

REPORT

NORTH WEST GROWTH AREA – MARSDEN
PARK NORTH, WEST SCHOFIELDS & VINEYARD
(STAGE 1) PRECINCTS
FLOOD EVACUATION STUDY

PREPARED FOR NSW DEPARTMENT OF PLANNING AND ENVIRONMENT

3 July 2018

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Glossary

Annual Recurrence Interval (ARI)	A statistical estimate of the average number of years between the occurrence of a flood of a given size or larger than the selected event. For example, floods with a flow as great as or greater than the 20-year ARI (5% Annual Exceedance Probability (AEP) flood event will occur, on average, once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
Flood planning level (FPL)	The FPL is a combination of the defined flood levels (derived from significant historical flood events or floods of specific annual exceedance probabilities) and freeboards selected for floodplain management purposes, as determined in management studies and incorporated in management plans.
Hydrograph	A graph that shows how the flow or stage (flood level) at any particular location varies with time during a flood.
Probable Maximum Flood (PMF)	<p>The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation (PMP) and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions.</p> <p>Generally, it is not physically or economically possible to provide complete protection against this event.</p> <p>The PMF defines the extent of flood-prone land – that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event, should be addressed in a floodplain risk management study.</p>
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (WMO 1986). It is the primary input to probable maximum flood estimation.
Riverine flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam. Riverine flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

All terms above are derived from *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*, AIDR Handbook 7, 2017, Third Edition.

CONTENTS

Glossary	i
1. Introduction.....	1
1.1 Study area.....	1
1.2 Project team	2
2. Project Scope	3
2.1 Study objectives.....	3
2.2 Project Assumptions and Exclusions.....	3
2.3 Development Context	4
3. Methodology	8
3.1 Project phasing	8
3.2 Workshopping.....	10
3.3 Technical Assumptions.....	10
4. Flood Risk and Traffic Modelling Observations	12
4.1 Summary of flood risk	12
4.2 Study precinct observations.....	13
5. Masterplanning Principles	15
5.1 Overview	15
5.2 Flood-responsive Subdivision Design Requirements	15
5.3 Supplementary principles	15
6. Roadmap for Future Work.....	17
7. Recommendations	18
7.1 Summary & Conclusions	18
7.2 Future directions.....	18

LIST OF TABLES

Table 1: Available shortest 'evacuation window' per study area (for fast 1:5000 chance per year event)	12
Table 2: Comparing vehicle numbers – precinct models to regional evacuation model.....	13

LIST OF FIGURES

Figure 1 - North West Growth Area (study areas highlighted)	2
Figure 2 - Marsden Park North Precinct location plan (Source: the Department, 2018)	5
Figure 3 - West Schofields Precinct (Source: the Department, 2018)	6
Figure 4 - Vineyard (Stage 1) Indicative Layout Plan (Source: the Department, 2017)	7
Figure 5: Project Phasing.....	8
Figure 6: Traffic Model Approach.....	10
Figure 7: Roadmap for integrating flood evacuation into future precinct planning	17

1. Introduction

In mid-2016, the Department of Planning and Environment (the Department) commissioned preliminary integrated flood risk and traffic modelling assessments of the North West Growth Area (NWGA) precincts of Marsden Park North, West Schofields, and Vineyard (Stage 1).

Stantec was engaged by the Department as part of a broader project team to inform the strategy objectives and planning direction for these three key land release precincts within the NWGA. This work was completed in early 2017.

Parts of the study precincts are within the Hawkesbury-Nepean River floodplain – significant tracts of the precincts are below the riverine Probable Maximum Flood (PMF). These study precincts are intended to accommodate residential populations in accordance with government objectives. The proposed residential densities will vary depending on whether land lies below or above the PMF.

Consequently, there is a need to advance understanding of the evacuation capacity/capability of the study precincts as master planning for these areas progresses.

The outcomes of this study will help inform:

- land use – appropriate precinct road layout and dwelling capacity; and
- broader regional flood evacuation modelling currently being undertaken by the Hawkesbury-Nepean Valley Flood Risk Management Directorate (the Directorate).

A key early decision in the planning for these areas has been to deliberately limit density below the extent of the PMF due to the nature of the flood risk in these locations, particularly in terms of evacuation risk.

Importantly, it is understood dwelling and vehicle numbers modelled for the precincts are either similar to or lower than those used in the current regional evacuation modelling undertaken by the Directorate.

1.1 Study area

The broader NWGA consists of a total of 16 precincts across an area spanning Vineyard in the north, North Kellyville in the east, Shanes Park in the west and Schofields in the south. Figure 1 provides a spatial representation of the NWGA and the study precincts.

The precincts the subject of this study are:

- Marsden Park North;
- West Schofields; and
- Vineyard (Stage 1).

