ST ANTHONY OF PADUA, MASTERPLAN

FLOOD ASSESSMENT

On behalf of Munns Sly Moore Architects

FINAL REPORT

JULY 2019

GRC Hydro
Level 9, 233 Castlereagh Street
Sydney NSW 2000

Tel: +61 432 477 036
www.grchydro.com.au

FINAL REPORT

Project Number:	*170041*
Project Name:	*St Anthony of Padua, Masterplan – Flood Assessment*
Date:	*3 July 2019*

Client:	Munns Sly Moore Architects
Client Contact:	Erik Innes

Authors:	 Beth Marson

Reviewed by:	 Stephen Gray

Table of Contents

1. Introduction

GRC Hydro have been engaged by Munns Sly Moore Architects to undertake a flood assessment for proposed development (as per the masterplan shown in Appendix A) at St Anthony of Padua, Catholic School in Austral (the subject site). Figure 1 presents the site's locality (see rear of report for figures). This flood study has been carried out using the 2D hydrodynamic modelling program, TUFLOW.

The site is located in the headwaters of the Kemps Creek catchment, with the watershed boundary being Edmonson/Tenth Avenue approximately 250m to the South-East. Flooding at the site is minor overland flow with depths in the 1% AEP event in the order of about 150mm to 300mm at most. In the PMF event flood depths increase to between 150mm and 600mm.

The site runs off into the Kemps Creek catchment which then in turn flows in a north direction and is a tributary of South Creek.

The site is currently composed of nine rural residential lots. The proposed development consists of a merger of the existing lots and the construction of an education facility. The masterplan is presented in Appendix A, and the proposed ground level is shown in Figure 8.

2. Work Scope

The following work scope has been executed:

- Site Visit;
- Development of detailed hydrologic and hydraulic flood models for the site inclusive of proposed case Masterplan represented as a 3D terrain model which has been inserted into the TUFLOW model;
- Provision of relevant flood information, as per Council's DCP, for the site inclusive of mapping, levels, etc.;
- Assessment of flood impacts associated with the proposed masterplan; and
- Reporting.

The goal of the work was to define design flood affectation at the subject site, ensure that the Masterplan was sympathetic to the site's existing flood affectation, that flood risk management was optimised and that compliance with Council requirements was achieved.

The work included defining design flood affectation for the subject site in the 1% AEP and PMF flood events. Also summarising applicable flood provisions from the *Camden Growth Centre Precincts Development Control Plan (DCP) 2015 – Schedule 1 (Austral and Leppington North)* and providing recommendations regarding the development and compliance with consent requirements.

3. Camden Growth Centre Precincts DCP 2015

The Camden Growth Centres DCP 2015 is applicable to this proposed masterplan.

The following table shows the comments to the relevant controls which are outlined in Section 4.3.1 *"Land affected by flooding*":

Table 1. The Camden Growth Centres DCP 2015 Controls and Comments

Clause	Controls	Comments
1	An example of the preferred subdivision pattern and locations of dwellings in the Environmental Living zone is at Figure 4-4. All applications for subdivision or for new dwellings are to demonstrate consistency with Figure 4-4.	NA
2	Where land zoned Environmental Living is also affected by flooding, dwellings are to be located outside the extent of the 1 in 100 year flood line (refer Figure 2-3).	As per Council correspondence floor levels are set at the PMF level
3	The floor level of all dwellings is to be at least 500mm above the level of the 1 in 100 year flood.	Compliant - the proposed works actually remove several fences from the land as nine lots are consoldated into one effectively.
4	Fencing within areas affected by the 1 in 100 year flood is to be minimised, and the design of fencing is to ensure that flood waters are not affected and that debris will not become trapped in fences.	Compliant - in the PMF depths do not exceed ~ 0.5 m in general and hazard is low. With no effective warning time evacuation in place is the only possible response and the design facilitates this by having all building floor levels at the PMF or higher.
5	The design of subdivision and the location of dwellings is to ensure that all residents are able to safely evacuate in the event of a flood. Evacuation routes are to be submitted with the development application.	others
6	Dwellings and other buildings are not be located within land affected by the Environmental Protection Overlay, shown on the Indicative Layout Plan.	others
7	Applications for new residential development or subdivision within the Environmental Living zone are to include landscaping plans and a vegetation management plan demonstrating how native vegetation is to be protected, rehabilitated and/or restored as part of the development. Landscaping is to consist of predominately native (preferably native to the local area) species.	others
8	Applicants are to demonstrate compliance with the requirements of Planning for Bushfire Protection where new development is proposed within the Environmental Living zone. The application is to consider protection from bushfire hazards relating to remnant vegetation and to vegetation that is proposed to be planted on the property or on adjoining properties.	others

Further, additional controls articulated by Council in our meeting of June 26th, 2019 are that all building floor levels should be equal or greater than the PMF and there should be no impact on adjoining private property.

4. Methodology

Existing design flood behaviour for the subject site is defined by hydraulic modelling developed as a part of the current study (Note this work pre-dates the availability of Council's model and hence our continuing are of it). This modelling is based on the use of a direct rainfall approach in a TUFLOW hydraulic model to convert applied rainfall into flood depths and levels. TUFLOW in commonly used in Australia for flood modelling and can be considered best practice.

