Concord RSL Redevelopment,
Flood Assessment

On behalf of Mounties Group

Source: Google Street View

FEBRUARY 2018

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CONCORD RSL REDEVELOPMENT
FLOOD MODELLING AND ASSESSMENT

FINAL REPORT
FEBRUARY 2018

Project Concord RSL Redevelopment, Flood Modelling and Assessment	**Project Number** 170056
Client Mounties Group	**Client Representative** Tom Zarimis (Philon)
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Date 14 February 2018	**Verified by**  Stephen Gray

Revision	Description	Distribution	Date
1	Final Report		February 2018

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Terminology used in this Report

The revision of the Australian Rainfall and Runoff Guidelines (2016) (Reference 4) has resulted in a change in the terminology used to refer to the probability of floods. Most notably, Average Recurrence Interval (ARI) has been replaced with Annual Exceedance Probability (AEP). AEP is expressed using the percentage probability that an event of a certain size or larger will occur in any one year. For example, the 100 year ARI (or 1 in 100 year ARI) flood event is now referred to as the 1% AEP flood event.

The Probable Maximum Flood (PMF) is the largest possible flood that can occur at a given location. The probability of the event is in the order of 1 in 1 million years, which is 10,000 times more rare than the 1% AEP flood event. The 1% AEP rainfall is in the order of 80 mm (occurring over an hour). The PMF for the site is in the order of 450 mm occurring over 30 minutes.

Executive Summary

Redevelopment of Concord RSL (the subject site) is proposed to include an integrated seniors' independent living village. The subject site is located on Nirranda Street in Concord, east of the intersection with Nullawarra Avenue, as indicated in Figure 1 (see rear of report for figures). As per requirements for a Site Compatibility Certificate, the following flood assessment has been prepared.

The objective of this analysis is to define the existing flood situation for the subject site in the 1% AEP and PMF flood events.

The Floodplain Development Manual 2005 (FDM) (Reference 3) is a State Government Guideline that aims to guide development on the floodplain. The manual outlines the following development provisions pertinent to this assessment and these are listed below:

- *"Higher FPL's (than the 1% AEP plus 0.5 m freeboard) may be necessary for aged care facilities and other types of developments with particular evacuation or emergency response issues."* (Section K 3.1 FPLs for Development Control)
- *"Access routes do not have to be above the PMF level but be at a level of protection that, in combination with effective warning time, development type and flood duration, provides adequate time of evacuation and reduces risk to acceptable levels."* (Section L 6.8 Effective Flood Access)

The modelling herein has established the existing flood conditions at the subject site for the 1% AEP and PMF events. Flood liability is shown in Figures 4 and 6 for the 1% AEP and PMF events, respectively.

Further, as per the FDM, we have assessed the flood risk at the site by examining various aspects of the flooding as recommended by the FDM. In summary we are of the view that the proposed developments flood risk can be managed to an acceptable level. We base our conclusion on the following:

- **Flood Mechanism** – the subject site is impacted by runoff from a low density urban catchment area of 150 hectares only. Flooding is overland and not mainstream. Flood waters at the subject site are ponded and not free flowing and hence velocities are low. Flood waters initially store in the lowest mangrove remnants on the southern side of Norman Drive. Water which is excess of drainage existing system capacity will pond, with drainage occurring via seven 1.2 diameter trunk pipes. Flooding at the subject site in the 1% AEP event is relatively minor in extent. A review of all available information, including interviews with long-time residents of the area, has failed to identify any historical flood events that have impacted the subject site;
- **Development type** – the Site Compatibility Certificate is for an integrated seniors' independent living village. We are of the view this specific usage reduces the necessity for PMF egress as per the NSW Floodplain Development Manual (NSW, 2005);
- **Evacuation** – clearly the subject site, being located in a relatively small urban catchment, has no effective warning time. The development as proposed will have its lowest habitable floor levels above the PMF level (note this is also a Council requirement). As such, evacuation in place, the only realistic response to the flooding hazard, is implicitly achieved; and finally
- **Flood Duration** - The opportunity for the duration of flooding to hamper site egress is limited as shown in Plot 1. Egress at all times will be available, even for small cars, in the 1% AEP event. It is only for events rarer than the 1% AEP event that site egress may be hampered. If we examine the worst case PMF event, we note that floodwaters impact on site egress for

between one and two hours. We confirm that this is indicative of short duration flooding and that this also contributes to reducing risk to acceptable levels at the subject site.

Based on the above analysis then and the FDM criteria articulated herein, it is clear that the proposed development can be achieved with flood risks kept at acceptable levels.

