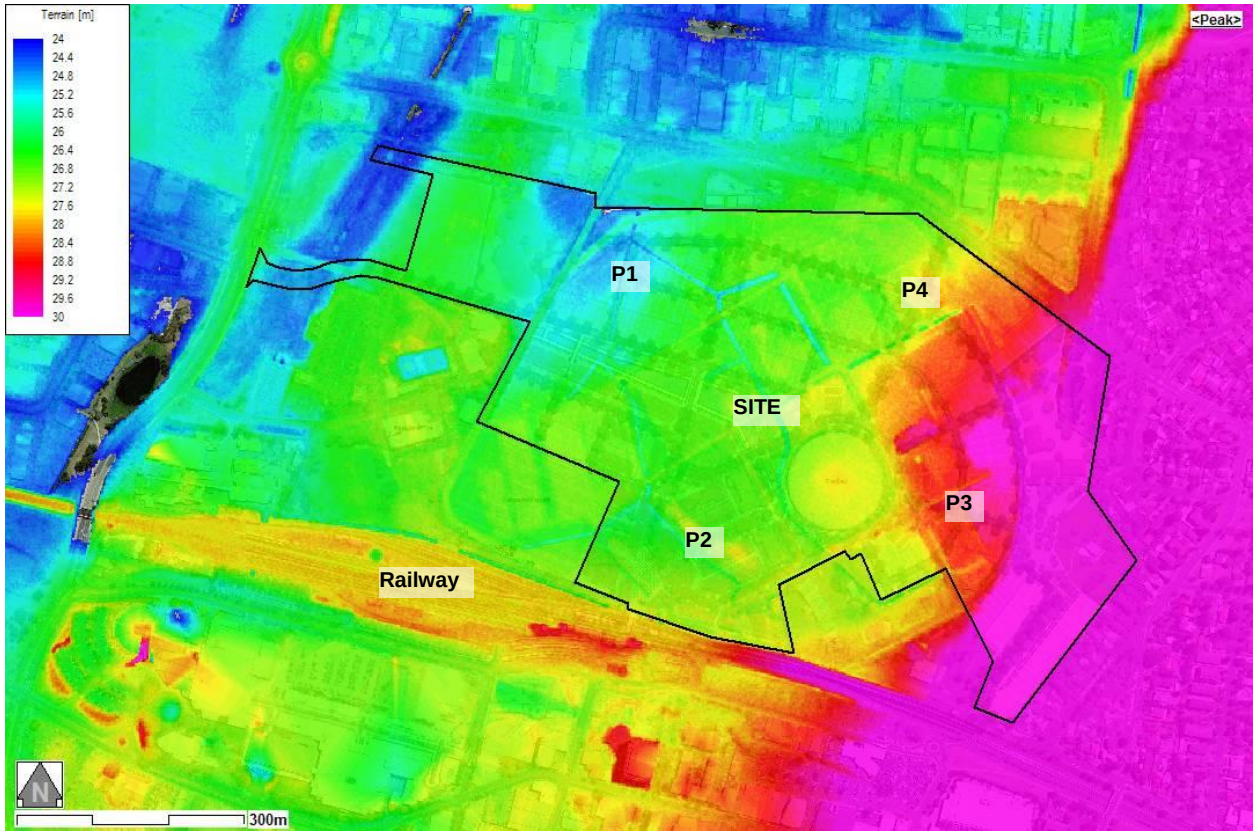
Site Description

The site of the redevelopment covers an area of approximately 40ha. The site is relatively flat over most of its area although at the eastern end it rises to levels of above RL35m AHD. Approximately 25% of the site at the eastern end is above the Probable Maximum Flood (PMF) levels as is the area further to the east outside the site. It is important to note from a flooding viewpoint, that the site is located on the edge of the floodplain.

Access from the site at Coreen Avenue and The Crescent provide a rising route to The Northern Road and then access to the M4. The access to the Northern Road is at a high level above the lower lying flood prone land and The Northern Road is part of the State Emergency Service (SES) regional flood evacuation strategy for access to the M4 and then to the regional assembly area at Homebush.

Figure 1 – Concept Plan Layout

Figure 2 – Site Topography



*Note: See **Table 1** for location markers*

3. Regulatory context

At a glance

- Section 117 Ministerial Direction
- Development Controls

The Section 117 Ministerial Direction

The Section 117(2) Ministerial Direction dated 19 July 2007 provides directions on a range of issues including Flood Prone Land (Section 4.3).

This direction applies to the subject site as it is flood prone land. This direction applies to Councils and reinforces the need to comply with government policy with respect to development on flood prone land. Clause 5, Section 4.3 of the Direction does not permit rezoning of Special Use land to Residential or Industrial landuse within flood planning areas. A small part of the north western area of the subject site is within the flood planning area assessment. Nonetheless, residential development on this site has been contemplated by both local and state government for a considerable length of time.