4.1 Direct Rainfall

A direct rainfall approach applies rainfall directly to the individual cells of the 2D hydraulic model. 'Traditional' flood modelling typically utilises two individual models; a hydrologic model which simulates the rainfall-runoff process of a catchment, and a hydraulic model which uses flow from the hydrologic model to produce flood behaviour such as flood levels, depths and velocities. The direct-rainfall method is a relatively recent method of flood modelling which is particularly useful for overland flow flood modelling in very flat catchments such as the subject site.

As per Project 15 of ARR 2016 care needs to be taken when utilising the direct rainfall method in TUFLOW. Critically runoff hydrographs should be inspected to ensure that hydrologic response is not being unnaturally muted. The site is very well suited to the application of the rainfall on grid methodology owing to its very flat nature and the very poor definition of its flow paths. The chief drawback of applying hydrologic model developed hydrographs to the hydraulic model, as might typically be done, would be that flow concentration might be overestimated.

The modelling work reported upon herein has been conducted in accordance with methodology recommended in Australian Rainfall and Runoff 1987 (AR&R, Reference 1) as well as Project 15 from ARR 2016. Note these were the appropriate standards at the time the study began in 2017.

4.2 TUFLOW Model Build

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

Following initial runs which indicated that areas to the south of the subject site were impacted by local drainage, rather than Major Drainage (or overland flow as it is more commonly called.

The hydraulic modelling system is comprised of the following elements:

- LiDAR data (Nepean East 2011) has been used to inform a 2 m finite difference grid. This data has a typical accuracy of ±0.15 m (1^{st} confidence interval);
- Rainfall losses were applied as follows:
    - Initial Loss: 10 mm
    - Continuing Loss: 2.0 mm/hr
- Pipe elements (shown in Figure 3) are based on data obtained from survey including pipe sizes and invert levels;
- Buildings can block flood waters natural flow path and therefore significantly impact flood behaviour. As such, buildings in the vicinity of the subject site were “nulled” out of the TUFLOW model.
- Manning’s roughness values were applied as follows:
    - General: 0.045
    - Roads: 0.02
    - Sparse Vegetation: 0.055
    - Dense Vegetation: 0.08
- A free draining outlet was allowed at the catchment’s downstream boundary at an appropriate distance downstream so that the boundary behaviour does not impact on design flood level estimates within the subject site.

A critical duration analysis was undertaken in the TUFLOW model which found that the 2 hour storm duration was critical in the 1% AEP event and a 15 minute duration was critical in the PMF event.

5. Existing Flood Behaviour

Figure 3 indicates the existing 1% AEP design flood affectation. Note that all flood maps are trimmed to exclude all flood depths less than 100 mm. This is appropriate as at some threshold overland flow ceases to be a flooding issue and becomes a storm water issue. Trimming of design flood depths less than some threshold depth (typically ranging between 0.1 and 0.3 m in the authors experience) is best practice as it ensures that property effected by inconsequential inundation in the 1% AEP event is not overly restricted relative to flood risk.

If we refer to Figure 4, we can more easily see how flow moves across the site. Note however that Figure 4 shows results for the PMF, not the 1% AEP event. The PMF is a very rare event about 10,000 times rarer than the 1% AEP event. It has been modelled herein as it informs risk management requirements for the site.

As can be seen however there are four flow paths across the site shown in Figure 4. These are separated by a ridge of sorts that splits the site from approximately the SE corner to the NW corner. There is only one flow path in the northern portion of this split, this being the flow path that runs to the NE corner of the site. In the southern portion we see three flow paths; one that runs from east to west across the site out onto Tenth Avenue, another that runs to the SW corner of the site from the NE, and then another that runs from the NE to the SW corner of the lot.

6. Implementation of the Proposed Masterplan

The following elements from the proposed masterplan (shown in Appendix A) were incorporated into the TUFLOW model:

- Proposed buildings were nulled out of the TUFLOW model – this means no flow occurs through the space occupied by buildings;
- Designed ground levels were provided by Warren Smith & Partners (WS&P) as a 3D TIN that was inserted into our model; and
- Proposed pipe elements were based on data obtained from WS&P.

Figure 5 shows the 1% AEP event proposed flood behaviour on the subject site.

The proposed building alignment and the flood levels in PMF event are shown in Figure 7. Council has instructed that all buildings should be no lower than the PMF event flood levels.

7. Flood Impact Assessment

A flood impact assessment has been undertaken which compared the existing and proposed flood behaviour using the TUFLOW hydraulic model. The proposed building alignment (shown in Appendix A) was implemented in the TUFLOW model and the changes in peak flood levels (impacts) compared to the existing conditions for the 1% AEP event as shown in Figure 6.

Flood level impacts of less than 0.01 m are considered to not be significant (Project 15, ARR 2016) and as such are shown as no impact.

