SGC
Engineering Value

Reference: 2014.0191-R02

Date: February 29, 2016

Construct Corp
Attention: Bill Yassine
Suite 601, Level 6, 71 Macquarie Street
Circular Quay NSW 2000

Dear Sir,

RE: PROPOSED TOWNHOUSES – 37-39 PAVESI STREET, GUILFORD WEST

INTRODUCTION

S&G Consultants Pty Ltd (SGC) have been engaged by Construct Corp to carry out an overland flow study in support of the proposed residential development at 37-39 Pavesi Street, Guildford West.

Holroyd City Council requires an overland flow study because the site is noted as flood affected in the flood study for Prospect Creek prepared by Lyall & Associates.

REFERENCE DOCUMENTS

The following documents have been referenced in this report:-

1. Site survey prepared by Land Development Solutions ref. 6154 dated 04/02/2014;
2. Architectural drawings prepared by Form Architects;
3. NSW Government The Floodplain Development Manual – The management of Flood Liable Land (2005);
4. Bureau of Meteorology (2003). The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method, June;
5. Engineers Australia, *Australian Rainfall & Runoff* (AR&R 1999);
6. Aerial Scanning Data (ALS) for the study area received from LPI; and
7. Holroyd City Council DCP 2013 Part A Section 8.0 "Flood Prone Land".

NATURAL & BUILT ENVIRONMENT

The site is made of Lot 37 in DP 10958 being 37-39 Pavesi Street in the suburb of West Guildford. The site falls in the Local Government Area of Holroyd City Council.

The site is bounded by 2 x 1.8m DIA water supply pipes to the North which is the main overland flowpath, Pavesi Street to the South, residential lots to the East and commercial/industrial lots to the West. The site is currently fully developed with existing warehouses and bitumen driveways.

The site has a rectangular shape and is characterised by a natural gradient from North to South towards Pavesi Street.

The site is located within the prospect creek catchment area and has an impervious area greater than 90%. Figure 1 shows the location of the site.

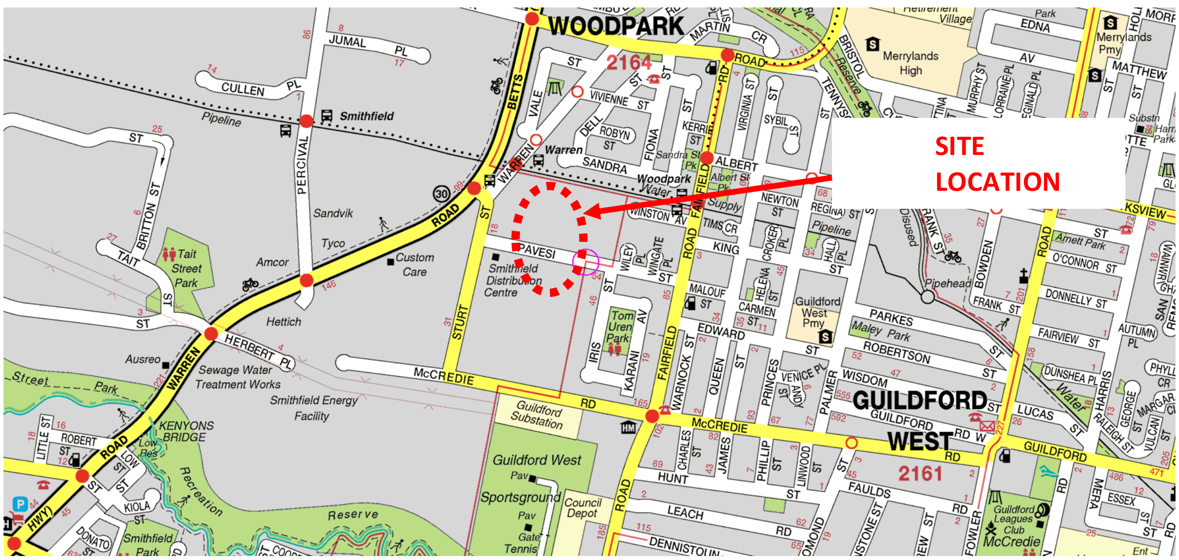

Figure 1 Locality Plan

PROPOSED DEVELOPMENT

The proposed development involves the demolition of the existing warehouses and the construction of new residential dwellings sharing a common driveway as depicted on the architectural plans by FORM Architects.

Figure 2 Proposed Development 3D view

OVERLAND STUDY

Holroyd City Council

Council Engineer advised that a flood study is required to determine the flood level to ascertain the extent of flow path through the site and asses the impact of the proposed warehouse on the overland flow depth. The flood study should be carried out for a range of storm events up to and including the PMF.

Prospect Creek

The Prospect Creek is an urban watercourse that flows through the Western Sydney suburbs of Bankstown, Liverpool, Holroyd, Fairfield and Blacktown before eventually flowing into the Prospect Reservoir. The creek has a catchment area of approximately 98sq km consisting mainly of developed landscape for residential, industrial and recreational uses.

The flow of the creek is regulated by Sydney Water as the creek forms part of the water supplied to the Sydney metropolitan area.

Previous Studies

Holroyd City Council has engaged Lyall & Associates to prepare an overland flood study for the Prospect Creek catchment.

The flood identified the site of interest as being affected by the 1% Annual Exceedance probability (AEP) Flood.

A copy of the map showing the flood extents for lot 37 obtained from Council is included below for reference (**Error! Reference source not found.**).

It is understood that Lyall & Associates are currently still finalising the overland flood study for Prospect Creek and the outcomes of the study are to be confirmed.

Objectives

The purpose of this flood study is to establish the 100-year overland flood level for the site for both the pre-developed and post-developed states. The results will be compared with the flood extents map received from Holroyd Council and the overland flow report prepared by Lyall & Associates.

The results obtained from the post-developed state will then be reviewed which will form the basis of the controls for setting the floor levels.

In summary, the objectives are as follows:-

- Develop a computer model that can be used to predict the magnitude and extent of future flood events;
- Define design flood levels, velocities and depths for the catchment;
- Define the extent of flooding for the 100-year and the Probable Maximum Flood (PMF) for the catchment;
- Determine if the proposed development has any impact on the flooding characteristics; and
- Proposed mitigation and flow measures to accept and convey the flows through the site (if required).

Hydrological Modelling

A hydrologic model combines rainfall information with local catchment characteristics to estimate a runoff hydrograph. For this study, XP-STORM was used for the local upstream catchment that contains the site of interest.

For the purpose of this flood assessment related to the development of 37-39 Pavesi Street, the study area is roughly bounded by Tennyson Street at the high point and The Horsley Drive at the low point.

The estimated design rainfalls were applied to the hydrological model in order to predict design runoff hydrographs. Design peak flood discharges were obtained for the 25min, 45min, 1hr, 1.5hr and 2hr duration for 100-year ARI storm event.

The catchment upstream from the site is predominately urban residential whilst the catchment downstream consists mainly of industrial and commercial developments.

For the purpose of this flood study, rain on grid method is used.

