

Health Infrastructure NSW
c/- Mace Australia Pty Ltd
Suite 1703, Level 17,
44 Market Street,
SYDNEY NSW 2000

5th April 2023

Attention: Joelle Jello

Dear Joelle,

FAIRY MEADOW AMBULANCE STATION DEVELOPMENT FLOOD ASSESSMENT

1. INTRODUCTION

Health Infrastructure NSW (HI) proposes to construct a new regional ambulance station on vacant land located on Innovation Way, Fairy Meadow, in the north-west of the University of Wollongong (UoW) Innovation Campus (*refer Figure 1*). A design for the ambulance station has been developed and is presented in **Figure 2**.

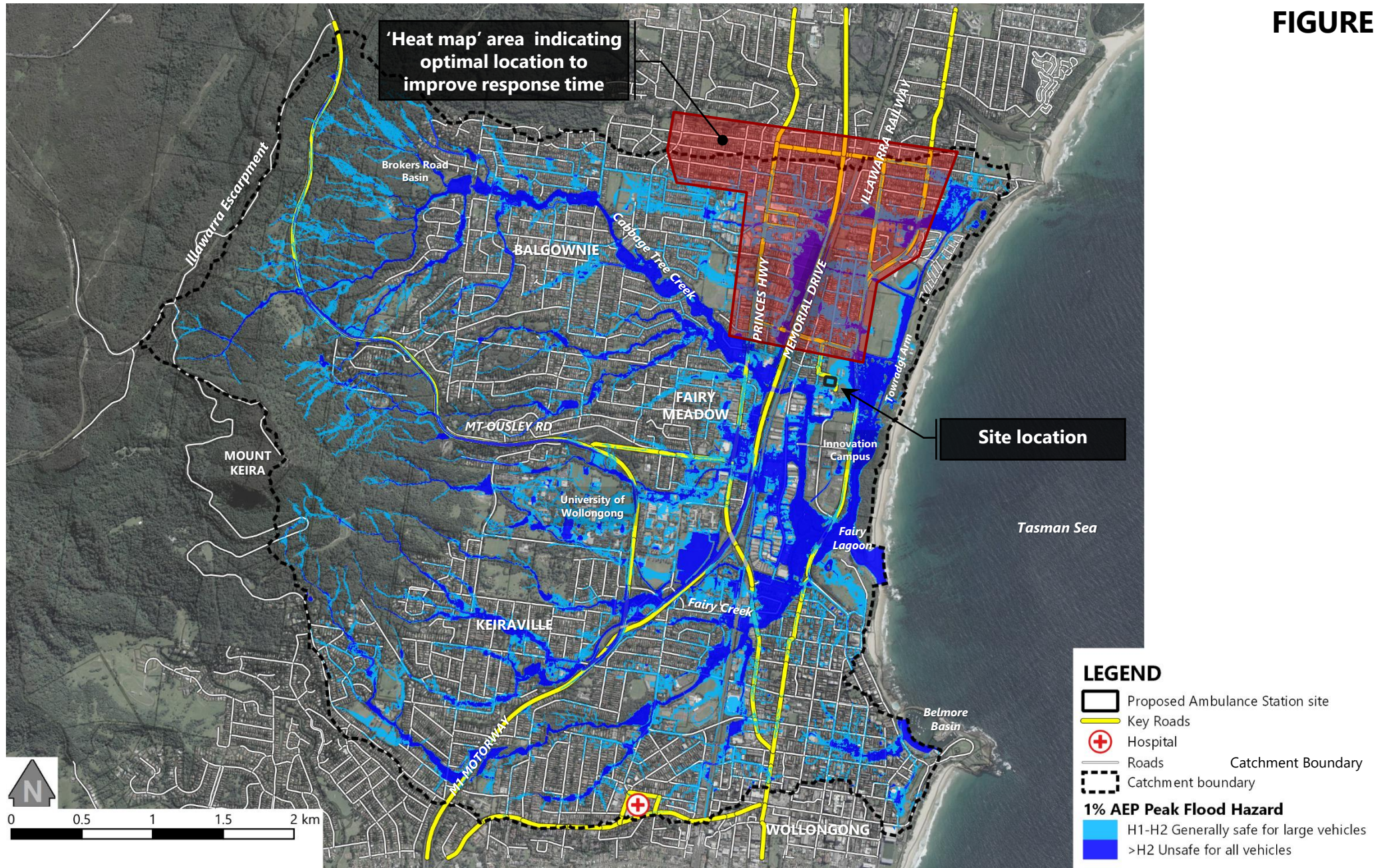
Through a clinical planning process which includes analysis of triple zero (000) ambulance call outs and response times, HI has identified that there is a critical need for a new ambulance station in Fairy Meadow, in the vicinity of the 'heat map' area indicated in **Figure 1**. The new station will help to improve paramedic response times and provide critical lifesaving care to the local community.

The selected site lies within the lower Fairy and Cabbage Tree Creeks Catchment. The catchment has a history of flooding, with extensive damage caused to private and public property located near creeks and major drainage channels during the August 1998 flood. Flood modelling and mapping completed as part of the *Fairy and Cabbage Tree Creeks Flood Study* (Advisian, 2020) indicates that the site is flood affected.

Advisian was engaged by Mace Australia on behalf of HI to provide flood information relating to the site to assist in community consultation activities and the preparation of a Review of Environmental Factors (REF), and to respond to flood-related queries raised by Wollongong City Council (Council) and the NSW State Emergency Service (SES).

This letter report documents the existing flood behaviour at the site, presents the expected impacts of the proposed development on flood behaviour, and provides information relevant to flood emergency response at the site and for determining an appropriate design floor level for the ambulance station. It also provides responses to queries raised by Council, the SES and neighbouring residents.

FIGURE 1



Prepared by:

Advisian
Woolley Group

SITE LOCATION, 1% AEP FLOOD EXTENT AND AMBULANCE RESPONSE 'HEAT MAP'

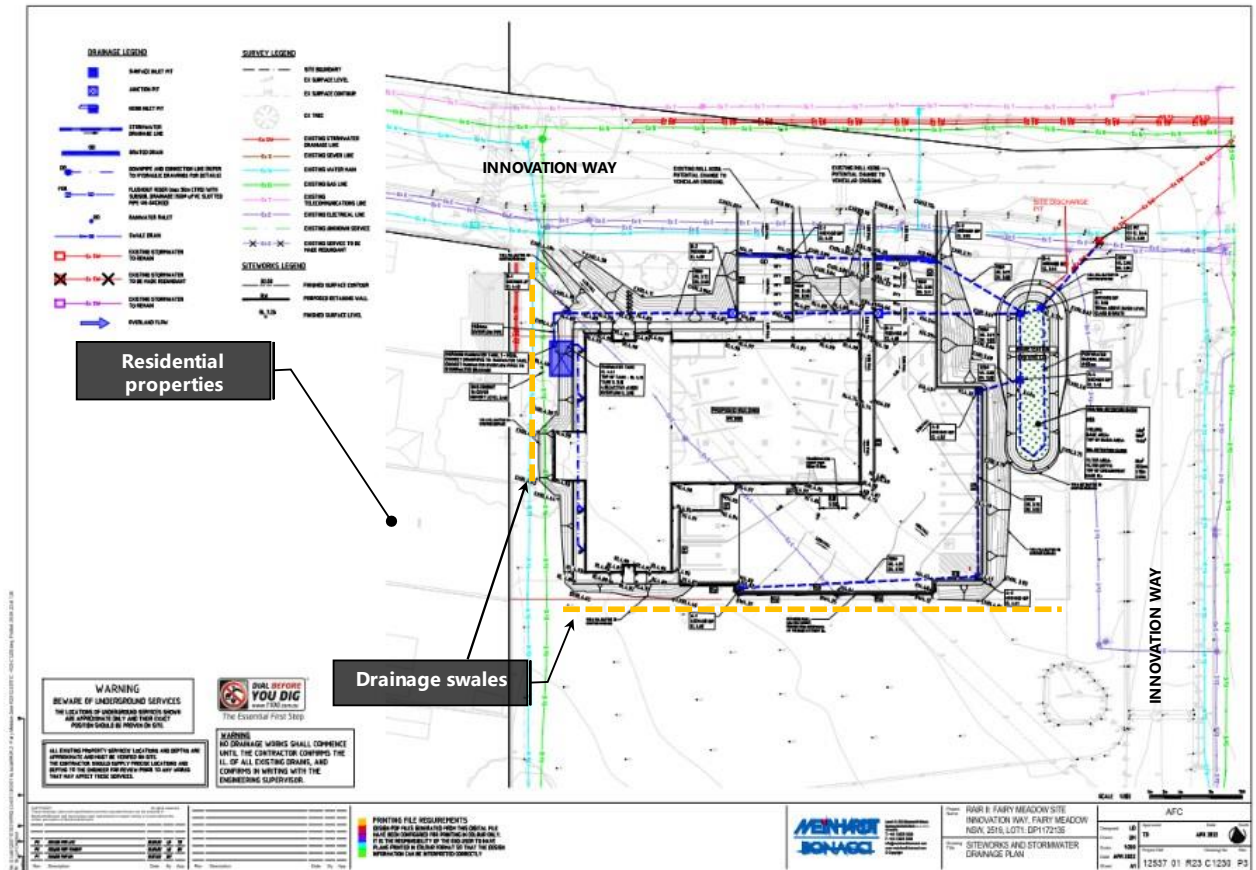


Figure 2 Proposed Development Layout

2. SITE DESCRIPTION

The proposed ambulance station site is bound by residential properties to the west, Innovation Way (a private road within the UoW Innovation Campus) to the north and east, and the Campus East student accommodation building to the south.

It is located about 150 metres north-east of Cabbage Tree Creek. In large flood events such as the 1% Annual Exceedance Probability (AEP) flood (equivalent to a 1 in 100 year flood), floodwaters spill over the banks of Cabbage Tree Creek and flow overland in a north-easterly direction across the site toward a tributary of Towradgi Arm which lies about 250 metres to the east across Squires Way (refer **Figure 1**).

According to Light Detection and Ranging (LiDAR) survey data captured in 2013, the existing topography of the site slopes down from a maximum ground elevation of about 5 mAHd in the south-west to a minimum of about 3.6 mAHd in the north-east at Innovation Way.

3. EXISTING FLOOD BEHAVIOUR

Flood Modelling Approach

For the purposes of this report, the two-dimensional TUFLOW hydraulic model that was developed for use in the *Fairy and Cabbage Tree Creeks Flood Study* (Advisian, 2020) has been adopted and used to define existing and “post-development” flood conditions.

Details of the adopted TUFLOW model version are as follows:

- Software version: 2018-03-AD\TUFLOW_iDP_w64, Classic
- Original TUFLOW Control File: FCT_200101_~s1~_~e1~_~e2~_~s2~.tcf
- Post-Development TUFLOW Control File: FCT_Amb230215_~s1~_~s2~_~e1~_~e2~_~s3~.tcf
- Grid Size: 3m grid
- Hydrology approach: ARR 1987
- Input Hydrographs: FCT_CS08b_STR04brb_C1p4_F09_ARR87_XXyrXXm_3IFDs_Meta_loc.ts1

Flood Modelling Results for Existing Conditions

TUFLOW flood model results from the *Fairy and Cabbage Tree Creeks Flood Study* (Advisian, 2020) have been used to prepare a series of maps showing local flood parameters in the vicinity of the site under existing conditions; i.e., pre-development conditions.

The following A3 flood mapping is presented in **Attachment A** for the 1% AEP and 1 in 500 AEP design flood events and for the Probable Maximum Flood (PMF).

- **Figure A-1 to Figure A-3:** Peak Flood Levels for Existing Conditions
- **Figure A-4 to Figure A-6:** Peak Flood Depths for Existing Conditions
- **Figure A-7 to Figure A-9:** Peak Flow Velocities for Existing Conditions
- **Figure A-10 to Figure A-12:** Provisional Flood Hazard for Existing Conditions.

Flood hazard provides a measure of the potential risk to life and property posed by a flood. Australian Rainfall and Runoff 2019 (ARR 2019) presents a set of hazard curves which assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. These curves have been adopted to define flood hazard in this study and are reproduced in **Figure 3**.

Figure 4 shows a range of simulated design flood extents at the site. In the 20% to 5% AEP events inundation is limited to local runoff which concentrates along the eastern boundary of the site adjacent to Innovation Way. In the 2% AEP and larger events floodwaters spill over the banks of Cabbage Tree Creek and flow overland in a north-easterly direction across the site toward a tributary of Towradgi Arm to the east of Squires Way.

A summary of the existing conditions flood modelling results at the site is provided in the following (refer **Figure A-1 to A-12**).

- 1% AEP event
 - The peak flood level near the south-western corner of the proposed building is 4.61 mAHD
 - Peak flood depths are typically less than 0.2 m and reach a local maximum of about 0.4 m
 - Peak flood velocities are typically in the range of 0.5 to 1.0 m/s
 - The site is predominantly subject to H1 hazard conditions which are considered 'generally safe'.

- 1 in 500 AEP event
 - The peak flood level near the south-western corner of the proposed building is 4.75 mAHD
 - Peak flood depths are typically in the range of 0.2 to 0.4 m and reach a local maximum of about 0.5 m
 - Peak flood velocities are typically in the range of 1.0 to 1.5 m/s
 - The site is predominantly subject to H2 hazard conditions which would be unsafe for small vehicles, but relatively safe for people.
- PMF event
 - The peak flood level near the south-western corner of the proposed building is 4.91 mAHD
 - Peak flood depths range from about 0.2 m in the south-western corner of the site to about 1.3 m in the north-eastern corner of the site
 - Peak flood velocities are typically in the range of 1.0 to 1.9 m/s
 - The site is predominantly subject to H3 hazard conditions (unsafe for vehicles, children and the elderly) and H4 hazard conditions (unsafe for all vehicles and people). These conditions would generally not be expected to cause significant structural damage to buildings.