The proposed development does comply with the NSW Government's Flood Prone Land Policy and the Floodplain Development Manual 2005 by adopting the flood planning level (100yr ARI flood level plus a 500mm freeboard) for the minimum habitable floor level and minimizing the risk to personal safety and property damage.

The directive does not permit rezoning of land within flood planning areas from Special Use to Residential unless the inconsistency is of a minor significance (Clause 9 [b]). The proposed project rezoning is considered allowable under this directive because the potential impacts in terms of adverse effects on flooding in existing developments are of minor significance. The classification of minor significance is because:

- **The area involved on the site is minor and the development would result in this flood affected planning area on the site being smaller;**
- **The minor flooding on the site is a backwater effect and as such, filling of this minor area would have no significant adverse impacts on flood behavior; and**
- **As the flooding up to flood planning levels is backwater flooding, there is no cumulative flooding impact caused by the proposed development.**

The proposed development complies further with the directive by not permitting development in a floodway, by not causing significant flood impacts on other properties and by not requiring substantial increased government spending on flood mitigation measures, infrastructure or services.

Development Controls

The development controls required to ensure compliance with the Floodplain Development Manual 2005 and Section 4.3 of the Section 117 Direction are:

- Minimum habitable floor level to be the 100yr ARI flood level plus 0.5m freeboard (RL 25.9m AHD); and
- The north western area of the site to be filled up to 1.5m in the lower areas to ensure the flood risk in floods rarer than the 100yr ARI event would reduce the risk of substantial property damage to socially acceptable and sustainable levels.

A review of the Penrith City Council DCP-2006 was undertaken to ensure compliance and applicability of their flood development controls.

Council adopts a merit based approach to all development and building decisions (Section 2 [d]) and recognizes that flood prone land is a valuable resource and should not be unnecessarily sterilized from development due to flooding (Section 1).

In Section 3.8, the DCP states that Council will generally not support rezoning to a higher economic use in flood liable land. However, the proposed development meets the requirements of the DCP objectives and as such, would be an acceptable development on a merits based assessment. The relevant areas of compliance with the Aims and Objectives (Section 2) are:

- Minimizes the potential risk to life and property to an acceptable level;
- Potential for flood losses are contained with effective planning and development control;
- Is not an unsuitable landuse given the proposed development controls and its integration with the rail station and adjacent CBD development;
- Does not cause significant adverse flooding impacts on existing development;
- The development is not located within a floodway or high hazard area.

Council adopts a merits based approach to development requiring filling in flood prone land (Section 3.11). The site is located at the upstream end of the Boundary Creek catchment and will incorporate local drainage infrastructure to maintain peak flood flows at existing rates for local storms. This will ensure no significant adverse flooding impacts in downstream areas (see the Stormwater Management Report). In a regional Hawkesbury Nepean River flood, there is only backwater type flooding over the site up to the 500yr ARI flood with minor flood velocities over the site for more severe floods. The site filling proposed for flooding purposes is restricted to the north western corner so as to reduce the hazard for property damage in extreme floods. Filling elsewhere on the site is proposed to provide sufficient falls across the site for pipe and surface drainage flows in floods less severe than the 100yr ARI event. As such, the proposed filling will meet the Council's criteria (Section 3.11) by not causing any significant changes to flood behavior, no potential for cumulative flood impacts, no significant adverse impacts on surrounding development and local drainage problems.

4. Methods and results

Flood Behaviour

The Hawkesbury Nepean River has a large catchment and can take more than 24 hours for the peak flood flow in the river in a severe flood to reach Penrith after the rainfall has occurred in the catchment.

The flood levels in rarer floods are affected by the capacity of relatively narrow gorges downstream of Penrith such that typically the 200yr, 500yr, 1000yr and PMF floods cause flood levels up to 0.9m, 1.7m and 5.6m higher respectively than for the 100yr ARI flood.

This behavior presents issues with how to deal with risk to personal safety and structural damage to dwellings and infrastructure.

The SES has formulated an emergency response plan for flooding in the Hawkesbury Nepean River which involves evacuation of people from flood affected areas. The decision is taken to evacuate up to about 9 hours prior to the flood peak reaching Penrith to provide sufficient time for evacuation to Homebush via the M4.

The risk to substantial structural damage to dwellings has been examined by the Hawkesbury Nepean Floodplain Management Steering Committee (HNFMSC) in 2006 and established that light weight dwellings (timber or brick veneer) can withstand acceptable structural damage in a flood risk up to the low category (refer Section 5). Above this category, it would be necessary to have mitigation measures such as a concrete or steel frame structure linked to a structural foundation to prevent substantial damage by floodwaters.

The objective of this assessment is to establish whether the proposed development can integrate into the SES regional evacuation strategy and how the development would manage the structural damage risk.