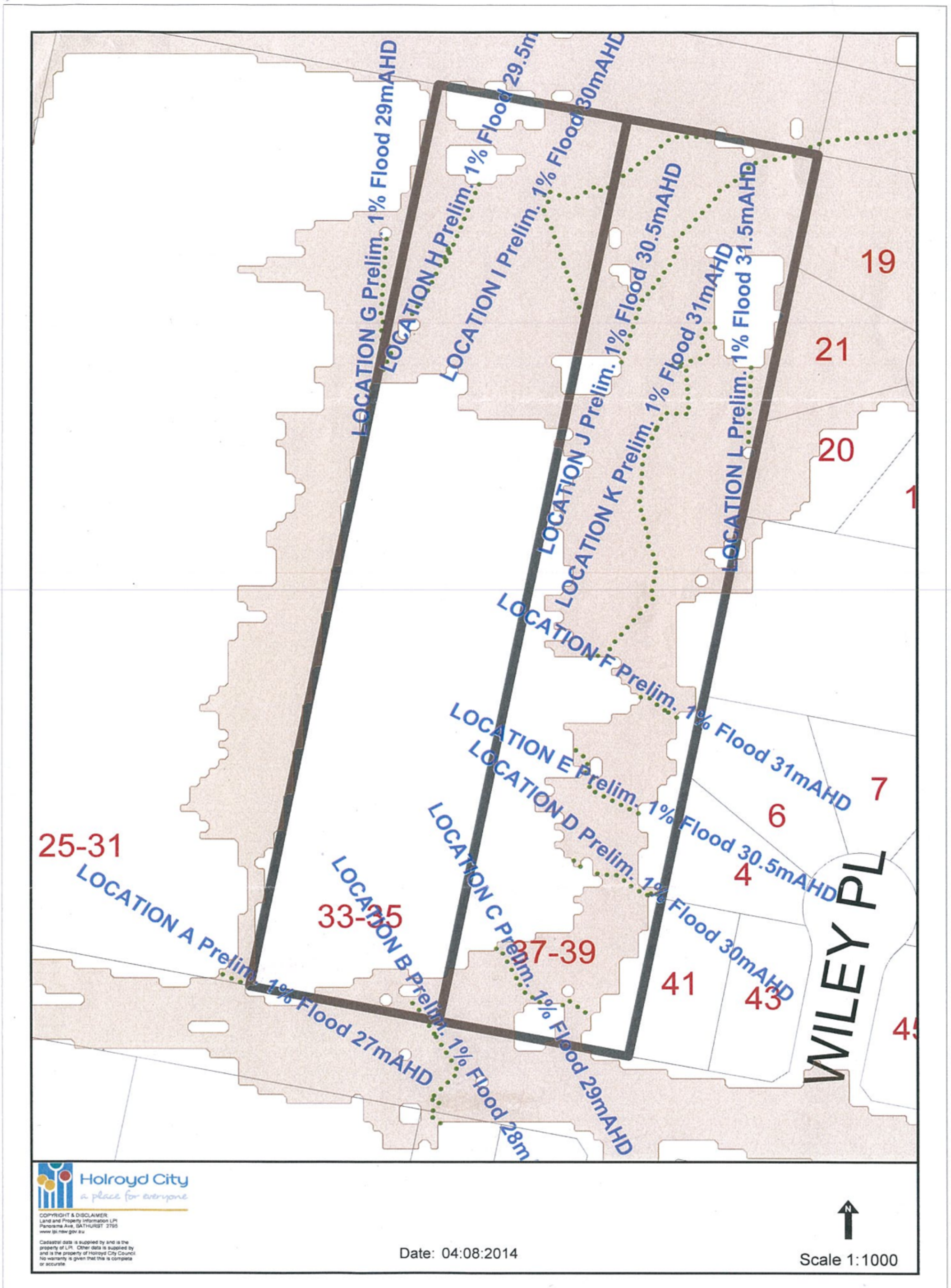

Figure 3 Flood Extents Map – Holroyd Council

Design Rainfall

The design Intensity-Frequency-Duration (IFD) parameters obtained from The Bureau of Meteorology for the catchment are presented in Figure 4.

Intensity-Frequency-Duration Table

Location: 33.825S 150.975E NEAR.. Merrylands Issued: 11/9/2013

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	82.7	106	134	151	172	201	222
6Mins	77.5	99.3	126	141	162	188	209
10Mins	63.4	81.2	103	116	132	154	171
20Mins	46.3	59.3	75.1	84.1	96.2	112	124
30Mins	37.6	48.2	61.0	68.4	78.2	90.9	100
1Hr	25.5	32.7	41.5	46.6	53.3	62.1	68.8
2Hrs	16.7	21.5	27.5	31.0	35.6	41.6	46.2
3Hrs	12.9	16.7	21.5	24.3	27.9	32.8	36.4
6Hrs	8.31	10.8	14.0	15.9	18.5	21.8	24.3
12Hrs	5.38	6.99	9.21	10.5	12.3	14.5	16.3
24Hrs	3.50	4.56	6.07	6.97	8.13	9.68	10.9
48Hrs	2.24	2.92	3.92	4.52	5.29	6.32	7.11
72Hrs	1.67	2.19	2.95	3.41	4.01	4.80	5.41

(Raw data: 32.79, 6.98, 2.19, 61.95, 14.51, 4.8, skew=0.00, F2=4.3, F50=15.83)

Figure 4 Rainfall Data (Holroyd Council)

Probable Maximum Precipitation

The Probable Maximum Precipitation (PMP) was estimated using the publication The Estimation of Probable Maximum Precipitation in Australia: Generalised Short - Duration Method (Bureau of Meteorology, 2003).

A weighted average of the PMP intensities was applied to the 2D portion of the model. These PMP intensities are shown in Error! Reference source not found..

The critical duration for the PMP event generally ranged from 15 minutes through to 1 hour.

Table 1 PMP Rainfall Intensities

Notable Duration (mins)	Duration (hrs)	Depth (mm)	Intensity (mm/hr)
15	0.25	168.00	672.00
30	0.50	242.00	484.00

Notable Duration (mins)	Duration (hrs)	Depth (mm)	Intensity (mm/hr)
45	0.75	305.00	406.67
60	1.0	354.00	354.00

The following table shows the 2D land-use roughness adopted.

Table 2 Model Land Use Roughness & Losses

Land Use	Roughness	Initial Loss (mm)	Continuing Loss (mm/hr)
Residential	0.08	5	1.5
Commercial	0.04	5	1.5
Road	0.01	0	0
Roof	0.015	0	0
Buildings	0.5	0	0
Shrubbery	0.15	5	1.5
Parland	0.1	5	1.5

Pit Inlet Rating Curve

The 2D inlet rating curve for the inlet pits is based on gully pit with 1.8m lintel and grate. A blockage factor of 50% has been applied to the depth to account for potential blockages as requested by Council.

Pit Losses

Hydraulic head losses at pits are not part of the modelling capabilities in the current version of the software modelling suite. Losses were considered in the model by adopting a higher conduit entrance and exit loss of 0.5.

Hydraulic Modelling

Definition

A hydraulic model converts runoff (traditionally from a hydrological model) into water levels and velocities throughout the major drainage/creek systems in the study area (known as the model 'domain', which includes the definition of both terrain and roughness). The model simulates the hydraulic behaviour of the water within the study area by accounting for flow in the major channels as well as potential overland flow paths, which develop when the capacity of the channels is exceeded. It relies on boundary conditions, which include the runoff hydrographs produced by the hydrologic model and the appropriate downstream boundary.

A 1D/2D fully dynamic hydraulic model was established for the study area. XP-STORM (1D) and XP-2D, a dynamic hydraulic modelling system developed by XP SOLUTIONS was used in this study. XP-2D is a 2-Dimensional model which uses TUFLOW as its 2D engine. TUFLOW is used world-wide and has been shown to provide reliable, robust simulation of flood behaviour in urban and rural areas through a vast number of applications.

The model allows addition of a 2-Dimensional (2D) domain (representing the study area topography) to a 1-Dimensional (1D) network (representing the channels in the study area) with the two components dynamically coupled and solved simultaneously.

An important feature of the model is the ability to model the hydraulic structures in the 1D component rather than in the 2D domain. The benefit of this approach is that structure hydraulics are modelled more precisely than the approximate representation possible in a 2D domain.

Stormwater drainage pits, pipes and channels are represented in the model as 1-Dimensional elements which are dynamically linked to the water conveyed across the elevation grid.

Model Schematisation

The survey data included in the model was extrapolated from Digital Terrain Model (DTM) created from the ALS (Airborne Laser Scanning) received from LPI.

Manning's roughness adopted is n = 0.05 for the earth channels, with the 2D domain having a higher roughness as per Table 2.

The pits shown as nodes in the model are 1D elements that are linked to the 2D overland flow grid. The ground elevation of each pit for its respective location within the DTM was generated from a Tin file. The links between the pits represent council stormwater pipes. The link size, location, length and type were interpolated based on the Pavesi Street Catchment Plan received from Holroyd City Council.

