



09 March 2016

Martin Moore
Morgan Moore and Associates
Level 5, 140 Arthur Street
NORTH SYDNEY NSW 2060

Our ref: 22/16052
Your ref: 16877

Dear Martin

**ARV Warriewood
Bowling Green**

Our Anglican Retirement Villages, Report for Warriewood Retirement Village, Water Management Report UPDATE (ARV-WMRU, November 2013) refers.

We have reviewed the "as built" bowling green, including the retaining wall, fence and pergola shade structures.

On the attached plan we have overlain the PMF flood event, being the upper envelope of flooding expected on the site, in the location of the bowling green. Given that the bowling green, including the fence and pergola shade structures are above the PMF flood level, it is considered that they will have negligible impact on flooding at the site. The retaining wall is directly beneath the north-eastern bowling green edge returning on part of both ends and it is considered that this structure will also have negligible impact on flooding at the site.

The bowling green, including the retaining wall, fence and pergola shade structures are thus expected to have negligible impact on our general findings documented our Anglican Retirement Villages, Report for Warriewood Retirement Village, Water Management Report UPDATE (ARV-WMRU, November 2013).

Yours faithfully
GHD Pty Ltd

Rainer Berg
Principal Hydrology
(02) 8898 8815



LEGEND

— PMF Flood Level PMF Flood Extent

1:1,000
 0 0.0075 0.015 0.03
 Kilometres (at A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Anglican Retirement Villages
 Warriewood Brook STAGES 4 to 6
 Post Development Flood Levels & Affection

Job Number | 22-16052
 Revision | A
 Date | 23/08/2013

Figure 1



14 March 2016

Martin Moore
Morgan Moore and Associates
Level 5, 140 Arthur Street
NORTH SYDNEY NSW 2060

Our ref: 22/16052
Your ref: 16877

Dear Martin

**ARV Warriewood
ILU Amendments – flood comments**

Our Anglican Retirement Villages, Report for Warriewood Retirement Village, Water Management Report UPDATE (ARV-WMRU, November 2013) refers. We have reviewed the amendments made to the approved layouts of the ILUs as follows:

- In Stage 4, generally comprising changes to window configurations, cladding over doors, deletion of polycarbonate roofing and installation of skylights in lieu, deletion of privacy screens at the entry and substitution with a low height wall, minor internal changes to store rooms of some ILU types and extension of the Type A decks
- Similar amendments as noted above, to ILU types originally approved for Stage 5 (14 ILUs) plus new ILU types for Stage 5

On the plan we have also overlain the PMF flood event, being the upper envelope of flooding expected on the site. Given that the locations of the ILUs are all above the PMF flood level, we consider that these amendments will have no impact on flooding at the site and our general findings documented in the above-mentioned report.

Yours faithfully
GHD Pty Ltd

Rainer Berg
Principal Hydrology
(02) 8898 8815



LEGEND

— PMF Flood Level PMF Flood Extent

1:1,000
 0 0.0075 0.015 0.03
 Kilometres (at A3)

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Anglican Retirement Villages
 Warriewood Brook STAGES 4 to 6

Post Development Flood Levels & Affection

Job Number	22-16052
Revision	A
Date	23/08/2013

Figure 1



06 April 2016

Martin Moore
Morgan Moore and Associates
Level 5, 140 Arthur Street
NORTH SYDNEY NSW 2060

Our ref:22/16052/15922_2016MarUpdate
Your ref:

Dear Martin

ARV Warriewood Stage 4-6 Water Management - Stormwater Clarification

Following our Anglican Retirement Villages, Report for Warriewood Retirement Village, Water Management Report UPDATE (ARV-WMRU, November 2013) and our advice of 13 December 2013 providing further clarification regarding stormwater management at the site, we herewith amend this advice for recent minor increases in imperviousness for Stages 4 to 6. Our assessments are made in accordance with the Warriewood Valley Urban Land Release, Water Management Specification (WMS) adopted by Pittwater Council in February 2001.

1 Site Storage Requirements (SSR)

The ARV-WMRU nominates that the site is mostly located within Sector 4. To this end it is elected to use the Sector 4 Site SSR and PSD requirements for the ARV site.

The WMS suggests a SSR value of 368 m³/ha for Sector 4 based on a total impervious area of 50% of the site. With ongoing development on the site, the percentage impervious area at the ARV site has increased by a small amount to 62% and the SSR has been recalculated in accordance with the WMS. A RAFTS hydrologic model was used for these calculations to determine the required Sector 4 storage, that will throttle discharges to match "Base Conditions". The results are listed in Table 1 below, which shows that a revised SSR of 378 m³/ha is required for Sector 4 to 6. In defining the ARV site area, two cases were considered as follows:

- Case 1: Site area based on the entire site, namely 6.15ha
- Case 2: Site area based on the ARV site, less the area dedicated to Council immediately adjacent to the creek, namely 5.48 ha

From Table 2, it is noted that the already constructed lake on the site adequately meets the revised SSR for both site area cases.



