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REVIEW OF WAVERLEY FLOOD STUDY AND DRAFT DCP AMENDMENT

Waverley Council

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Date of final issue:	27 April 2023
File Path:	https://glnplanning.sharepoint.com/sites/GLNPlanning/Shared Documents/Projects/Active/11882 Waverley Council - Peer Review of Flood Study and Flood DCP/Reports/11882 Rpt.docx
Project Manager:	Paul Grech
Client:	Waverley Council
Project Number:	11882

Document History and Status

Version	Issue To	Qty	Date	Prepared by	Reviewed by
Draft	Patrick Hay (WC)	1-e	05.04.2023	PG	PL
Final	Patrick Hay (WC)	1-e	27.04.2023	PG	-

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1 Introduction

1.1 Commission

GLN Planning was commissioned by Waverley Council to peer review the key documents relating to the Waverley LGA Flood Study prepared by BMT for Council dated January 2021 (**Flood Study**) and proposed amendment to the Waverley Development Control Plan 2022 (**Draft DCP**) based on Draft DCP provisions prepared by WMS dated September 2021.

1.2 Background

In April 2021, Council adopted the Waverley Flood Study after technical investigations and two rounds of community engagement. In July 2021, the NSW Government issued NSW Flood Prone Land Package (**the 2021 Package**). The 2021 Package included changes to the standard instrument local environmental plan, which consequently amended *Waverley Local Environmental Plan 2012* (**the LEP**), and provided guidance for other related matters including inclusions for development control plans.

The Flood Study represents the initial stage of the NSW Floodplain Risk Management (**FRM**) process as outlined in the NSW Floodplain Development Manual published in April 2005 by the NSW Government (**the Manual**). The Flood Study made recommendations in regard to the adoption of flood planning levels (**FPL**s) and Flood Planning Areas (**FPAs**) for planning purposes.

Subsequent stages in the NSW FRM process involve the preparation of a Floodplain Risk Management Study (**FRMS**) and a Floodplain Risk Management Plan (**FRMP**) that will investigate the consequences of the flood risks identified by the study, potential mitigation measures and recommendations to be implemented through the FRMP. While these mitigation measures can include planning controls, it is not unusual for planning controls to be reviewed based on the findings of a flood study as the preparation of a FRMS and FRMP typically take many years to complete and the Manual encourages Councils to always act on the best available information.

The Flood Study provided a 3 tier classification (**Types A, B** and **C**) for lots that should be subject to flood related development controls (**Flood Control Lots**) based on the level of confidence of the flood modelling due to the nature of the terrain. Types B and C Flood Control Lots were identified as requiring further investigation to determine the extent of the lot affected (Type B) and whether flooding would affect the identified lot or adjacent land (Type C).

As a logical adjunct to the preparation of the Flood Study, Council commissioned the preparation of draft amendments to the DCP (**Draft DCP**) to introduce appropriate flood related development controls. This provided the opportunity to address the additional lands subject to flood risks and the more detail information regarding flood extents and hazard identified by the Flood Study

Based on the Flood Study, Water Modelling Solution (**WMS**) prepared the Draft DCP provisions dated September 2021 and a Flood Risk Precinct (**FRP**) Map to be used for the purposes of applying the DCP controls. The FRP Map adapted information contained in the Flood Study to categorise lots as either part of a Low, Medium or High FRP, which cumulatively represent all proposed Flood Control Lots for the Waverley LGA.

The amendment to the DCP was exhibited in June-July 2022. During the exhibition process Council notified over 10,000 landowners and received feedback from a number of residents, many concerned with the risk classification (low, medium or high) given to their properties and the implications this may have on property values, insurance premiums and their ability to renovate or redevelop their property in the future.

Council subsequently engaged GLN Planning and KBR Consulting to undertake a peer review of the Flood Study and Draft DCP, which is the subject of this report.

1.3 Purpose of this report

The purpose of this report is to document the findings of a peer review of the key documents relating to the Flood Study and Draft DCP.

1.4 Study Team

In order to address the various components of the brief, the peer review was undertaken by the following study team:

- GLN Planning (**GLN**)
- KBR.

GLN is the lead consultant and addresses town planning related matters, specifically the approach taken to the preparation of the Draft DCP, the format and content of the Draft DCP and associated FRP mapping, and other related matters. Paul Grech (GLN Director), is the principal author of this report and has 40 years experience working as a town planner with involvement in flood risk management projects during the last 30 years for both local and state governments across Australia and private industry, most of which involved the preparation or review of FRM planning controls.

KBR addresses the assumptions and methodology adopted by the Flood Study and suitably of the information provided by the Flood Study to inform the FRP mapping relied upon by the Draft DCP and technical matters related to controls in the draft DCP. The Review by KBR was led by Joshua Eggleton (KBR National Industry Lead – Water Resources) who is an experienced water resource engineer that has completed a wide range of public and private sector projects primarily related to floodplain management across Australia.

1.5 Information Reviewed or Considered

The following is a list of the information sourced and considered.

- Flood prone land package changes as documented in the DPE Planning Systems Circular issued to Councils in final form on 14 July 2021 (**2021 Package**)
- *Considering flooding in land use planning – Guideline*, DPIE, 14 May 2021 (**2021 Guideline** provided with the 2021 Package)
- *Floodplain Development Manual*, Department of Infrastructure, Planning and Natural Resources, April 2005 (**the Manual**)

- *Draft Floodplain Management Manual,* Environment, Energy and Science Department of Planning and Environment (DPE), 2022, and associated complementary Guides (Draft Flood Risk Management Manual and associated draft Guidelines. (**Draft Manual**)

- *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* Australian Institute of Disaster Resilience 2017 (**Handbook 7**)

- *ISO 31000:2009 Risk management — Principles and guidelines*

- Draft Shelter in Place Guideline, Department of Planning & Environment, 2022 (exhibited 17 January until 28 February 2023. (**Draft SIP Guideline**)

- Waverley LGA Flood Study, Final Report, January 2021, prepared by BMT for Waverley Council (**Flood Study**)

- Draft DCP provisions prepared by Water Modelling Solution (**WMS**) for Council dated September 2021 (**Draft DCP**)

- Submissions received by Council in regard to the exhibition of the Draft DCP

- Review of Submissions to Draft DCP, 6.10.2022, prepared for Council by WMS (**Submissions Report**)

- Council Officer reports regarding the establishment of the Waverley Council Floodplain Management Committee, Flood Study and Draft DCP, to Council Meetings of 21.08.2018, 19.05.2020, and 13.04.2021.

2 General

2.1 Statewide Planning Guidance

Current Floodplain Development Manual

The Manual and NSW Flood Prone Land Policy have changed over time since first adopted in the early 1980s but have principally retained the following key principles:

- Local Government is responsible for FRM in NSW with financial and technical support being provided by the State Government. The actions, decisions and information provided by Council and exercised in this duty are indemnified through the provisions of Section 733 of the *Local Government Act, 1993*. Indemnity is provided where Council acts in good faith, which is deemed to be in accordance with the principles of the Manual unless proven otherwise.

- A merit approach is to be adopted for the purposes of formulating a FRMP that provides a basis for decision making in the floodplain. This is in recognition that flood prone land is a valuable resource which should not be unnecessarily sterilised by the rigid application of prescriptive criteria, and to avoid the approval of inappropriate proposals. The merit approach is defined in the Manual as follows:

  The merit approach weighs socio-economic, ecological and cultural impacts of land use options

for different flood prone land areas together with flood damage, hazard and behaviour implications, and environmental protection and wellbeing of the State's rivers and floodplains.[1]

The level of flood risk acceptable to the community is to be determined through a process typically overseen by a committee comprised of local elected representatives, community members and State and Local Government officials. This process is shown in **Figure 1**.

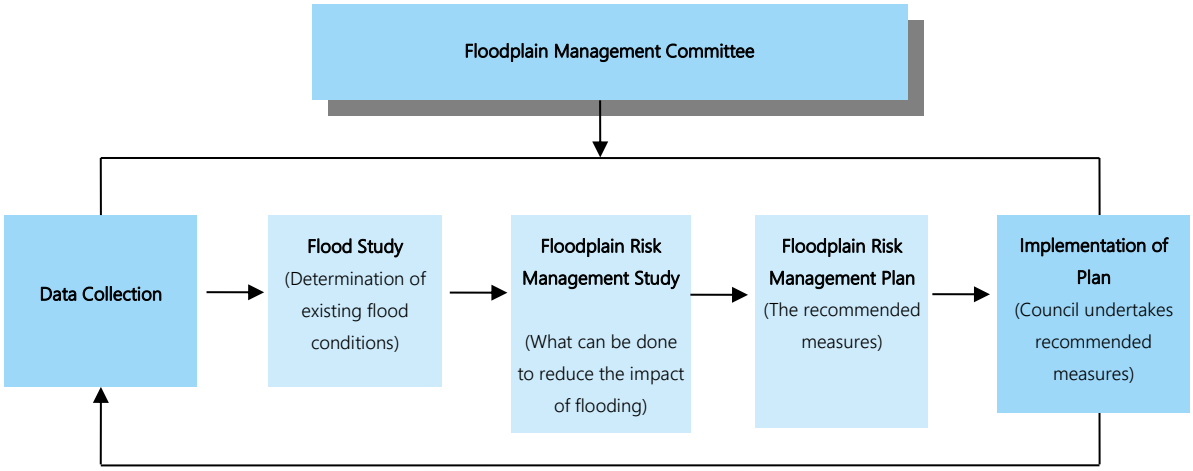


Figure 1 NSW FRM Process (adapted from the Manual 2005, pg.6)

The ultimate intent is to prepare FRMPs for individual floodplains that are adopted by Councils. FRMPs should have an integrated mix of management measures that address existing, future and continuing risk. These measures include planning and managing the approval of the location and form of new development.

The Manual and planning controls under the *Environmental Planning And Assessment Act 1979* (**EP&A Act**) should not be considered as providing alternate approaches. The Flood Prone Lands Policy and Manual are separate to the principal planning legislation in NSW, being that contained within the EP&A Act and associated Regulations. Ultimately, the planning recommendations of a FRMP may be reflected in planning instruments and policies brought into force in accordance with the EP&A Act, such as the DCP.

The way that FRM should ultimately be considered in plans made under the EP&A Act is primarily determined by a combination of matters including the Manual, guidelines and circulars issued by the NSW *Department of Planning and Environment* (**DPE**), national guidance documents such as Handbook 7 (AIDR, 2017) , the interplay of the LEP and DCP, Council planning strategies and higher order plans and polices prepared by the DPE, and the environmental, economic and social circumstances of individual Councils. Relevant legislation, planning instruments and policies are reviewed below to provide a basis for reviewing the Flood Study and Draft DCP.

[1] 2005 Manual, NSW Government, 2005, page 23.

Draft Flood Risk Management Manual and associated draft Guidelines

The Draft Manual was placed on public exhibition in the early part of 2022. The primary document consists of a more concise Manual complemented by a series of guideline documents.

The Draft Manual retains similar principles as the existing Manual. The most significant new guidance relevant to this report includes:

- The *Understanding and Managing Flood Risk Guide* (**Guide FB01**) This includes example considerations for DCP's (Appendix B). Three examples have been provided, each utilising a matrix approach based on dividing the floodplain into flood risk precincts, *Flood Planning Constraints Categories* or floodway and areas inside and outside of the FPA. Generic controls are provided under headings similar to those used in the Draft DCP. These example DCP's are intended to provide a guide only, requiring tailoring for individual council circumstances.

- The *Flood Impact At Risk Assessment Guide*, (**FIRA Guide**) which outlines matters to consider when preparing and reviewing flood impact assessments for development assessment purposes. Such a guide could replace, or inform a review of Council's current requirements for the preparation of site specific flood impact assessments.

The Draft Manual and above Guides have been taken into consideration when reviewing the Draft DCP.

Flood Planning Guideline

On January 31, 2007 the then NSW Planning Minister announced a guideline for development control on floodplains (**2007 Guideline**). An overview of the 2007 Guideline and associated changes to the EP&A Act and Regulation was issued by the Department of Planning in a Circular dated January 31, 2007 (Reference PS 07-003). The 2007 Guideline issued by the Minister at that time was in effect related to a package of directions and changes to the EP&A Act, Regulation and Manual.

This 2007 Guideline provided an amendment to the Manual. The Guideline confirmed that unless there were "exceptional circumstances", Councils were to adopt the 100 year flood as the flood planning level (**FPL**) for residential development, with the exception of some sensitive forms of residential development such as seniors living housing. That Guideline provided that controls on residential development above the 1 in 100 year flood could only be imposed subject to an "exceptional circumstances" justification being agreed to by the Department of Planning (now DPE) and the Department of Natural Resources (now also part of DPE) prior to the exhibition of a Draft LEP or Draft DCP.

The direction regarding the selection of an FPL in the 2007 Guideline did not apply to all land uses (only standard residential) and recognised the need to consider the full range of flood sizes, up to and including the PMF and the corresponding risks associated with each flood. Where there was a reason ('exceptional circumstances') a different FPL not based on the 100 year flood (plus freeboard) could also be applied with government approval. The direction did not apply to pre-existing planning controls.

More recently, the NSW Government introduced significant changes to the FRM statutory planning framework across NSW with the Implementation of the DPE Flood Prone Lands Package. These changes were initiated on 14 May 2021 and came into effect on 14 July 2021.

The Flood Prone Land Package changes were introduced in a DPE Planning Systems Circular issued to Councils in final form on 14 July 2021 and included the *Considering flooding in land use planning – Guideline* (the **2021 Guideline**).

The principal changes relate to the harmonisation of the FRM provisions of all LEPs but with important incidental implications for DCPs and flood planning maps. Notably, the prescription in the 2007 Guideline regarding the adoption of the 100 year flood as the FPL for residential development without exceptional circumstances approval was abandoned. The current Guideline now allows Council greater autonomy in determining FPLs and FPA mapping.

The 2021 Circular provided advice to Councils on the recent changes that included:

- an amendment to clause 7A of Schedule 4 to the *Environmental Planning and Assessment Regulation 2000*
- a revised local planning direction regarding flooding (for consideration in the review of Planning Proposals) issued under section 9.1 of the EP&A Act
- two LEP clauses which introduce flood related development controls (one compulsory – clause 5.21 and one optional – clause 5.22)
- all FPA maps are now deleted from LEPs
- introduction of the 2021 Guideline
- revoking of the 2007 Guideline.

Notable direction provided by the 2021 Guideline includes:

- The guideline applies to both mainstream and overland flow flooding (pg.3).
- The full range of flooding up to and including the PMF must be considered when undertaking strategic land use planning (pg.3).
- "Councils should define their FPAs and FPLs in their development control plans (DCPs) and outline if there are multiple FPAs/FPLs and where they apply. For example, a council may have a different FPAs for different catchments based on the flood risk identified through the FRM process. Council may also have different FPLs based on the land use type (for example, residential, industrial, commercial developments) and these should be documented in their DCP. Council may have a range of development controls to suit the flood constraints and different types of development" (pg.5).
- "The manual identifies the 1% AEP flood event, or an equivalent historic flood, as an appropriate starting point for determining the DFE for development controls, including for residential development. The manual allows the selection of a rarer DFE to address broad scale flood impacts in consideration of the social, economic, environmental and cultural consequences associated with floods of different probabilities" (pg.5). DFE is an abbreviation for "defined flood event" which can be added to freeboard to determine an FPL.
- "The typical freeboard for residential development due to flooding from waterways, such as rivers or creeks, is 0.5m. A lower freeboard or an alternative approach to freeboard may be

used where the consequences to people and property of low probability flood events are assessed as minor through the FRM process" (pg.5).

- "Where councils propose alternative FPL's, they are required to demonstrate and document the merits of this approach based on a risk management approach that is consistent with the FRM process and the principles of the manual" (pg.5).

- All areas where flood-related development controls apply should be mapped where flood study information is available, with publicly accessible maps (pg.7).

- It is suggested that Councils could attach their adopted flood policies, flood studies and FRMS&Ps to their DCPs to ensure they are considered in the assessment of a DA (pg.5). However, in our view this is unnecessary. Ideally the Flood Study or future FRMP should be publicly available but all relevant planning recommendations should be translated to a DCP.

Our review takes into consideration the changes introduced with the Flood Prone Lands Package, including the new 2021 Guideline.

2.2 Relevant State Environmental Planning Policies

No State Environmental Planning Policy (**SEPP**) has been prepared dealing specifically with the issue of flooding, but some regulate development in response to potential flood risks.

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (the **Codes SEPP**) has some relevance to this report. The Codes SEPP effectively provides approval pathways as alternatives to a full DA for certain low impact development as "exempt" or "complying" development. Exempt development requires no approval provided it complies with certain criteria. Complying development must meet certain criteria but also requires an approval in the form of a complying development certificate (**CDC**) which must be issued by Council or a private certifier subject to specified conditions.

The Codes SEPP is divided into a number of "Codes" that deal with exempt development and different types of complying development. Those Codes of relevance are the Exempt Development Code (Part 2), the General Housing Code (Part 3), and the Commercial and Industrial (New Buildings and Additions) Code (Part 5A).