1. Background

Redevelopment of Concord RSL (the subject site) is proposed including an integrated seniors' independent living village. The subject site is located on Nirranda Street in Concord, east of the intersection with Nullawarra Avenue, as indicated in Figure 1 (see rear of report for figures).

The site is subject to limited flooding in the 1% AEP event (see Figures 4 and 5 at rear of report). 1% AEP flood levels and extents are sensitive to both the tide level and the degree to which drainage assets are blocked.

The following work scope has been executed:

- Site Visit;
- Collection of previous studies and review;
- Contacted Canada Bay Council to obtain trunk drainage details;
- Coarse Rainfall on Grid modelling (as preliminary);
- Development of detailed hydrologic and hydraulic flood models for the site;
- Provision of relevant flood information for the site inclusive of mapping, levels etc.; and
- Reporting inclusive of relevant flood policy requirements for the proposed development.

The goal of the work was to define the existing flood situation for the subject site in the 1% AEP and PMF flood events for a Site Compatibility Certificate (SCC) application, used as a part of the Seniors Housing SEPP. This work also involved summarising applicable flood provisions from the Floodplain Development Manual and providing recommendations regarding the development and compliance with consent requirements.

2. Relevant Policy

2.1 Floodplain Development Manual

The Floodplain Development Manual 2005 (Reference 3) supports the Flood Prone Land Policy to reduce the impact of flooding, flood liability on owners/occupiers of flood-prone property and reduce public and private losses. The manual outlines various development provisions, most pertinent of which to this assessment are:

- *"Higher FPL's (than the 1% AEP plus 0.5 m freeboard) may be necessary for aged care facilities and other types of developments with particular evacuation or emergency response issues."* (Section K 3.1 FPLs for Development Control)
- *"Access routes do not have to be above the PMF level but be at a level of protection that, in combination with effective warning time, development type and flood duration, provides adequate time of evacuation and reduces risk to acceptable levels."* (Section L 6.8 Effective Flood Access)

3. 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 (WBNM) to convert rainfall into runoff and then a hydraulic model (TUFLOW) to convert applied runoff into flood depths and levels. Both WBNM and TUFOW are commonly used in Australia for flood modelling and can be considered best practice.

The study was conducted in accordance with methodology recommended in Australian Rainfall and Runoff (AR&R, Reference 1).

3.1 Hydrologic Model

A hydrologic model was developed using WBNM to convert rainfall into runoff for input in the TUFLOW hydraulic model. This process involves an analysis on the 150 hectare catchment upstream of site (shown in Figure 2). The following information was used in this model:

- Percentage impervious for each catchment;
- Bureau of Meteorology 1987 rainfall intensities;
- A lag parameter of 1.6 (default and recommended in the absence of gauged data justifying adoption of other values);
- For the 1% AEP Event:
    - Initial Loss: 10 mm
    - Continuing Loss: 2.5 mm/hr
- For the PMF Event:
    - Initial Loss: 1 mm
    - Continuing Loss: 0 mm/hr

A critical duration analysis was undertaken in the hydrologic model which found that the 2 hour duration was critical in the 1% AEP event and the 45 minute duration in the PMF event.

3.2 TUFLOW Model Build

GRCHydro have built a modelling system to undertake the following assessment. TUFLOW is a hydraulic modelling tool that can utilise one and two-dimensional model elements.

The hydraulic modelling system is comprised of the following elements:

- LiDAR data has been used to inform a 2 m finite difference grid. This data has a typical accuracy of ±0.15 m (1st confidence interval);
- Pipe elements (shown in Figure 3) are included based on pipe diameter and configuration provided by Council. This data did not include pipe inverts and as such inverts were informed by an offset from Lidar ground elevations;
- Manning's roughness values were applied as follows (shown in Figure 3):
    - General: 0.04
    - Roads: 0.02
    - Golf Course: 0.04
    - Dense Vegetation: 0.07
- A fixed tailwater was adopted at the catchment's downstream boundary (more information is provided below in Table 1).

4. Existing Flood Behaviour

The tailwater and storm water blockage scenarios assessed for the 1% AEP and PMF events are presented in

Table 1. These tailwater levels are based on the Sydney Harbour levels adopted in the City of Sydney Catchment Flood Study (BMT WBM, 2014).