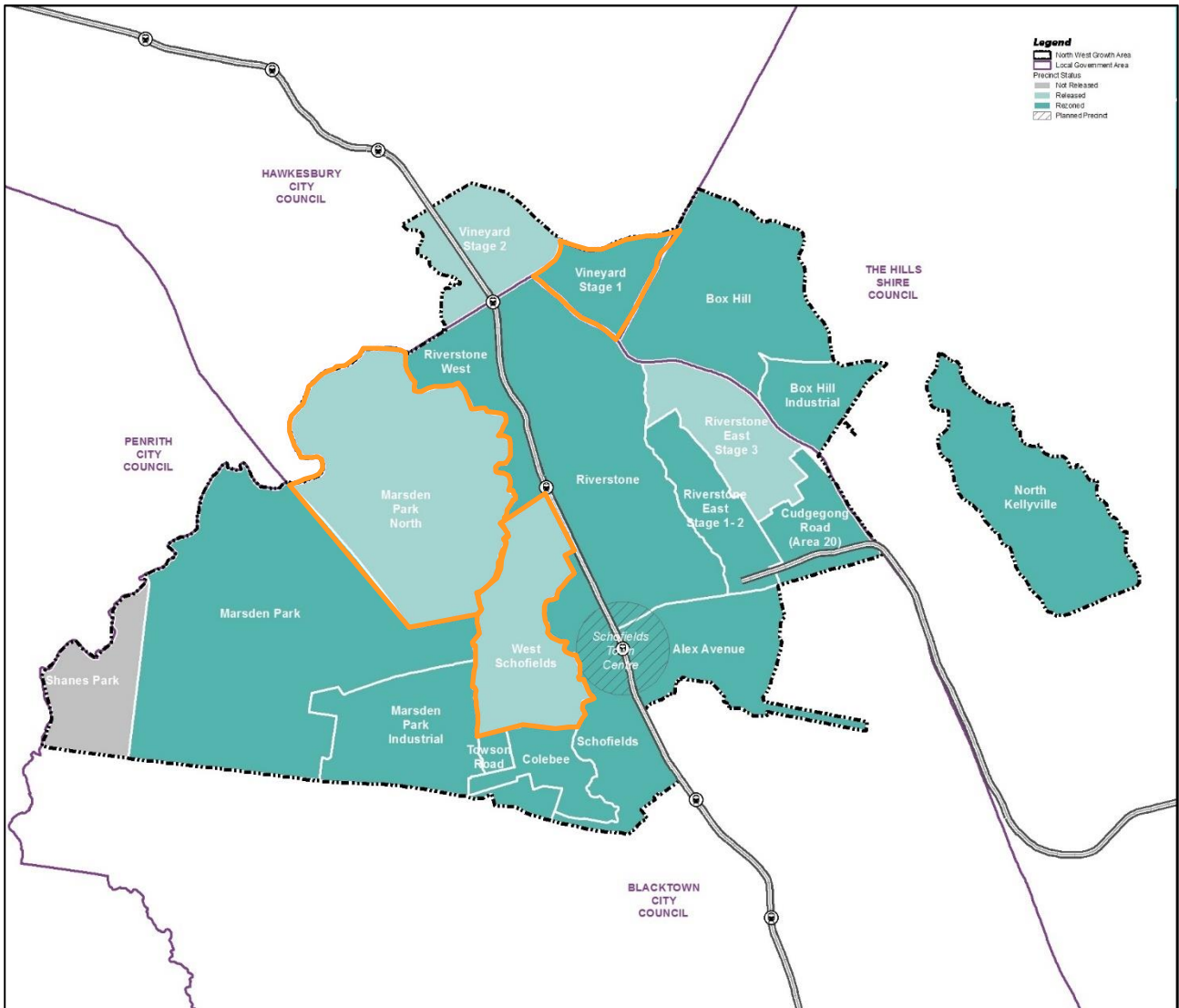


Figure 1 - North West Growth Area (study areas highlighted)

1.2 Project team

The project team engaged to undertake this work consisted of:

- Stantec – project coordination, land use planning and traffic modelling;
- Water Technology – flood risk assessment and evacuation strategy advice; and
- Vinayak Dixit (University of NSW) – strategic advisory and methodology development for evacuation strategy and traffic modelling.

2. Project Scope

Regional flood evacuation modelling being undertaken by the Directorate as part of the Hawkesbury-Nepean Valley Flood Risk Management Strategy covers a large part of the NWGA and is focused on assessing the capacity of the arterial road network to support an evacuation in the event of an extreme flood event (identified by the Directorate for the purposes of the modelling as the 5000 Annual Recurrence Interval (ARI) event). The Directorate advises that although the State Emergency Service (SES) plans for the potential evacuation up to a PMF, this event is very rare (in the order of 1 in 100,000 years), the 5,000 ARI event was adequate for planning purposes as there is limited additional risk between the 5000 ARI and PMF events.

Richmond Road and Windsor Road are two of the regional evacuation routes serving the Hawkesbury-Nepean Valley and NWGA, both of which generally lie in a north/south direction.

It is understood that the regional road network will be under pressure to evacuate the floodplain in extreme events such as a 5000 ARI event.

It is on this basis that the Department seeks to supplement this regional evacuation modelling body of work with a focus on the study precincts so that evacuation considerations can inform the future master planning and development design process for these precincts as they develop over time.

While planning for these precincts was still in its initial stages, the Department worked with Infrastructure NSW to better understand the flood risk in these precincts, and particularly on how to build evacuation considerations into future planning.

The Department will continue to work with the Directorate and Councils to refine approaches to land use, road infrastructure and evacuation as more detailed planning and the rezoning for these precincts occurs.

The work to date is necessarily 'broad-brush' and preliminary in nature, given the limited design data and information that was available at the time it was undertaken.

As planning for greenfield urban development is an iterative process, it is important to create a roadmap to outline how flood evacuation risk will be carefully managed over time by building on the preliminary work undertaken to date. This roadmap is a key output of this initial body of work.

2.1 Study objectives

The objective of the project, as established by the Department, is to provide the NSW Government with advice on managing and options for managing the flood risk in the three precincts. Given these precincts are subject to flood risk, a risk-appropriate land use planning outcome is required that balances flood risk considerations with development capability of the precincts. This will support decisions on housing growth and infrastructure commitments in the NWGA. The objectives of this work include:

- undertaking flood risk examinations from available regional riverine hydrograph data and local flood modelling data – across the risk spectrum;
- developing a mesoscopic traffic model based on future road layouts and forecast traffic demand;
- developing evacuation timeline models and departure curves for comparison against the regional evacuation model; and
- identifying evacuation limitations (if any), test options and propose land use/layout alternatives to address evacuation concerns.

2.2 Project Assumptions and Exclusions

This report was compiled during the formative stages of the land development process for the study precincts. It is noted that plans for Vineyard (Stage 1) were well advanced, being on exhibition in early 2017 and zoned in December 2017, however, limited road layout data was available for the Marsden Park North and West Schofields precincts as these areas were still under master planning at the time of undertaking the study.

Flooding data available for use in the study was generally limited to regional riverine flood data provided by the Directorate. Local flooding considerations have been incorporated where that data is available. No joint probability or coincident flooding analysis was conducted as part of the study, nor is it understood to have been available as an input into the study.

A range of technical assumptions have been made, particularly in relation to the flood risk investigations and the traffic modelling methodology given the limited information available. These are described in section 3.3.

The project team has assumed the data provided is fit-for-purpose and can be relied upon for the purposes of the project. The project team has not undertaken any independent verification of the data.

2.3 Development Context

2.3.1 Marsden Park North

The Marsden Park North Precinct is located within the Blacktown Local Government Area. At present it is characterised by mostly rural and rural residential activities of very low density and accommodating the Australian Christian College – Marsden Park. Key features of the Marsden Park North Precinct relevant to this study are:

- The Precinct is bound by Richmond Road to the west, the South Creek Floodplain to the north, and Bells Creek and Eastern Creek to the east, with land between the 1:100 chance per year flood level and PMF comprising 247.8ha out of the total developable area of 330.3ha.
- Key higher-order roads within the Precinct include:
 - Bandon Road (proposed) from Richmond Road/Elara Boulevard intersection, via the Park Road corridor and extending to the north
 - Garfield Road West, running east-west between Richmond Road crossing Eastern Creek to meet Garfield Road East.

Precinct planning has progressed on the basis of a proposed residential density range for the Marsden Park North Precinct on land located between the 1:100 and PMF of 15 and 20 dwellings per hectare, proposed to be capped at a maximum of 4,100 dwellings, consistent with the number tested by the Directorate.

A precinct location plan for Marsden Park North is presented in Figure 2.



