NEILLY DAVIES & PARTNERS PTY LTD
ABN 71 121 623 550

Level 3, 55 Chandos Street
St Leonards NSW 2065

PO Box 370
ST LEONARDS NSW 1590

Phone (02) 9438 1515
Fax (02) 9438 5546

Email info@neillydavies.com.au
Web www.neillydavies.com.au

Flood Assessment Report
Job No. S14311

5 Rynan Avenue
Edmondson Park 2174
15 August 2014

Prepared for:

JOSHUA FARKASH & ASSOCIATES PTY. LTD

Contents

Neilly Davies Document control			
Version	**Created / Amended by**	**Date**	**Checked by**
A	**Daniel Ghashghaie**	**28/07/2014**	**Bala Muhunthan**

1. Introduction

As requested an investigation by the hydraulic engineer was performed at 5 Rynan Ave, Edmondson Park. This is a report that has been prepared to assess the impact of the proposed development on the adjoining creek (Cabramatta creek) flood behaviour, specifically on the overflow and flood level of the surrounding area. This assessment has been carried out based on information provided by the client including the survey report of the property, information about Cabramatta creek catchment including peak flow estimate of the creek which is extracted from Cabramatta Creek Floodplain Management Study & Plan by Bewsher Consulting and Contour and Flood Plans provided by Liverpool City Council.