8. Conclusions

This flood study and flood impact assessment has been undertaken by qualified civil engineers (specialising in floodplain modelling), in accordance with Australian Rainfall and Runoff, the NSW Floodplain Development Manual and Council's DCP.

Flood behaviour for the subject site has been modelled using a TUFLOW direct rainfall hydraulic modelling system.

The existing conditions and proposed masterplan flood behaviour has been examined. No proposed building is impacted by over floor flood liability. Importantly flood affectation is not exacerbated for any private property other than the subject site.

9. References

1. Pilgrim DH (Editor in Chief), Australian Rainfall and Runoff – A Guide to Flood Estimation, Institution of Engineers, Australia, 1987.

2. NSW Government, Camden Growth Centre Precincts Development Control Plan 2015, 2015.

3. NSW Government, Floodplain Development Manual, 2005.

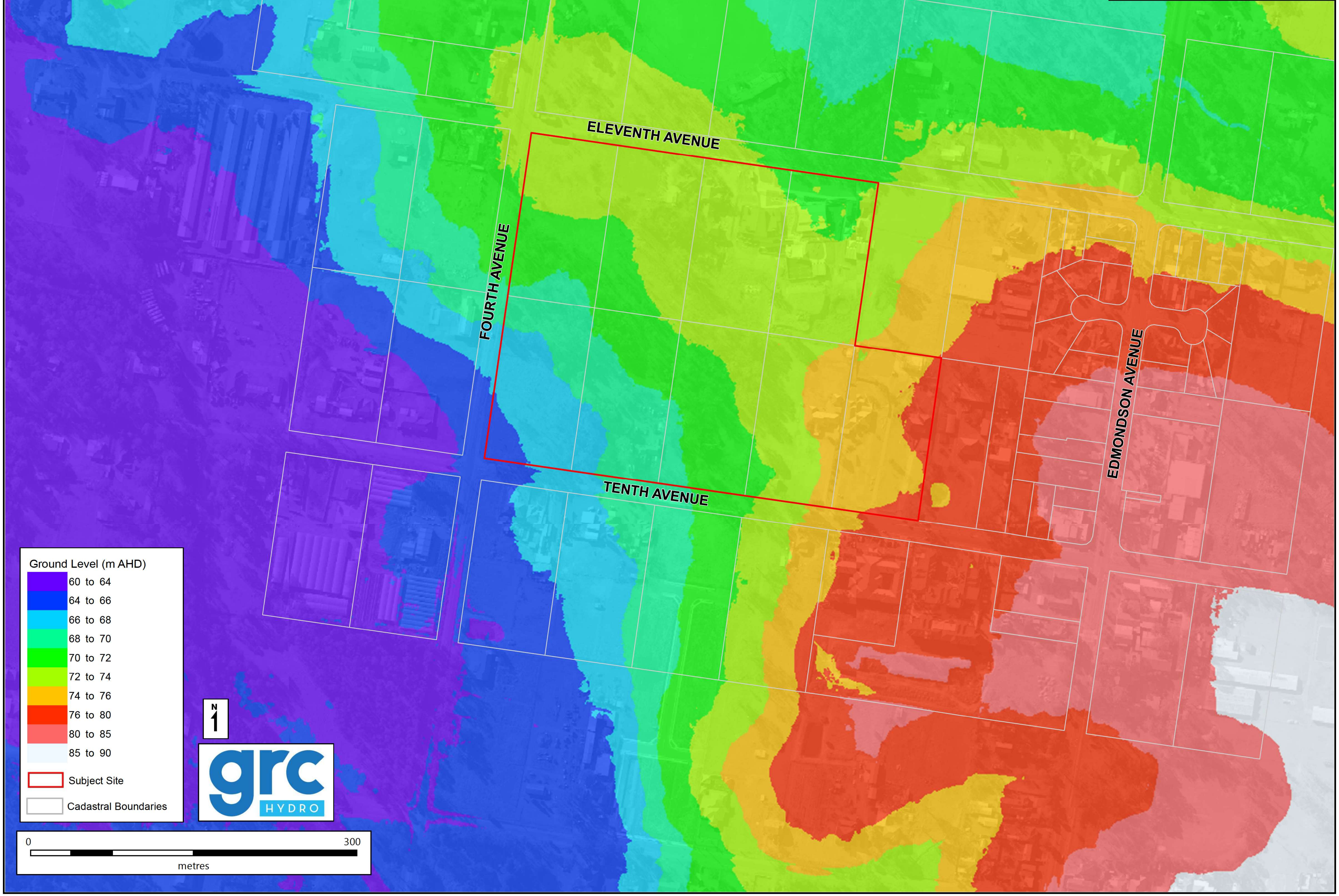
APPENDIX A

LANDSCAPE MASTER PLAN
ST ANTHONY OF PADUA , AUSTRAL
CONCEPT PROPOSAL
L - MP 03 Issue F
LEGEND
ELEVENTH AVENUE
TENTH AVENUE
FOURTH AVENUE

