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Job Number: *190006*
Date: *6 September 2023*

David Waghorn
Planning Ingenuity
Suite 510, 531 – 533 Kingsway
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Dear David,

Re: Flood Investigation for 187 Slade Road, Bexley North

1. Executive Summary

GRC Hydro were engaged by Planning Ingenuity to undertake a flood investigation at 187 Slade Road, Bexley North (the Site).

The assessment of existing flood liability demonstrated that the site is subject to overland flows.

The proposed development incorporates on-site flood risk mitigation measures and has been optimised to ensure does not impact on flood behaviour elsewhere.

- Sections 1-4 contextualises the existing flooding behaviour.
- Sections 5-6 shows the proposed development to be compliant with regards to flood impacts.
- Section 7 details the compliance with floor levels requirements.
- Section 8 assesses the development in relation to flood risk.
- Section 9 addresses the compliance requirements outlined in the Ministerial Direction, Local Environmental Plan (LEP) and Development Control Plan (DCP).

Overall GRC's work identifies the following:

- Compliance with Council's requirements is readily achieved.
- The diversion of existing stormwater conduit under Slade Road does not exacerbate flooding.
- Flood risk can be effectively managed by an evacuation in place response which is the default response in any case given the short duration of time for evacuation and then the short duration of flooding at the site.
- The public accessible areas created by the development provide safe refuge to any at the perimeter of the site when flooding begins around the Site.

2. Introduction

Development is proposed for the subject Site located at 187 Slade Road, Bexley North. The development is located in an urban area with a 28-hectare upstream catchment. Under current conditions the Site is affected by minor overland flow flooding from the carpark to the South-West and from Sarsfield Circuit. The location of the Site is shown in Image 1. GRC Hydro have been engaged by Planning Ingenuity to investigate the existing flood liability in relation to State and Local Government planning policies to assess the suitability of development for the Site and to identify flood mitigation measures.

3. Previous Studies

The Bardwell Creek 2D Flood Study Review was undertaken by WMAwater in 2018. The study used a hydrologic model (WBNM) and hydraulic model (TUFLOW) to model design flood behaviour for events ranging from the 20% Annual Exceedance Probability (AEP) to the Probable Maximum Flood (PMF). The modelling system was calibrated and validated to historic events. These models were found to adequately represent flood behaviour in the study area.

The TUFLOW model results were used as the basis for investigating flooding as part of this study. Some model amendments were made by GRC Hydro, in the vicinity of the Subject Site based on observations from Site visits and local knowledge of the area. The key model amendment was to facilitate the existing overland flow path through 232 Slade Road. Site visit revealed that the building basement is designed to allow flood water throughout the building and discharge into the railway line to the North (see Image 2).

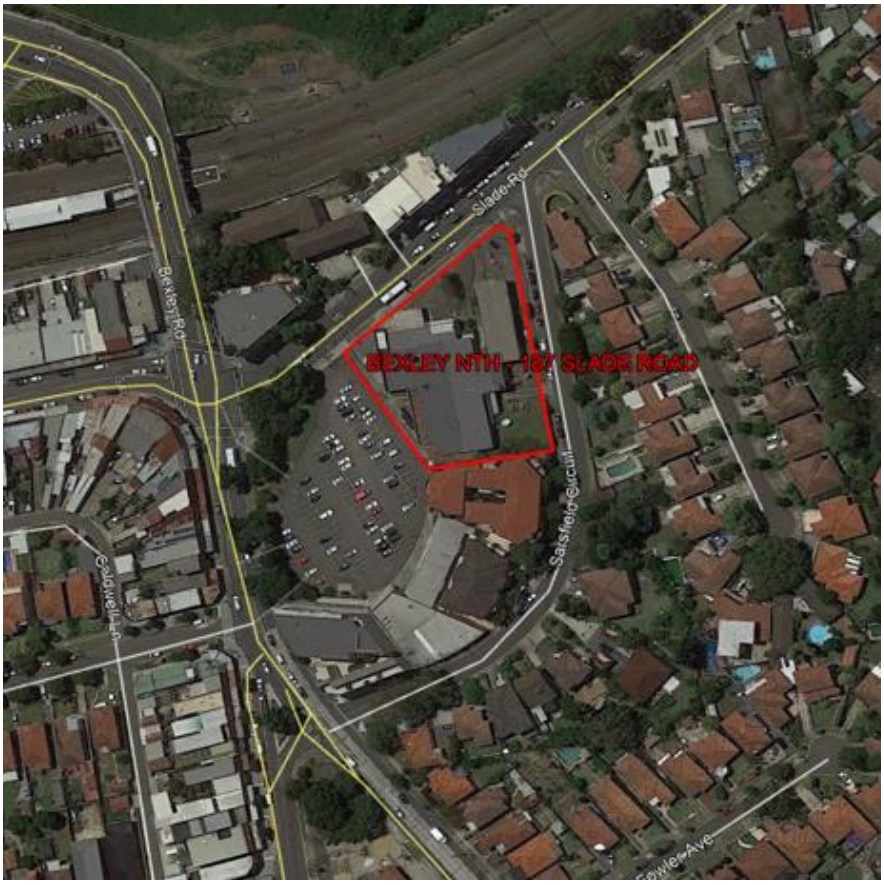


Image 1: Project Site Location - 187 Slade Road - Bexley North

Image 2: View of property in 232 Slade Road from Slade Road

4. Existing Flood Behaviour

The Site experiences flooding when rainfall in the catchment to the South exceeds system stormwater capacity and overland flow moves generally from South to North. Both the car park to the West and Sarsfield Circuit conveys overland flow. The Site's upstream catchment is shown in Image 3. Runoff from this catchment arrives at the intersection of Sarsfield Circuit and Bexley Road, flowing North. The flow is then split between Sarsfield Circuit and Bexley Road, with the latter flowing into the car park adjacent to the Site.

Figures 1-4 shows the flood depths and levels for events including the 20%, 10%, 1% AEP and PMF. In the 1% AEP event, on the Site boundary, flood depths range from 0.1 to 0.2 m on Sarsfield Circuit while along the Western boundary there are depths of around 0.2m to 0.6 m (measured in the sag point into the car park area). On Slade Road depths range from 0.1m to 0.6m (measured in the Slade Road Sag point in front of building in 232 Slade Road).

Model results indicate that the relatively new development at the corner of Sarsfield Circuit and Bexley Road (building at 2-6 Sarsfield Circuit) redirected flow on to Sarsfield Circuit that would have otherwise continued on Bexley Road. This has likely contributed to the flood risk at the subject Site.

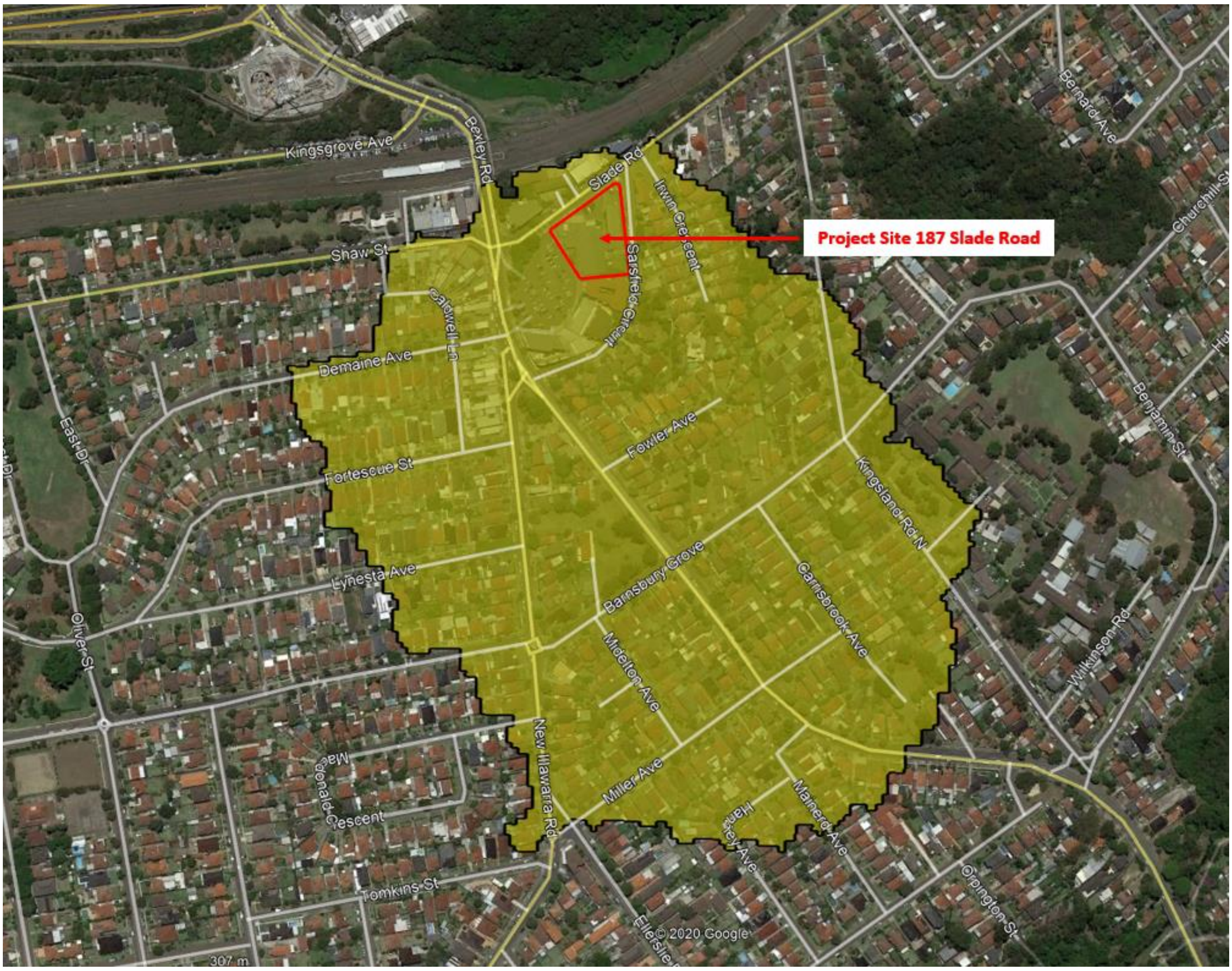


Image 3: Subject Site upstream catchment (27.8ha)

5. Flood Assessment of Proposed Development

The planning proposal is for an intensification of use of the subject Site whilst maintaining the existing use. The proposed construction consists of two new buildings. The area between the two buildings blocks (Laneway) is a publicly accessible open space. Basement levels are proposed with car access from Sarsfield Circuit at location shown in Image 4.

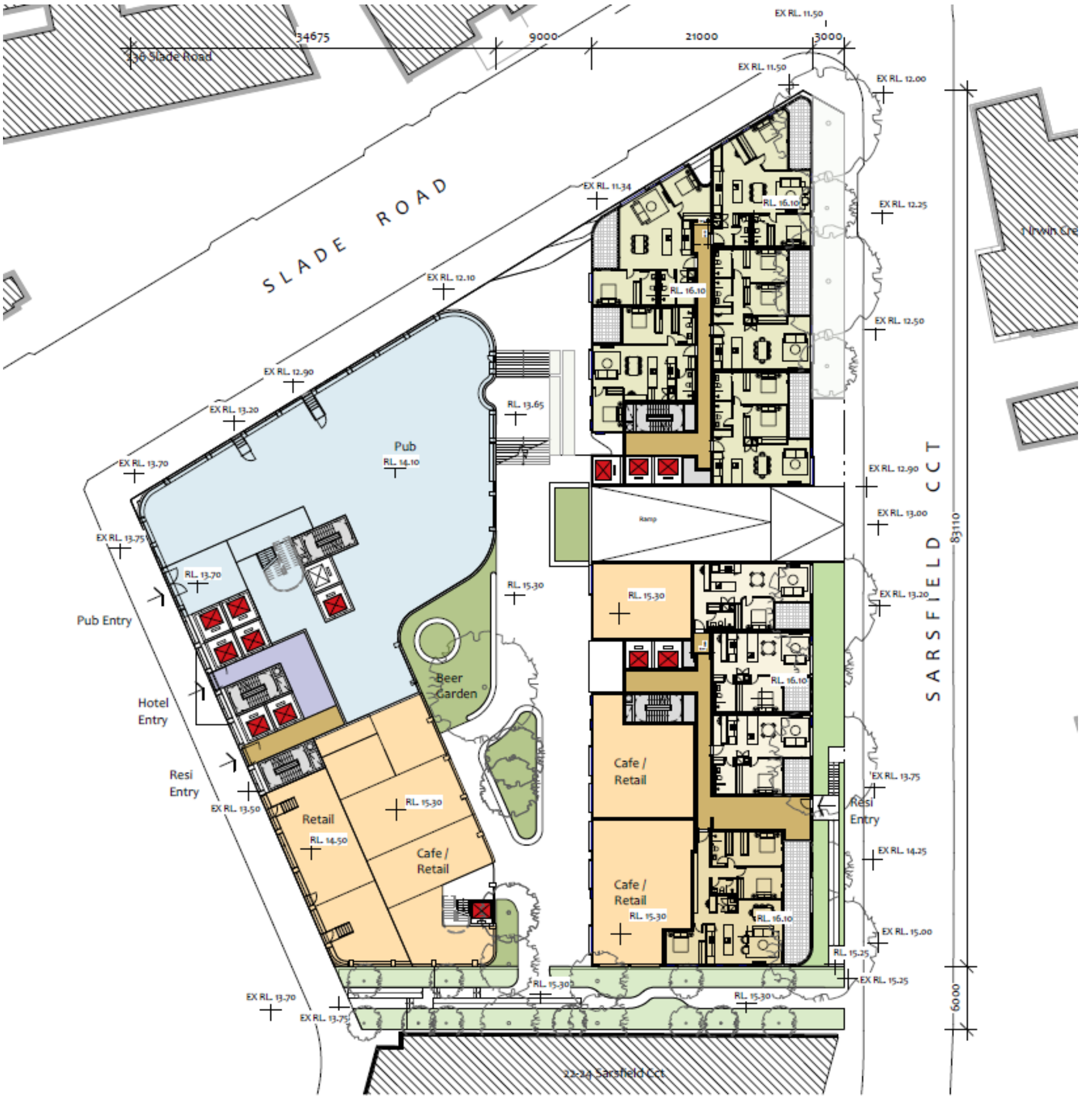


Image 4: Proposed Development

The proposed development contains several features that enhance its compatibility with site flood risk. The features are shown in Image 5 and are as follows:

1) **Pipe diversion and upgrade**: the existing 900 mm diameter pipe that traverses the Site will be demolished and replaced by a 1050 mm diameter pipe along Slade Road. The larger pipe will reduce friction losses and increase the pipe storage, reducing the hydraulic grade line and the potential impact in the car park area.
2) **Pipe upgrade:** The existing 900 mm pipe that crosses Slade Road will be upgraded to a 1200 mm diameter pipe or to an alternative drainage conduit of similar cross-sectional area.
3) **Swale:** A swale will be included in the building landscaping on the East side of the development. The proposed swale is 2m wide and 300-400 mm deep.
4) **Swale drainage:** The proposed swale will cross the proposed Car Park access ramp via a 2000mm x 700mm culvert. Swale profile will need to be adequately defined to allow sufficient cover above the crossing structure.