Table 1: Tailwater and Blockage Scenarios Assessed

Scenario	Figure	Design Event	Tailwater	Structure Blockage
A	Figure 4	1% AEP Event	5% AEP Tailwater (1.38 m AHD)	50% blocked
B	Figure 5	1% AEP Event	Mean sea level (0 m AHD)	*No blockage*
C	Figure 6	PMF Event	1% AEP Tailwater (1.44 m AHD)	*No blockage*
D	Figure 7	PMF Event	Mean sea level (0 m AHD)	*No blockage*

Figure 4 (Scenario A) shows the existing flood behaviour in the vicinity of the subject site in the 1% AEP event assuming an elevated tide condition and 50% pipe blockage (a conservative 1% AEP scenario). Flow arrives at the site primarily from the south-west where floodwaters flow around the development and into two flow paths (one to the north of the site and another to the south). Both of these flow paths terminate at large inlet pits which outlet into Yaralla Bay. In the 1% AEP event, the capacity of the existing drainage system is exceeded and additional flow is conveyed overland

Figure 6 (Scenario C) presents the existing flood behaviour for the PMF event.

Figure 9 presents the flood levels and depths for the 1% AEP (Scenario A) and PMF (Scenario C) events.

5. Sensitivity Analysis

The Study Area's sensitivity to tailwater level and structure blockage in the trunk drainage system were examined using the hydraulic model.

Scenario B applied a mean sea level (0 m AHD) and an unblocked stormwater network in the 1% AEP event. Figure 5 shows the peak flood depths and levels for this scenario. A comparison of both 1% AEP figures (4 and 5) indicate that the study area is sensitive to the tailwater level in Yaralla Bay and structure blockage with a flood level difference of up to approximately 0.65 m adjacent to the subject site.

Figure 7 presents the peak flood depths and levels when a mean sea level (0 m AHD) is applied in the PMF event (Scenario D). A comparison of Figures 6 and 7 indicate that the study area is insensitive to the applied tailwater in the PMF event.

6. Flood Egress

Flood egress at the subject site is affected by flood liability. More details are provided in the following sections.

6.1 Flood Hazard

Flood hazard is a measure of the potential harm posed by flooding and considers a number of factors including depth of flooding, velocity of flood waters, access to escape routes and duration of inundation. The preliminary flood hazard for Scenario A for the 1% AEP event is shown in Figure 8. These flood hazard categories were defined in accordance with the Floodplain Development Manual (Figure L2) (Reference 3) as indicated in Image 1 (below).

Image 1: Hydraulic Hazard Categories (Reference 3)