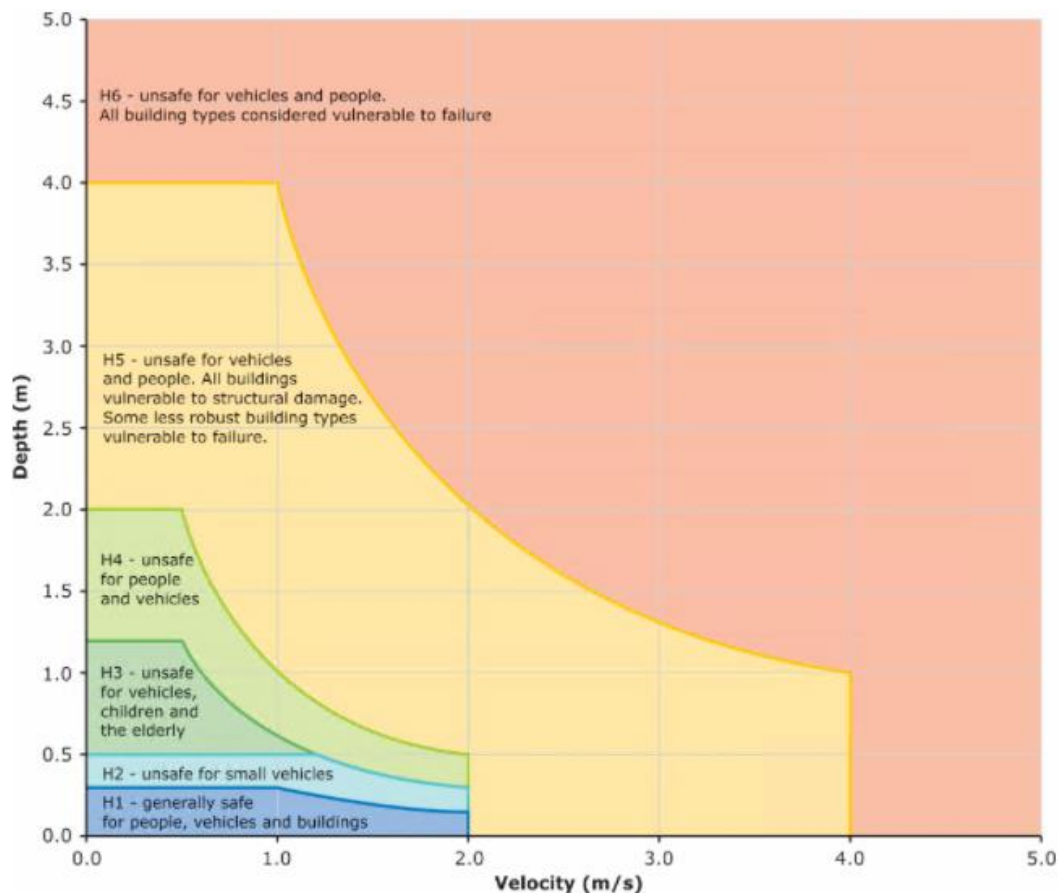
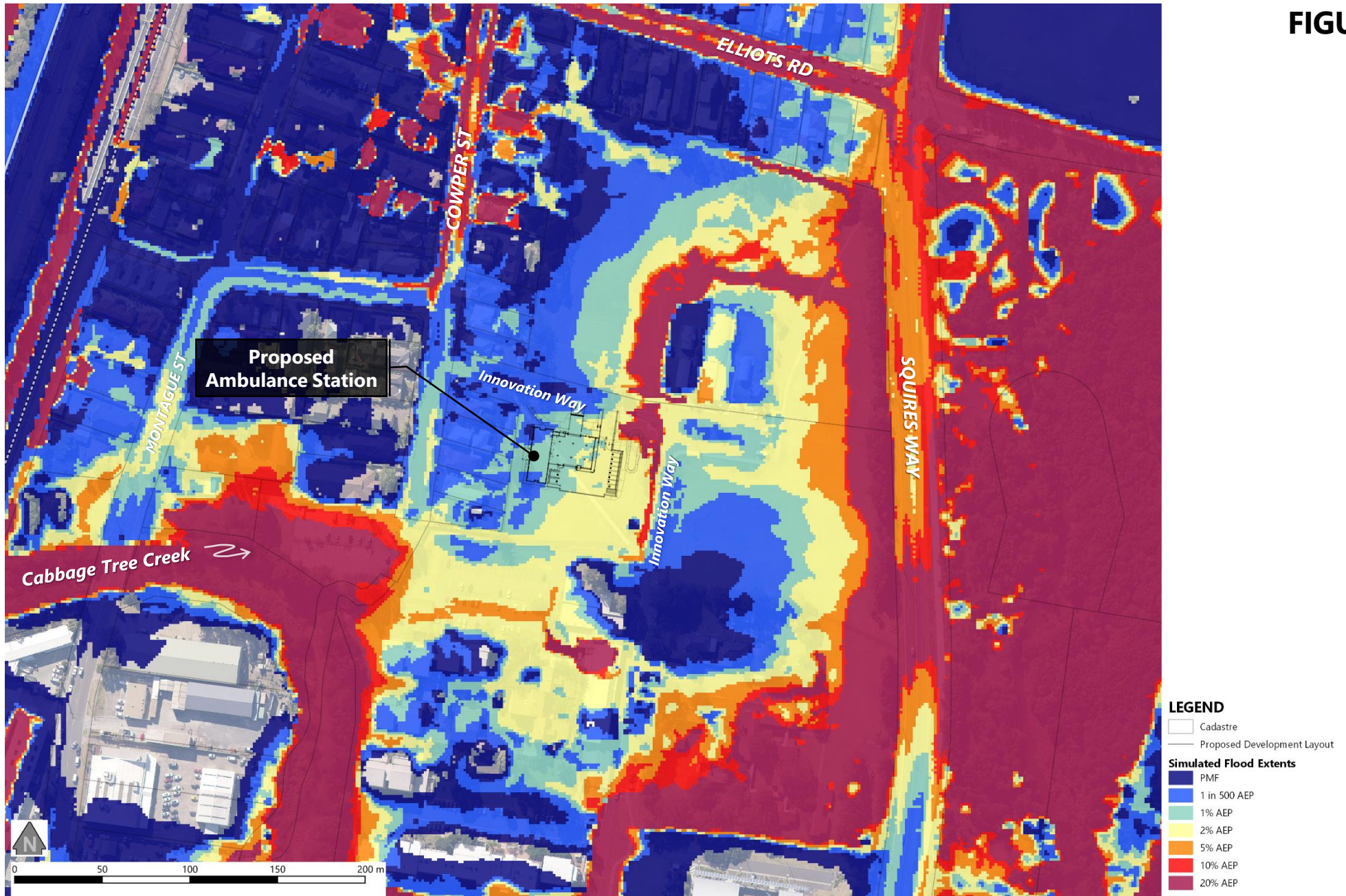


Figure 3 ARR 2019 Flood Hazard Categories

FIGURE 4



Prepared by:

Advisian
Worley Group

**SIMULATED DESIGN FLOOD EXTENTS AT THE SITE
UNDER EXISTING CONDITIONS**

4. POST-DEVELOPMENT FLOOD CONDITIONS

Description of the Proposed Development

The development proposal involves the construction of a single storey ambulance station building, car park and associated drainage infrastructure including a bioretention basin (refer **Figure 2**).

The building and car park would be constructed on a fill platform with levels ranging from about 4.6 to 5.0 mAHD. The finished floor level of the building is to be above the PMF peak flood level, as outlined in the following section.

Swales have been incorporated into the design along the western and southern edges of the platform to direct stormwater runoff and flood flows around the building.

The proposed fill platform, building and swales have been incorporated into the TUFLOW model to prepare a 'post-development' version of the model.

Flood Planning Level / Finished Floor Level

The flood planning level (FPL) used to determine appropriate finished floor levels for new development is typically defined as "*the level of a 1 % AEP flood event plus 0.5 metres freeboard*" (e.g., *Wollongong DCP 2009*).

However, it is not uncommon for a more conservative floor level based on the PMF to be applied for sensitive development types (e.g., *NSW Floodplain Development Manual 2005, Section K3.1*). This includes emergency services facilities such as ambulance stations that may provide an important contribution to community safety during flood events.

This notion is further supported by recent flood planning advice in NSW including the Local Environmental Planning (LEP) "special flood considerations clause" (*not yet adopted by Council*), and the findings of the NSW Flood Inquiry 2022.

Accordingly, it is recommended that the ambulance station adopt a finished floor level not less than the PMF peak flood level or "*the level of a 1 % AEP flood event plus 0.5 metres freeboard*" (*whichever is greater*). Relevant flood levels extracted from TUFLOW model results are reported in **Table 1**. Based on these results Advisian recommends a finished floor level of 5.25 mAHD be adopted.

Table 1 Recommended Finished Floor Level

Level (mAHD)	Existing Conditions	Post-Development Conditions
1% AEP	4.61 mAHD	4.66 mAHD
1% AEP + 0.5m freeboard	5.11 mAHD	5.16 mAHD
PMF	4.91 mAHD	5.15 mAHD
Recommended floor level	5.25 mAHD (0.1 m above post-development PMF)	

*All levels extracted near south-west corner of building. Levels are progressively lower moving to the north-east.

Post-Development Flood Impacts

Flood level difference mapping was prepared to quantify off-site impacts that could potentially be caused by the proposed development and is presented in **Attachment B** (refer **Figure B-1** to **Figure B-3**). The difference maps show changes in peak flood level estimates from the results of model simulations undertaken for 'existing' and 'post-development' scenarios. Increases in peak flood level are represented by shades of warm colours and decreases in peak flood level are represented by shades of cool colours. The white shading indicates changes in peak flood level that are between +/- 0.02 metres (*i.e., less than 20 mm*).

Mapping showing comparisons of flood hazard under 'existing' and 'post-development' conditions are also presented in **Attachment B** (refer **Figure B-4** to **Figure B-6**).

A summary of simulated flood level and hazard impacts associated with the proposed development is provided in the following.

▪ 1% AEP flood level and hazard impacts

- The extent and depth of inundation on Innovation Way is increased
 - Depths on the roadway to the east of the development are increased from a maximum of about 0.1 m to a maximum of about 0.2 m.
 - An area of roadway to the north-west of the development becomes newly inundated to peak depths of 0.05 to 0.15 m.
 - The road in the vicinity of the development is affected by H1 (generally safe) and H2 hazard (unsafe for small vehicles) under existing conditions. Simulations indicate that the development would result in an increase in the extent of the road affected by H2 hazard. It would not, however, result in an increase in the maximum hazard that a vehicle must pass through to leave the Innovation Campus.
- The depth of inundation in the back yards of two Cowper Street properties is increased
 - A maximum increase of 80 mm is indicated locally. However, this appears to relate to the proposed swale within the development site and is mapped marginally (*less than 1.5 m*) within the neighbouring property due to the 1.5 metre horizontal resolution of the TUFLOW model and results.
 - Increases of 20 to 30 mm are indicated extending a distance of less than 6 metres into the yard of one of the properties.
 - The above flood level increases are less than the 'permissible flood impact' set out in Table 2 of Wollongong Development Control Plan (DCP) 2009, Chapter E13. Specifically, the cited permissible flood level impact for 'Government Infrastructure Projects' is 100 mm on residential properties.
 - The hazard within the back yards of the properties remains H1 (generally safe).

▪ 1 in 500 AEP flood level and hazard impacts

- The extent and depth of inundation on Innovation Way is increased
 - Depths on the roadway to the east of the development are increased from a maximum of about 0.14 m to a maximum of about 0.23 m.
 - Depths on the roadway to the north-west of the development are increased from a maximum of about 0.2 m to a maximum of about 0.3 m.

- The road in the vicinity of the development is affected by H2 hazard (unsafe for small vehicles) and H3 hazard (unsafe for all vehicles, children and the elderly) under existing conditions. Under post-development conditions some H3 to H4 hazard is indicated to the east of the development along the western edge of the road. This coincides with the dish-drain/kerb in the model terrain, and H3 conditions would extend only partly into the north-bound lane. Accordingly, vehicles passing the site would not be subject to an increase in the maximum hazard classification.
- The depth of inundation in the back yards of four Cowper Street properties is increased
 - No 'permissible flood impact' limits are specified in Wollongong Development Control Plan (DCP) 2009, Chapter E13 for events larger than the 1% AEP.
 - A maximum increase of about 0.15 m is indicated locally along the boundary of two to three back yards adjacent to the proposed swale within the development site, with increases of 0.1 m extending a maximum of 6 metres into one of the properties.
 - Increases of 20 mm or more extend a maximum distance of about 12 metres into the yards of two of the properties.
 - The flood level increases do not affect the existing houses at the properties and thus would not alter the existing potential for above floor flooding to occur.
 - The hazard within the rear 4 to 8 metres of two properties is increased from H1 (generally safe) to H2 (unsafe for small vehicles). According to the ARR2019 hazard curves, these conditions remain relatively safe for children and the elderly.
- **PMF flood level and hazard impacts**
 - Inundation of Innovation Way
 - No increases in the depth or extent of inundation on Innovation Way is indicated.
 - Under existing conditions, the road in the vicinity of the development is subject to a maximum hazard of H4 (unsafe for all vehicles and people). Under post-development conditions some H5 hazard (unsafe for all vehicles and people, buildings vulnerable to structural damage) is indicated on Innovation Way to the east of the development. The road would be impassable under both scenarios.
 - The depth of inundation in the back yards of four Cowper Street properties is increased
 - Maximum increases of 0.10 to 0.15 m extend about 5 metres into one property and about 10 metres into another.
 - Increases of 20 mm or more extend 10 to 20 metres into the yards of four properties. Increases of 20 to 40 mm affect part of the house footprint at one property, however the house appears to be raised well above the ground and would not be flooded above floor level.
 - Under existing conditions hazard within the properties is predominantly H1 and H2 (generally safe for people). Under post-development conditions there is a slight increase in the extent of H2 hazard and there is a localised area of H3 hazard (unsafe for children and the elderly) in one yard across an area totalling about 30 m². This is not considered to represent a material change in risk to life or property.

5. FLOOD EMERGENCY RESPONSE

According to 'Schedule 5: Prescriptive Controls – Fairy Cabbage Tree Creek Floodplain' in Chapter E13 of Wollongong DCP 2009, a 'Site Emergency Response Flood Plan' is required where floor levels are below the flood planning level. As the floor level of the proposed building is to be constructed above the PMF a Site Emergency Response Flood Plan is not required.

Nonetheless, given the flood risk in the area and the potential for the ambulance station to contribute to community safety during flood events, site staff should be educated about local flood behaviour and what to do in the event of a flood. Prior to site occupation, HI will prepare a NSW Ambulance Continuity Plan outlining how the ambulance station would be managed during extreme flooding, as has been done with other NSW stations within the floodplain.

The following information and advice should be considered in the event of a flood (*refer Figure 5*).