   At the downstream end of the proposed swale, a new pipe (500mm diameter) will join the swale to the existing stormwater network.

5) **Lowered ground**: At the end of the swale (North-East corner of the development), the ground is lowered from the existing level of 12.17 mAHD to 11.35 mAHD (tying into the swale) and then the ground is graded in the North-West direction towards the Slade Road footpath at level 11.23 mAHD.
6) **Connection Lane at South of development**: Following Council's request, a 6m wide lane has been allowed at the South end of the development for connection between the parking area at West and Sarsfield Circuit. As per Council request, the lane must have a high point ("crest") at least 200mm higher than the 1% AEP water level in the Sarsfield Circuit gutter.

See the numbered items in Image 5.

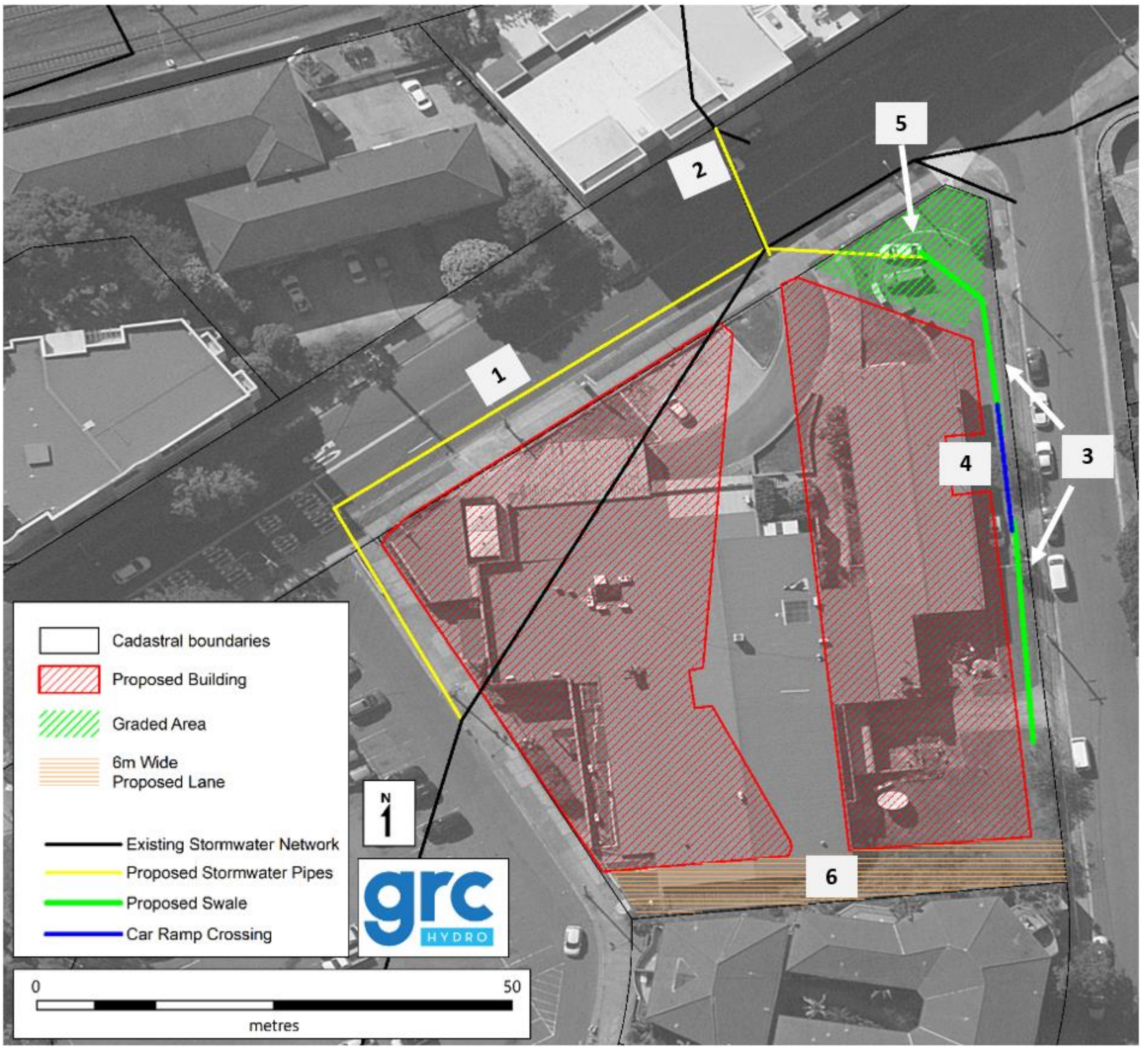


Image 5: Proposed Flood Mitigation Measures

6. Impact of the Proposed Development

The proposed development was schematised in the hydraulic model (TUFLOW). The development was represented as a 'proposed' scenario that modified the building footprints and drainage features around the Site, as described in the previous section. The hydraulic model was then used to assess the impact of the development on existing flood behaviour. Figures 5-8 shows the proposed case flood depths and levels for events including the 20%, 10%, 1% AEP and PMF. The impact maps for the 20%,10% and 1% AEP events are shown in Figures 9 to 11.

The figures show that the building has a localised effect on the existing flood behaviour. On the West side of the building there is a slight decrease in flood level of less than 0.1 m. While there is a slight loss of flood storage (black area) this is offset by the increased stormwater capacity. (associated with pipe upstream potentially).

On Sarsfield Circuit there is also a loss of flood storage against the building, however it is offset by the swale and the level reduction at North-East of the development. The adverse impact is localised at the Southern-East end of the development, and it is contained within the subject Site boundaries.

Overall, in regard to flood impact, the proposed development has minimal impacts on flood behaviour and does not result in flood impacts to other private properties or public roads. It will not result in increased requirement for government spending on flood mitigation measures.

6.1 Pipe Diversion

The proposed development comprises works on limited council drainage assets as described below.

In the Existing Scenario in fact, a 900mm dia. pipe runs under the existing building in 187 Slade Road from the car park at West to a drainage pit on the Slade Road at North of the building (pipe "EXISTING (a)" in Image 6)

From this pit, a 900mm dia. pipe crosses Slade Road and connects to a large pit located at the entrance of the car park of building in 232 Slade road (pipe "EXISTING (d)" in Image 6) from where a 1200mm dia. pipe discharge to the railway line at North.

The new stormwater layout proposes to demolish the pipe "EXISTING (a)" and re-route it to North, along Slade Road, to avoid interference with the new construction and facilitate future maintenance if required (pipes "PROPOSED (b)" and "PROPOSED (c)" in Image 6). The proposed diversion will increase the length of the pipe by approximately 19m and will introduce some sharper deflection angles that might reduce the capacity of the existing system. To cater for the additional energy losses due to the extended length of the pipe (friction losses) and for the less efficient geometry of the network (minor losses), it is proposed to upsize the diversion pipes to 1050mm dia.

Additionally, it is proposed to upsize the 900mm dia. "EXISTING (d)" pipe to 1200mm dia. "PROPOSED (d)" pipe (or alternative drainage structure of equivalent cross-sectional area) to match the diameter of the pipe discharging to the railway line.

TUFLOW simulations were run for events from the 20%AEP to the PMF event to test the new drainage scheme against the existing one.

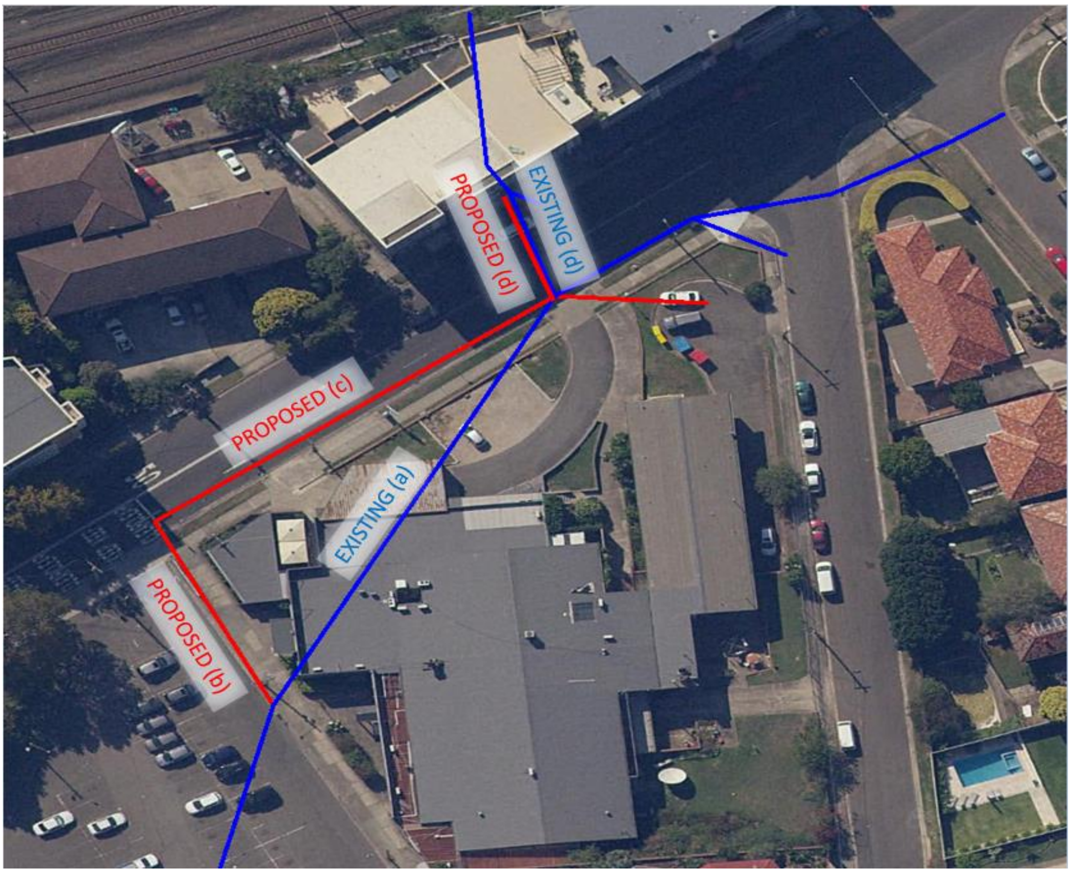


Image 6: Pipe diversion scheme

In TUFLOW, the Engelund energy loss approach was used to calculate the minor losses due to the bends and change of direction. This approach calculates the loss coefficients at pipes junctions as sum of entry and exit head losses, losses due to the bend and drop in invert levels (further explanation can be found in Chapter 5.12.5.4 of TUFLOW manual).

Table 1 lists the computed loss coefficients at the peak flow time for the Existing and Proposed pipes in all events from the 20%AEP to PMF. The table reports:

- inlet loss coefficient i.e. the energy losses due to expansion of flow within the manhole at the outlet of the inlet culvert
- additional loss coefficient due to bend and change in invert levels and any manhole energy loss contribution
- outlet loss coefficient i.e. the energy losses due to contraction from the manhole and re-expansion of flow within the entrance of an outlet culvert

Table 1: TUFLOW minor losses coefficients

AEP	PEAK MINOR HEADLOSS COEFFICIENT (Inlet / Form / Outlet)				
	EXISTING		PROPOSED		
	(a)	(d)	(b)	(c)	(d)
20%	0.19/0.02/0.42	0.16/0.45/0.45	B	0.16/0.80/0.39	0.16/0.77/0.28
10%	0.19/0.02/0.42	0.16/0.45/0.46	0.17/0.16/0.39	0.16/0.80/0.41	0.16/0.77/0.29
1%	0.19/0.02/0.44	0.16/0.41/0.47	0.19/0.16/0.44	0.17/0.79/0.44	0.16/0.76/0.30
PMF	0.17/0.02/0.40	0.18/0.37/0.54	0.18/0.18/0.43	0.17/0.73/0.42	0.16/0.75/0.34

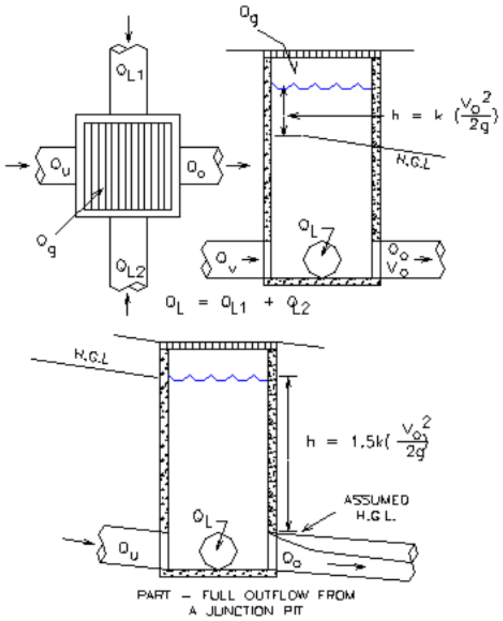
Table 1 shows that the total minor loss coefficient (sum of Inlet, Form and Outlet coefficients) increases from 0.65 to 0.79 at the first bend ("EXISTING (a)" and "PROPOSED (b)") and from 1.04 to 1.22 at the last one ("EXISTING (d)" and "PROPOSED (d)").

Additionally, in the proposed scheme, a 90-degree bend is introduced ("PROPOSED (c)") for which a total minor coefficient of around 1.4 is calculated.