Relevant clauses of the Codes SEPP apply to "flood control lots" defined as:

> ***flood control lot*** *means a lot to which flood related development controls apply in respect of development for the purposes of industrial buildings, commercial premises, dwelling houses, dual occupancies, multi dwelling housing or residential flat buildings (other than development for the purposes of group homes or seniors housing).*
>
> ***Note****. This information is a prescribed matter for the purpose of a certificate under section 149 (2)* [now 10.7] *of the Act.*

The term "Flood control lots" exist only for the purposes of the Codes SEPP. Consequently the process of "lot tagging" to identify Flood Control Lots is a practice that had initially evolved in the preparation of flood studies to assist Councils for the purposes of issuing s10.7 planning certificates. Consequently Flood Control Lot Maps are not necessarily an appropriate format for FPA maps.

The term 'flood-related development controls' within the definition of flood control lot is not defined but would include any development controls relating to flooding that apply to land, that are a matter for consideration under section 4.15 of the Act[2]. These development controls may apply through an LEP or DCP.

2.3 Waverley LEP

The relevant planning instrument is *Waverley Local Environmental Plan 2012* (**the LEP**) The standard instrument mandatory FRM clause 5.21 applies. Subclause 5.21(5) provides:

flood planning area *has the same meaning as it has in the Floodplain Development Manual*

The Manual (pg.21) provides:

flood planning area *the area of land below the FPL and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Manual.*

flood planning levels (FPLs) *are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "standard flood event" in the 1986 manual.*

Council has not opted into the optional SFC clause 5.22 in the standard instrument. We understand that Council did discuss this with the DPE and was advised that this would not be appropriate until Council had completed its FRMS and FRMP:

[2] See 2021 Guideline. Page 2.

2.4 Council Flood Mapping

Council currently provides flood mapping as part of its online mapping information. This mapping identifies relatively few properties based on limited information available prior to the current Flood Study (**Figure 2)**. These limited properties are those that would be currently subject to flood related development controls.

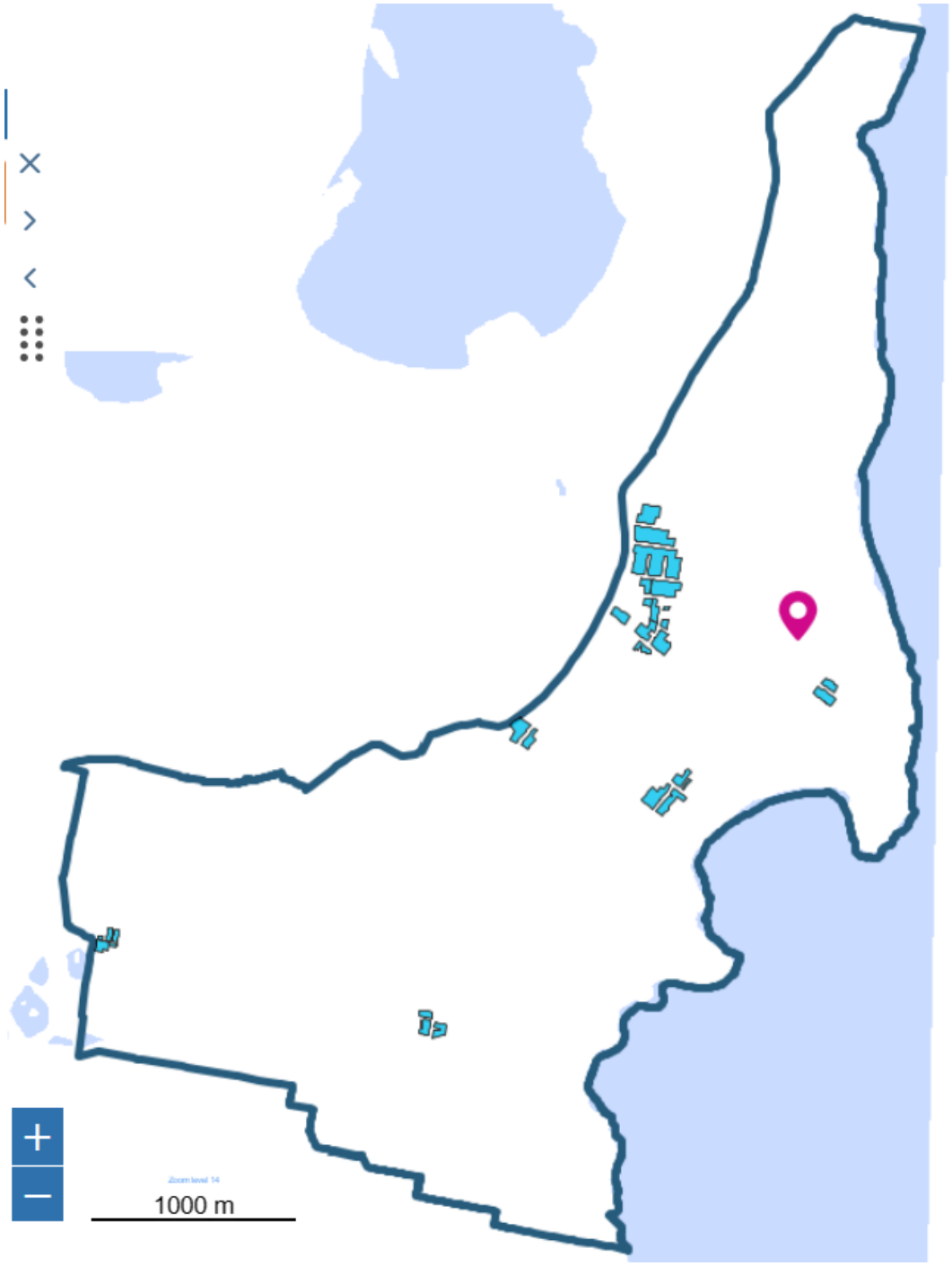


Figure 2 Online Flood Planning Area Mapping

2.5 Existing DCP Provisions

In summary the existing FRM provisions of the DCP (Section B5 clause 5.2) comprise the following:

- Refers to the LEP to define the FPA
- FPL for habitable floors – 1% + 300mm freeboard
- FPL for non-habitable floors – 150mm above adjacent ground.
- Auto flood gates for basements.
- Refers to *Water Management Technical Manual* – mainly stormwater management.

The existing DCP provisions are not consistent with current LEP provisions – in particular the DCP refers to the LEP for guidance as to the FPA while clause 5.21 and the 2021 Guideline recommends that the DCP performs this function.

Importantly, the existing DCP FRM provisions do not reflect a risk based approach which is best practice as promoted by Handbook 7, or the appropriate range of controls suggested within Guide FB01 provided with the draft Manual.

3 Review of Flood Study and Draft DCP

3.1 Flood Study

A detailed review of the Flood Study as required by the brief was undertaken by KBR. a full copy of their report is contained as **Appendix A**. In summary the KBR report concludes the following:

- The Flood Study was completed in accordance with the NSW State Government's Floodplain Development Manual (2005), and Australian Rainfall & Runoff (ARR) 2016 (the current ARR guideline at the time of completion of the Flood Study).
- The adopted modelling methodology is considered reasonable and appropriate for the catchment. However, there are limitations in the adopted approach that directly influence the level of confidence in certain (predominantly steeper upper catchment) sections of the catchment. BMT have clearly acknowledged these limitations and considered them in their approach to lot tagging.
- Further investigation of key model limitations and assumptions discussed in this review should be considered within the FRMS.
- The adopted approach to lot tagging should be clearly articulated and repeatable but should also consider the level of uncertainty/confidence in the underlying modelling. Any deviation from the selected criterion to add or remove tagged properties based on engineering judgement or visual inspection should be documented for future reference.
- The BMT approach to lot tagging considered the level of uncertainty in the underlying

modelling but is not simple to articulate or replicate.

- The WMS approach to lot tagging follows a set criterion (i.e. well-articulated) and is simple to replicate but does not take into consideration the level of uncertainty in the underlying modelling.

- The approach to defining the FPA is a matter that can be considered further as part of the FRMS. In the interim, the WMS FRP approach is considered a reasonable, albeit conservative, approach to determining the FPA and FRP maps for the application of DCP controls.

- The FRP map is currently presented using the lot-based approach as discussed in Section 3.2. It is recommended that the FRP map be modified to adopt a line-based approach (i.e. based on the actual extent of the three precincts) to convey the flood extent and level of risk to the community to an improved level of accuracy. The lot-based map can be retained for use internally by Council to understand what DCP controls apply to each lot (based on the adopted post-processing of the FRP polygons detailed in Section 3.3 [of the KBR Report]).

While not directly related to our brief we note that the Flood Study (pg.90) concludes that "most of the inundation modelled and presented in this study would be regarded as "stormwater" for the purposes of the assessment of insurance claims". In contrast to insurance for stormwater damage, household insurance for flood damage is relatively new. The process for introducing flood insurance included Australian regulations adopting the following standard definition of "flood" in June 2012:

> *The covering of normally dry land by water that has escaped or been released from the normal confines of:*
>
> *any lake, or any river, creek or other natural watercourse, whether or not altered or modified; or*
>
> *any reservoir, canal, or dam.*

Separate to coverage for flood damage, most household insurance policies include cover for storm or rainwater damage which while not subject to a standard definition, typically refers to water that has fallen naturally from the sky. Simplistically, storm damage is associated with water travelling to a watercourse or water body, while flood damage is associated with water travelling from a watercourse or water body. It should be noted that the Flood Study only defined a few watercourses within the study area (such as Tamarama Gully and Bronte Gully).

3.2 Principles to be considered in Review of Draft DCP

3.2.1 Introduction

As alluded to above, there are no guidelines that prescribe the format or content of flood related development controls in a DCP. However best practice would require DCP controls adopt a risk based approach. This needs to be accompanied by appropriate mapping. The general principles of

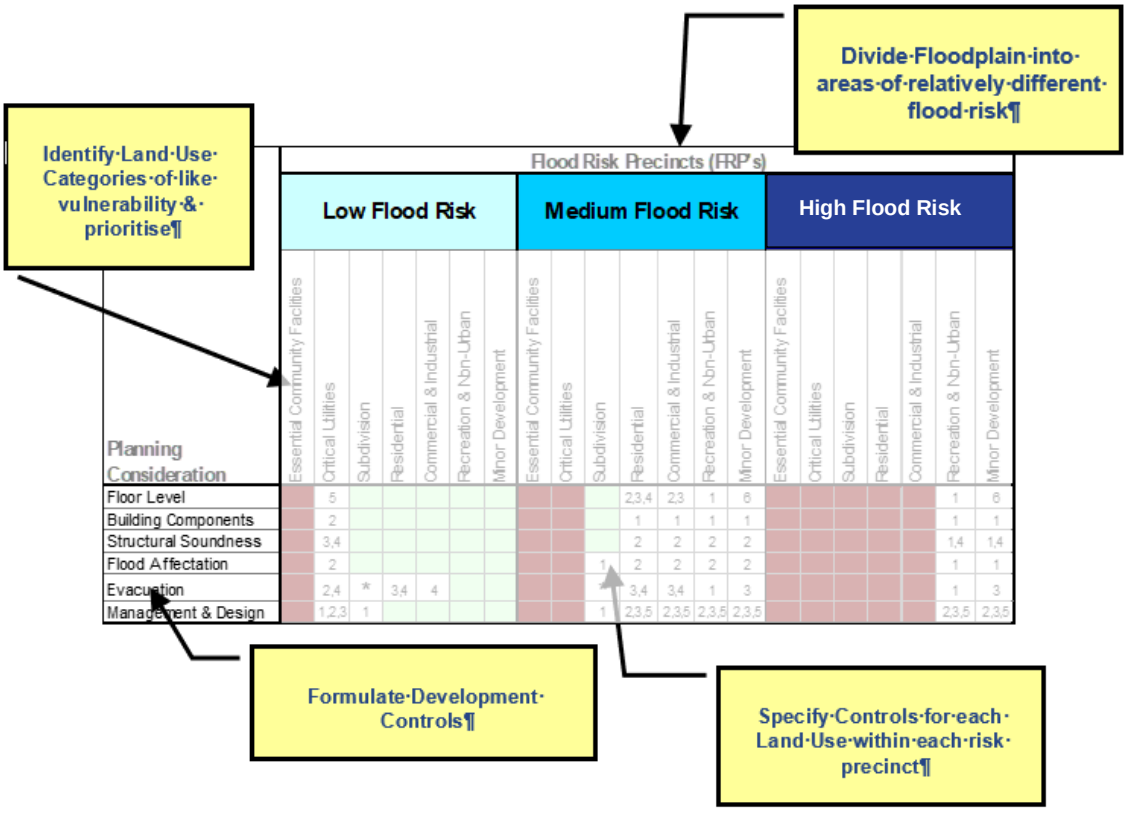
how this may be achieved is discussed below prior to undertaking a review of the draft DCP.

3.2.2 A Risk Based Approach for the Application of the DCP

Historically, the FRM statutory planning framework was based on determining a singular FPL to determine the extent of an FPA which in turn governs the appearance of statutory flood planning maps. However this does not allow for the application of a risk based approach which needs to consider the full range of potential floods and the variable sensitivity of different land uses to flooding.

The "Planning Matrix approach"[3] was formulated to address the inadequacy's of past approaches. This approach does not rely on a singular FPL and requires the mapping of typically 3 "precincts" with different levels of flood hazards. This is consistent with the recommendation of the Queensland Commission of Inquiry following devastating flooding in 2010-2011, that recommended that flood planning maps be prepared showing "…'zones of risk' (at least three) derived from information about the likelihood and behaviour of flooding." [4] Cumulatively these 3 precincts can constitute an FPA map.

The principles for applying the Planning Matrix approach are depicted on **Figure 3**, noting that the land use categories and metrics of the controls should be adapted to the meet the circumstances of



[3] Bewsher & Grech, May 1997, *A New Approach to the Development of Floodplain Controls for Floodplains*, paper presented to the 37th Annual Floodplain Management Conference, Maitland.

[4] Queensland Flood COI Final Report, March 2012, pg. 68.

different floodplains. This approach operates in conjunction with FRP maps. The Planning Matrix approach is consistent with a risk based approach.

Figure 3: Principles for Applying the Planning Matrix Approach

The Planning Matrix approach has been adopted by about a third of councils in the Sydney Metropolitan, Illawarra and Hunter regions of NSW[5] and is now endorsed as part of the example DCP's included in the DPE draft Guide FB01 (*Understanding and Managing Flood Risk Guide*) accompanying the draft Manual. Importantly, the matrix approach operates in conjunction with the mapping of FRPs (typically low, medium and high flood risk precincts - **FRP**s). Rather than identify a single FPA within which all development is equally subject to the same planning considerations, the FRPs are used in conjunction with the planning matrix to determine which controls apply, to which land uses, within each FRP.

3.2.3 How to Map the Floodplain for the Purposes of Applying the DCP

The function of flood planning maps prepared for statutory planning purposes is to trigger approval pathways and FRM considerations to be addressed in the assessment of a development application. This is different to more complex flood maps produced by Flood Studies that can be used for the purposes of strategic planning.

While there could be many permutations for preparing maps for statutory planning flood purposes, in recent years there have been mainly 3 approaches:

1. **A single line Map** – This approach shows a line based on a single FPL (typically the 1 in 100 year chance flood plus freeboard) to trigger the consideration of flood planning controls for areas only within that line.

2. **Flood Control Lot Map –** This maps the whole of lots that are identified as substantially affected by a single FPL (typically the 1 in 100 year chance flood plus freeboard) to trigger the consideration of flood planning controls for the whole of lots identified in this way.

3. **Flood Risk Precinct (FRP) Map –** This typically maps the whole of the floodplain (ie up to the PMF) into three areas (normally referred to as Low, Medium and High FRPs) based on various flood considerations to apply different planning controls to different land uses in different parts of the floodplain.

The merits of each approach are discussed below.

A Single Line Map

A Single Line Map is the simplest to understand and is historically the most common approach but has the following disadvantages:

[5] Based on research undertaken by GLN planning in 2021 which reviewed the FRM planning policy framework of 49 LGAs in the Sydney Metropolitan, Illawarra and Hunter regions of NSW prior to any changes initiated in July 2021 associated with the Flood Prone Lands Package,

- Can miscommunicate to the public that if located above the line then no flood risks exist, whereas in reality flood risks up to the PMF would exist.
- In some cases the flood risk can be over stated, (eg where the addition of freeboard to the 1 in 100 flood level exceeds the PMF, with no adjustments).
- It does not allow for the application of flood related planning controls based on a best practice risk based approach.

It is considered that this mapping format is not the optimal approach.

Flood Control Lot Map

As discussed above, there is no specific requirement to prepare a Flood Control Lot Map (ie that depicts flood control lots as defined by the Codes SEPP). However, in practice this is normally done for the purpose of having a GIS based source to automatically trigger which properties should be noted as a Flood Control Lot on a S10.7 Planning Certificate. Other flood maps cannot readily perform this function because it is common practice to exclude the "tagging" of Flood Control Lots if an immaterial proportion of the lot is affected by flooding (eg less than 10% being a criterion commonly used).

Flood Control Lot Maps had historically been used by some Councils within planning instruments. Prior to the changes brought by the Flood Prone Land Package, a few LEPs (e.g. Rockdale and Marrickville LEPs) and the DCPs of some other Councils adopted Flood Control Maps as Flood Planning Area maps. However, this is not favoured for the following reasons:

- Some lots remain only partially affected by actual flooding but are tainted as wholly flood affected (this being a particular issue with large lots).
- Such maps portray a distorted view of the flood risk across an area, which works against communicating clear and accurate information about flood risk to the community.
- It does not allow for the application of flood related planning controls based on a best practice risk based approach.