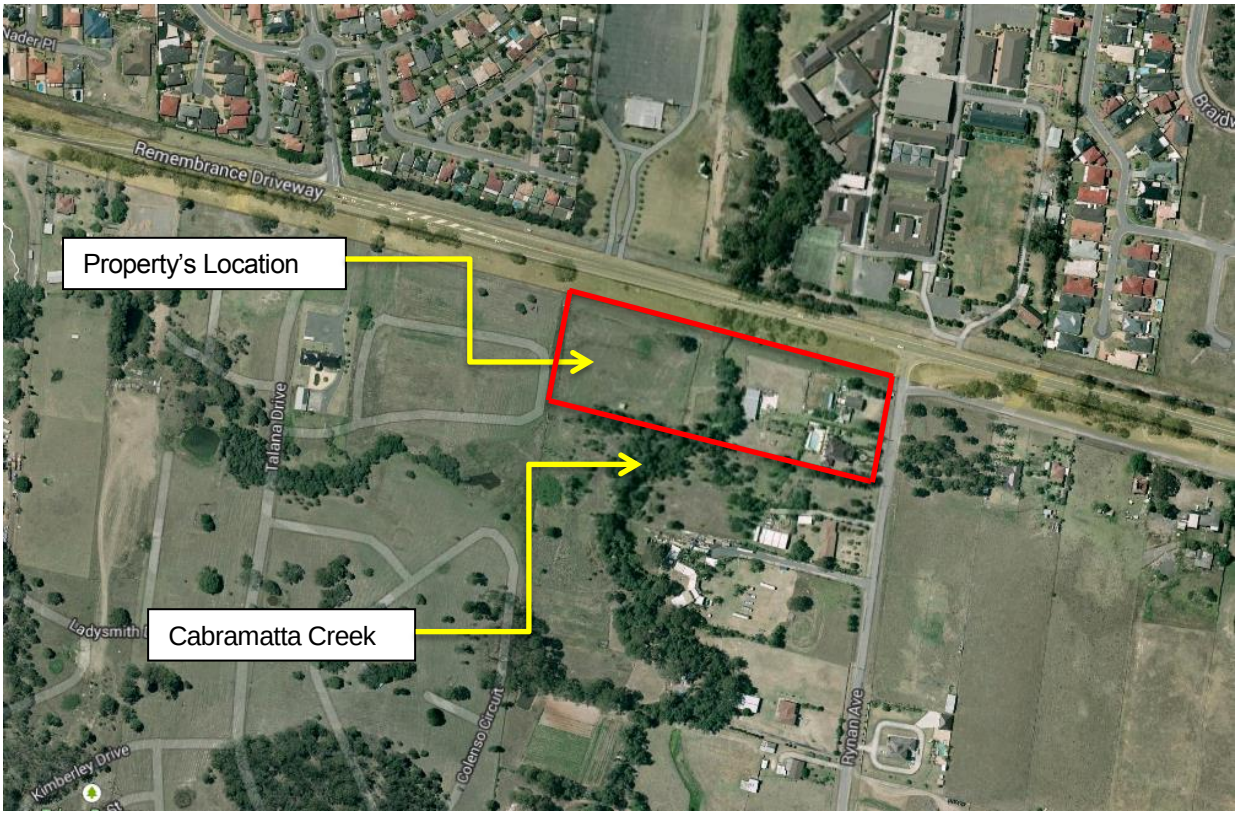


Figure 1 – Location Plan

As it is shown in the aerial view (Figure 1), Cabramatta Creek is crossing the property and dividing it into two almost equal parts. The creek catches stormwater of the entire catchment and conveys the water to the Georges River. A flood study has been undertaken to identify the reach

and depth of overland flows associated with the creek to assess the impact of the proposed development on such flows and vice versa.

The existing residential property at 5 Rynan Ave, Edmondson contains a one story dwelling at north-east of the property and a two story dwelling at south-east of the property. The proposal is to subdivide the entire area which is about 20,000 sqm to two main subdivisions. A multi-level development will be built on the eastern subdivision and the western subdivision will be sub-divided in to 7 lots for residential villas.

The main focus of this report is on the residential villas which are located on medium risk flood area while the multi-level development is not located on a flood affected land and therefore flood assessment is not required to be conducted for this part of development.

2. Findings & Discussion

A comprehensive flood study as per Liverpool council requirement has been conducted to find out whether the proposed development will have adverse effects on the flow rate and flooding of the adjoining creek. A part of Cabramatta creek reach with the length of about 450m, starting 200 m away from southern boundary of the property and ending 200 m after the property's northern boundary including the surrounding local catchment has been modelled and the results of hydraulic analysis have been used to identify the compliance of development with standard provisions. Modelling of the local catchment surrounding the property has been done using Hec-Ras software with land elevation contour lines taken from survey drawings provided by the property owner.

2.1. Site context

Proposed development located alongside Camden Valley Way and at the west side of Rynan Avenue. As it is illustrated in figure-2 extracted from the Cabramatta Catchment Flood Study provided by Liverpool council (refer to Appendix- 5) the development site is close to southern boundary of Cabramatta catchment. Based on the Liver Pool City Council Flood Map (Appendix-1) the development site has been subjected to different flood hazard zonings from high flood risk in proximity of the creek bank to non-affected area to the east end of the site. The western

subdivision which is the main subject of this report is located in medium flood risk category. The planning matrix proposed by Cabramatta Creek Flood management Study identified the high flood risk areas unsuitable for residential or commercial land use, however the medium flood risk area can be developed under specific conditions which will be described later on in this report.