Melbourne Water pit loss coefficient table (https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/standards-and-specifications/loss-coefficient) is commonly referenced by other Councils and Authorities . The table provides loss coefficients for a variety of junction pits configurations. A loss coefficient between 1.3 and 1.5 is recommended for pits at "L" bends which validates the coefficient calculated by TUFLOW

Table 2: Pit loss coefficients from Melbourne Water

Description	Q_u	Q_L	Q_g	k
Inlet pit with one outlet pipe:				
(a) side entry	-	-	≈Qo	10
(b) grated pit	-	-	≈Qo	5
Inlet pit on through pipe	~0.9Qo	-	some	0.5
	~0.7Qo	-	~0.3Qo	1.3
	~0.5Qo	-	~0.5Qo	2.1
Junction pit on through pipe	≈Qo	-	-	-
Inlet pit on through pipe with laterals	~0.9Qo	some	some	0.5
	~0.7Qo	some	some	1.1
	~0.5Qo	some	some	1.5
	~0.3Qo	0.7Qo	some	2.0
Junction pit on through pipe with laterals	~0.9Qo	some	-	0.5
	~0.5Qo	~0.5Qo	-	1.5
	~0.2Qo	~0.8Qo	-	2.0
Inlet pit on L bend	-	~Qo	some	1.5
Junction pit on L bend	-	≈Qo		1.3
Inlet bend on T junction with laterals	-	~Qo	some	1.8
Junction pit on T junction with laterals	-	≈Qo		1.6
Drop pit				
(a) direction change less than 45 degrees	~Qo	-	some	2.0
(b) direction change more than 45 degrees	~Qo	-	some	2.5



TUFLOW also provides indication about the flow regime in the pipes at every simulation time step. All pipes at peak flow time are tailwater controlled with submerged entrance and exit (Flow regime type "F"). An exception is represented by the proposed (b) pipe in the 20%AEP event where an inlet-controlled regime type B is calculated and for this reason TUFLOW does not provide minor loss coefficients results.

Image 7 shows flow regimes in diversion pipes

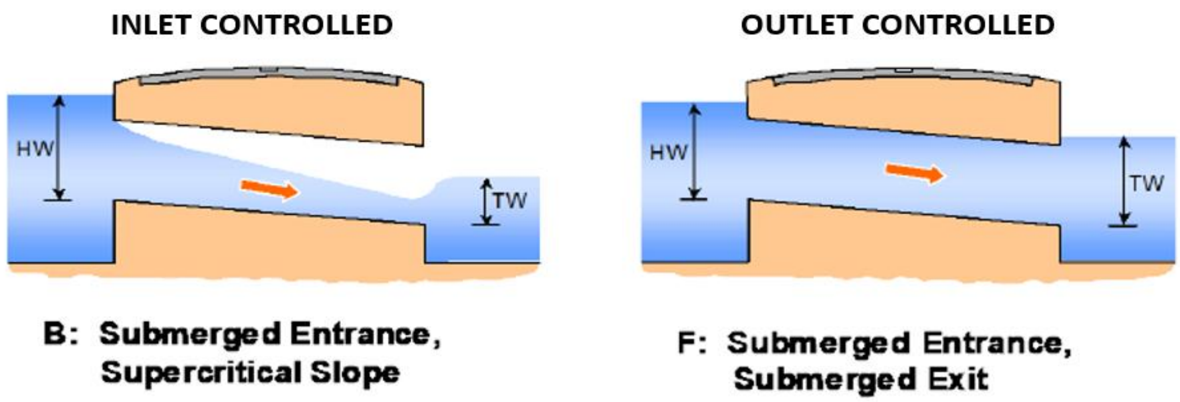


Image 7: Flow regimes in diversion pipes

Table 3 are the peak flow rates in the existing and proposed network and the peak Hydraulic Grade Line (HGL) at the drainage pit in the car park at West of the Site (where the diversion pipe departs). Peak flow for all the simulated events increased by approximately 30% while the HGL at the pit in the car park ("U/S Peak HGL") reduces approx. by 150 to 200 mm for all events up to the 1% AEP and by 13mm in the PMF.

Table 3: Peak flow rates and HGL in the existing and proposed network

AEP	PEAK FLOW (m^3/s)					U/S PEAK HGL (mAHD)	
	EXISTING		PROPOSED			EXISTING	PROPOSED
	(a)	(d)	(b)	(c)	(d)		
20%	1.6804	1.919	1.962	1.987	2.579	13.042	12.854
10%	1.961	1.951	2.036	2.063	2.625	13.176	12.955
1%	2.107	2.07	2.258	2.295	2.748	13.526	13.382
PMF	2.306	2.697	2.456	2.668	3.476	14.52	14.507

Hand calculation has also been done to compare the existing and proposed pipe configuration. The calculation is based on the Gauckler-Manning-Strickler resistance formula for the friction energy losses calculation and on the TUFLOW computed minor loss coefficients to calculate the losses at each change in direction.

In Table 4 below, a constant inflow of $2m^3/s$ was assumed for both the existing and proposed scheme and the total head loss (friction losses + minor head losses) was calculated under the assumption of uniform flow regime.

Table 4: Head loss hand calculation – Existing VS Proposed network

	EXISTING	PROPOSED	Comment
Q (m^3/s)	2.000	2.000	constant inflow ~ equal to the 1% AEP flow
Ltot (m)	83.670	101.960	total lenth of pipe = L1+L2
L1 (m)	67.780	86.070	L is the pipe length . L1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
L2 (m)	15.890	15.890	L is the pipe length . L2 refers to is pipe (d) in both the existing and proposed
k	66.660	66.660	Gaukler Strickler coefficient , corresponding to a Manning coefficient = 0.015
dia 1 (m)	0.900	1.050	dia is the pipe diameter. dia1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
dia 2 (m)	0.900	1.200	dia is the pipe diameter. dia2 refers to pipe (d) in both the existing and proposed
A1 (m^2)	0.636	0.866	A is the pipe cross sectional area. A1 refers to pipe (a) in the existing and pipe (b+c) in the proposed $A = \pi r^2$
A2 (m^2)	0.636	1.131	A is the pipe cross sectional area. A2 refers to is pipe (d) in both the existing and proposed
R1 (m)	0.225	0.263	R is hydraulic radius. R1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
R2 (m)	0.225	0.300	R is hydraulic radius. R2 refers to is pipe (d) in both the existing and proposed
ΔHfr1 (m)	1.102	0.615	ΔHfr is head loss due to frictions. ΔHfr1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
ΔHfr2 (m)	0.258	0.056	ΔHfr is head loss due to frictions. ΔHfr2 refers to pipe (d) in both the existing and proposed
Δhfrtot (m)	1.360	0.670	Δhfrtot is the sum of ΔHfr1+ΔHfr2
V1 (m/s)	3.144	2.310	V is the average pipe cross sectional velocity. V1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
V2 (m/s)	3.144	1.768	V is the average pipe cross sectional velocity. V2 refers to is pipe (d) in both the existing and proposed
φ1	0.650		minor head loss coeff of first bend in existing case
φ2	1.040		minor head loss coeff of second bend in existing case
φ3		0.790	minor head loss coeff of first bend in proposed case
φ4		1.400	minor head loss coeff of second bend in proposed case
φ5		1.220	minor head loss coeff of third bend in proposed case
ΔHBEND1 EXIST (m)	0.327		head loss (m) due to the first bend in the existing network. It is calculated with φ1 and the V^2/(2g) , where V is the velocity of the DS pipe
ΔHBEND2 EXIST (m)	0.524		head loss (m) due to thesecond bend in the existing network. It is calculated with φ2 and the V^2/(2g) , where V is the velocity of the DS pipe
ΔHBENDTOT EXIST (m)	0.851		total head loss due to bends in the existing network.
ΔHBEND1 PROP (m)		0.215	head loss (m) due to the first bend in the proposed network. It is calculated with φ3 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBEND2 PROP (m)		0.381	head loss (m) due to the second bend in the proposed network. It is calculated with φ4 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBEND3 PROP (m)		0.194	head loss (m) due to the third bend in the proposed network. It is calculated with φ5 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBENDTOT PROP (m)		0.790	total head loss due to bends in the proposed network.
Δhtot exist (m)	2.211		sum of friction losses and bend losses in the existing network
Δhtot prop (m)		1.460	sum of friction losses and bend losses in the proposed network

Both TUFLOW and the hand calculation demonstrate that the new proposed scheme is hydraulically more efficient than the current one.

In TUFLOW, due to the increased pipe conveyance capacity, peak flow in the diverted pipes is greater than in the existing ones while the peak Hydraulic Grade in the upstream pit (in the West car park) is reduced by approximately 150mm.

In the hand calculation, where same inflow is assumed in the pre and post development scheme, the total energy loss ("Δhtot") in the new scheme is significantly lower.

7. Minimum Floor Level Requirements

Whilst the Site is flood liable in the 1% AEP event, flood risk itself is minimal. Flood depths are transitory (duration is limited), hazard is relatively minor owing to relative shallowness of flood waters. There is no expectation that flood risk cannot be adequately managed. Far from being mainstream flooding which can pose a risk to life the flood affectation would more accurately be characterised as being overland flow (stormwater/flood fringe). Image 8 shows the hydraulic categories in the 1% AEP event for the existing case. Flood storage and flood fringe are the prevalent categories.

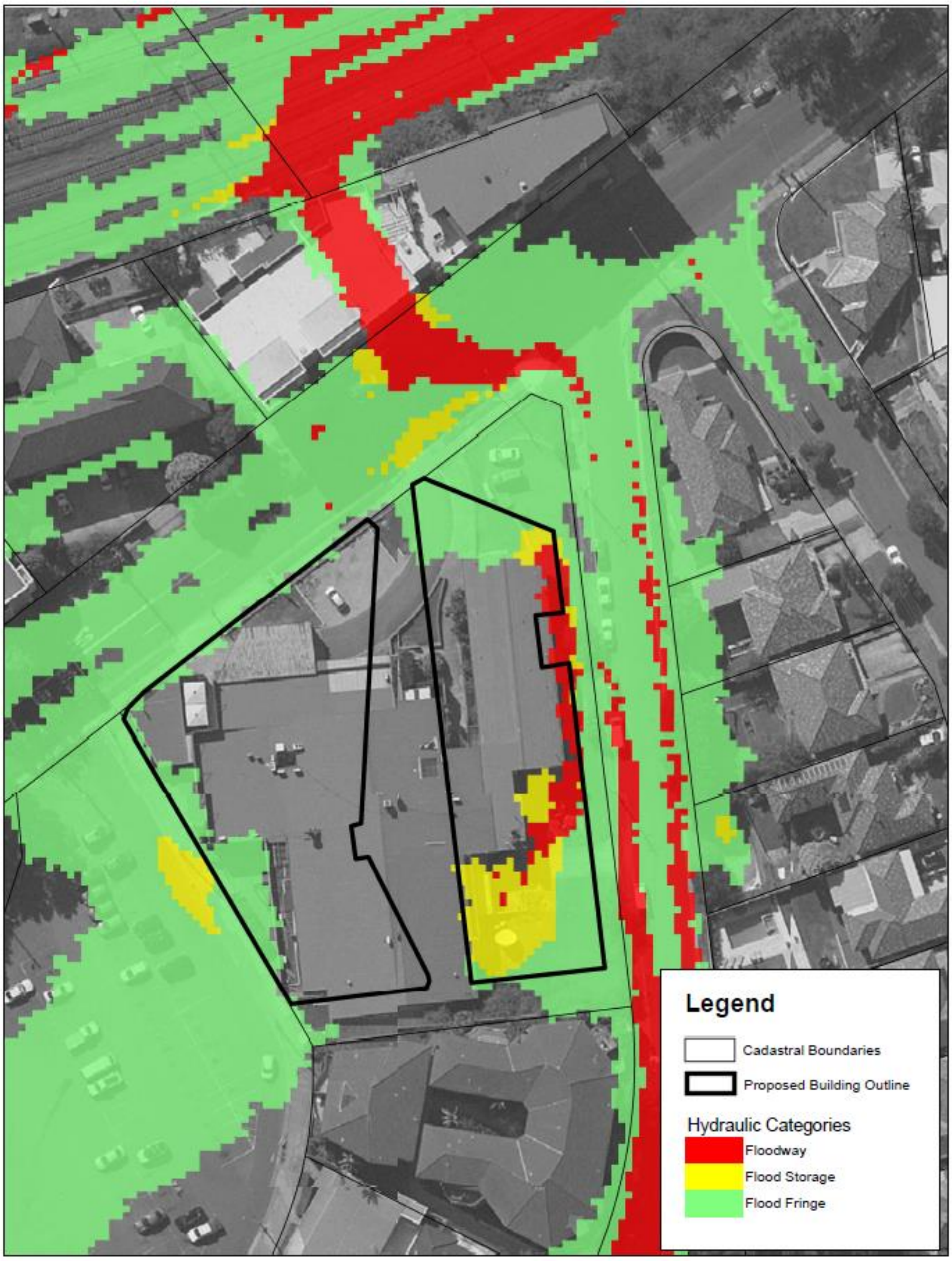
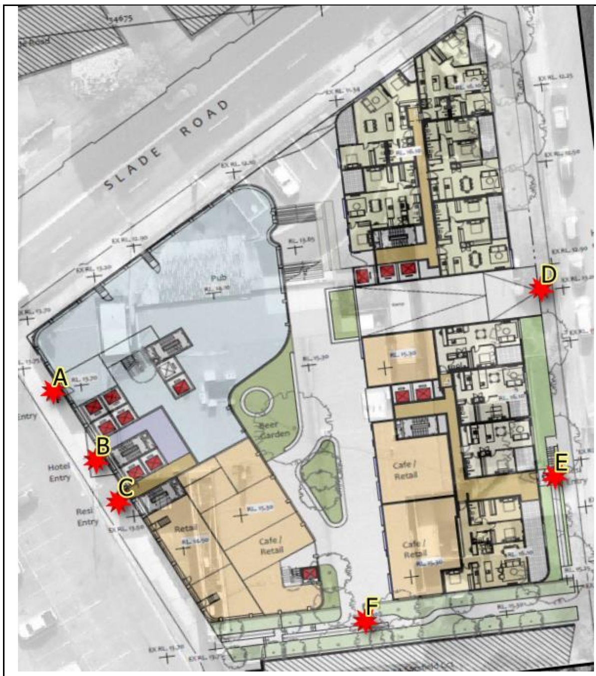


Image 8: Flood Categories (1%AEP)

The PMF (Probable Max Flood) is a consideration in building design and risk management. The Floodplain Development Manual (2005) defines the PMF as "*[…] the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation, and where* *applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event […]"*

Table 5 provides the computed peak water levels for the 1% AEP event and PMF against the proposed FPLs. The PMF does not scale excessively at the Site, with levels being generally 0.3 to 0.5 m higher than 1% AEP levels. This is due to the limited upstream catchment. One exception is at the northern end of the site where the PMF level is more than 1m higher than the 1% AEP level due to the limited capacity of the overland flow route through the building car park at 232 Slade Road.

