GRC Hydro
Level 20, 66 Goulburn Street
Sydney NSW 2000

Tel: +61 413 631 447
www.grchydro.com.au

Job Number: *250006*
Date: *24th January 2024*

Deb Hart
The Amplify Group
180 Pacific Hwy,
Killara NSW 2071

Dear Deb,

Re: 2 Marshall Ave, St Leonards NSW 2065 Planning Proposal Flood Assessment

Introduction

Development is proposed for 2 Marshall Ave, St Leonards (the subject site – see Figure 1) situated in the Lane Cove Council (Council) Local Government Area.

No Council-endorsed flood study identifies flood affectation at the subject site. Modelling work reported upon herein has been carried out using a DRAINS hydrologic model and TUFLOW hydraulic model developed by GRC Hydro.

GRC has executed the following work scope in accordance with practices outlined in Australian Rainfall & Runoff (ARR 2019):

- Build a DRAINS hydrologic model to derive flows for conservative 1% AEP estimates.
- Build a TUFLOW hydraulic model to derive water levels, depths and hazards for the 5% Annual Exceedance Probability (AEP), 1% AEP and Probable Maximum Flood (PMF) design events under the site's existing conditions.
- Assess the flood affectation of the site.
- Review pertinent planning documentation for applicable flooding controls.
- Develop flood maps which present flood depths and levels for the 5% Annual Exceedance Probability (AEP), 1% AEP and PMF scenario.
- Produce a report detailing the analysis.

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Site Description

Location

The subject site is located at the corner of Marshall and Canberra Avenues, bounded at north by Marshall Ave and to the south and west by The Landmark Quarter development.

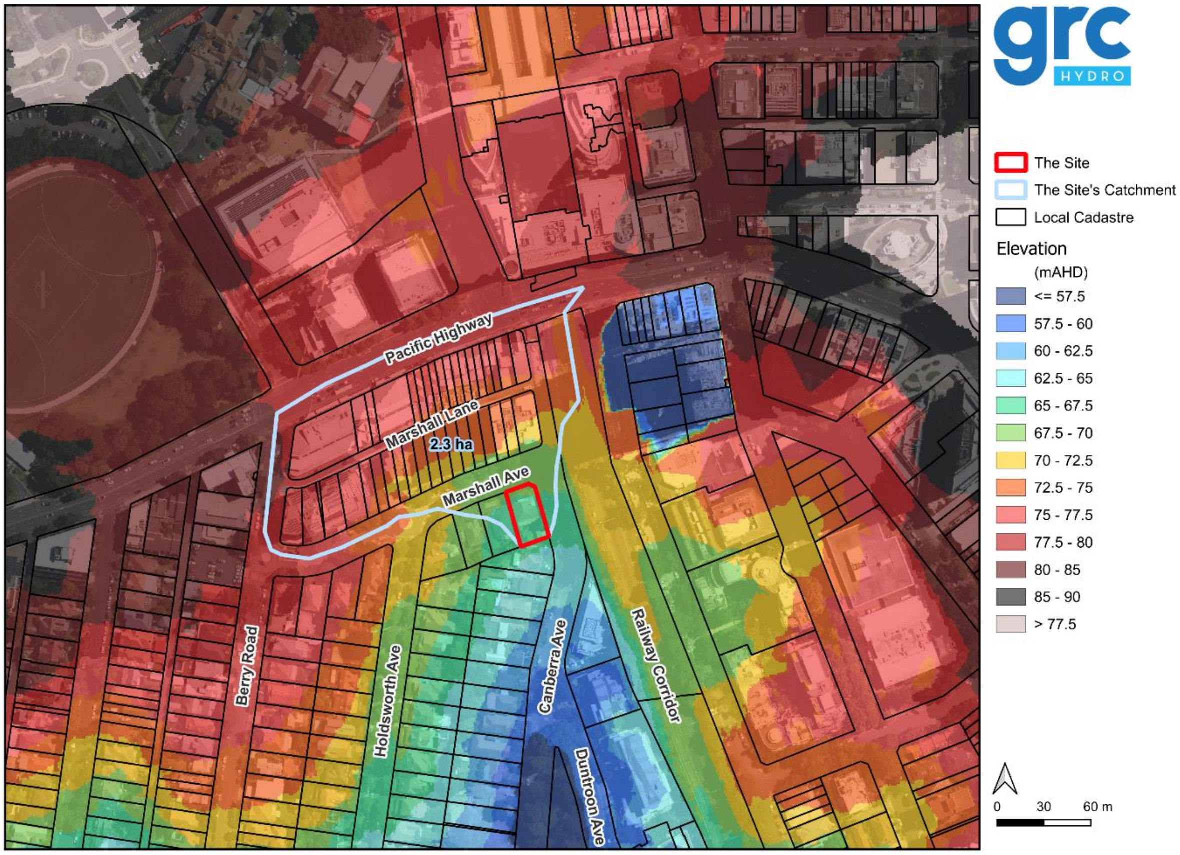
The site currently contains a single detached house and a garage at rear that connects with Canberra Ave.

Figure 1: Existing Built Form at the Site

Topographic Context

The overland catchment to the site is approximately 2.3 ha. The site slopes in a southerly direction, with a maximum elevation in the site's north-eastern corner of approx. 68.0 mAHD sloping down to a minimum elevation of 65.3 mAHD in its south-western corner. The Digital Elevation Model map shown in Figure 2 clearly shows the diminutive nature of the catchment that can flow to the subject site. What it doesn't show are the significant obstacles that flow must traverse in order to reach the subject site. Arguably the catchment size is not large enough nor concentrated enough to cause flood flow.