Figure 2 - Marsden Park North Precinct location plan (Source: the Department, 2018)

2.3.2 West Schofields

The West Schofields Precinct is located to the immediate south-east of the Marsden Park North Precinct, bounded by Bells Creek in the west and Eastern Creek in the east and Townson Road and proposed Burdekin Link Road to the south. Dwelling densities in the Precinct currently fluctuate, with older, larger allotments mixed with newer, denser subdivisions. Key features of the West Schofields Precinct relevant to this study are:

- Land below the 1:100 flood planning level comprises 313.94ha, and between the 1:100 level and PMF comprises 101.33 out of the total Precinct area of 576.97ha;
- Key higher-order roads within the Precinct include:
 - Schofields Road which runs in an east-west direction and will be upgraded/extended to meet South Street in the west (due for completion July 2019). The intersection of Schofields Road and Carnarvon Street will be raised to meet the 1:100 flood planning level
 - Burdekin Link Road, planned to meet the 1:100 flood planning level east of Eastern Creek, within the Schofields Precinct.

The Department advises an initial housing estimate of 2,000 dwellings for the entire Precinct was proposed in the Structure Plan 2006. Initial precinct planning undertaken for the Precinct suggests potential for up to 4,400 dwellings (excluding the Townson Road development of approximately 336 homes), with the dwelling yield below PMF capped at 2,000 dwellings.

A precinct location plan for West Schofields is presented in Figure 3.

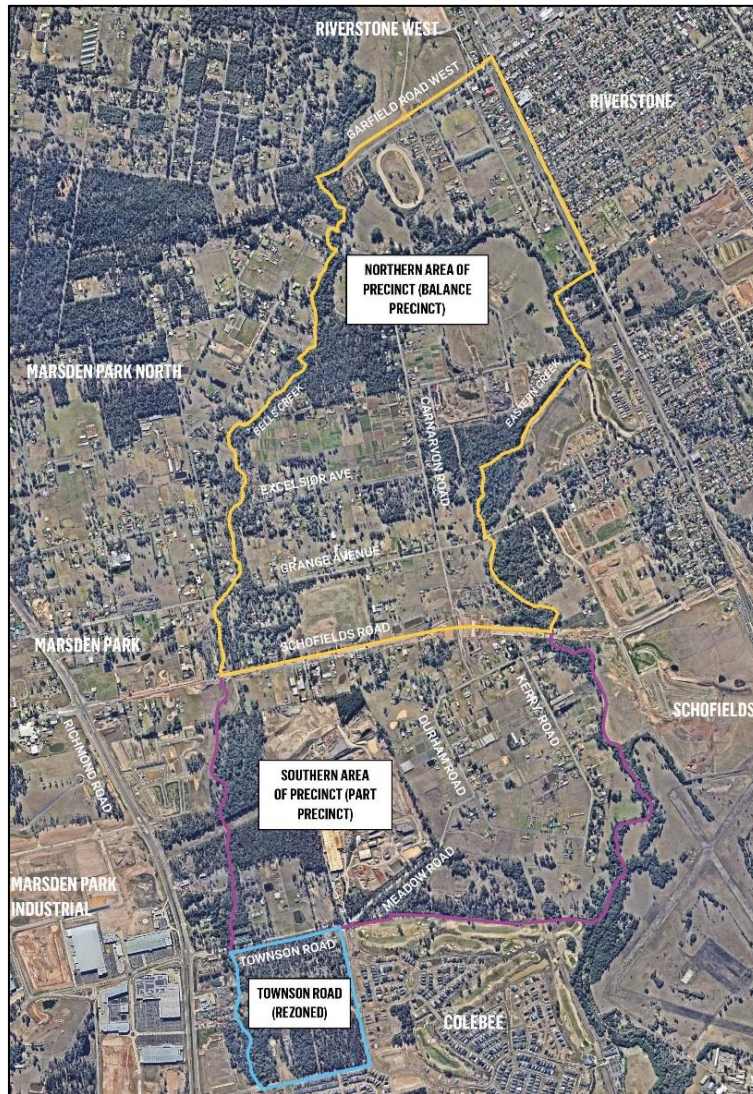


Figure 3 - West Schofields Precinct (Source: the Department, 2018)

2.3.3 Vineyard

The Vineyard Precinct is located in the north-east of the NWGA. The Stage 1 area is bisected by the Killarney Chain of Ponds, creating a pocket of land with direct frontage to Windsor Road that is 'isolated' from the balance of the Precinct. See Figure 4.

The proposed residential yield on land below the PMF is approximately 730 dwellings. Approximately 190 dwellings are proposed south of the Killarney Chain of Ponds below the PMF and above 1:100, and the balance is proposed north of the creek. Land south of the creek would require evacuation to Windsor Road. Land north of the Killarney Chain of Ponds would be evacuated toward Menin Road/Boundary Road and Old Pitt Town Road, as advised in the Water Cycle Management study prepared by Mott MacDonald for the Department.

The Stage 1 area was rezoned in December 2017. The final indicative layout plan for Vineyard (Stage 1) is presented in Figure 4.