The pits and pipes shown as nodes and links are modelled as a 1D element. Once the pit and pipe storage capacity is exceeded, flow is able to spill into the two-dimensional (2D) overland flow grid, which overlies the 1D elements in the model. As floodwater recedes, flow is also generally able to drain from the overland areas back into the underground stormwater infrastructure.

1D Model Set-up

For the 1D components of the model, the pits and pipes were located in their respective locations as observed from the catchment map received from Holroyd Council and site visits to ensure that most of the upstream flow was captured through the 1D model. Albert Street Park (located upstream from the site) was observed on site and was found to replicate the behavior of an above ground basin. Details of structures within the study area (such as box culverts, swales and open channels) were also gathered, and included in the model.

2D Model Set-up

Two-dimensional (2D) hydraulic modelling was carried out to determine the flood behaviour in the study area. A fine grid size (2.5m x 2.5m) was deemed necessary to define the extent of the flooding through the developed areas. This resulted in approximately 60 thousand grid cells for the model domain in the study area.

Model Terrain

A terrain grid (also referred to as a 'topographic' grid) was developed to represent ground elevations based on ALS data provided by LPI, with some modifications based on the cross-section ground survey.

Buildings

The majority of the buildings around the site area were modelled with a high Manning's roughness. This was based on building outlines extracted from the survey drawings and ortho-rectified imagery.

Estimation of Critical Duration

Due to the long computational run times, the model runs were carried out for critical durations only (the duration of rainfall over the catchment that will result in the greatest depth of flooding). The critical duration for each model zone was determined from preliminary modelling undertaken using a 10mx10m grid.

The 100 year storm was run repeatedly with a 25, 45, 60, 90 and 120 minute duration. The results indicated that the 120 minute storm event was the critical duration.

Table 3 Critical Durations Adopted

ARI	Critical Duration (min)
100	120
PMF	30

Boundary Conditions

Downstream Boundary

A maximum tailwater level of 21.79m AHD has been adopted as the downstream boundary condition for the overland flowpath at the lowest point of the extent of the study area which coincides in Sturt Street to the South West of site. This tailwater level has no impact on the flood modeling results as it is taken a long distance away from the site where the terrain is much lower.

Design Flood Modelling Results

Design flood modelling was undertaken for the 100-year ARI and PMF design flood events.

The results for the 100-year ARI and PMF events are presented in **Appendix 1** of this report.

Discussion

The proposed development, in its residential nature, provides open space areas that allow the overland flows from the upstream properties to enter the site and be conveyed to the street in a safe manner. As such, it is proposed to have the fence along the eastern and the northern boundaries as open style fence to Council standard detail SD8025 or approved equivalent.

The flood impact map (Figure 13) shows that the proposed development does not have an adverse impact on flooding upstream and downstream of the site. The proposed finished levels across the site with the exception of the dwellings will be similar to the existing levels on site. No filling that will obstruct the overland flow should be proposed.

The Flood Planning Level (FPL) recommended in the NSW Floodplain Development Manual (2005) is 0.5m above the calculated 100-year ARI flood level across the site. The floor levels have been raised to incorporate this requirement. The floor levels vary across the site. Reference is made to the architectural plans for details.

The site will be inundated during the PMF event. Suitable controls should be applied for the development as follows:-

- Electrical equipment to be stored and located above the PMF level;
- The proposed building materials should be flood compatible up to the PMF;
- A structural engineer is to certify that the building is capable to withstand the shear load of the flooding up to PMF; and
- On-Site evacuation to the 2nd storey levels is proposed for evacuation during a PMF flood event. The 2nd storey level is above the PMF level and provides shelter for residents during extreme flood events such as the PMF.

Conclusions

A detailed investigation on the flooding behaviour has been undertaken in the vicinity of 37-39 Pavesi Street, Guildord West.

A detailed 1D/2D hydraulic model was established. This model has a 2D resolution of 2.5m. Hydrological modelling was undertaken utilising rain on grid method for the study area.

Using the established models, the study has determined the flood behaviour for the 100-year design flood and the Probable Maximum Flood (PMF). The primary flood characteristics reported for the design events considered include depths, levels and velocities. The study has also defined the Provisional Flood Hazard for flood-affected areas.

The study looked into the impact of the proposed development on the flooding behaviour and its impact on the flood levels both upstream and downstream.

The flood maps are included under **Appendix 1**.

Should you have any further queries or questions, please do not hesitate to contact the undersigned.