Figure 2: Site Location and Elevation



Along the northern boundary of the subject site on Marshall Avenue there is a sag point as shown in Figure 2 above (green is lower than yellow). An inlet pit is situated at the sag. Should pit inlet capacity be exceeded, or the pipe already be full from upstream sources (Pacific Highway sag and Marshall Lane), overland flow may eventuate and then flow between 2 and 4 Marshall Ave. The catchment continues to drain down Canberra Ave towards Berrys Creek approx. 500m downstream of the site.

Current Zoning

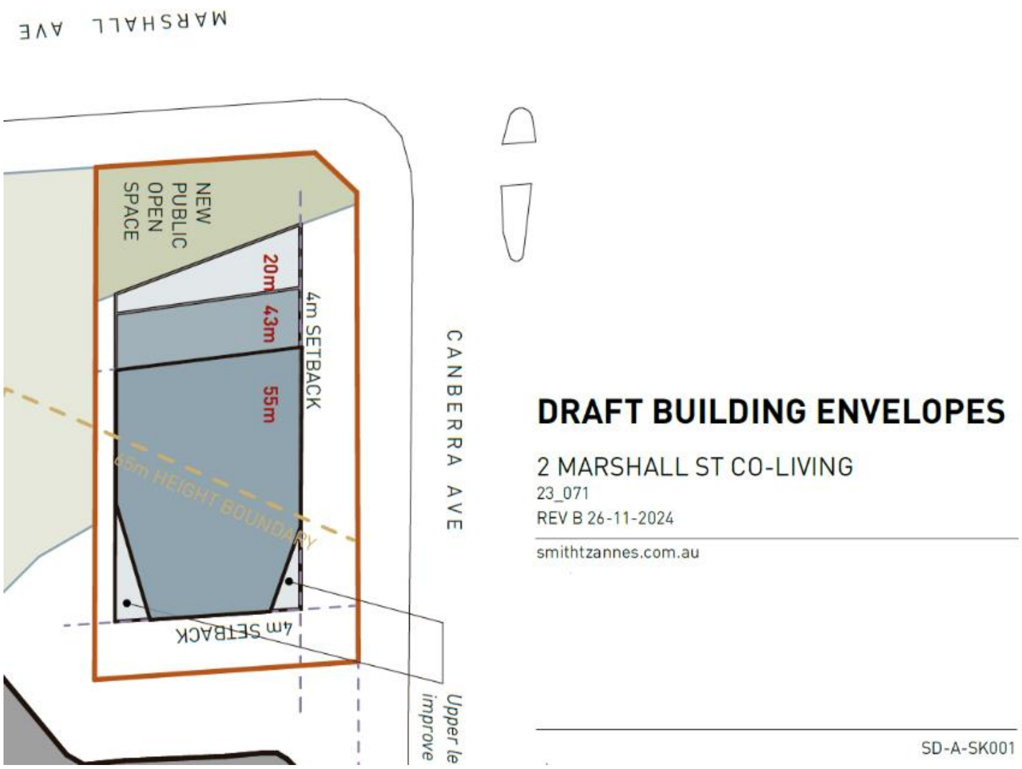
The site is zoned R4: High Density Residential (according to the NSW Planning Portal Spatial Viewer). High density residential apartment buildings are, at the time of writing, being built on the lots immediately to the south and west of the subject site.

Figure 3: Land Use Zoning for the Site (NSW Planning Portal Spatial Viewer)

Proposed Development

A new residential complex is being proposed at the site. The footprint of the current proposal is identified below (Smith Tzannes, 26/11/2024). GRC understands that the proposed development's interaction with the surrounding ground plane, including the position and elevation of pedestrian and car parking entrances, is yet to be detailed.

Figure 4: Draft Building Envelopes (Smith Tzannes, 26/11/2024)



The proposed footprint has an approximate area of 346 m^2 and the existing dwellings have a combined area of 245 m^2.

Relevant Policy

The *Lane Cove Development Control Plan (DCP, 2009)* stipulates the following requirement for flood studies in Section O.10.:

> *In situations where there is a known flooding problem, or there is a risk of stormwater inundation, a flood study of the catchment containing the development site will be required. The flood study shall be in accordance with current practice as outlined in Australian Rainfall & Runoff, and subject to the satisfaction of Council's Engineer.*

This assessment has been undertaken in accordance with this guidance.

Modelling Methodology

Existing design flood behaviour for the subject site is defined by hydrologic and hydraulic modelling developed as a part of the current study. This modelling is based on the use of a hydrologic model (DRAINS) to convert rainfall into runoff and then a hydraulic model (TUFLOW) to convert applied runoff into flood depths and levels. Both DRAINS and TUFLOW are commonly used in Australia for flood modelling and can be considered best practice.

Hydrologic Modelling

A hydrologic model was developed using DRAINS to convert rainfall into runoff for input into the hydraulic model using the methodologies outlined in the Australian Rainfall and Runoff guide for flood estimation (ARR1987). This process involves an analysis of the 68-hectare catchment surrounding the site. The following information was used in this model:

- Digital Elevation Model (DEM) based on LiDAR sourced from ELVIS, used to delineate the sub-catchments.
- Percentage impervious for each catchment based on aerial imagery;
- Bureau of Meteorology 1987 rainfall intensities;
- ILSAX model has been used with soil type 3;
- A retardance coefficient of 0.015 for impervious area and 0.04 for the remaining area.

The DRAINS model was run for a range of durations from 5 minutes to 180 minutes for the 1% AEP event. The critical duration assessment was performed in the hydraulic model and is further detailed in the section below.