FIGURES

FIGURE 1
CATHOLIC SCHOOL DEVELOPMENT
SUBJECT SITE LOCATION

FIGURE 2
CATHOLIC SCHOOL DEVELOPMENT
GROUND LEVEL



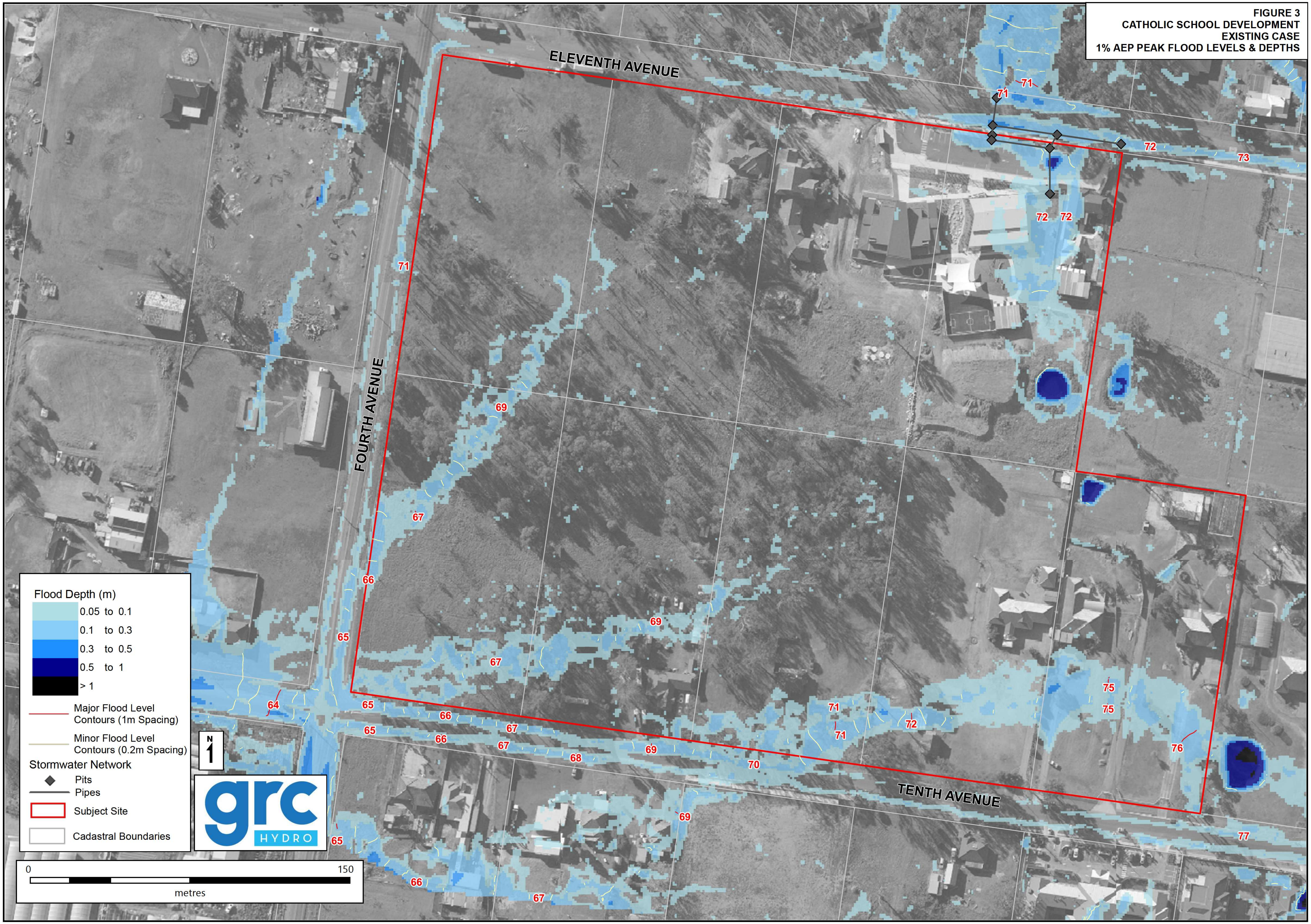