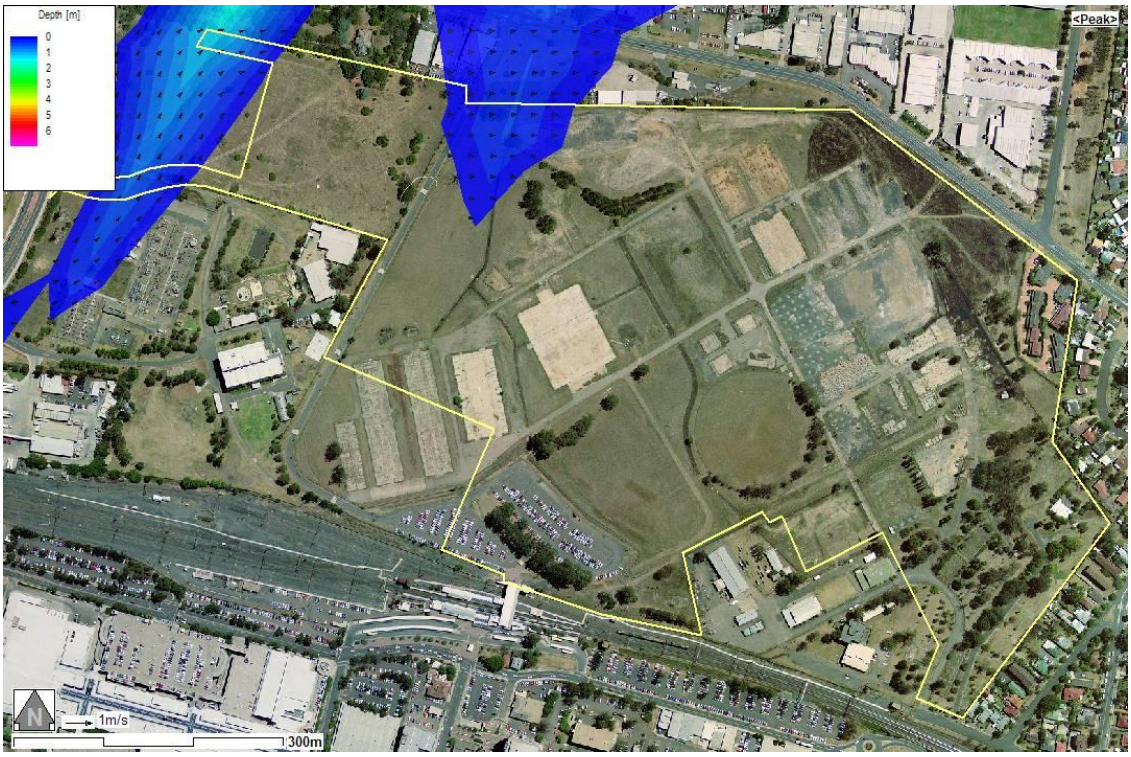
Flood Levels and Velocities

The extent of flood inundation on the existing site and the flood velocities for the 100yr, 200yr, 500yr, 1000yr and PMF floods are presented on **Figures 3 to 7**. The flooding conditions under existing ground levels are discussed in the following sections.

100yr ARI Flood

In the 100yr ARI, the floodwaters from the Nepean River backup onto a minor portion of the north western corner of the site in the area of a constructed drainage line. Being a backwater effect, the flow velocities are negligible with a water depth generally of 0.1m (see **Figure 3**).

