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SYDNEY GRAMMAR SCHOOL WEIGALL SPORTS COMPLEX

SSDA FLOOD ENGINEERING REPORT

Prepared for: Jattca

By: enstruct group pty ltd

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SYDNEY GRAMMAR SCHOOL WEIGALL SPORTS COMPLEX

FLOOD ENGINEERING REPORT

ISSUE AUTHORISATION

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Project No: 6011

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enstruct group pty ltd
www.enstruct.com.au

Sydney
61 2 8904 1444
Level 4,
2 Glen Street,
Milsons Point NSW 2061

Melbourne
61 3 9108 1100
Ground Floor.
555 Bourke Street,
Melbourne VIC 3000

Brisbane
61 7 3726 6000
Level 19,
1 Eagle Street
Brisbane QLD 4000

Executive Summary

This report has been prepared to support the SSDA of a proposed multi-use indoor sports facility for Sydney Grammar School (SGS) at Weigall Fields. It responds to the Planning Secretary's Environmental Assessment Requirements (SEARS) (SSD-10421) which outlines the requirements for flooding:

> 17. Flooding
>
> Identify flood risk on-site (detailing the most recent flood studies for the project area) and consideration of any relevant provisions of the NSW Floodplain Development Manual (DIPNR, 2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity. If there is a material flood risk, include design solutions for mitigation.

To determine flood levels at the site, Woollahra Council's flood model was obtained, and the proposed Building 1 added to the model. Building 2 is and open car park at the ground level, and is not flood affected in a 1% AEP flood event. In an event larger than the 1% AEP, water can pass through Building 2, so no changes were made to the model here. Additional changes were made to bring the model up to date with current best practice, including Australian Rainfall and Runoff 2019 and the CSIRO Climate Futures Tool to consider the effects of climate change.

Table 1 Flood Modelling Results Summary

Location	1% AEP flood level (including climate change)	Probable Maximum Flood (PMF) level
Building 1 south-western corner	6.4 mAHD	6.8 mAHD
Building 1 north western corner	4.6 mAHD	6.2 mAHD
Building 1 north eastern corner	4.0 mAHD	6.2 mAHD
Building 2 southern end	4.1 mAHD	5.8 mAHD
Building 2 northern end	3.7 mAHD	5.7 mAHD

The impact of the development on the surrounding properties with respect to flooding was found to be negligible. While there is some redistribution of flooding as it moves around the proposed Building 1, this impact is local only and does not affect surrounding properties or roads. Building 2 will have no impact on flooding in a 1% AEP event

The proposed sports facility responds to the flood risk at the site by providing protection from flooding for all storms up to and including the Probable Maximum Flood (PMF). In the event of an extreme flood event such as the PMF the surrounding area will be subject to flooding. In a flood emergency, site occupants can remain in place and wait for flood waters to recede.

The proposal responds to the SEARS and meets Woollahra Council's flood planning requirements.

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1 Project Description

This report has been prepared to support the SSDA for the Weigall Sports Complex.

1.1 The scope of the project is as follows:

1. Demolition of the following existing structures and buildings (which are not heritage significant) at the southern edge of the SGS Weigall Sports Ground:

   (a) Multipurpose/tennis courts and associated fencing;

   (b) Barry Pavilion;

   (c) The existing cricket nets off Alma Street; and

   (d) Paved car park near Neild Avenue.

2. Construction of the SGS Weigall Sports Complex comprising the following:

   (a) Building 1 - Sports facilities building accommodating the following facilities:

      (i) Ground floor: Main pool, programme pool, terrace/assembly facing Weigall, entry foyer, offices, change rooms, back of house, services and external car parking (5 spaces) and loading

      (ii) Mezzanine floor: spectator terrace and services

      (iii) First floor: Multipurpose sports hall 01 – basketball and volleyball, Multipurpose sports hall 02 –cardio, weights, taekwondo, fencing, PDHPE, change rooms, storage and services

      (iv) Level 2: Multipurpose room 04; Multipurpose sports hall 03 –cardio, weights, taekwondo, fencing, PDHPE, storage and services

      (v) Driveway entry from Neild Avenue (comprising relocation of the existing driveway southwards with existing driveway potential retained for maintenance access)

   (b) Building 2 – Car park comprising an ancillary car park of one/two split levels accommodating 93 spaces with an additional 4 spaces on grade, accessed from an existing entry from Alma Street (located on the existing cricket nets site). The lower ground level includes the flexibility to be used as an extension of the existing playing fields

   (c) Parking for a total of 102 cars comprising:

      (i) Building 1: 5 spaces

      (ii) Building 2: 97 car spaces (93 within the building and four at grade)

(d) Landscaping of the site including tree removal/retention/replacement, paths, fencing and lighting

(e) Building identification signage

(f) New kiosk substation.

3. Use of the completed building as an educational establishment with external/community use of the proposed facilities that coordinates with the programming of the SGS.

The proposal does not include any of the following:

• General learning areas (GLA)

• An increase in the existing student or staff population.

1.2 Site description

The key characteristics are summarised below:

Location

The State Significant Development Application (SSDA) site is part of the Weigall Playing Fields located on Neild Avenue at Rushcutters Bay.

Weigall is bordered by (see Figure 1):

- Neild Avenue to the west (Neild Avenue is classified as a collector road and also forms part of the State Road MR625 managed by Roads and Maritime Services)
- State Rail land and the Eastern Suburbs Railway viaduct to the north
- White City (Hakoah Club and Maccabi Tennis Club), SGS Edgecliff Preparatory School, Vialoux Avenue, Alma Street and residential development to the south
- Residential development to the south and north-east
- A Sydney Water stormwater channel which traverses the site
- A right of way from Alma Street, benefiting the site, which crosses the site formerly known as White City.