FIGURE 3
CATHOLIC SCHOOL DEVELOPMENT
EXISTING CASE
1% AEP PEAK FLOOD LEVELS & DEPTHS

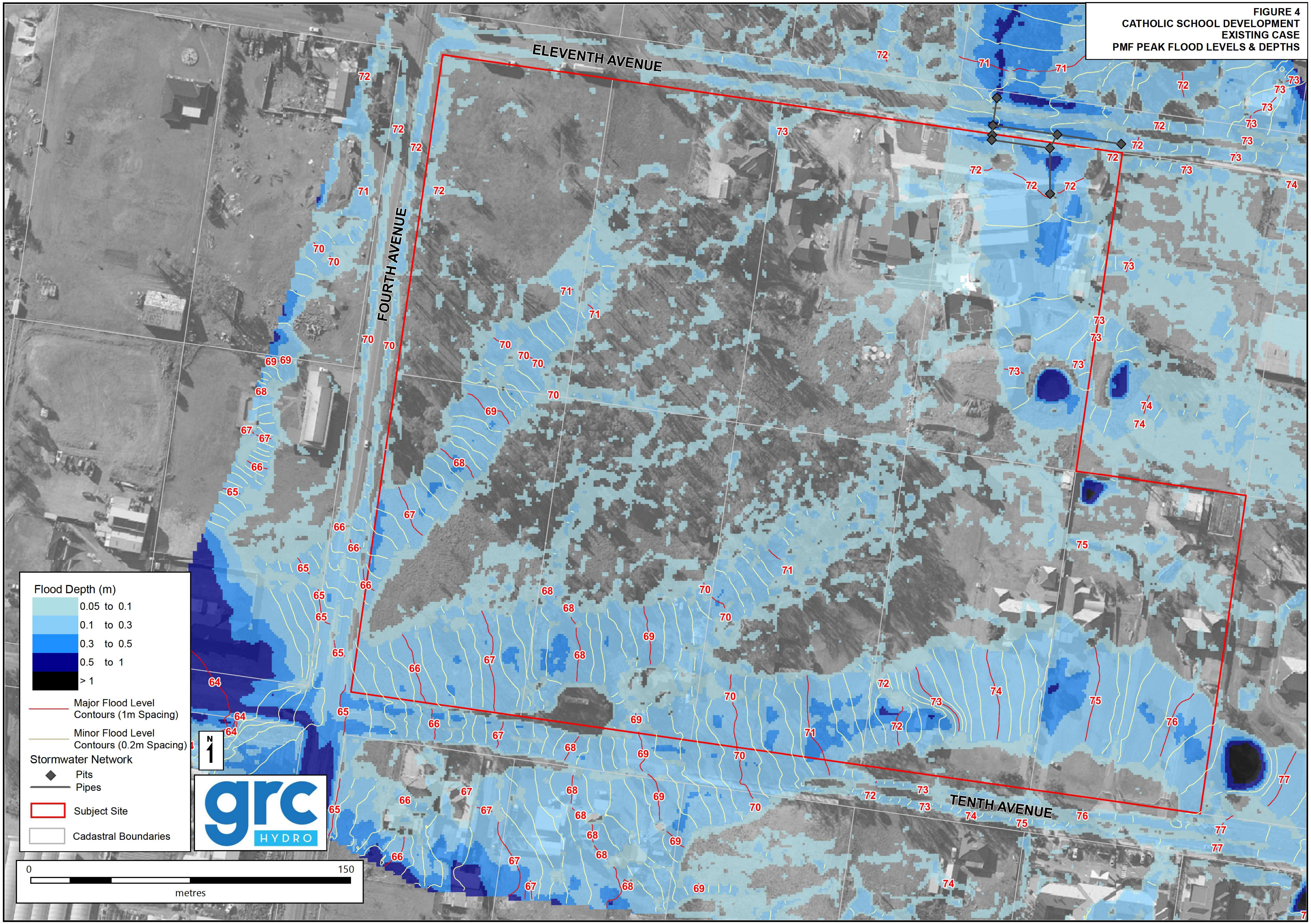
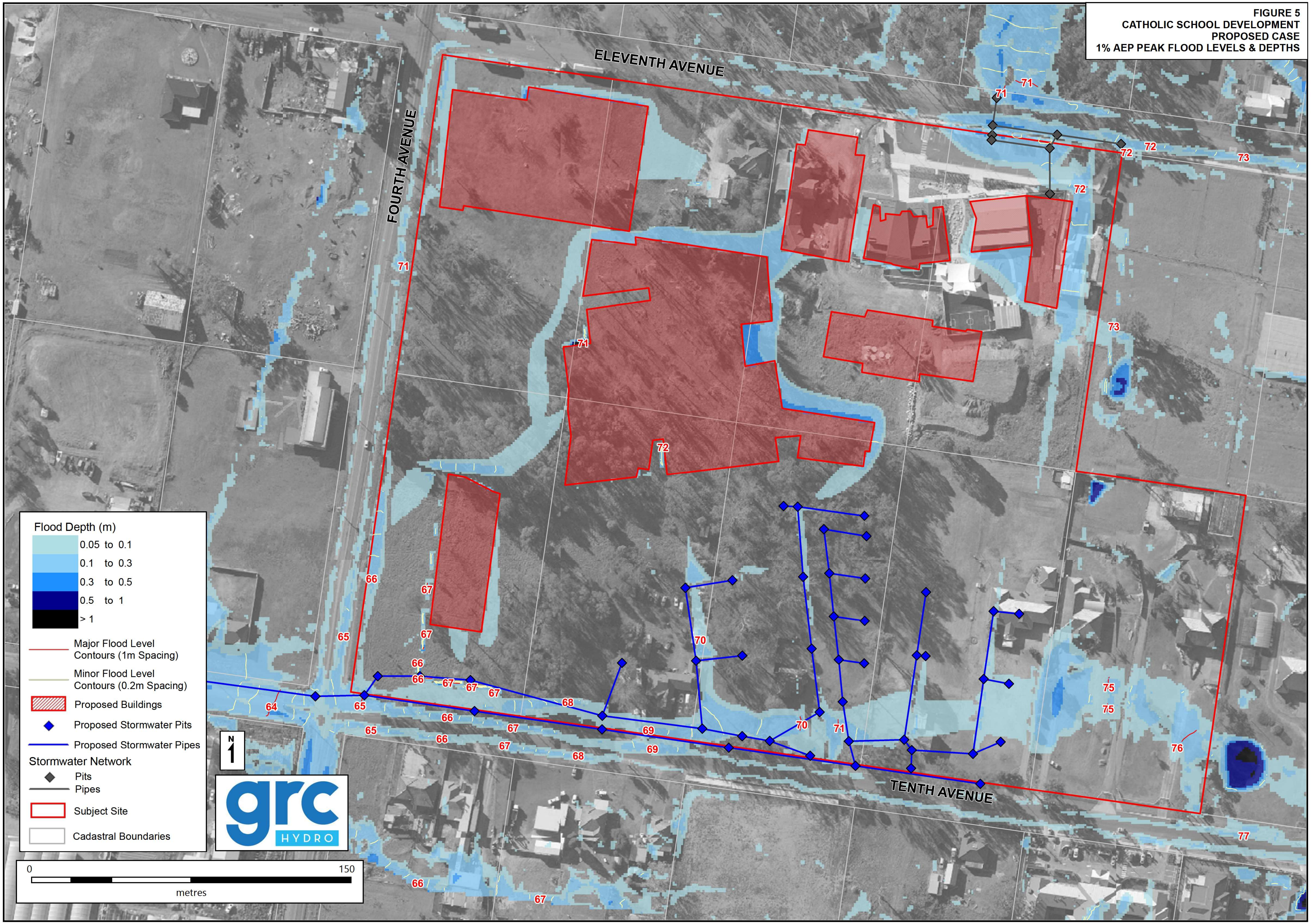