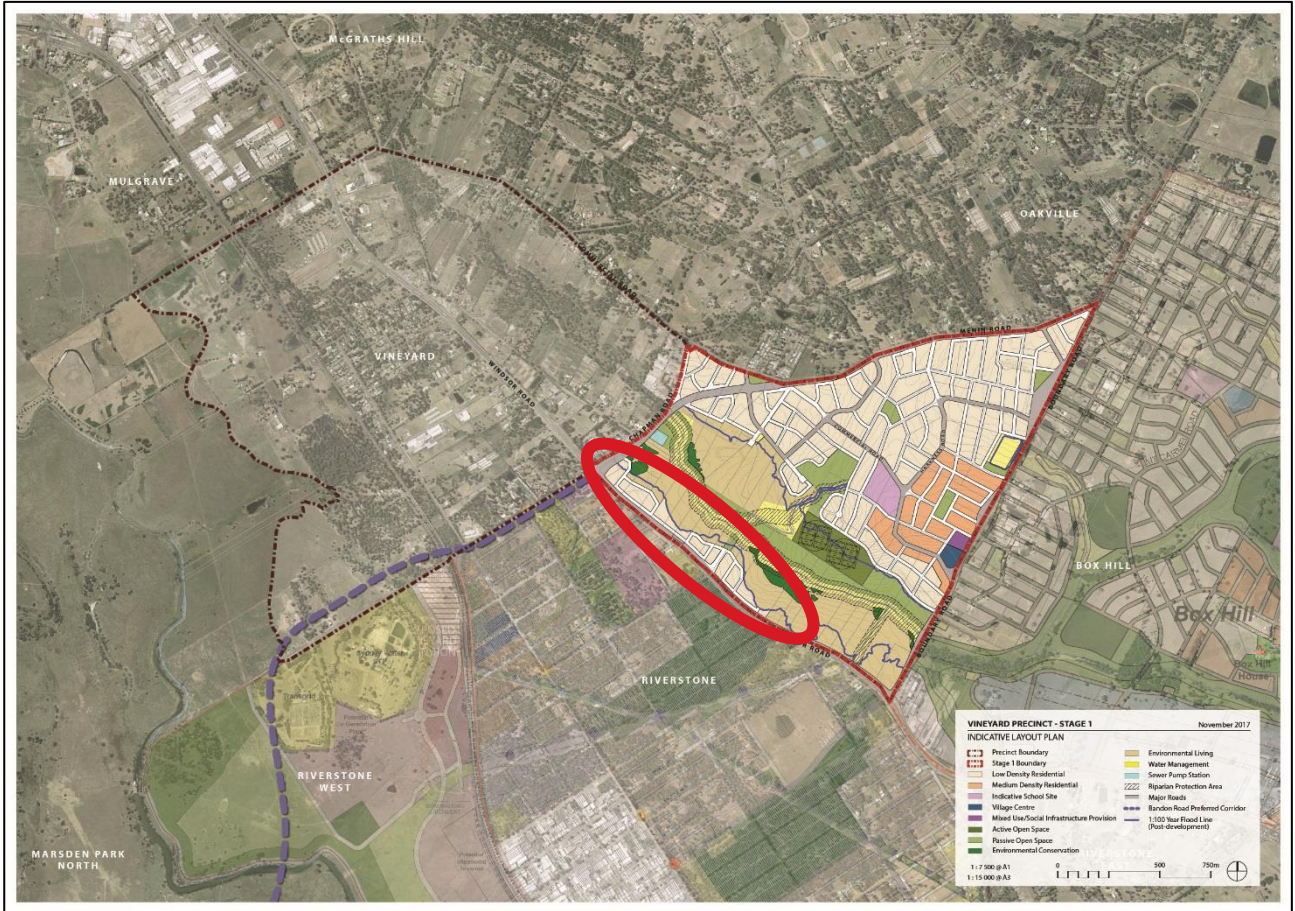


Figure 4 - Vineyard (Stage 1) Indicative Layout Plan (Source: the Department, 2017)

3. Methodology

3.1 Project phasing

In meeting the scope objectives a bespoke methodology was developed through consultation with the Department given the available data and unique project circumstances. Figure 5 demonstrates the broad project phasing undertaken in delivering this project.

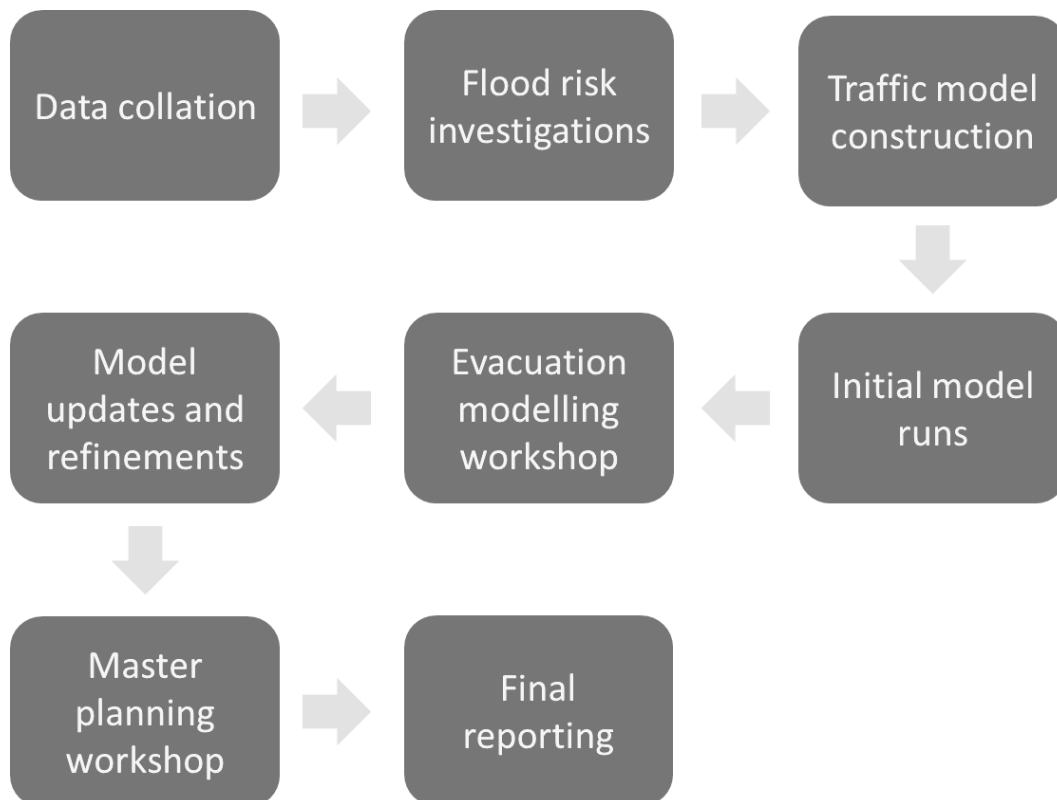


Figure 5: Project Phasing

3.1.1 Flood Risk Investigations

The Flood Risk Investigations report for this body of work was prepared by Water Technology. This work provided a description of the flood risk assessment process and the analysis developed to inform the evacuation strategy development.

Key elements of the methodology included:

- analysis of regional hydrograph data received from the Directorate and synthesis of this into time step-based visualisations coupled to the arterial road layout of each precinct to understand road linkages that are inundated, and at what time step; and
- identification of the available 'evacuation window' for each precinct, derived by subtracting the timing of first road inundation from the first event inundation downstream.

It is noted that the 'evacuation windows' identified above do not represent time between when a study area is first inundated to when the last evacuation route within that study area is cut, given all study areas exhibited a capability for rising road access to the regional evacuation routes (based on regional riverine flooding considerations only). It in fact represents a far more conservative approach, being the time between when key regional evacuation routes downstream (i.e. along Richmond and Windsor Roads) are cut and the time of first inundation of roads within the study area. This approach was taken given the final road layouts for the study areas, and a final distribution of density within the areas, had not been determined at the time of analysis.

3.1.2 Flood Evacuation Methodology

The flood evacuation methodology in this section was developed by Vinayak Dixit of the UNSW within the constraints of the available data. The analysis is predicated on arriving at indicative evacuation timelines for each precinct utilising the evacuation timeline model developed by Steve Oppen¹ and the NSW SES². The timeline for a given subsector is developed independent of the timeline of other subsectors. Evacuations are triggered based on:

- Evacuation route cut: if all evacuation routes of a given subsector are cut, then this subsector requires evacuation and the evacuation deadline for this subsector is the latest road cut time – as mentioned in (Oppen, 2004; NSW State Emergency Service, 2014): "The closure by flooding of the last useable evacuation route marks the end of the available evacuation time." This is then used to shut down the affected roads at this time.
- Rising road access: if at least one evacuation route of a given subsector is not cut, the flood gauges inside the subsector trigger the evacuation. The evacuation deadline is then the latest flooded gauge time for that subsector, where non-flooded gauges are ignored. If no gauge within a given subsector is flooded, then the evacuation of this subsector is not triggered.

It should be noted that the cumulative impact of traffic evacuating from other locations along the regional evacuation routes has not been modelled for the purposes of this study.