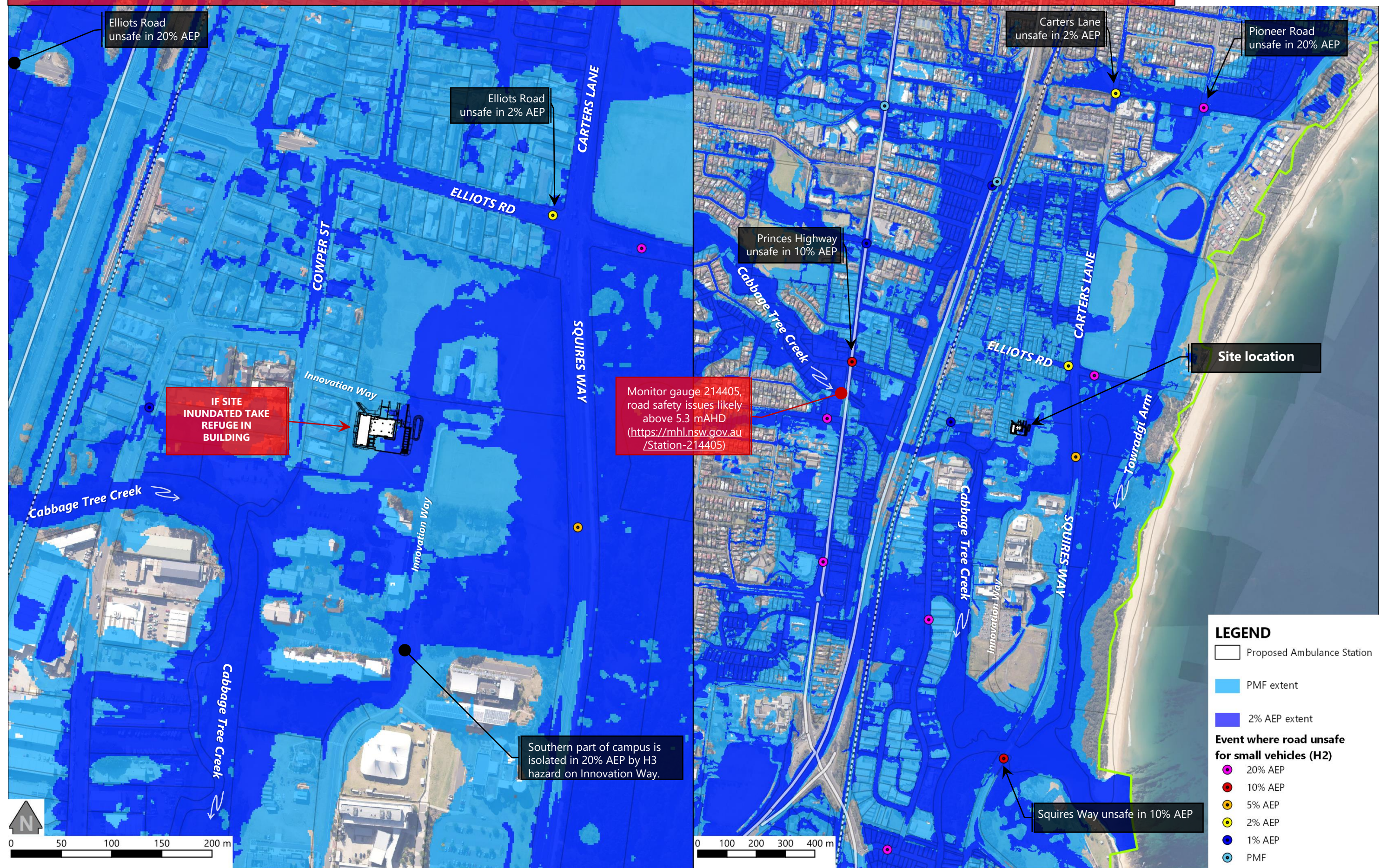
- (i) During a flood, it would be safe to shelter-in-place in the building at the site (*provided that the floor level is constructed above the PMF as intended*).
- (ii) The duration of inundation across the catchment may range from as little as 30 minutes through to several hours depending on the location and the nature of the storm event. The site itself may experience inundation of 1 to 4 hours duration in events of a 2% AEP magnitude or larger.
- (iii) Do not attempt to drive through floodwater. Driving through floodwater is the major cause of death during floods. Floodwater may be deeper or faster flowing than it appears and can contain hidden snags or debris, or the road beneath may be damaged. Ambulance drivers who may be required to drive through floodwaters should be provided with specialist training.
- (iv) If evacuation of the site is being considered during a storm or flood event, water levels at the Cabbage Tree Creek gauge should be monitored (<https://mhl.nsw.gov.au/Station-214405>) and consideration given to the following:
 - A level of 5.3 mAHD is used by the SES as a response trigger level, indicating that some roads are likely to begin experiencing inundation soon thereafter. At a level of 5.5 mAHD the Princes Highway at Hungry Jacks is likely to be inundated, as is Montague Street. These levels could be considered as a threshold for determining whether it is appropriate to complete an early evacuation.
 - If floodwaters have begun to spill across the site from the south-west it is expected that hazardous road conditions would be encountered during evacuation, and it would be preferable to remain at the site until conditions abate.
 - The safest route out of the local floodplain is to the north along Carters Lane via Storey Street and Holder Street. If significant inundation is encountered on local roads (*e.g., Elliots Road, Carters Lane or Squires Way*) when leaving the site, it is likely that hazardous road conditions would be encountered elsewhere during the journey. Accordingly, it would be preferable to return to the site and shelter-in-place until conditions abate.
- (v) On receipt of a Bureau of Meteorology (BoM) Preliminary Flood Warning, Flood Warning, Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for Flash Flooding consider whether it is appropriate to complete an early evacuation of the site prior to flooding by:
 - monitoring the BoM website (<http://www.bom.gov.au/nsw/warnings/index.shtml>) and local radio stations for updates; and,
 - checking water levels at the Cabbage Tree Creek gauge (<https://mhl.nsw.gov.au/Station-214405>)

- (vi) The SES may advise the community to evacuate. The SES will issue an 'Evacuation Warning' when the intent is to warn the community of the need to prepare for a possible evacuation. The SES will issue an 'Evacuation Order' when the intent is to instruct the community to immediately evacuate in response to an imminent threat. In such case, follow the instructions issued by the SES. The SES will issue an "All Clear" notification when return to evacuated areas is safe after floodwaters have receded and reliable access is available.

The above information is summarised in **Figure 5**. The extent of the 2% AEP flood (*in which the site is first inundated*) and the PMF relative to the proposed site layout and building footprints is also shown, along with information on inundation of local roads.

DO NOT DRIVE THROUGH FLOODWATERS – IF SIGNIFICANT ROAD INUNDATION IS ENCOUNTERED RETURN TO AMBULANCE STATION AND TAKE REFUGE IN BUILDING UNTIL CONDITIONS ABATE

FIGURE 5



Prepared by:

Advisian
Worley Group

Date: 9/3/2023
Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
WBIM version: FCT_CS08b_STR04brb_C1p4_F09_event~3IFDswn
TUFlow version: FCT_Amb230215_s1~s2~e1~e2~s3~tcf
Design: PostDev002

FLOOD EMERGENCY RESPONSE CONSIDERATIONS

6. WOLLONGONG DEVELOPMENT CONTROL PLAN CHAPTER E13, 2009

The Wollongong Development Control Plan (DCP) 2009 sets the standards, controls and regulations that typically apply when carrying out development within the Wollongong LGA. The specific controls in the DCP support the broader conditions of the Wollongong LEP 2009 and state-wide policies.

'Chapter E13: Floodplain Management' provides Council's requirements for development upon flood prone land and land below the flood planning level, and has the following objectives:

- a) Maintain the existing flood regime and flow conveyance capacity;
- b) Maintain the function of floodway and flood storage areas;
- c) Reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone land;
- d) Reduce private and public losses from flooding;
- e) Improve public safety with respect to flooding;
- f) Minimise the potential impact of development and other activity upon the aesthetic, recreational and environmental value of the waterway corridors;
- g) Increase public awareness of the hazard and extent of land affected by the full range of potential floods;
- h) Ensure new development must, as far as practical, reduce the existing flood risk, and in no circumstances should the flood risk be worsened;
- i) Ensure new development (with the exception of waterway crossings) does not encroach within areas susceptible to channel erosion, migration, bank failure and slumping; and
- j) Deal equitably and consistently with all matters requiring Council approval on flood affected land, in accordance with the principles within the latest version of the NSW Floodplain Development Manual or its update.

While the proposed ambulance station would not be subject to development assessment by Council under the DCP, it is understood that HI would generally aim to align with its overall objectives.

Sections of the DCP relevant to flood-related assessment of the proposal are as follows:

- Section 6.4.3 of Chapter E13, which sets out some general prescriptive controls
- Section 6.6.3 of Chapter E13, which sets out prescriptive standards surrounding fencing on the floodplain
- Section 7 of Chapter E13, which addresses standards surrounding filling of the floodplain
- Schedule 5 of Chapter E13, which sets out additional prescriptive controls for the Fairy and Cabbage Tree Creeks floodplain.

The relevant clauses and responses to each of these clauses are detailed in **Table 2**. Schedule 5 provides differing controls for Low, Medium and High Flood Risk Precincts (FRPs). The site lies within the Medium FRP (*i.e., it is affected by low hazard in the 1% AEP event*) in an area classified hydraulically as 'flood fringe'; *i.e., generally areas of low depth and flow conveyance where development would not be expected to have a significant effect on existing flood conditions (refer Chapter 8.2 of Fairy and Cabbage Tree Creeks Flood Study (Advisian, 2020)).*

Table 2 Relevant Wollongong DCP 2009 flood related clauses and responses

Item	Requirement	Response
Section 6.4.3 – General Prescriptive Controls		
1	'Government infrastructure projects' are not to increase off-site flood levels on residential properties by more than 100 mm in events up to the 1% AEP.	Flood level impact mapping for the 1% AEP event as presented in Figure B-1 indicates that the proposal would not result in adverse flood level increases of more than 80 mm on neighbouring residential properties.
2	In the PMF the development is not to: <ul style="list-style-type: none"> ▪ Cause adverse flood impacts to evacuation routes or onsite refuge service levels ▪ Result in additional flood affected allotments ▪ Adversely impact flood warning times ▪ Cause changes to above yard or above floor flooding. 	Flood level impact and hazard mapping for the PMF event is presented in Figure B-3 and Figure B-6 and indicates that the proposal: <ul style="list-style-type: none"> ▪ Would result in an increase in hazard on part of Innovation Way (<i>a private UoW road</i>) from H4 to H5. The road would be impassable under both existing and post-development conditions, while the majority of the Innovation Campus would become isolated prior to this occurrence due to inundation of Innovation Way 200 m to the south of the ambulance site. Accordingly, the existing constraints to evacuation of the Innovation Campus would not be materially altered. ▪ Would not result in affectation of additional lots. ▪ Would not adversely impact flood warning times, as localised impacts do not alter the arrival time of flows from Cabbage Tree Creek. ▪ Would result in increases in peak flood levels of 20 to 150 mm within the yards of 4 residential lots. This would result in only minor changes in hazard (<i>predominantly remaining in the H1-H2 range</i>) and is not considered to represent a material change in risk to life or property.
3	The development must not increase over floor flooding of residential, commercial, or industrial buildings in a 20% AEP, 1% AEP or PMF event.	The proposal would not alter flood levels at any houses or commercial/industrial buildings in the 20% or 1% AEP events (<i>refer Figure B-1</i>). In the PMF event flood level increases of 20 to 50 mm would reach part of the house footprint at one property. However, the affected area is raised approximately 1 metre above ground level and would not be flooded above floor level in the PMF.
4	The development must not cause additional lots to be impacted in the 1% AEP or PMF event.	No additional lots are impacted in the 1% AEP or PMF events.
Section 6.6.3 – Fencing, Prescriptive Standards		

5	Council requires a Development Application for all new solid (non-porous) and continuous fences above 0.6m high, in the High and Medium FRP's. It must be demonstrated that the fence would not impede flow or floodwaters.	If fencing is proposed, typical porous cyclone wire fencing (or similar) should be adopted to avoid impeding the passage of floodwaters through the site.
Section 7 – Filling of the Floodplain		
6	Any proposed filling of a site must be accompanied by an analysis of the effects on flood levels of similar filling of developable sites in the area.	<p>A cumulative filling analysis has not been undertaken. However, the proposed filling occurs within a 'flood fringe' area (<i>as opposed to 'flood storage' or 'floodway'</i>) and, accordingly, would not result in loss of a significant storage and would not be expected to contribute to significant cumulative development impacts in this regard.</p> <p>It is understood that development of the 'Dragons High Performance Centre' has been proposed in an adjacent area of the Innovation Campus. HI has liaised with the UoW and Dragons HPC design team and will endeavour to coordinate the final earthworks design for the site to minimise the combined flood level impacts of the two developments.</p>
7	Generally, there is to be no net increase in fill in the floodplain. Compensatory excavation of a lower, adjacent area of similar flood function may be used to offset fill.	Analysis of flood storage volumes for existing conditions and for the proposed landform was undertaken using the waterRIDE software and found a net loss in 1% AEP flood storage of about 350 m ³ . However, this occurs in a 'flood fringe' area and does not result in exceedance of the permissible flood impacts specified in Table 2 of Chapter E13 (<i>refer Item 1 above</i>).
8	Filling above the 1% AEP level may be permitted if there are no adverse impacts in rarer events.	The majority of filling on the site occurs above the 1% AEP level, resulting in a greater loss of storage in the PMF event. However, the resulting impacts in the PMF event do not manifest as a material change in risk to life or property (<i>refer Item 2 above</i>).
Schedule 5 – Prescriptive Controls for the Fairy & Cabbage Tree Creeks Floodplain		
9	Land use to be suitable for Medium FRP. It is noted that filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.	The ambulance station would be considered a 'Essential Community Facility' under Chapter E13 and would be deemed an 'unsuitable land use' within the Medium FRP. However, by designing the floor level to be above the PMF the flood risk at the facility is reduced such that there is little potential for flood damage or danger to life. Additionally, analysis of ambulance call outs and response times by HI has highlighted that the ambulance station would provide considerable benefit to the community under normal conditions.
10	No floor level criterion is set for 'Essential Community Facilities'.	Chapter 4 of this report investigated relevant levels for consideration in setting the design floor level. A finished floor level of 5.25 mAHD is recommended to be adopted. This level is 0.1 m higher

		<p>than the post-development PMF at a critical location outside the south-west of the building, and is also above the 1% AEP level plus 0.5 m freeboard.</p> <p>This level is considered appropriate to reduce the potential for flood damage to the facility and the risk to life of occupants.</p>
11	All structures to have flood compatible building components below or at the 1% AEP flood level plus 0.5m (freeboard).	All building components are to be located above the 1% AEP level plus 0.5 m and the PMF level.
12	All structures to withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus freeboard, or a PMF plus freeboard if required to satisfy evacuation criteria.	All buildings are to be located above the 1% AEP plus 0.5 m and the PMF. It should be confirmed that the retaining wall along the southern side of the building can withstand PMF forces (<i>peak depth 1.2 m, velocity 2.1 m/s at ~45 degrees, velocity-depth product 2.1 m²/s</i>).
13	Engineers report required to certify that the development will not increase flood affectation elsewhere.	Refer to Items 1 to 4 above.
14	Reliable access or refuge required during a 1% AEP flood. The development is to be consistent with any relevant flood evacuation strategy or similar plan.	<p>The building is to be located above the PMF level. As such, it would be safe to shelter-in-place in the building during a flood. The building would be safely accessible from the rest of the site.</p> <p>There are no special evacuation issues at the site that would prevent adherence to any existing regional evacuation plans. A NSW Ambulance Continuity Plan will be prepared outlining how the ambulance station would be managed during flooding, as has been done with other stations located in the floodplain.</p>
15	Site Emergency Response Flood Plan required (except for single dwelling-houses) where floor levels are below the PMF.	Proposed building floor levels are located above the PMF level. However, a NSW Ambulance Continuity Plan will be prepared outlining how the ambulance station would be managed during flooding.
16	Area to be available to store goods above the 1% AEP flood level plus 0.5m (freeboard).	All floor levels are located above the 1% AEP level plus 0.5 m and the PMF level.
17	No external storage of materials below the flood planning level which may cause pollution or be potentially hazardous during any flood.	No potentially polluting or hazardous materials should be stored externally below the 1% AEP level plus 0.5m. It is understood that none is proposed.

7. RESPONSES TO REF NOTIFICATION FROM COUNCIL, SES AND NEIGHBOURS

It is understood that HI has notified various potential stakeholders of the proposed ambulance station and the preparation of the associated REF. A number of flood-related queries were received from Council, SES and residents of neighbouring residential properties and are addressed in **Table 3**.

