Level 1, 215 Pacific Highway Charlestown NSW 2290
PO Box 180 Charlestown NSW 2290
T (02) 4943 1777 F (02) 4943 1577
E newcastle@northrop.com.au

7 September 2017

Canal Aviv Pty Ltd
c/- Simon Degaris
Self Storage Investments Pty Ltd
Level 13, 135 King Street
SYDNEY NSW 2000

Dear Simon,

RE: Proposed Self Storage Facility, 1-3 Ricketty Street, Mascot

Northrop Consulting Engineers Pty Ltd has been engaged to undertake engineering design and flood modelling for the proposed self-storage development at Mascot on Lots 24 and 25 DP 515070, otherwise known as 1-3 Ricketty Street.

The purpose of this letter is to summarise the results of the development level flood study for a Development Application submission to Bayside Council. This flood investigation has been undertaken to determine the impact of the development on local flood behaviour.

Included in this letter is and assessment of the upstream catchment, methodology utilised to undertake the assessment, summary of the results, and discussion of the implications for the development.

This assessment has been undertaken in accordance with the following guidance documents:

- NSW Floodplain Development Manual (2005); and
- Australian Rainfall and Runoff (1987).

Catchment

The site is affected by flooding from two sources: the local catchment to the east and from Alexandra Canal.

Flooding from Alexandra Canal has been previously characterised in the Alexandra Canal Model Conversion (BMT WBM, 2016). The catchment is bounded by Southern Cross Drive and Moore Park Golf Course to the east, Sydney Park and King Street to the west, and Redfern Railway Station up to approximately Wade Park and Albion Street to the north. The catchment is highly urbanised with a mix of residential, commercial, industrial and open space land uses. Modelling extends down the canal to just upstream of the subject site and results obtained from this location are used in this assessment as the upstream boundary condition.

The local catchment extends to the east to between Bourke and O'Riordan Streets and covers an area of approximately 44 hectares. This catchment is also highly urbanised and can be characterised as industrial with a majority of surface area being impervious and only small pockets of pervious landscaped areas.

Prepared	JF	30/08/2017
Reviewed	GB	31/08/2017
Admin	LD	31/08/2017

Methodology

The analysis was undertaken generally in accordance with the methods described in Australian Rainfall and Runoff 1987 Guidelines (ARR 1987). The decision not to consider the Australian Rainfall and Runoff 2016 Guidelines (ARR 2016) was made for consistency with the previous modelling undertaken as part of the Alexandra Canal Model Conversion (BMT WBM, 2016).

The XP-STORM software which features the TUFLOW finite difference computational engine was used to establish a flood model and analyse the proposed development scenario.

The 1% AEP 25 minute and two hour storm events were considered for this assessment. The PMF level has been obtained from the BMT WBM report.

Northrop have established a two-dimensional (2D) flood model to characterise flood water behaviour within site and the surrounding local catchment to determine the impact the proposed development has on local flood behaviour.

Hydrological Model Establishment

Temporal patterns were obtained from the Bureau of Meteorology (BoM) and the Alexandra Canal Model Conversion (BMT WBM, 2016), as it is the most recent flood study covering this area.

For the Alexandra Canal catchment, a hydrograph was extracted from the modelling associated with the Alexandra Canal Model Conversion (BMT WBM, 2016). This was inserted approximately 500 metres upstream of the development site. The inflow hydrograph is representative of the two hour storm event and is shown below in Figure 1.