Yours faithfully
S&G Consultants Pty Limited

Sam Haddad
Director (Civil)
MIEAust CPEng NPER

Appendix 1 – Flood Mapping

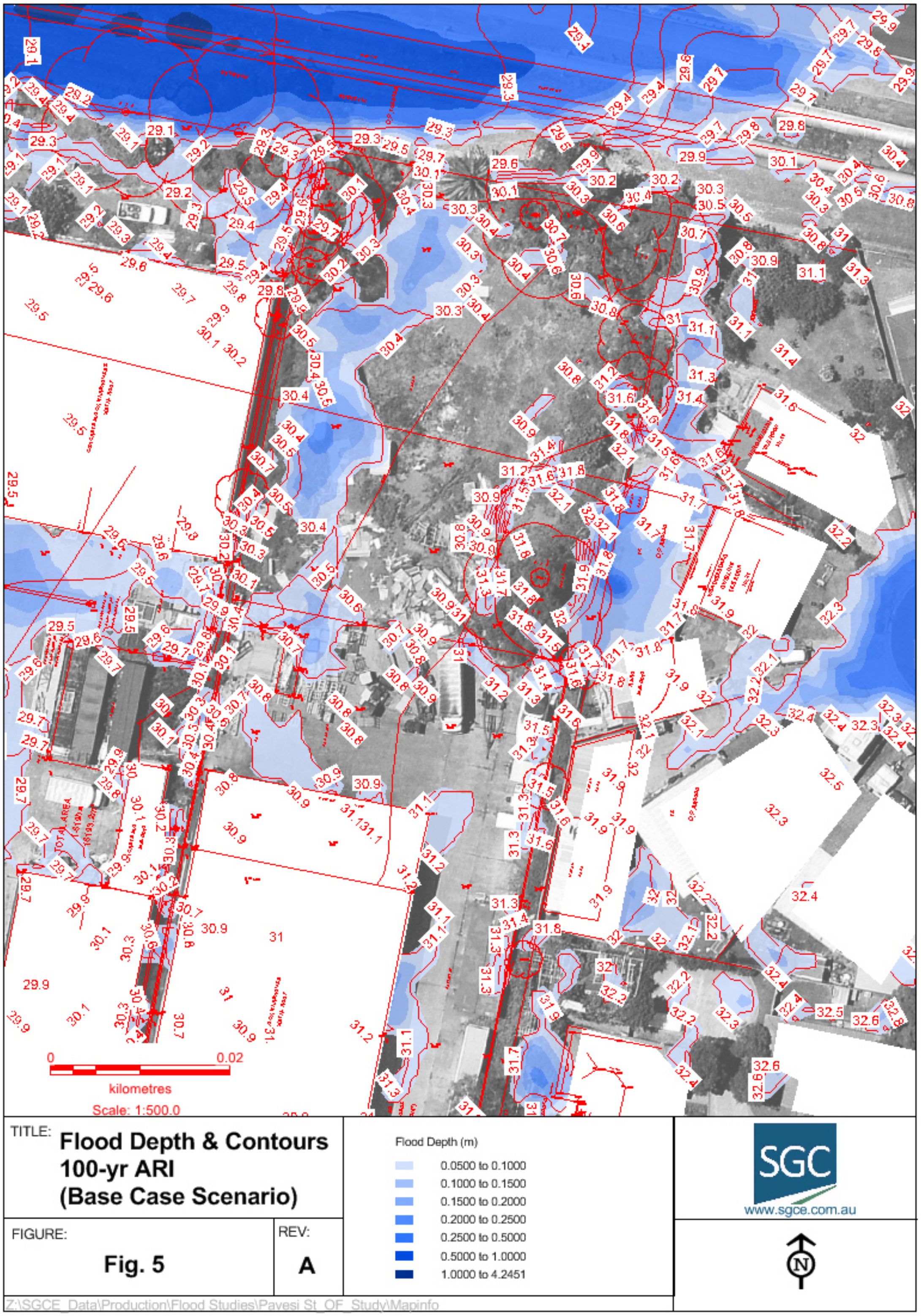

Figure 5 Flood Depth & Contours – Base Case Scenario – 1 of 2

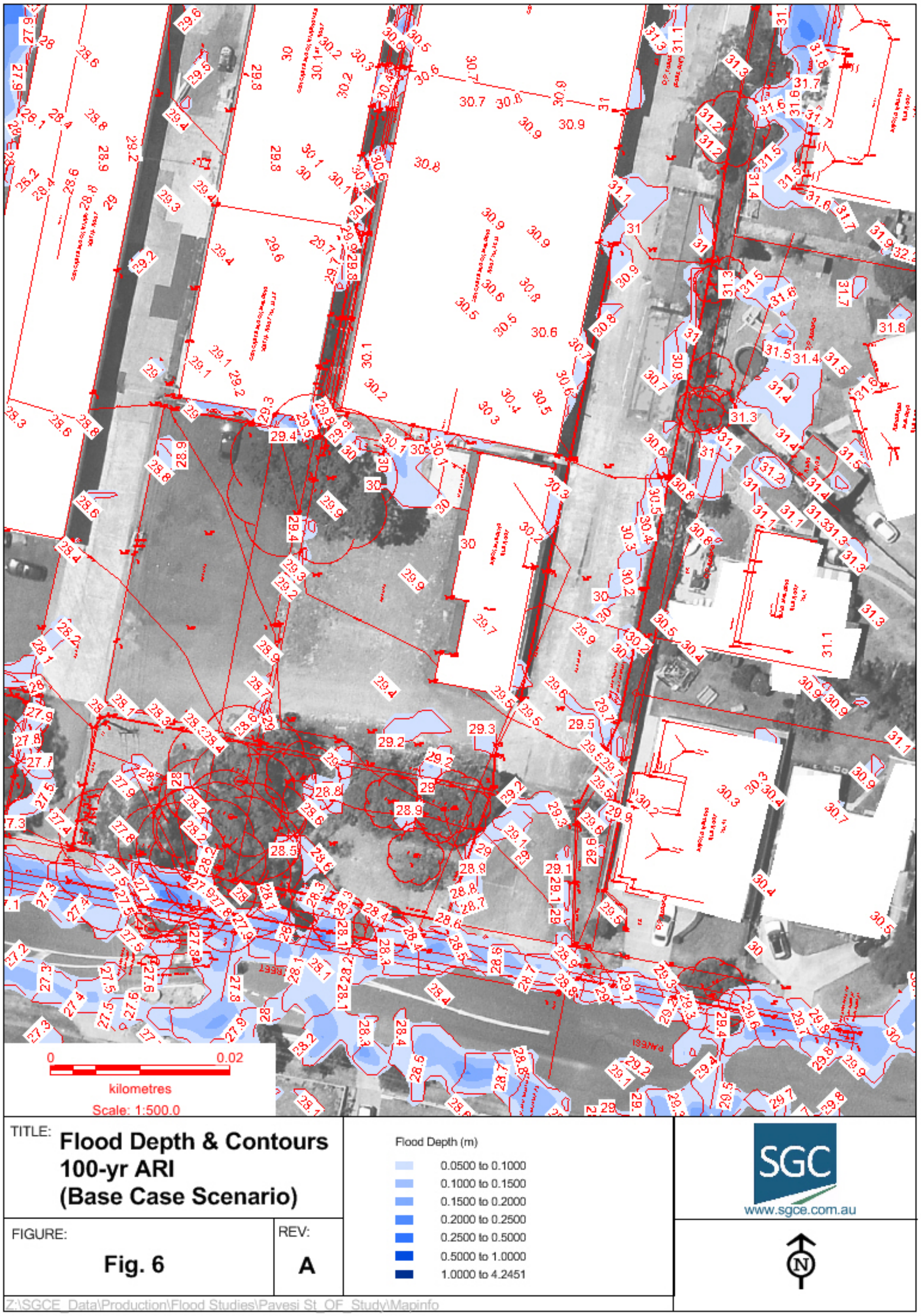