Figure 3 – 100yr ARI flood depths and velocity vectors

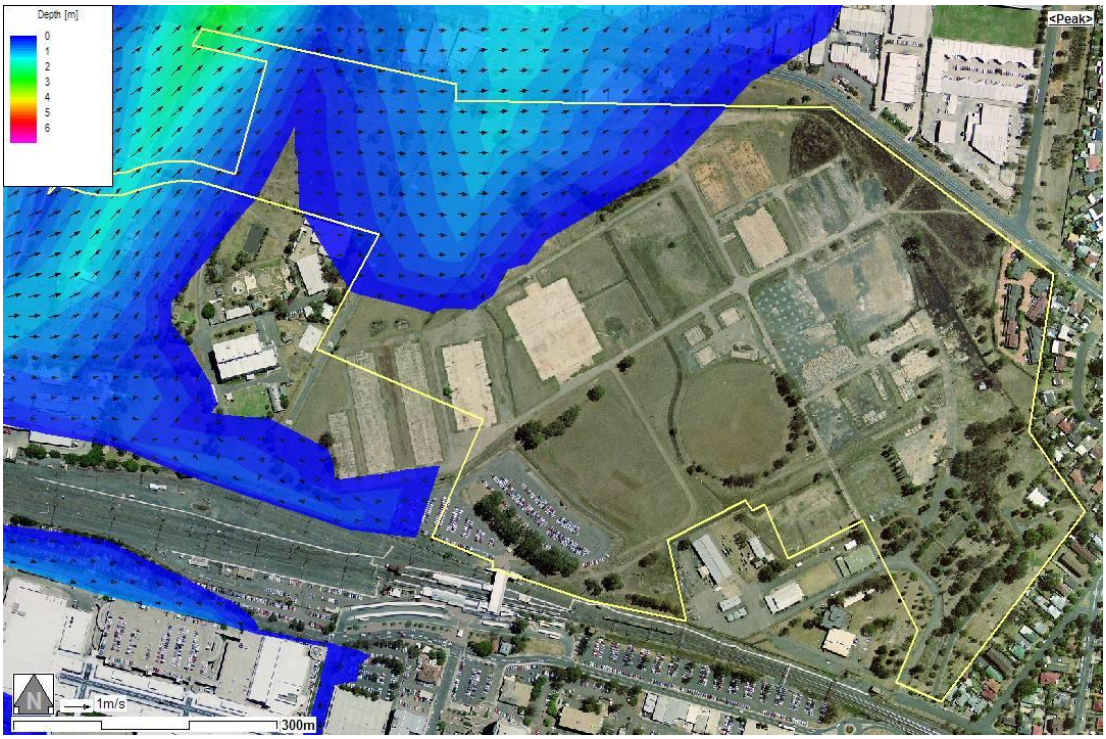


200yr ARI Flood

In the 200yr, the extent of backwater flooding increases to cover the north western corner of the site and the flow velocities are still negligible (see **Figure 4**).

The water depths and velocities in this area range up to 1m and 0.3m/s respectively. The highest flood on record (1867) is estimated to have a return interval of around 300yr ARI near Penrith.

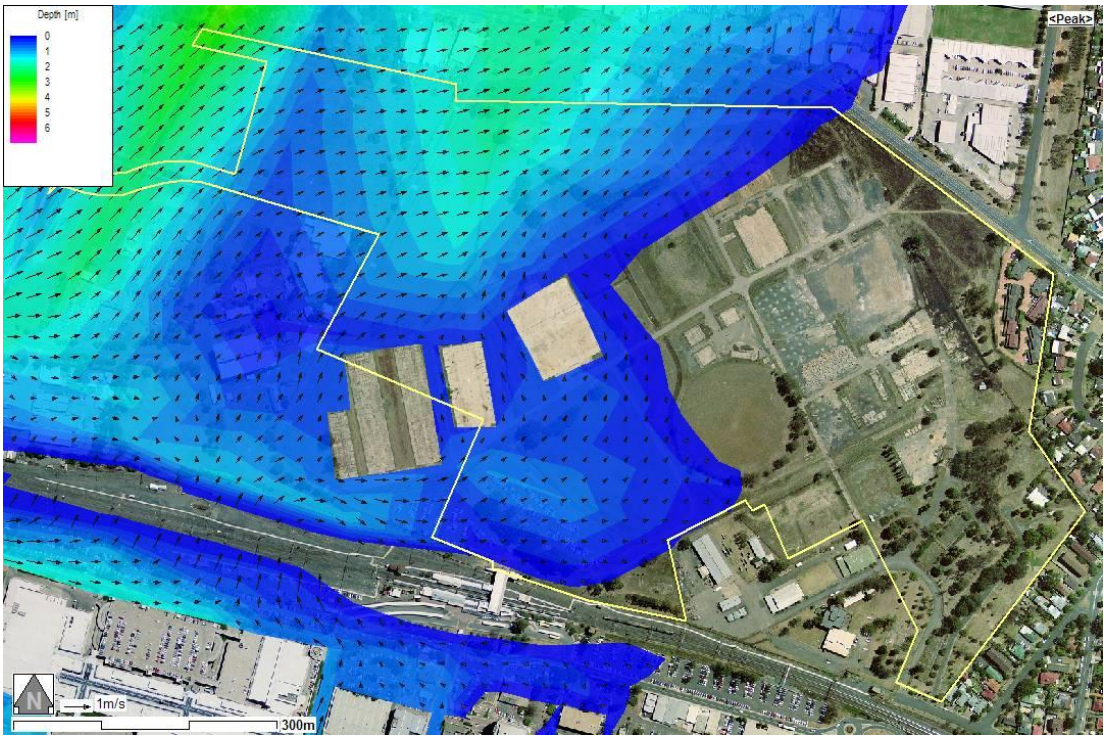
Figure 4 – 200yr ARI flood depths and velocity vectors



500yr ARI Flood

In the 500yr ARI flood, the flows still do not overtop the railway embankment so the flood flow velocities over the site are still low. The extent of flooding is approximately half way across the site with depths and velocities ranging up to 1.6m and 0.4m/s respectively (see **Figure 5**).