3.1.3 Traffic Modelling

The main objective of the traffic modelling approach was to understand whether the vehicles below PMF could be evacuated prior to the *first* road being cut by flood within each of the precincts, and thus begin to impinge upon or limit evacuation processes. An overview of the traffic modelling approach is presented in Figure 6.

Evacuation would primarily be undertaken using vehicles, and therefore the impact assessment relies on traffic models. The models rely on three main components: (a) the road network (b) the flood events, and (c) the evacuation demand.

The extent of the road network modelled was identified as consisting of existing and proposed roads within the three precincts of Marsden Park North, West Schofields and Vineyard. Further review and validation of this road network by an independent person is warranted as more detailed analyses are conducted.

Initially, road layouts for both the 2026 and 2041 scenarios were developed for model construction however following advice at the modelling workshop in July (refer to section 3.2) consideration of the 2026 scenario was discontinued. It emerged there was uncertainty over which sub-precincts of the study areas would be developed by 2026, versus those that would remain undeveloped at that time. Therefore, the full build-out scenario of 2041 became the prime focus of the analysis moving forward.

Data on projected total dwellings per precinct, and projected dwelling numbers under PMF for all precincts and vehicles in the horizon year was collected. Simulation modelling software AIMSUN was used to develop the road network over scaled background imagery from Nearmap.

¹ Oppen, S. (2004). *The Application of Timelines to Evacuation Planning*. NSW State Emergency Service

² NSW State Emergency Service. (2014). *Hawkesbury Nepean Flood Emergency Sub Plan*.

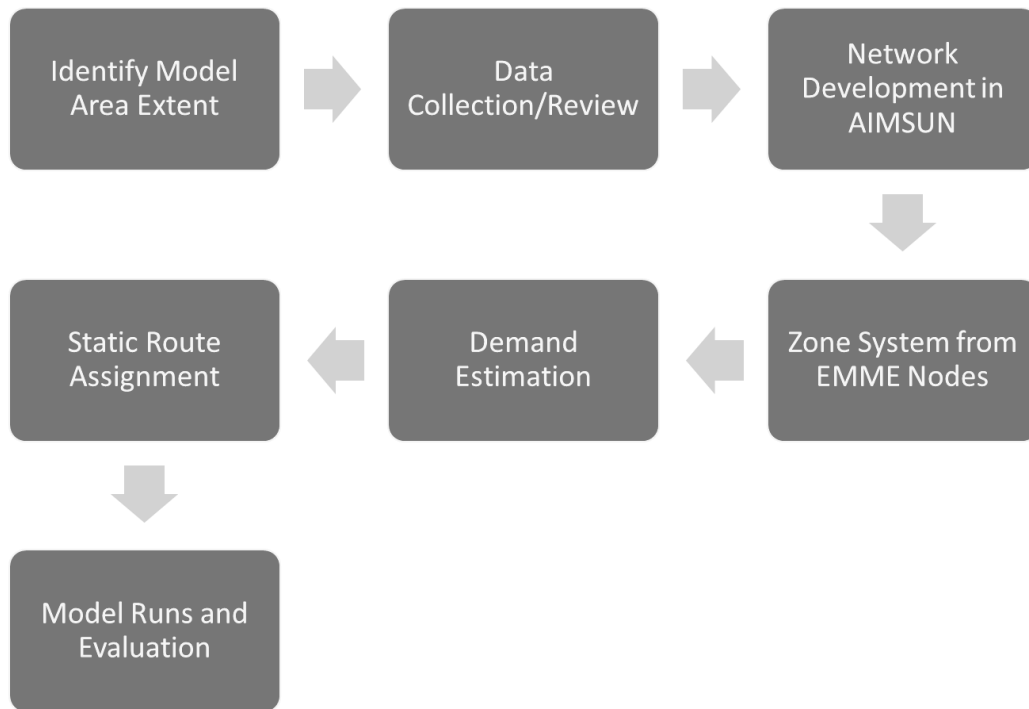


Figure 6: Traffic Model Approach

3.2 Workshopping

A workshop was held on 12 July 2017 with representatives from the Department, the Directorate, Roads and Maritime Services (RMS) and SES, where the approach to and initial results from the flood risk assessment work and traffic modelling work was presented.

There was uncertainty related to masterplan layout and development horizon for West Schofields and Marsden Park North at the time of the workshop. This impacts on the ability to reasonably understand the likely populations subject to more frequent events. Therefore, following the presentation of the approach adopted in the preparation of the 2026 and 2041, and total population / population under extreme flood (5.00 ARI) model scenarios, the Department advised that it wished to proceed with traffic modelling the 2041 extreme flood scenarios only for the precincts under study.

A further masterplanning workshop was held on 18 September 2017 with representatives from SES, the Directorate, the Department, Blacktown City Council and the consultants engaged in preparing the masterplan layouts for Marsden Park North and West Schofields. The flood evacuation traffic modelling in this study had been completed by this time.

3.3 Technical Assumptions

3.3.1 Flood Data

Regional riverine flood data used in the analysis was provided by the Directorate, while local creek flooding data was provided by the Department where it was available. Local flooding data was provided to the project team after traffic modelling had been completed.

3.3.2 Precinct layouts

Site layouts have been provided by the Department (where available) and are understood to have initially been designed with regard to Section 6 of the Designing Safer Subdivisions Guidelines, or 'Brown Book', which focuses on 'designing for emergency response and evacuation'. This is discussed further in section 5 below. It is noted that Vineyard (Stage 1) was the only study precinct to have a finalised road layout. The Marsden Park North layout provided was subject to further masterplanning work, and the existing road layout was available for West Schofields for this study.

3.3.3 Road layout data

Selection of arterial roads – designated arterial roads are only available from the Department for Marsden Park North – all other arterial road layouts have been derived from the full road layouts provided by the Department based on good traffic modelling practice. Comment on the road layout used in the study was sought from RMS via DPE but not obtained.

2026 vs 2041 road layouts – In the preparation of the 2026 road layouts for modelling (which ultimately were not sought by the Department for modelling), the approach was based on estimating likely constructed roads drawn from the infrastructure strategy information available from the Department. Specific precinct staging plans for the study precincts are not currently available, which would make the flood evacuation observations herein solely for the purposes of the full 2041 development scenario.

3.3.4 Waterway crossings and bridge heights

Due to the formative stages of master plan preparation for the study precincts, the Department has been unable to provide technical data or assumptions on flood immunity for the existing or proposed roads in any of the development precincts. The approach agreed with the Department was to assume that all roads and lots within the subject areas are to be built to at least current flood risk standards, which is the Flood Planning Level (FPL) (1:100 event +0.5m freeboard). Where existing ground elevation is already above the FPL, this existing ground elevation is taken to be the elevation of the existing or proposed road.

This will be tempered with site-based modelling assumptions in the traffic modelling where this assumption may be impractical (For example, raising the eastern end of Garfield Road West to 1:100 flood planning level standard may be impractical due to the existing topography and resultant costs).