It is considered that this mapping format is also not the optimal approach. However, it is recommended that a Flood Control Map be prepared for the purposes of tagging properties for notification on S10.7 Planning Certificates, but that such a map be contained on Council's GIS system for internal use only.

3.2.4 Flood Risk Precinct (FRP) Maps

The flood risk precincts (**FRP**s) approach is preferred. For the reasons outlined above it provides a best practice risk based approach that is designed to work with the Planning Matrix Approach. The FRP approach divides the whole of the floodplain into precincts that do not miscommunicate known flood risk to the community and provides a platform from which planning controls can be established with minimal complexity.

The criteria used to demarcate between each FRP could vary. While not specifically referenced in the context of preparing a DCP, the draft Guide FB01 suggests the following criteria for FRP's:

- *high risk precinct – high hazard (from the 2005 Manual) or H5 and H6 as determined through FRM Guide FB03 – and in some cases floodways in the DFE event. This is the most constrained area of the floodplain*

- *medium risk – low hazard (from the 2005 Manual) or H1 to H4 as determined through FRM Guide FB03 in the DFE event and extending out to the FPA (based on the DFE plus freeboard)*

- *low risk – outside the FPA and potentially out to the extent of the PMF.*

The above suggestion in draft Guide FB01 is based on the premise that that there would be 2 maps – an FPA map and a separate FRP Map. Recognising the specific purpose of such maps is to trigger the need to consider FRM matters in the assessment of a development application, a simpler approach could suffice that does not rely on a separate FPA map. Given that the 2021 Guideline encourages the delineation of FPA areas in a DCP, having a single map that also allows for the application of DCP controls would be less confusing to the general public and administratively more efficient.

Having regard to the above background and principles, we review the questions asked of us in our brief below.

3.3 Flood Mapping to Support the Draft DCP

Comment on the appropriateness of the lot tagging method

In addition to KBR's technical review of the mapping derived from the Flood Study it is relevant to consider the appropriateness of utilising the flood map provided with the Draft DCP.

The Flood Study determined a Preliminary FPA based on a 1 in 100 year chance flood plus freeboard. The intent of the FPA map was to identify areas to be subjected to flood related development controls. However, the Draft DCP relies on FRP maps that are different to the FPA Map.

It has been common practice in NSW, since about the time of the 2007 Guideline, for Councils to adopt an FPA based on the 1 in 100 year chance flood plus 0.5m freeboard (with or without climate change factored in) for the purposes of applying LEP considerations and then to adopt DCP controls often based FRP maps. As discussed above, this conundrum was a consequence of the historical approach relying on a single FPL. This was also an expedient means of dealing with the 2007 Guideline which constrained the imposition of flood related planning controls on standard residential development. This changed with the introduction of the NSW Flood Prone Land Package and associated Guideline in 2021.

Given the Flood Study was prepared prior to the NSW Flood Prone Land Package changes and the Draft DCP was narrowly focused on that document, it is unclear as to what is now intended to be the FPA map for the purposes of applying clause 5.21 in the LEP. The options for defining the FPA for the purposes of clause 5.21 of the LEP could include:

1. Adopt a separate map that is ideally referenced in the DCP but explained as different to the FRP map used in the DCP.

2. State in the DCP that the Medium and High FRPs are the FPA for the purposes of the LEP.

3. Adopt the outer bounds of all the FRPs as the FPA.

Option 1 is likely to be confusing to the public, unnecessarily adds administrative complexity and could create conflict with the DCP. While this option might decrease the number of properties upon which development would be subject to consideration of clause 5.21 of the LEP if the FPA in the Flood Study was adopted, there would be inconsistency with the triggering of FRM considerations under the DCP using proposed FRP maps.

Option 2 is also likely to be confusing to the public, and would result in conflict between the DCP and LEP. The DCP provides basic emergency and environmental management considerations for a range of uses in the Low FRP for a range of uses[6]. Additionally the FRPs are based on flood extents exclusive of freeboard, meaning if Council was to rely on the more conventional FPA as provided in the Flood Study, its outer bounds would lie somewhere between the lines that the delineate the Medium and Low FRPs.

In our opinion, Option 3 is .preferable. To ensure consistency between application of the LEP clause 5.21 considerations and the DCP controls it would be desirable for the DCP to explicitly outline that satisfaction of the provisions of the DCP is a means of addressing clause 5.21. Additionally, while a scaled down version could be inserted in the DCP (as proposed by the Draft DCP) it would be the FRP map should be available electronically on Council's online maps (which is what was proposed).

The Draft DCP Flood Map uses a hybrid approach that combines an FRP Map approach with a Flood Control Lot map approach. To our knowledge such an approach has not been used in another jurisdiction in NSW or other parts of Australia. It's uniqueness does not necessarily mean it is not appropriate and we see there are both advantages and disadvantages with the approach, as outlined below.

Advantages	Disadvantages
Adopts a format that allows for the application of flood related planning controls using a risk based approach (ie the Planning Matrix Approach)	Does not reflect the actual pattern of flooding across the catchment, which could confuse the public particularly when comparing with flood extent maps in the Flood Study.
Allows for a degree of uncertainty in the flood mapping that could be warranted given the complex urban environment mapping constraints discussed by KBR. For example the Flood Study mapping might provide confidence that a lot is subject to some flood hazard albeit without a high level of confidence about the extent while the DCP map could trigger the application of planning controls for	Could overstate the level of flood risk on an individual lot (ie because only a part of the lot is actually flood affected).

[6] Note detailed review of the Draft DCP in Appendix B recommends that floor level and flood compatible building controls be also applied in the Low FRP. This is to ensure that development occurring in the Low FRP but on the edge of the edge of the Medium FRP on land only marginally above the 1% AEP flood level adopts the 1% AEP flood level plus appropriate freeboard. This will avoid inconsistencies in possible situations with development applications where neighbours are at almost the same ground level but one is required by Council to have elevated floor levels and the other is not.

Advantages	Disadvantages
a lot where further detail investigations could be undertaken.	

Based on the KBR review and the above, we consider that the proposed hybrid approach should be replaced with a conventional line based map derived from modelled flood extents. However, it would be appropriate to provide a statement on the map that recognises the known accuracy limitations as discussed by KBR.

Figure 4 provides an example area from the exhibited DCP map which uses a Flood Control Lot mapping approach. **Figure 5** shows how the same area could appear applying line-based FRP mapping approach. We note that when using Council's online mapping system the aerial photograph layer can be turned on/off, so differences associated with that aspect of the images in these figures should be understood in that context.

Figure 4: Hybrid Flood Control Lot & FRP Mapping Approach

(Extract from Exhibited Draft DCP Map)

Figure 5: FRP Mapping Approach

(Extract from map generated by Council)

Limitations on the accuracy of base flood mapping should not preclude the adoption of updated flood planning maps for development assessment purposes. This is not an uncommon situation and in our experience it can be adequately addressed by clearly outlining the limitations of the accuracy of the base mapping with the published maps. As discussed above, the principal purpose of a statutory planning map is to trigger the application of planning controls and FRM considerations. The DCP controls can appropriately provide flexibility to enable applicants to provide site specific flood assessments and could include performance based design solutions to respond to the particular circumstances of an individual property when preparing a development application.

The Manual encourages Councils to rely on the latest available information when preparing planning controls, and indemnity is provided in accordance with s733 of the *Local Government Act, 1993* when acting in accordance with the principles of the Manual. Updated flood planning maps would also address inconsistencies between existing flood planning maps and information provided in the flood study to minimise the opportunity for miscommunicating known flood risks to the community.

In addition to the technical mapping issues discussed by KBR, we consider that the area within the High FRP should be refined. The High FRP should identify that part of the floodplain within which the intensification of development is unlikely to be acceptable after practical ameliorative measures are considered, due to both flood hazard conditions and potential emergency management issues. The Flood Study (pg.84-85 and Figure 7-3) identified individual properties that are unsafe for sheltering in place (because they are potentially at risk of structural damage due to flooding) and roads that may not be trafficable by heavy vehicles (limiting rescuing capabilities) during the peak of a flood event. These individual properties should be included in a High FRP, if not already included, and further analysis undertaken to determine whether any properties isolated by flooded roads could become unsafe for sheltering in place, in which case they should also be included in the High FRP.

While consideration could be given to factoring in climate change to the determination of flood extents and hazards in the delineation of FRPs, we do not consider this is critical at this stage provided FPLs used in the planning controls ultimately factor in climate change as discussed further below.

3.4 Draft DCP Provisions

Comment on the methodology undertaken to prepare the amendments to the Development Control Plan, inclusive of reviewing a consultant report discussing this process.

In answering this question we have considered both the process for the preparation of the Draft DCP and the content of the Draft DCP.

3.4.1 Process

We have not identified any issues with the process for preparing the DCP. The DCP was based on detailed knowledge provided by the Flood Study. Based on the documents we reviewed and discussion with Council officers, the notification of the draft DCP met the requirements of the EP&A Act and Council's Public Participation Policy.

3.4.2 Content

We have considered the following aspects of the content of the Draft DCP:

- General Format
- Stated Objectives
- Definition of Land Use Categories
- Substance of controls
- Defined Terms

Appendix B provides a detailed review of the DCP having regard to the above aspects. The following provides a summary of this review.

General Format

The format of the draft DCP is consistent with that adopted by other DCP's that adopt a similar Planning Matrix approach. However we recommend the incorporation of performance criteria to complement the prescriptive controls.

Section 4.15(3A)(b) of the *Environmental Planning and Assessment Act 1979*, requires:

> *(3A) Development control plans If a development control plan contains provisions that relate to the development that is the subject of a development application, the consent authority—*
>
> *...*
>
> *(b) if those provisions set standards with respect to an aspect of the development and the development application does not comply with those standards—is to be flexible in applying those provisions and allow reasonable alternative solutions that achieve the objects of those standards for dealing with that aspect of the development, ...*

Given the complex nature of the highly urbanised area to which the controls apply, and the potential for refinement of the understanding of the flood hazards on individual sites subject to site specific assessments, performance criteria will enable council to flexibly apply the controls to ensure the intended outcome is achieved. This provides reasonable flexibility to ensure that any unavoidable inaccuracies with the flood modelling that have underpinned the definition of FRP's would not unreasonably impact the development potential of individual properties.

Stated Objectives

The stated objectives could be simplified and clarified to avoid any confusion in regard to the intent of the controls.

Additionally the objectives could confirm the intention that satisfaction of the DCP controls would address the considerations required by clause 5.21 of *Waverley Local Environmental Plan 2012*. This provides greater clarity for both applicants and Council assessment officers when addressing all FRM issues associated with a development application. Importantly this would also clarify that the intent of utilising the FRP mapping prepared for the DCP, to also define the LEP FPA, is not intended to expand the restrictions on development when being considered under clause 5.21 of the LEP.

Land Use Categories

In our view the number of land use categories proposed are excessive in the context of the Waverley LGA, and can be reduced to simplify the matrix, in the following way:

- The categories of "Essential Community Facilities" and "Sensitive Uses and Facilities" can be consolidated as the same controls would be relevant to both.
- A separate land use category for "Subdivision" is not necessary, and relevant considerations can be incorporated into controls for each land use category.
- The category for "Tourist Related Development" can be dispensed with as most uses in this category would be uncommon to the Waverly LGA and can be incorporated into other land use categories.

Range of Controls

The range of controls are generally consistent with best practice, including the suggested DCP controls in Guide FB01. However some minor refinements are recommended as to how subdivision matters are addressed, to simplify the matrix without diminishing the intent of the controls.

Substance of Controls

The substance of the controls generally reflect best practice, but detail refinements that reflect the highly urbanised and complex nature of the Waverley LGA have been recommended.

The various FPLs referred to in the DCP do not factor in climate change. On the basis that this is a consequence of the information available within the Flood Study we consider that this is acceptable at this stage. Sensitivity analysis undertaken by the Flood Study included consideration of a range of increased rainfall intensity scenarios having regard to government guidelines for consideration of climate change impacts. However final design flood levels were exclusive of the effects of these increased rainfall scenarios. Further consideration of the effects of climate change and any adjustments required to FPL's should be undertaken at the FRMS stage.

Defined Terms

Many of the relevant defined terms are not referred to in the flood planning controls and can be deleted. Recommendations have also been made to simplify terms so that they are more clearly understood by the general public while remaining technically appropriate. Where relevant, definitions contained within the now available Draft *Floodplain Risk Management Manual* have been recommended.

3.4.3 Consistency with the Manual and 2021 Guidelines

Is the DCP consistent with the Floodplain Development Manual 2005 and the Considering flooding in land use planning Guidelines?

As discussed above there is no mandatorily prescribed format for flood risk management DCP provisions. The Planning Matrix and FRP Map approach, that has been adopted by a substantial

number of Councils in NSW, is considered to be consistent with both the Manual and 2021 Guidelines.

3.4.4 Low Medium and High Risk Categorisation

Is the categorisation of low, medium and high flood risk the most appropriate given the results of the flood study and the context of Waverley? What other approaches could be adopted?

We have addressed this above.

3.4.5 Best Practice

Does the DCP follow best practice, particularly in relation to what Councils with similar flood risk are adopting?

While we have identified the potential for improvements, the general approach adopted by the draft DCP is consistent with best practice.

Best practice, in regards to the preparation of flood related planning controls, allows for a risk based approach to the assessment of the acceptability of development. The use of the Planning Matrix approach together with FRP maps, provides an appropriate means of achieving best practice.

3.4.6 Submissions Report

Comment on the post-exhibition report prepared, addressing the concerns raised by residents.

Both the Draft Flood Study and Draft DCP underwent extensive public consultation processes. We have been requested to comment specifically on the post-exhibition report (Submissions Report) for the Draft DCP. We note that we were also provided with access to all 99 submissions received by Council.

The Submissions Report (pg.1) outlines its purpose was to provide:

- an overview of the submissions received
- a summary of the key issues raised
- recommendations about possible responses and next steps.

The Submissions report also provides a comparison of the FRP precincts on the Draft DCP map and

the properties identified by the former LEP FPA Map.

The following 6 key issues, in order of recurrence, were identified as being raised in the submissions:

1. flood risk precinct classification
2. implications to property value
3. consultation process
4. implications to insurance premiums
5. implications to development
6. applicability of FRP to apartments.

This appears to provide a fair representation of the submissions received. The Submissions Report also identifies the location of submitters.

This Submissions Report outlines how responses are to be made in the short, medium and long term. The description of the approach for short and medium term responses basically deals with the administrative process to be followed as opposed to discussing the validity of the submissions.

The comments provided in regard to long term responses outlined how the issues raised in submissions would be appropriately addressed at the FRMS stage of the NSW Floodplain Risk Management process.

In our view, the Submissions Report does address its stated purposes. However, while we agree that the issues raised are matters that would appropriately be addressed when preparing a FRMS, no direct responses to the validity of the issues raised were provided. Further, it should be recognised that these submissions specifically related to the Draft DCP prepared in accordance with the provisions of the EP&A Act. While the Draft DCP is related, the Flood Study is being prepared in accordance with the NSW Floodplain Risk Management process which will at some later time involve the preparation of a FRMS.

Notwithstanding the above, Council has now commissioned this review which is substantially focused on addressing the primary issues raised in the submissions.

3.4.7 Potential Improvements

Based on findings from the peer review of the Flood study and DCP, what changes could be made to improve the DCP?

As outlined above we have reviewed the content of the DCP and associated definitions and provide detailed recommendations for improvements within **Appendix B**. These recommendation are for Council's consideration.

While the detailed review of the Draft DCP includes recommended specifications for site specific assessments, this could be reviewed further having regard to the FIRA Guide provided with the Draft

Manual, once finalised and adopted.

Ideally the flood related planning controls and mapping approach should also be consistent with that adopted by Randwick City Council for the same catchment area. The Flood Study was undertaken for both the Waverley LGA and a smaller part of the Randwick LGA covering Clovelly. Randwick Council's website indicates that they are yet to adopt a Final Flood Study. Accordingly we would recommend that this report be forwarded to Randwick City Council for consideration.

4 Conclusion

This report has been prepared to peer review of key documents relating to the Waverley LGA Flood Study prepared by BMT for Council dated January 2021 (**Flood Study**) and the proposed amendment to the Waverley Development Control Plan 2022 (**Draft DCP**) based on Draft DCP provisions prepared by WMS dated September 2021.