Figure 5 – 500yr ARI flood depths and velocity vectors

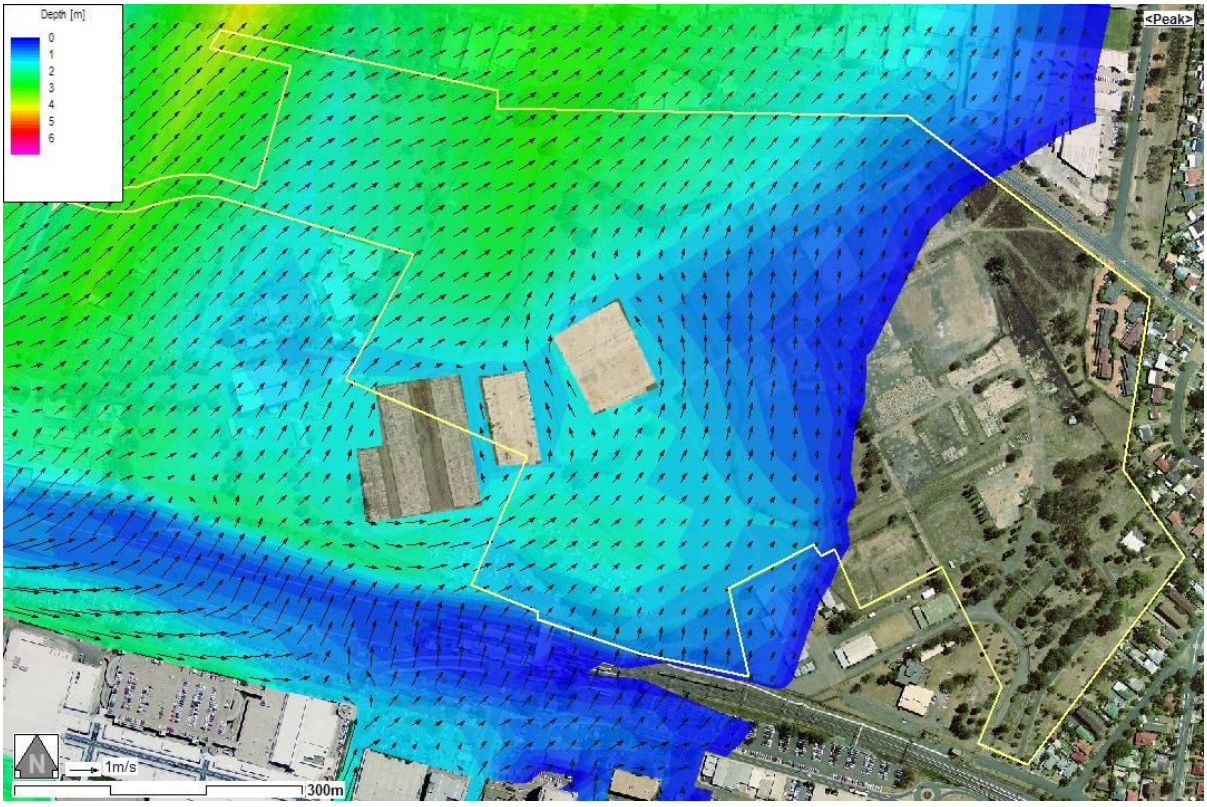


There are three concrete slabs within the site that are surrounded by flood water yet remain free from inundation. Based on flood level estimates these slabs will be inundated in the 500 year ARI flood event. An anomaly exists within the flood model that results in these three concrete slabs being blocked out. Work undertaken to date has made no amendment to the flood model to ensure that results presented in this report are consistent with Council's flood model.

1000yr ARI Flood

In the 1000yr ARI flood, the floodwaters would extend over approximately 60% of the site with depths and velocities ranging up to 2.6m and 0.6m/s respectively. In this event the railway embankment would be overtopped from the railway station extending westwards (see **Figure 6**).