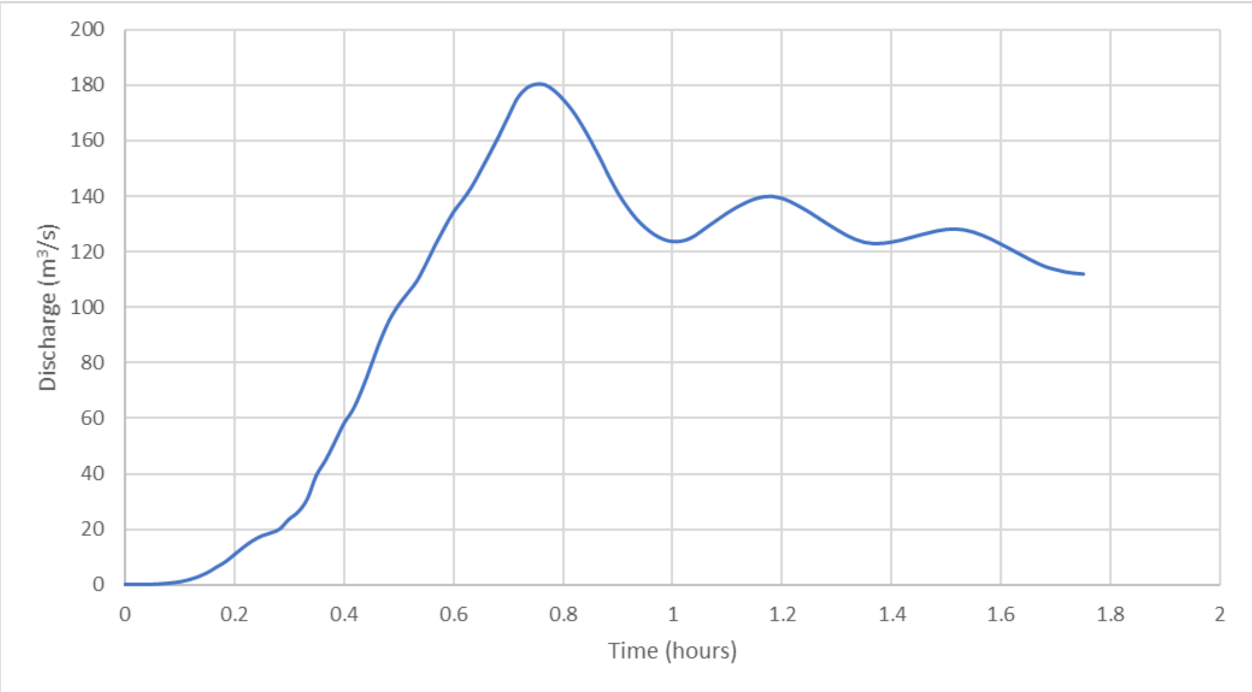

Figure 1 – Alexandra Canal Inflow Hydrograph

For the local catchment, a rainfall on grid approach was adopted for the hydrological model. The two hour storm rainfall is applied directly to the 2D grid and allowed to flow according to the local topography. This has the benefit of not needing to delineate sub-catchments based on engineering judgement and allowing for flow between sub-catchments when significant ponding and overland flow occurs. Rainfall characteristics were obtained from the BoM.

Hydraulic Model Establishment

Hydraulic model inputs include terrain, boundary conditions, Manning's roughness values, structure details, stormwater infrastructure and blockage values.

The 2D hydraulic model is constructed using a 3 m x 3 m grid cell sizing. A one second timestep is adopted to balance model stability and run times.

The digital elevation model (DEM) is based on LiDAR 1 m grid data collected in 2008 and ground survey obtained as part of the development of the site in 2017. For the proposed development, surface level changes were modelled in 12d and imported to the hydraulic model.

The boundary conditions adopted for the design 1%AEP event include the flow hydrograph as described above, and the tailwater level at the downstream extent of the Alexandra Canal Model Conversion (BMT WBM, 2016) at 2.5m AHD.

However, due to the nature of flooding in the local area originating from both Alexandra Canal and/or the local catchment runoff, two additional cases are considered: a low tailwater level (0.7 m AHD) combined with a 1% AEP rainfall event, and an elevated tide level (maximum 2.5 m AHD) with no rainfall. This ensures that the impact assessment for this proposed development covers a range of possible flooding scenarios.

Manning's roughness values adopted are summarised below in Table 1.

Table 1 - Manning's Roughness Values

Surface Type	Constant / Variable	Roughness Value
Roads	Constant	n = 0.02
Canal	Constant	n = 0.018
Buildings	Variable	d < 0.15m, n = 0.015 d > 0.15m, n = 0.300
Developed lots	Constant	n = 0.04

The depth varying roughness for buildings is intended to simulate the direct rainfall on roof tops quickly flowing onto the adjacent ground levels but also allowing for adequate behaviour of overland flows interacting with buildings by either slowly passing through or being diverted around the structure.

Structures within the local catchment, including the existing and proposed buildings within the development site are modelled with raised elevations of 600 mm to simulate flood waters initially being diverted around the structure. However, once flood waters exceed the 600 mm depth it begins to flow through the structure, simulating flows through doorways and windows.

The Council drainage network is also included as one-dimensional elements in the hydraulic model. This includes the pit and pipe network along Gardeners Road which drains towards the canal, and Bourke Street which drains to the north. More pertinent to the proposed development, the pit and pipe network to the immediate east of 1-3 Ricketty Street drains between the existing buildings via a 1200 mm diameter Sydney Water owned reinforced concrete pipe (RCP) towards Alexandra Canal.