Table 3 Response to flood-related queries from Council, SES and neighbours

Flood-related Queries	
Queries raised by Wollongong City Council	
1	<p><u>Query:</u> Council records list the site as flood affected (medium risk). The flood planning level should be ascertained from Council's Development Engineering Division and considered in the design of the building and site layout. This may have implications for floor levels, cut/fill etc.</p> <p><u>Response:</u> Flood mapping confirms that the site lies within the Medium FRP (<i>i.e., is affected by $\leq H3$ hazard in the 1% AEP</i>).</p> <p>Chapter 4 of this report investigated relevant levels for consideration in setting the design floor level. A finished floor level of 5.25 mAHD was recommended to be adopted. This level is 0.1 m higher than the post-development PMF at a critical location outside the south-western corner of the building and is also above the 1% AEP level plus 0.5 m freeboard. This level is considered appropriate to reduce the potential for flood damage to the facility and the risk to life of occupants.</p>
2	<p><u>Query:</u> Chapter E13 – Floodplain Management of Wollongong Development Control Plan 2009 should be referenced in the progression of the proposal.</p> <p><u>Response:</u> While the proposed ambulance station would not be subject to development assessment by Council under the DCP, it is understood that HI would aim to align with its objectives. An assessment of the development against relevant clauses from Chapter E13 of DCP 2009 is presented in Table 2. Key findings include the following:</p> <ul style="list-style-type: none"> ▪ We understand that the ambulance station is considered an 'essential community facility'. Schedule 5 of DCP Chapter E13 indicates that this is an unsuitable landuse within the floodplain (<i>i.e., low, medium and high FRPs</i>). However, through a significant clinical planning process that analyses triple zero data HI has identified that an ambulance station in Fairy Meadow would significantly improve paramedic response times and provide critical lifesaving care to the local community. Figure 1 displays the optimal location for the station against the 1% AEP flood extent, showing that much of the area is flood affected. By designing the floor level of the ambulance station to be above the PMF level the flood risk at the facility is reduced such that there is little potential for flood damage or risk to life of occupants. ▪ 'Government infrastructure projects' are not to increase off-site flood levels on residential properties by more than 100 mm in events up to the 1% AEP. Flood modelling shows that the maximum adverse flood level impact during the 1% AEP event is 80 mm along the boundary of neighbouring residential yards. Impacts have been mitigated by designing swales to direct overland flows to the north and east around the building. ▪ Adverse flood level impacts are indicated within the yards of neighbouring properties in the PMF. However, these would not alter above floor flooding, and would result in only minor changes in hazard that would not pose any material change in risk to life or property. ▪ The proposal would not result in affectation of additional lots or buildings in any flood events. ▪ In the 1% AEP, the proposal would result in an increase in the <u>extent</u> of H2 hazard (<i>unsafe for small vehicles</i>) on Innovation Way (<i>a private internal UoW road</i>) but would not increase the maximum road hazard and therefore would not materially alter potential for access or egress from the Innovation Campus. In the PMF, the hazard classification at part of Innovation Way would increase from H4 to

H5, however the road would be impassable under both conditions and therefore potential for access or egress from the Innovation Campus would not be materially altered. Under both existing and post-development conditions in the 1% AEP and PMF events the majority of the Innovation Campus would become isolated due to inundation of Innovation Way 200 m to the south of the ambulance site. This would occur prior to inundation of the road adjacent to the site. Accordingly, the existing constraints to evacuation of the Innovation Campus would not be materially altered.

- The proposal would involve filling below the 1% AEP level, resulting in a net loss in flood storage of about 350 m³. However, this occurs in a 'flood fringe' area and does not result in exceedance of the permissible flood impacts specified in Table 2 of Chapter E13.

- 3 **Query:** A Flood Emergency Response plan should be prepared by a suitably qualified engineer.

Response: According to Schedule 5 of DCP Chapter E13 a Site Emergency Response Flood Plan is required where floor levels are below the PMF. All proposed floor levels will be located above the PMF level. However, NSW Ambulance will prepare a Business Continuity Plan outlining how the ambulance station would be managed during flooding including how they will be alerted of flooding and how they will return to the station.

Queries raised by SES

- 1 **Query:** Consider the impact of flooding on the infrastructure and its occupants up to and including the PMF, including consideration of building material and construction.

Response: The finished flood level of the ambulance station building is to be above the PMF. Accordingly flood compatible building components would not be required.

The maximum site hazard classification in the PMF is H4. Such conditions would generally not be expected to cause significant structural damage. It should be confirmed that the retaining wall along the southern side of the building can withstand PMF forces.

If required, it would be safe for occupants to take shelter in the building during floods up to and including the PMF.

- 2 **Query:** We note that Wollongong Local Environment Plan has not currently adopted the special flood consideration clause, however the Department of Planning and Environment is proposing to strengthen the planning rules to better protect and manage new development through the special flood considerations clause in all NSW council LEPs or the Resilience and Hazards SEPP 2021. Consideration should also be given to using the PMF as the flood planning level when siting and developing emergency response facilities such as ambulance stations (Floodplain Development Manual 2005, Section K3.1). Particularly in light of the recent NSW Flood Inquiry 2022.

Response: **Chapter 4** of this report investigated relevant levels for consideration in setting the design floor level. It is not uncommon for a conservative floor level based on the PMF to be adopted for sensitive development types such as emergency response facilities (e.g., *NSW Floodplain Development Manual 2005, Section K3.1*). This notion is further supported by recent flood planning advice in NSW including the Local Environmental Planning (LEP) "special flood considerations clause" (not yet adopted by Council), and the findings of the NSW Flood Inquiry 2022.

A finished floor level of 5.25 mAHD is recommended to be adopted. This level is 0.1 m higher than the post-development PMF at a critical location outside the south-west of the building and is also above the 1% AEP level plus 0.5 m. This level is considered appropriate to reduce the potential for flood damage to the facility and the risk to life of occupants.

- 3 **Query:** Ensure workers and people using the facility during and after the construction are aware of the flood risk, for example by using signage.

Response: NSW Ambulance is to prepare an Ambulance Station Business Continuity Plan. This will include comprehensive flood emergency response protocols and requirements for relevant signage on the property.

- 4 Query: Develop an appropriate business emergency plan to assist in being prepared for, responding to, and recovering from flooding. The NSW SES has a template which can assist in this process:
<http://www.sesemergencyplan.com.au/>.

Response: The afore mentioned Business Continuity Plan will include protocols for preparing for, responding to, and recovering from flooding.

Queries raised by residents of neighbouring residential properties

Query: A number of queries were received from residents of neighbouring residential properties along Cowper Street. These related to local runoff, drainage, overland flows and flooding as follows:

- Stakeholder queried dish drain performance, flooding and overland flows.
- Stakeholder noted concern about the performance of the existing dish drain to the rear of his property and that the development may worsen the issue.
- Stakeholder queried whether the drain's performance could be improved.
- Stakeholder queried how overland water flows in major weather events.

Response:

Local runoff and drainage:

- The neighbouring properties slope down at about 1.5% from Cowper Street, draining eastward towards an existing dish drain along the western edge of the ambulance station site. Flow of local runoff from the properties into this dish drain is partially impeded by existing fences and sheds. The local landform is quite flat and, therefore, drainage from the dish drain is naturally slow.
- The proposal has incorporated an augmented swale along the site boundary in place of the dish drain as well as additional stormwater drainage pipes. This is intended to improve site drainage and the flow of runoff away from the residential backyards.

Flooding and overland flow:

- In floods of a 2% AEP magnitude (*equivalent to a 1 in 50 year flood*) and larger, floodwaters spill over the banks of Cabbage Tree Creek and flow overland in a north-easterly direction across the site and parts of the neighbouring properties toward a tributary of Towradgi Arm to the east of Squires Way.
 - According to the Wollongong DCP 2009 'Government infrastructure projects' are not to increase off-site flood levels on residential properties by more than 100 mm in events up to the 1% AEP (*equivalent to a 1 in 100 year flood*). Flood modelling shows that the maximum adverse flood level impact in the 1% AEP event is 80 mm along the boundary of neighbouring residential yards. Larger potential impacts have been mitigated by designing swales to direct overland flows to the north and east around the building.
-

8. CONCLUSIONS

Results extracted from the *Fairy and Cabbage Tree Creeks Flood Study* (Advisian, 2020) and the associated TUFLOW hydraulic model have been used to provide flood information relevant to the proposed development of an ambulance station at Fairy Meadow.

This has included definition of existing flood behaviour at the site, assessment of the expected impacts of the proposed development on flood behaviour, provision of a recommendation on the finished floor level for the ambulance station, provision of information relevant to flood emergency response at the site, and responses to flood-related notifications received from Council, the SES and neighbouring residents.

I trust that this letter report provides HI with the required information to assist in the preparation of an REF regarding the proposed ambulance station development and to respond to flood-related queries from Council, SES and the local community.

If you would like to discuss or clarify any item, please feel free to contact myself or Warick Honour.

Yours faithfully
ADVISIAN



Leon Collins

Lead Engineer, Water Resources



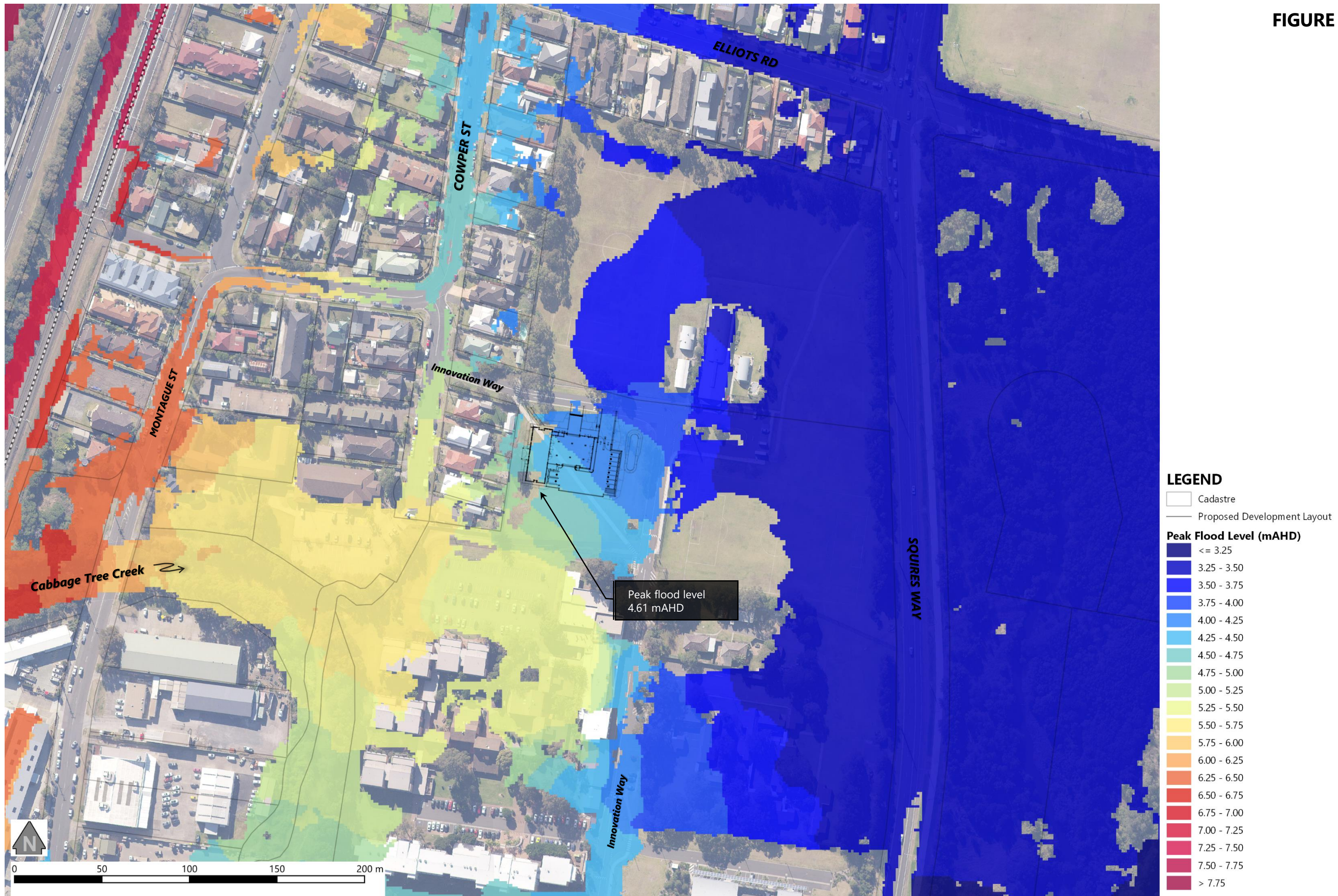
Warick Honour

Principal Engineer

ATTACHMENT A

DESIGN FLOOD MAPPING FOR EXISTING CONDITIONS

FIGURE A-1



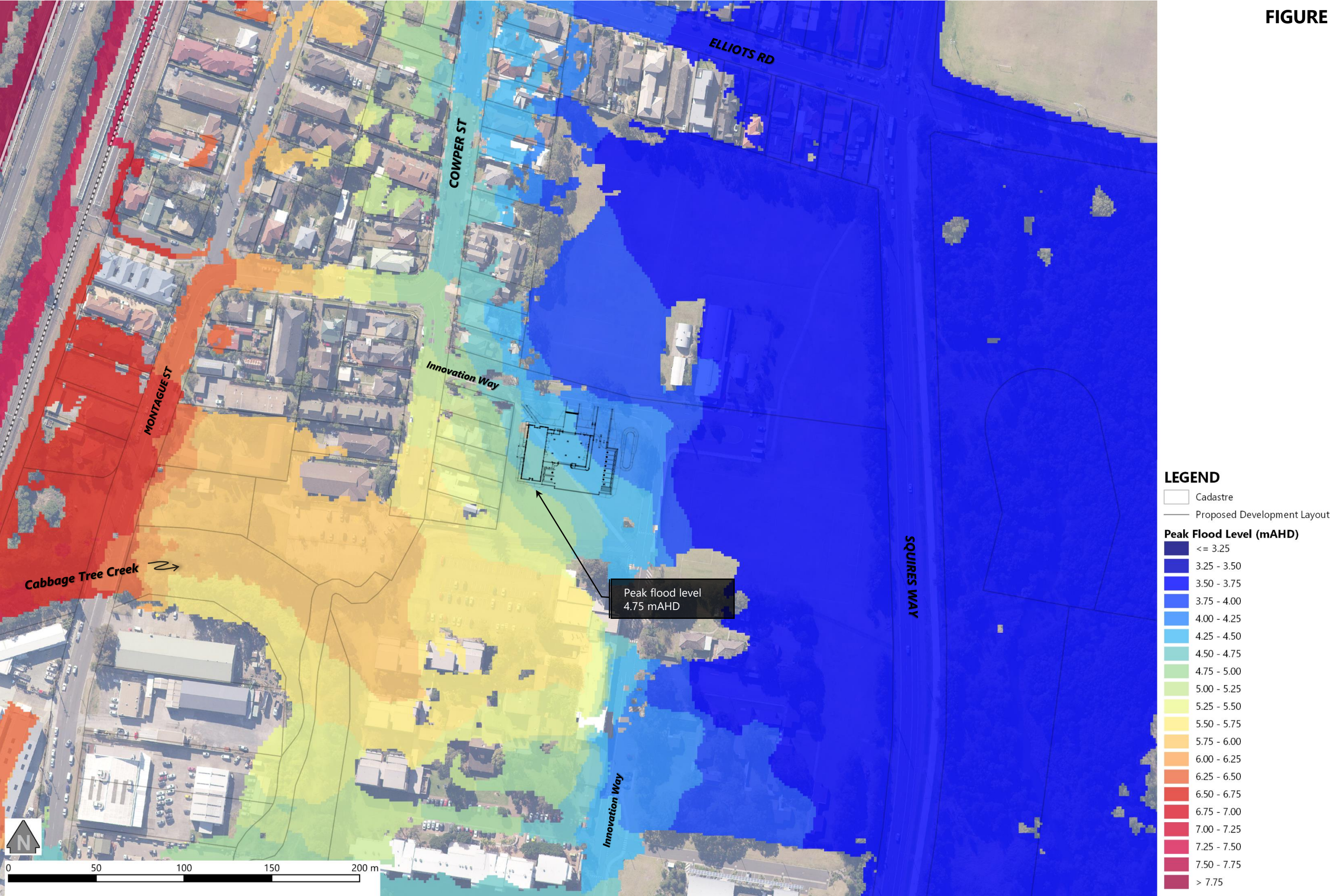
Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
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TUFLOW version: FCT_Amb230215_~s1_~s2_~e1_~e2_~s3_~tcf