Technical aspects of the Flood Study were reviewed by KBR who concluded:

- The Flood Study was completed in accordance with the NSW State Government's Floodplain Development Manual (2005), and Australian Rainfall & Runoff (ARR) 2016 (the current ARR guideline at the time of completion of the Flood Study).
- The adopted modelling methodology is considered reasonable and appropriate for the catchment. However, there are limitations in the adopted approach that directly influence the level of confidence in certain (predominantly steeper upper catchment) sections of the catchment. BMT have clearly acknowledged these limitations and considered them in their approach to lot tagging.
- Further investigation of key model limitations and assumptions discussed in this review should be considered within the FRMS.
- The adopted approach to lot tagging should be clearly articulated and repeatable but should also consider the level of uncertainty/confidence in the underlying modelling. Any deviation from the selected criterion to add or remove tagged properties based on engineering judgement or visual inspection should be documented for future reference.
- The BMT approach to lot tagging considered the level of uncertainty in the underlying modelling but is not simple to articulate or replicate.
- The WMS approach to lot tagging follows a set criterion (i.e. well-articulated) and is simple to replicate but does not take into consideration the level of uncertainty in the underlying modelling.
- The approach to defining the FPA is a matter that can be considered further as part of the FRMS. In the interim, the WMS FRP approach is considered a reasonable, albeit conservative, approach to determining the FPA and FRP maps for the application of DCP controls.
- The FRP map is currently presented using the lot-based approach as discussed in Section 3.2. It is recommended that the FRP map be modified to adopt a line-based approach (i.e. based on the actual extent of the three precincts) to convey the flood extent and level of

risk to the community to an improved level of accuracy. The lot-based map can be retained for use internally by Council to understand what DCP controls apply to each lot (based on the adopted post-processing of the FRP polygons detailed in Section 3.3 [of the KBR Report]).

GLN reviewed the Draft DCP, having regard to the KBR conclusions and the intrinsic relationship that flood planning mapping has with the format and content of such a DCP. The conclusions reached with regard to the questions asked within our brief are summarised as follows:

- The Draft DCP Flood Map uses a hybrid approach that combines an FRP Map approach with a Flood Control Lot map approach. While we recognise there are some advantages with such an approach we recommend that it be replaced with a conventional line based map derived from modelled flood extents. However, it would be appropriate to provide a statement on the map that recognises the known accuracy limitations as discussed by KBR.

- The FRP map should be used to identify the flood planning area to which clause 5.21 of the LEP would apply. However, to ensure consistency between application of the LEP clause 5.21 considerations and the DCP controls it would be desirable for the DCP to explicitly outline that satisfaction of the provisions of the DCP is a means of addressing clause 5.21. This will provide clarity to the community as to the combined flood related considerations for development applications for both the LEP and DCP.

- We have not identified any issues with the process for preparing the DCP.

- We provide detail recommendations for improvements to the Draft DCP. In particular, we recommend inclusion of performance criteria which would provide flexibility to ensure that any unavoidable inaccuracies with the flood modelling that have underpinned the definition of FRP's would not unreasonably impact the development potential of individual properties.

- The Planning Matrix and FRP Map approach relied on by the Draft DCP is consistent with DCPs adopted by a substantial number of Councils in NSW and is considered to be consistent with both the Floodplain Development Manual and 2021 Guidelines. The matrix could be simplified by for example rationalising land use categories.

- The approach adopted by the draft DCP is consistent with best practice.

- The Submissions Report does address the stated purpose for which it was prepared. However, no direct responses to the validity of the issues raised were provided. While consideration of these issues at the Floodplain Risk Management Study stage as recommended in the Submissions Report is appropriate the submissions specifically related to the Draft DCP prepared in accordance with the provisions of the *Environmental Planning and Assessment Act, 1979* and not the NSW Floodplain Risk Management process. Notwithstanding, Council has now commissioned this review which is substantially focused on addressing the primary issues raised in the submissions.

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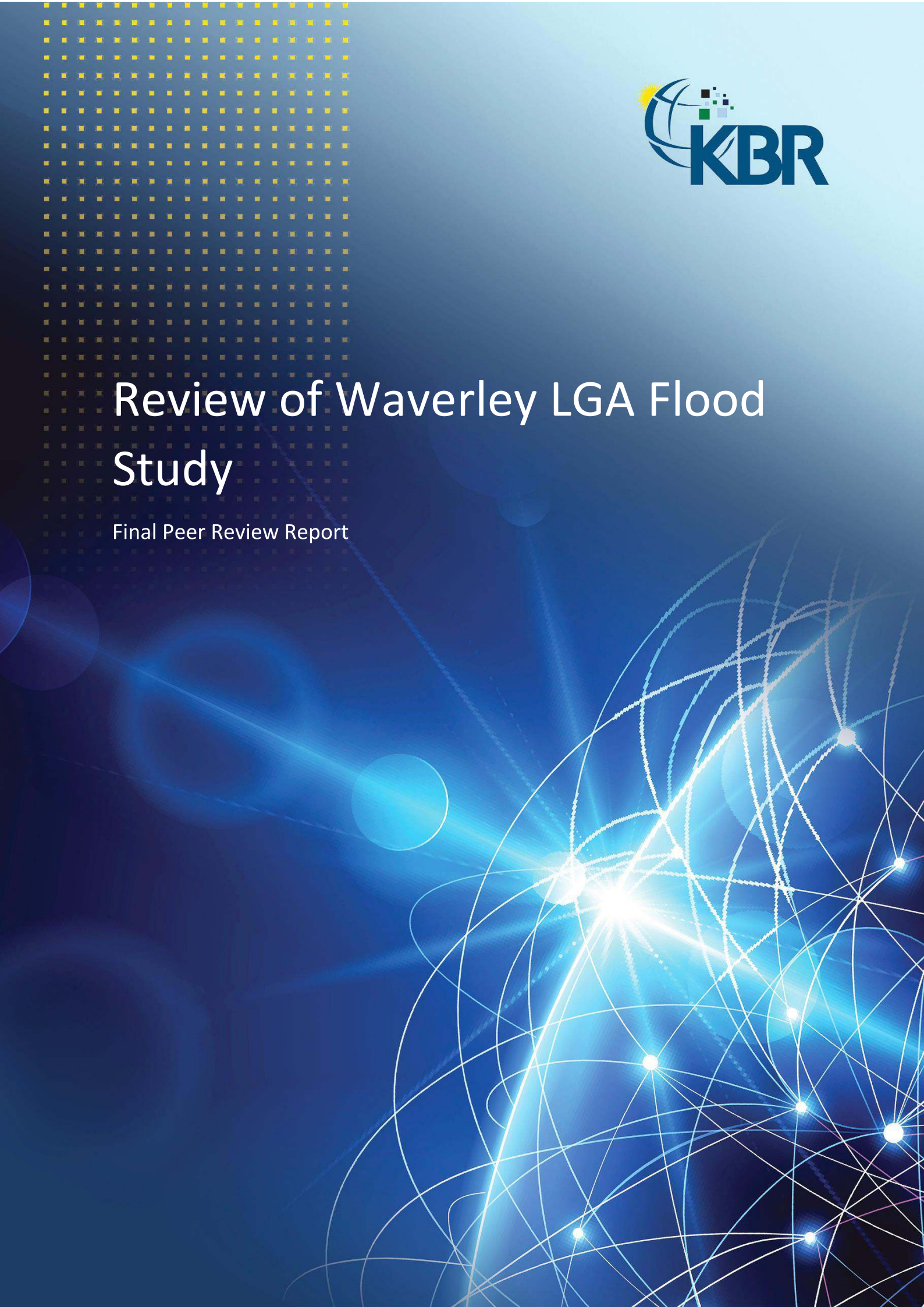
APPENDIX A: REVIEW OF FLOOD STUDY BY KBR

11882 Rpt
April 2023

Review of Waverley LGA Flood Study

Final Peer Review Report



Review of Waverley LGA Flood Study

Final Peer Review Report

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27 April 2023

SEW352-TD-WR-REP-0001 Rev0

Acknowledgments

KBR acknowledges the Traditional Custodians throughout Australia and their continuing connection to land, water, culture and community, and pays respect to their Elders past and present.

Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to undertake a peer review of the Waverley Flood Study in accordance with the scope of services set out in the contract between KBR and GLN Planning ('the Client'). That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between KBR and the Client. KBR accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

Revision History

Revision	Date	Comment	Signatures			
			Originated by	Checked by	Technical Approval	Project Approval
0	27/4/23	Issued for Use	Joshua Eggleton	Dan Morgan	John Brown	Joshua Eggleton
			Digitally signed by Joshua Eggleton Date: 2023.04.27 12:56:12 +10'00'	Dan Morgan 2023.04.27 13:05:26 +10'00'	Digitally signed by John Brown (Sydney) DN: cn=John Brown (Sydney), ou=Users, email=John.Brown@kbr.com Date: 2023.04.27 20:51:19 +10'00'	Digitally signed by Joshua Eggleton Date: 2023.04.27 13:59:02 +10'00'

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1 Introduction

1.1 COMMISSION

KBR was commissioned by GLN Planning on behalf of Waverley Council to prepare a peer review of the key documents relating to the Waverley LGA Flood Study prepared by BMT for Council dated January 2021 (the Flood Study) and proposed amendment to the Waverley Development Control Plan 2022 (the DCP).

1.2 BACKGROUND

In April 2021, Council adopted the Flood Study after technical investigations and two rounds of community engagement.

The Flood Study represents the initial stage of the NSW Floodplain Risk Management (FRM) process as outlined in the NSW Flood Plain Development Manual published in April 2005 by the NSW Government (FDM). The Flood Study made recommendations regarding the adoption of flood planning levels (FPLs) and a Flood Planning Area (FPA) for planning purposes.

Subsequent stages in the NSW FRM process involve the preparation of a Floodplain Risk Management Study (FRMS) and Floodplain Risk Management Plan (FRMP) that will investigate the consequences of the flood risks identified by the study, potential mitigation measures and recommendations to be implemented through the FRMP. While these mitigation measure can include planning controls, it is not unusual for planning controls to be reviewed based on the findings of a flood study as the preparation of a FRMS and FRMP typically take many years to complete and the FDM encourages Councils to always act on the best available information.

The Flood Study provided a three-tier classification (Types A, B and C) to identify lots that should be considered for flood related development controls (Flood Control Lots) based on the level of confidence of the flood modelling due to the nature of the terrain. Type B and C Flood Control Lots were identified as requiring further investigation to determine the extent of the lot affected (Type B) and whether flooding would affect the identified lot or adjacent land (Type C).

As a logical adjunct to the preparation of the Flood Study, Council commissioned the preparation of draft amendments to the DCP (Draft DCP) to introduce appropriate flood related development controls. This provided the opportunity to address the additional lands subject to flood risks and the more detailed information regarding flood extents and hazard provided by the Flood Study

Based on the Flood Study, Water Modelling Solution (WMS) prepared the Draft DCP provisions dated September 2021 and a Flood Risk Precinct (FRP) Map to be used for the purposes of applying the DCP controls. The FRP Map adapted information contained in the Flood Study to categorise lots as either part of a Low, Medium or High FRP, which cumulatively represent all proposed Flood Control Lots for the Waverley LGA.

The amendment to the DCP was exhibited in June-July 2022. During the exhibition process Council notified over 10,000 landowners and received feedback from a number of residents, many concerned with the risk classification (low, medium or high) given to their properties and the implications this may have on property values, insurance premiums and their ability to renovate or redevelop their property in the future."

Council subsequently engaged GLN Planning and KBR Consulting to undertake a peer review of the Flood Study and Draft DCP, which is the subject of this report.

1.3 STUDY TEAM

To address the various components of the brief, the peer review was undertaken by the following study team:

- GLN Planning (GLN)
- KBR.

GLN is the lead consultant and addresses town planning related matters, specifically the approach taken to the preparation of the Draft DCP, the format and content of the Draft DCP and associated FRP mapping, and other related matters.

KBR addresses the assumptions and methodology adopted by the Flood Study and suitability of the information provided by the Flood Study to inform the FRP mapping relied upon by the Draft DCP and technical matters related to controls in the draft DCP.

1.4 PURPOSE OF THIS REPORT

The purpose of this report is to document the findings of a peer review of the key documents relating to the Flood Study undertaken by KBR.

1.5 INFORMATION REVIEWED OR CONSIDERED

The following is a list of the information sourced and considered.

- Waverley LGA Flood Study Final Report (BMT, 2021)
- Waverley LGA Flood Study Flood Mapping Compendium Final Report (BMT, 2021)
- Waverley LGA Flood Study TUFLOW model and associated input and output files
- Waverley DCP Flood Chapter – Response to Public Exhibition Submissions (WMS, 2022)
- Draft DCP provisions prepared by Water Modelling Solution (WMS) for Council (WMS, 2021)

1.6 SCOPE OF REVIEW

KBR's scope for the peer review of the Flood Study was as follows:

- Acquire Flood Study documents and associated data from Council.
- Prepare for and attend project objectives workshop at the outset of the Peer Review.
- Comment on the appropriateness of the adopted Flood Study and flood modelling methodology.
- Comment on the correctness of the assumptions adopted in the Flood Study and associated modelling.
- Based on the methodology and assumptions, comment on whether the Flood Study conclusions are appropriate.
- Comment on whether the identified categorisation of flooding (type A to C) has been correctly identified.
- Comment on whether the overall conclusions are correct, including the identification of 12 hotspot areas.

No allowance was made for a detailed review of hydrologic or hydraulic models developed as part of the Flood Study.

This peer review also does not comment on the community consultation elements of the Flood Study.

2 Flood Study Methodology

2.1 SUMMARY

The Flood Study was completed in accordance with the NSW State Government's Floodplain Development Manual (2005), and Australian Rainfall & Runoff (ARR) 2016 (the current ARR guideline at the time of completion of the Flood Study).

The key objectives of the Flood Study were as follows:

- Update the existing flood information for the Waverley LGA catchments based on the Drainage System Modelling completed in 2007.
- Develop and calibrate appropriate hydrologic and hydraulic models
- Determine flood conditions for a range of design flood events
- Identify properties at risk of flooding during various design flood events.

To achieve the above objectives, BMT developed the following models:

- An XP-RAFTS hydrologic model to develop flood hydrographs to apply as inflow boundaries to the hydraulic model
- A TUFLOW hydraulic model to determine flood levels, velocities, depths and flood hazard across the study area.

Site inspections were completed by BMT to gain an appreciation of local hydraulic features and their potential influence on flood behaviour and to ground truth the hydraulic model outputs.

2.2 LIMITATIONS OF HYDRAULIC MODELLING IN URBAN CATCHMENTS

As a precursor to the peer review, it is important to note that modelling of overland flooding in urban environments is a complex undertaking. As detailed in Section 4.1 of the Flood Study Report, the ability to represent the intricate local hydraulic controls in urban environments is limited by the resolution and accuracy of the available data (e.g. topographic data) and the adopted hydraulic model and modelling methodology. The available data and adopted approach to hydraulic modelling has a level of inherent uncertainty with regard to certain floodplain mechanism as detailed in Table 2-1 below (a more detailed review of modelling methodology is detailed in Table 2-2). There are also typically instances throughout the upper catchment reaches that may be perceived by the community as being "flooding", which are in fact local drainage issues and not considered as overland flooding.

Table 2-1 Limitations with Overland Flow Modelling in Urban Environments

Source of Uncertainty	Adopted Approach	Comment
Stormwater pit capture for on-grade locations	The pipe network is represented as 1D elements dynamically linked to the 2D domain at specified pit locations. Pit inlet capacities have been modelled using lintel opening lengths and grate sizes based on the collected data. Pit inlet dimensions have been assumed where data were not available, based on site inspections and nearby pits.	For high magnitude flood events (>5% AEP) the pipe drainage system capacity is anticipated to be exceeded with the major proportion of flow conveyed overland. Therefore, any limitations in the model representation of the drainage system are not expected to influence results for these events.
Available flow capacity of kerb and gutter profiles	Kerb and gutter profiles were defined using LiDAR data and a 2m 2D cell size	The adopted approach is considered reasonable for an LGA/catchment wide flood

Source of Uncertainty	Adopted Approach	Comment
	which results in the LiDAR data being sampled every 1m. No reinforcement of kerb or gutter profiles was undertaken.	study. However, no reinforcement of kerb and gutter profiles may result in artificial breakout of flows from the road profile resulting in overland flow paths through urban properties. BMT has acknowledged this by identifying areas where this may be occurring and classifying as Type C lots as discussed later in this document. The (localised or global) representation of kerb and gutter profiles or an alternative approach to represent appropriate conveyance of flows through road corridors may warrant further investigation as part of the Floodplain Risk Management Study (FRMS) if suitable survey data is available.
Crest level controls of driveway entrances	Similar to kerb and gutter profiles, driveway crests were defined using LiDAR data and a 2m 2D cell size which results in the LiDAR data being sampled every 1m.	The adopted approach is considered reasonable for an LGA/catchment wide flood study. However, the adopted approach may result in the crest level of the driveway which acts as the control level in maintaining flow within the road profile not being represented in the TUFLOW model. This may then result in water artificially spilling from the road profile forming an overland flow path through adjacent properties. It should also be noted that given the steep grades and resolution of the LiDAR data, the crest level may also not be captured in the data used to set the TUFLOW model topography in the first place.
Complexity of urban lot vegetation	Captured within the applied surface roughness for urban lots.	Urban lot vegetation (including garden beds and landscaping features) may act to redirect flows within urban environments. This level of complexity cannot readily be captured within an urban overland flow model.
Flow under, over, around and through various fence types	Brick and/or concrete walls acting as barriers to the progression of catchment runoff were represented on a localised (i.e. not catchment wide) basis where identified/appropriate in the hydraulic model. Other obstructions less sturdy in nature (such as wooden or Colorbond fences) have not been incorporated, as they typically fail when floodwaters build on the upstream side. These elements are effectively captured within the applied surface roughness for urban lots.	The adopted approach is considered reasonable for an LGA/catchment wide flood study. Further investigation of flow obstructions may be warranted as part of the FRMS to further validate key flowpaths to provide increased confidence in Type C properties discussed later in this document.
Flood storage within underground basements and domestic/commercial stormwater tanks	Not represented in the hydraulic model.	Difficult to incorporate accurately into a TUFLOW model without detailed information of flow ingress location/arrangement, storage and drainage of flows. Therefore, assuming this information was not readily available for use in the Flood Study, the adopted approach is considered reasonable.

