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To:
Andrew Thurlow
Development Director
iNTREC Management Pty Ltd
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Artarmon NSW 2064 Australia

CC:

Project name:
159-167 Darley Road

Project ref:
60613516

Date:
August 20, 2020

Memo

Subject: Flooding Advice for 159-167 Darley Street, Mona Vale

Dear Andrew,

We refer to our proposal regarding the above and are pleased to provide the following flood advice as detailed in this memorandum. This preliminary advice is intended to inform the concept design general arrangement of a medium density development and assist discussions with Northern Beaches Council regarding the Planning Proposal.

Project Appreciation

iNTREC Management Pty Ltd (iNTREC) has an interest in 159-167 Darley Street in Mona Vale (the Site). The existing lots are currently occupied by individual residential houses and iNTREC are investigating options for development of the Site to potentially include a combination of townhouses apartment complexes.

According to the McCarrs Creek, Mona Vale and Bayview Flood Study (2017) completed by Royal HaskoningDHV on behalf of Northern Beaches Council (NBC), the Site is subject to flooding. Overland flow enters the Site from the upstream catchment in the south east. The resulting flood waters are described by NBC as being of low and medium flood hazard categories during a range of storm magnitudes.

The McCarrs Creek, Mona Vale and Bayview Flood Study (2017) was completed using the TUFLOW software and adopted a combination of survey types including LiDAR data. While LiDAR data can provide a reasonable basis for defining catchment wide topography in the context of a regional flooding strategy, it does not have the granularity to assess individual sites where the change in topography can be abrupt. AECOM have acquired a copy of the NBC flood model and have incorporated a detailed site survey obtained by iNTREC to better reflect the local site conditions and aid in developing a strategy to manage flood waters for the Site.

Site Description

The Site is located adjacent to Cahill Creek, which discharges to the Pittwater Estuary. The Site location is illustrated in Figure 1 in Appendix A. Overland flows arrive at the site from the south/south-east and flow towards Cahill Creek. The overland flows concentrate in an undefined valley through 167 Darley Street. There is a defined flow path through the rear of the properties directing water through several neighbouring properties before discharging towards Kunari Place. The overland flow path through the lots aligns with an existing Sydney Water owned ø150 PVC waste-water pipe identified in the detailed site survey. Due to the defined nature of the flow path, careful consideration of the type of development adopted is required to ensure impacts on neighbouring properties are mitigated to as low as reasonably practical.

Available Information

A summary of the data referenced in development of this technical memorandum is presented in Table 1.

Table 1. Available information

Data	Type	Source	Description
Flood Report	Pdf	Northern Beaches Council	McCarrs Creek, Mona Vale and Bayview Flood Study Review (2017) prepared by Royal HaskoningDHV.
Flood Model	TUFLOW (MID/MIF)	Northern Beach Council	The McCarrs Creek, Mona Vale and Bayview flood model (2017) prepared by Royal HaskoningDHV. Is intended to be used in conjunction with the McCarrs Creek, Mona Vale and Bayview Flood Study Review (2017) report.
Topographic Data	dwg	C-Side Surveyors	Site survey (dated 01/10/2019) capturing details within the Site with focus on 163-165 Darley Street and sections of Darley Street and Kunari Place. The survey includes the key features of the overland flow path which generally influence the behaviour of flood waters at the development site which is the primary focus of this assessment. It has been used to update the terrain incorporated into the TUFLOW model.

Flood Assessment

Supplied Model

The TUFLOW model obtained from Northern Beaches Council (Supplied Model) contains three model areas based on the nature of the sub-catchments within the model areas. The model areas include ‘Rural’ catchments, ‘Pittwater’ catchments and ‘Urban’ catchments. For the purpose of the current investigation, only the ‘Urban’ model has been used as it covers the Cahill Creek, Mona Vale Main Drain, Hillcrest and Mona Vale Golf Course sub-catchments.

The ‘Urban’ model extent and layout is shown in Figure 1. A number of assumptions and parameters of the supplied TUFLOW model developed by Royal HaskoningDHV are described below:

- Modelling was undertaken using TUFLOW Build 2016-03-AA with Classic engine
- Model boundaries:
    - Inflows have been applied as 2D Rainfall on Grid with temporal patterns taken from Australian Rainfall and Runoff (AR&R87) (Institute of Engineers Australia, 1987)
    - The downstream boundaries were set as height vs time (HT) & height vs flow (HQ) boundaries. Half of the model sub-catchments drain north to the Pittwater Estuary and half drain east to the Pacific Ocean at Mona Vale Beach.
    - Ocean tailwater levels and estuary tailwater levels
- A 3 metre grid size was adopted.
- Ground surface elevations were based on:
    - 1 metre gridded Airborne Light Detection and Ranging (LiDAR) survey captured September 2011;
    - Previously acquired survey information;
    - Detailed survey acquired by Mepsteads & Associates surveyors as part of the McCarrs Creek, Mona Vale and Bayview Flood Study (Royal HaskoningDHV, 2017) (survey completed in 2015), which was used to modify the terrain through a series of break lines
- Underground stormwater system incorporated as 1D elements within the modelling extents. It should be noted that there is a stormwater system along Darley Street that can be seen in Google Street View that is not represented by the TUFLOW model.
- According to the flood report, the following storms were considered critical local to the subject Site:
    - 2 hour storm for the 20% AEP event
    - 2 hour storm for the 1% AEP
    - 15 minute storm for the PMF event

The material roughness representing the bed resistance to overland flow are commonly represented by Manning’s ‘n’ values. The values adopted by the Study were assigned based on aerial photography and cadastral information and distinguish between different materials such as roads, grassed areas and various types of development.

Base Case Model

The base case TUFLOW model for this study has been updated based on the Supplied Model by NBC. The base case terrain is generally the same as the one used in the Supplied Model but with the inclusion of the detailed site survey listed in Table 1. Within the Site, the survey provides coverage of property lots 163-165 Darley Street, and sections towards the rear of property lots 159-161 and 167 Darley Street. While the survey does not cover the 5 lots, it includes the key features of the overland flow path which generally influence the behaviour of flood waters at this location which is the primary focus of this assessment. The detailed survey extents are considered suitable for the purposes of this high-level preliminary study. The brick retaining wall on the Site adjacent to the overland flow path was also included in the base case using break lines.

The same storm durations as for the Supplied Model were used.

Base Case Modelling Results

Table 3 provides a summary of flood depths and velocities at a selection of locations across the site for the 20% AEP, 1% AEP and PMF events (refer also to Figure 2 to 7 in Appendix A). Flow depths are generally less than 0.4m for the 20% AEP and 1% AEP events, and less than 0.6m in the PMF event, with the exception of some localised deeper sections in the flow path. Velocities within the Site can reach 1 m/s in the 20% AEP,1.3 m/s in the 1% AEP event and up to 1.9 m/s in the PMF event. The magnitude of peak velocities at the Site do not differ from those of the Supplied Model.

From Figure 4, it can be seen that the Site is located outside mainstream flooding around Cahill Creek and is only affected by an overland flow path (approximately 13m wide). Additional maps that present the difference between the flood depth estimated in the NBC model and those obtained by incorporating the detailed site survey 20% AEP, 1% AEP and PMF events are also included for discussion purposes.

Table 2 shows a summary of the flow estimated to be entering and exiting the site during the 1%AEP event (Figure 8).

Table 2. Flow Summary for the Site

Flow Boundary	Location	Flow
Inflow	South-western boundary (Boundary 1 U.S.)	Total 0.8 m^3/s with approximately 0.5 m^3/s concentrated within the channel (Channel U.S.)
Inflow	South-east boundary (Boundary 2 U.S.)	0.3 m^3/s
Outflow	North-western boundary (Boundary D.S.)	Total 1.3 m^3/s with approximately 0.9 m^3/s concentrated within the channel (Channel D.S.)

Table 3. Depth and velocity results and point locations across the Site considering new detailed site survey (refer to Figure 8 for Sample Point locations)

Sample Point	20% AEP		1% AEP		PMF	
	Depth (m)	Velocity (m/s)	Depth (m)	Velocity (m/s)	Depth (m)	Velocity (m/s)
Point 1	0.30	0.8	0.36	1.0	0.54	1.3
Point 2	0.46	1.0	0.53	1.3	0.73	1.9
Point 3	0.33	0.6	0.41	0.6	0.64	0.8
Point 4	0.25	0.7	0.32	0.8	0.52	0.8
Point 5	0.33	0.2	0.40	0.3	0.62	0.5
Point 6	0.35	0.4	0.39	0.8	0.58	1.0
Point 7	0.54	0.1	0.59	0.3	0.74	0.4
Point 8	0.18	0.0	0.18	0.1	0.20	0.2
Point 9	0.16	0.0	0.16	0.0	0.18	0.1
Point 10	0.33	0.3	0.35	0.3	0.39	0.3
Point 11	0.28	0.2	0.30	0.2	0.33	0.3
Point 12	0.15	0.1	0.17	0.2	0.22	0.3