Figure 6 Flood Depth & Contours – Base Case Scenario – 2 of 2

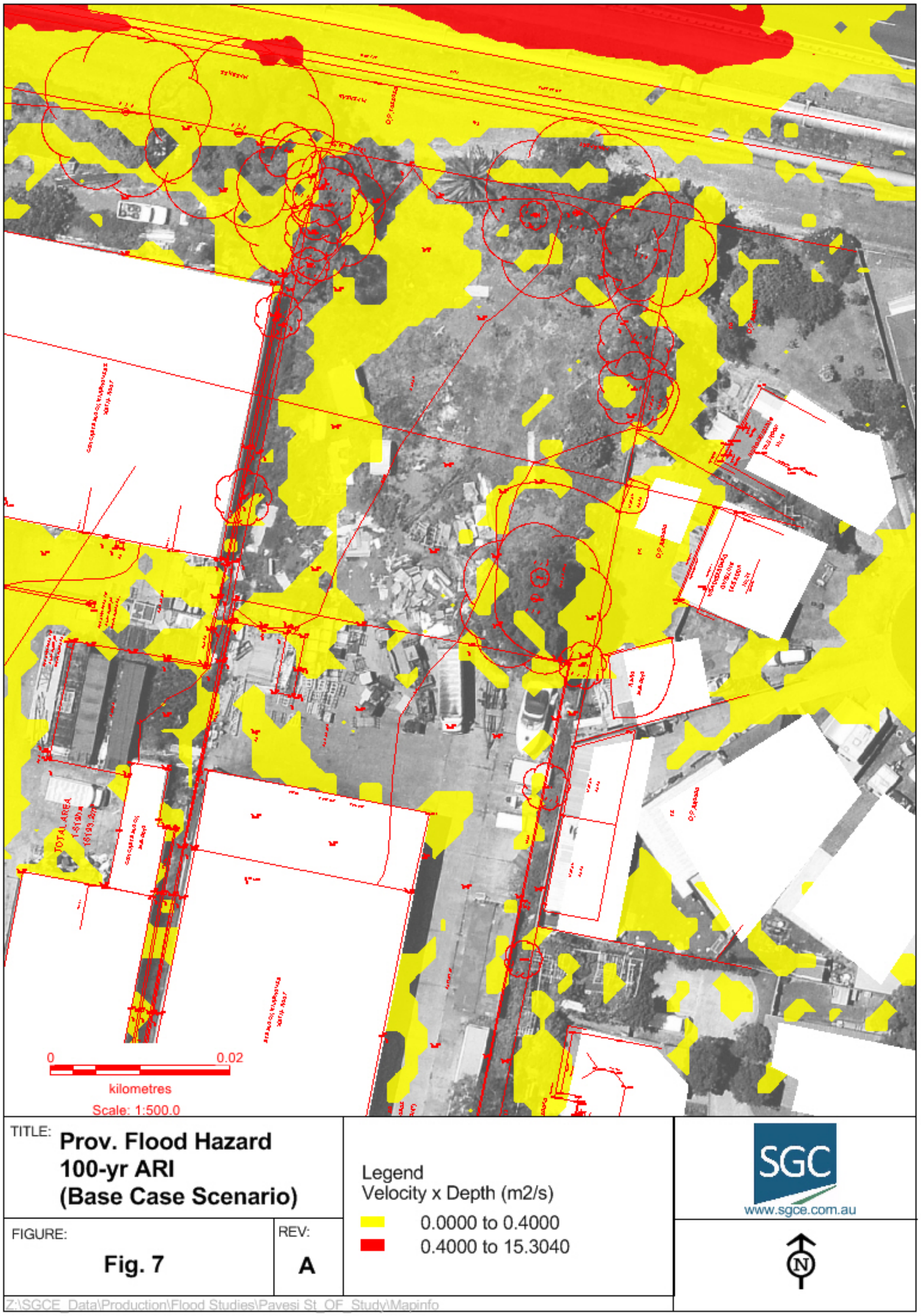

Figure 7 Provisional Flood Hazard – Base Case Scenario – 1 of 2

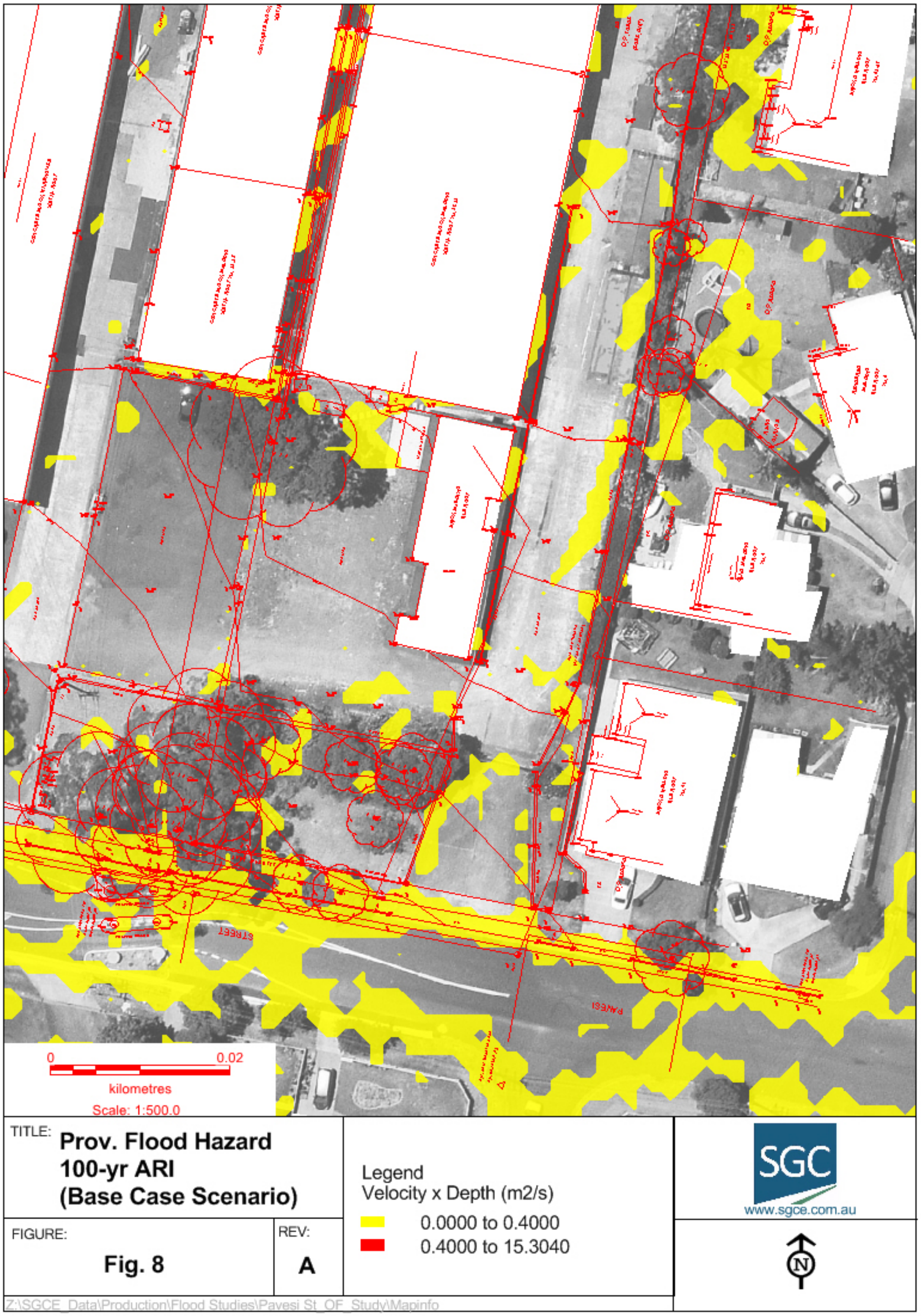