Figure 1 Site Context (Allen Jack and Cottier)

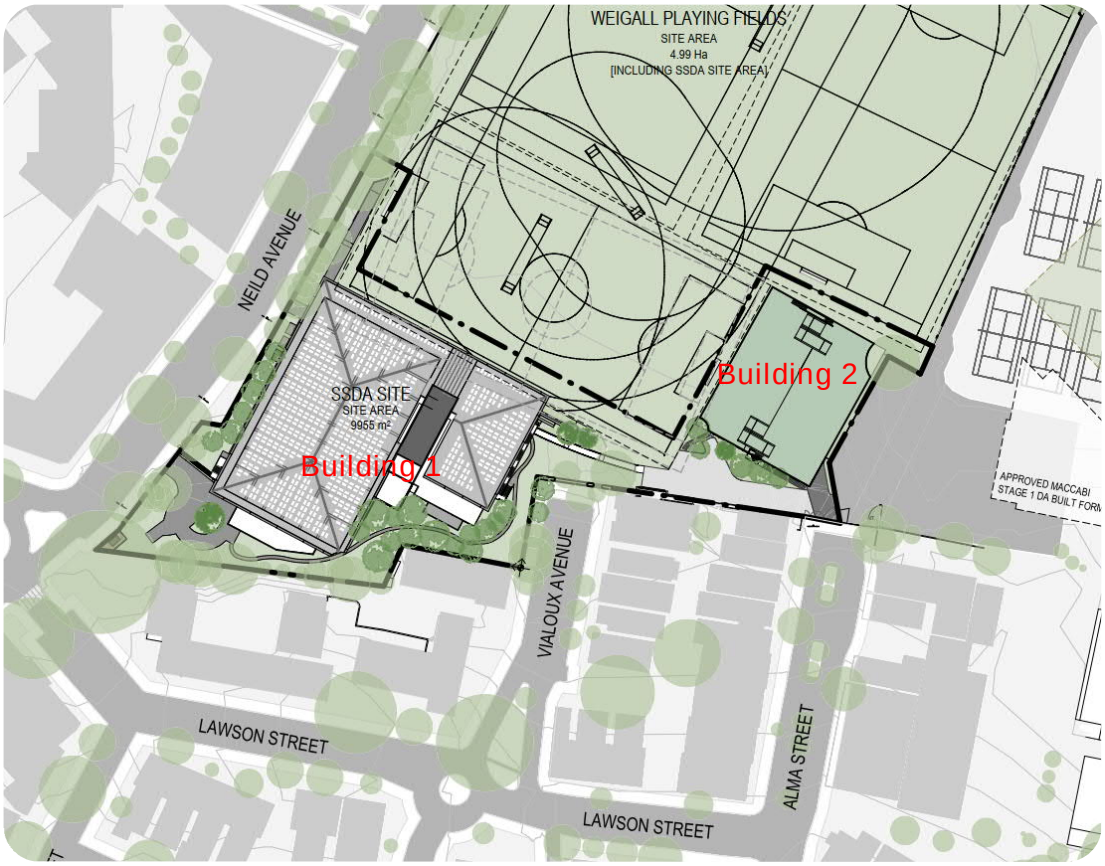

Figure 2 Locality Plan (Allen Jack and Cottier)

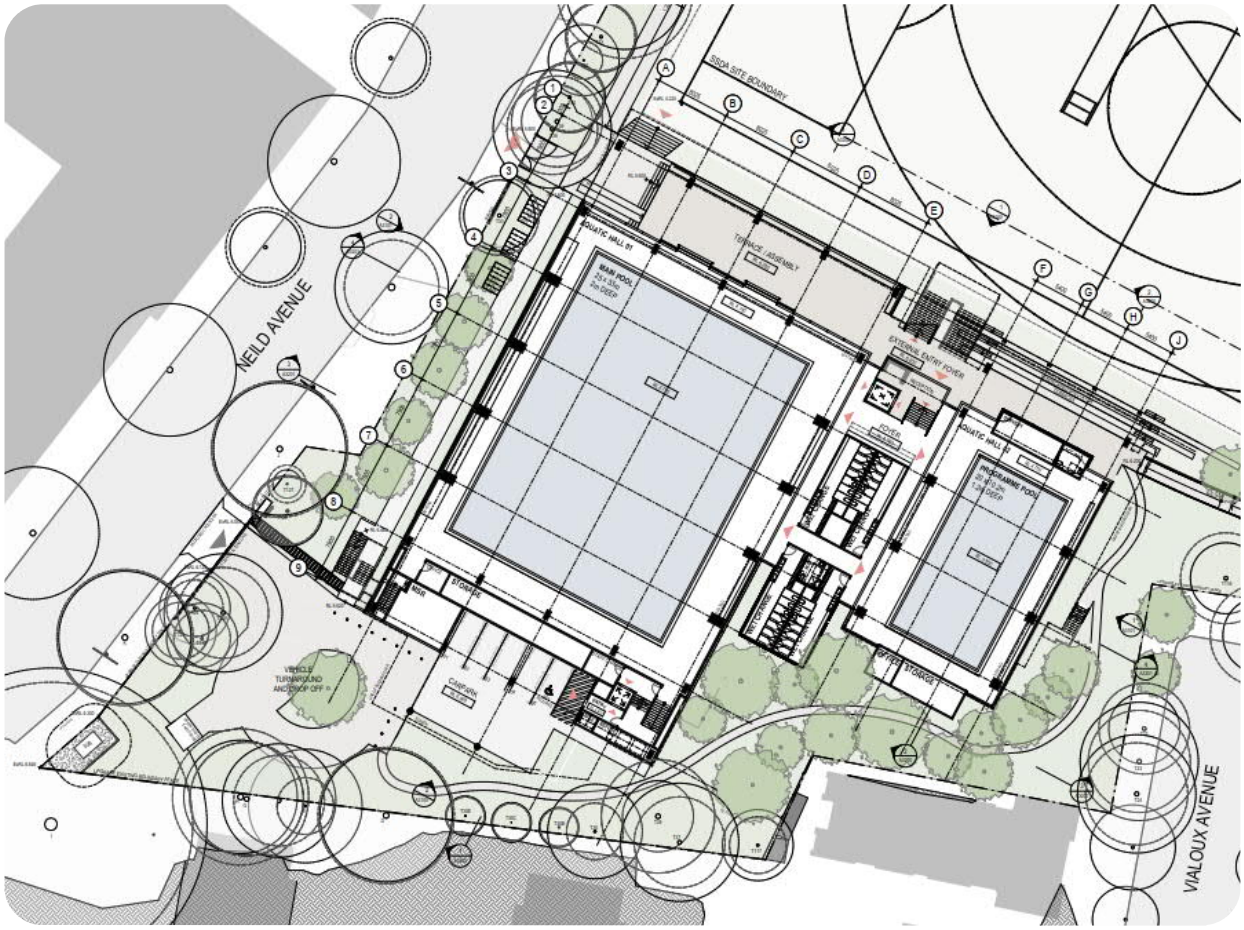

Figure 3 Building 1 - Ground Floor General Arrangement - Alan Jack and Cottier Architects