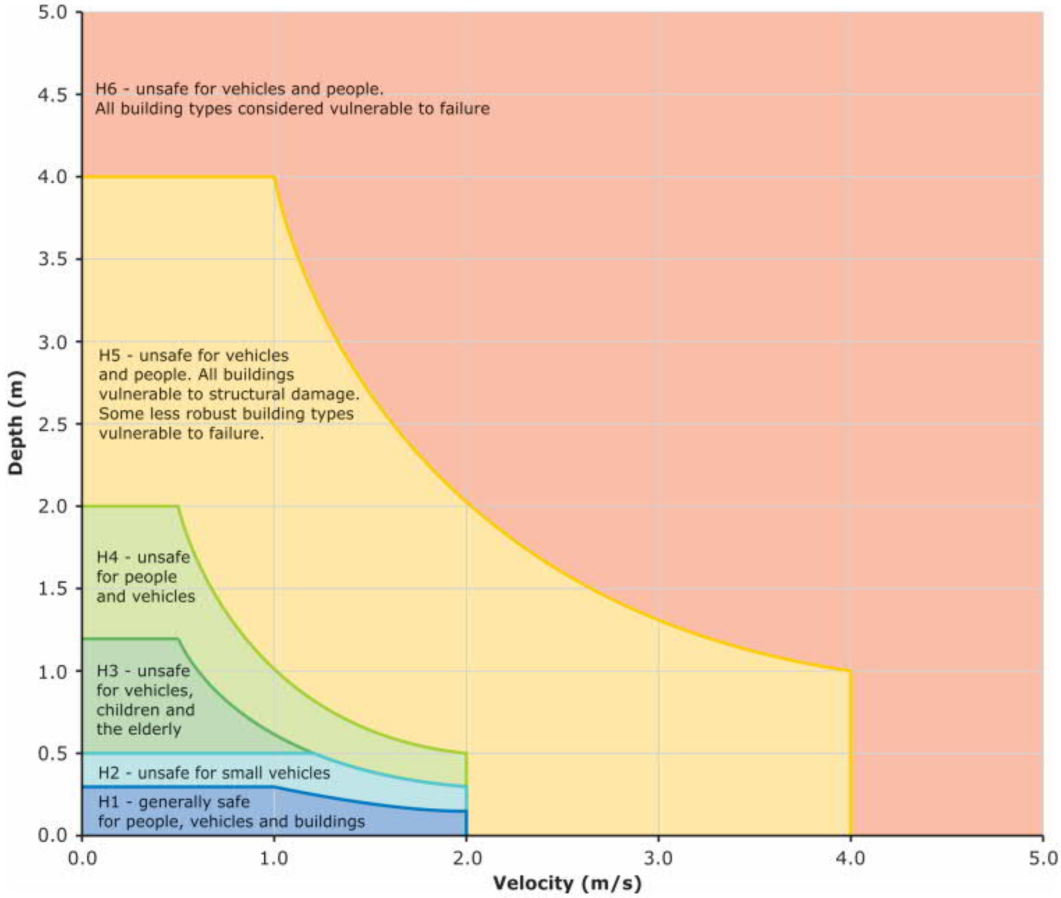

Figure 1 Combined Flood Hazard Curves

(Source Figure 6.7.9 ARR 2019)

With reference to the Combined Flood Hazard curves and the flood classifications within ARR2019 (extract included in Figure 1), the depth and velocity estimates for the existing conditions generally carry a low risk to buildings. The proposed development should aim to incorporate measures that also consider the risk to people and vehicles where applicable which we anticipate can be managed as part of the development.

Comparison of Supplied Model Results and Base Case Modelling Results

A comparison of flood levels between the Supplied Model and base case model was also undertaken. The level differences in the 20% AEP, 1% AEP and PMF events are shown in Figure 9 to 11. The results show that the flood extent within the property is very similar, with some localised changes in flood levels as a result of the detailed site survey.

An additional map that presents the difference in terrain between the Supplied Model and the base case has also been included for discussion purposes in Figure 12. This terrain difference map shows that the overland flow path is closer to the existing buildings on the property, rather than running very close to the property line which is what the Supplied Model indicated. This shows how the localised changes in flood level spatially correspond to the changes in model terrain. A cross section shown in Figure 8 shows how the terrain and water level has changed is presented in Figure 13 below.

