5. EXISTING FLOOD ENVIRONMENT

5.1. Flood Behaviour Overview

Below provides a summary of the existing flood behaviour in Manly Lagoon catchment as defined in the 2013 Flood Study and subsequent model update undertaken as part of this FRMS&P:

- 2 hour duration events typically provide for the worst case flooding conditions in Manly Lagoon, with a level of 3.0 mAHD at Pittwater Bridge for the 1% AEP event;
- The rise in flood water levels can be relatively fast due to the size of the catchment. Peak flood levels in Manly Lagoon are recorded less than 30 minutes after the flood peaks at Brookvale and in the Burnt Creek deviation;
- Flooding can result from either elevated ocean conditions, catchment flooding, or a combination of both, however catchment flood events represent the dominant flooding mechanism in the catchment. Whilst ocean derived flooding will cause inundation for properties close to the lagoon, the extent and severity of flooding is significantly less than the corresponding catchment derived event;
- The entrance condition has some influence on catchment flood behaviour with higher entrance berm levels providing for higher peak flood levels. The existing entrance management policy provides for manual breakout of the Lagoon entrance at defined trigger levels in preparation for imminent flooding. Irrespective of this, significant flood extents may be expected during a major catchment event; and
- Four hotspot locations have been identified which are the most adversely affected areas in the catchment. These are shown on Figure 8 and are described below.

Location A – Kenneth Road & Balgowlah Road

Due to the low ground levels, the area around Kenneth Road is highly flood affected. The road is inundated in all design events, and peak depths reach 1 m in the 1% AEP event, with velocities of 1.5 m/s. The area is affected by lagoon flooding and overland flooding.

Location B – Balgowlah

Flooding occurs in this area as a result of three different mechanisms – overland flooding, catchment flooding and ocean flooding, and can result in high velocities and depths.

Location C – Manly Lagoon north bank

Manly Lagoon is located at the downstream end of the catchment. In a 1% AEP event the flood levels peak at 2.9 mAHD. Flooding is influenced by two consecutive bridges and the entrance conditions / low flow pipes.

Location D – Brookvale

Clearview Place is a primary flowpath in this area. The high flows and velocities present a significant risk to pedestrians, motorists and property along the street. The street is aligned with the original creek channel, which was replaced with a pipe. However, the pipe capacity is exceeded in the 1% AEP event, resulting in peak depths of 1.65 m and peak velocities of 1.1 m/s.

Warringah Mall is at the downstream end of an open channel. A culvert under the mall directs water to the lagoon, however, the culvert capacity is exceeded in significant flood events. This results in peak depths of 1.5 m and velocities of 1 m/s in the 1% AEP event.

5.1.1. Design Flood Data

Table 3 provides peak flood levels at key locations (shown on Figure 9) across the catchment for the 10%, 5%, 1% AEP and PMF design events

Table 3: Design Flood Levels at Key Locations

ID	Location	Peak Flood Level (mAHD)			
		10% AEP	5% AEP	1% AEP	PMF
1	Manly Lagoon at Pittwater Bridge	2.55	2.69	2.96	5.75
2	Manly Lagoon at Riverview Parade	2.58	2.72	2.99	5.76
3	Manly Creek upstream the lagoon	3.90	4.18	4.83	6.17
4	Manly Creek at Mermaid Pools	11.31	11.66	12.15	14.96
5	Brookvale Creek downstream M8	5.85	5.91	6.06	6.70
6	Manly Lagoon downstream Kenneth Road	2.56	2.70	2.97	5.75
7	Brookvale Creek at Clearview Place	19.76	20.19	20.79	23.73
8	Brookvale Creek at Warringah Mall	11.30	11.83	12.51	14.59
9	Burnt Bridge Creek between West Street and M8	12.32	12.53	12.87	13.86
10	Burnt Bridge Creek at Hope Street	33.18	33.51	34.30	35.88
11	M8 upstream Balgowlah	10.65	10.96	11.12	12.20

5.2. Hydraulic and Hazard Classification

For the purposes of floodplain risk management in NSW, floodplains can be divided into hydraulic and hazard categories. Details of this process are provided in the NSW Governments Floodplain Development Manual (2005, Appendix L) (Reference 2) and *Managing the floodplain: a guide to best practice in flood risk management in Australia* (Reference 3), as well as briefly described below.

Hydraulic categories describe the flood behaviour by categorising areas depending on their function during the flood event, specifically, whether they transmit large quantities of water (floodway), store a significant volume of water (flood storage) or do not play a significant role in either storing or conveying water (flood fringe). Although the three categories of hydraulic function are described in the Floodplain Development Manual (The Manual) (Reference 2), their definitions are largely qualitative and the manual does not prescribe a method to determine each area. The Manual gives one indication of how to quantitatively differentiate floodway and flood storage, when it states that flood storage areas, when completely filled with solid material, will not raise peak flood levels by “more than 0.1 m and/or would cause the peak discharge anywhere downstream to increase by more than 10%”.