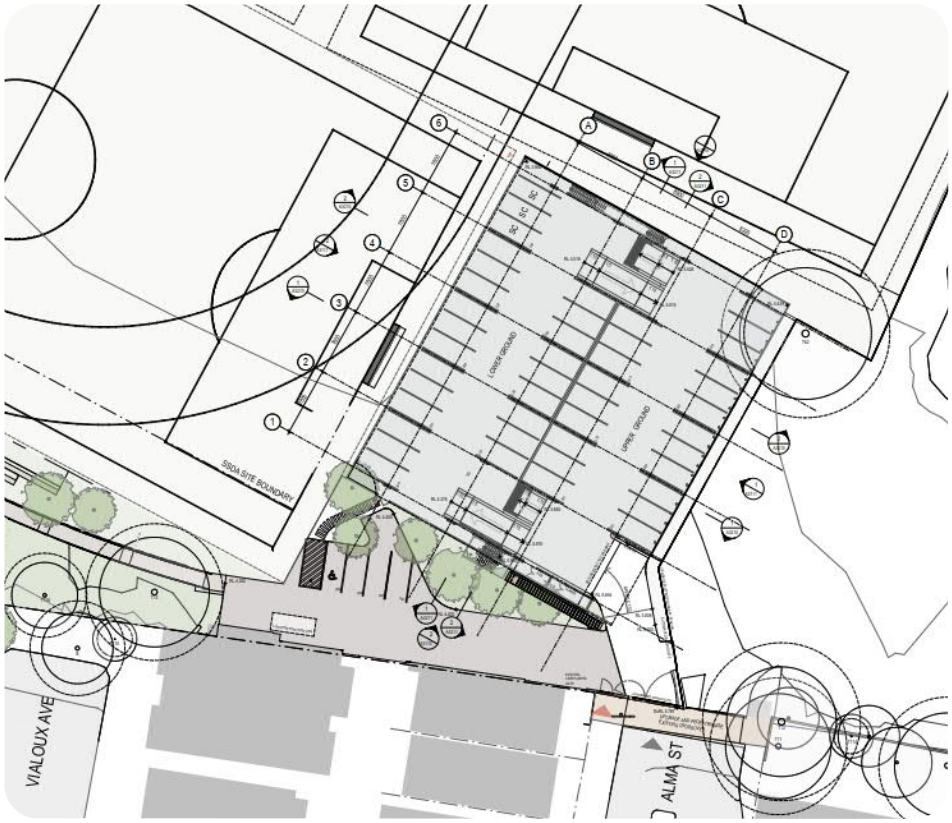

Figure 4 Building 2 - Ground Floor General Arrangement - Alan Jack and Cottier Architects

1.3 Relevant Documents

The following documents have been used in the preparation of this report

- Woollahra Development Control Plan 2015
- Rushcutters Bay Floodplain Risk Management Study and Plan – WMA Water 2012
- Paddington Flood Study Draft Report – Catchment Simulation Solutions (CSS) 2016
- Planning Secretary's Environmental Assessment Requirements (SSD-10421)
- Australian Rainfall and Runoff 2019 (ARR2019)

1.4 Planning Secretary's Environmental Assessment Requirements

The Planning Secretary's Environmental Assessment Requirements (SEARS) (SSD-10421) outlines the requirements for flooding:

> 17. Flooding
>
> a) Identify flood risk on-site (detailing the most recent flood studies for the project area) and consideration of any relevant provisions of the NSW Floodplain Development Manual (DIPNR, 2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity. If there is a material flood risk, include design solutions for mitigation.
>
> 26. Flooding and Overland Flow
>
> The site is within a flood affected zone and as such the following shall be provided.
>
> Flooding Study – Protection of Property
>
> During large storm events, there may be potential for both mainstream and overland flows to occur. Under provisions made in the State Government Floodplain Development Manual, an assessment of these flows must be undertaken so that suitable flooding protection measures can be incorporated in the proposed development. To this end, the applicant is to engage a suitably qualified hydraulic engineer to determine the likely 1 in 100-year flow level and flooding impacts.
>
> It is expected that a hydrological (hydrograph model), and hydraulic analysis of the upstream catchment will be required. The existing in-ground drainage capacity in the catchment must be considered. The extent of Councils drainage infrastructure in the subject catchment may be ascertained by visual inspection of drainage plans at Councils Customer Services Counter. A registered surveyor shall provide levels within the adjacent roadway, and as necessary.

To protect the development from potential flooding, the property vehicular and pedestrian access threshold levels must be designed to provide a minimum freeboard protection in accordance with Clause E2.3.3 Flood Planning Levels in the Woollahra DCP Chapter E2 – Stormwater Flood Risk Management. The hydraulic engineer must certify that the levels, or alternative protection measures, proposed in the architectural details are satisfactory to protect the property from inundation. Adjoining properties must not be affected by proposed flood protection measures. Details of all proposed flood protection measures must be submitted with the overland flow assessment.

This report responds to the SEARS.

2 Site Flooding

Weigall Fields are subject to flooding. The Tuflow flood model and Drains hydrologic model for the catchment prepared by CSS was provided to enstruct on behalf of Woollahra Council.

2.1 Model Changes

The following changes have been made to the existing conditions flood model

- The Drains model hydrology updated to reflect the 2019 revision of Australian Rainfall and Runoff. As part of this process, the intensity, frequency and duration (IFD) data was updated to the 2016 values from the Bureau of Meteorology.
- The flood model provided to enstruct was based on the Paddington Flood Study, and was focused on the total catchment, including the upper reaches. Whereas the Rushcutters Bay Floodplain Risk Management Study and Plan has a greater focus on the lower reaches of the catchment where ocean levels are more relevant. Downstream boundary conditions in the flood model were updated to capture the impact of the ocean level on flooding. The downstream boundary conditions for this report were adopted from the Ruschutters Bay Study:

OCEAN Event		DESIGN EVENT (ARI)	RAINFALL Event	
Peak Design Ocean Level (m AHD)	Co incident Design Rainfall Event (ARI)		Co incident Design Ocean Event (ARI)	Co incident Design Ocean Level (m AHD)
1.45	100 year	**PMF**	100 year	1.43
1.43	20 year	**100 year**	20 year	1.40
1.42	20 year	**50 year**	20 year	1.40
1.40	20 year	**20 year**	20 year	1.40
1.20	10 year	**10 year**	10 year	1.20
1.20	5 year	**5 year**	5 year	1.20
1.20	2 year	**2 year**	2 year	1.20

2.2 Climate Change Impacts

There is now widespread acceptance that human activities are contributing to observed climate change. Human induced climate change has the potential to alter the prevalence and severity of rainfall extremes, storm surge and floods. Recognition of the risks associated with climate change is required for better planning for new infrastructure and mitigating the potential damage to existing infrastructure (ARR2019).