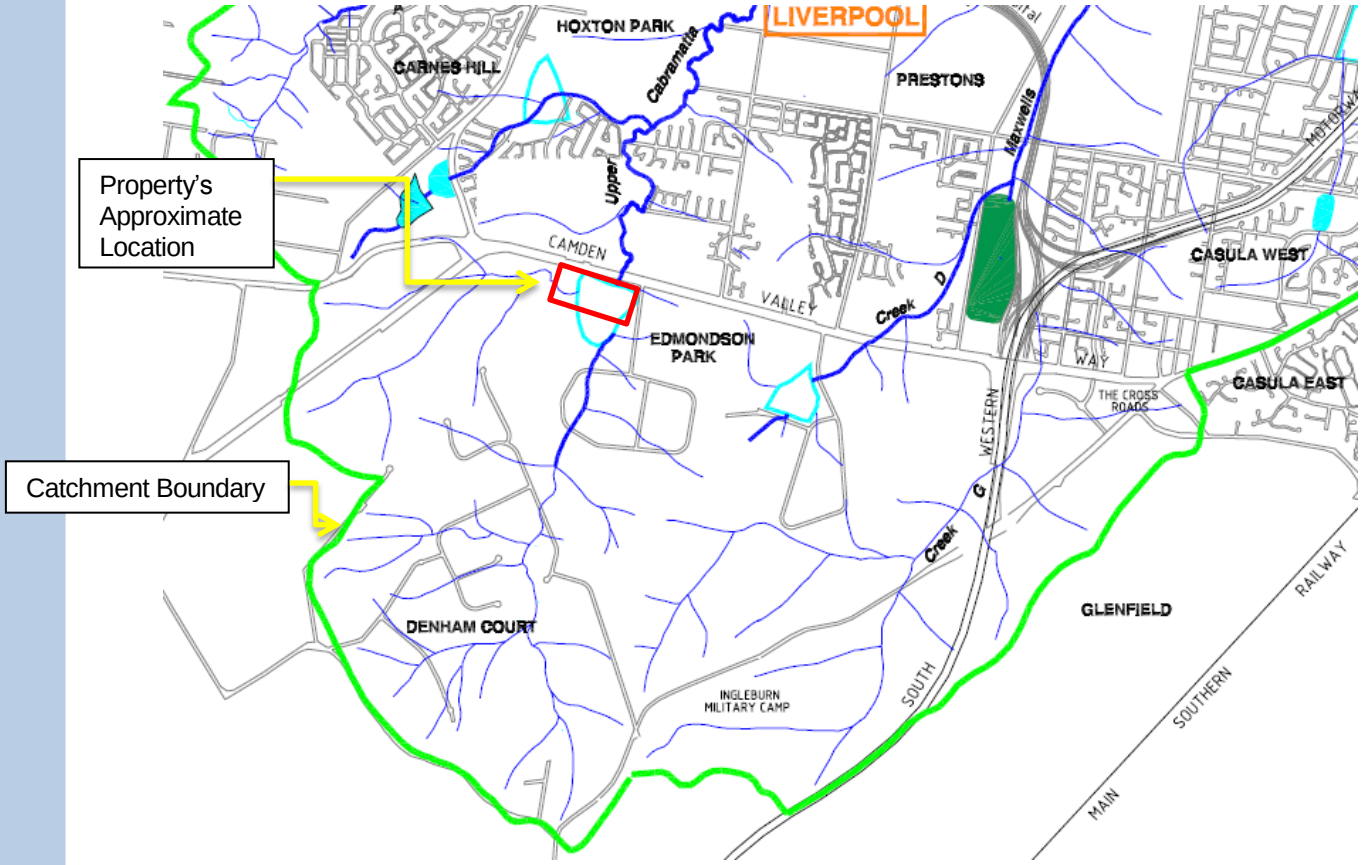


Figure 2 – Cabramatta Creek Catchment

2.2. Catchment Hydrology and Hydraulics

Cabramatta Creek is a major tributary of the Georges River, located in the south-west of the Sydney Metropolitan region. The catchment has an area of 74 km2. It is bordered roughly by the South-Western Freeway and the Hume Highway in the east, Denham Court in the South, Sydney Water's "Water Race" at West Hoxton in the west, and the suburbs of Cabramatta, Mt. Pritchard, Heckenberg, Busby, Hinchinbrook, Green Valley and Cecil Hills to the north as it is shown in Appendix-2 (A part of the catchment in the vicinity of the site has been shown in Figure-2).

Based on the flood study conducted by Bewsher Consulting and provided by Liverpool council, peak flow discharge for the portion of the creek in the vicinity of the property for various flooding events has been tabulated in Table-1. These figures have been used in the hydraulic modelling of a local catchment containing the project site. Peak flow estimates for the entire length of Cabramatta Creek can be found in table B.1 of Appendix-5.