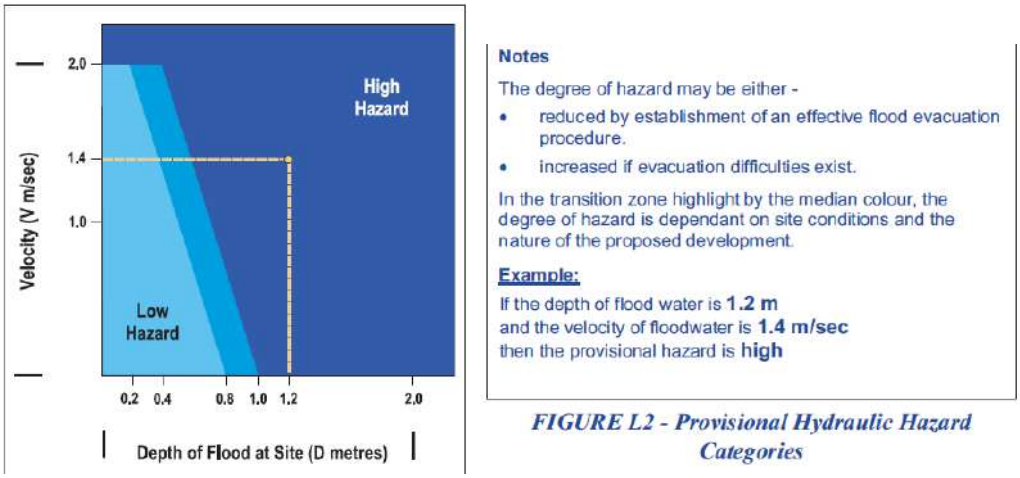


FIGURE L2 - Provisional Hydraulic Hazard Categories

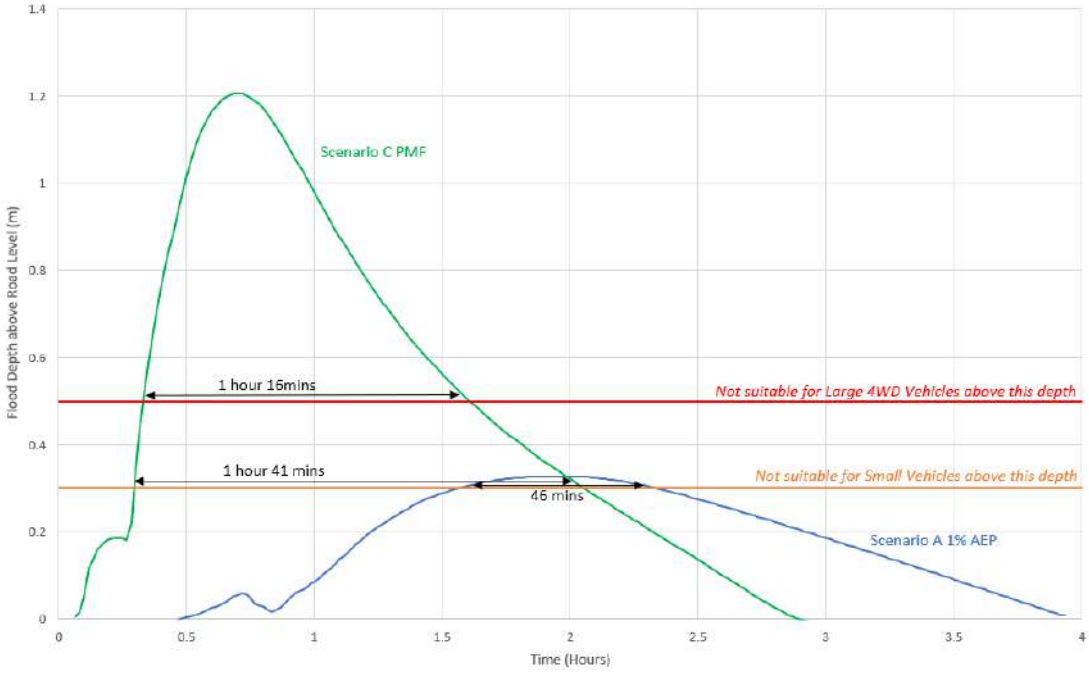
In the 1% AEP, the site is primarily affected by low hazard flooding and limited high hazard flooding to the south-east of the site. The proposed route for flood access (along the western site of Nirranda Street, then north along Nullawarra Avenue) is affected by low hazard flooding only.

6.2 Depth and Duration of Inundation

The existing flood behaviour presented in Figure 4 for the 1% AEP event and Figure 6 for the PMF event indicate that flood access is possible for the 1% AEP event. Based on Book 6, Section 7.2.4 of ARR2016 (Reference 4), small vehicles can withstand flood depths of up to 0.3 m before beginning to float. Large four-wheeled drive vehicles can withstand flood depths of up to 0.5 m before they float.

Plot 1 (below) provides the duration of inundation at the lowest point on the proposed egress route (along the western side of Nirranda Street, then north along Nullawarra Avenue). This point is identified in Figure 1. As can be seen, small cars have egress from the site even in the 1% AEP event.

Plot 1: Duration of Inundation for Small and Large Vehicles



In the PMF, large flood depths result in access for small vehicles being cut for approximately 1 hour 41 minutes and for 1 hour 16 minutes for large 4WD vehicles. It is estimated that Ambulance access would lie somewhere between these two figures (1 hour 30 minutes).

7. Conclusions

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Based on the above analysis then and the FDM criteria articulated herein, it is clear that the proposed development can be achieved with flood risks kept at acceptable levels.

8. References

1. Pilgrim DH (Editor in Chief), **Australian Rainfall and Runoff – A Guide to Flood Estimation**, Institution of Engineers, Australia, 1987.
2. City of Canada Bay, **City of Canada Bay Development Control Plan 2017**, March 2017.
3. NSW Government, **Floodplain Development Manual**, 2005.
4. Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) **Australian Rainfall and Runoff: A Guide to Flood Estimation**, © Commonwealth of Australia (Geoscience Australia), 2016.