**1% AEP EVENT PEAK FLOOD LEVELS
[EXISTING CONDITIONS]**

FIGURE A- 2



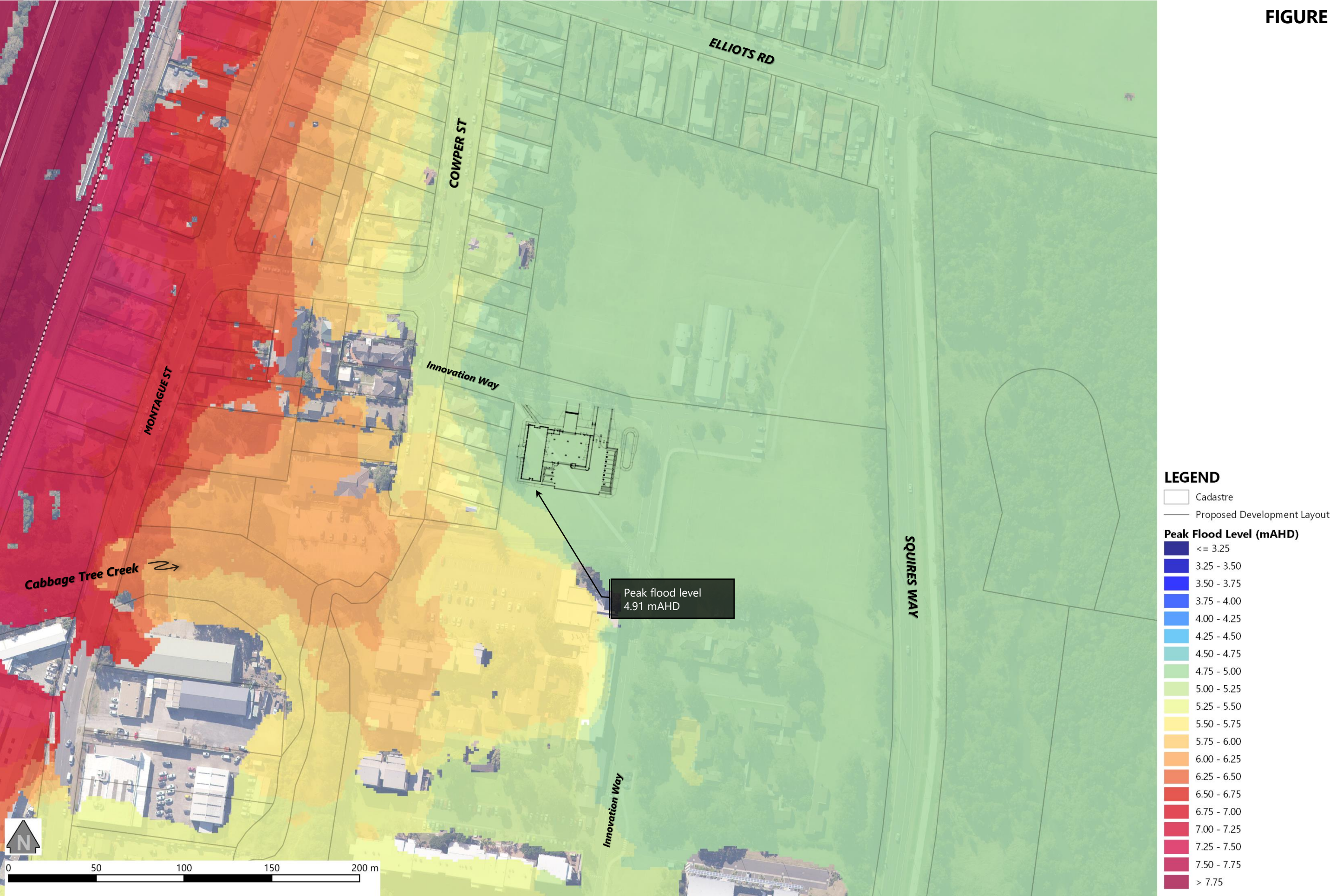
Prepared by:

Advisian
Worley Group

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Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
WBIM version: FCT_CS08b_STR04brb_C1p4_F09_event~3IFDs.wbn
TUFLOW version: FCT_Amb230215_s1~s2~e1~e2~s3~tcf

**1 IN 500 AEP EVENT PEAK FLOOD LEVELS
[EXISTING CONDITIONS]**

FIGURE A- 3



Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
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**PMF PEAK FLOOD DEPTHS
[EXISTING CONDITIONS]**