The Climate Futures web tool developed by the CSIRO provides projections for the factors influenced by climate change. The relevant factors for flooding are sea level rise, and changes in rainfall intensity and frequency. ARR2019 recommends using Representative Concentration Pathways (RCPs) of 4.5 and 8.5 in a climate change impact assessment. The RCP 8.5 projected to the year 2100 represents the maximum consensus case for climate change impacts and has been adopted for this study. The predicted increase in rainfall intensity is 19.7% compared to current conditions.

2.2.1 Downstream boundary conditions

The downstream boundary conditions adopted for this study and based on the CSIRO climate futures tool are presented in Table 2

Table 2 Downstream boundary conditions

Rainfall event	1% AEP storm	PMF
Existing Climate	5% AEP ocean level = 1.40 mAHD	1% AEP ocean level = 1.44 mAHD
RCP 8.5 @ 2100	5% AEP ocean level = 2.24 mAHD	1% AEP ocean level = 2.28 mAHD

2.3 Proposed Conditions

The proposed Building 1 was added to the model as an impermeable object. Flood water is forced around the buildings.

Building 2 was not included in the flood model. The site of the proposed Building 2 is not flood affected in a 1%AEP event. During a larger storm event such as the PMF the Building 2 site will be flooded. The building is designed to allow flood waters to enter and pass through the car park. Any impact of Building 2 on flooding will be localised and managed in the drainage design.

There is a stormwater pipe that runs from the northern end of Vialoux Street to Neild Avenue. This pipe clashes with the proposed excavation for Building 1. Existing information from dial-before-you-dig and from the flood model show this as a 900mm diameter pipe. Site survey has found the pipe is actually a 600mm diameter pipe. The model was updated to include a diversion around the northern side of the site. This diversion pipe has been modelled as a 900mm diameter pipe under the assumption that Sydney Water and Woollahra Council will require this network upgrade as part of the proposed works.

3 Existing Conditions Results

3.1 Rushcutters Bay Floodplain Risk Management Study and Plan

The Rushcutters Bay Floodplain Risk Management Study and Plan prepared by WMA Water 2012 shows the site is flood affected. The flood study result is presented below.

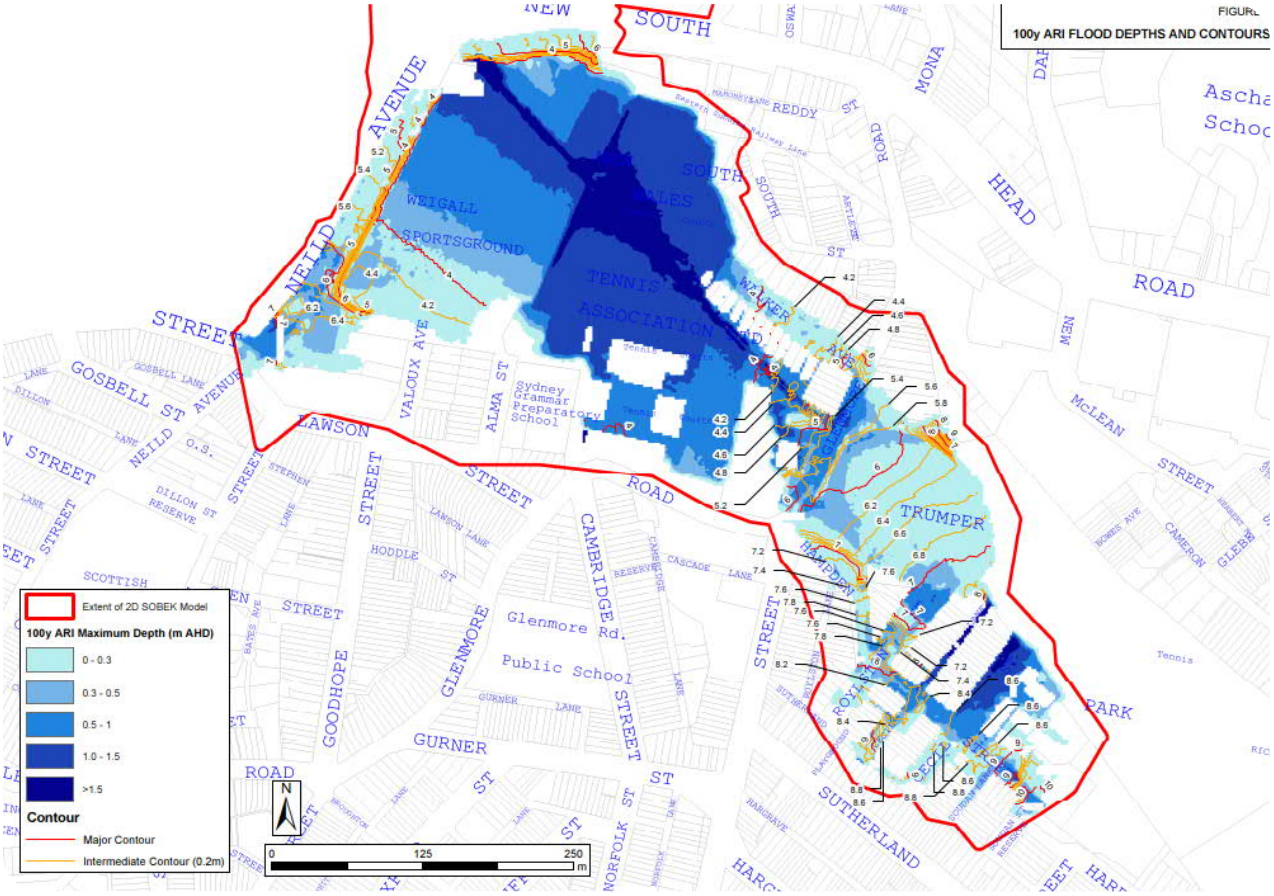

Figure 5 1% AEP flood map (Source: Rushcutters Bay Flood Study)

3.2 Original results compared with ARR2019 results

As noted in section 2.1, the model supplied by Council was adjusted to the current best practice of ARR2019. The impact of the change in rainfall intensities with the revised version of ARR is are presented below.

Figure 6 Impact of ARR2019 rainfall compared with the original study (1% AEP)

Under the existing conditions model, it was demonstrated that the impact of updating the flood model to include ARR2019 hydrology reduced flood levels by approximately 70mm on the fields downstream of the site. In the channel at the northern end of the fields the impact is approximately 300mm reduction in flood levels.

3.3 Impact of Climate Change on existing conditions

The flood model was run with increased rainfall intensity and predicted future sea level conditions as outlined in Section 2.2.