TUFLOW Modelling

TUFLOW is a 2D numerical hydraulic modelling package. This software is widely used and is considered best practice under the NSW Floodplain Risk Management Program. It is used to convert applied flows from the hydrology model to derive flood depths, levels, and velocities.

The developed hydraulic model is comprised of the following elements:

- LiDAR data (Date: May 2020) has been used to generate a 2 m model grid. This data has a typical accuracy of ±0.15 m (1st confidence interval).
- The kerb/gutter and road crests are hydraulic features that have a significant impact on flood behaviour. As such these features have been represented in the model as break lines with invert heights determined by analysis of the LiDAR.
- Buildings can block flood paths and therefore impact flood behaviour. Accordingly, existing buildings in the vicinity of the subject site were blocked out of the TUFLOW model.
- The focus of this work is to describe the flood affectation of the land. As such, the existing house has been removed from the site in order to define its flood liability.
- Manning's 'n' roughness values were applied as follows
    a. Roads - 0.02;
    b. Dense Vegetation Area - 0.08;
    c. General Residential Area – 0.04
- Stormwater pits and pipes are not incorporated in the model. This is based on a conservative assumption that stormwater pipes are 100% blocked during a flood event.

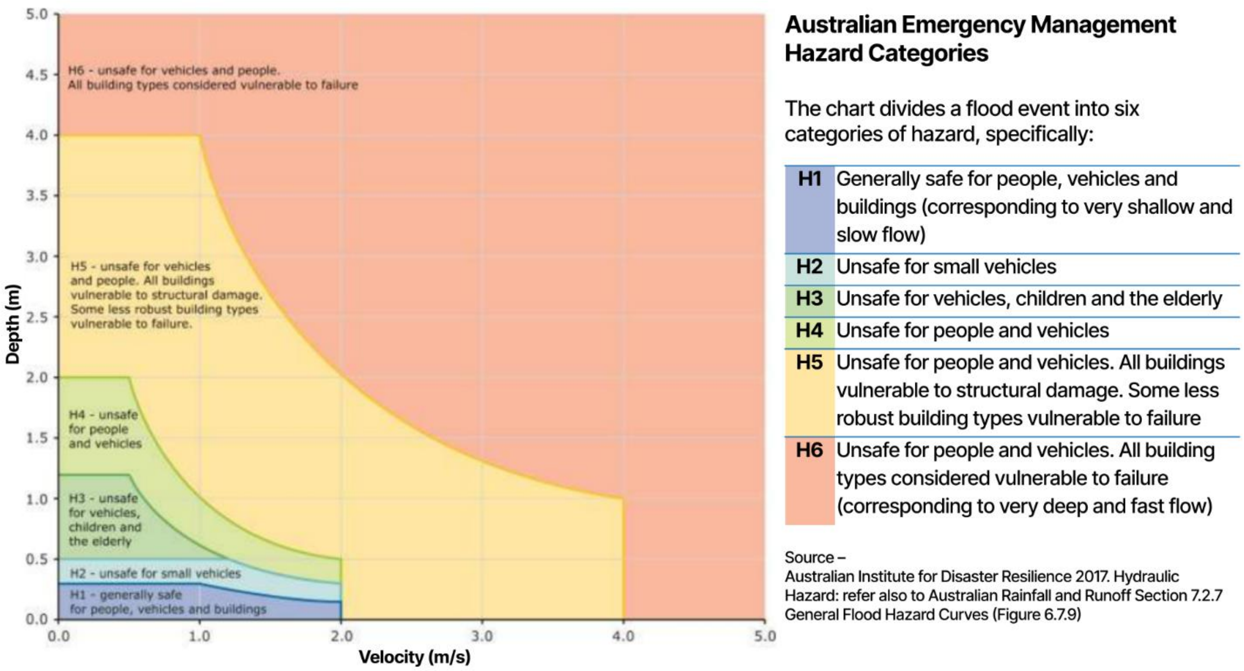
- A fixed tailwater was adopted approx. 500m downstream of the site (approx. 15 m lower than the subject site).

The critical duration assessment was undertaken in TUFLOW for the location of the subject site. The critical duration is selected as the duration producing the highest flood level. The assessment has resulted in a critical duration of 25 minutes for the 5% AEP and 1% AEP events.

Flood Hazard Categorisation

In terms of assessing flood hazard, the latest floodplain management practices use the hazard categories identified in the Australian Disaster Resilience Guideline 7-3 Flood Hazard (AIDR 2017) – see below. GRC has modelled and documented flood hazard in this assessment in accordance with these categories.