Table 5: Water levels and proposed FPL



Location	1%AEP mAHD	PMF mAHD	FPL mAHD
Pub Entry "A"	13.9	14.5	14.5
Hotel Entry "B"	13.9	14.5	14.5
Residential Entry "C"	13.9	14.5	14.5
Vehicular Entrance "D"	12.8*	13.3	13.3
Residential Entry "E"	13.7	14.0	14.2
Pedestrian Laneway "F"	14.8*	15.0*	15.3**

*= measured on Sarsfield Road

**= crest level at the 6m wide access lane

A minimum freeboard of 500mm above the 1%AEP water levels is assured at all building entrances, in respect of Council DCP. Building Entrances A-C are at the PMF level. The Vehicular entrance "D" is also above the PMF level.

8. Flood Risk Assessment

An insight into the potential risk to life as a result of flooding can be ascertained by assessing the flood hazard. Flood hazard is quantified by considering the flood depth and velocity in combination (AIDR, 2017). The hazard categories of H1 (lowest) to H6 (highest) based on the Australian Emergency Management Institute (2014) of Image 9 were considered.

Available warning time for the Site is short due to the small size of the catchment upstream of the Site, leading to a “flash flood” classification. Review of the flood models found that the 1%AEP peak flood flow occurs approximately 10 minutes after the rainfall peak which leaves little time for flood evacuation and preparation. Evacuation of the buildings is not advised as it could potentially result in people entering hazardous floodwater areas. For flash flood catchments, the provision of an effective flood warning service is not feasible. A benefit of the flash flood setting is that the duration of flooding is typically short with hazardous flooding to typically last less than one hour.

Figures 12 and 13 in the Appendix, are the 1%AEP and PMF flood hazard maps for the Existing and Proposed Scenario. In the 1%AEP event, the flood hazard variations are negligible. In the PMF, a slight increase of the flood H5 hazard category is shown at the downstream end of the Sarsfield Circuit, which does not modify the overall hazard category of the area.

Hazard along the escape routes on Slade Road is generally low, being globally classified as H1 level. An analysis of the PMF event indicates that people should not moving around the Site once a certain threshold of depth is crossed. It is clear, however, that this threshold event will occur rarely (less often than once per one hundred years). Also, arguably it will be normal for people not to be occupying these outdoor areas during an extreme flood event.

The Site access is limited by the trafficability of Slade Road, which is classified as H5 in the PMF as per flood hazard category. Therefore, shelter-in-place for Site occupants is recommended during a flood event. It shall be noted that, given the nature of public accessibility of the proposed Laneway, the proposed Site will represent a safe refuge for pedestrians caught by flash flooding.

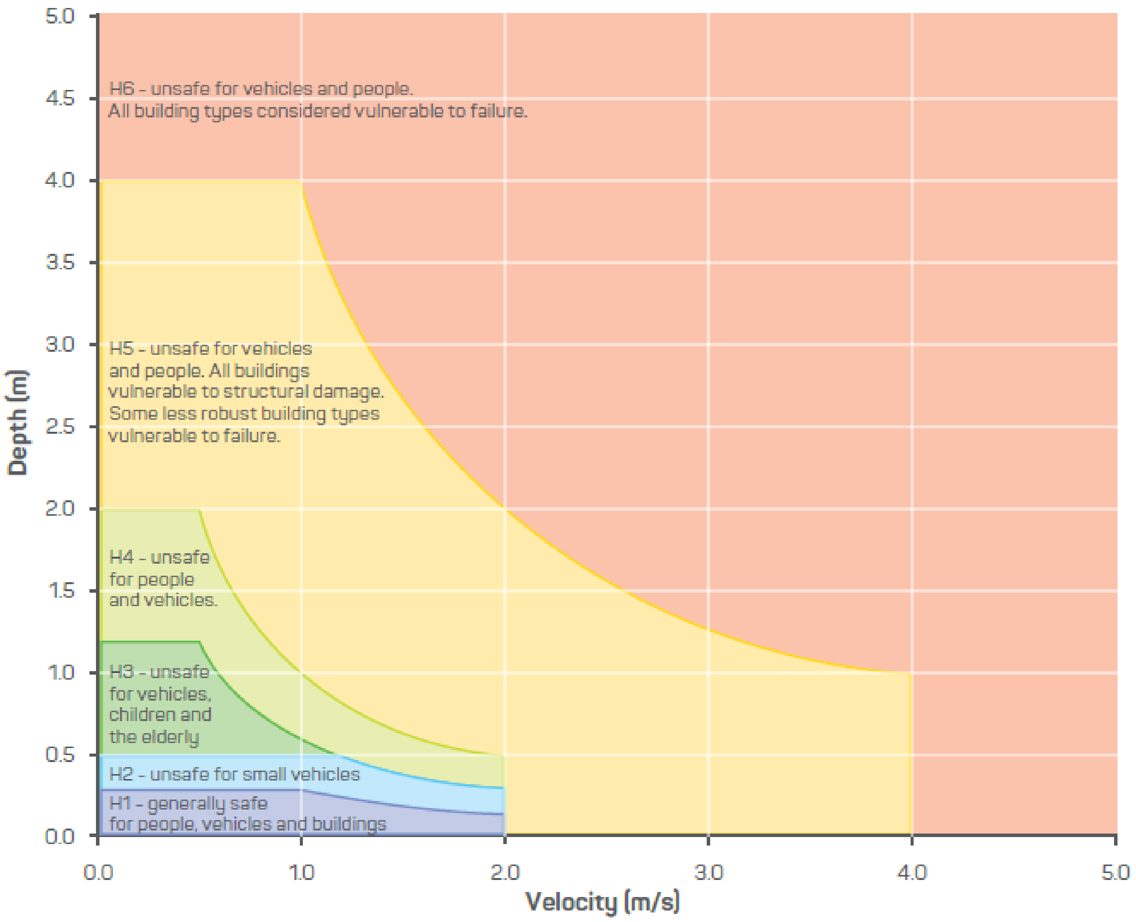


Image 9: Flood Hazard Category by Australia Emergency Management Institute (2014)

9. Development's Suitability Relative to Relevant Planning Requirements

GRC has assessed the proposed development relative to the site's flood affectation with regard to the following relevant planning instruments: The following tables set out the compliance of the proposed development with Local Planning Directions in Section 9.1(2) of the Environmental Planning and Assessment Act 1979, specifically Section 4.1 – Flooding. The flood-related components of these planning instruments are quoted below with GRC responses regarding the compliance of the proposed development included.

Bayside Development Control Plan (2022)

High Flood Hazard – Prescriptive Controls are relevant for this development.

Objective or Control	GRC Response
A1) Habitable floor levels to be no lower than the 1% AEP flood level plus 0.5m freeboard.	Table 5 demonstrates that all habitable floor levels are compliant.
A3) Non-habitable floor levels to be no lower than 1% AEP flood level.	See above
B2) All structures to have flood compatible building components below the PMF level.	Flood compatible building materials as detailed in Section 9.5.3 of the DCP are to be used below the PMF level. The appropriateness of selected building materials for development must be confirmed by the architect.
B3) Flow-through open form fencing (louvres or pool fencing) is required for all new fencing and all new gates up to the 1% AEP flood level to allow floodwaters to flow through.	Not applicable.
B4) All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the 1% AEP flood level plus 0.5m freeboard. All existing electrical equipment and power points located below the 1% AEP flood level plus 0.5m freeboard within the subject structure must have residual current devices installed that turn off all electricity supply to the property when floodwaters are detected.	All electrical conduits are situated above the required level.
C2) An engineer's report shall be provided to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to the PMF Level.	Flood depths and flows are mild compared to the proposed built form. This can be provided as a condition.

D1) The development must not result in increased flooding elsewhere in the floodplain. A flood assessment report (refer to Schedules – Chapter 9.5.4) shall be provided to demonstrate that the development: • does not divert floodwaters to the detriment of elsewhere on the floodplain. • does not increase flood level or velocity elsewhere on the floodplain. • does not result in a detrimental loss of flood storage. • reduces the existing flood hazard, where possible. *A flood impact assessment for a site is not required where the flood storage and floodway capacity are retained. For example, a building can be elevated to retain the existing floodway and flood storage to permit the free flow of water under the building.*	As described, a number of design features, including upgraded stormwater drainage and a swale, have been incorporated into the development, so as to ensure no diversion of floodwaters or interference with flood storage. There are no adverse flood impacts resulting from the development. These conclusions are demonstrated by the modelling carried out and presented herein.
E1) The minimum finished floor level of open car parking spaces or carports shall be at or above natural ground level. A flow-through roller door (or horizontal louvers) is permitted for a carport structure. Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise, it will be considered to be enclosed. Open car parking areas shall not be located within a floodway.	Open car parking is proposed on the west of the proposed development only in an existing public carpark.
E2) For above ground level garages, the minimum surface level shall be no lower than the 1% AEP flood level.	No garages are proposed above ground level, hence not applicable.
E3) Basement garages/storage/car parking, low-level driveways must be physically protected from inundation by floods equal to or greater than the 1% AEP flood level plus 0.5m freeboard. The crest of the driveway shall be located within the property boundary. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the 1% AEP flood level plus 0.5m freeboard level. *Council will not accept any options that rely on the electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark for new development. Flood barriers may be accepted for an existing development to improve flood protection.*	The basement carpark entrance is situated at least at 13.3 mAHD, which is above the PMF level and meets criteria for 1% AEP plus 0.5 m (see table 5).

F1) A qualified civil engineer shall be engaged to prepare an onsite emergency response flood plan is required to detail whether evacuation procedures are required and if so, how they will be initiated, warning signs and preservation of flood awareness as owners and/or occupants change through time. Adequate flood warning systems (such as water level sensors, and alarm stations), signage and exits shall be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel. The evacuation plan shall be easily accessible to current and future occupants. If safe evacuation cannot be achieved within a sufficient response time then a shelter-in-place refuge is required, together with a plan for self-sufficiency for up to 12 hours. This plan must consider as a minimum: sufficient area for all the occupants, adequate clean water for all occupants; portable radio with spare batteries; torch with spare batteries; first-aid kits; emergency power; and a practical means of medical evacuation. Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.	There is not a large difference between the PMF and the 1% AEP flood level at the Site, with around 0.3-0.6 m difference generally. The new development will be protected from flooding and will allow any occupants to take refuge during a flood inside the building.
G1) If a site or part of the site is affected by a Flood Hazard Category of H5 and H6, buildings and structures can be exposed to significant structural damage with a high risk to life. Intensification of existing land use in the affected area is not permitted unless it can be demonstrated to the satisfaction of the consent authority that the risk level on the property is or can be reduced.	The Site is located in an urban area with many nearby properties. Impact assessment shows that by upgrading stormwater drainage and inclusion of a swale, there is no adverse impact on properties' flood affectation. The area does not have potential for cumulative impacts due to such development as the catchment is already fully developed.
G2) Storage of materials that may cause pollution or are potentially hazardous during any flood is not permitted below the 1% AEP plus 0.5m freeboard.	No storage areas are allocated below the 1% AEP plus 0.5m freeboard level at any location of the proposed development.
G4) Where a building is elevated to retain the existing floodway, overland flow path and flood storage, the undercroft area is to remain open to permit the free flow of water under the building. A positive covenant is required.	In existing case, a floodway is present along Sarsfield Circuit, and there was also some on-site flood storage. The proposed development incorporates flood mitigation measures along the lot boundary to provide compensatory flood storage.

G5) Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. *All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the 1% AEP plus 0.5m freeboard level. All chemicals associated with the pool are to be stored at or above the 1% AEP plus 0.5m freeboard level.*	No pools are proposed at the ground level of the development, hence not applicable.

Bayside Local Environmental Plan (LEP) (2021) – Section 5.21

Section 5.21 Flood Planning for the Bayside Local Environmental Plan (LEP) outlines flood related controls relevant to the proposed development. These controls are provided below.

Objective	GRC Response
(1) The objectives of this clause are as follows— *(a) to minimise the flood risk to life and property associated with the use of land,*	Risk to life is minimal as flood hazard is low and flood levels do not scale substantially. Safe evacuation is possible interior to the building.
(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,	Development has been made compatible with PMF flood behaviour and as such the development is resilient to potential changes due to climate change and this objective has been met.
(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,	A detailed impact assessment has been carried out and is reported in Figures 9 to 11. No impacts result from the proposed works in the 20%, 10% and 1% AEP events. The catchment is already developed and as such cumulative development is a non-issue.
(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.	Given the nature of public accessibility of the proposed Laneway, the proposed development will create a safe refuge for people caught by flash flooding. Shelter in place is the only suitable strategy given the lack of warning and short duration of flood. Being in a car during such an event is not preferable.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—	
(a) is compatible with the flood function and behaviour on the land, and	The land is flood fringe and flood storage in the context of overland flooding – not mainstream flooding. The impact modelling further reinforces the suitability of the works at this location.
(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	A detailed impact assessment has been carried out and is reported in Figures 9 to 11. No impacts result from the proposed works in the 20%, 10% and 1% AEP events.
(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	Given the nature of public accessibility of the proposed Laneway, the proposed Site will represent a safe refuge for people caught by flash flooding. Shelter in place is the only suitable strategy given the lack of warning and short duration of flood.
(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	As above safe evacuation is inherent in the design.
(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	The existing site is a commercial development. The proposed works will not impact the environment given standard precautions during construction.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—	
(a) the impact of the development on projected changes to flood behaviour as a result of climate change,	Development has been made compatible with PMF flood behaviour and as such the development is resilient to potential changes due to climate change and this objective has been met.
(b) the intended design and scale of buildings resulting from the development,	Answered by others.

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	Given the nature of public accessibility of the proposed Laneway, the proposed Site will represent a safe refuge for people caught by flash flooding. Shelter in place is a suitable strategy given the lack of warning and short duration of flood and ensures the safety of people caught on site during a flood.
(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	Given the site of the proposed works, only pluvial flooding is an issue and since GRC have modelled the site in a PMF and still found that flood risk to be manageable, the exacerbation of design pluvial events is not a concern.

Ministerial Directions – Section 4.1 - Flooding

Notes:

1) *Bayside Council LEP does not have Special Flooding Considerations in Clause 5.22, hence item (4) is not applicable.*

Objective	GRC Response
The objectives of this direction are to: *(a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and*	Compliance with controls and objectives of the DCP and LEP as demonstrated in the tables above clearly indicates that the development is consistent with Government policy and the NSW Floodplain Development Manual (NSW, 2005).
(b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.	The table above responds to Section 5.21 of the Bayside Council LEP and Table 12 of the Bayside Council DCP.
Application	
This direction applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.	No response required.