FIGURE 4
CATHOLIC SCHOOL DEVELOPMENT
EXISTING CASE
PMF PEAK FLOOD LEVELS & DEPTHS

FIGURE 5
CATHOLIC SCHOOL DEVELOPMENT
PROPOSED CASE
1% AEP PEAK FLOOD LEVELS & DEPTHS



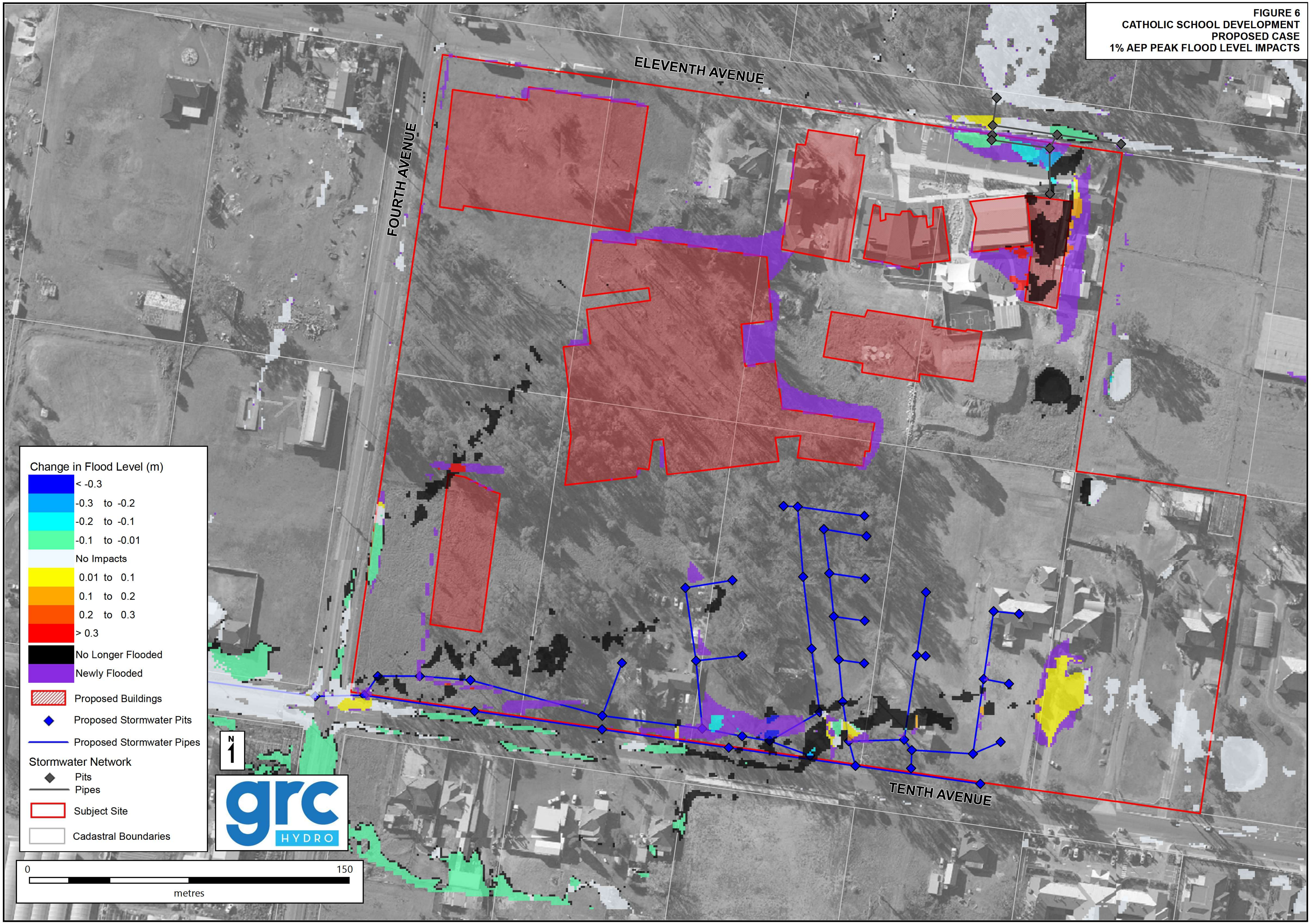


FIGURE 6
CATHOLIC SCHOOL DEVELOPMENT
PROPOSED CASE
1% AEP PEAK FLOOD LEVEL IMPACTS
ELEVENTH AVENUE
FOURTH AVENUE
TENTH AVENUE
Change in Flood Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impacts
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded
Proposed Buildings
Proposed Stormwater Pits
Proposed Stormwater Pipes
Stormwater Network
Pits
Pipes
Subject Site
Cadastral Boundaries
N
grc HYDRO
0
150
metres