Figure 8 Provisional Flood Hazard – Base Case Scenario – 2 of 2

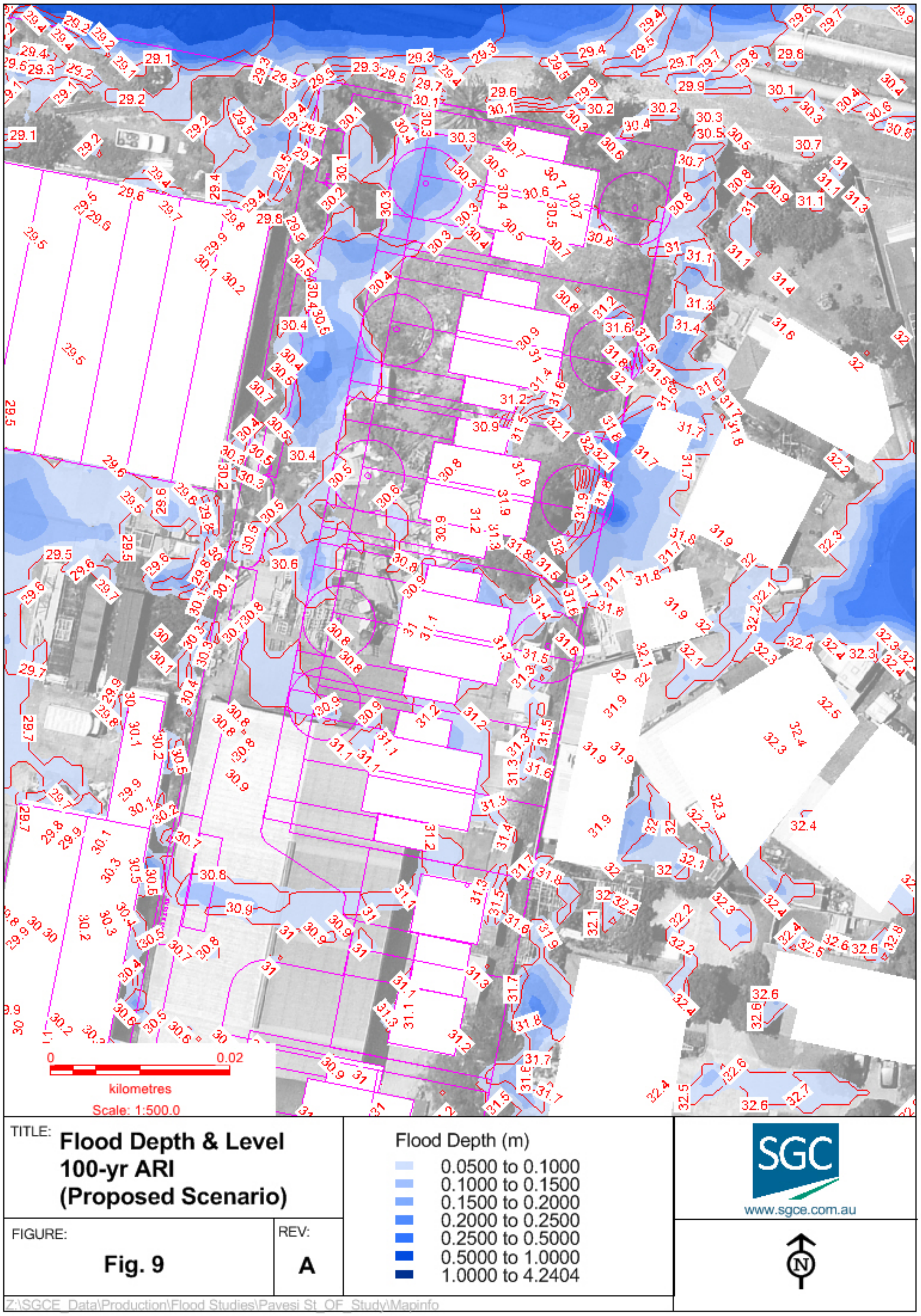

Figure 9 Flood Depth & Contours – Proposed Scenario – 1 of 2

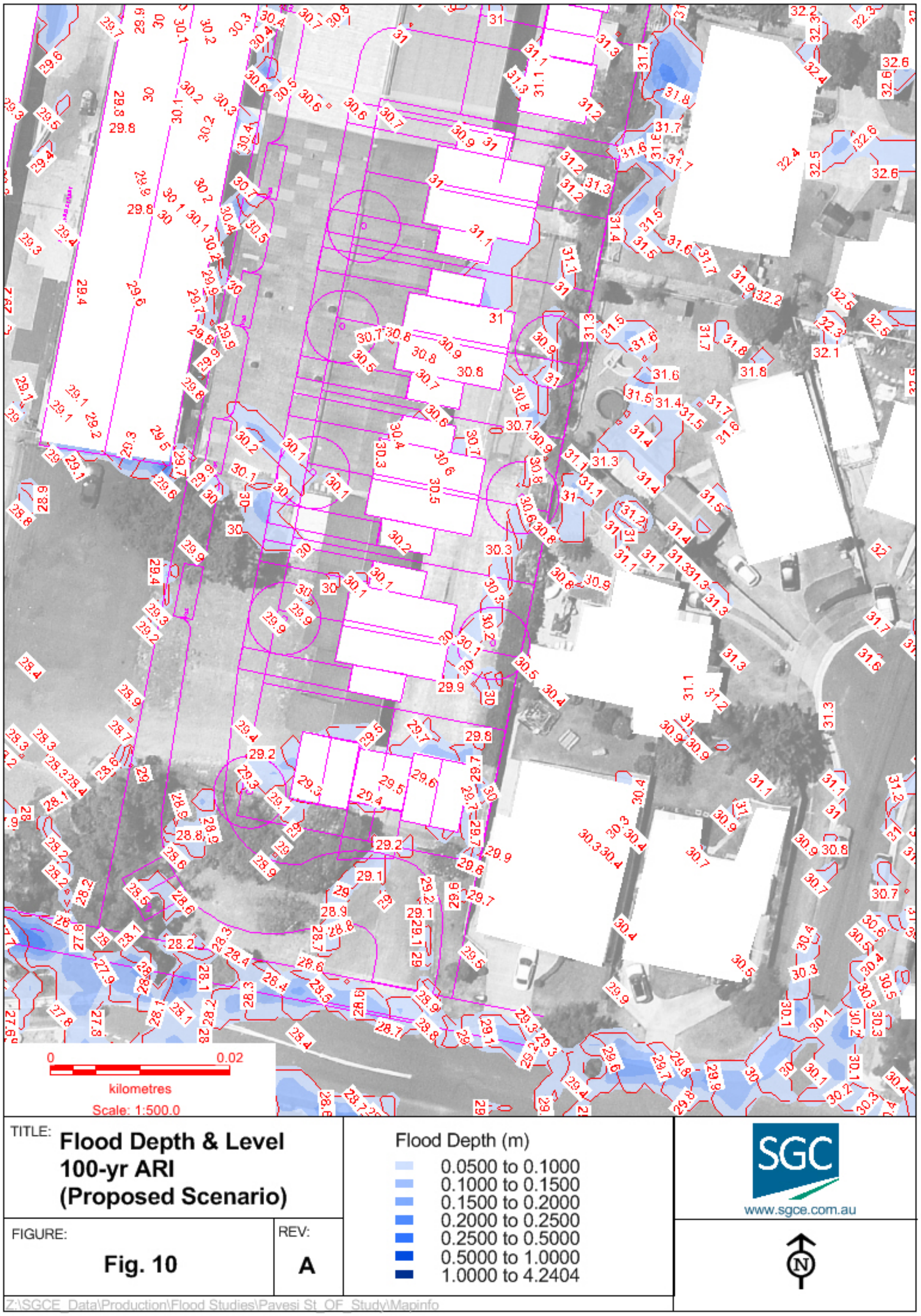

Figure 10 Flood Depth & Contours – Proposed Scenario – 2 of 2