The proposed development contains two sets of reinforced concrete box culverts (RCBCs). A proposed twin 1.5 m high, 2.4 m wide RCBC is located along the northern property boundary and allows for both storage of runoff during rainfall events coinciding with low flood levels in Alexandra Canal and storage of tidal inflows when flood levels in Alexandra Creek are high. The downstream outlet arrangement comprises a one-way 375 mm diameter low level outlet for local runoff to discharge and a high level triple 0.6 m high, 0.3 m wide RCBC for tidal water inflow and outflow.

The second proposed set of box culverts is also a twin 1.5 m high, 2.4 m wide RCBC and is located along the southern property boundary. This allows for both storage of runoff during rainfall events coinciding with low flood levels in Alexandra Canal and storage of tidal inflows when flood levels in Alexandra Creek are high. The downstream outlet arrangement comprises a one-way 375 mm diameter low level outlet for local runoff to discharge and a high level double 0.6 m high, 3.6 m wide RCBC for greater local catchment runoff in addition to tidal water inflow and outflow. In addition, high level double 0.6m high, 3.6m wide culverts located at the southern corner of the site collects runoff from the upstream local catchment and conveys it to the canal.

Additional underground storage is connected to the two proposed RCBC on the canal side of the proposed buildings. The total volume of storage is 600 m^3 attached the northern RCBC and 400m^3 for the southern RCBC.

All hydraulic structures (i.e. pipes) have been modelled with an entrance loss of k=0.5 and an exit loss of k=1.0. Additionally, a 50% blockage factor is applied to all surface inlet pits.

Results

It was determined that whilst the 25 minute storm was critical for the canal as shown in the BMT WBM report, the two hour produced a higher level in the sag points and as such was adopted for the comparison analysis. The difference in peak flow was negligible (180.4m^3/s in the two hour versus 180.6m^3/s for the 25 minute).

Flood mapping for existing conditions are attached and include the following;

- Existing conditions flood water depths, elevations and velocities are shown in Figures F1 to F6;
- Proposed conditions flood water depths, elevations and velocities are shown in Figures F7 to F12; and
- The resulting differences in flood water elevations and velocities are shown in Figures F13 to F18.

Discussion

For all events considered, flood elevation and velocity impacts due to the proposed development are generally contained within the site with the most significant increases and decreases caused by the change in location of structures within the site. Generally, level differences are less than 10mm external to the site.

In the design 1%AEP case (local runoff with 2.5m AHD tailwater) differences offsite are in the order of 15mm up to a localised maximum of 25mm as shown in Figure 13.

Given this area is only used for carparking and not a thoroughfare for traffic, and increased risk to property and persons is insignificant. Furthermore, freeboard to the existing buildings to the south east is still over 500mm.

In the lower tailwater with 1%AEP flow, a reduction in the flood depth level in the Ricketty Street sag pit was calculated to be up to 175mm and increases were less than 10mm elsewhere. For the 1%AEP tailwater only event, increases were less than 10mm.

In general, most of the area surrounding the site is inundated (for the both existing and developed scenario), including local roadways, thus limiting the potential for safe evacuation during a significant flood event. The proposed development will not change flood characteristics in the immediate vicinity, therefore a site specific Flood Emergency Response Plan (FERP) should be prepared for the proposed development facility and implemented prior to its occupation/operation.

Finished floor levels for habitable areas have been set at 3.0 m AHD, which is above 1%AEP plus 500mm freeboard. This is considered an appropriate mitigation measure to minimise risk to property damage in accordance with the NSW Floodplain Development Manual.

It is anticipated that the proposed development will be constructed in stages, with one building and its associated carparking at a time. It is expected this will not adversely impact flood behaviour resulting from the proposed flood mitigation works for the new building and the residual conveyance and storage around the remaining existing building.

Conclusion

The proposed self-storage development at 1-3 Ricketty Street, Mascot is located within the Alexandra Canal floodplain and is subject to significant local catchment flooding. This flood impact assessment concludes that the development is compliant with the local council development controls and adheres to the guidance set out in the NSW Floodplain Development Manual. Adjacent properties are not negatively impacted by changes in flood behaviour caused by the development, and finished floor levels are set at or above the flood planning level of the 1% AEP flood level plus 500 mm.

Regards,

Joel Fraleigh

Civil / Water Resources Engineer
Northrop Consulting Engineers Pty Ltd

Limitation Statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Canal Aviv Pty Ltd.

The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report except where expressly permitted in writing or required by law, no third party may use or rely on this report unless otherwise agreed in writing by Northrop.

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The report was prepared on the dates shown and is based on the conditions and information received at the time of preparation.

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