Figure 5: Hazard Categories Description

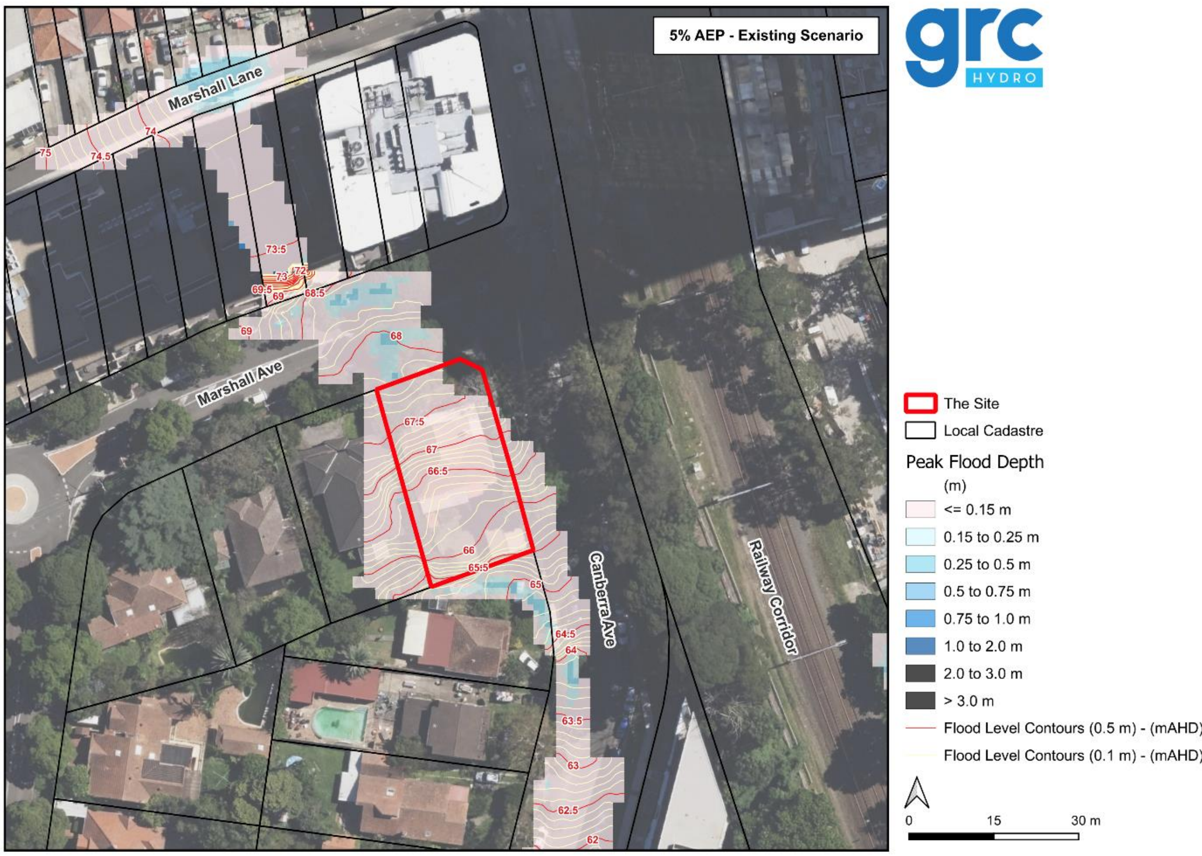


Existing Flood Behaviour

5% AEP

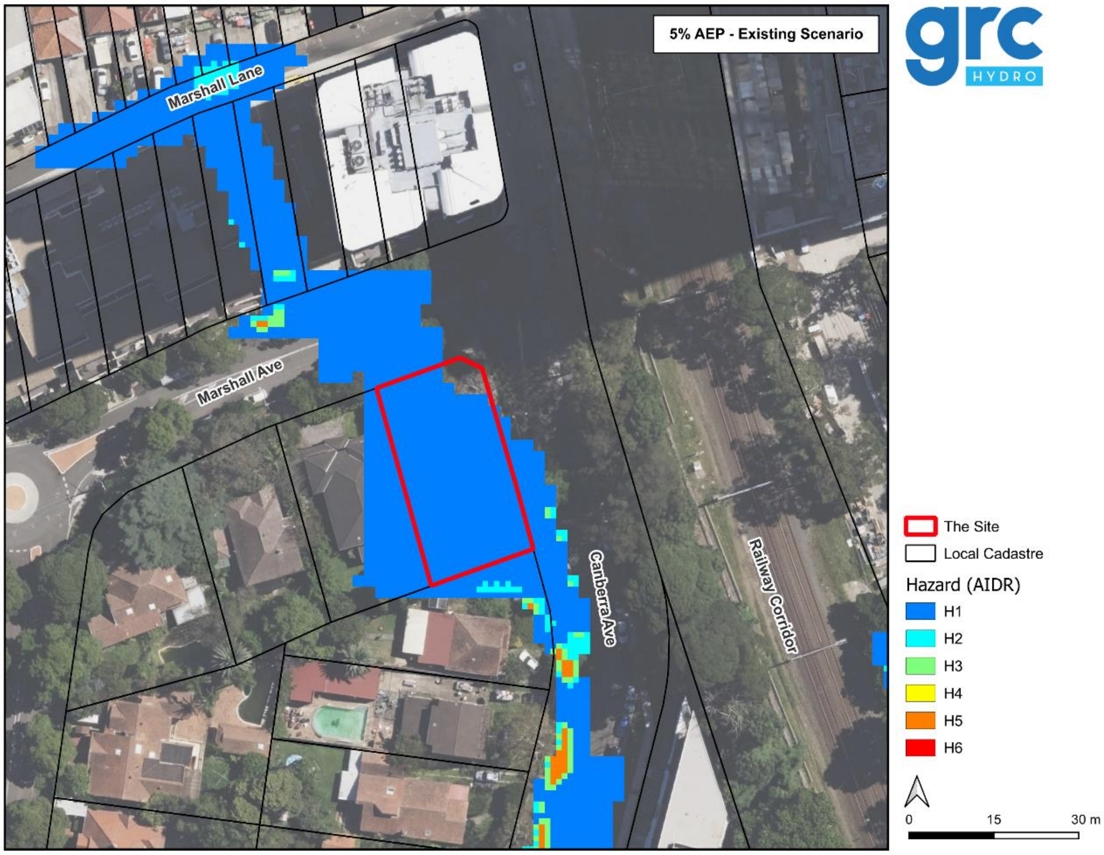
The design 5% AEP flood depths and levels for the existing conditions are presented in the figure below. Overland flooding at the site occurs when flows accumulate at the sag point along Marshall Ave and then spill south across the site to Canberra Ave.