Source of Uncertainty	Adopted Approach	Comment
Flow under, around and between buildings and/or through gates	Buildings along key footpaths were represented via a high Manning's 'n' surface roughness to reflect the impediment of flow but also account for the potential flood storage.	The adopted approach does not provide for full obstruction of flow. However, representation of buildings as full obstructions to flow also presents complex challenges in urban environments with regard to flow between buildings being inhibited depending on the adopted grid cell size (e.g. the adopted cell size is 2m and gaps less then 2m between buildings would occur in the catchment). The adopted approach is reasonable but may warrant further investigation as part of the FRMS to further validate key flowpaths to provide increased confidence in Type C properties
Collection and re-distribution of debris by catchment runoff and the potential impact on the inlet capacity of the stormwater drainage network and/or hydraulic structures such as culverts	A pit blockage of 50% for sag pits and 20% for on-grade pits has been adopted in design event modelling in line with AR&R 2016 guidelines. Hydraulic structure blockages determined using Chapter 6: Blockage of Hydraulic Structures, Book 8 in Australian Rainfall and Runoff - A Guide to Flood Estimation (2016).	Appropriate.

2.3 REVIEW OF MODELLING METHODOLOGY

The review of the adopted modelling methodology for the Flood Study is detailed in Table 2.1 below.

Some items have been flagged for further consideration, investigation or review as part of the subsequent Waverley LGA FRMS. The FRMS provides an opportunity to review and revise (if required/deemed appropriate) the modelling should there be any change in the recommended guidelines (e.g. Australian Rainfall & Runoff), change in software (e.g. updated release of TUFLOW) or additional information (e.g. survey data) that was not available at the time of completion of the Flood Study. The model developed as part of the Flood Study should be subject to a detailed review of model health and configuration at the outset of the FRMS.

Table 2-2 Review of Adopted Modelling Methodology

Modelling Theme / Parameter name	Adopted Approach	Comment
Hydrologic Model		
Adopted Engine	XP-RAFTS	XP-RAFTS is considered suitable for use for the Flood Study. However, it should be noted that XP-RAFTS has been discontinued as a supported program at the end of 2021, with the software supplier recommending conversion of XP-RAFTS model to XP-SWMM as an alternative hydrologic model.
Catchment Delineation	A database of over 3,000 individual sub-catchments (one for each pit) was previously developed as part of the Drainage System Modelling completed in 2007. BMT consolidated the 3,000 sub-catchments into 805 sub-catchments covering the study area.	This is an unusually high number of sub-catchments for a catchment of this size. However, at this scale, the majority of the hydraulic routing of surface flows would be undertaken within the hydraulic model. The high number of catchments would also prevent the over allocation of inflows to pits located in

Modelling Theme / Parameter name	Adopted Approach	Comment
		the upper catchment which may occur using larger sub catchments. As such, the adopted approach is considered reasonable.
Hydraulic Model		
Adopted Engine	TUFLOW HPC	TUFLOW HPC is considered suitable for use for the Flood Study.
Model Configuration	Combined 2D (floodplain) / 1D (stormwater drainage) model with a 2m 2D cell size.	Appropriate.
Topography	Model topography based on 1m resolution DEM derived from 2013 NSW Land and Property Information LiDAR survey with additional reinforcement of gullies and embankments as required.	Appropriate and suitable for 2m 2D cell size. No reinforcement of kerb and gutter profiles may result in artificial breakout of flows from the roadway resulting in overland flow paths through urban properties. May warrant localised reinforcement as part of the FRMS if suitable survey data is available.
Hydraulic Roughness	Hydraulic roughness assigned using a combination of aerial photography and cadastral data with Manning's 'n' values presented in report for different surface types.	Applied Manning's 'n' values of 0.040 for low density residential lots (without building digitised) and 0.060 for Medium and High Density Residential Lots (without building digitised) are considered reasonable but at the lower end of the expected values for these surface types especially when the adopted value is accounting for buildings, fences and urban lot vegetation. Recommend further consideration as part of FRMS.
Buildings	Localised representation of buildings via increased Manning's n roughness value of 1.0 within simulated/predicted flowpaths.	Approach considered reasonable. The representation of buildings may warrant further investigation as part of the FRMS to investigate sensitivity of model to alternate approaches to representing buildings (i.e. representing as complete or partial flow obstructions).
Stormwater Drainage Network	5,200 pipes for a combined run length of over 101km was included in model as 1D elements embedded within 2D domain based on data on pit/pipe locations, pit inlet type/dimensions and pipe sizes provide by Council.	Appropriate. Minimum pipe size included in model not defined in report. For high magnitude flood events (>5% AEP) the pipe drainage system capacity is anticipated to be exceeded with the major proportion of flow conveyed overland.
Boundary Conditions	Inflows applied directly to 1D pipe network or directly to 2D domain in the absence of pipe network. The downstream model limit corresponds to the water level in either Sydney Harbour or the South Tasman Sea.	This approach assumes that there is sufficient pit capture to pass the flow into the pipe network until pipe capacity is reached at which point flows surcharge into the 2D domain (i.e. surface flow). Considered appropriate.
Major Flow Path Representation	BMT noted that each modelled flow path has been verified based on LiDAR elevation data, site visit notes, aerial photography and Google Street View imagery to incorporate local hydraulic controls into the TUFLOW model, where appropriate. This involved the	Approach considered reasonable with localised reinforcement/representation of fences and walls. May warrant further investigation as part of the FRMS to further validate key flowpaths and representation of appropriate road conveyance to provide increased confidence in

Modelling Theme / Parameter name	Adopted Approach	Comment
	inclusion of brick and/or concrete walls as barriers to the progression of catchment runoff. Other obstructions less sturdy in nature (such as wooden or Colorbond fences) have not been incorporated, as they typically fail when floodwaters build on the upstream side.	Type C properties discussed later in this document.
Model Calibration and Validation		
Selected Events	Calibration events: December 2015. Validation events: August 2015, February 2017.	Available calibration data limited to anecdotal flood information such as observations, photographs and peak flood level estimates based on observed flood marks (i.e. no gauges available). A reasonable calibration was achieved noting the uncertainty associated with anecdotal flood information.
XP-RAFTS Flow Validation	A Direct Rainfall approach was adopted with the TUFLOW model to validate the flows generated by the XP-RAFTS hydrologic model.	A reasonable correlation was achieved between the 1% AEP 45-min and 90-min duration events been the XP-RAFTS and Direct Rainfall Approach for a single overland flow path. A cross check against other overland flow paths or comparison of extents and levels may also further validate the adopted approach. However, the limitations highlighted in urban overland flow modelling can be potentially exacerbated by the direct rainfall approach. As such, further analysis may not yield reliable results.
Design Event Modelling		
Design Rainfall	IFD 2016	Appropriate.
Aerial Reduction Factor	ARF of 1.0 adopted.	Given the makeup of the study catchment an ARF of 1.0 is considered appropriate.
Design Rainfall Losses	Pervious Initial Loss: 20mm Pervious Continuing Loss: 2mm/hr Impervious Initial Loss: 2mm Impervious Continuing Loss: 0mm/h	Based on adopted calibration/validation values. Comparably higher then ARR 2019 DataHub but generally aligns with values for neighbouring catchments and are therefore considered reasonable.
Temporal patterns	Ensemble approach as per ARR 2016.	Appropriate.
Critical Duration	The 20-minute and 45-minute durations were critical for catchment areas affected by overland flooding, and the 90-minute duration was critical for areas affected by storage flooding. For the PMF, the critical durations were found to be the 15-minute, 30-minute and 90-minute durations.	Appropriate approach (noting is it based on mean flood level within TUFLOW and not flows in XP-RAFTS). Critical durations considered typical for catchment of this nature.
Design Downstream Boundary	Constant water level boundary assigned based on Flood Risk Management Guide (OEH, 2015).	Appropriate.
Structure Blockage	A pit blockage of 50% for sag pits and 20% for on-grade pits has been adopted in design event modelling in	Appropriate.

Modelling Theme / Parameter name	Adopted Approach	Comment
	line with AR&R 2016 guidelines. Hydraulic structure blockages determined using Chapter 6: Blockage of Hydraulic Structures, Book 8 in Australian Rainfall and Runoff - A Guide to Flood Estimation (2016).	

2.4 POST-PROCESSING OF FLOOD MODEL OUTPUTS

BMT applied the following filters to the TUFLOW model design flood extents:

(1) Areas where depth does not exceed 0.15m were removed from the design flood extents;

(2) Areas where the velocity-depth product (i.e. V x D) exceeds 0.10m2/s were re-instated;

(3) Flood islands with an area of less than 200m2 were removed.

BMT outlined that the results were filtered to remove sheet flow from the final design extents such that only regions of significant flood depth or of significant velocity-depth product were included.

BMT simulated the following design events: 0.2%, 1%, 2%, 5%, 10%, 20% and 50% AEP, 1EY (63.2% AEP) (note – ARR2019 recommends that events more frequent than 50% AEP should be expressed as X Exceedances per Year (EY). For example, 1 EY is equivalent to a design event with a 12-month recurrence interval when there is no seasonality in flood occurrence – this can also be termed the 63.21% AEP) and PMF events. For each event, a map of peak flood level, depth and velocity was prepared covering the modelled area. In addition, mapping was prepared detailing the flood function and provisional flood hazard categorisation.

3 Flood Lot Tagging Approach

As outlined by BMT, Flood Control Lots are intended to relate to properties that are known to have a flooding constraint and should be referred to Council's flood-related development controls because of their potential to be flood affected.

As previously stated, the Flood Study provided a three-tier classification (Types A, B and C) to identify lots that should be considered for flood related development controls (Flood Control Lots) based on the level of confidence of the flood modelling.

Subsequent to the Flood Study, Water Modelling Solution (WMS) prepared a Flood Risk Precinct (FRP) Map to be used for the purposes of applying the DCP controls. The FRP Map adapted information contained in the Flood Study to categorise lots as either part of a Low, Medium or High FRP, which cumulatively represent all proposed Flood Control Lots for the Waverley LGA. The FRP approach has no direct correlation to BMT's three-tier classification (Types A, B and C).

3.1 FLOOD PLANNING LEVELS AND FLOOD PLANNING AREA

As detailed in Section 7.7.1 the Flood Study, Flood Planning Levels (FPLs) are used for planning purposes and can also be used to determine the extent of the Flood Planning Area (FPA), which is effectively the area of land subject to flood-related development controls. It is typical for FPLs to be derived from designated design flood events plus a freeboard allowance, to account for underlying uncertainties, such as the variation between flood modelling results and actual flood events, the effect of localised factors on flood levels and potential wave action. The 1% AEP event is usually adopted as the designated flood, however the FPL and FPA can include allowances for future climate change conditions (i.e. rainfall intensity increases). The incorporation of climate change considerations into the FPLs and adopted freeboard should be considered as part of the FRMS.

BMT adopted the 1% AEP event as the basis of the FPA, with a 0.3m freeboard applied (0.5m for area affected by oceanic flooding). The freeboard was applied to the simulated 1% AEP extent and extrapolated outwards until in intersected with the LiDAR DEM. The resulting extents formed the preliminary FPA as presented in Figure 3-1. This approach is considered appropriate for defining the preliminary FPA. However, the preliminary FPA should be reviewed and refined as part of the FRMS.

3.2 THREE-TIER CLASSIFICATION

As outlined by BMT, the FPA can be used to determine which properties to define as potential flood control lots. However, as outlined previously, there are significant uncertainties regarding flood modelling of shallow overland flowpaths in complex urban environments. As such, BMT undertook a ground-truthing exercise to verify the simulated results against actual site conditions to ensure that the model results are interpreted and correctly applied for flood planning purposes.

BMT adopted the following three-tier classification to the identified flood control lots across the study area based on the level of confidence of the flood modelling:

- "Type A" – lots for which standard flood-related development controls and a single Flood Panning Level (FPL) can be applied. Lots with this classification are typically located within areas along a major overland flood flow path. The surface grades are relatively gentle, and the modelling of flood extents and flood levels is relatively certain (i.e. comparably high level of confidence in model results).

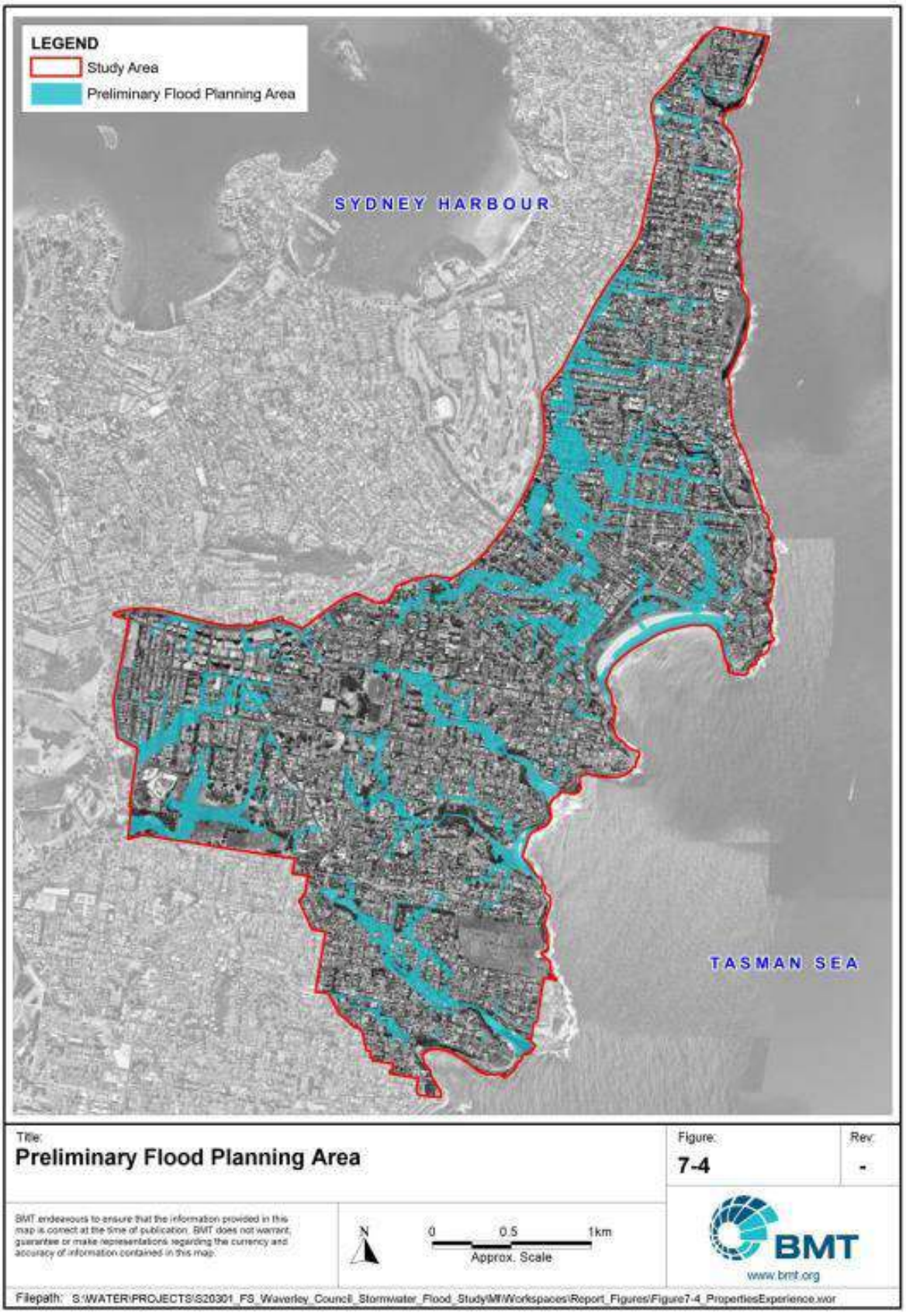

Figure 3-1 Preliminary FPA (BMT, 2021)

- "Type B" – lots through which an overland flood flow path is conveyed and confirmed through ground truthing. Type B lots are typically in areas of relatively steep topography and the location, depth and velocity of overland flows cannot determined with certainty by the flood modelling as the model resolution and available data is not at a fine enough scale to resolve the local hydraulics. As such, standard flood-related development controls cannot be readily applied because there is uncertainty in the modelled peak flood level and also because a single representative FPL for the lot is not appropriate (e.g. steep sloping lots will have a high gradient in the FPL across the lot).
- "Type C" – lots captured by the preliminary FPA but are lots for which the flood modelling should not be relied upon for determining the presence or absence of overland flow paths. These are typically located within steep upper catchment areas that have relatively small contributing catchments or lots adjacent to a roadway that was effectively containing the overland flow with an encroachment onto the lot once a suitable freeboard is added to define the FPA.