Figure 6 – 1000yr ARI flood depths and velocity vectors

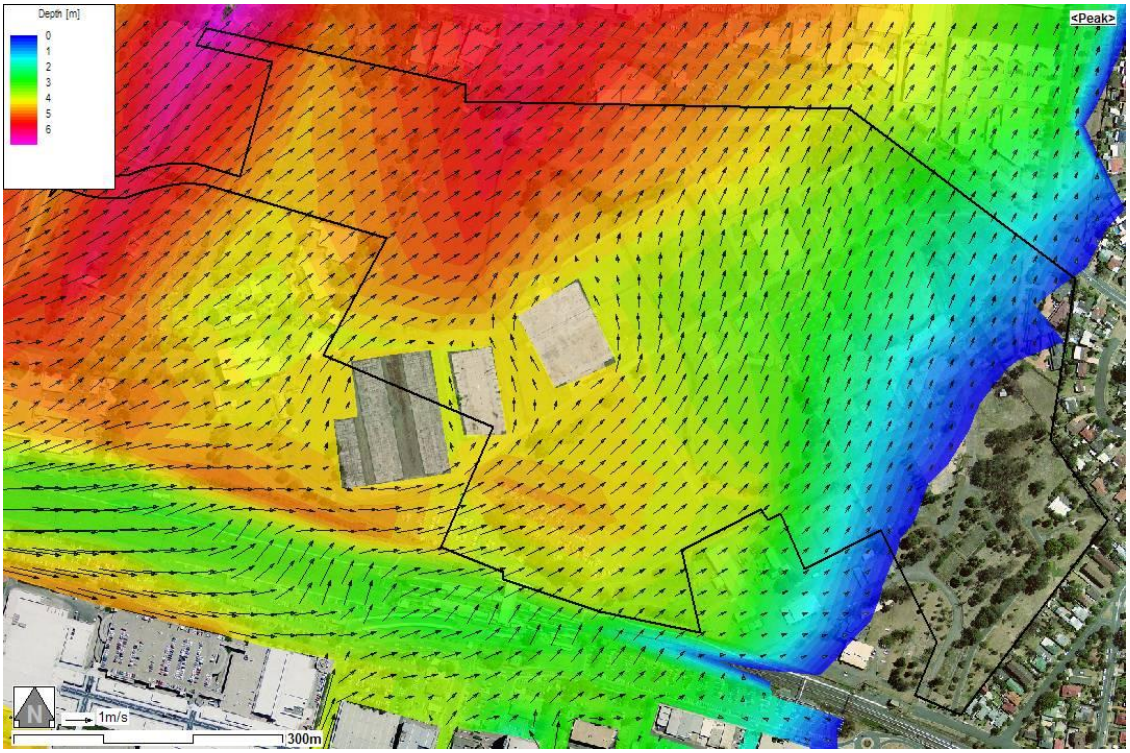


There are three concrete slabs within the site that are surrounded by flood water yet remain free from inundation. Based on flood level estimates these slabs will be inundated in the 1000 year ARI flood event. An anomaly exists within the flood model that results in these three concrete slabs being blocked out. Work undertaken to date has made no amendment to the flood model to ensure that results presented in this report are consistent with Council's flood model.

PMF

In the PMF, the railway embankment would be overtopped over approximately 75% of the southern boundary of the site. The eastern 25% of the site would be above the PMF level and unaffected by flooding. In this event, the flood depths and velocities over the site would range up to 5.5m and 0.8m/s (see **Figure 7**).

Figure 7 – PMF flood depths and velocity vectors



There are three concrete slabs within the site that are surrounded by flood water yet remain free from inundation. Based on flood level estimates these slabs will in fact be inundated in the PMF flood event. An anomaly exists within the flood model that results in these three concrete slabs being blocked out. Work undertaken to date has made no amendment to the flood model to ensure that results presented in this report are consistent with Council's flood model.