FIGURES

FIGURE 1
CONCORD RSL REDEVELOPMENT
SUBJECT SITE LOCATION

YARALLA BAY

NORTHERN FLOW PATH

SOUTHERN FLOW PATH

MYALL STREET

NULLAWARRA AVENUE

WILGA STREET

NIRRANDA STREET

NORMAN STREET

MEPUNGA STREET

Source: Google Earth

Duration of Inundation Inspection Point

Subject Site

Cadastral Boundaries

N

0 250

metres

FIGURE 2
CONCORD RSL REDEVELOPMENT
UPSTREAM CATCHMENT & GROUND LEVEL

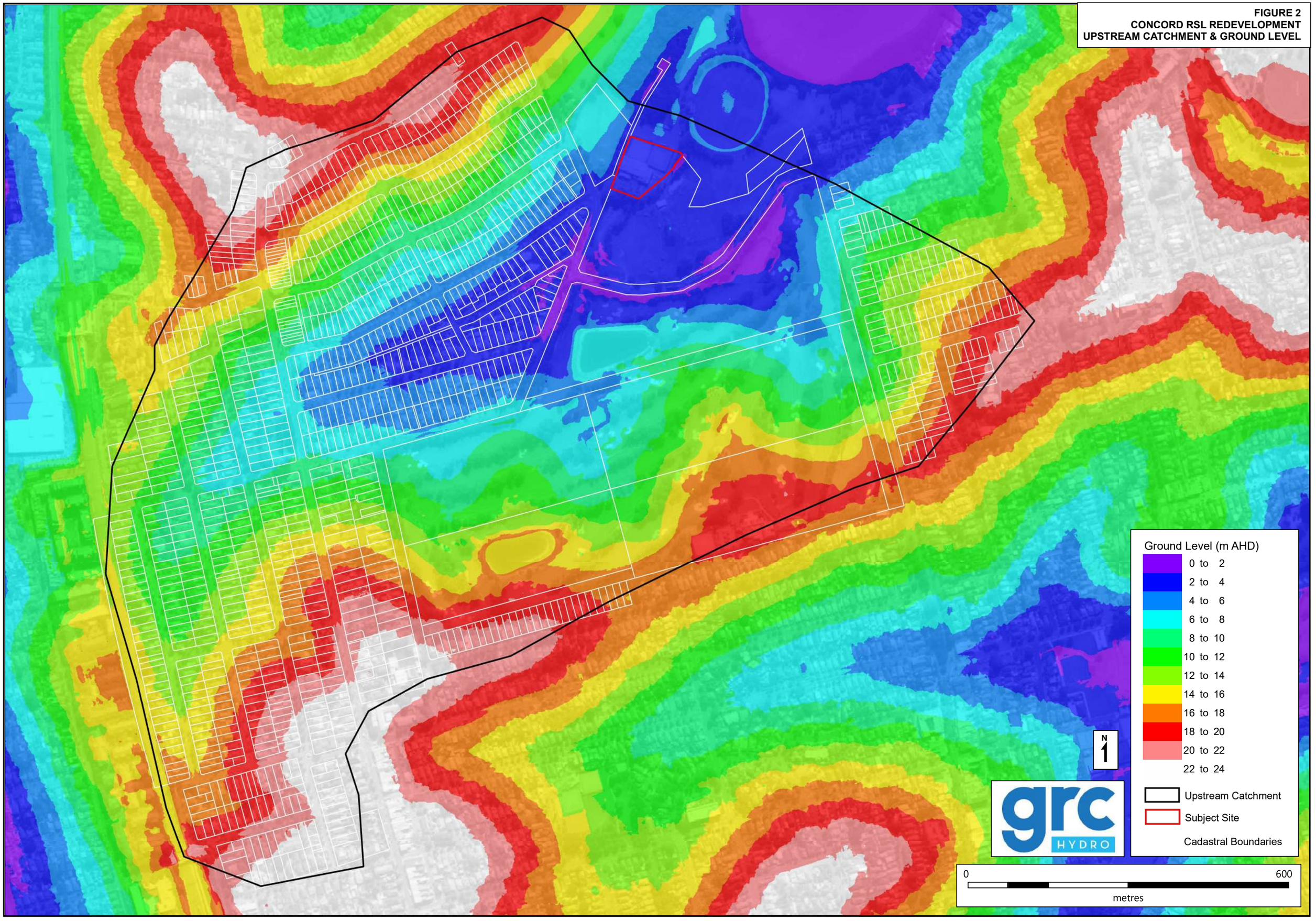

FIGURE 3
CONCORD RSL REDEVELOPMENT
HYDRAULIC MODEL ROUGHNESS VALUES

Manning's Values
- Residential (Manning's Value 0.04)
- Golf Course (Manning's Value = 0.04)
- Dense Vegetation (Manning's Value = 0.07)
- Roads (Manning's Value = 0.02)
- Stormwater Network
- Hydraulic Model Boundary