As discussed in Section 2.2, there is a level of inherent uncertainty associated with overland flood modelling in urban environments. BMT have attempted to address this uncertainty within the adopted three-tier classification by identifying Type C lots within the FPA and acknowledging the low level of confidence in the model outputs for these locations. Further explanation of this is detailed in Section 7.7.2 of the Flood Study report.

The spatial coverage of the three-tier classification is presented in Figure 3-2.

The three-tier classification is presented as a combination of a line-based approach (i.e. extent line/polygon based on the simulated flood extent) and lot-based approach (i.e. extent based on definition of cadastral lots).

The advantage of the line-based approach is that it conveys the actual simulated flood risk to the community as the extent is based on the simulated flood model outputs. This allows the community to understand the proportion of a lot that is at risk of flooding and the level of risk. The disadvantage is that a lot may fall within multiple 'risk classifications' with different associated DCP controls which may lead to confusion within the community of what DCP controls apply to each lot.

Conversely, the advantage of the lot-based approach that it identifies each lot in accordance with its dominant 'risk classifications' which can remove the confusion as to what DCP controls apply. However, the disadvantage is that it may overestimate the actual simulated extent of flood risk and does not convey the simulated flood risk to the community in terms of the proportion of a lot that is at risk of flooding (e.g. 15% of the total area of the lot may be at risk of flooding but the lot-based approach would cover the lot in full).

3.3 FLOOD RISK PRECINCTS

As defined in Appendix B of the *Waverley DCP Flood Chapter – Response to Public Exhibition Submissions* (WMS, 2022), WMS utilised the model outputs from the Waverley LGA Flood Study (BMT, 2021) to prepare FRP polygons.

The raw outputs from the Flood Study were first post-processed as defined in Figure 3-3. Whilst there is potential for some variations in adopted threshold values (e.g. 0.15m depth filter) for post-processing between Councils, the adopted values are considered reasonable and appropriate.

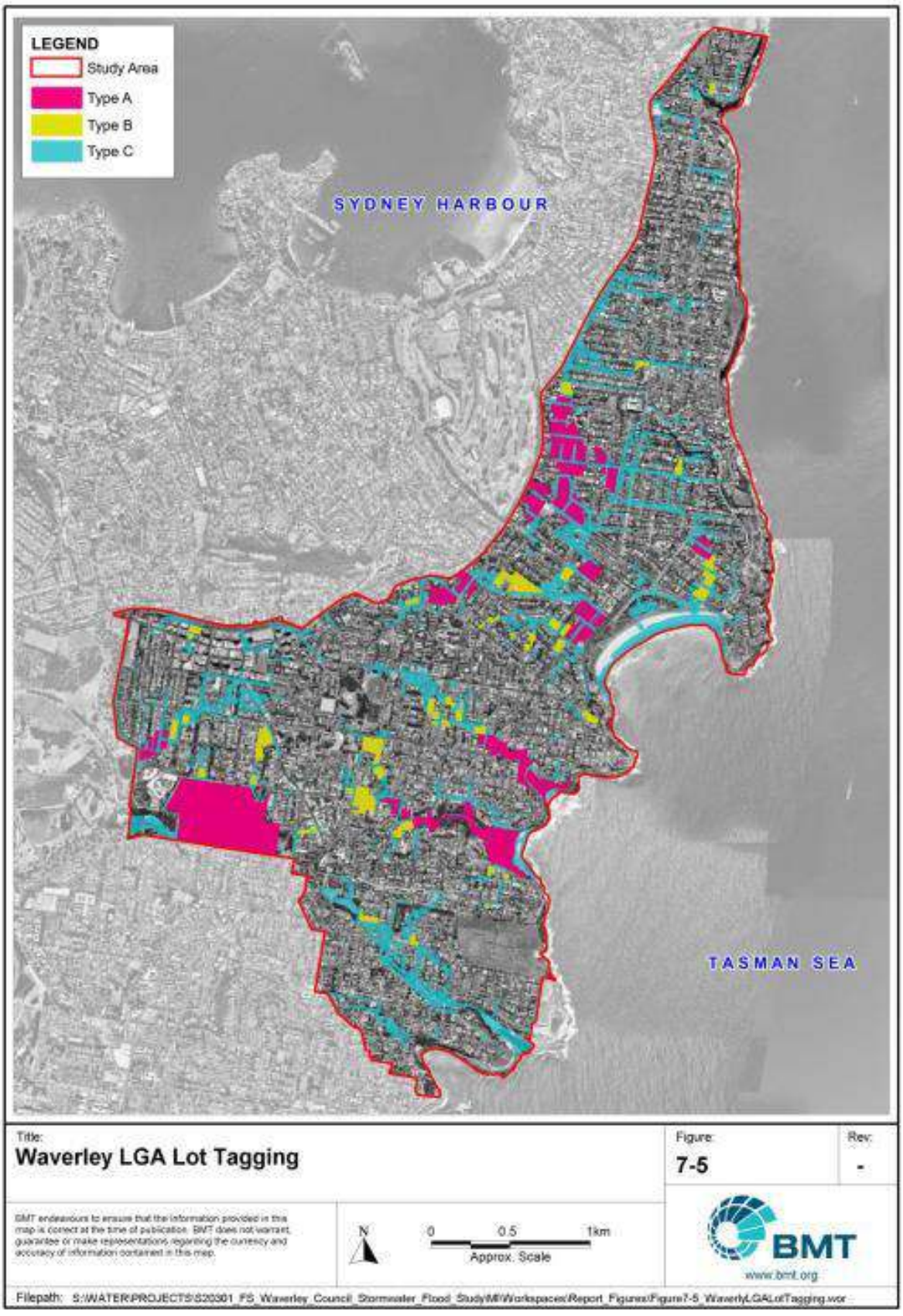

Figure 3-2 Waverley LGA Lot Tagging (BMT, 2021)

Filtering/Clipping	Per Waverley LGA Flood Study (Section 7.1.1): - Areas where depth does not exceed 0.15m were removed from design flood events - Areas where the velocity depth product (i.e. V x D) exceeds 0.1m²/s were reinstated - Flood islands with an area of less than 200 m² were removed
Peak Flood Depths	• Extracted Maximum depths of raw results for each AEP/PMF using TUFLOW utility • Clipped max grid based on clip boundary • Post-processed with raster statistics tool in QGIS
Peak Flood Levels	• Extracted Maximum WSL's of raw results for each AEP/PMF using TUFLOW utility • Clipped max grid based on clip boundary • Post-processed with raster statistics tool in QGIS
Hazard: H1- H6	• Extracted Maximum depths of raw results for each AEP/PMF using TUFLOW utility • Clipped max grid based on clip boundary • Post-processed with raster statistics tool in QGIS

Figure 3-3 Post-Processing Approach (WMS, 2022)

Following the post-processing, FRP polygons were defined based on a combination of the post-processed/filtered 1% AEP and PMF results based on the criteria detailed in Figure 3-4.

High Flood Risk	Areas with a hazard classification of H4-H6 in the 1% AEP event
Medium Flood Risk	Areas with a hazard classification of H1-H3 in the 1% AEP event
Low Flood Risk	The area between the 1% AEP extent and the PMF extent

Figure 3-4 FRP Criteria (WMS, 2022)

In addition to the post-processing detailed above, the following criteria was applied to tag lots as high, medium or low FRP's:

- only lots with more than 15% of their area situated within the flood risk precinct polygon were tagged (i.e. included in the flood risk precinct mapping).
- Lots are assigned the FRP that covers the greatest area with the lot, unless:
  - a High FRP covers more than 0.5% of the lot area, then it is assigned a minimum rating of Medium FRP.
  - a higher FRP covers more than 15% of the lot area, then the higher FRP is assigned.

The resulting FRP map is presented in Figure 3-5. The FRP map is presented using the lot-based approach as previously discussed.

As previously stated, the FRP approach has no direct correlation to BMT's three-tier classification (Types A, B and C). However, it is reasonable to expect that all Type A, Type B and Type C lots flagged by BMT would have been captured within the FRP map. Furthermore, as presented in Section 3.4, the FRP approach would flag a greater number of lots than the three-tier classification approach as no manual review and removal of tagged lots has been undertaken.

3.4 COMPARISON OF LOT TAGGING APPROACHES

A comparison of the number of lots tagged under the LEP (2012), three-tier classification approach (BMT) and flood risk precinct approach (WMS) is detailed in Table 3-1.

Table 3-1 Comparison of Total Lots Tagged

Definition	Lots Tagged
LEP (2012)	
Total	942
Three-Tier Classification (BMT, 2021)	
Type C	2100
Type B	400
Type A	650
Total	3150
Flood Risk Precincts (WMS, 2021)	
Low	2830
Medium	1392
High	146
Total	4368

Both the BMT and WMS approach result in a significant increase in the number of tagged lots when compared to LEP (20212). However, comparing the sum of Type A and Type B lots from the BMT approach (1050) (i.e. the lots with a level of confidence suitable to be tagged for application of flood controls in the opinion of BMT) provides for a reasonable comparison to LEP (2012). The WMS approach results in the highest number of tagged lots.

The adopted approach to lot tagging should be clearly articulated and repeatable but should also consider the level of uncertainty/confidence in the underlying modelling. The BMT approach to lot tagging considered the level of uncertainty in the underlying modelling but is not simple to articulate or replicate. The WMS approach to lot tagging follows a set criterion (i.e. well-articulated) and is simple to replicate but does not take into consideration the level of uncertainty in the underlying modelling.

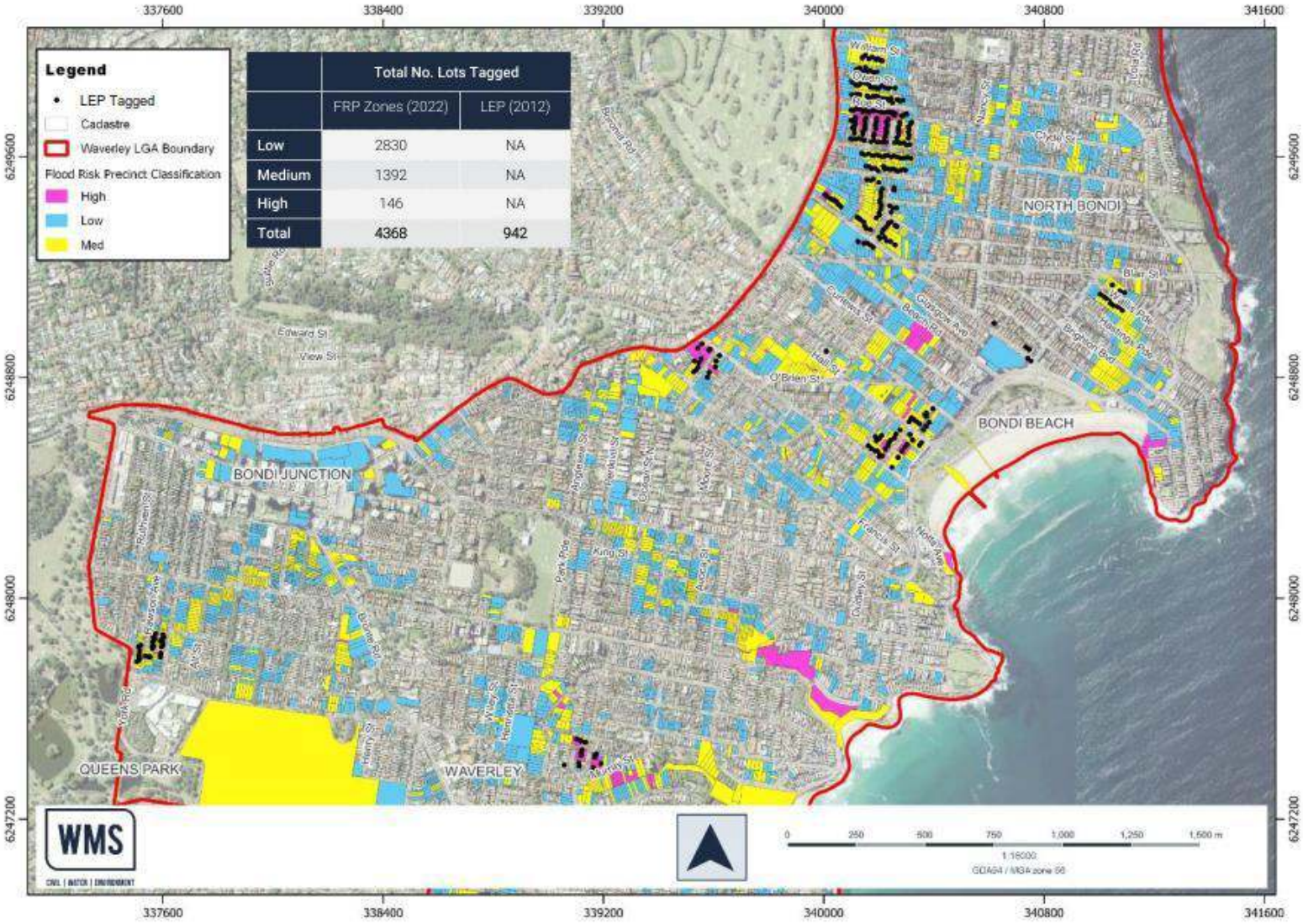

Figure 3-5 Flood Risk Precinct Map (WMS, 2022)

4 Conclusions and Recommendations

The conclusions and recommendations of the peer review completed by KBR are as follows:

- The Flood Study was completed in accordance with the NSW State Government's Floodplain Development Manual (2005), and Australian Rainfall & Runoff (ARR) 2016 (the current ARR guideline at the time of completion of the Flood Study).
- The adopted modelling methodology is considered reasonable and appropriate for the catchment. However, there are limitations in the adopted approach that directly influence the level of confidence in certain (predominantly steeper upper catchment) sections of the catchment. BMT have clearly acknowledged these limitations and considered them in their approach to lot tagging.
- Further investigation of key model limitations and assumptions discussed in this review should be considered within the FRMS.
- The adopted approach to lot tagging should be clearly articulated and repeatable but should also consider the level of uncertainty/confidence in the underlying modelling. Any deviation from the selected criterion to add or remove tagged properties based on engineering judgement or visual inspection should be documented for future reference.
- The BMT approach to lot tagging considered the level of uncertainty in the underlying modelling but is not simple to articulate or replicate.
- The WMS approach to lot tagging follows a set criterion (i.e. well-articulated) and is simple to replicate but does not take into consideration the level of uncertainty in the underlying modelling.
- The approach to defining the FPA is a matter that can be considered further as part of the FRMS. In the interim, the WMS FRP approach is considered a reasonable, albeit conservative, approach to determining the FPA and FRP maps for the application of DCP controls.
- The FRP map is currently presented using the lot-based approach as discussed in Section 3.2. It is recommended that the FRP map be modified to adopt a line-based approach (i.e. based on the actual extent of the three precincts) to convey the flood extent and level of risk to the community to an improved level of accuracy. The lot-based map can be retained for use internally by Council to understand what DCP controls apply to each lot (based on the adopted post-processing of the FRP polygons detailed in Section 3.3).

APPENDIX B: DETAIL REVIEW OF DRAFT DCP

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6.2 FLOOD PLANNING

Sections 6.2.1-6.2.8 apply to land identified in the 'Flood Planning Areas' layer on Council's mapping website. These Flood Planning Areas cumulatively represent the Flood Planning Area referred to in clause 5.21 of Waverley LEP 2021.

Section 6.2.9 provides controls for all other development.

Waverley Online Mapping Tool	
Discover Waverley Mapping Tool	
Map Configuration	Planning
Layer	Flood Planning Areas

There are three different ~~flood risk~~ levels of potential flood risk associated with the Flood Planning Areas, high, medium and low, see below. ~~The Flood Planning Areas are available on Council's mapping website.~~

Flood Risk Precinct	Description	Technical Definition
High	Land within the 1% AEP flood extent with a high hydraulic hazard classification. There is a high potential for damage to property, risk to life or evacuation difficulty. *Most development should be restricted in this precinct. In this precinct there would be a significant risk of flood damages without compliance with flood related building and planning controls.*	Land classified as "H4-H6" in the 1% AEP event (Waverley LGA Flood Study, 2021)
Medium	Land below the 1% AEP flood that is not subject to high hydraulic hazard and where they are no significant evacuation difficulties. Note: in this precinct there would still be significant risk of flood damage, but these damages can be minimised by the application of appropriate development controls	Land classified as "H1-H3" in the 1% AEP event (Waverley LGA Flood Study, 2021)
Low	All other land within the floodplain (ie. within the extent of the probably maximum flood (PMF), that is not classified as a High or Medium Flood Risk Precinct. *Note: The Low Flood Risk Precinct is where the risk of damages is low for most land uses. The Low Flood Risk Category is that area above the 1% AEP flood, and most land uses would be permitted in this category. Development controls may apply to special land uses with critical functions or vulnerable occupants.*	Flood affected land between the PMF and 1% AEP extent.

Note: Where sufficient information is not available, but the potential for flood risk issues are evident based on available information, a~~A~~pplicants may be required to undertake a ~~flood study~~site specific flood assessment. These situations include where:

a) Council has knowledge that the property has been previously affected by or impacted upon flooding or an overland flow path;

~~(b) The property is on the low side of the road and/or the~~ boundary levels are below

Commented [PG1]: To provide for confirmation of the LEP FPA in the DCP as promoted by the 2021 Guideline, noting that the Guideline also recognises that a Council may have multiple FPAs.