Table 1 – Cabramatta Creek Peak Flow Estimate

Sub catchment Description	100 YEAR		20 YEAR		PMF	
	Flow	Crit. Dur.	Flow	Crit. Dur.	Flow	Crit. Dur.
(min)	(m^3/s)	(min)	(m^3/s)	(min)	(m^3/s)	(min)
Cam Valley Way	94	120	67	120	403	60
Cabramatta Creek	95	120	68	120	404	60

2.3. HEC-RAS Model of Cabramatta Creek

A HEC-RAS model has been created to find out the precise circumstances of overland flow. The exact survey data has been taken from the survey model and imported to HEC-RAS to create this model.

HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. The program was developed by the US Department of Defence, Army Corps of Engineers in order to manage the rivers, harbors, and it has found wide acceptance by many others since its public release in 1995.

HEC-RAS model has been created for two scenarios, Pre-development scenario which demonstrates the existing condition of creek and flooding levels and post-development scenario which shows the flooding levels and impact of development on Cabramatta River flood behaviour at the location of the proposed development and also downstream and upstream lands. In this model it is assumed that the entire western subdivision land up to the proposed line of subdivision has been raised or blocked against overland flow and subsequently the natural floodplain storage reduced.

The result of the analysis which demonstrates the exact stormwater flow level has been tabulated in Appendix – 3 of this report and discussed in detail in the following paragraphs.

2.4. Modelling Results

Results of flood analysis shows that the maximum water level at the existing condition at the location of the development can reach to 40.88 m with respect to Australian Height Datum (AHD) for a storm with 20 year ARI and in extreme condition during 100 year ARI flooding event it will reach 41.02m. These maximum flood levels are measured at the northern boundary of the property, water level decreases as we travel towards South of the property. We will have maximum water depth of about 1.3 m over the western subdivision area close to the creek boundary.

Proposed development will result in increase in flood level by only 60mm during 20 year ARI storm so flood level will reach 40.94m. The effect of development on 100 year ARI storm is slightly more and will increase the water level to 41.11m which is 90 mm higher than the existing flood level.

Cross sections of the property and flood levels after and before the development are shown in drawing S03 & S04 in Appendix 4 of this report. Flood levels of both scenarios for 20 and 100 year ARI storm events has been marked and compared in these drawings. In addition a Site Plan showing the centre line of the water channel and 100 year flood line along with footprint of the proposed development are illustrated in drawing S01 which is in Appendix 4 of this report.

The hydraulic analysis results for both scenarios which were modelled by Hec_Ras have been illustrated in Appendix 3. A brief summary of flood levels and velocities has been tabulated in Table-2 to facilitate comparison of these results for pre-development and post-development scenarios.

Table 2 – Summary of Flood Modelling results

	Location	20 ARI		100 ARI	
		Flood Level	Velocity	Flood Level	Velocity
Pre-Development	Ch 2+50 (Close to Southern boundary)	40.87	0.85	41.01	0.98
	Ch 2+10 (middle of propert)	40.83	1.12	40.95	1.29
	Ch 1+80 (Close to Northern Boundary)	40.80	0.93	40.92	1.08
	Ch 1+70 (Downstream Boundary)	40.80	0.81	40.92	0.95
Post-Development	Ch 2+50 (Close to Southern boundary)	40.93	0.86	41.10	1.01
	Ch 2+10 (middle of propert)	40.86	1.34	41.00	1.65
	Ch 1+80 (Close to Northern Boundary)	40.79	1.41	40.98	1.76
	Ch 1+70 (Downstream Boundary)	40.78	1.25	40.95	1.55

2. 3. Flood Risk Management Requirements

The Floodplain management policy which has been introduced by Cabramatta Creek Floodplain