N

grc HYDRO

0 500
metres

FIGURE 4
EXISTING CONDITIONS 1% AEP DESIGN EVENT
SCENARIO A - PEAK FLOOD DEPTHS & LEVELS

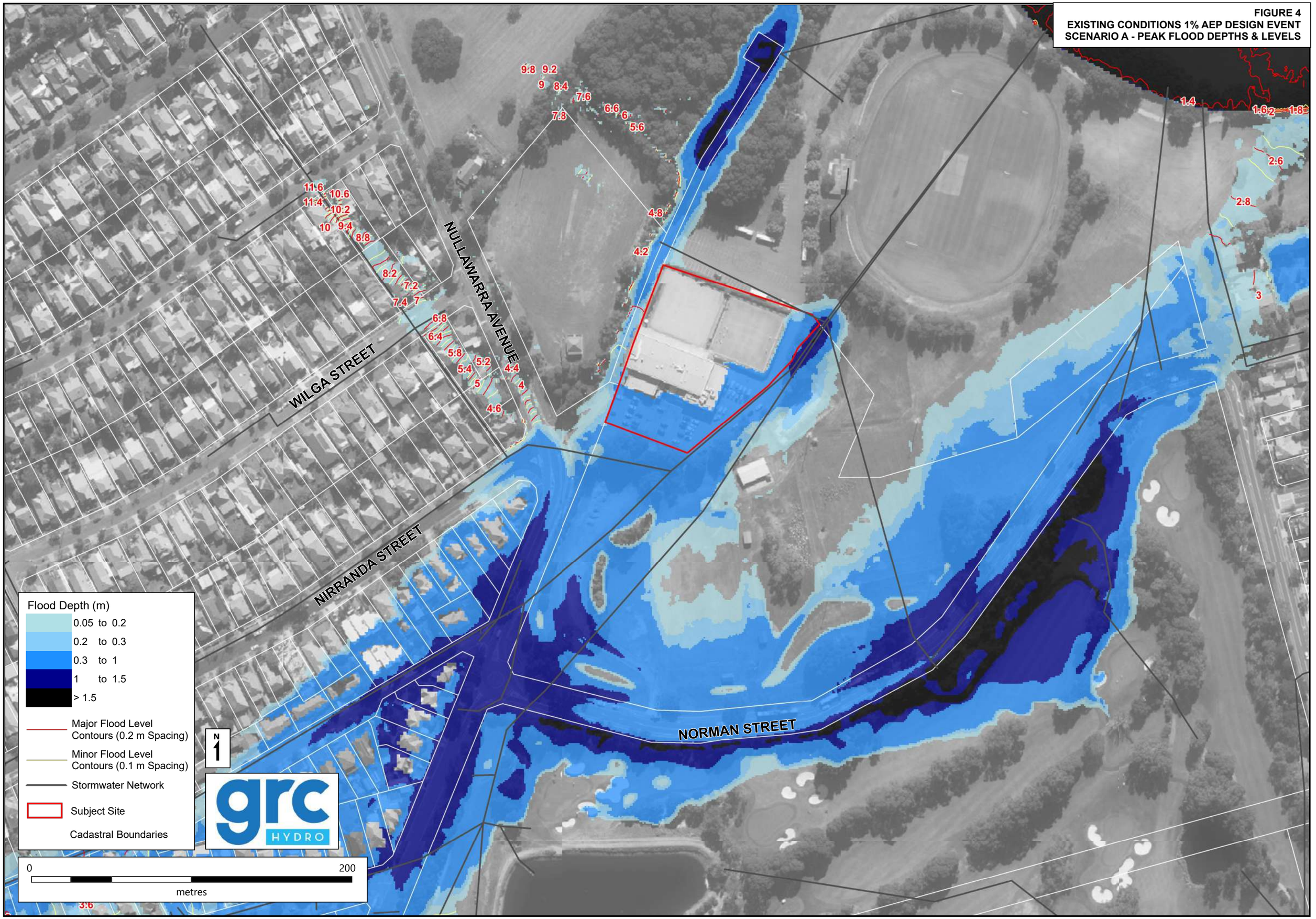

FIGURE 5
EXISTING CONDITIONS 1% AEP DESIGN EVENT
SCENARIO B - PEAK FLOOD DEPTHS & LEVELS

NULLAWARRA AVENUE
WILGA STREET
NIRRANDA STREET
NORMAN STREET

Flood Depth (m)
- 0.05 to 0.2
- 0.2 to 0.3
- 0.3 to 1
- 1 to 1.5
- > 1.5

Major Flood Level Contours (0.2 m Spacing)
Minor Flood Level Contours (0.1 m Spacing)
Stormwater Network
Subject Site
Cadastral Boundaries