Hydraulic categories have been defined by considering detailed assessment of flood behaviour, the available topographic information and interpretation of the hydraulic model results and knowledge of the catchment. Figure 10 to Figure 17 show the categorisation for the PMF, 0.1%, 0.5%, 1%, 5%, 10% and 20% AEP catchment design as well as the 1% AEP catchment with 5% AEP ocean coincident event.

As with hydraulic categories, hazard classification plays an important role in informing floodplain risk management in an area. Previously, hazard classifications were binary – either Low or High Hazard as described in the Manual. However, in recent years there has been a number of developments in the classification of hazard. *Managing the floodplain: a guide to best practice in flood risk management in Australia* (Reference 3) provides revised hazard classifications which add clarity to the hazard categories and what they mean in practice. The classification is divided into 6 categories (Diagram 3) which indicate the restrictions on people, buildings and vehicles:

- H1 - No constraints;
- H2 – Unsafe for small vehicles;
- H3 - Unsafe for all vehicles, children and the elderly;
- H4 - Unsafe for all people and all vehicles;
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction; and
- H6 – Unsafe for people or vehicles. All buildings types considered vulnerable to failure.

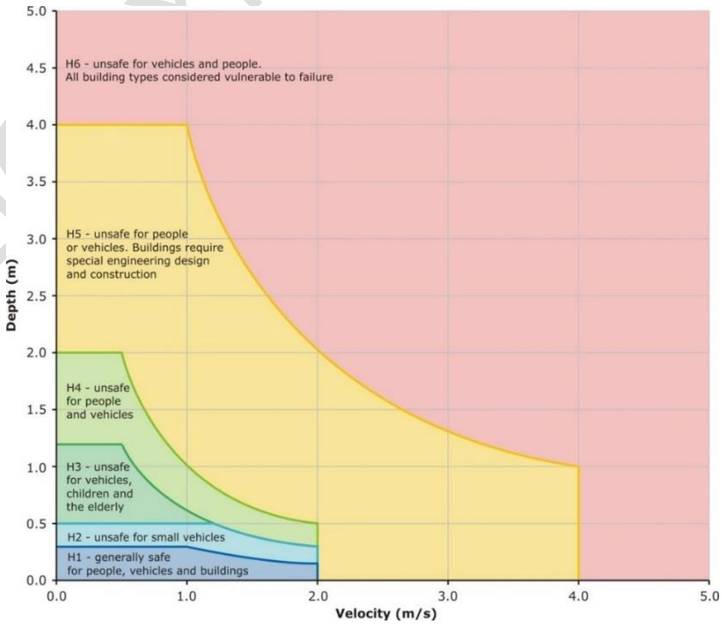

Diagram 3 Hazard Classifications

Hazard categories are often grouped based on consequences. Figure 18 to Figure 25 provide the hazard classification for all the design events, with H1 & H2 and H3 & H4 grouped into two categories due to their similarity in consequences. Under this classification, the most hazardous areas of the floodplain are generally constrained to the non-habitable areas, the parks, reserves, golf courses etc., lying adjacent to the waterways. There are two pockets of residential development, however, which are shown to be in areas unsafe for people and/or vehicles from the 5% AEP event – these are already identified as hot spot locations (Kenneth Road and Riverview Parade).

The Floodplain Development Manual (NSW State Government, 2005) requires that other factors be considered in determining the "true" hazard such as size of flood, effective warning time, flood readiness, rate of rise of floodwaters, depth and velocity of flood waters, duration of flooding, evacuation problems, effective flood access, type of development within the floodplain, complexity of the stream network and the inter-relationship between flows. However, to assess the full flood hazard all adverse effects of flooding have to be considered. As well as considering the provisional (hydraulic) hazard it also incorporates threat to life, danger and difficulty in evacuating people and possessions and the potential for damage, social disruption and loss of production. The classification is a qualitative assessment based on a number of factors as listed in Table 4. A weighting of 1 or 2 would reduce the provisional hazard severity, 3 would have no impact, and 4 or 5 would increase the hazard severity.

Table 4: Hazard Classification

Criteria	Weighting	Comment
Size of flood	3	Whilst some residential areas located in areas unsafe for people / vehicles from the 5% AEP event, the majority of residential areas are located in the lower hazard areas for all events except the PMF.
Flood Awareness of the Community	3	Recent flooding and near-misses has elevated the communities' awareness of flooding. Initiatives such as the Northern Beaches Flood Warning System assist in maintaining this awareness.
Depth and Velocity of Floodwaters	3	Already accounted for in the provisional hazard
Effective Warning and Evacuation Times	5	Fast onset of flooding with little warning time means residents may be caught off guard.
Evacuation Difficulties	3	The majority of properties can be evacuated to nearby high land if required.
Rate of Rise of Floodwaters	4	Flash flooding characteristics increases the likelihood that people may not be aware of the flood risk until access routes are inundated.
Duration of Flooding	2	The catchment is generally subjected to short durations of flooding, and therefore areas are unlikely to be isolated or hazardous for significant durations of time.
Effective Flood Access	3	The majority of the catchment has effective flood access. Those areas without effective flood access are already categorised in the higher risk categories.

Based on the above assessment, the provisional flood hazard categorisations will not be changed and already capture the true hazard satisfactorily.