Application	
(1) A planning proposal must include provisions that give effect to and are consistent with: *(a) the NSW Flood Prone Land Policy,*	The development complies with the NSW government's Flood Prone Land Policy. This is evinced by compliance with DCP and LEP as demonstrated above.
(b) the principles of the Floodplain Development Manual 2005,	Complies with the FDM. This is evinced by compliance with DCP and LEP as demonstrated above.
(c) the Considering flooding in land use planning guideline 2021, and	Compliance with the guideline follows on from its compliance with LEP and DCP.
(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	The model used came from a local flood study. No specific study recommendations pertain to the proposed works.
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	Not applicable – the site is not zoned Recreation, Rural, Special Purpose or Conservation Zones
(3) A planning proposal must not contain provisions that apply to the flood planning area which: *(a) permit development in floodway areas,*	No development is proposed in areas of floodway. There are some areas of floodway on Sarsfield Road and also downstream of the site on Slade Road. But as documented herein the site is flood fringe and flood storage.
(b) permit development that will result in significant flood impacts to other properties,	Impact assessment shows that there is no adverse impact on properties' flood affectation.
(c) permit development for the purposes of residential accommodation in high hazard areas,	The development does not locate residential or other development in high hazard areas.

(d) permit a significant increase in the development and/or dwelling density of that land,	The development increases the site's dwelling density but does not increase the density in flood affected areas (for example the Eastern portion has been set aside as a swale). The existing use of the site is a pub/hotel with significant development at ground level with multiple entrances at grade. The proposed development raises ground floor entrances, significantly reducing the site's flood-affectation. The proposed development will therefore reduce the intensity of use in flood-affected areas.
(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	Development proposed does not meet these criteria and therefore this is not applicable. It is noteworthy however that effective evacuation is straightforward at the site. Evacuation strategy would consist of a shelter-in-place approach as flooding will occur with little to no warning and be of short duration.
(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,	Not applicable.
(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	The proposed design includes a number of stormwater drainage features to manage flooding and ensure building occupants are not placed at risk in the design flood. This ensures there is no increased requirement for government spending on mitigation or emergency management.
(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	Development does not include hazardous industries or hazardous storage establishments.
(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.	The site development is compatible with the FDM NSW 2005.

Yours Sincerely,

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Director
NER 2435438

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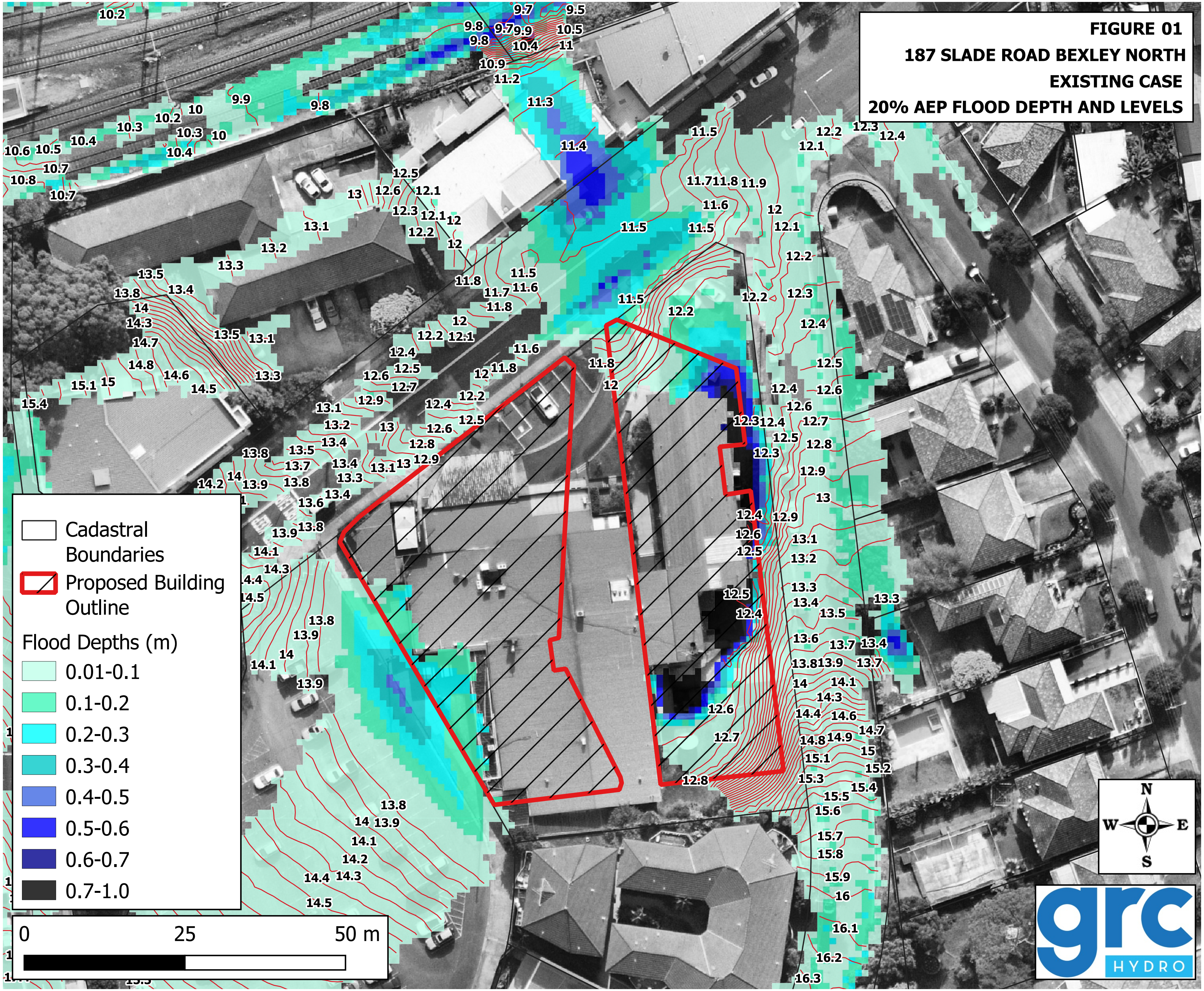