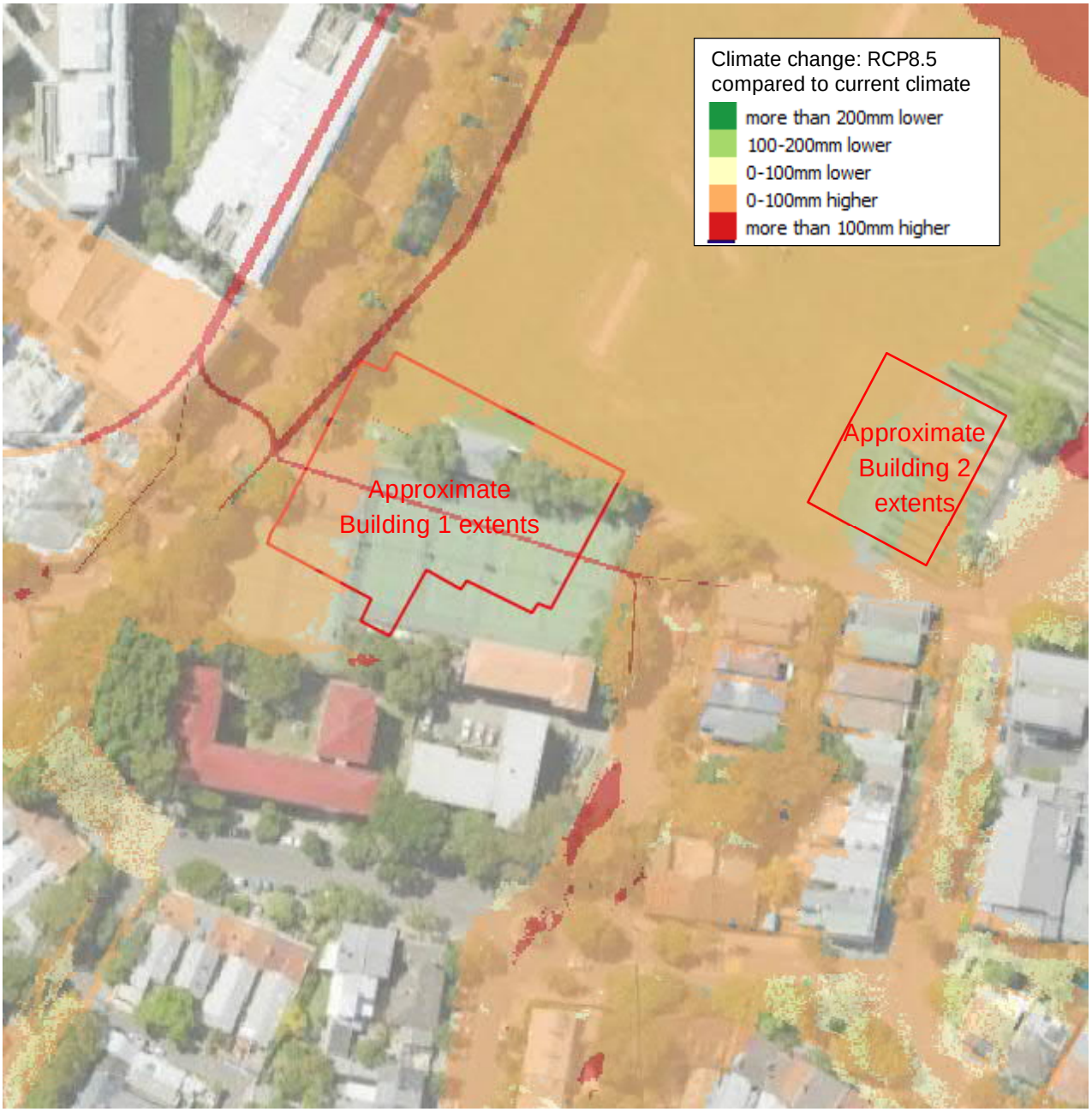

Figure 7 Existing conditions model with climate change impacts (1% AEP)

The results show an increase in flood levels at the site to be relatively small. There is an increase in flood level of approximately 30mm on the fields, and up to 70mm on Neild Avenue. Near the northern end of the Weigall Fields (150 m north of the subject site), where flooding becomes dominated by ocean level conditions, the increase in flood levels is approximately 500mm.

With the relatively small impact of climate change on the flood levels at the site, the worst-case scenario (RCP 8.5 in 2100) has been adopted for flood planning purposes. This represents a conservative approach, however with the impact of climate change on flood levels of less than 100mm at the site, it is considered that the impact on the design is minor. Any increase in floor levels as a result of the increased flood levels will build resiliency into the design.

3.4 Adopted Existing Conditions results

Below is the existing conditions results utilising ARR2019 methodology and including the impact of climate change.