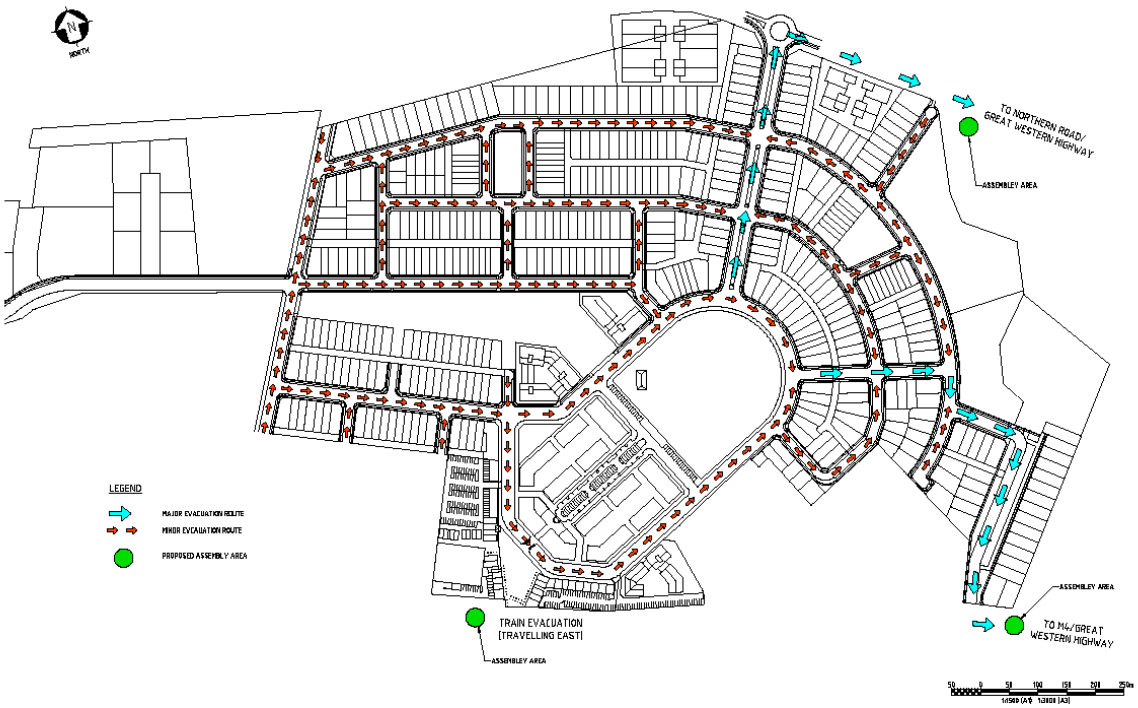
Previous Flood Assessments

In 2002, Egis Consulting prepared a report that is contained in Penrith City Council's *"North Penrith Urban Area: Development Control Plan – Draft Amendment 1 (March 2002)".* The report detailed a *"Flood Evacuation Strategy and Supporting Plan"* which concluded that a residential development would have an acceptable evacuation plan for regional floods up to the PMF in consideration of the Hawkesbury/Nepean Floodplain Management Strategy.

Prepared in consultation with the SES, the EGIS report identified six possible vehicle and pedestrian evacuation routes depending on the state of the flood which would be controlled by the NSW SES. Two of the routes via Castlereagh Road would become impassable in the early stages of a severe flood but that there were three routes to the Great Western Highway/M4 which were flood free. A further option for pedestrians only would be to access trains from Penrith railway station.

The proposed development in 2010 still provides flood free access to the Great Western Highway, The Northern Road & eventually the M4. The emergency response plan for this development in a severe flood has remained consistent and valid over the last 9 years. In considering this, **Figure 8** details the flood evacuation route prepared for Landcom's proposed mixed use development.

Figure 8 – Flood Evacuation route



Risk to Property

The Hawkesbury Nepean Floodplain Management Steering Committee (HNFMSC) has formulated an assessment methodology for reviewing the acceptability from a community expectation viewpoint of the risk to major structural damage from severe flooding events (>100yr ARI). This methodology is outlined in the guidelines entitled *"Managing Flood Risk Through Planning Opportunities"* prepared in 2006. It measures risk in terms of exposure, hazard and vulnerability. Exposure is measured by the probability of the flooding in that rare floods such as the PMF have a lesser exposure than for a 200yr ARI flood. Hazard measures the extent of the physical forces of the flood in terms of flow depth and velocity. The vulnerability relates to a measure of the consequences for the community of the damage.

The proposed development would fill the drainage line area in the north western corner of the site in accord with the overall site drainage concept. This will also remove the flood hazard in this area for severe floods (>100yr ARI).

The flood conditions over the site have been summarized by presenting the characteristics at four points on the site. These points are presented in **Figure 2** and the results are contained in **Table 1**.

Table 1 – Regional Flood Characteristics across the site

Location	Water Level (m AHD)	Depth (m)	Velocity (m/s)	V*d Esq./s)
100yr ARI Flood				
P1	25.4	0.1	0.1	0.1
P2, P3 & P4	Dry			
200yr ARI Flood				
P1	26.3	1.0	0.3	0.4
P2, P3 & P4	Dry			
500yr ARI Flood				
P1	27.0	1.6	0.4	0.7
P2	27.1	0.7	0.2	0.1
P3 & P4	Dry			
1000yr ARI Flood				
P1	28.0	2.6	0.6	1.6
P2	28.1	1.8	0.4	0.7
P3	Dry			
P4	27.9	0.3	0.3	0.1
PMF Flood				
P1	30.9	5.5	0.7	3.5
P2	31.0	4.6	0.7	3.2
P3	31.0	0.8	0.4	0.5
P4	30.9	3.3	0.8	2.4

This risk assessment has been undertaken for the proposed development for floods from the 100yr ARI to the PMF. The results are presented in **Table 2**.

Table 2 – Site Flood Risk Assessment

Flood	Residential Area Depths	Residential Area Affected (%)	Structural Damage Risk
100yr ARI	0	0%	None
200yr ARI	0 to 0.3	22%	Low
500yr ARI	0 to 0.9	35%	Low
1000yr ARI	0 to 2.0	58%	Low
PMF	0 to 4.9	87%	Low

Risk assessment based on 'Managing Flood Risk Through Planning Opportunities', *Hawkesbury-Nepean Floodplain Management Steering Committee*, 2006

The structural damage risk over the entire site is either none or low depending on the location. As indicated in the HNFMSC guidelines, a low structural risk is considered an acceptable community expectation and consequently does not require flood mitigation or flood proofing measures for the dwelling construction. This same conclusion would apply to the risk to infrastructure which involves roads, drainage, sewerage, water, power, telecom and gas.