FIGURE 01
187 SLADE ROAD BEXLEY NORTH
EXISTING CASE
20% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO

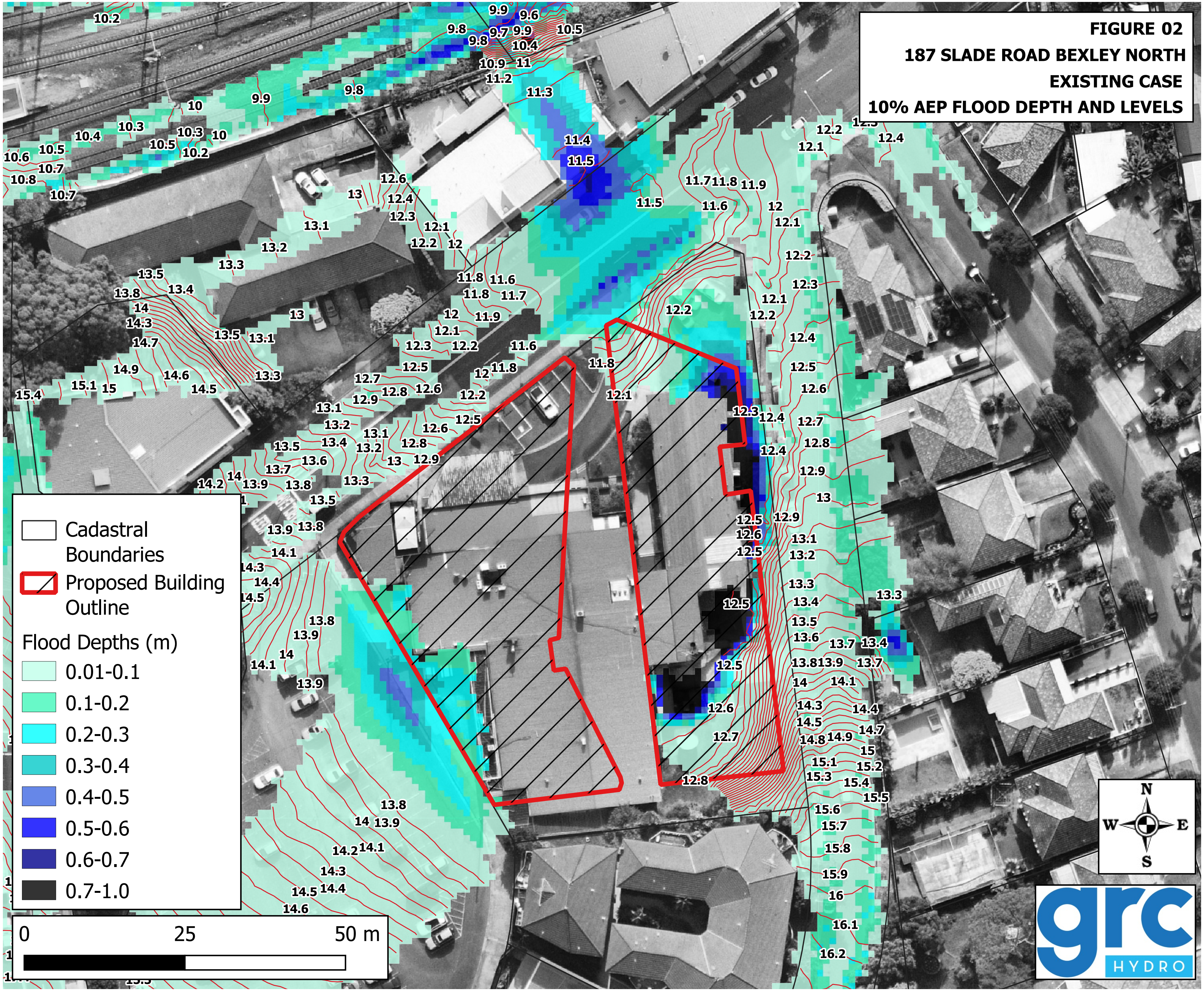


FIGURE 02
187 SLADE ROAD BEXLEY NORTH
EXISTING CASE
10% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO

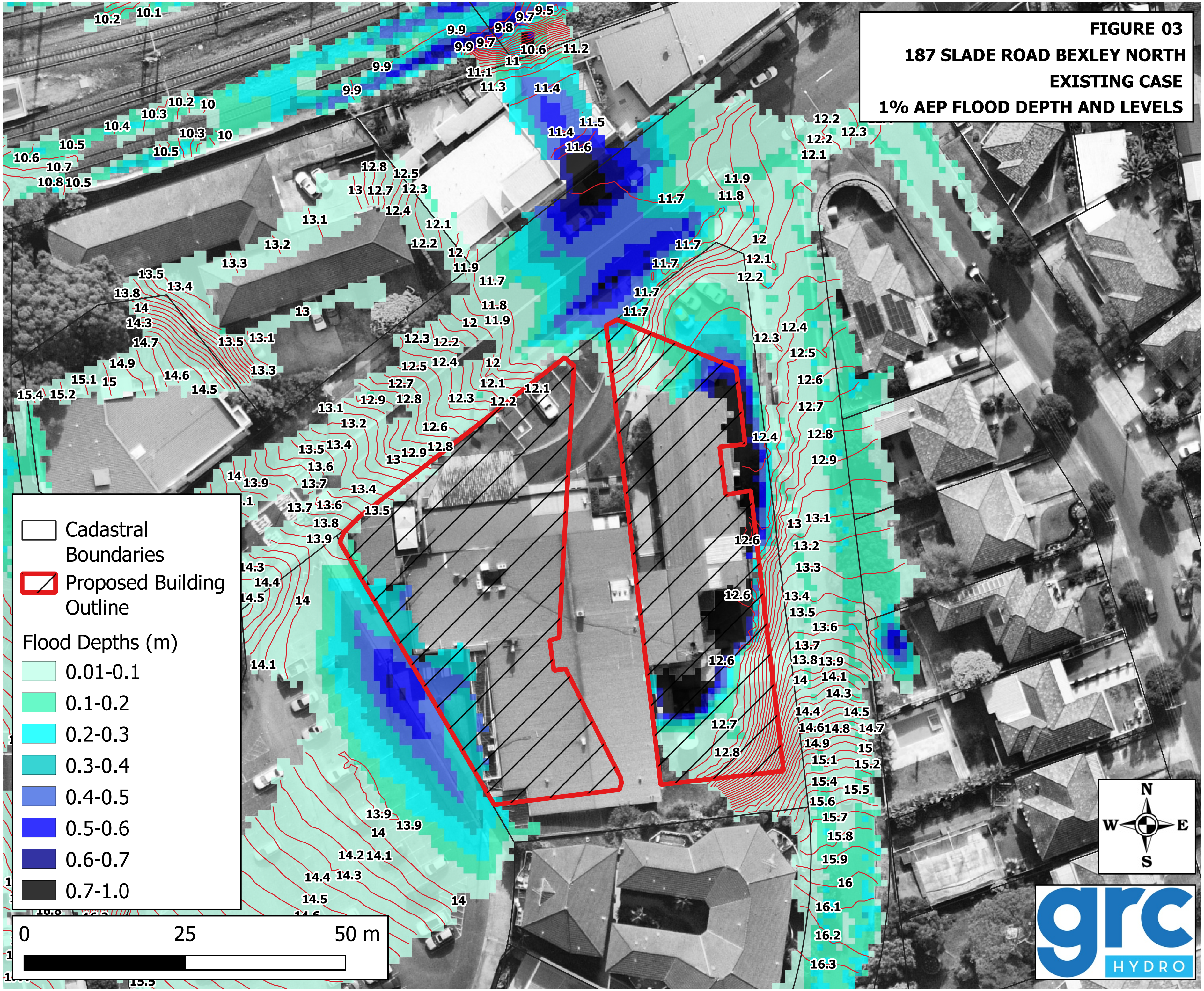


FIGURE 03
187 SLADE ROAD BEXLEY NORTH
EXISTING CASE
1% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO

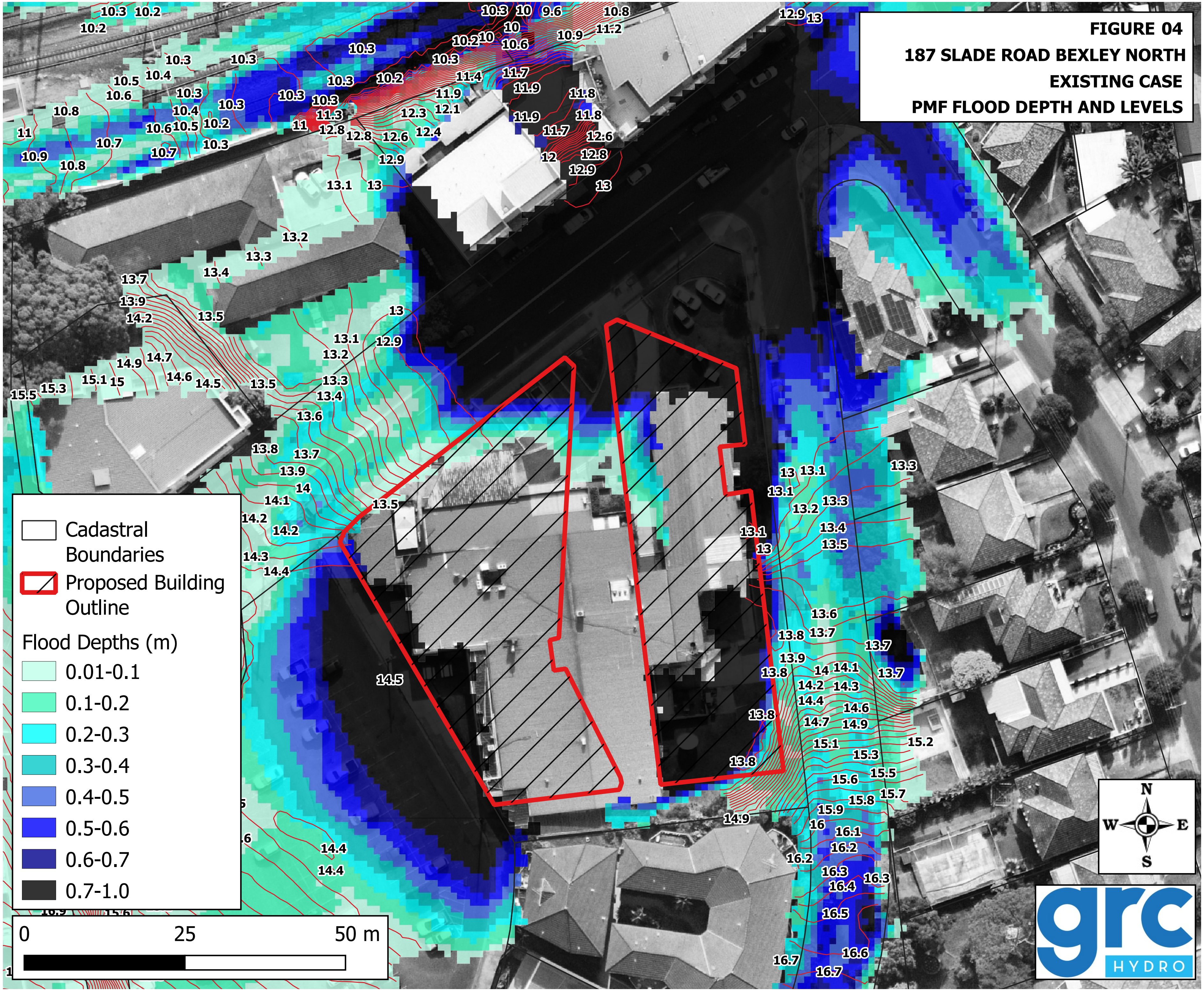


FIGURE 04
187 SLADE ROAD BEXLEY NORTH
EXISTING CASE
PMF FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO

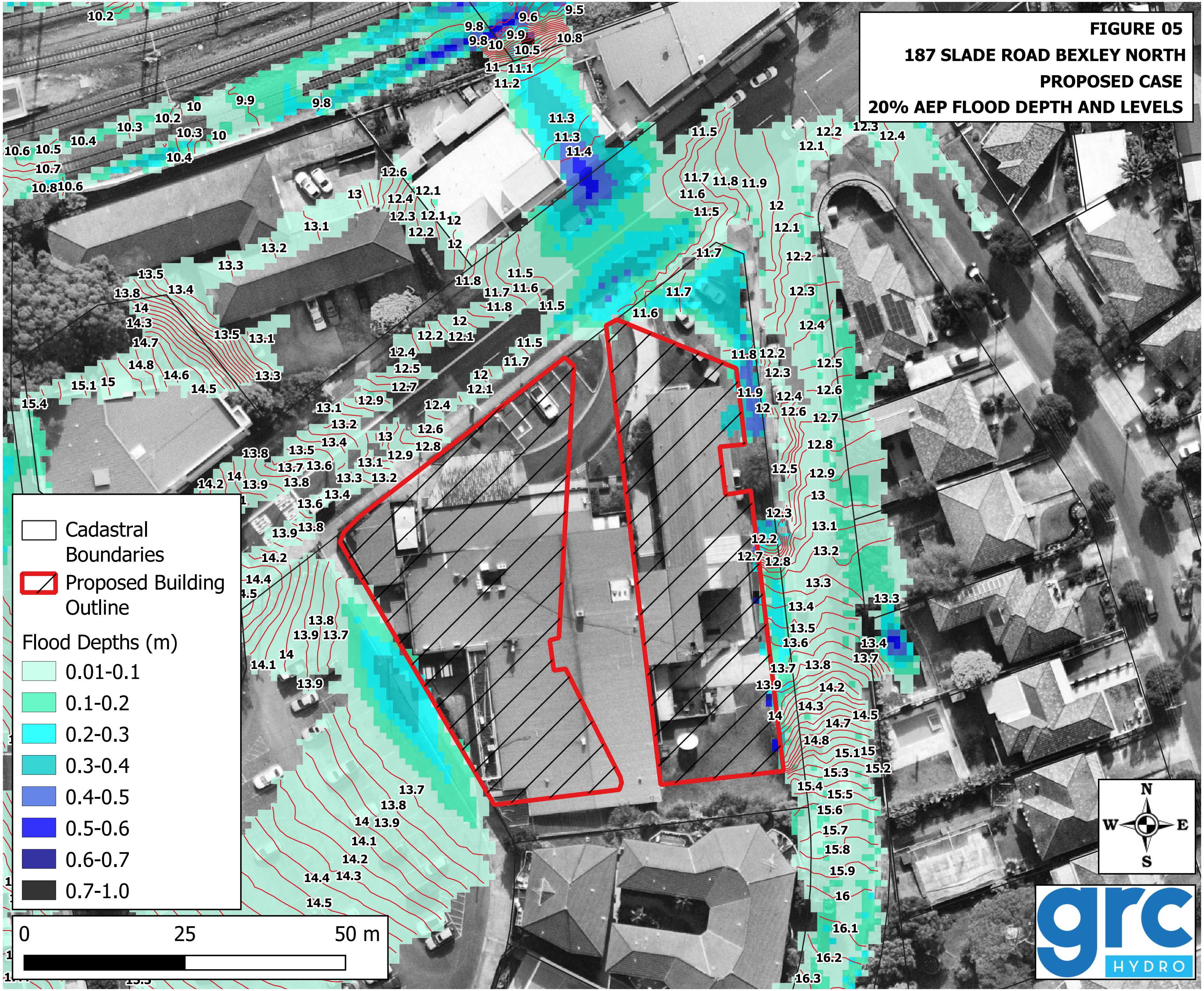