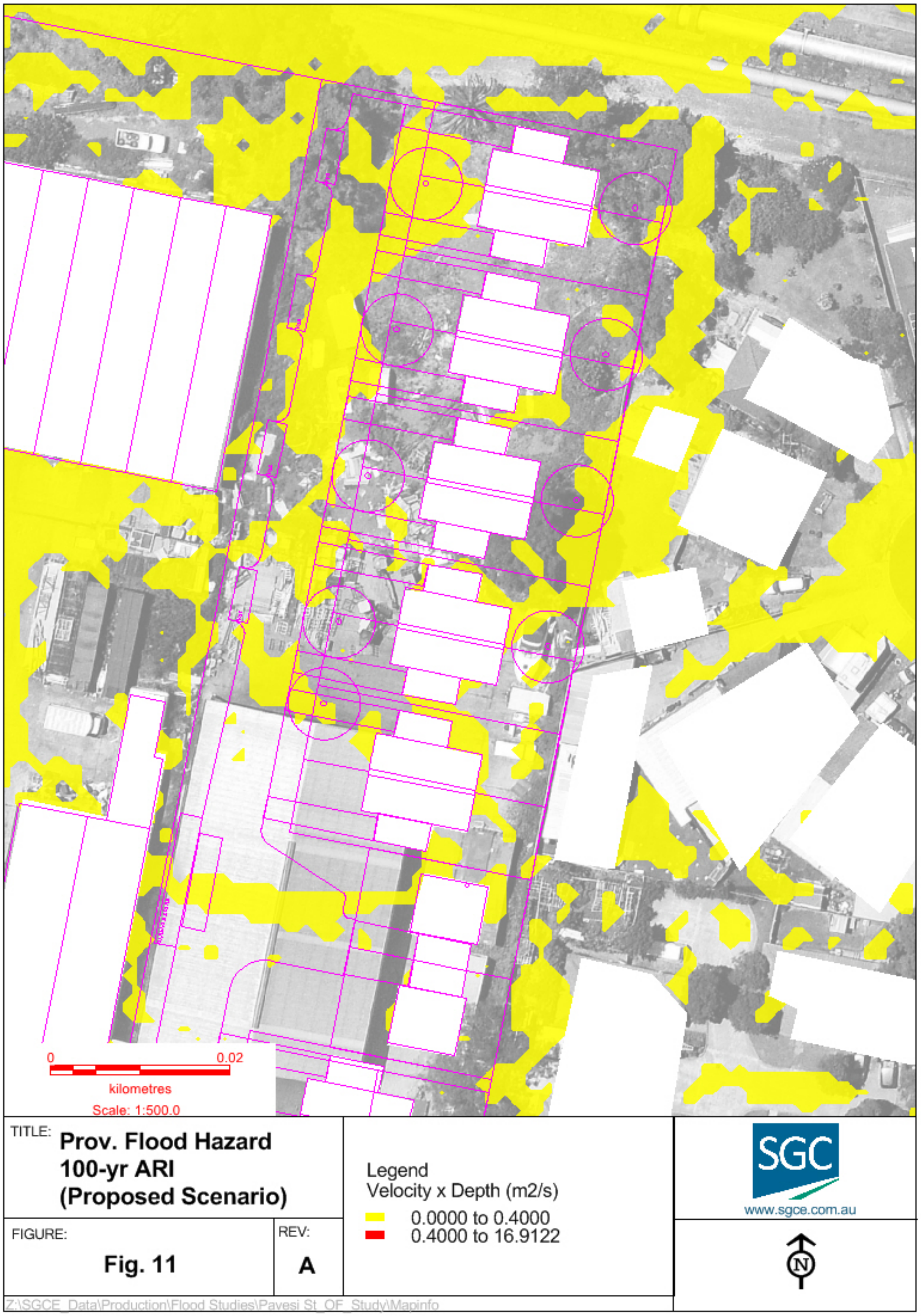

Figure 11 Provisional Flood Hazard – Proposed Scenario – 1 of 2

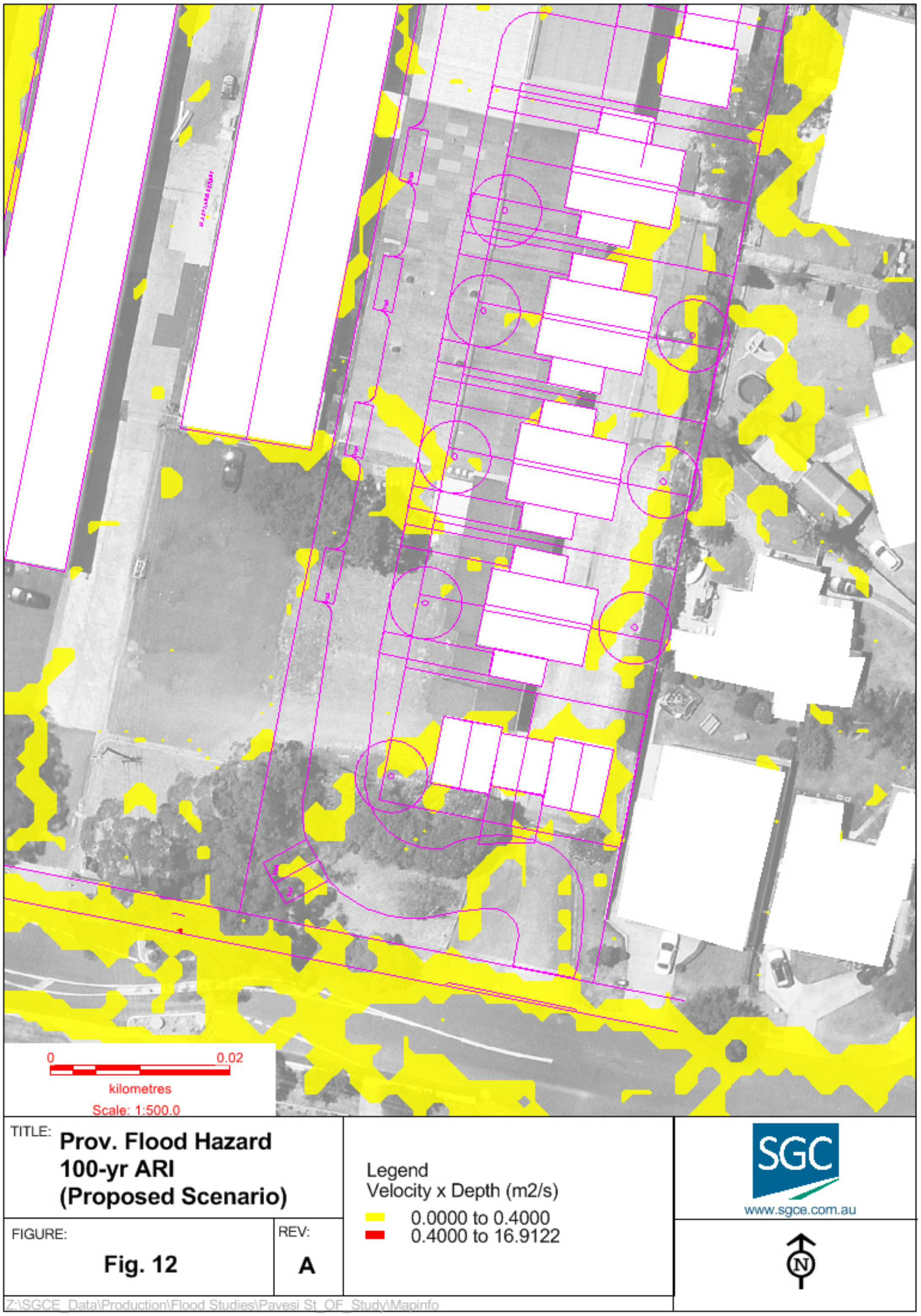

Figure 12 Provisional Flood Hazard – Proposed Scenario – 2 of 2

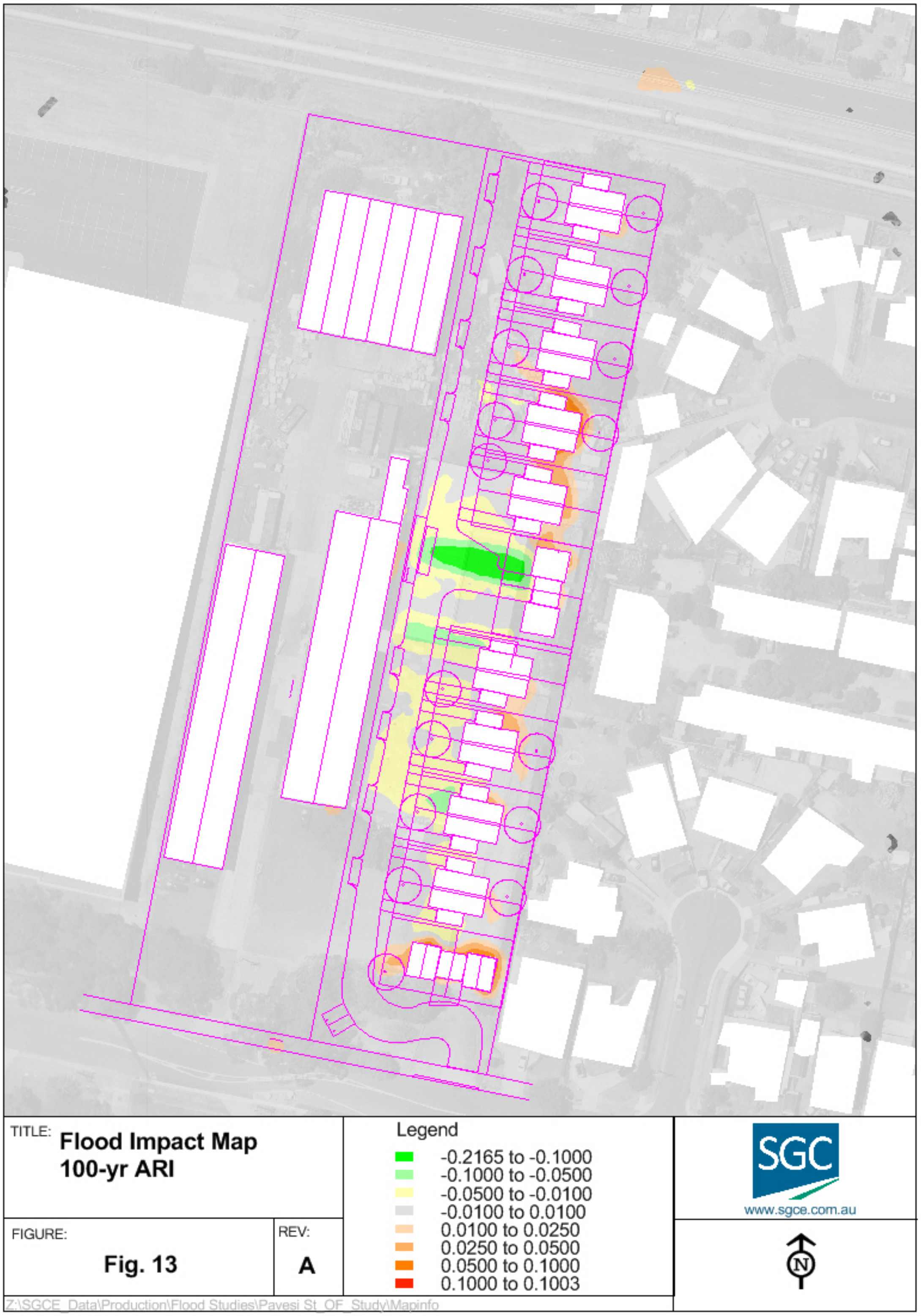