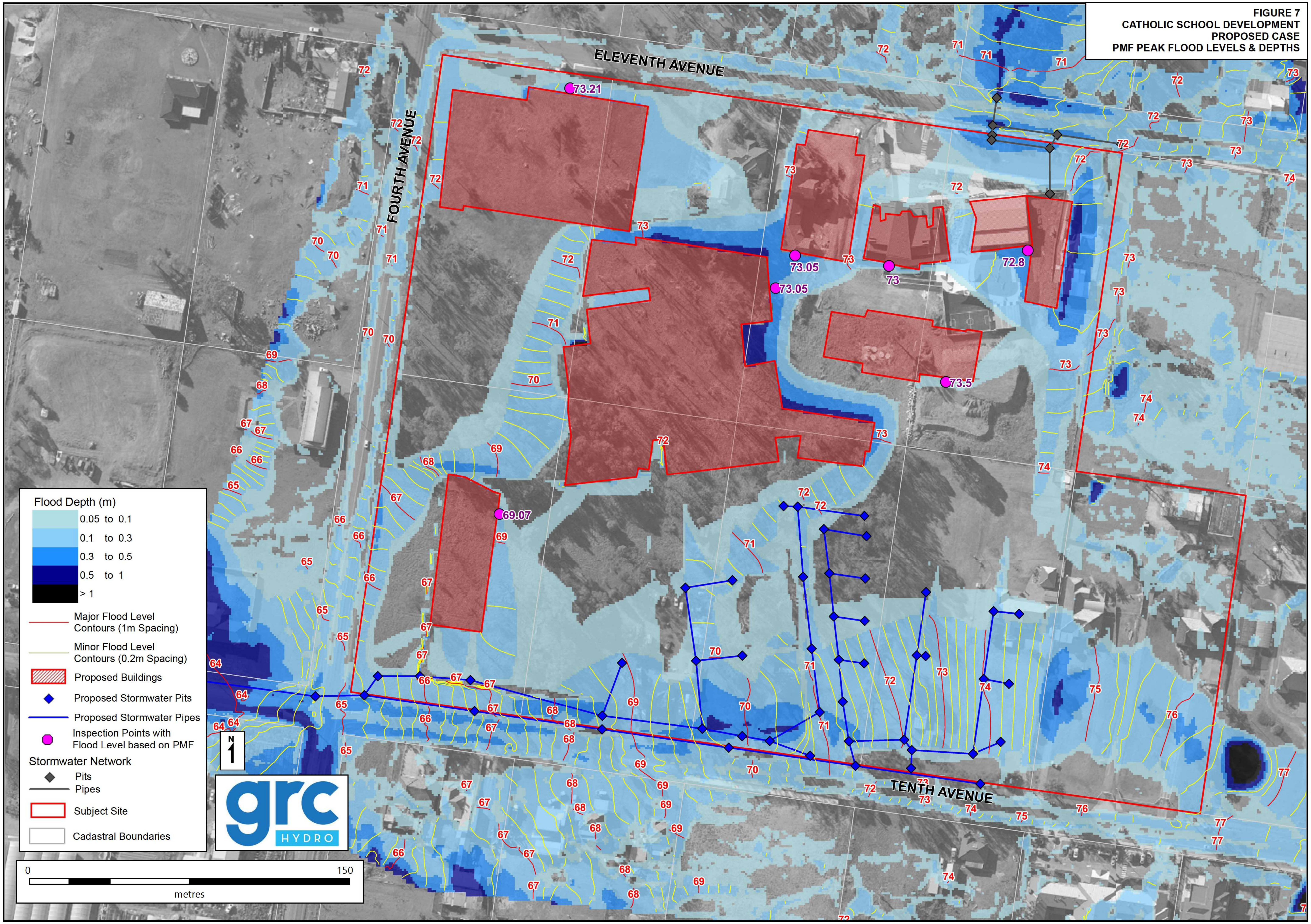


FIGURE 7
CATHOLIC SCHOOL DEVELOPMENT
PROPOSED CASE
PMF PEAK FLOOD LEVELS & DEPTHS
ELEVENTH AVENUE
FOURTH AVENUE
TENTH AVENUE
73.21
73.05
73.05
73
72.8
73.5
69.07
Flood Depth (m)
0.05 to 0.1
0.1 to 0.3
0.3 to 0.5
0.5 to 1
> 1
Major Flood Level Contours (1m Spacing)
Minor Flood Level Contours (0.2m Spacing)