Figure 6: Peak Flood Depths and Levels – 5% AEP – Existing Scenario



The site is subjected to shallow waters across the site. The depths at the site do not exceed 0.15 m thus would be precluded from being classified as major drainage flows as per the definition found in the 2005 NSW Floodplain Development Manual (FDM).

Figure 7: Flood Hazard – 5% AEP – Existing Scenario



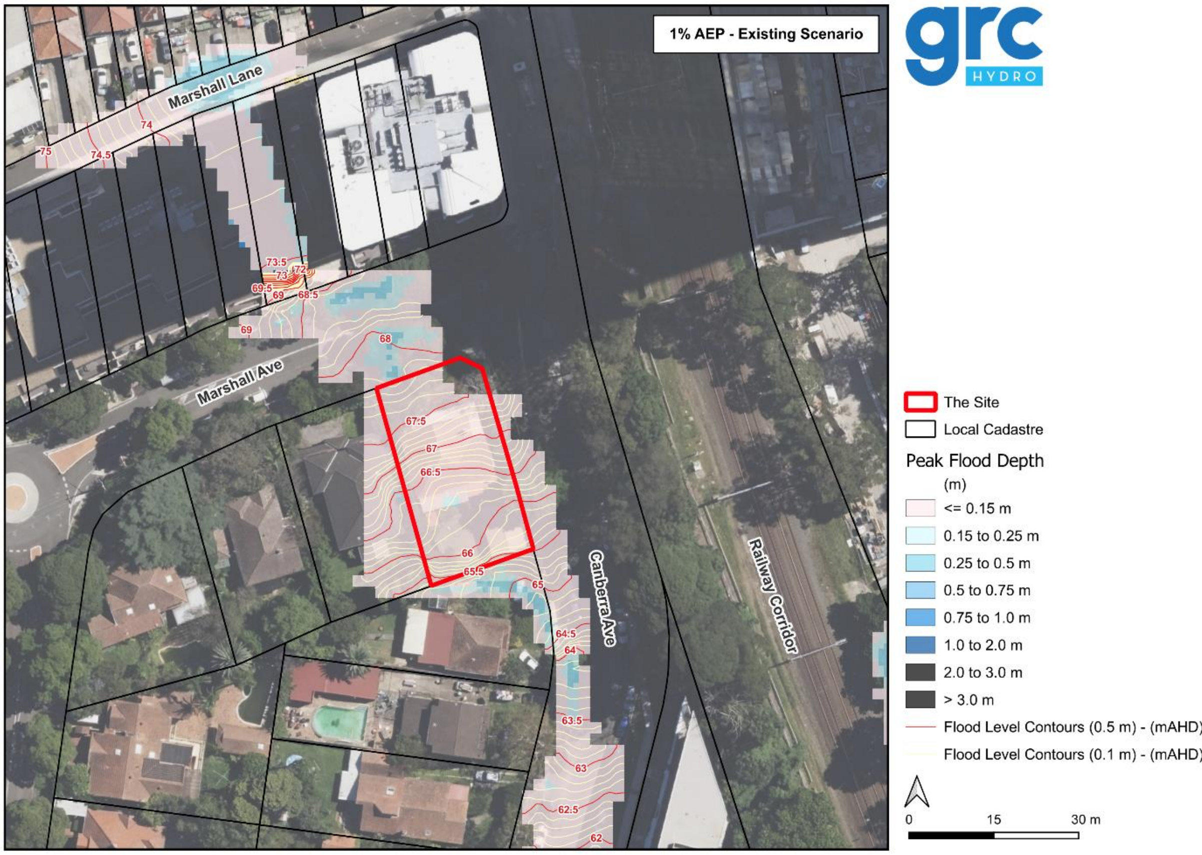
The flood hazard across the site is H1 – the lowest classification.

The flow magnitude at site is less than 1 m^3/s and could readily be addressed via installation of piped drainage.

1% AEP

The design 1% AEP flood depths and levels for the existing conditions are presented below. Overland flooding at the site occurs when flows accumulate at the sag point along Marshall Ave and spill southward across the site with a combined peak flow of 0.85 m^3/s.