Table 1 SSR Calculations

Site conditions	Storage required (m ³)	SSR required (m ³ /ha)	Comment
The entire Sector 4 at 50% impervious	19440	368	In agreement and validated against WMS
Sector 4 with the ARV site at 62% impervious	19950	378	

Table 2 ARV SSR and available Storage

Item	Area (ha)	SSR (m ³) based on 378 m ³ /ha	Available storage (m ³) [from as built survey]	Comment
Require SSR based on the total site area	6.15	2322		
Require SSR based on the total site area, less the dedicated creek area	5.48	2071		
Storage provided by already constructed site lake, determined from As Built plans			3030	Storage volume between normal lake level 2.65m AHD (controlled by the outlet invert) and lake embankment crest allowing for 0.1m freeboard, namely 4.1m AHD.

2 Permissible Site Discharge (PSD)

The already constructed site lake controls the site discharge by way of a low level outlet, which throttles outflows via a 450mm diameter orifice plate. To determine the site discharge, a DRAINS stormwater model was configured using the latest site pervious and impervious areas. Simulations were undertaken in accordance with the nominated events in the WMS, and outflows were compared to the allowable PSD nominated in the WMS (Table A-2) for Sector 4.

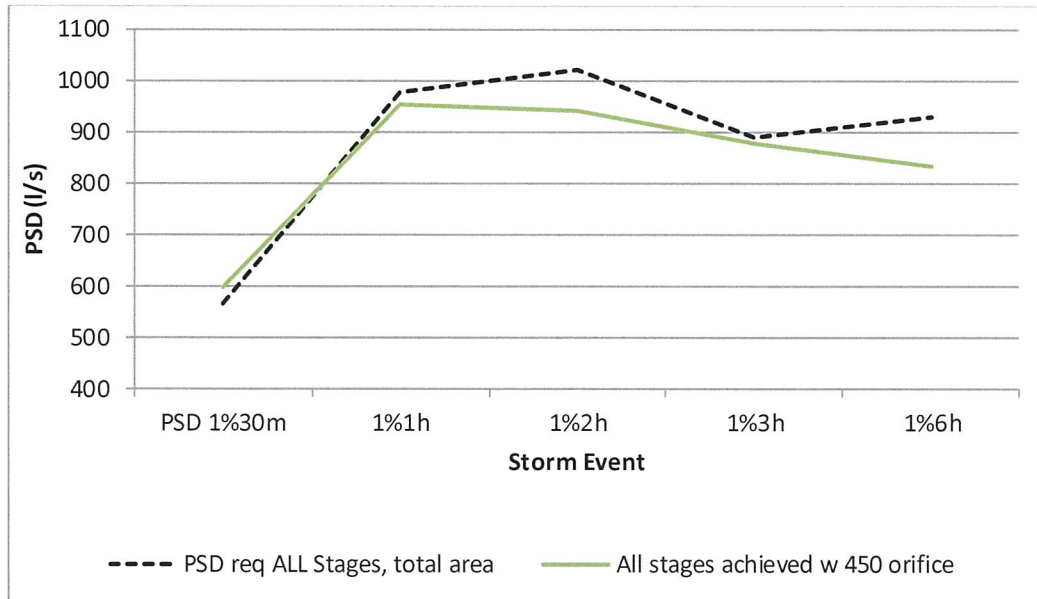
The results in Table 3 show that the configuration of lake outlet with the existing 450mm orifice plate, approximately achieves the requirements stipulated in WMS. The maximum storage uptake in the lake is 2700 m³, which is still well within the SSR requirements discussed in Section 1.



Table 3 PSD required and achieved

Storm Event	Require PSD based on the total site area of 6.15ha (l/s)	PSD achieved with current 450mm diameter orifice plate (l/s)
1% AEP – 30min	566	600
1% AEP – 1hr	978	953
1% AEP – 2hr	1021	942
1% AEP – 3hr	892	878
1% AEP – 6hr	929	835

Figure 1 Iteration of Orifice Plate Diameters





3 Conclusion

Through further stormwater calculations in accordance with the WMS, it has been shown that:

- The already constructed lake on the site adequately meets the revised SSR calculated for the ARV site, which has a 62% impervious area
- The maximum storage uptake in the lake is 2700 m³, which is still well within the SSR requirements

Yours faithfully
GHD Pty Ltd

A handwritten signature in black ink, appearing to read 'Rainer Berg', written over a horizontal line.

Rainer Berg
Principal Hydrology
(02) 6650 5600