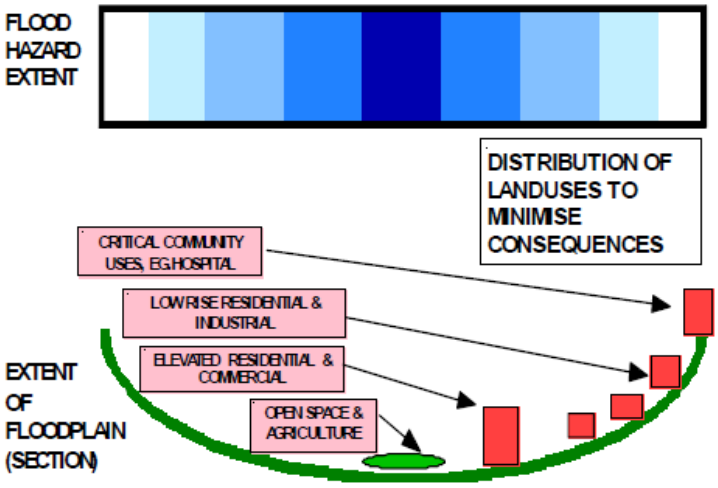


Figure –3 Distributing Land Uses under the Planning Matrix Approach
Using this approach, a matrix of development controls, based on the flood hazard and the land use, can be developed which balances the risk exposure across the floodplain

Management Study, proposes the following planning matrix approach.

Based on this approach following requirements for residential developments in medium flood risk areas shall be satisfied:

Requirements	Comments
Habitable floor levels to be no lower than the 100 year flood level plus freeboard.	Based on conducted study the 100 year average flood level will be 41m (Appendix-1)
Non-habitable floor levels to be no lower than the 20 year flood unless justified by site specific assessment.	Based on the conducted study the 20 year average flood level will be 40.86m (Appendix-1)
A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the under croft area is not to be enclosed.	To be considered in sub-division design
Freeboard equals an additional height of 500mm.	Based on the minimum required free board, the minimum allowable floor level has been given in Table-3
Engineer's report to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus freeboard, or a PMF if required to satisfy evacuation criteria (see below).	To be considered by the Structural Design Engineer.

The flood impact of the development to be considered to ensure that the development will not increase flood effects elsewhere, having regards to: (I) loss of flood storage; (II) changes in flood levels and velocities caused by alterations to the flood conveyance; and (III) the cumulative impact of multiple potential developments in the floodplain. An engineer's report may be required.	Loss of flood storage wouldn't be significant. Flood levels and velocity of some points of local catchment has been shown in Table-2. According to conducted modelling and analysis of local catchment maximum increase in flood level for 100 year ARI flood event will be 90mm and maximum change in velocity will be 0.68 m/s.
The minimum surface level of open car parking spaces or carports shall be as high as practical, but no lower than the 20 year flood or the level of the crest of the road at the location where the site has access. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 20 year flood.	Based on the current study the 20 year average flood level will be 40.86m (Refer to table-3 for more detail) this level should be considered when designing driveways and garages.
Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year flood.	Proper consideration shall be taken in design.
The level of the driveway providing access between the road and parking space shall be no lower than 0.3m below the 100 year flood or such the depth of inundation during a 100 year flood is not greater than either the depth at the road or the depth at the car parking space. A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.	To be considered in driveway design.
Enclosed car parking and car parking areas accommodating more than 3 vehicles (other than on Rural zoned land), with a floor level below the 20 year flood or more than 0.8m below the 100 year flood level, shall have adequate warning systems, signage and exits.	To be considered in driveway and garage design.
Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year flood.	To be considered in driveway and garage design.

Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF level, or a minimum of 20% of the gross floor area of the dwelling to be above the PMF level.	Refer to appendix-4 plan S03 & S04 and also Table-3 for minimum habitable floor level and appendix-3 for PMF levels
The development is to be consistent with any relevant flood evacuation strategy, Flood Plan adopted by Council or similar plan.	Flood warning and evacuation procedures shall be considered in design.

3. Overview and Recommendation

As it has been stated above a hydraulic model of subject development has been prepared and analysed considering the catchment hydrology and the existing water bodies surrounding the property. As a result of this study the depth and velocity of the overland flow were identified and have been presented in Appendix 3 and 4 along with a plan of the property and sections along the property. The provided cross sections of the proposed development is showing the anticipated flood level for 100year ARI and boundary of the proposed subdivisions.