FIGURE A- 4

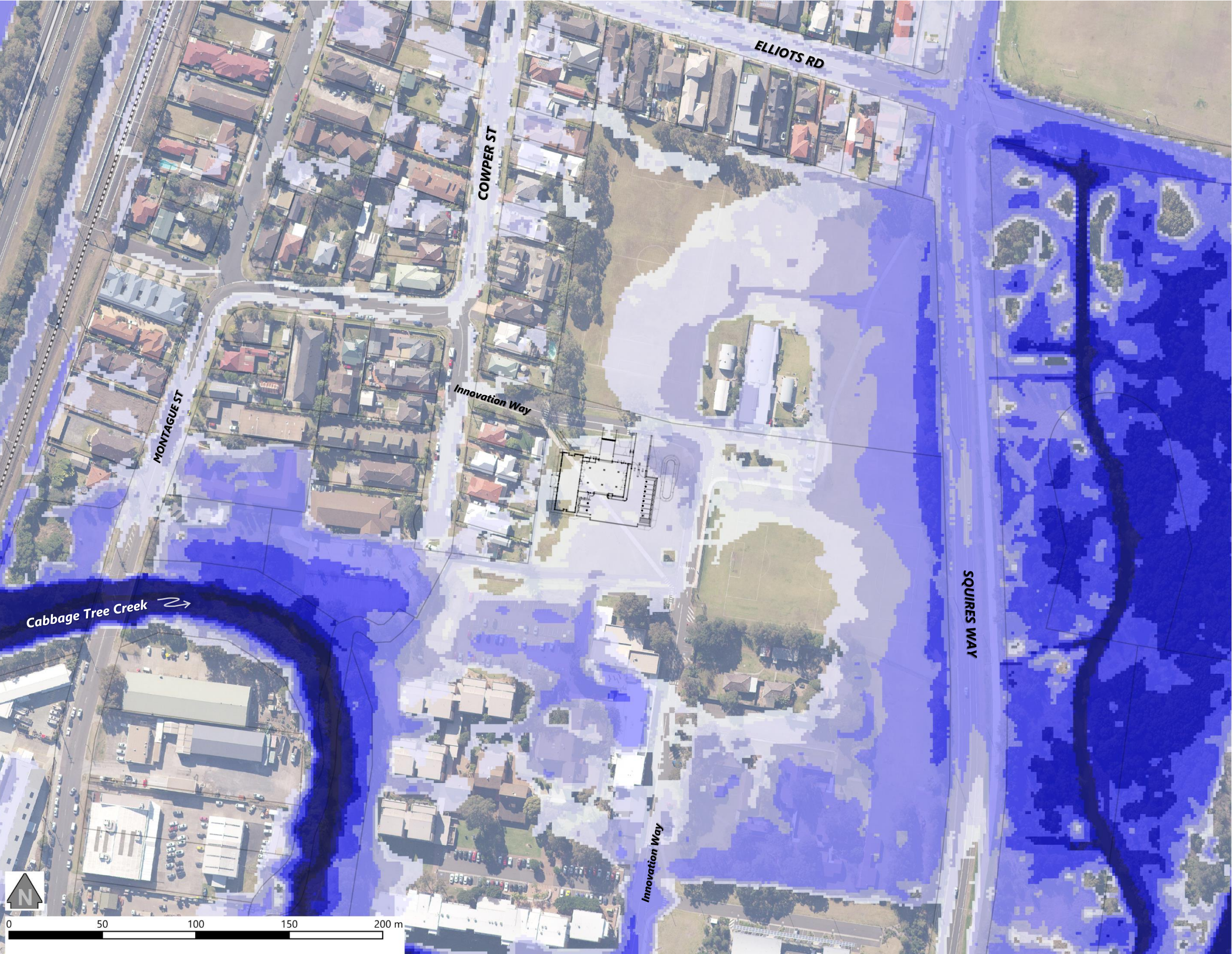


FIGURE A- 5

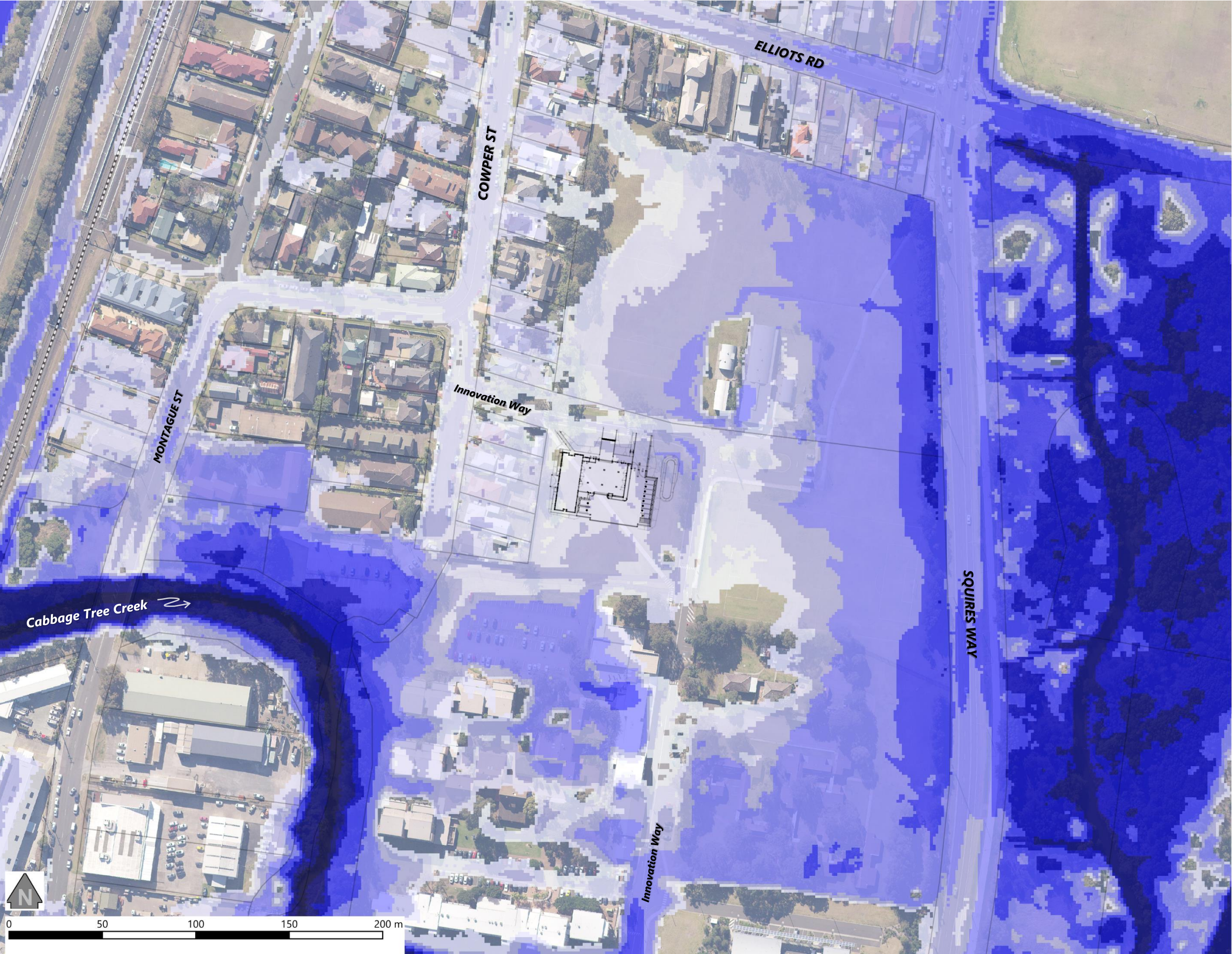


FIGURE A- 6

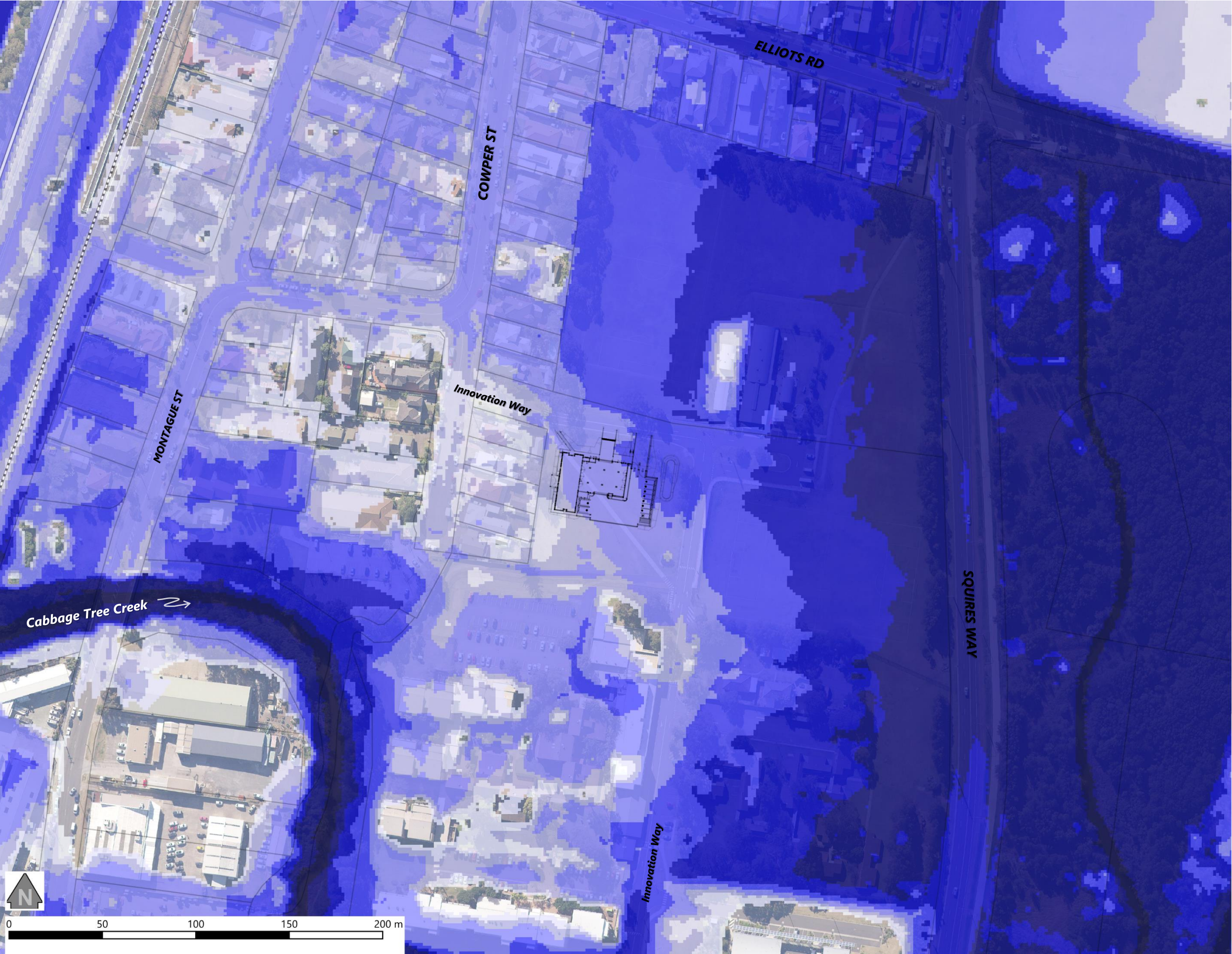


FIGURE A- 7

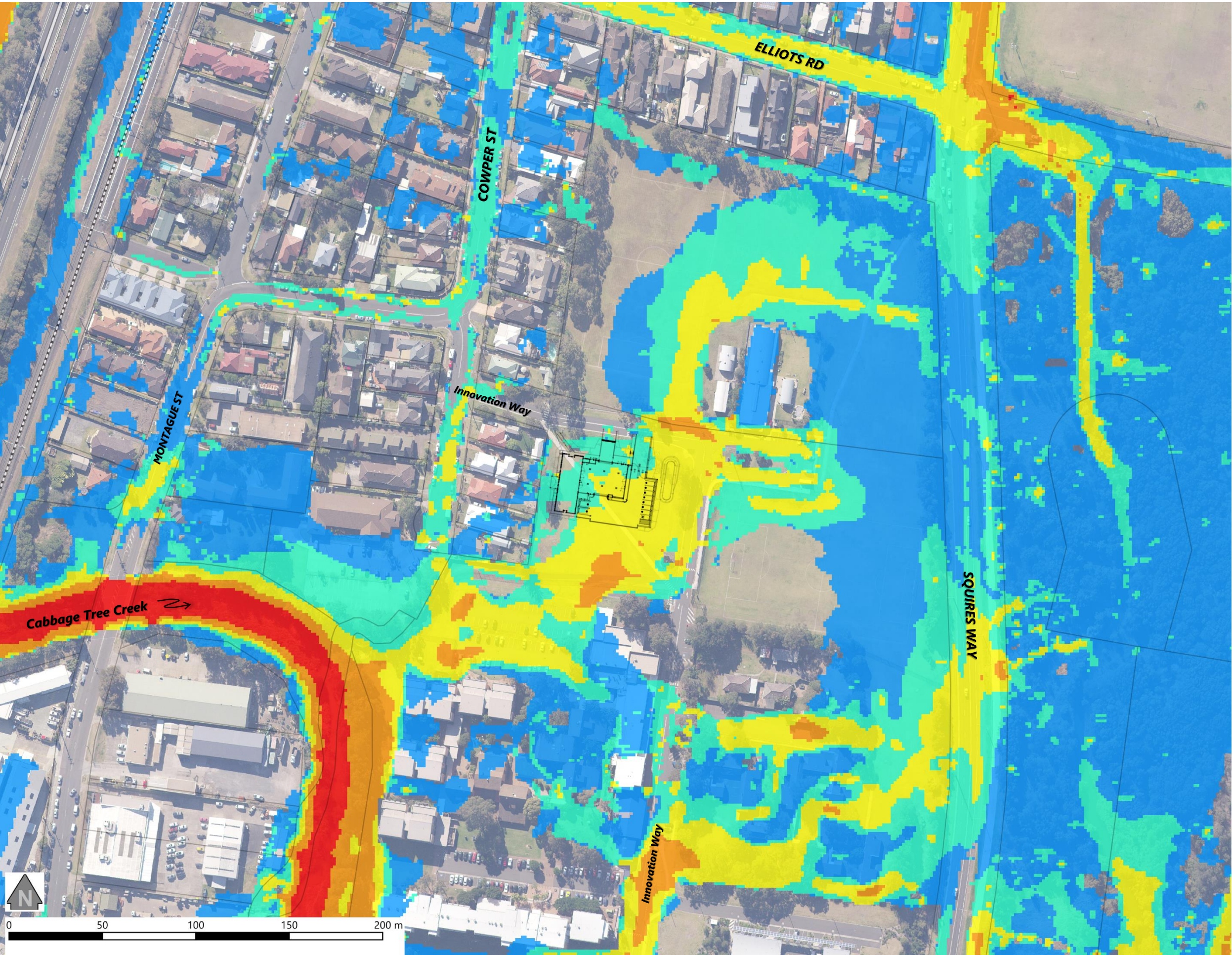
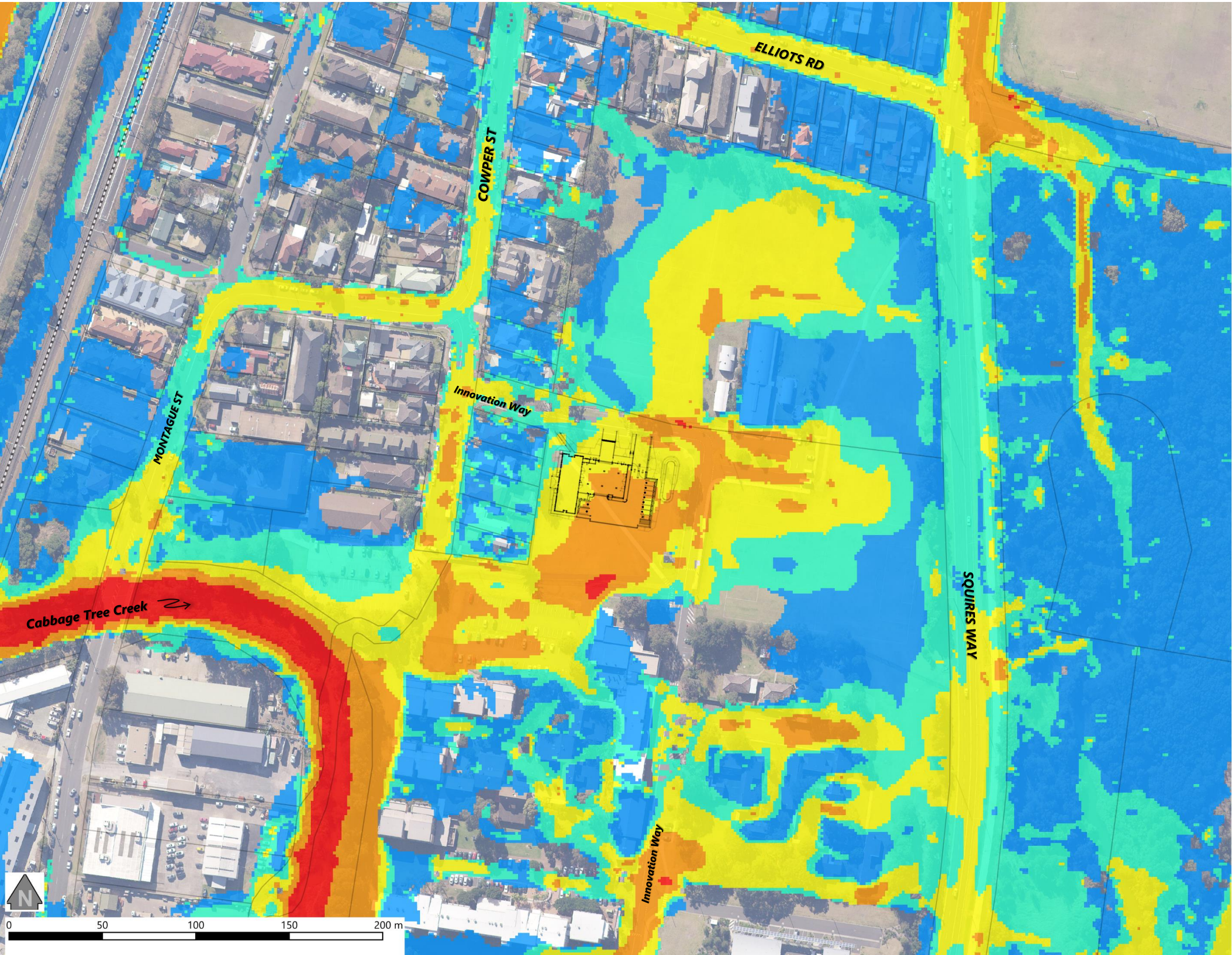


FIGURE A- 8



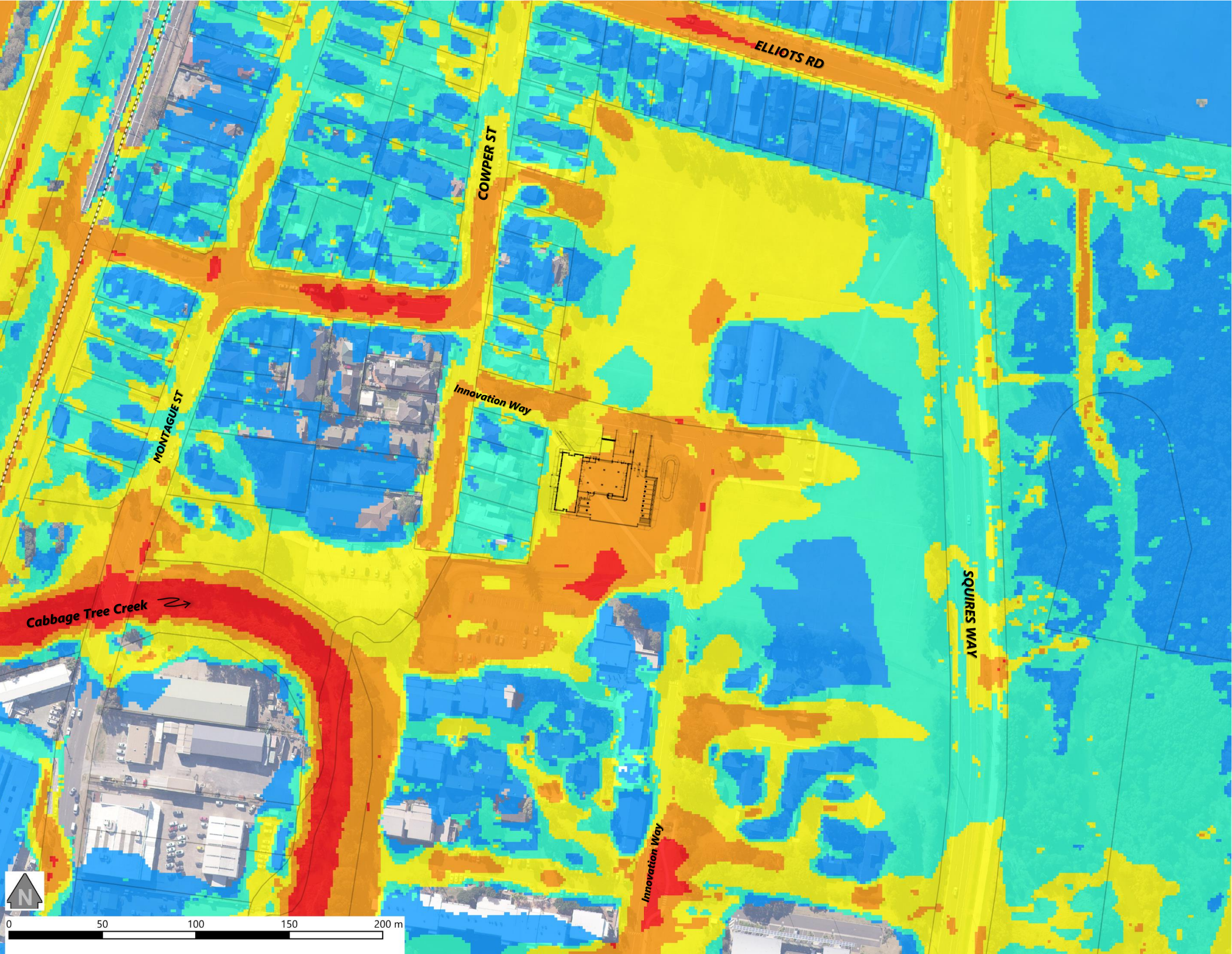
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Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
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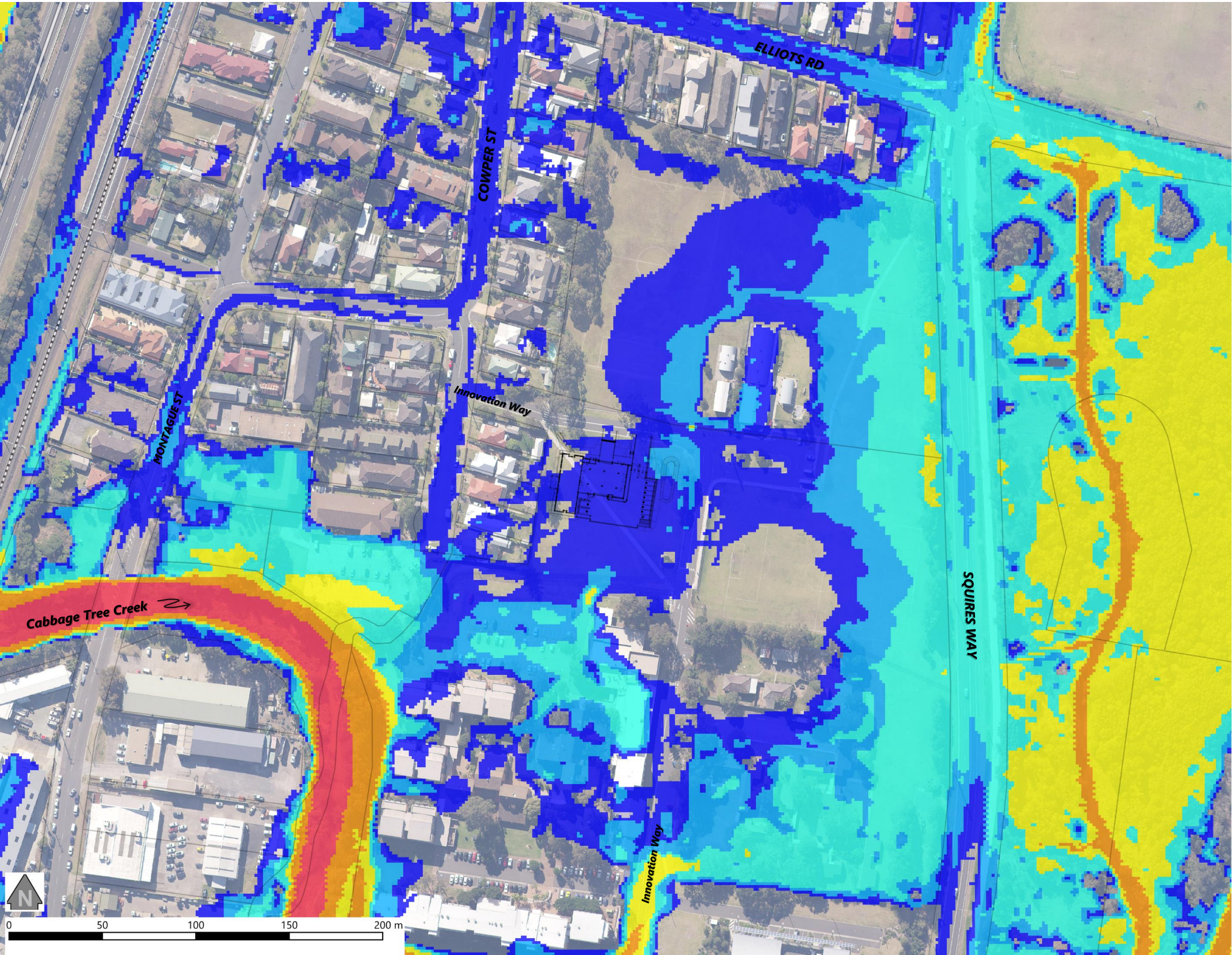
**1 IN 500 AEP EVENT PEAK FLOOD VELOCITIES
[EXISTING CONDITIONS]**