3.3.5 Evacuation parameters

Evacuation assumptions used in the traffic modelling have been developed by Vinayak Dixit from UNSW and derived from Oppen. The following assumptions have been made:

- arterial roadways that act as main evacuation routes are modelled;
 - Roadway capacity will be based on standards from Austroads. Given that evacuation traffic dynamics are fairly different, the Austroad standards in conjunction with published empirical evidence will be used to determine road capacity – based on additional request from SES, this link capacity is reduced to 600 veh/hr/lane;
 - traffic signals will be timed based on the evacuation demand for each approach.

4. Flood Risk and Traffic Modelling Observations

4.1 Summary of flood risk

4.1.1 Riverine flood risk

This body of work produced the timings for understanding the available 'evacuation window' between when an extreme riverine flood from the Hawkesbury Nepean River may cut downstream evacuation from the likes of Richmond and Windsor, and the time at which the first roads within each study area are likely to be cut.

Table 1: Available shortest 'evacuation window' per study area (for fast 1:5000 chance per year event)

Design Event - 1:5000	Timing of first event (hours)	Time of first road inundation within study area (hours)	Available evacuation time (hours)*
Marsden Park North	21 (WMA Point ID 1506)	28	7
West Schofields	21 (WMA Point ID 1506)	26	5
Vineyard	20 (WMA Point ID 129)	26	6

It is noted that the 'evacuation windows' identified above do not represent time between when a study area is first inundated to when the last evacuation route within that study area is cut, given all study areas exhibited a capability for rising road access to the regional evacuation routes (based on regional riverine flooding considerations only). It in fact represents a far more conservative approach, being the time between when key regional evacuation routes downstream (i.e. along Richmond and Windsor Roads) are cut and the time of first inundation of roads within the study area. This approach was taken given the final road layouts for the study areas, and a final distribution of density within the areas, had not been determined at the time of analysis. The analysis did show that rising road access was available to all precincts though (with the exception of the smaller number of dwellings within the Vineyard (Stage 1) precinct south of the Killarney Chain of Ponds).

With this in mind, assuming that there is no evacuation traffic from other subsectors on the same evacuation route, time available to evacuate the vehicles modelled will likely be greater than the 'evacuation window' specified, however the timing above provide a useful reference point to understand evacuation timings given the data constraints.

4.1.2 Local flood risk

The precincts are likely to be affected by local flood events occurring in Bells Creek and Eastern Creek other smaller tributaries. Limited local flood modelling was available for the precincts across the full spectrum of events from rare to extreme at the time of the study and was provided to the project team after traffic modelling had been completed.

Local flooding information should be improved over time to inform more detailed planning for the sub-precincts. This should inform finer scale road design to ensure that the new road network enables rising road evacuation notwithstanding local flood events along key routes. A joint probability analysis/coincident flooding modelling approach would better bear out when local flooding is likely to affect roads relative to the larger riverine flooding so this can be combined into evacuation modelling.

4.2 Study precinct observations

4.2.1 Comparison of vehicle numbers to regional evacuation model

A comparison of the vehicle projections incorporated into the modelling for the study precincts against the vehicle numbers in the regional evacuation model is presented in Table 2. The projections used for the study precincts have been based on the dwelling projections provided by the Department multiplied by generally conservative vehicle ownership rates. The regional evacuation model numbers were provided by the Directorate.

Table 2: Comparing vehicle numbers – precinct models to regional evacuation model

	Vehicles in network (2041) (current modelled assumptions)		Vehicles in network (2041) (regional evacuation model)		Difference
	Total	Below PMF	Total	Below PMF	
	Vehicles		Vehicles in network (regional evac model)		# of vehicles
Vineyard (Stage 1)	3176	1242	N/A	4266*	N/A*
Marsden Park North	9696	6974	N/A	6803	171
West Schofields	8917	3715	N/A	5034	-1319

* It is noted that as Vineyard (Stage 1) is a sub-component of the broader Vineyard area, a direct comparison between the available Vineyard evacuation sub-sectors in the regional evacuation model and that solely within Vineyard (Stage 1) is not possible.

As noted in the table above modelled numbers for West Schofields differ markedly to that of the regional model – the regional model provides for significantly more vehicles than modelled for the precinct as part of this analysis, while Marsden Park North is generally similar (with only 171 more vehicles in it than the regional evacuation model – and this minor discrepancy could be resolved through less conservative dwelling projections such as 1.6 vehicles per dwelling).

The West Schofields difference is significant – there are significantly more vehicles modelled in the regional evacuation model than it would appear could be expected to locate in the precinct through the 2000 sub-PMF dwelling cap.

The difference between the models for Vineyard was not able to be reasonably determined given the boundaries of the Vineyard precinct under study was a subset of a broader SES subsector area upon which the regional evacuation model numbers are drawn. Like the other study precincts, it is likely that there would be limited discrepancy if dwelling projections haven't changed from that provided originally to the Directorate for the purposes of the regional model construction.

4.2.2 Marsden Park North

Based on the assumptions include in the flood risk assessment and traffic modelling analyses, rising road access relative to riverine flooding is available to enable evacuation to the regional evacuation route of Richmond Road. Local flooding assessments and road design as part of future sub-precinct planning will need to be undertaken to ensure these roads are resilient to local flood events so they are not cut prior to larger scale riverine flooding events.

4.2.3 West Schofields

West Schofields was the least advanced in terms of precinct planning at the time the analysis was carried out, however an urban design workshop was undertaken with the Department precinct planning team and representatives from SES, the Directorate, and Blacktown Council to provide advice on key road layout principles that are to be incorporated into the broader urban design of the precinct. This is discussed in section 5.

4.2.4 Vineyard (Stage 1)

Rising road evacuation access is available to the evacuation route of Old Pitt Town Road for residents to the east of the Killarney Chain of Ponds. The limited number of new dwellings planned adjacent to Windsor Road are intended to evacuate via Windsor Road. Given the small number of dwellings, this is not expected to create significant concerns for broader regional evacuation from Windsor and Pitt Town and other locations downstream.

4.2.5 Relationship to other settlements

The analysis undertaken is based on the relationship between the timing of downstream flooding cutting the key evacuation routes of Richmond Road and Windsor Road. The above analysis is therefore premised on evacuation ceasing from these downstream locations due to those roads being cut from the rising floodwaters.

Interface with other established and emerging settlements has not been modelled, such as the influence of Marsden Park or Windsor Downs on evacuation processes for the study precincts – this is understood to be the role of the regional evacuation model to address.

Notwithstanding, the demonstrated rising road access for the study precincts (subject to local flooding considerations) enables longer evacuation times than that modelled where constraints to the regional evacuation routes may cause evacuation delays within the precincts.