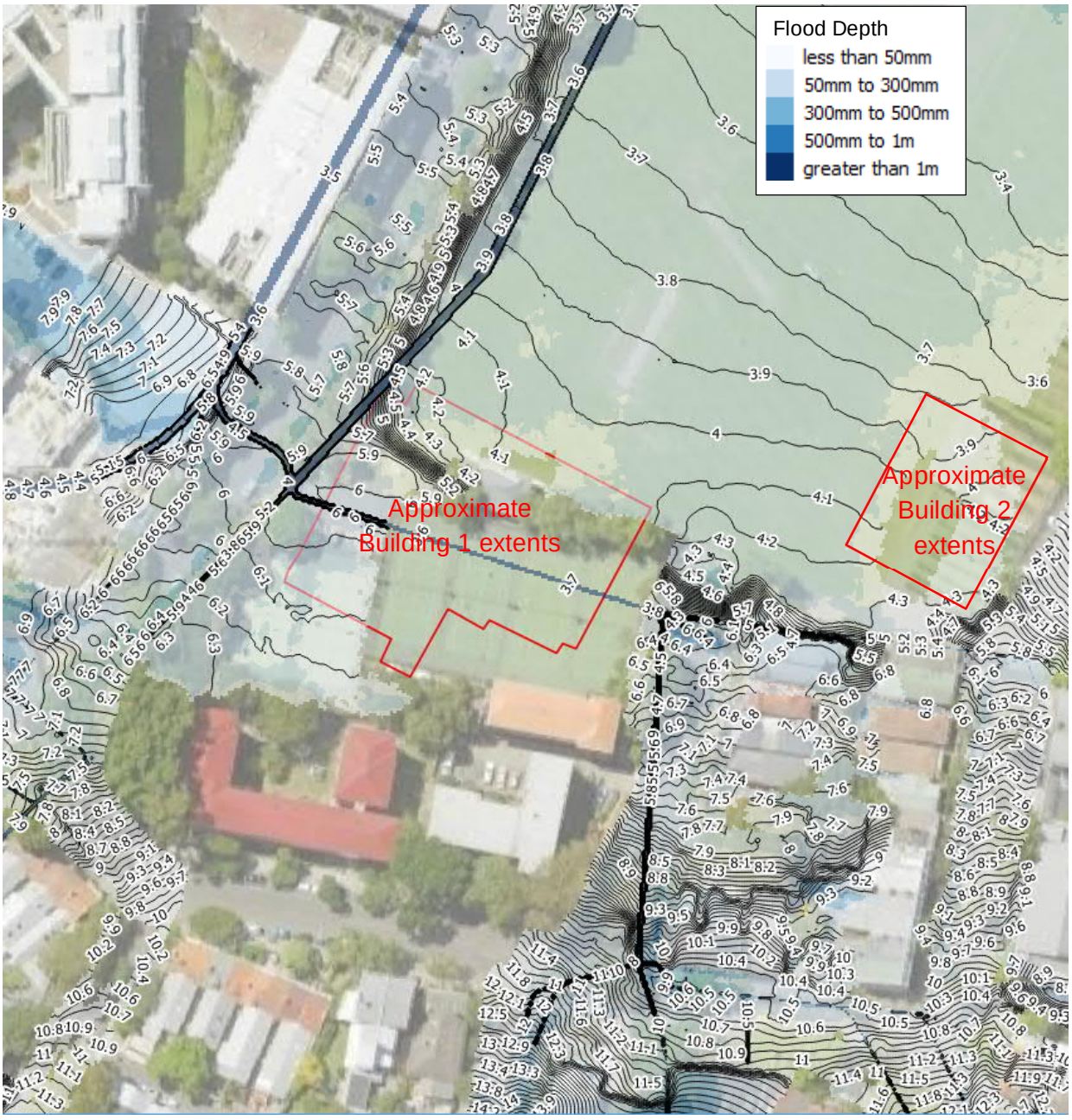

Figure 8 1% AEP - Existing conditions (ARR2019) pus climate change

3.5 Probable Maximum Flood

The Probable Maximum Flood (PMF) was modelled for flood planning purposes. The PMF methodology used in the CSS report is considered current best practice, however the downstream tailwater condition has been updated to incorporate climate change as per Table 2.

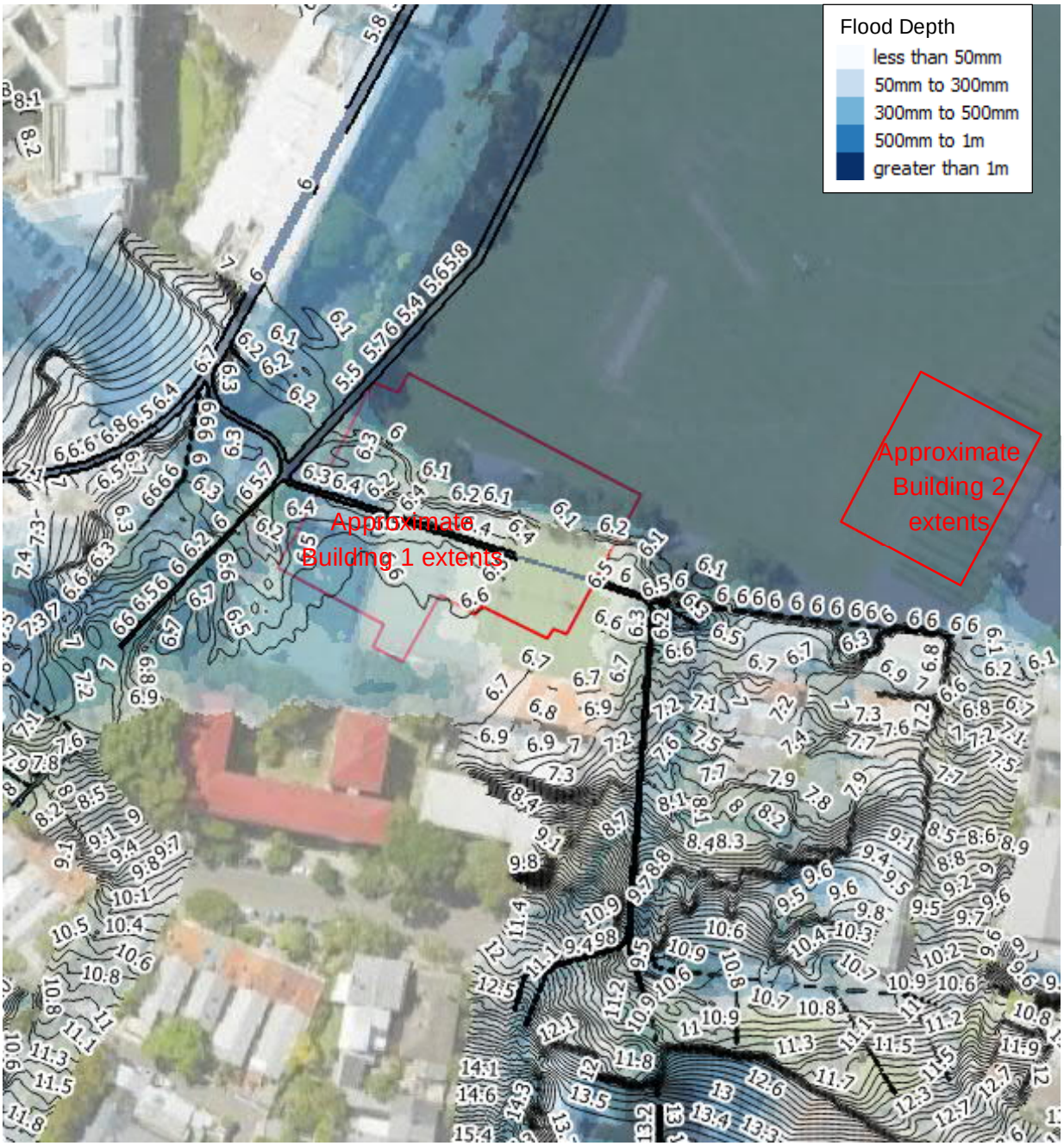

Figure 9 PMF - Existing conditions

4 Proposed Conditions Results

For all proposed conditions results presented below, the storm events include allowance for climate change as discussed in Section 3.3.

The proposed conditions model includes the proposed Building 1 footprint at the ground level, and the diversion of the Sydney Water 900mm drain to the north of the building. For more information, refer to section 2.3 of this report.