N
1

grc HYDRO

0 200
metres

FIGURE 6
EXISTING CONDITIONS PMF DESIGN EVENT
SCENARIO C - PEAK FLOOD DEPTHS & LEVELS

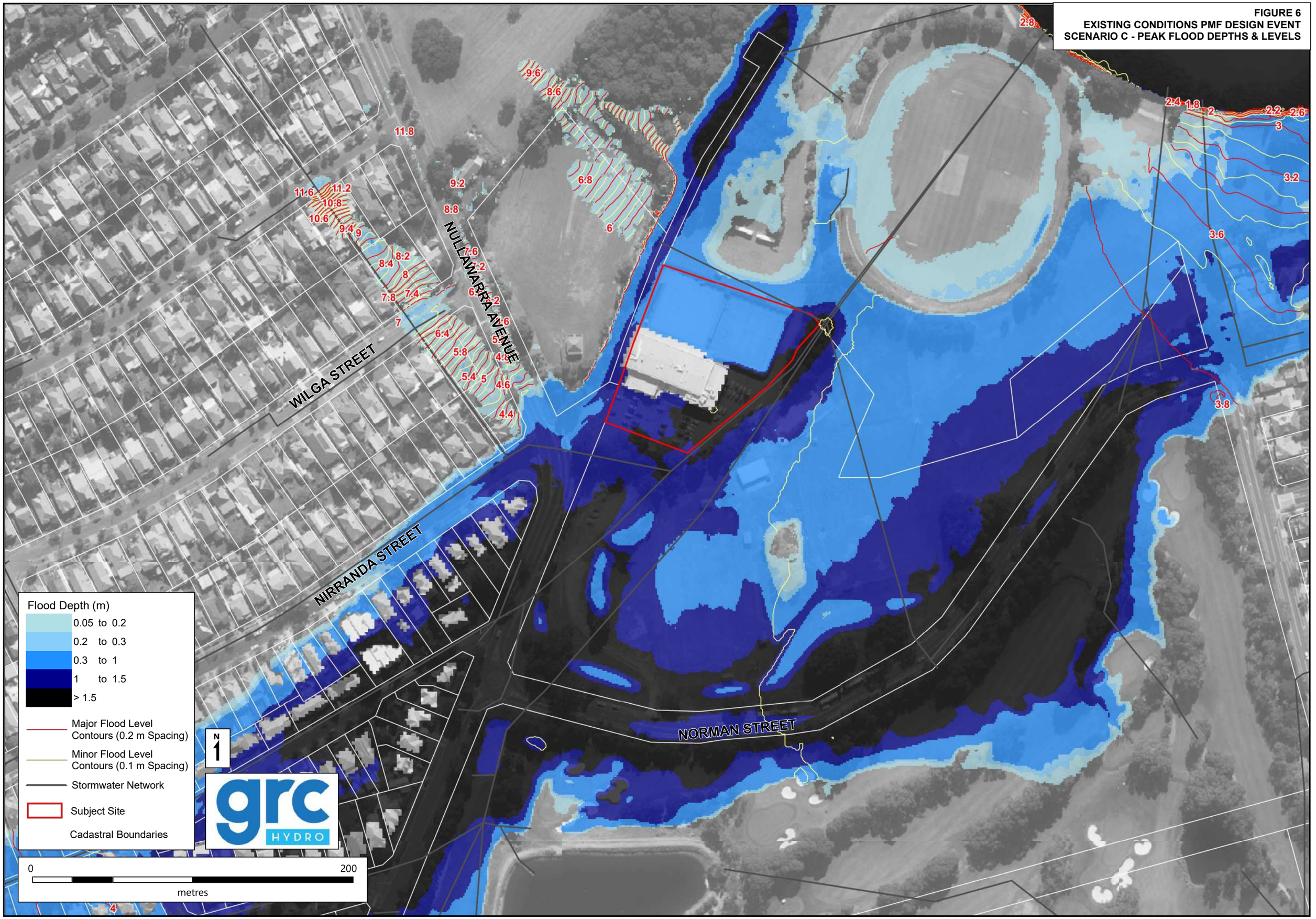

FIGURE 7
EXISTING CONDITIONS PMF DESIGN EVENT
SCENARIO D - PEAK FLOOD DEPTHS & LEVELS

WILGA STREET
NULLAWARRA AVENUE
NIRRANDA STREET
NORMAN STREET

Flood Depth (m)
- 0.05 to 0.2
- 0.2 to 0.3
- 0.3 to 1
- 1 to 1.5
- > 1.5

Major Flood Level Contours (0.2 m Spacing)
Minor Flood Level Contours (0.1 m Spacing)
Stormwater Network
Subject Site
Cadastral Boundaries