5. Masterplanning Principles

5.1 Overview

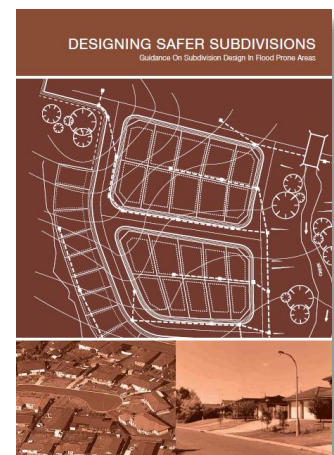
A master planning workshop was convened by the Department during September 2017 to seek further guidance on integrating flood evacuation considerations into the ongoing master planning efforts for Marsden Park North and West Schofields – ideally to arrive at an understanding of what may represent 'Brown Book compliance' (refer to section 7.2 below) for these precincts.

The workshop was attended by representatives of SES, the Directorate, the Department, Blacktown City Council and the consultants engaged in preparing the master plan layouts for Marsden Park North and West Schofields. The flood evacuation traffic modelling in this study had been completed by this time.

5.2 Flood-responsive Subdivision Design Requirements

Section 6 of the Designing Safer Subdivisions Guidelines, or 'Brown Book', focuses on 'designing for emergency response and evacuation'. The intent of this section of the document is to highlight the key considerations in designing subdivisions located on flood prone land which provide a safe environment for residents, where flood hazard and evacuation is appropriately addressed at the planning stage of such projects.

The document emphasises the functioning of evacuation routes needs to take account of a range of floods up to the probable maximum flood (PMF) with varying rates of rise, not just the adopted design flood. In instances where it becomes foreseeable that a severe flood will necessitate evacuation (including instances where residents may remain, on a higher floor), then designing for evacuation from the outset is essential. This varies from site to site and is dependent on the type of flooding, flood behaviour and duration of flooding, hence the need for flood studies to provide a sound basis for decision making. This is also important in terms for ensuring community re-occupation as quickly as possible.



5.3 Supplementary principles

Principles to supplement and/or extrapolate upon those encouraged by the 'Brown Book' identified and agreed by participants at the workshop included:

5.3.1 Broad principles

- Avoid the need for broad scale cut and fill – focus on conserving the existing function of the floodplain;
- Maintain internal road immunity at or above the FPL (1:100 + 0.5m freeboard) – avoid road 'divots' that may drop arterial road links below the FPL, and also comply with rising road access requirements to minimise the need for waterway crossings (which may substantially increase subdivision cost);
- Perimeter roads are acceptable where there is clear and multiple opportunities for rising access – the design principle should be to enable as many rising roads as possible from the lower floodplain to flood free areas that do not trap residents seeking to evacuate;
- Consider rural land use below the FPL to make reasonable economic use of the land below the FPL, noting that limiting increases in life safety and property damage arising from such land use should be avoided;
- Encourage vulnerable uses such as child care and aged care to locate above PMF, particularly via future DCP requirements for the precincts - Education and child care facilities within the PMF will need review by Council and SES under Section 12 of the SEPP (Educational Establishments and Child Care Facilities) 2017;
 - Encourage within/close to commercial centres outside the floodplain (such as that of Marsden Park North);
 - Add advisory notes to DCP (e.g. for inclusion in development approvals) regarding the need to work with SES guidelines and advice to develop site-based evacuation plans that are compatible with community-based SES Flood Plans; and

- Trigger the Australian Building Codes Board (ABCB) building controls via LEP/DCP provisions – noting that there is currently some overlap between these building provisions and those contained within other regulatory instruments such as the Housing Code within the Exempt and Complying Development SEPP.

5.3.2 Precinct-specific principles

5.3.2.1 Marsden Park North

- Avoid substantial cut and fill requirements by increasing the elevation of the perimeter roads;
 - This approach can allow for additional large rural living lots on the lower side of the road without increasing risk below the FPL while ensuring dwelling pads are above 1:100;
- Perimeter roads and subsequent new dwellings should consider the interface with Asset Protection Zones for managing bushfire risk; and
- Look to increase north/south road capacity in addition to Bandon Road for normal traffic movement and flood evacuation purposes – such as via Park Road or Robert Street given they remain flood free. Additional carriageways could also be considered as a means of increasing capacity.

5.3.2.2 West Schofields

- Avoid substantial cut and fill requirements by increasing the elevation of the perimeter roads;
 - This approach can allow for additional large rural living lots on the lower side of the road without increasing risk below the FPL while ensuring dwelling pads are above 1:100;
- Develop road layout for West Schofields with an inherent focus on flood evacuation given the challenges presented by Bells Creek and Eastern Creek;
- Regional evacuation routes that cross the future transport corridor should maintain their rising road nature – creating an underpass that floods may result in early cutting of a key evacuation route during times of flood;
- Arterial/spine roads located above PMF should be straightened to increase traffic flow and avoid bottlenecks;
- Reconsider the role/alignment of Carnarvon Road given its existing low flood immunity – at least one additional north/south evacuation route is considered necessary;
- Investigate opportunities to raise South Street/Schofields Road extension to Richmond Road – particularly to account for local flood events that may cut this road prior to the regional flood event occurring; and
- Meadow Road represents the primary rising road access to the regional evacuation route of Richmond Road – future road layout should orient to connecting to that road to maintain rising road access for the precinct.

6. Roadmap for Future Work

The work to date has necessarily been preliminary in nature, given the extent of more detailed masterplanning that is required to arrive at more complete urban development layouts for the precincts.

Therefore, a roadmap for future work to continue to integrate flood evacuation considerations into the masterplanning of the three study precincts is warranted. This roadmap should provide high level guidance over the life of the precinct development process. As actual development rollout of these precincts is expected to take until at least 2041, there is a need to ensure that each phase of planning (from 'broad-brush' to finer scale, and ultimately to assessment of development applications) occurs with regard to previous evacuation investigations and the implications of developing the study areas on regional evacuation planning.

Further, it should adapt as more road design and flood modelling information becomes available – either regionally through the efforts of the Directorate, or on a precinct basis as more detailed planning occurs.

This roadmap, as presented in Figure 7, includes:

- Phase 1 – Undertaking a preliminary assessment of flood evacuation risk and develop design principles and recommendations to inform future planning – this is now complete through this body of work;
- Phase 2 – Inputting updated dwelling assumptions into the regional evacuation model to determine off site evacuation impacts and other relevant evacuation considerations (including feasible dwelling numbers between 1:100 and PMF), once road layouts for the precincts are finalised (particularly Marsden Park North and West Schofields) – to be included as part of future revisions to the regional evacuation modelling, as further evacuation modelling may highlight possible limitations on feasible dwelling numbers based on evacuation constraints on local and regional evacuation routes;
- Phase 3 – Undertaking more detailed sub-precinct planning that accords with the high-level principles develop in the preliminary assessment, and undertake more detailed sub-precinct evacuation modelling once local road layouts and specific densities are 'locked-in' through Phase 2 above;
- Phase 4 – Refining precinct evacuation processes and required road capacities once more detailed modelling is undertaken; and
- Phase 5 – Ensuring specific development applications are in accordance with sub-precinct and higher level evacuation and road design assumptions and requirements as development applications are submitted – through clear evacuation reporting requirements to be submitted as part of the application process.