4.1 1% AEP storm results

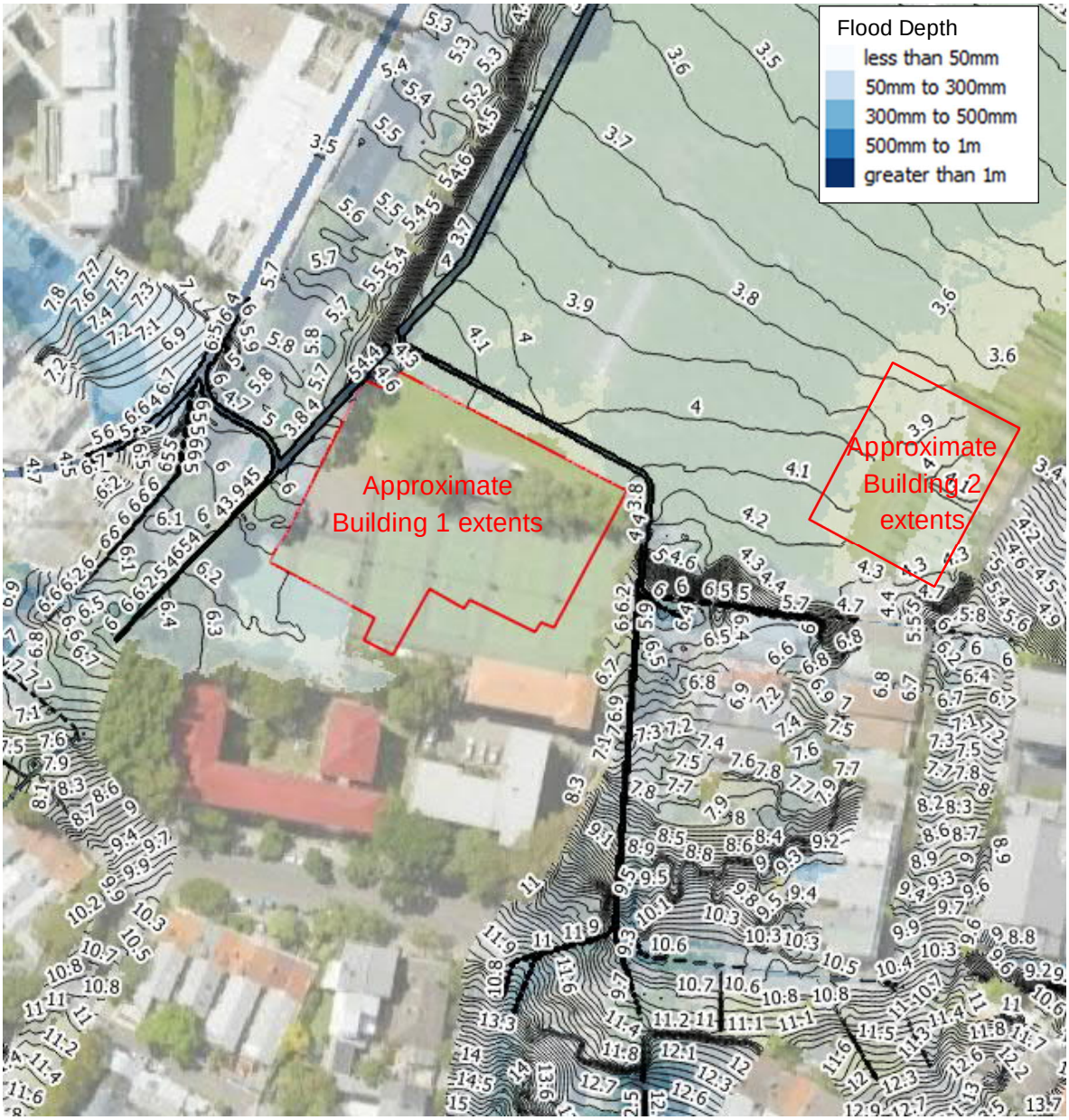

Figure 10 1% AEP storm event - proposed conditions

Figure 11 Impact of the development on the surrounding flood levels (1% AEP storm)

The development will have negligible impact on surrounding properties with respect to flooding. Referring to Figure 11, there are some minor local increases in flood levels, however these are limited to within the site and do not affect surrounding properties.

4.2 Probable Maximum Flood

The PMF produces flood levels varying from 6.90 mAHD on the southern side of the proposed Building 1, to 6.10 mAHD on the oval. The PMF level at Building 2 is 5.7 mAHD