FIGURE 05
187 SLADE ROAD BEXLEY NORTH
PROPOSED CASE
20% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
HYDRO

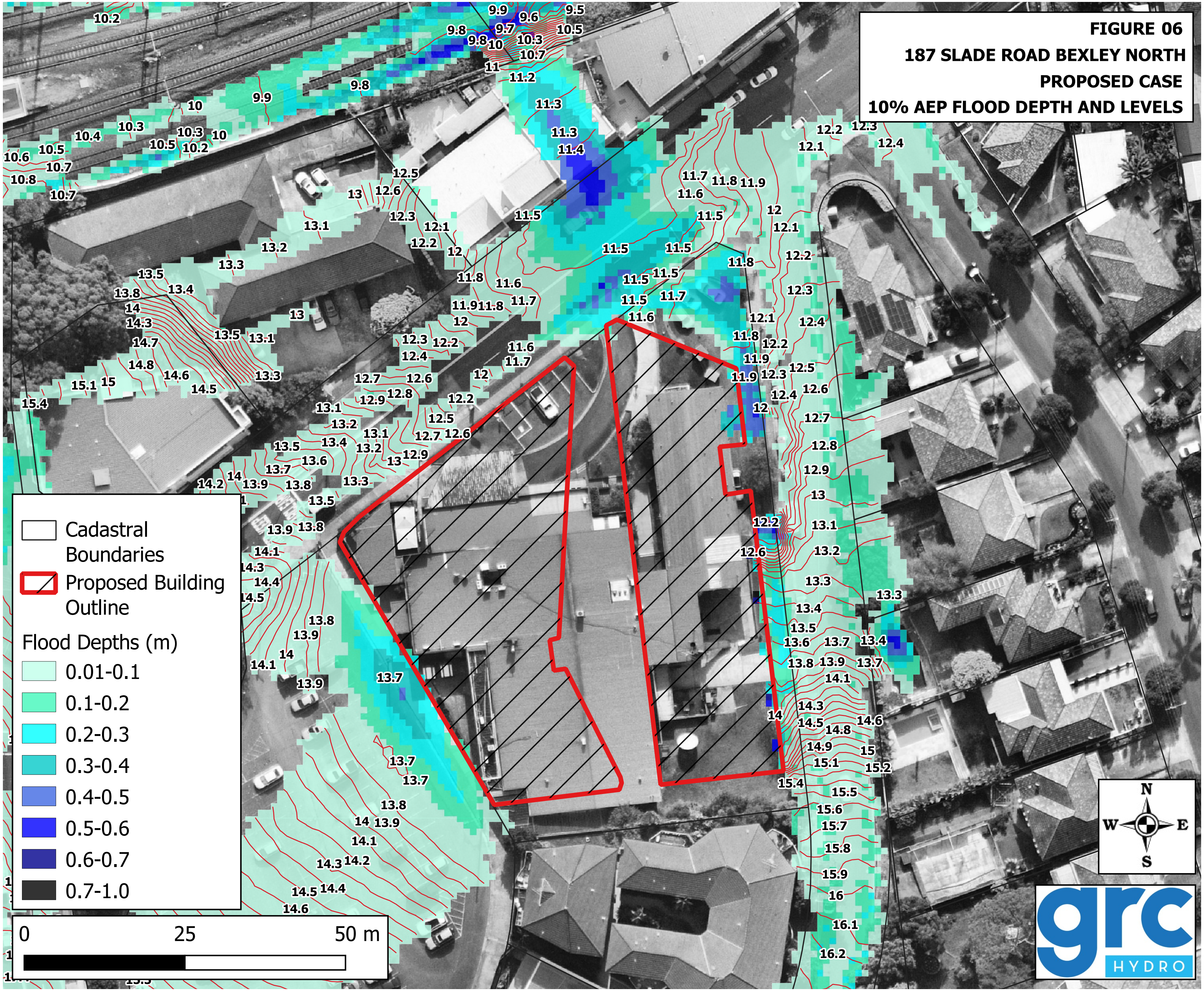


FIGURE 06
187 SLADE ROAD BEXLEY NORTH
PROPOSED CASE
10% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO

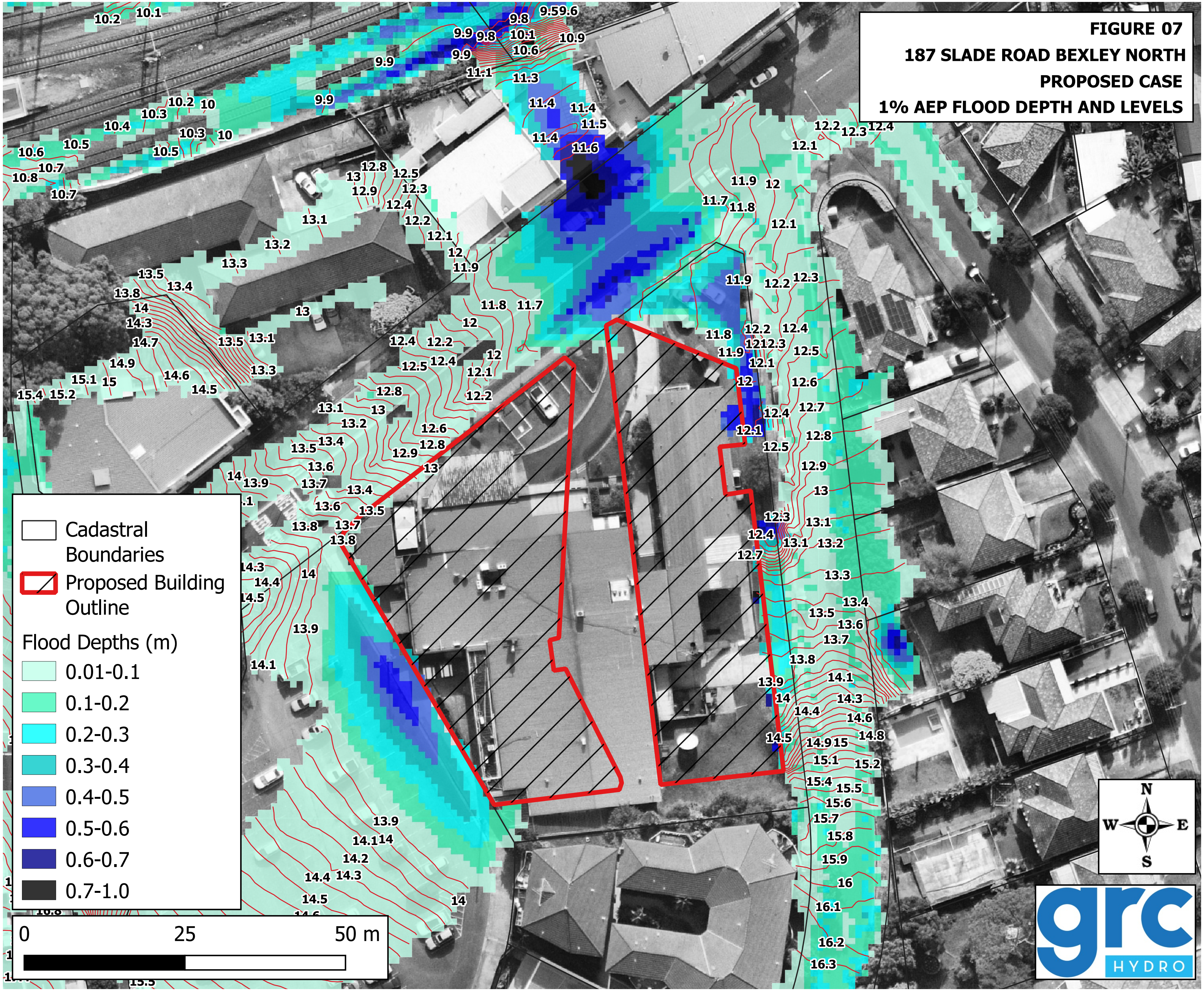


FIGURE 07
187 SLADE ROAD BEXLEY NORTH
PROPOSED CASE
1% AEP FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S

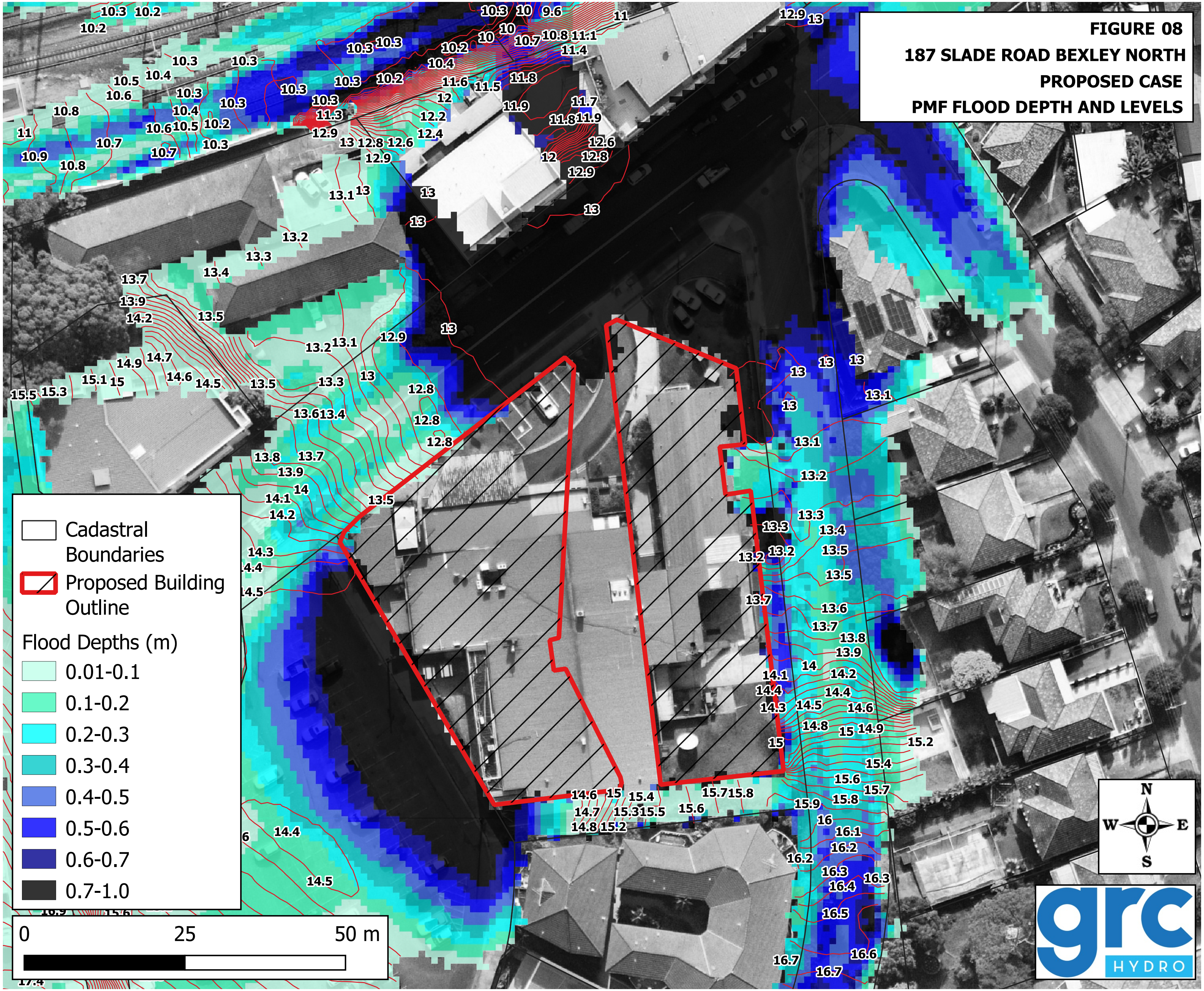
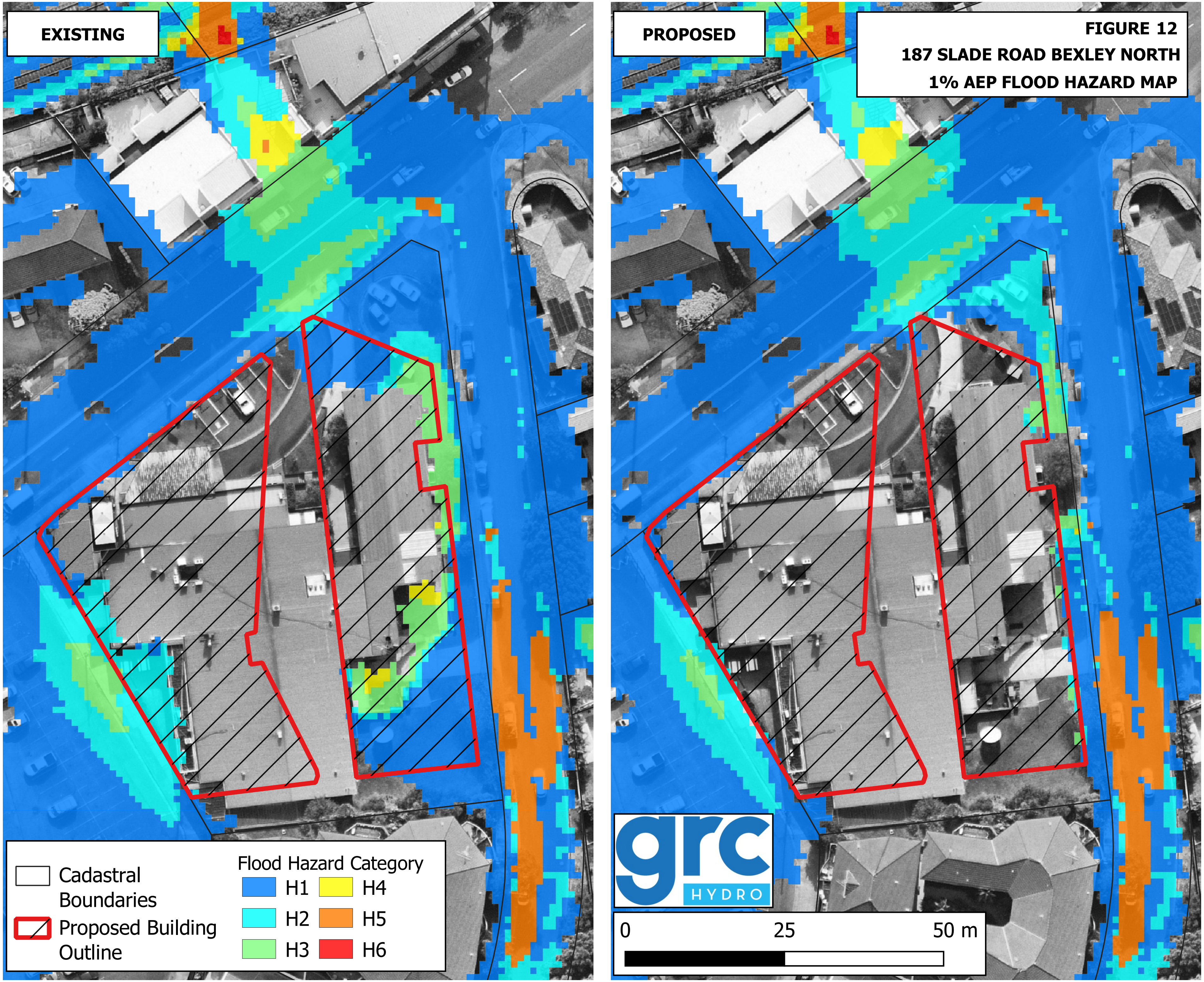
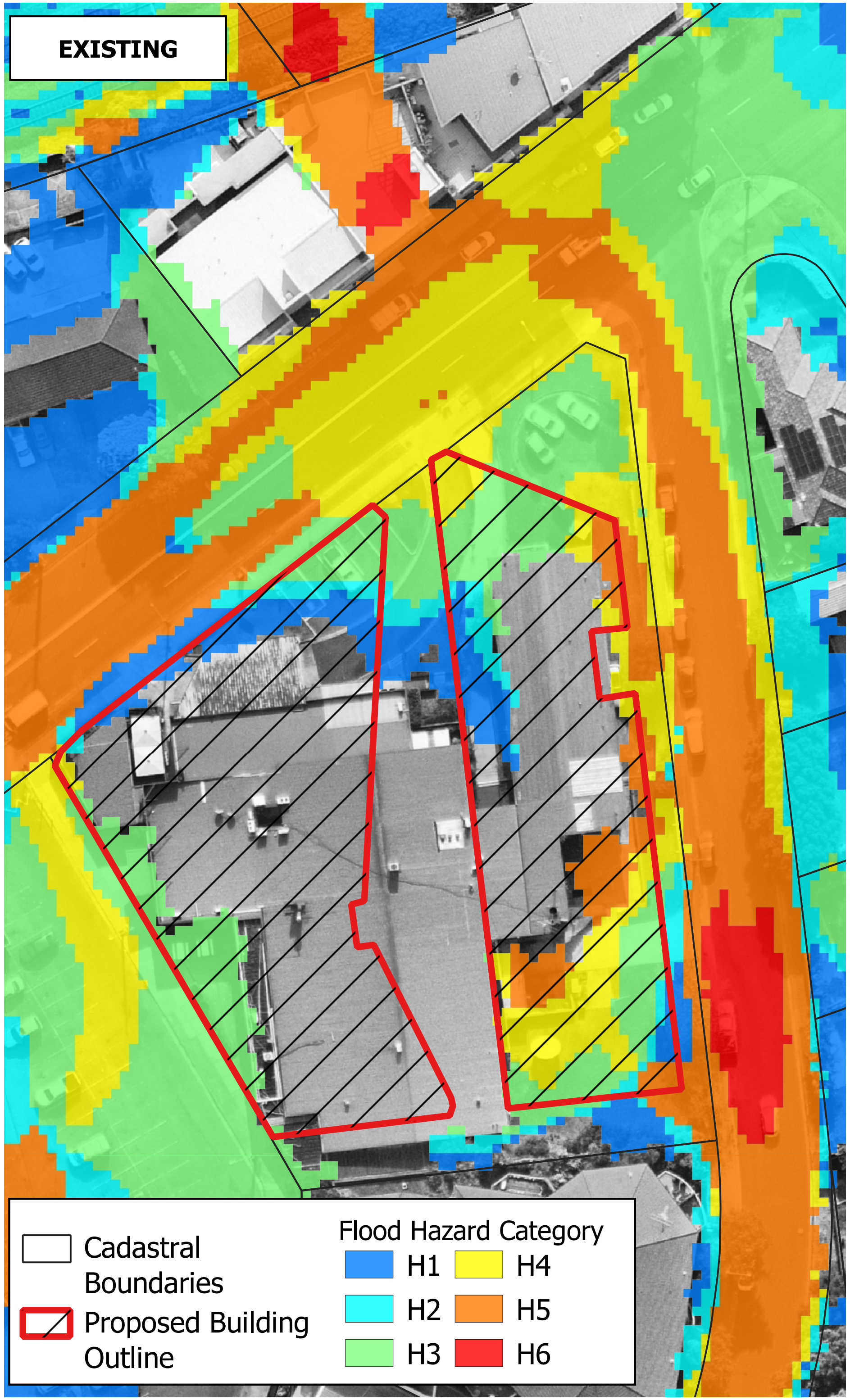
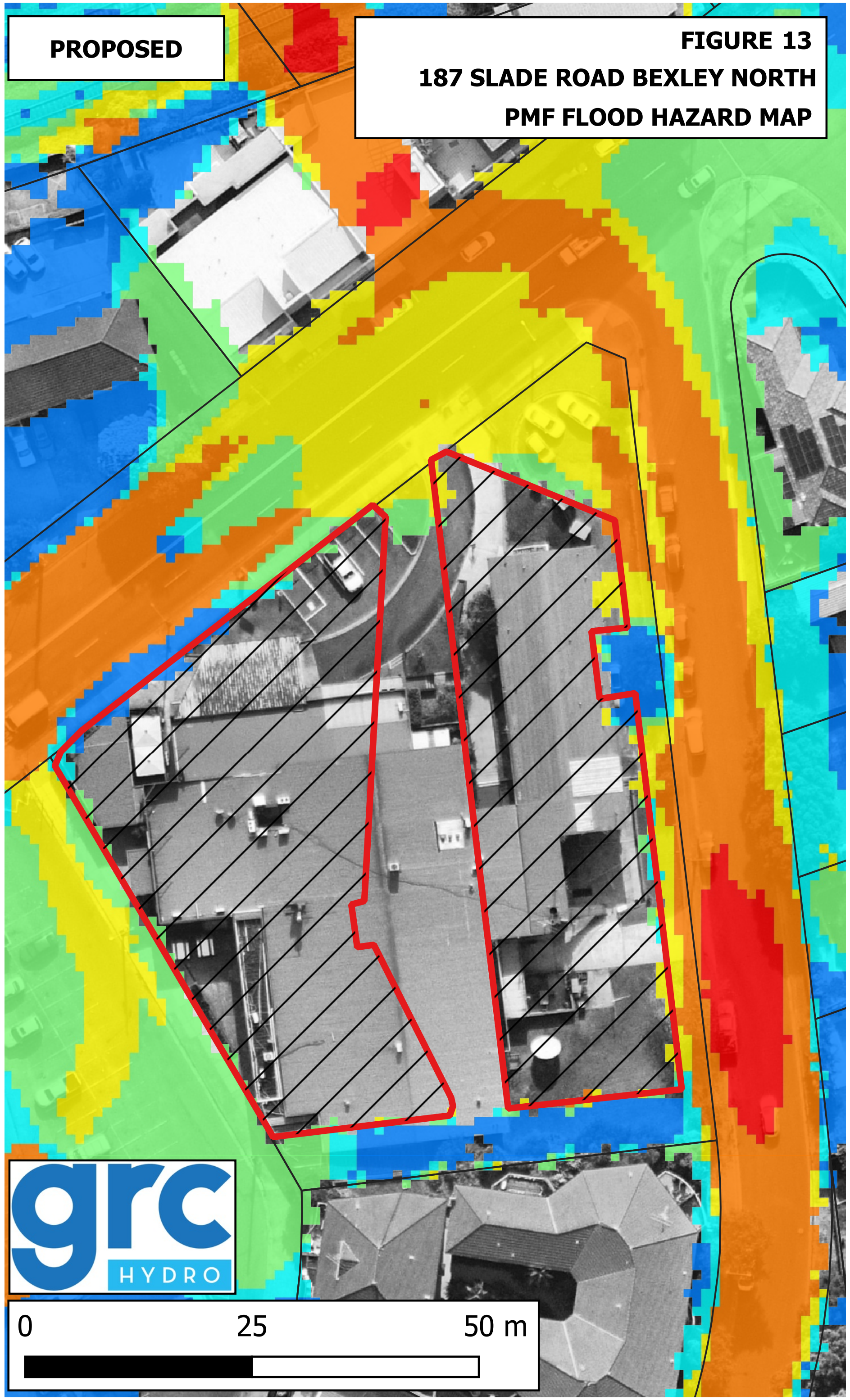