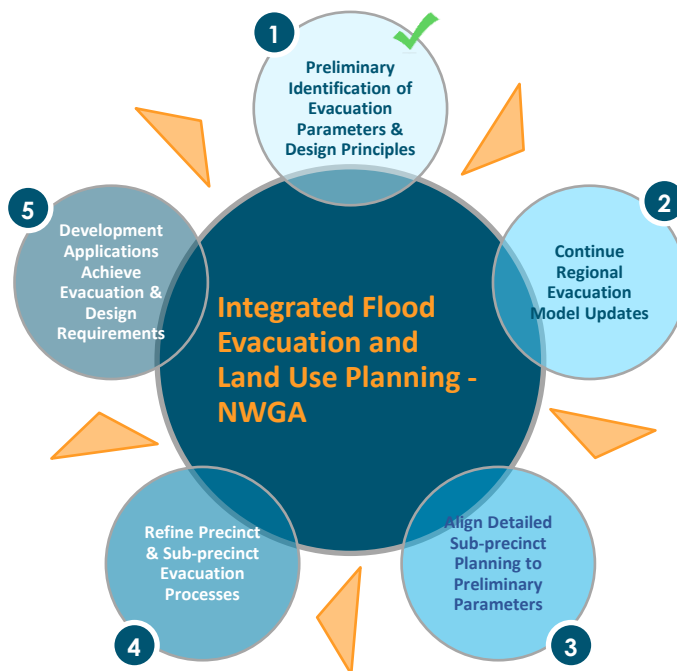


Figure 7: Roadmap for integrating flood evacuation into future precinct planning

7. Recommendations

7.1 Summary & Conclusions

This work provided an analysis of the flood evacuation context drawn from preliminary data for the three study precincts of Marsden Park North, West Schofields and Vineyard (Stage 1) for the purposes of informing the preparation of land use appropriate precinct layouts and dwelling capacities, and the broader regional flood evacuation modelling currently being undertaken by the Directorate.

Conclusions drawn from this analysis include:

- the analysis has demonstrated that rising road access relative to riverine flood is available to all study precincts when considering the existing and currently planned arterial road network, with several notable additional characteristics (refer to section 7.2 below);
- assuming all precinct roads are built to at least the 1:100 FPL, the evacuation timelines modelled are generally equivalent or similar to the shortest 'evacuation windows' identified for each study precinct. The evacuation window referred to in this report comprises the time elapsed between when downstream critical regional evacuation routes (i.e. from Windsor and Richmond) are cut and the time of first road inundation in the precinct. Rising road evacuation can continue following that evacuation window timeline;
- managing vehicle numbers at currently planned levels per precinct (by capping dwelling numbers) will ensure compliance with the regional evacuation modelling in its current form;
- the assumed vehicle numbers per precinct are highly sensitive to vehicles/dwelling ratios adopted per precinct – long term trends in reduction in car ownership, further public transport options and increasing use of autonomous vehicles over time may influence the number of dwellings allowed in each precinct in the long term, and/or alter vehicle-based flood evacuation behaviour;
- the analysis has not examined the interrelationship between concurrent evacuations from other precincts such as Marsden Park or areas to the north such as Windsor Downs – which is the role of the regional evacuation model to undertake;
- compliance with 'Brown Book' subdivision design requirements for Marsden Park North and West Schofields can be enhanced through the application of the additional master planning principles developed through the master planning workshop in road layout finalisation. Vineyard (Stage 1) appeared consistent with the subdivision design requirements discussed at the workshop.

While road layout planning is still ongoing for Marsden Park North and West Schofields, the key focus moving forward is to ensure road layouts include best practice flood responsive design through the application of flood risk-responsive design principles.

Focus should also be on iteratively addressing flood evacuation as more detailed planning for these precincts progresses over time – principally through ensuring more detailed planning aligns with the previous higher order planning for the areas.

7.2 Future directions

7.2.1 Broad recommendations

- All internal precinct roads should be developed to at least the 1:100 FPL flood immunity level (i.e. above 1:100 plus 0.5m freeboard) in order to comply with the modelling assumptions herein – additional immunity to account for local flooding events should also comply with broader Hawkesbury Nepean policy;
- Rising road access should continue to be a core element of precinct design as master plan layouts are refined/finalised;
- Maintain land use intent below PMF as currently proposed – a flood resilient master plan layout must be in place prior to entertaining any possible future increases in dwelling capacity below the PMF;
- As a separate body of work to the precinct planning process, consider developing a specific guideline that provides a consistent process for undertaking evacuation strategy and modelling assessments to accord with/integrate with the regional evacuation model to simplify and 'template-ise' the process for future sites and land releases – including being able to address flood evacuation queries/concerns at

different stages of the land release process – from concept to macro/mesoscopic level (if needed), to a micro-scale assessment once detailed road layout and land use mix is known. It is noted the upcoming Hawkesbury Nepean Road Master Plan will provide much of this along with future SES guidelines;

- Require site-based (i.e. per land release stage) evacuation assessments within the three study precincts as part of development assessment processes over time to accord with or improve the results indicated herein;
- Focus on local flooding considerations as part of more detailed layout and land development considerations – specific influence of local flooding on arterial evacuation routes within the precincts will require assessment to ensure the intended evacuation routes are not cut in local flooding events; and
- Wider road shoulders on all arterial roads should be considered as a means of readily increasing south-bound evacuation traffic capacity particularly within the precincts but also along Richmond Road.

7.2.2 Inter-precinct recommendations

- As part of master plan finalisation, improve connectivity/linkages between Marsden Park North and West Schofields precincts, particularly Garfield Road West across Eastern Creek, to enable multiple evacuation routes to be selected by SES over time.

7.2.3 Marsden Park North

- Incorporate the master planning principles identified in section 5 into master plan finalisation;
- As part of master plan finalisation, increase the role of Park Road or Robert Street (or similar north-south connection) as a higher capacity evacuation connection between Bandon Road (which is cut during flood events and hinders evacuation of dependent sectors) to facilitate evacuation of the northern part of the precinct via Garfield Road West onto Richmond Road.

7.2.4 West Schofields

- Incorporate the master planning principles identified in section 5 into master plan finalisation.

7.2.5 Vineyard

- It would appear from an evacuation perspective development of the Vineyard precinct can progress as per the current development layout intent given the availability of rising road access to Old Pitt Town Road for dwellings under PMF north of the Killarney Chain of Ponds, and the limited number of dwelling numbers south of the Ponds seeking to access the Windsor Road evacuation route.

7.2.6 Future amendments to evacuation modelling

There is an opportunity to update the traffic evacuation modelling undertaken as part of this study once the road layouts are 'locked in' through the master planning process. This will likely not occur for some years given the design and statutory planning processes required, however as per the roadmap identified in section 6 it will be beneficial to maintain a focus on flood evacuation for these precincts as further work progresses.

Continued engagement with the Directorate is recommended as the master plan layouts are finalised, and as more detailed planning for these precincts occurs over time so that updates to the regional evacuation model can be accommodated.

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