Commented [PG2]: The definition of the FRPs are primarily based on hazard which contribute to the determination of risk as technically defined.

Commented [PG3]: Repitition

Commented [PG4]: Consider extending description and definition to include areas with significant emergency management issues such as "properties identified as unsafe for Onsite Refuge" or isolated due to flooded roads in the Flood Study. This could require further analysis at the FRMS stage.

b) the level of Council's kerb;
c) The property is lower than surrounding properties;
d) The property is in a natural low point, gully or depression; or
e) The property is adjacent to or contains a flow path, open channel, watercourse or drainage line.

The assessment would ~~to~~ determine the ~~flood extent and~~ Flood Risk Categories in order to apply appropriate controls in addition to any further assessments required by this Development Control Plan.

Commented [PG5]: To distinguish between site specific assessments and catchment based Flood Studies, clarify when that might be needed and to note additional assessments may be required.

~~Council may require flood related development controls in situations where:~~

~~(a) Council has knowledge that the property has been previously affected by or impacted upon flooding or an overland flow path;~~
~~(b) The property is on the low side of the road and/or the boundary levels are below the level of Council's kerb;~~

~~(c) The property is lower than surrounding properties;~~
~~(d) The property is in a natural low point, gully or depression; or~~
~~(e) The property is adjacent to or contains a flow path, open channel, watercourse or drainage line.~~

Objectives

(a) Minimise risk to life and damage to property by controlling development on flood prone land

~~Reduce risk to human life and minimise damage to property caused by flooding.~~ (b) ~~Ensure that development is sited to minimise potential risk from flooding.~~

~~(c) Ensure that, in the event of a flood, adequate access to affected properties is available for emergency service personnel and that safe egress is available for residents and employees.~~

~~(d) Ensure that proposed development does not increase the flood inundation of other properties.~~

~~(e)~~ Ensure the impacts of the full range of potential floods up to and including the PMF are considered when assessing development having regard to the sensitivity of different land uses to flooding~~Ensure that sensitive land uses are designed and sited to minimise risk from flooding and have safe and reliable access~~.

(~~f~~c) Ensure that development does not have an unacceptable impact on flood behaviour, people's safety, surrounding properties and structures, and the natural environment;

(d) To provide detailed controls that if satisfied would address the considerations required by clause 5.21 of *Waverley Local Environmental Plan 2012*~~Ensure that potential environmental contamination resulting from inundation of sensitive developments is minimised by appropriate design and siting~~.

~~(g) Facilitate, where appropriate, conversion of floodways to natural waterway corridors.~~
~~(h) Minimise potential impact of development on the ecology and the aesthetic and recreational value of waterways.~~
~~(i)~~ ~~Ensure~~ that land identified by Council as having a potential flood risk is subject to a full flood risk assessment before approval of new development.
~~(j) Provide detailed controls for the assessment of applications lodged in accordance with the Environmental Planning and Assessment Act 1979 on land affected by potential floods.~~

Controls

How to determine what planning controls apply

Refer to land use risk categories in Annexure B6-1, and the planning controls matrix in Annexure B6-2 to determine which controls are applied.

Application of Controls

Compliance with the prescriptive controls must be demonstrated.

Commented [PG6]: To better reflect what is achievable through the DCP and delete superfluous objectives

Commented [PG7]: To provide a broader recognition of the intended risk based approach for all uses,

Commented [PG8]: To provide an overall recognition of the intent of various existing objectives

Commented [PG9]: To provide a clear statement that satisfaction of the DCP controls would be considered satisfaction of the LEP required considerations and that the adoption of the LEP FPA based on the FRP maps that extend to the PMF is not intended to impose any greater restrictions.

Commented [PG10]: Subject to future review of FPLs consider including an objective such as "Ensure that the effects of climate change are considered when assessing development on flood prone land."

Commented [PG11]: To remove outcomes unlikely to be achievable by individual DAs and outcomes addressed by the above objectives.

Commented [PG12]: Superfluous or potentially inconsistent with complying development permitted by Codes SEPP

Where the prescriptive controls are not satisfied, applicants must demonstrate that the performance criteria are clearly satisfied to the satisfaction of Council.

Commented [PG13]: Incorporate performance criteria so that the DCP can be flexibly applied, with clarity of intended outcomes, when required by s4.15(3A) of the EP&A Act. This also provides flexibility to vary controls that flow from Flood Study parameters that are refined based on site specific assessments.

6.2.1 Floor Level

Performance Criteria

1. The cost of damages that may be incurred over the expected life of a development should be no greater than that which could be reasonably expected to be met by the occupants and/or the developer without Government assistance.

2. Despite the need to elevate floors, the development must remain acceptable with regard to its appearance and accessibility from the public domain and the amenity of the occupants.

Prescriptive Controls

1. ~~——~~All floor levels are to be equal to or greater than the 5% AEP flood level.
2. Habitable floor levels are to be equal to or greater than the 1% AEP flood level plus ~~300mm~~ freeboard.
3. All floor levels are to be equal to or greater than the PMF level unless justified by a site-specific assessment.
4. All non-habitable floor levels shall be no lower than the 1% AEP flood level. Where ~~is this~~this is impractical, non-habitable spaces should be flood-proofed to the 1% AEP level.

5. Floor levels shall be equal to or greater than the level of the 1% AEP flood level plus freeboard. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the floor level of existing buildings, or the need for access for persons with disabilities, a lower floor level may be considered. In these circumstances, the floor level shall be as high as practical and when undertaking alterations or additions, no lower than the existing floor level. ~~Floor levels are to be as close to the flood planning level as practical (or higher), and no lower than the existing floor level when undertaking alterations and additions~~.

Commented [PG14]: To provide greater clarity as to what circumstances may not be practical

6.2.2 Building Components

Performance Criteria

1. All structures to have flood compatible building materials below the prescribed floor flood planning level.

Prescriptive Controls

1. All new structures are to have flood compatible building components below or at the 1% AEP flood level plus ~~300mm~~ freeboard. R~~,r~~efer to Annexure B6-3 for ~~the a~~ list of recommended flood compatible building components.
2. All new structures to have flood compatible building components below or at the PMF level.

Commented [PG15]: Should not be considered an exhaustive list

6.2.3 Structural Soundness

Performance Criteria

1. All development would be structurally sound when impacted by a 1% AEP flood plus freeboard.
2. Where development relies on sheltering in place to be acceptable it would be structurally sound when impacted by a PMF.

Prescriptive Controls

1. An engineer's report (refer to Annexure B6-4 for details) shall be provided for development~~s in a Medium or High risk area~~ to certify that any new structure can withstand the forces of floodwater, debris & buoyancy up to & including a 1% AEP flood level plus ~~300mm~~ freeboard. Note: certification to be up to and including PMF if required to satisfy evacuation criteria (see below).
2. An engineer's report (refer to Annexure B6-4 for details) shall be provided for developments ~~in a Medium or High risk area~~ to certify that any new structure can withstand the forces of floodwater, debris & buoyancy up to & including the PMF level.

Commented [PG16]: The Matrix identifies within which FRP the control applies

6.2.4 Flood Affectation

Performance Criteria

1. Development does not detrimentally increase the potential flood affectation on other development or properties either individually or in combination with the cumulative impact of development that is likely to occur in the same floodplain.

2. Development should not change the height or behaviour of flood waters elsewhere in the floodplain in a manner which is likely to materially and adversely impact other property. The assessment of these effects must include the potential for similar impacts that would arise as a consequence of other development in the floodplain that has the potential to occur in the future under current zoning and planning controls.

Prescriptive Controls

1. An engineer's report (refer to Annexure B6-4 for details) shall be provided ~~for developments in a Medium or High risk area~~ to certify that the development (including indoor and outdoor features, such as above ground swimming pools and associated pump housing) will not increase flood effects elsewhere, having regard to:
   - loss of flood storage;
   - changes in flood levels, flows and velocities caused by alterations to the flood conveyance.

6.2.5 Car Parking and Driveway Access

Performance Criteria

1. Measures will be in place to warn people not to drive out of car parking areas where this would be dangerous and provide guidance and facilities to be able to safely exit the carpark.
2. All reasonable and practical measures are implemented to reduce the likelihood of motor vehicles being damaged by a flood.
3. All reasonable and practical measures will be in place to manage the potential vehicles floating and causing damage or becoming debris during a flood.

Prescriptive Controls

1. The minimum surface level of open car parking spaces or carports shall be no lower than the 5% AEP flood level ~~+ 300mm~~plus freeboard.
2. ~~Enclosed car parking spaces (g~~Garages~~)~~ for three (3) or fewer vehicles shall have a minimum finished floor level no lower than the 5% AEP flood level plus ~~300mm~~ freeboard.
3. ~~Enclosed~~ Basement car parking ~~spaces (garages) for more than three (3) vehicles~~ shall ~~have a minimum finished floor level no lower than~~ be protected from inundation ~~the~~ by a 1% AEP flood ~~level~~ plus ~~300mm~~ freeboard.

Commented [PG17]: To clearly distinguish between domestic garages normally above ground and basement parking

Commented [PG18]: In recognition of basement parking having additional risks.

4. The crest of the driveway providing access between the road and ~~Basement~~ basement c~~C~~ar- ~~Parking~~ parking ~~or Below Ground Car Parking~~ shall be a minimum of 1% AEP flood plus ~~300 mm~~freeboard or the PMF, whichever is higher.

5. Restraints or vehicle barriers shall be provided to prevent floating vehicles leaving a site during a 1% AEP flood. (Note: A flood depth of more than 200mm will cause serious water damage to a typical vehicle and a depth of 300mm is sufficient to cause a typical vehicle to float.)

Commented [PG19]: To clarify intent

6.2.6 ~~Evacuation~~Emergency Management

Commented [PG20]: To reflect the broader intent of the controls

Performance Criteria

1. The development should be designed and be able to be managed to ensure that during a flood emergency all occupants are capable of seeking safe refuge.

Prescriptive Controls

1. The evacuation requirements of the development during flooding shall be considered ~~and identified~~ in the Statement of Environmental Effects.
2. Reliable access for pedestrians or vehicles shall be provided from a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF level. Where safe and practical this should involve evacuation to an area outside of the PMF extent. ~~The evacuation requirements of the development are to be considered up to the PMF level and identified in the Statement of Environmental Effects.~~
3. The development shall be consistent with any relevant flood strategy, Floodplain Risk Management Plan adopted by Council or similar.
4. ~~The Applicant shall demonstrate that evacuation of potential development as a consequence of a subdivision proposal can be undertaken in accordance with the Flood Planning controls.~~
5. ~~T~~The Applicant shall provide a flood emergency response plan that demonstrates how risk to life will be managed during a flood event. For example, a safe ~~the~~ evacuation route needs to be clearly identified, or a shelter in-place strategy with reliable access shall be provided to an area of refuge above the PMF level.

Commented [PG21]: superfluous

Commented [PG22]: To be definitive as to what outcome is sought

Commented [PG23]: Replace with note under Matrix as to considerations for subdivision

Commented [PG24]: To use terms consistent with those used in practice

6.2.7 Management and Design

Performance Criteria

1. The development should be designed and managed to ensure that during a flood it does not cause unacceptable levels of pollution and valuable goods are capable of being protected.

Prescriptive Controls

1. ~~The Applicant is to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with the DCP.~~
2. ~~The~~ The Applicant is to demonstrate that an area is available to store goods above the 1% AEP flood level plus ~~300 mm~~ freeboard.
3. ~~2~~. No storage of materials below the 1% AEP plus ~~300 mm~~freeboard which may cause pollution or be potentially hazardous during any flood.
4. ~~3~~. In-ground swimming pools are to have surrounding coping/tiling that is no more than 100 mm above surrounding ground level. All pumping/electricals are to be above the 1% AEP flood level plus ~~300 mm~~ freeboard.

Commented [PG25]: Replace with note under Matrix as to considerations for subdivision

6.2.8 Fencing

1. Fencing is to be constructed in a manner that does not obstruct the flow of floodwaters so as to have an adverse impact on flooding.
2. Fencing shall be constructed to withstand the forces of floodwaters.

Commented [PG26]: Can be more efficiently addressed as a note to the Planning Matrix

6.2.9 All Other Areas

(a) For sites not in a 'flood planning area' habitable floor levels must comply with the drainage requirements of the BCA.

(b) A reduction in the required floor level will only be considered if the development includes the installation of an automatic flood gate system.

Commented [PG27]: Unclear as to basis of this requirement in the context of drainage requirements of the BCA. Considering deleting this requirement and allowing for consideration of such alternate measures on the basis of development specific performance solutions.

Annexure B6-1
Land Use Risk Categories

Land use is categorised into eight Land Use Risk Categories according to the sensitivity of each type of land use to flooding. The definitions of each land use are based on the Waverley LEP 2012 and are categorised as follows.

Category	Examples (not exhaustive, refer to Waverley LEP 2012 for full list)
~~Essential Community Facilities~~	Emergency services; public administration building that may provide an important contribution to the notification or evacuation of the community during flood events (e.g. SES headquarters and Police Stations); hospitals and residential care facility.
~~Sensitive Uses and Facilities~~Sensitive and Hazardous Development	Offensive storage establishments; seniors housing; child care centres; preschools; schools and other educational institutions; correctional centres; liquid fuel depots; public utility undertakings (including electricity generating works; sewerage treatment plant; sewerage systems; telecommunication facilities; utility installations and water treatment facilities) which are essential to evacuation during periods of flood or if affected would unreasonably affect the ability of the community to return to normal activities after flood events; and waste disposal facilities.
~~Subdivision~~	~~Subdivision of land which involves the creation of new allotments with potential for further development.~~
Residential	Boarding houses; camping or caravan park site; health consulting rooms; home businesses; home industries; home occupation; hotel or motel accommodation; residential accommodation (excluding seniors housing and residential care facilities); serviced apartments; and other development within residential lots including but not limited to construction of garages, swimming pools, and the construction of an outbuilding with a floor area that exceeds 30 $m^{2,}$, fencing and/or retaining walls.
Commercial or Industrial	Business premises; office premises; retail premises or buildings or land used for industrial activity.
~~Tourist Related Development~~	~~Camp sites or caravan parks - short-term sites (1) only~~ ~~As defined by the Local Government (Manufactured Home Estates, Caravan Parks, Camping Grounds and Moveable Dwellings) Regulation 2005~~
Recreation or Non-urban Uses	Agriculture; aquaculture; animal boarding or training establishments; extractive industry; recreation facility (indoor), recreation facility (outdoor); recreation facility (major); recreation areas and minor ancillary structures (e.g. toilet blocks or kiosks); and water recreation structure.
Concessional Development	Residential development that involves: a) An internal or external alteration to an existing dwelling, which does not change the floor area and/or footprint of the existing dwelling; b) An addition to existing premises of not more than 10% of the floor area of the existing building footprint; c) A change of use which does not increase flood risk having regard to property damage and personal safety;

Commented [PG28]: Table should be expanded to include all defined development within the Standard Instrument LEP to avoid uncertainty. The parent definitions of multiple subsidiary definitions can be used to minimise the number of listed definitions.

Commented [PG29]: These 2 categories can be collapsed into 1 as the they are similar and the same controls are applied to both.

Commented [PG30]: Subdivision is expected to typically form part of development proposals involving the built form outcomes. This category could be dispensed with and an overall note included to the effect that when assessing subdivision the planning controls for the intended end use will be taken into consideration to ensure that any potential development on a new lot would be capable of meeting the controls.

Commented [PG31]: Tourist developments referred to here are uncommon in the Waverley LGA and can be redistributed into other categories.

Category	Examples (not exhaustive, refer to Waverley LEP 2012 for full list).
	d) Subdivision which does not propose the creation of new allotments with potential for further development; e) The construction of an outbuilding with a floor area of no greater than 30 m^2.

Annexure B6-2
Planning Controls Matrix for Flood Planning

The Planning Controls Matrix identifies the prescriptive flood related development controls that apply to the Flood
Planning Areas and land use category. Refer to all~~The detailed~~ controls ~~are provided~~ in B6.