N
1

grc HYDRO

0 200
metres

FIGURE 8
EXISTING CONDITIONS 1% AEP DESIGN EVENT
SCENARIO A - PRELIMINARY FLOOD HAZARD

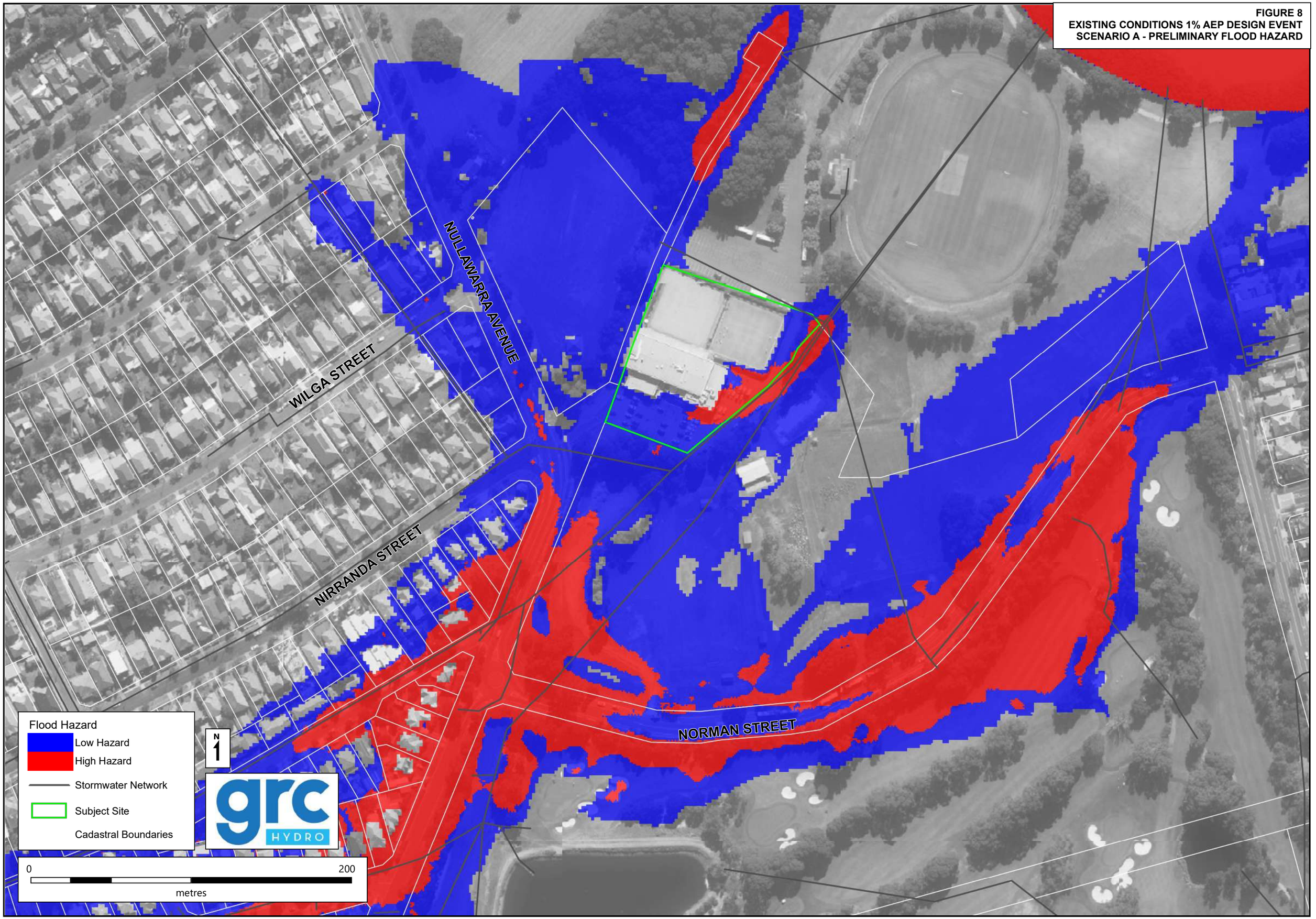

FIGURE 9
EXISTING CONDITIONS
PMF AND 1% AEP DESIGN LEVELS

3.24 mAHD
0.09 m
3.91 mAHD
0.76 m

Not Flooded
3.91 mAHD
0.51 m

Not Flooded
3.90 mAHD
0.56 m

Not Flooded
3.90 mAHD
0.67 m

3.12 mAHD
0.25 m
3.91 mAHD
1.05 m

3.03 mAHD
0.85 m
3.90 mAHD
1.72 m

3.03 mAHD
0.46 m
3.91 mAHD
1.34 m

3.04 mAHD
0.55 m
3.91 mAHD
1.42 m

1% AEP FLOOD LEVEL (m AHD)
1% AEP FLOOD DEPTH (m)
PMF FLOOD LEVEL (m AHD)
PMF FLOOD DEPTH (m)
Stormwater Network
Subject Site
Cadastral Boundaries

N

grc HYDRO

0 50
metres