Based on the above mentioned investigations and council risk management requirements it appears that it is possible to build residential villas in the western subdivision area however proper action shall be taken to avoid inundation and flooding of the dwellings. In order to do so the following recommendations have been made:

1- **Change of subdivision boundary location**

The northern corner of residential subdivision (dwelling No 2B) is located in high flood risk area. As per council flood management plan any construction in this area is prevented so the subdivision design needs to be amended to avoid building over high flood risk area. (Refer to appendix-4 S01)

Table 3 – Minimum Habitable Floor Requirements

Lot No	100 ARI Flood Level	PMF Flood Level	Minimum Habitable FloorLevel
1A	40.92	42.1	41.42
2A	40.92	42.1	41.42
3A	41.06	42.37	41.56
2B	40.9	42.09	41.4
3B	40.92	41.08	41.42
2C	40.95	42.14	41.45
2D	41	42.21	41.5

2- Filling of development area:

Filling of low positioned land can be considered to raise the land above designed flood level so that it can be developed. The minimum habitable floor level for each subdivision lot has been tabulated in Table-3; these figures can be used to calculate the required earthwork quantity and gradient of land in subdivision design.

Filling of the subdivision area will result in the natural flood storage of area being lost and downstream flood behaviour might be impacted. Based on conducted analysis over local catchment area the flood level of the creek for 100 year ARI flooding event at the location of the site's downstream border will be increased by 30mm and reaches to 40.95m and flow velocity will increase to 1.5m/s which is 0.6 m/s more than the current flow velocity at the point.

Due to the existence of a culvert immediately downstream the site which is conveying the stormwater under the Camden Valley Way, alteration in floodplain size and storage volume at the site location will not have considerable effect on downstream flood behaviour. The culvert acts as a control structure to limit the flow discharge and controls flood levels downstream.

In addition upstream flood level will be impacted by land fill. The extent of impact would be up to 100 m from the property's southern boundary and the average increase in flood level will be 67mm which seems to be tolerable. The flood levels at the property location, downstream and upstream have been tabulated in more detail and provided in Appendix-4 of this report.

3- Construction of Levees

In some cases where filling of the land is not possible or extensive amount of earthwork is required, Levees can be used to prevent flooding of populated areas on the floodplain. Erection of proper levee on proposed subdivision boundary can reduce the designed flood level and depth of filling. However construction of levee on proposed line of western subdivision will have similar effect on flood behaviour at downstream and upstream of development site as it was described in recommendation-2. To reach sufficient level of protection a proper levee needs to be designed and specified by engineer. We can provide a proper design in construction stage if requested.

4- construction of flood retaining walls

A proper Flood Retaining Wall can be designed and erected on subdivision boundary to reduce the impact of flooding. This retaining wall will be similar to levees in function and the same condition shall be applied.

5- Consideration of Onsite Detention

To ensure that downstream peak flow rates are not increased as a result of the proposed development a proper Onsite Detention shall be designed and built to control the discharge rate of stormwater to Cabramatta creek. The total post-development stormwater discharge rate of the site should remain the same as existing pre-development discharge rate.

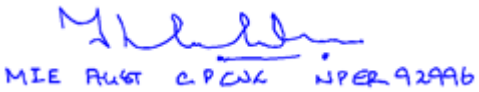
In summary one or a combination of the above recommended actions can be considered to comply with design flood level and eliminate the chance of flooding on proposed developments while minimising the impact of development on Cabramatta creek flood behaviour.

In accordance with accepted engineering practice, a flood study of the local catchment has been undertaken and potential impact of the proposed development on catchment flood behaviour has been analysed and explained in detail in this report however relevant local authority needs to

review and confirm whether dimensions of this impact on the area of the catchment adjoining to the property is acceptable.

If you have any queries or need further clarification, please do not hesitate to contact this office.

Yours faithfully,



Dr Bala Muhunthan
B.Sc., (Hon) Civil Eng., M. Eng. Sc., PhD, FICE, FIE Aust., CP Eng. NPER