FIGURE A- 9



PMF PEAK FLOOD VELOCITIES
[EXISTING CONDITIONS]

FIGURE A- 10



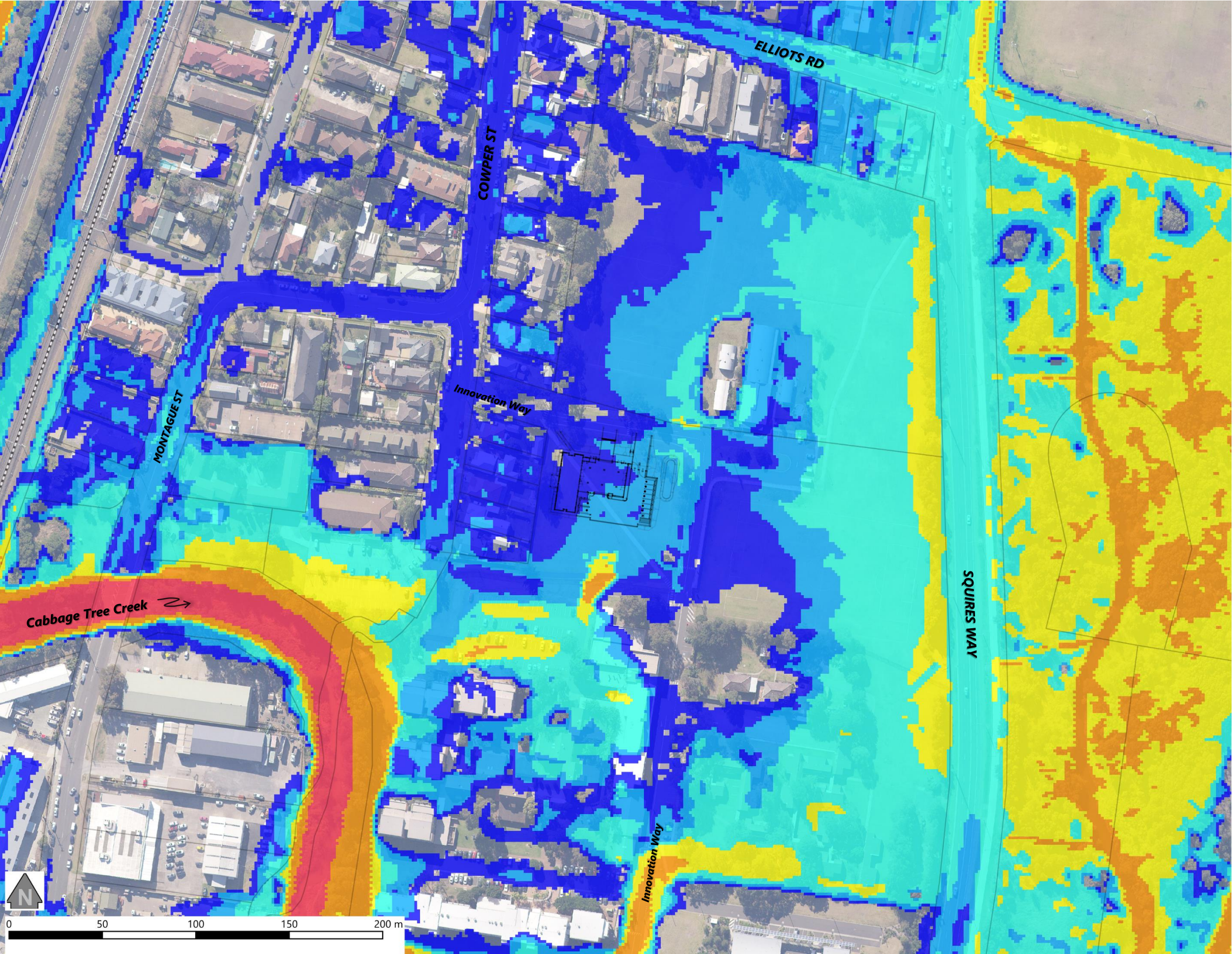
LEGEND

— Cadastre
— Proposed Development Layout

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure

FIGURE A- 11



LEGEND

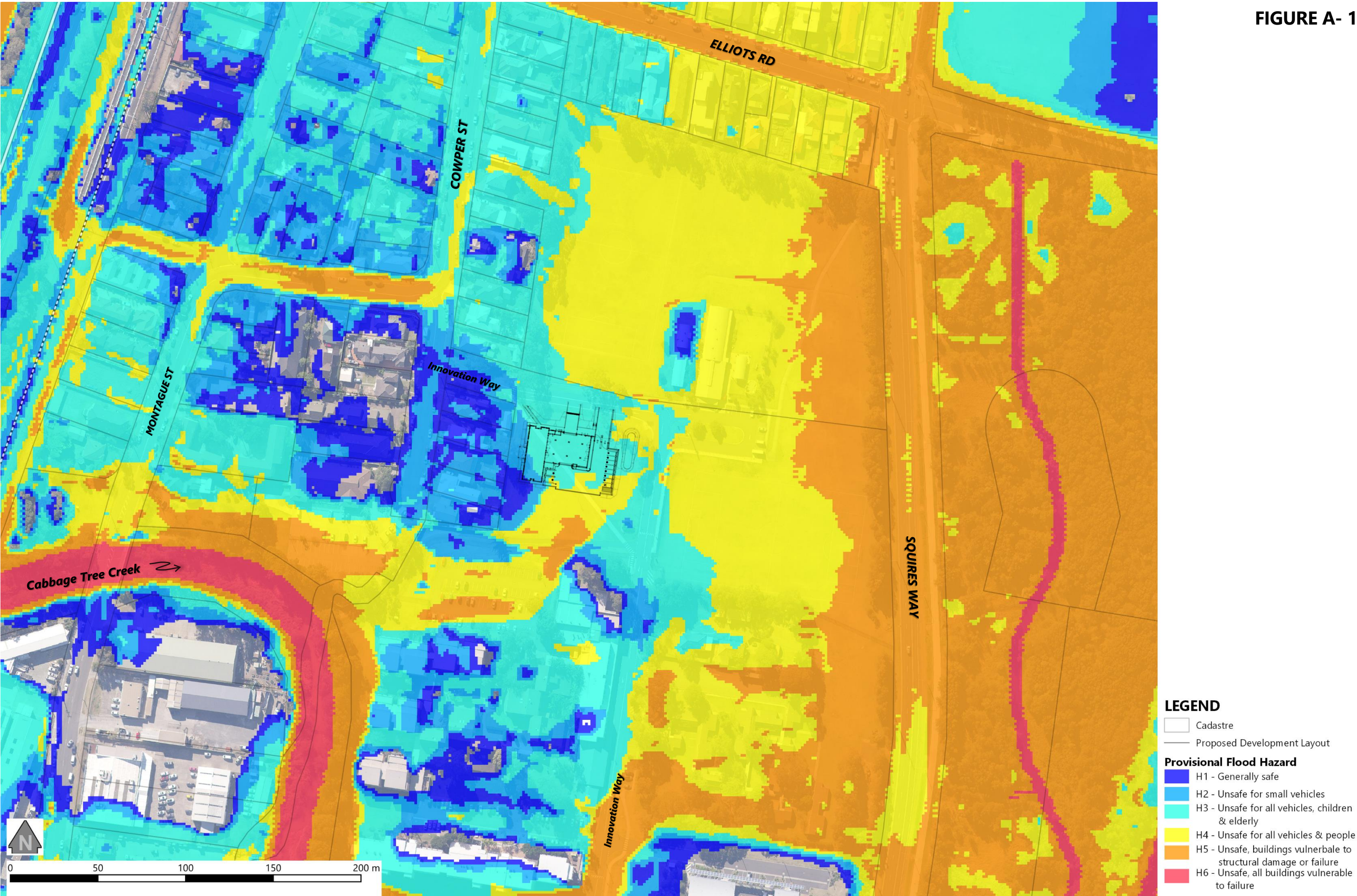
— Cadastre

— Proposed Development Layout

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure

FIGURE A- 12



Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
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WBIM version: FCT_CS08b_STR04brb_C1p4_F09_event~3IFDs.wbm
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PMF PROVISIONAL FLOOD HAZARD
[EXISTING CONDITIONS]

ATTACHMENT B

FLOOD LEVEL IMPACT AND HAZARD MAPPING FOR 'POST-DEVELOPMENT' CONDITIONS

FIGURE B-1



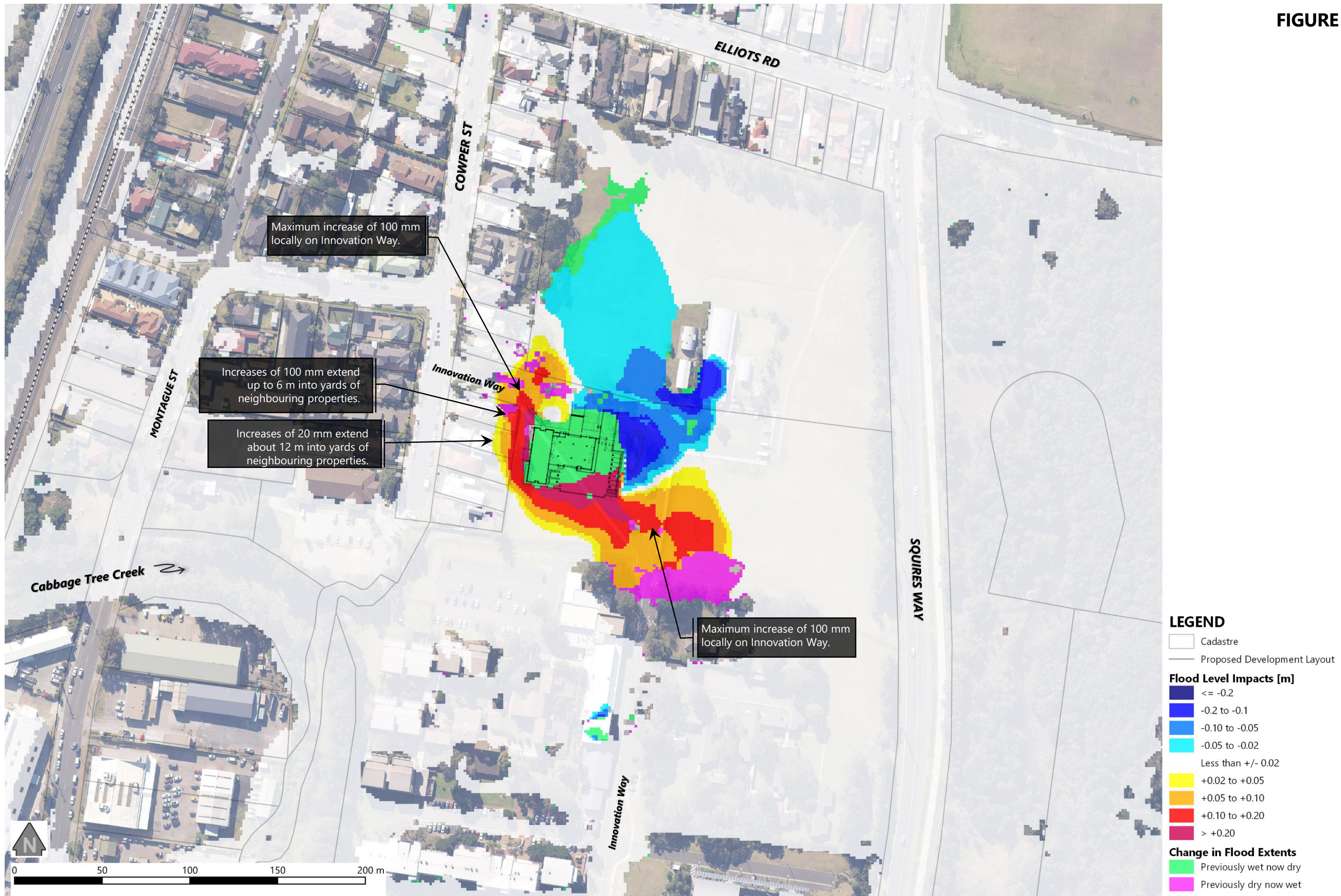
Prepared by:

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Worley Group

Date: 9/3/2023 Design: PostDev002
Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
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1% AEP EVENT PEAK FLOOD LEVEL IMPACTS
[POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE B-2