Figure 13 Flood Impact – 100yr ARI

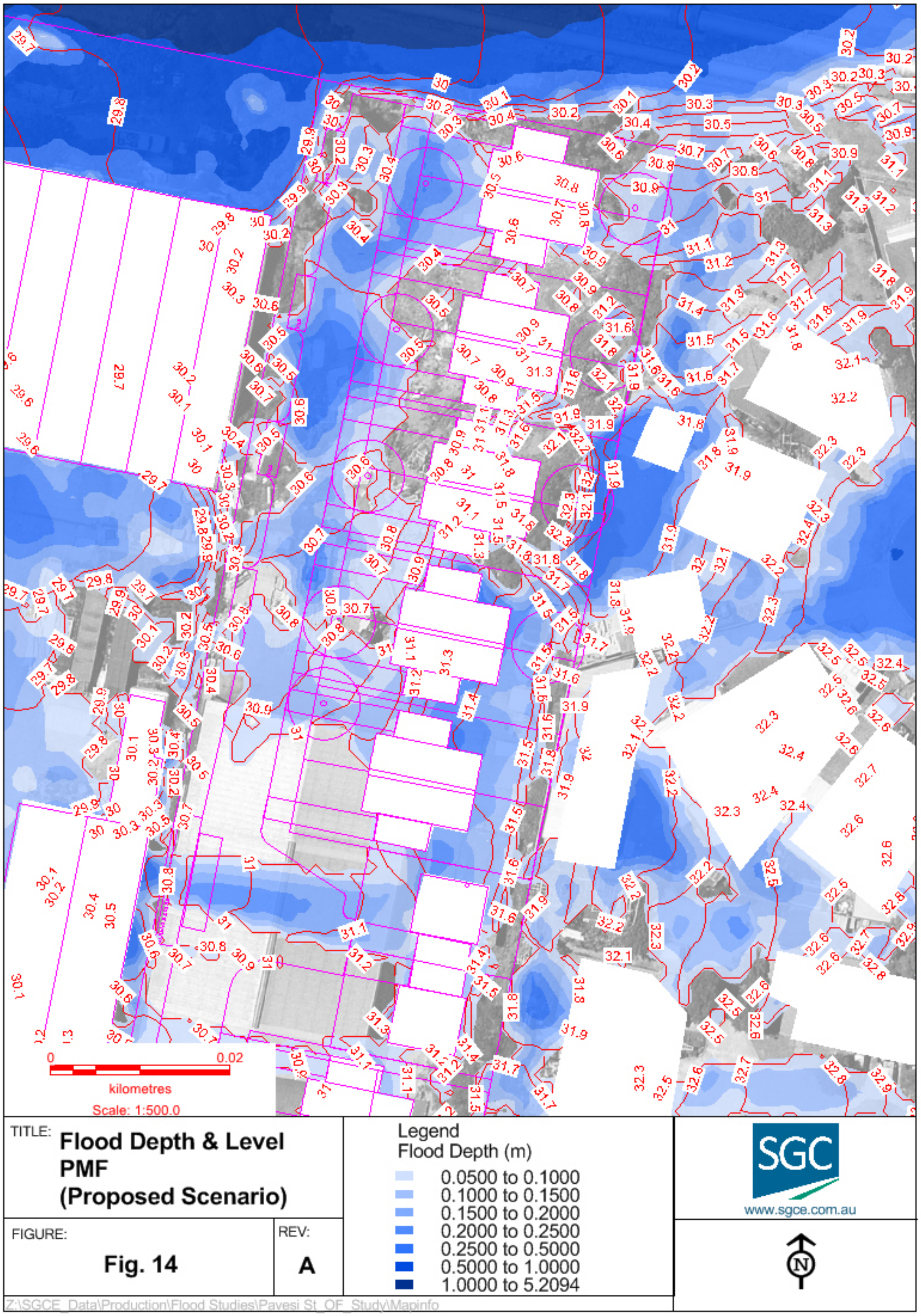

Figure 14 Flood Depth & Contours – Proposed Scenario – PMF – 1 of 2

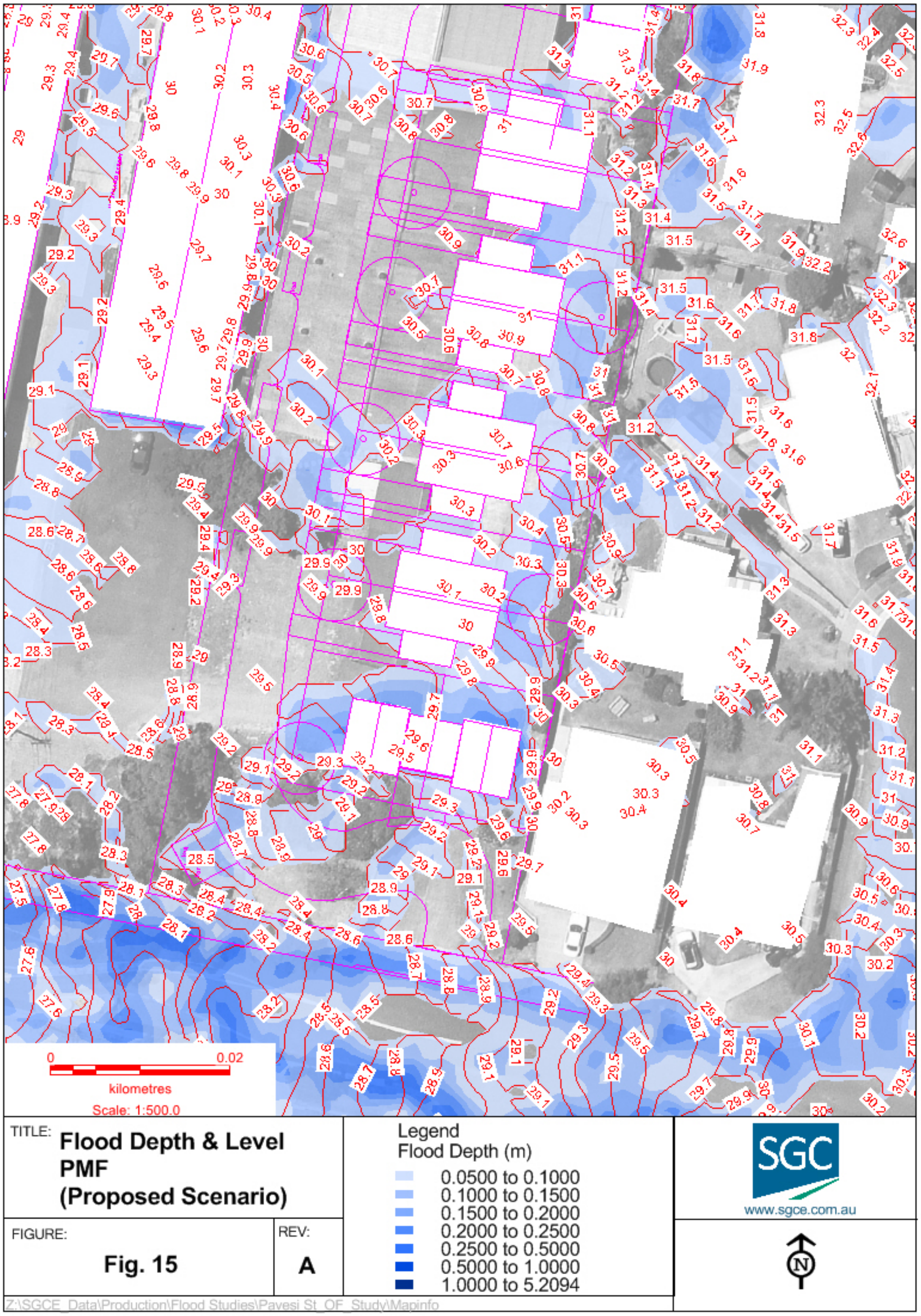

Figure 15 Flood Depth & Contours – Proposed Scenario – PMF – 2 of 2