Proposed Buildings
Proposed Stormwater Pits
Proposed Stormwater Pipes
Inspection Points with Flood Level based on PMF
Stormwater Network
Pits
Pipes
Subject Site
Cadastral Boundaries
N
grc
HYDRO
0
150
metres

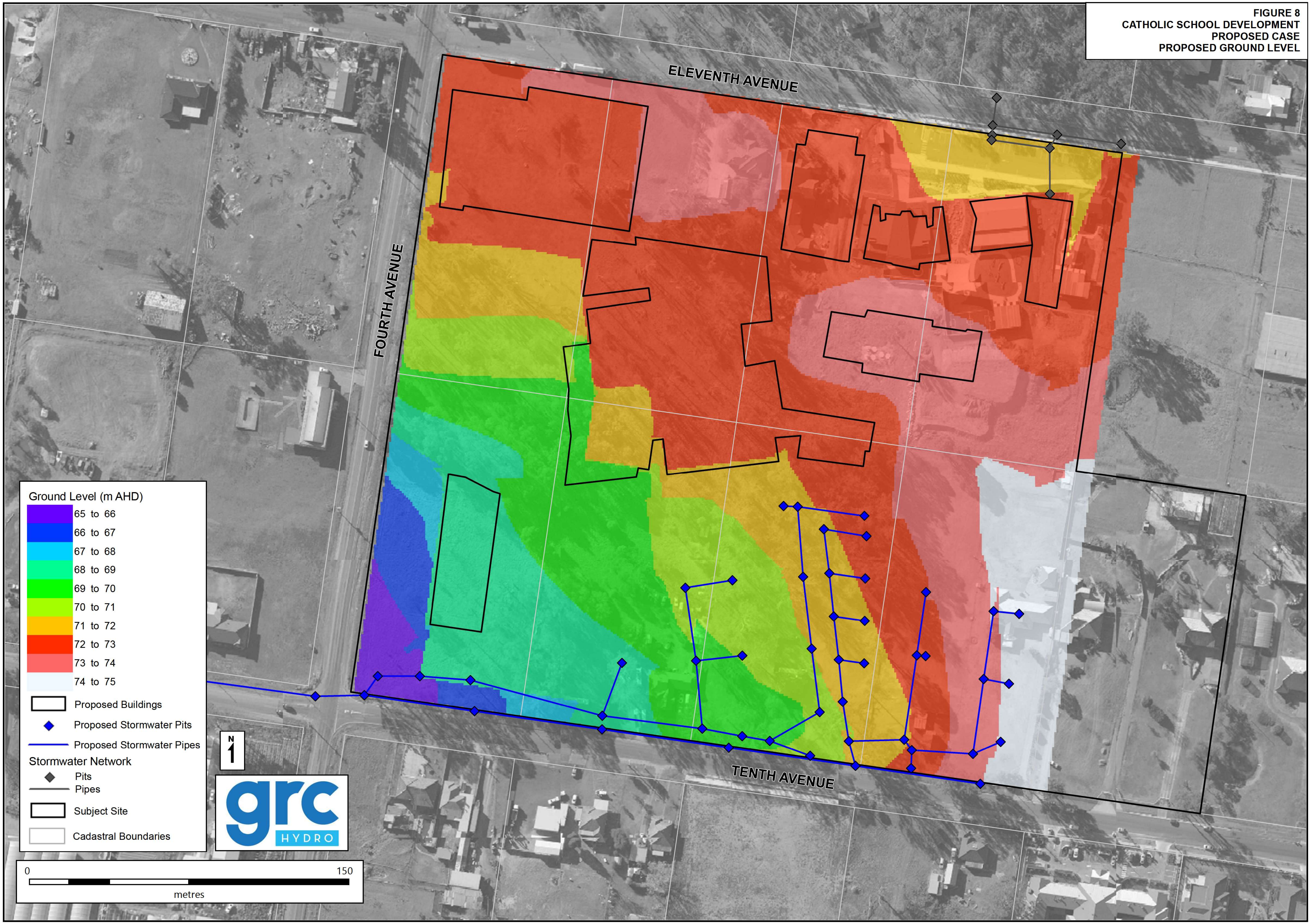


FIGURE 8
CATHOLIC SCHOOL DEVELOPMENT
PROPOSED CASE
PROPOSED GROUND LEVEL