Flood Risk	Low Flood Risk								Medium Flood Risk								High Flood Risk							
LAND USE	Essential Community Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial or Industrial	Tourist Related Development	Recreation or Non-urban Uses	Concessional Development	Essential Community Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial or Industrial	Tourist Related Development	Recreation or Non-urban Uses	Concessional Development	Essential Community Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial or Industrial	Tourist Related Development	Recreation or Non-urban Uses	Concessional Development
Floor Level	3	3		[2]	2	2						2, 4	2, 4	2, 4	1	5				2, 4	2, 4		1	5
Building Components	2	2		1	1	1						1	1	1	1	1				1	1		1	1
Structural Soundness	2	2				2						1	1	2	1	1				1	1		1	1
Flood Affectation											1	1	1	1	1	1			1	1	1		1	1
Car Parking & Driveway Access	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4				1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	4, 5	4, 5				1, 2, 3, 4, 5	1, 2, 3, 4, 5		4, 5	4, 5
~~Evacuation~~Emergency Management	2, 3	2, 3	1	1	1	1	1	1			4	1	1, 3	1, 3	1, 3	1			4	1	1, 3, 5		1, 3	1
Management & Design			1								1	2, 3, 4	2, 3	2, 3, 4	2, 3, 4	2, 3, 4			1	2, 3, 4	2, 3		2, 3, 4	2, 3, 4
Fencing	1	1	1	1	1	1	1	1			1, 2	1, 2	1, 2	1, 2	1, 2	1, 2			1, 2	1, 2	1, 2		1, 2	1, 2

Key

No Controls	
Subject to significant flood constraints (refer to General Note 1)	
DCP Control Reference no.	1

General Notes:

1. ***Significantly Constrained Land**: Where development types are likely to be incompatible with the hazards existing within the nominated part of the floodplain without substantial mitigation measures. Consequently the development may be found unacceptable unless the design of the development together with the mitigation measures can address any potential unacceptable amenity or environmental impacts. Alternatively, this may require a reduction in the otherwise anticipated development intensity for the land.*
2. ***Filling:** Filling of a site, or site modification works in general, that is partially affected by flooding (if acceptable to Council) may change the flood risk precinct, and the associated development controls that apply to development on the site.*
3. ***Multiple FRPs**: Development controls relate to the FRP identified for the site. Where a site has two or more FRPs the relevant sets of controls apply to each risk precinct but for practical purposes the stricter controls would normally apply across the whole development.*
4. ***Fencing:** Refer to section XX of the DCP for planning considerations involving only the erection of a fence. Any fencing that forms part of a proposed development is subject to the relevant flood effect and structural soundness considerations of the relevant category.*
5. ***Freeboard:** Where required the following freeboard heights apply:*
   a. *Areas subject to oceanic flooding conditions: 500mm*
   b. *Other areas: 300mm.*

Commented [PG32]: Collapse number of land use categories as discussed above

Commented [PG33]: Floor level and flood compatible building controls should be also applied in the Low FRP. This is to ensure that development occurring in the Low FRP but on the edge of the edge of the Medium FRP on land only marginally above the 1% AEP flood level adopts the 1% AEP flood level plus appropriate freeboard. This will avoid inconsistencies in possible situations with development applications where neighbours are at almost the same ground level but one is required by Council to have elevated floor levels and the other is not.

Commented [PG34]: To recognise the legal situation that the DCP controls cannot override the LEP in regard to permissibility and to better reflect the intent of the provision.

6. ***Mixed Use Development:*** *For mixed-used developments, the planning controls apply to each use to the extent relevant. For example Floor level and Building Component controls will typically apply to only the ground floor, while the balance of the controls could apply to the overall development.*

7. ***Subdivision****: When assessing subdivision the planning controls for the intended end use will be taken into consideration to ensure that any potential development on a new lot would be capable of meeting the controls.*

**Note: New residential, commercial or industrial development are not permitted in the High Flood Risk areas. Redevelopment that does not intensify the occupancy will be assessed on a merit basis presented by the applicant.*

For mixed-used developments, the planning controls matrix applies to the relevant ground floor use.

Key

Not Relevant	
Unsuitable Land Use	
DCP Control Reference no.	1

Annexure B6-3
Flood Compatible Material

Commented [PG35]: A note could be included to the effect that this list is not exhaustive and other materials and methods can be proposed for Council's consideration. References to other Guidelines and emerging research could be provided.

Building Component	
Flooring and sub-floor	• Concrete slab-on-ground monolith
	• suspended reinforced concrete slab
Floor covering	• clay tiles
	• concrete, precast or in situ
	• concrete tiles
	• epoxy, formed-in-place
	• mastic flooring, formed-in-place
	• rubber sheets or tiles with chemicals-set-adhesive
	• silicone floors formed-in-place
	• vinyl sheets or tiles with chemical-set adhesive
	• ceramic tiles, fixed with mortar or chemical-set
	• asphalt tiles, fixed with water resistant adhesive
Wall structure	• Solid brickwork, block work, reinforced, concrete or
Roofing structure (for situations where the relevant flood level is	• reinforced concrete construction • galvanised metal construction
Doors	• solid panel with water proof adhesives
	• flush door with marine ply filed with cell foam
	• painted metal construction
	• aluminium or galvanised steel frame
Wall and ceiling linings	• fibro-cement board
	• brick face or glazed
	• clay tile glazed in waterproof mortar
	• concrete
	• concrete block
	• steel with waterproof applications
	• stone, natural solid or veneer, waterproof grout
	• glass blocks
	• glass
	• plastic sheeting or wall with waterproof adhesive
Insulation windows	• Foam (closed cell types)
	• Aluminium frame with stainless steel rollers or similar corrosion and water ~~resistent~~resistant
Nails, bolts, hinges and fittings	• Brass, nylon or stainless steel; • Removable pin hinges • Hot dipped galvanised steel wire nails or similar.

Electrical and mechanical equipment *For dwellings constructed on land to which this DCP applies, the electrical and mechanical materials, equipment and installation must conform to the following requirements:*	
Main power supply	Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, must be located above the relevant flood level. Means must be available to easily disconnect the dwelling from the main power supply.
Wiring	All wiring, power outlets, switches, must be to the maximum extent possible, located above the maximum flood level. All electrical wiring installed below this level must be suitable for continuous underwater immersion and must contain no fibrous components. Earth leakage circuit-breaker (core balance relays) or a Residual Current Device must be installed. Only submersible type splices must be used below maximum flood level. All conduits located below the relevant designated flood level must be so installed that they will be self-draining if subjected to flooding.
Equipment	All equipment installed below or partially below the relevant flood level must be capable of disconnection by a single plug and socket assembly.
Reconnection	Should any electrical device and/or part of the wiring be flooded it must be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.
Heating and air conditioning systems *Where viable, heating and air conditioning systems should be installed in areas and spaces of the house above maximum flood level. When this is not feasible, every precaution must be taken to minimise the damage caused by submersion according to the following guidelines:*	
Fuel	Heating systems using gas or oil as fuel must have a manually operated valve located in the fuel supply line to enable fuel cut-off.
Installation	Heating equipment and fuel storage tanks must be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks must be vented to an elevation of 600 millimetres above the relevant flood level.
Ducting	All ductwork located below the relevant flood level must be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, a closure assemble operated from above relevant flood level must protect the ductwork.

Annexure B6-4
Flood Risk Management Report Requirements

A Flood Assessment (FA) must be prepared by a professional engineer who specialises in hydraulic engineering. The FA must be prepared in accordance with the relevant sections of this Chapter. The 20% AEP, 1% AEP and PMF flood events must be modelled to assess the impact on existing flood conditions of a proposed development to property, infrastructure and the environment. The FA will be required for any type of development where the development occurs in the floodplain (i.e. situated within the Flood Planning Area) or where the Site in question is tagged as a Flood Control Lot.

Unless it can be demonstrated that hydraulic modelling is not required, the FA must be prepared using Council's TUFLOW model (note: a fee is payable for the TUFLOW model). Once engaged, the consultant must enter into a license agreement for the use of Council's flood model for the specific purpose of preparing the FA for the proposed development only.*[A link to the form to acquire the model and detailing the fee would be helpful here]*

The FA must address the following:

- Description of the Site (including existing stormwater drainage and local catchment characteristics) and details of the proposed development
- Flood affectation to the Site during the 5% AEP, 1% AEP and PMF events under existing (i.e. pre-development) conditions
- Overview of the Flood Risk Precinct and associated development controls applicable to the Site
- Flood affectation to the Site during the 5% AEP, 1% AEP and PMF events under post-development conditions
- Overview of the change in flood conditions associated with the proposed development
- Discussion of adherence to applicable planning controls
- Proposed mitigation measures to address any impacts or minimise risk to personal safety of occupants and the risk of property damage
- A flood evacuation strategy (Flood Emergency Response Plan) (if required) *[Further guidance on requirements may be required here]*
- On site response plan to minimise flood damage, and provide adequate storage areas for hazardous materials and valuable goods above the flood level (if required)
- The architectural/engineering plans on which the assessment is based
- Supporting calculations and mapping
- The professional qualifications and experience of the author(s).

~~A Flood Risk Management Report must be prepared by a suitably qualified and practising engineer with experience in floodplain risk management. The report must be prepared in accordance with the relevant sections of Annexure B6-4.~~

~~Council will request a report to determine the effects of a proposed development on flooding and the effect of flooding on a proposed development. A report will be required for any type of development where the development occurs in the floodplain or in areas where overland flow is suspected.~~

~~Unless it can be demonstrated that flood modelling is not required, any modelling must be undertaken using Council's TUFLOW model (subject to local refinements including revisions to the DEM using detailed survey). A fee is payable to use the TUFLOW model. Once engaged, the consultant must enter into a license agreement for the use of Council's flood model for the specific purpose of preparing the flood study for the proposed development only.~~
~~The Flood Risk Management Report must at a minimum address:~~

1. ~~Extent of the 5% AEP flood, 1% AEP flood and PMF event in the vicinity of the development in the pre-development and post-development stage (where modelling has been undertaken).~~

2. ~~Peak Flood Velocity, Hydraulic Categorisation and Flood Hazard mapping during the 5% AEP, 1% AEP flood and PMF event in the vicinity of the development in the pre-development and post-development stage (where modelling has been undertaken).~~

Commented [PG36]: These requirements were reviewed in consultation with KBR to seek to provide better clarity and consistency with other policies and guidelines and current terminology.

Commented [PG37]: To align with the requirements of the Codes SEPP.

3. Any difference in mapping to compare changes in flood behaviour from the pre-development and post-development stage (where modelling has been undertaken).

4. Recommendations on all precautions to minimise risk to personal safety of occupants and the risk of property damage for the total development to address the flood impacts on the site during a 1% AEP flood and PMF event. These precautions must include but not be limited to the following:
    a. Types of materials to be used to ensure the structural integrity of the development for immersion and impact of velocity and debris for the 1% AEP flood event and PMF;
    b. Waterproofing methods, including electrical equipment, wiring, fuel lines or any other service pipes or connections;
    c. A flood evacuation strategy (Flood Emergency Response Plan); and
    d. On site response plan to minimise flood damage, and provide adequate storage areas for hazardous materials and valuable goods above the flood level.

5. Details of any flood mitigation works (including any supporting modelling and calculations) that are proposed to protect the development.

6. The architectural/engineering plans on which the assessment is based.

7. The date of site inspection undertaken.

8. The professional qualifications and experience of the author(s).

DEFINITIONS

NOTE: ONLY KEY DEFINITIONS RELEVANT TO FLOOD RISK MANAGEMENT HAVE BEEN CONSIDERED

Note: Terms used in this Plan are defined in Waverley LEP 2012 and the Act and override any identical definition in this dictionary. The definitions below refer to terms that are not defined by either the LEP or the Act.

A

Annual Exceedance Probability (AEP) - The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage ~~The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year. Example, if a peak flood discharge of 500 m3 /s has an AEP of 1%, it means that there is a 1% chance (that is one in 100 chance) of a 500 m3 /s or larger event occurring in any one year.~~

Commented [PG1]: Superfluous (not used)

Commented [PG2]: Simplify to be more understandable to the general public (definition taken from the Draft Manual)

~~**Australian Height Datum (AHD)** - A common national plan of level corresponding approximately to mean sea level.~~

~~**Average Recurrence Interval (ARI)** - The average time interval (expressed in years or fraction of years) between recurrences of a rainfall event of a given intensity and duration. For example, floods with a discharge as great as, or greater than, the 20-year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.~~

B

Basement Car Parking ~~**or Below Ground Car Parking**~~ - The car parking area generally below ground level where inundation of the surrounding areas may raise water levels above the entry level to the basement, resulting in inundation. Basement car parks are areas where the means of drainage of accumulated water in the car park has an outflow discharge capacity significantly less than the potential inflow capacity.

Commented [PG3]: To align precisely with the term used in the controls

C

Commented [PG4]: Superfluous as specified in Land Use Category table

~~**Critical Facilities** - Includes hospitals and ancillary services, communication centres, police, fire SES, major transport facilities, sewerage and electricity plants; any installations containing critical infrastructure control equipment and any operational centres for use in a flood.~~

D

E

Effective Warning Time - The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to raise furniture, evacuate people, and transport their possessions.

Commented [PG5]: Term not used in Emergency Management controls but can be if Council considers sufficient information is or could be available.

Evacuation - The transfer of people and or stock from areas where flooding is likely, either close to, or during a flood event. It is affected not only by warning time available, but also the suitability of the road network, available infrastructure, and the number of people that have to evacuate during floods.

F

DEFINITIONS

Flood - A natural phenomenon that occurs when water covers land that is normally dry. It may result from coastal inundation (excluding tsunamis) or catchment flooding, or a combination of both. ~~A relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage as defined by the Floodplain Development Manual before entering a watercourse, and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences excluding tsunami.~~

Commented [PG6]: Replaced with simplified definition in Draft Manual

Flood compatible building components - A combination of measures incorporated in the design and/or construction and alteration of individual buildings or structures subject to flooding, and the use of flood compatible materials for the reduction or elimination of flood damage.

ABBREVIATIONS

Flood compatible materials - Those materials used in building which are resistant to damage when inundated.

Flood evacuation strategy - The proposed strategy for the evacuation of areas within effective warning time during periods of flood as specified within any policy of Council, the Floodplain Risk Management Plan (FRMP), the relevant State Government disaster plan, or by advice received from the State Emergency Services (SES) ~~or as determined in the assessment of individual proposals.~~

~~**Flood hazard** - The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods.~~

~~**Flood planning area** - The area where flood related development controls apply. It includes land below the flood planning level (FPL) and may extend to include other areas of land where the high consequences in low probability events require additional flood related controls to reduce damages or to not alter the floodway in rarer flood events.~~

~~**Flood planning level (FPL)** - In the Waverley LGA, the FPL is the level of a 1% AEP flood event plus 300 mm freeboard, unless otherwise stated in an adopted Floodplain Risk Management Study and/or Floodplain Risk Management Plan.~~

~~**Flood prone land** - Land susceptible to flooding by the probable maximum flood (PMF) event. Flood Prone Land is synonymous with flood liable land.~~

Flood proofing - A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages. Examples include use of tiled surfaces and installing power points above flood planning levels etc.

Flood refuge area - An onsite refuge above the PMF that provides reasonable shelter for the likely occupants of the development commensurate with the period of time that refuge is likely to be required in floods up to the PMF.
Note: In general, it is not acceptable to rely on a refuge provided by or on other development sites. In all cases where an onsite refuge is provided, it is to be both intrinsically accessible to all people on the site, sheltered and an integrated part of the development (i.e. a second storey with internal stair access). The route to the refuge is to be fail safe, plainly evident and self-directing.

Flood Fringe Areas - The remaining areas of flood prone land after floodway and flood storage areas have been identified.

Floodway Areas - Areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked would cause a significant redistribution of flow or a significant increase in flood levels.

Flood Storage Areas - Floodplain area that is important for the temporary storage of floodwaters during a flood.

Floodplain - (Synonymous with flood liable and flood prone land) is the area of land that is subject to inundation by the PMF.

Floodplain Development Manual (FDM) - Floodplain Development Manual (2005) or the latest version.

Commented [PG7]: To distinguish strategies for an area form those that may be required for an individual site via a FERP as specified by the controls.

Commented [PG8]: Superfluous

Commented [PG9]: Superfluous, Defined in LEP which refers back to the Manual and clarified in the Controls as required by the 2021 Guideline.

Commented [PG10]: Superflous

ABBREVIATIONS

~~**Floodplain Risk Management Plan (FRMP)** - A plan prepared for one or more floodplains in accordance with the requirements of the FDM.~~

~~**Floodplain Risk Management Study (FRMS)** - A study prepared for one or more floodplains in accordance with the requirements of the FDM.~~

Freeboard - A factor of safety typically used in relation to the setting of minimum floor levels or levee crest levels~~A margin of safety applied to calculations that estimate the water surface during a storm event. The freeboard accounts for the inaccuracies in calculation methods. The height between water level and the underside of a structure or top of an embankment/channel wall is referred to as freeboard.~~

Commented [PG11]: Simplified definition from draft Manual

G

H

Habitable - In a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom; In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

I

L

M

N

Non – Habitable Room - Spaces not occupied frequently or for extended periods.

O

Outbuilding - An unattached building or structure that includes a bird aviary, cubby house and other play equipment, cabana, garden shed and greenhouse and the like.

Commented [PG12]: These would be permitted as Concessional Development under the controls. Review to ensure they are all appropriate and would not be likely to provide a significant blockage.

Overland flow - Runoff from rainfall that flows over the land before entering a watercourse, creek, river, lake or dam. Overland flow can flow down roads, driveways and through homes and buildings. It is typically shallow and fast flowing.

Overland Flow Path - The path that stormwater may take if the piped or channelled stormwater system becomes blocked or its capacity exceeded. Overland flow paths provide a fail safe system to ensure that stormwater is not likely to cause flood damage.

P

Probable Maximum Flood (PMF) - The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.

Probable Maximum Precipitation (PMP) - 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 (World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.

R

Reliable Access - During a flood means the ability for people to safely evacuate an area subject to imminent flooding within effective warning time, having regard to the depth and velocity of flood waters, the suitability of the evacuation route, and without a need to travel through areas where water depths increase.

Risk - The chance of something happening that will have an impact. It is measured in terms of consequences and probability (likelihood).

S

T

U

V

W