Figure 8: Peak Flood Depths and Levels – 1% AEP – Existing Scenario

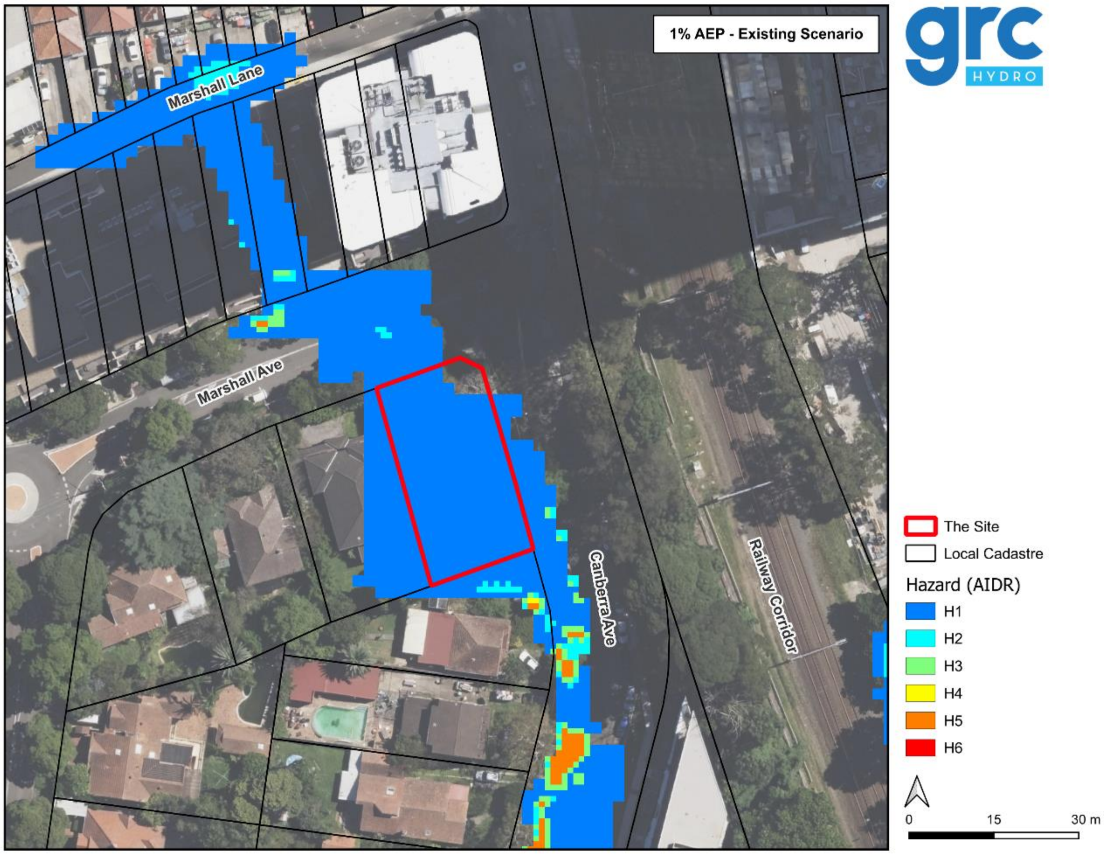


In this 1% AEP design event, the site is subjected to very shallow waters across the entire site. For the most part, the depths do not exceed 0.15 m with one small location in the middle that's 0.16 m.

The depth velocity product does not exceed 0.4 m^2/s at any location.

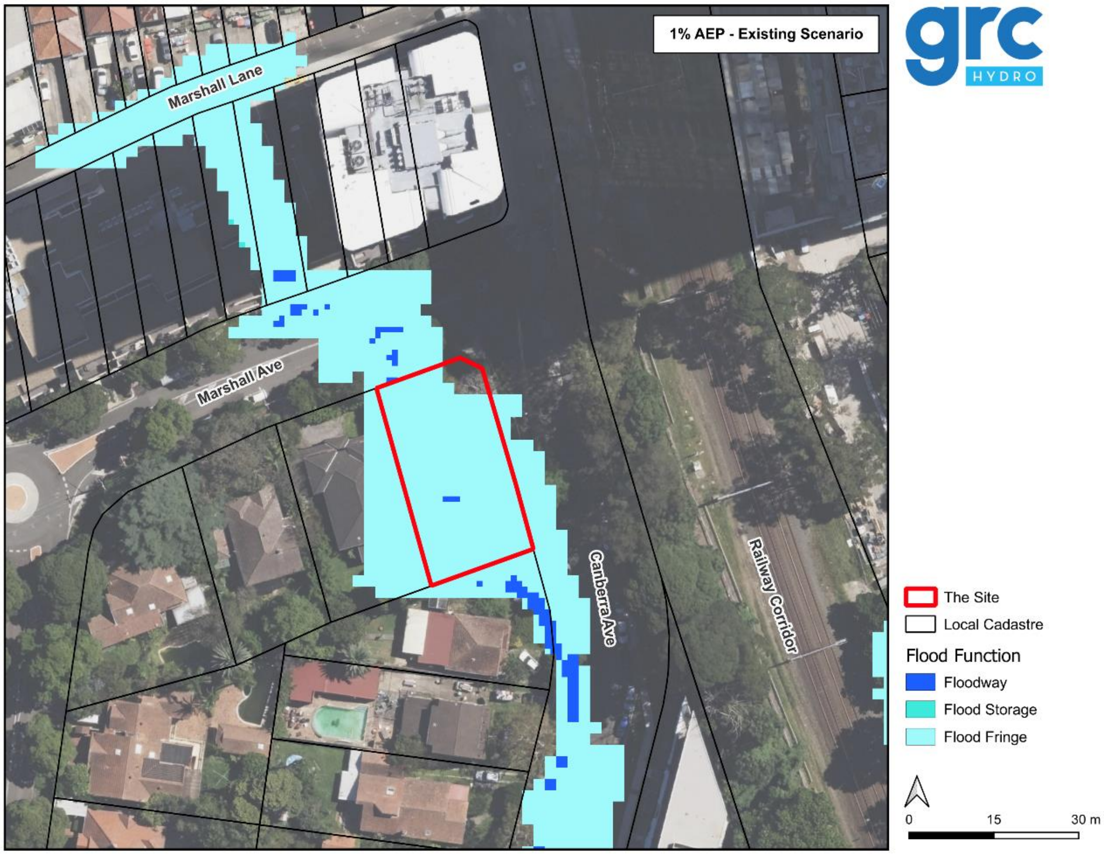
Overall then we see that flood depths and hazard have not increased from the 5% AEP to the 1% AEP event and this is indicative of an area impacted by drainage and not flooding. Note for example how the 5% and 1% AEP levels are for all intents and purposes identical. Locations that are flooded will see a significant difference between 5% and 1% AEP floods as the 1% AEP flood is 5 times less likely than the 5% AEP. For example in the Nepean River Valley the difference between the 5% and 1% AEP event is several metres. On the subject site that discrepancy is close to zero and certainly no more than 0.1 m.