The proposed development, therefore, does not require controls to reduce property or infrastructure damage to socially acceptable and sustainable levels.

Risk to life

Access to and from the site in a flood is not constrained as all the land to the immediate East is above the PMF level thereby producing a ready and fail safe access to high land and refuge facilities.

Notwithstanding this, it is recognized that responsibility for management and execution of flood evacuation in the Hawkesbury-Nepean Valley rests with the NSW SES. Accordingly, there is a responsibility for subdivision developments to demonstrate the availability of clearly defined evacuation routes with sufficient capacity and sufficient time for the proposed population to safely evacuate.

The primary evacuation route will logically be Coreen Avenue, providing a single outgoing lane connecting to the four lane section of the Northern Road. The Crescent, adjacent to the railway, will serve as an alternate route. Both of these routes provide rising egress away from the site to flood free land.

The development is proposed to accommodate approximately 1000 dwellings, and at the regional average of 1.8 vehicles per household and an evacuation rate of 600 vehicles per hour per lane, it will take 2.7 hours to evacuate the site. This expected duration is a conservative estimate given that the development will be a transport orientated development. The adjacent industrial area from the railway north towards Andrews Road will also need to make use of Coreen Avenue as a primary evacuation route. The industrial development encompasses approximately 110 ha, and at 20 persons per hectare and 0.8 vehicles per person, it will also take approximately three hours to evacuate. Thus up to six hours will be required to evacuate the site and the industrial area under full occupation. The actual duration will be less than 6 hours as residents in the proposed development would have at least three routes to The Northern Road/Great Western Highway/M4.

The low point on the evacuation route for the site is RL 25.60m AHD, whereas, for the majority of the industrial area feeding onto Coreen Avenue from Castlereagh Road, the low point is RL 24.3m AHD just east of Castlereagh Road. The rate of rise of floodwaters extracted from the 1000yr ARI and PMF hydrographs is approximately 0.25m/hr and thus, there is a gap of 6.8 hours between these two levels, providing more than sufficient scope for the subject site to evacuate in sequence after the industrial area.

The residential area to the east is already above the flood prone land and as such, has no time constraints on its evacuation. The evacuation route along the Northern Road for residents further north in the Richmond-Windsor area is restricted by the single lane capacity to the north of the site. Therefore the access of residents from the North Penrith site to the Northern Road will not further restrict the evacuation of other areas. There is also substantial capacity in the streets east of the site to store cars on flood free land prior to access to the Northern Road.

The proposed development of the North Penrith site, therefore, will not have a significant adverse impact on the risk to personal safety of existing residents and proposed residents of the subject development. This is because the proposed development will not have a significant adverse impact on the evacuation of existing areas or create a need to augment existing infrastructure.

5. Assessment

The proposed development has been formulated such that it meets the objectives of the NSW Government Flood Prone Land Policy and the Penrith Council's DCP. This is achieved by minimizing the risk to personal life and flood damages by:

- Setting minimum habitable floor levels at the flood planning level (100yr ARI flood plus 500mm freeboard);
- Providing adequate emergency response in line with the NSW SES regional evacuation plan for floods more severe than the 100yr ARI event up to the PMF;
- The site and adjacent areas has land above the PMF level to provide a fail safe backup evacuation option if required;
- Not having a significant adverse impact on flooding in adjacent areas or the ability for people in adjacent areas to evacuate in severe floods;
- Having a development which, for floods greater than 100yr ARI has a level of risk for structural damage to residences/infrastructure which is socially acceptable and sustainable;
- Not requiring significant government funding/resources to upgrade infrastructure/services in order to support evacuation or mitigate structural damage;
- On a merits assessment will comply with the Penrith City Council DCP, due to the above reasons, and;
- Will comply with the 117 Direction on the basis of the above reasons that support the contention of an inconsistency which is of minor significance.

Appendix 1: Glossary

Includes short explanations of key technical terms, acronyms and initialis that are used in the report. These are listed in alphabetical order.

Term	Meaning
AHD	Australian Height Datum
ARI	Average Recurring Interval
CBD	Central Business District
DCP	Development Control Plan
DGR	Director General's Requirements
EA	Environmental Assessment
Ecologically Sustainable Development	Ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making. It can be achieved by implementing the following principles and programs: ▪ the precautionary principle ▪ inter-generational equity ▪ conservation of biological diversity and ecological integrity ▪ improved valuation, pricing and incentive mechanisms.
Ha	Hectare(s)
HNSFC	Hawkesbury Nepean Floodplain Management Steering Committee
m	Metre(s)
NSW	New South Wales
PMF	Probable Maximum Flood
SES	State Emergency Service
RL	Reduced Levels
yr	Year