FIGURE 08
187 SLADE ROAD BEXLEY NORTH
PROPOSED CASE
PMF FLOOD DEPTH AND LEVELS
Cadastral Boundaries
Proposed Building Outline
Flood Depths (m)
0.01-0.1
0.1-0.2
0.2-0.3
0.3-0.4
0.4-0.5
0.5-0.6
0.6-0.7
0.7-1.0
0
25
50 m
N
W
E
S
grc
HYDRO


EXISTING
PROPOSED
FIGURE 12
187 SLADE ROAD BEXLEY NORTH
1% AEP FLOOD HAZARD MAP
Cadastral Boundaries
Proposed Building Outline
Flood Hazard Category
H1
H2
H3
H4
H5
H6
grc HYDRO
0
25
50 m


EXISTING
Cadastral Boundaries
Proposed Building Outline
Flood Hazard Category
H1
H2
H3
H4
H5
H6


PROPOSED
FIGURE 13
187 SLADE ROAD BEXLEY NORTH
PMF FLOOD HAZARD MAP
grc HYDRO
0
25
50 m

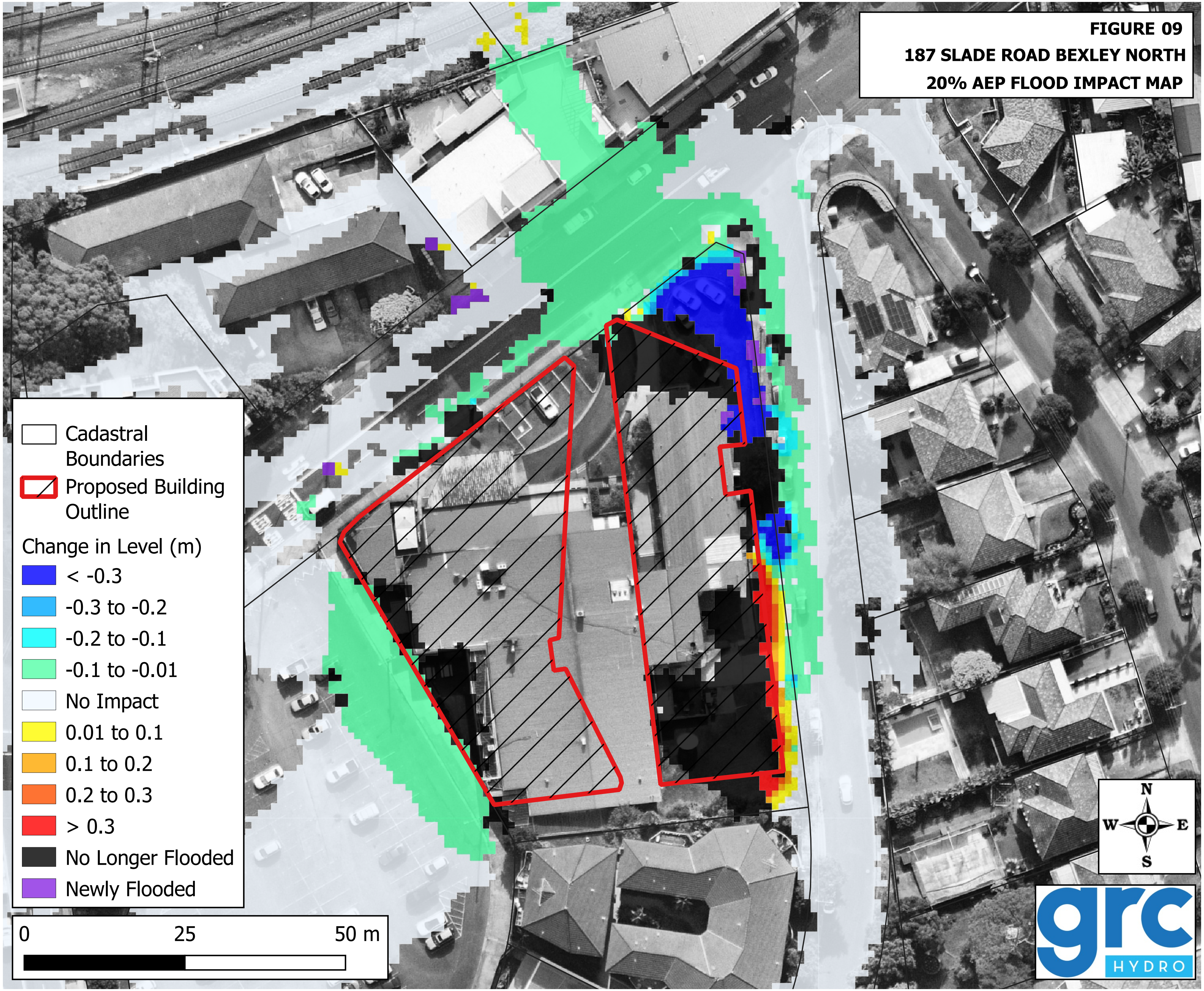


FIGURE 09
187 SLADE ROAD BEXLEY NORTH
20% AEP FLOOD IMPACT MAP
Cadastral Boundaries
Proposed Building Outline
Change in Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded
0
25
50 m
N
W
E
S
grc
HYDRO

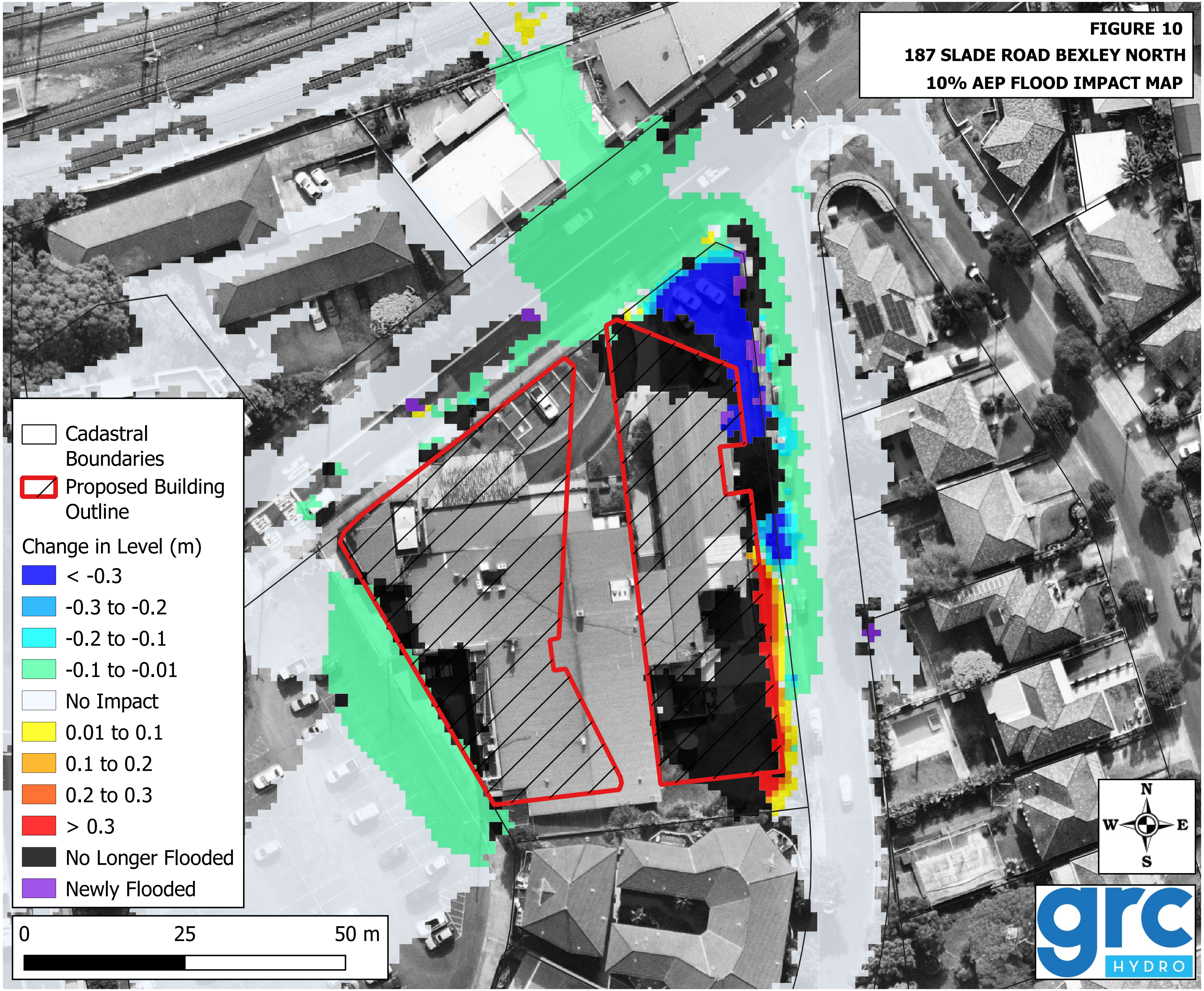


FIGURE 10
187 SLADE ROAD BEXLEY NORTH
10% AEP FLOOD IMPACT MAP
Cadastral Boundaries
Proposed Building Outline
Change in Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded
0
25
50 m
N
W
E
S
grc
HYDRO

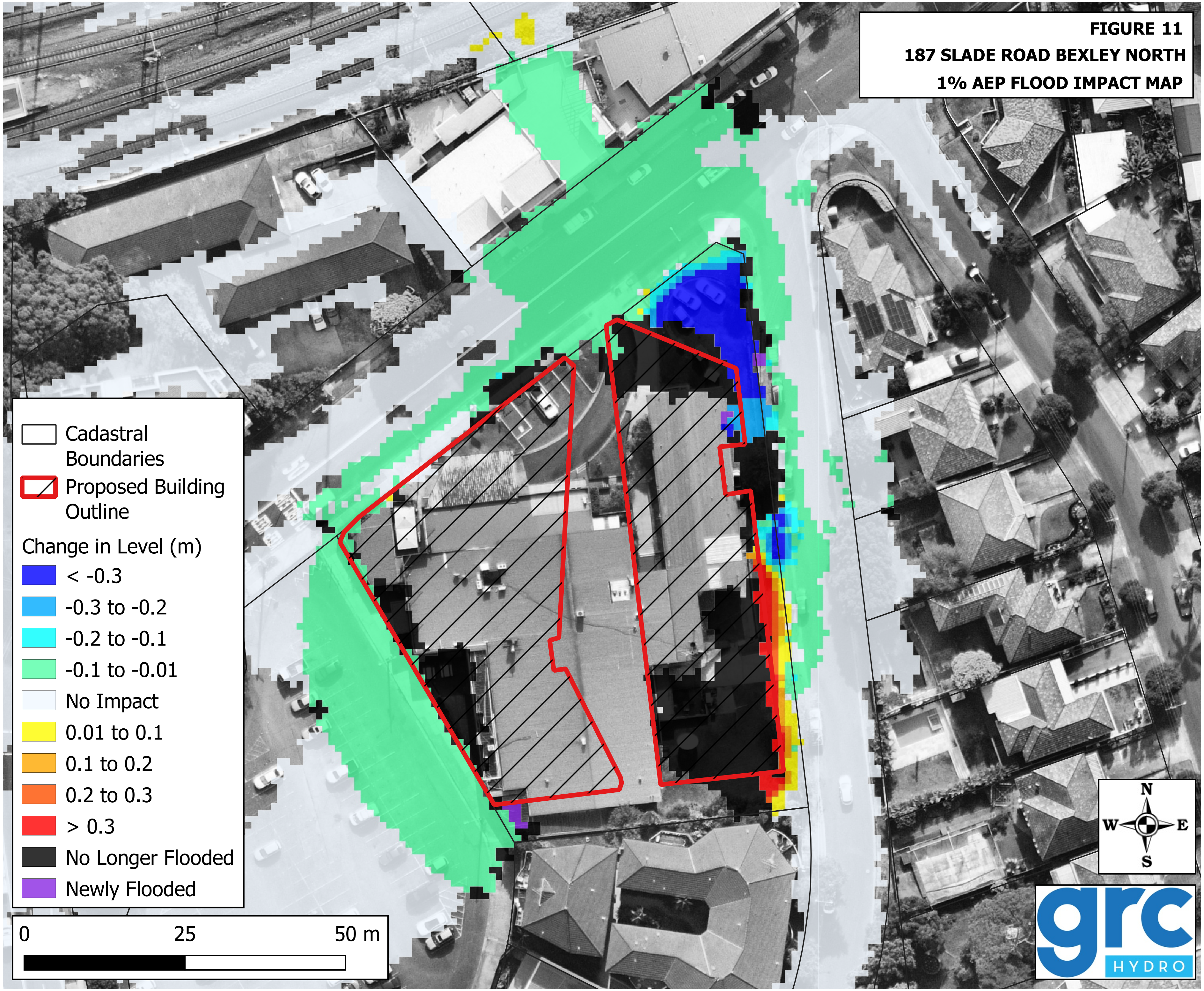


FIGURE 11
187 SLADE ROAD BEXLEY NORTH
1% AEP FLOOD IMPACT MAP
Cadastral Boundaries
Proposed Building Outline
Change in Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded
0
25
50 m
N
W
E
S
grc
HYDRO