Figure 9: Flood Hazard – 1% AEP – Existing Scenario



Across the entirety of the site, the flood hazard is H1 – the lowest classification.

Figure 10: Flood Function – 1% AEP – Existing Scenario



The flood function of the 1% AEP design event has been assessed according to the very conservative indicator technique that is presented in Howells et al., 2003 m (as per the guidance in the Department of Housing, Planning and Environment's Flood Function – Flood Risk Management Guide FB02). The site is accordingly classed as flood fringe.

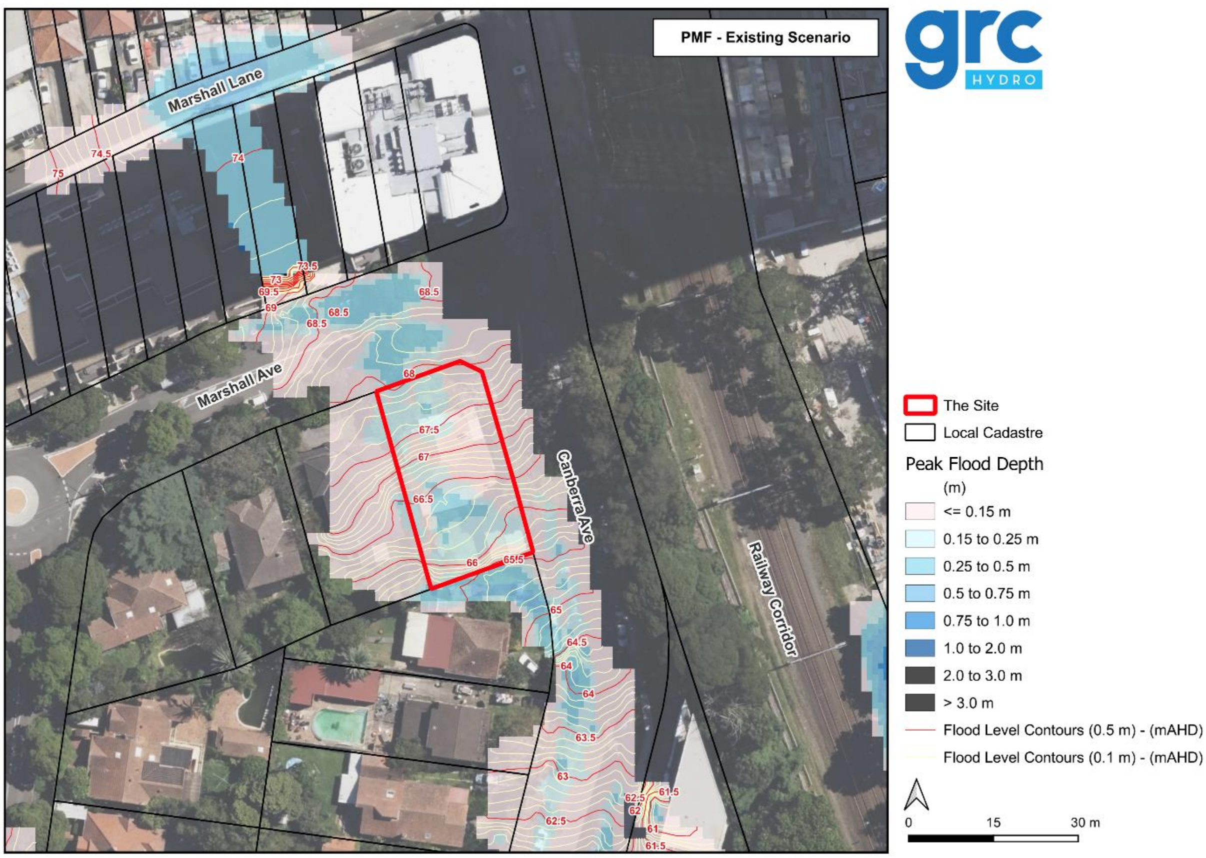
Probable Maximum Flood (PMF)

The design Probable Maximum Flood (PMF) flood depths and levels for the existing conditions are presented below. Flow is conveyed between 2 Marshall Ave and 1 Canberra Ave towards the western gutter along Canberra Ave, where floodwaters continue in a southerly direction.

For context, the Probable Maximum Flood is defined by the NSW State Emergency Services as follows:

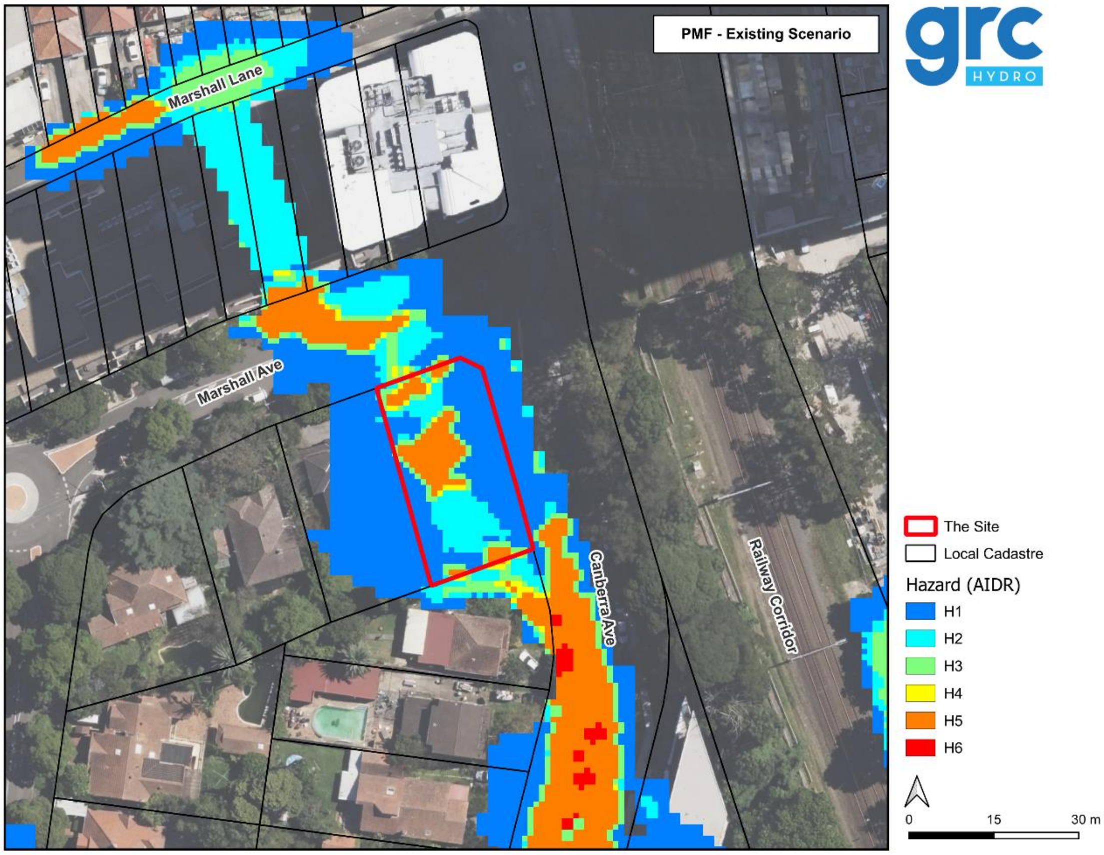
> *Probable Maximum Flood (PMF). The largest flood that could conceivably be expected to occur at a particular location, usually estimated from probable maximum precipitation. The PMF defines the maximum extent of flood prone land, that is, the floodplain. It is difficult to define a meaningful Annual Exceedance Probability for the PMF, but it is commonly assumed to be of the order of 10^4 to 10^7 (once in 10,000 to 10,000,000 years).*

Figure 11: Peak Flood Depths and Levels – PMF – Existing Scenario



In this PMF design event, the site is subjected to relatively shallow waters across the entire site. For the most part, the depths remain below 0.25 m and peak at 0.35 m deep in the centre of the southern portion of the site.

Figure 12: Flood Hazard – PMF – Existing Scenario



In the PMF event, the centre of the site is predicted to experience H5 hazard.

Compliance with Relevant Policy

Lane Cove Council details relevant flood related development controls in *Part O – Stormwater Management, Section 9 (Hydrology and Hydraulics)* and *Section 10 (Stormwater Inundation) of the Lane Cove Development Control Plan (DCP, 2009)* as follows:

1. In situations where there is a known flooding problem, or there is a risk of stormwater inundation, a flood study of the catchment containing the development site will be required. The flood study shall be in accordance with current practice as outlined in Australian Rainfall & Runoff, and subject to the satisfaction of Council's Engineer.
   This flood assessment has been undertaken in accordance with this guidance.

2. Development Applications on land that is subject to overland flow must give due consideration to the manner in which the proposed work will affect the free passage of overland flow through the property. The development is not to create or aggravate hazardous overland flow conditions.
   The proposed development, which is currently undergoing design amendments, will seek to mitigate flood affectation at the site and in the surrounding area.

3. Finished floor levels must be set at least 150 mm above the adjacent ground levels. Where it is proposed to build in an area known to be affected by overland flow, all spaces are to have a

minimum freeboard of 300mm above the calculated top water level for the 1 in 100-year ARI storm event. Freeboard may need to be increased to 500mm or greater where there are high flowrates, high flow depths or low confidence in the accuracy of the flood model.
The finished floor levels for the proposed development will be elevated in accordance with this guidance. This will be confirmed as detailed design progresses.

4. To prevent pedestrians being swept into overland flowpaths, the depth velocity product of overland flowpaths which are accessible to pedestrians should not exceed 0.4 m^2/s. Where vehicles alone are affected the depth velocity product of 0.6 m^2/s will be permitted.
The majority of the site is subject to flows less than 0.4 m^2/s in the 1% AEP event. Pedestrian areas will be restricted to areas with depth velocity product rates less than this. Accordingly, vehicle routes will be restricted to areas with depth velocity product rates less than 0.6 m^2/s.

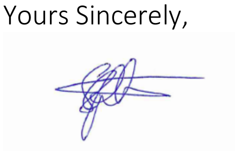
Conclusion

The flood affectation at 2 Marshall Ave, St Leonards has been assessed under existing conditions. 1% AEP flows from the 2.3-ha catchment are in line with GRC's expectations based on our work assessing hundreds of sites around the Sydney metropolitan area.

In a 1% AEP event, the site is subject to minor flooding with the bulk of the site subjected to waters shallower than 0.15 m in depth. This is traditionally not categorised as flooding. The PMF does show higher depths of flood waters and high levels of hazard but given the extremely low probability of the PMF, the fleeting nature of it and the fact that even modestly elevated floor levels will be suitable mitigation of PMF risk, this is manageable.

The site is presently zoned R4: High Density Residential. Whilst the proposed development would result in an increase in density and footprint, the development, in concert with the introduction of public open space immediately to the west of the subject site, offers an opportunity to safely manage the downstream passage of flows which may result in an improvement of flood affectation at, and downstream of the site.

Yours Sincerely,



Steve Gray

Director

Email: gray@grchydro.com.au

Tel: +61 413 631 447

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