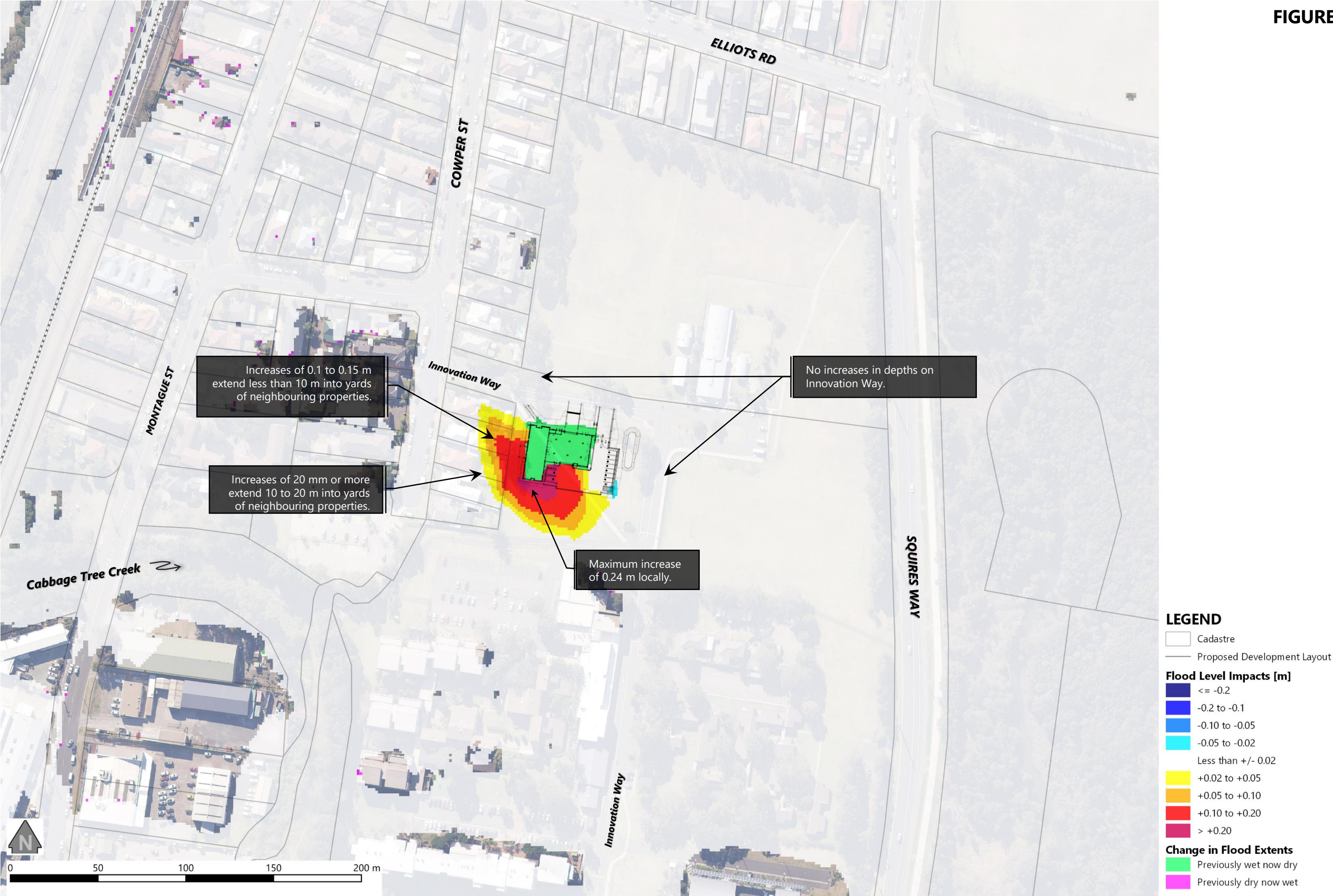
Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
WBIM version: FCT_CS08b_STR04brb_C1p4_F09_event~3IFDs.wbm
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1 IN 500 AEP EVENT PEAK FLOOD LEVEL IMPACTS
[POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE B-3



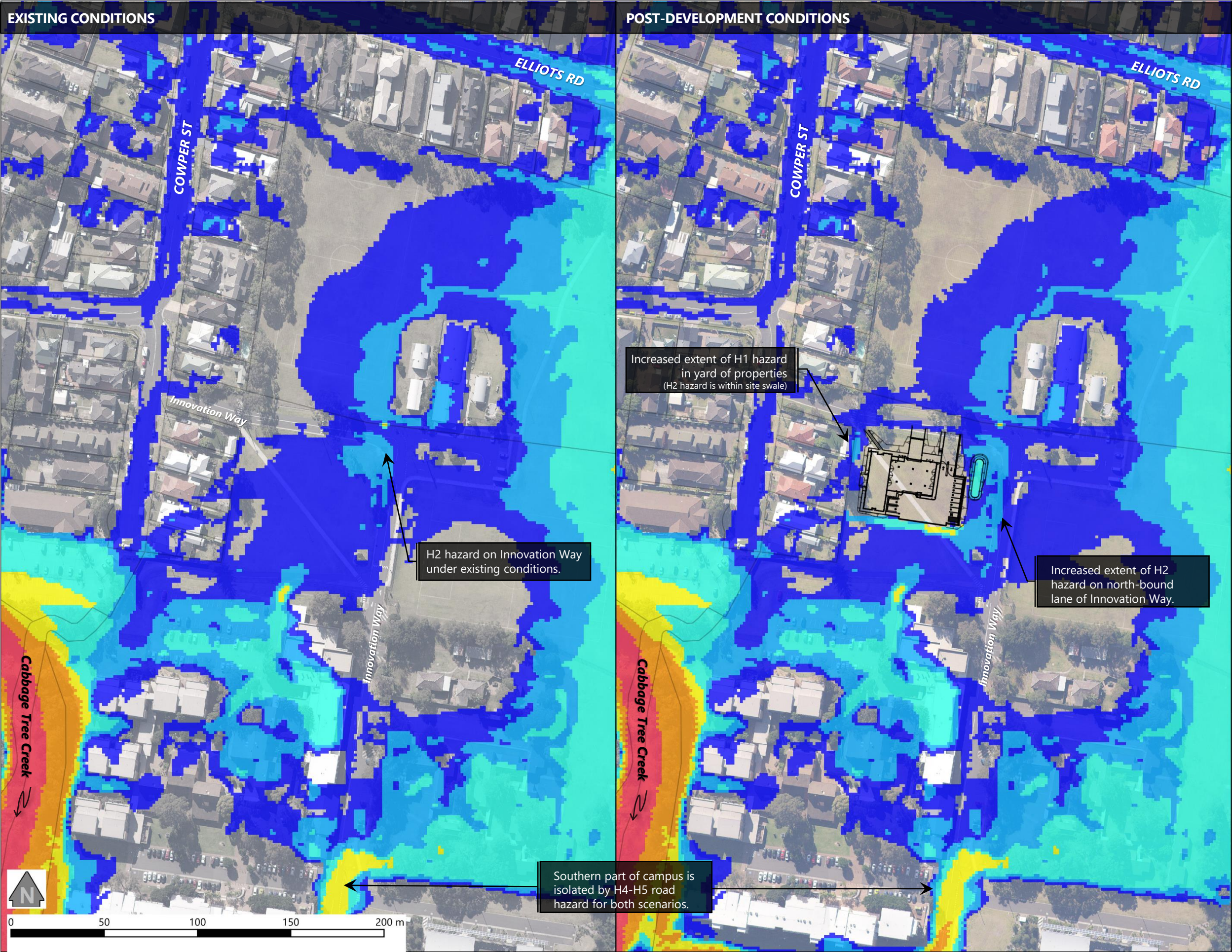
Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
WBIM version: FCT_CS08b_STR04brb_C1p4_F09_event~3IFDs.wbm
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PMF PEAK FLOOD LEVEL IMPACTS
[POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE B-4



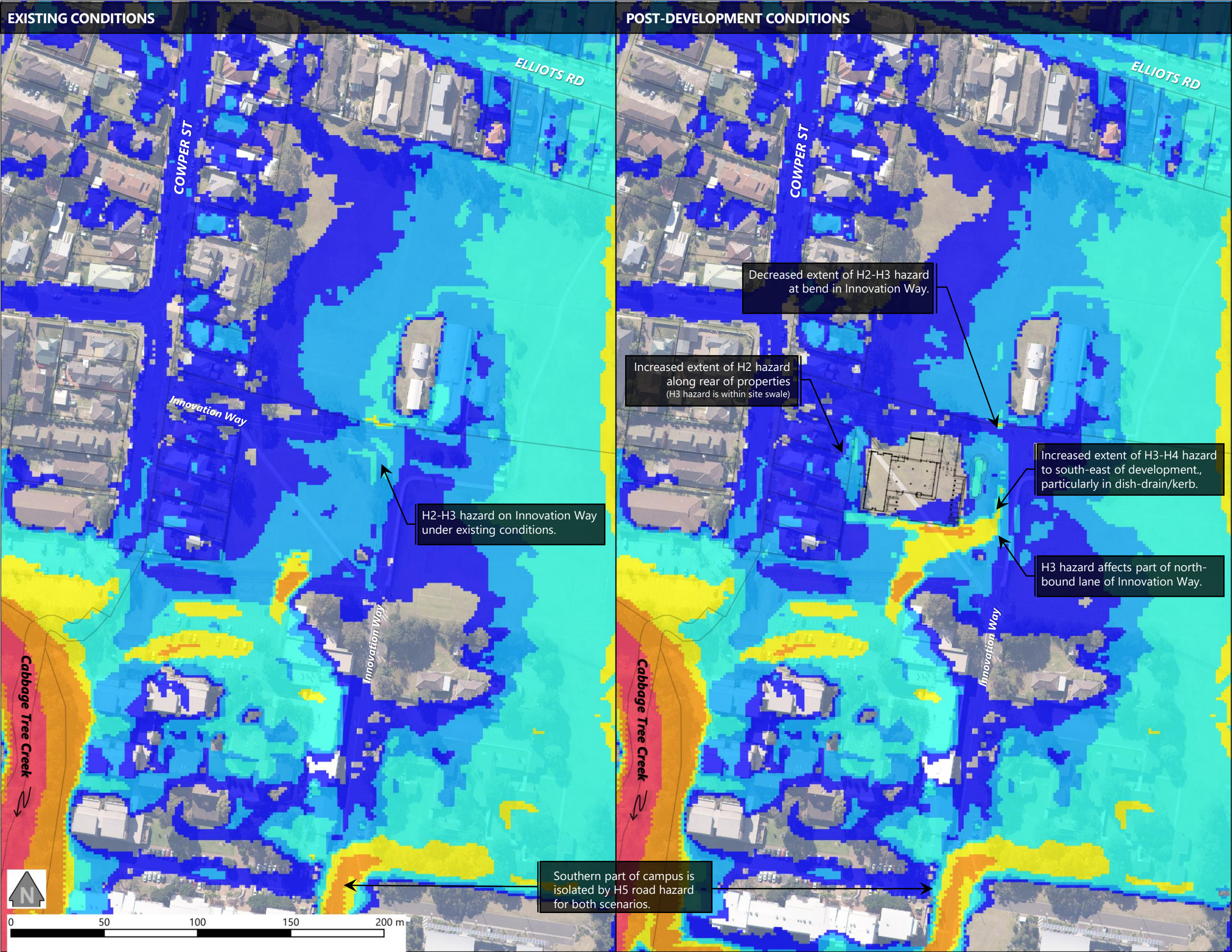
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Data Source: Fairy & Cabbage Tree Creeks Flood Study (Advisian 2020)
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COMPARISON OF 1% AEP EVENT FLOOD HAZARD
[EXISTING CONDITIONS VS POST-DEVELOPMENT CONDITIONS]

FIGURE B-5



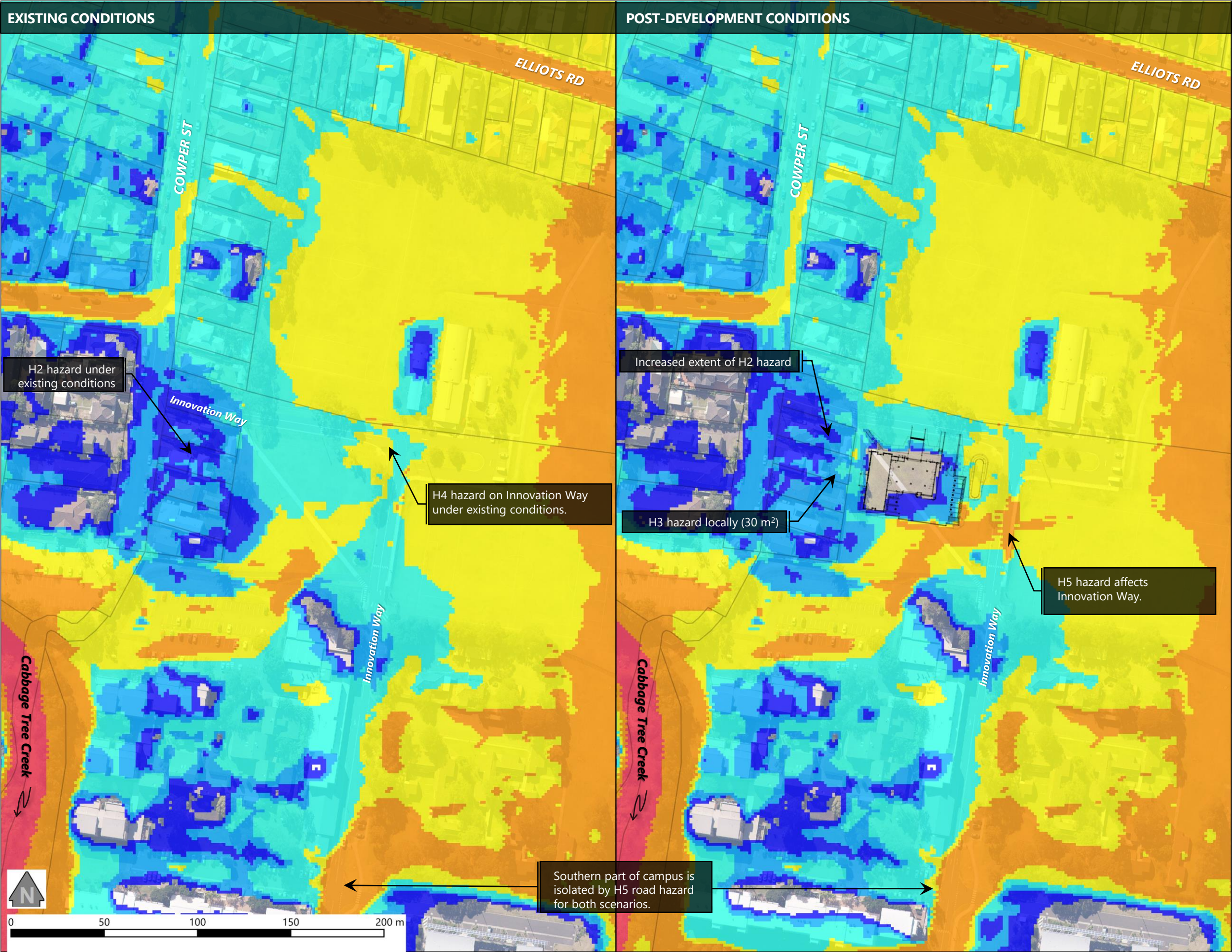
Prepared by:

Advisian
Worley Group

Date: 9/3/2023 Design: PostDev002
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**COMPARISON OF 1 IN 500 AEP EVENT FLOOD HAZARD
[EXISTING CONDITIONS VS POST-DEVELOPMENT CONDITIONS]**

FIGURE B-6



Prepared by:

Advisian

Date: 9/3/2023 Design: PostDev002
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COMPARISON OF PMF FLOOD HAZARD
[EXISTING CONDITIONS VS POST-DEVELOPMENT CONDITIONS]