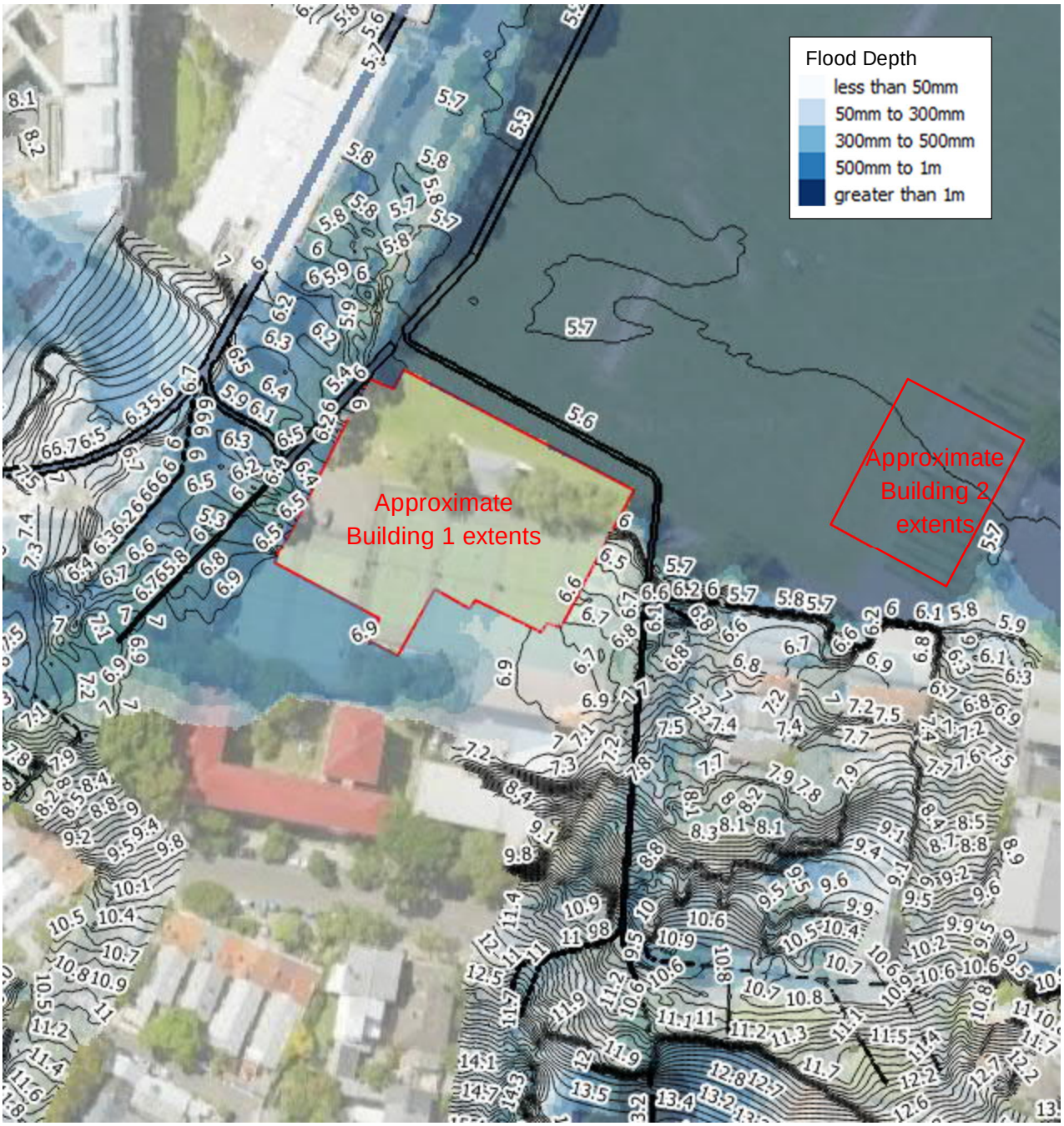

Figure 12 PMF - Proposed Conditions

5 Flood Planning

The following key requirements have been extracted from the Part E of the Woollahra DCP 2015:

5.1 Floor Levels:

Flood planning levels are shown in the below extract

Development type	Flood (and estuary) planning level
Habitable floor areas	100 Year ARI flood level plus 0.5m freeboard
Non-habitable floor areas	100 Year ARI flood level plus 0.3m freeboard
Habitable floor areas for foreshore developments subject to coastal inundation	The highest RL, calculated from the following: ▶ 100 Year ARI flood level plus 0.5m freeboard; or ▶ still water level plus 100 Year ARI wave run-up plus 0.3m freeboard
Ground level, open car parking spaces	20 Year ARI flood level plus 0.3m freeboard
Enclosed car parking spaces, three or fewer vehicles	20 Year ARI flood level plus 0.3m freeboard
Enclosed car parking spaces, more than three vehicles	100 Year ARI flood level plus 0.3m freeboard

Note that further to this, the DCP does include some provision for sea level rise:

Note: The NSW Chief Scientist has advised that the sea level rise benchmarks (measured as an increase above 1990 mean sea levels) of 40cm by 2050 and 90cm by 2100 are adequate in light of evolving understanding of the complex issues surrounding future sea levels.

All EPLs should be based on the 2100 benchmark.

While the above is related to properties subject to coastal inundation, sea level will have an impact on flood levels at the site. This is discussed in Chapters Climate Change Impacts 2.2 and 2.2.1 and has been factored into the results presented in this report.

5.2 Critical and sensitive developments

The DCP definition of “critical and sensitive developments” applies to the following types of developments among others: community facility; institutions; educational establishments; child care facilities; and schools.

C27	For critical and sensitive developments in low flood risk precincts, all habitable and non-habitable floor levels are no lower than the PMF flood level.

Building 1 of the proposed development is classified as a "critical and sensitive development", the finished floor levels of the development have been designed to be at or above the PMF level at all locations where flood waters could enter the building.

Further to this, building components below the PMF level must be flood compatible.

The proposed development mitigates against flood risk by applying the above principles to the design of the sports complex.

Building 2 of the proposed development is not classified as "critical and sensitive development", but is considered as "Enclosed car parking spaces, more than 3 vehicles". The requirement for this building is to have a 300mm freeboard to the 1% AEP flood.

5.3 Filling

Filling of the floodplain can displace flood waters, forcing it on to nearby areas. The DCP does not allow any impact on surrounding properties.

O2	To ensure that development does not cause flood levels to rise or exacerbate flooding on the surrounding floodplain.

The flood modelling presented in this report shows that the proposed development produces negligible impact of the on flooding in a 1% AEP storm event, with impacts limited to the site only.

5.4 Car Parking

There is no proposed basement car parking at the site.

The undercroft car park at the southern side of the proposed Building 1 has a minimum floor level of 6.50 mAHD which provides more than 300mm freeboard to the 1% AEP storm event.

Building 2 car park provides a minimum of 300mm freeboard to the 1% AEP flood levels as required by the Woollahra DCP

5.5 Buildings

Aside from issues of floor levels and freeboard, the DCP outlines restrictions on storage, services and building materials for buildings that may be affected by flooding.

C1	All structures have flood compatible building components below the 100 Year ARI level plus 0.5m freeboard.
C2	All electrical equipment (e.g. air conditioners and pool pumps) is located or protected to above the 100 Year ARI level plus 0.5m freeboard.
C3	All storage areas such as shelving are above the 100 Year ARI level plus 0.5m freeboard.
C4	The structure is built to withstand the forces of floodwater, debris and buoyancy up to and including the 100 Year ARI level plus 0.5m freeboard.

5.6 Flood Evacuation

For storm events larger than the 1% AEP, floodplain risk management shifts from protecting against property damage to focussing on the safety of people. For evacuation planning, the DCP considers the Probable Maximum Flood (PMF).

C5	Reliable evacuation access for pedestrians is provided from the lowest habitable floor area to a refuge area above the PMF level and designed to withstand PMF water forces.

Given the classification of the proposed development as a “critical and sensitive development”, the proposed Building 1 has been designed to be protected from flooding in a PMF event.

Neild Avenue, Vialoux Avenue and the Weigall Fields are all subject to flooding. A shelter-in-place flood response is considered as the best course of action in the event of a flood at the site. The critical duration storm is 60 minutes at the site. During a flood event, site users will remain in place for a matter of hours before they can safely evacuate the premises.

6 Conclusion

The report demonstrates the negligible impact the proposed development has on the surrounding flood behaviour.

In response to the SEARS requirements, the site has been designed to respond to flooding and mitigates against flood risk by being flood proof up to the PMF event. The impact of climate change on flooding has been discussed in this report and included in the design.