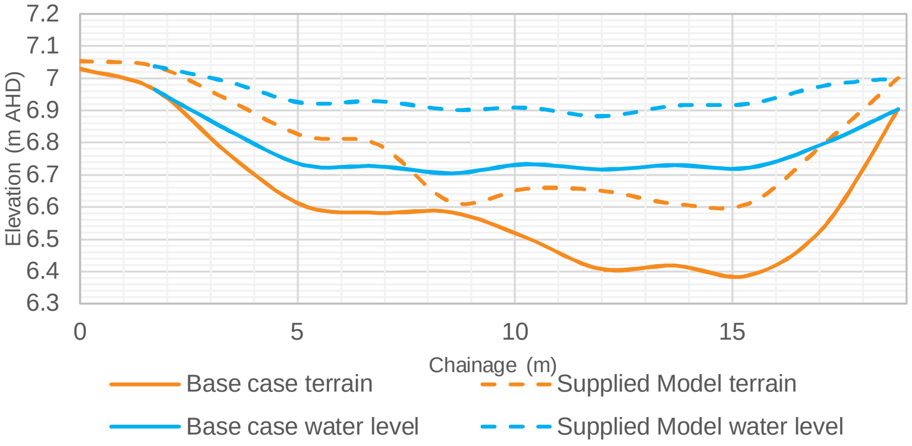

Figure 23. Terrain and water level at channel cross-section for Base Case Model and Supplied Model (1% AEP)

Recommendations

The base case modelling results indicate that the primary flow path through the back of the property at 159-167 Darley Street has slightly changed positions compared to the Supplied Model. The overland flow entering the Site from the neighbouring property is closer to Darley Street than what was indicated in the Supplied Model.

The survey presents a reasonable representation of the main overland flow path through the development and is generally suitable for this preliminary assessment, it is recommended a detailed survey be obtained which covers the full extent of the development area to ensure interfaces with existing developments are incorporated into the design.

From the supplied information, the elevation of the channel is lower than the Supplied Model suggests in some locations, and while the magnitude of peak flood depths has not changed, the relative level of the flood waters within the channel is lower. The revised modelling also suggests the peak velocities within the Site are very comparable to those indicated by the Supplied Model.

There are several options that could be pursued in consideration of development for the site. These should be pursued in consultation with NBC. Two mitigation measures have been described below, but the feasibility of each option is subject to site constraints and compatibility of the preferred site layout and NBC approval.

1. Site Layouts compatible with overland flows

   Incorporate overland flow paths either through the lot (such as swales or open spaces) to maintain existing flood behaviours or divert the overland flood towards Darley Street (e.g. via roadways or paths). This option could minimise direct impacts to neighbouring properties and is unlikely to require work outside of the Site boundary. Further investigation is required to confirm whether the Darley Street stormwater networks have enough capacity as the diverted overland flow may result in surcharging of the network and could have impacts to adjacent properties along Darley Street.

2. On-Site Drainage System

   An On-site Drainage System may reduce flood impacts by capturing overland flows and discharging them to the existing local stormwater network. Further investigation is required including approval from relevant authorities. Further, site constrains such as capacity of the existing network, the existing sewer line that traverses the Site and minimum cover/space for the pit and pipe installation may preclude this.

A combination of the above could also provide a flexible solution to managing the flood risk both on the site as well as on adjacent properties.

Ministerial Direction

The Planning Circular (NSW Government Department of Planning, 2007) will need to be addressed at the Planning Proposal stage. The Planning Circular details the “new guideline and changes to the section 117 direction and EP&A Regulation on flood prone land”. The relevance of this document will be to ensure that the flood planning level (FPL) criteria is met for the proposed development. The standard FPL for residential developments is the 100-year (1% AEP) flood level plus an appropriate freeboard, typically 0.5m.

Further discussion with Northern Beaches Council is recommended on flood planning requirements and the classification on the flooding behaviour (defined as either mainstream or major overland flow paths). Pending these discussions and confirmation on the development details, and resulting flooding behaviour in the proposed conditions, one of the two planning requirements may apply:

1. Mainstream Flooding: the 1% AEP flood level plus 0.5m is applied to residential finished floor levels (FFL) that do not provide a connection to a basement level; or
2. Major Overland Flow Paths: the 1% AEP is adopted as the residential FFL, however a 5m buffer is applied to the modelled flood extent.

It should be noted that the sketch provided in Figure 14 (Appendix A) is based on existing conditions. It is recommended that a proposed conditions flood model be developed as part a future detailed Development Application submission to estimate the impact on the overland flow regime, as this may influence the flood planning levels proposed.

Additionally, as the current Urban Design Study by Giles Tribe indicates basement parking, a higher level of protection may be required for all openings that connect to the basement i.e. lift cores, stairs, ventilation, driveway entrances etc. It is recommended that this be discussed with NBC and to confirm all final requirements.

If you have any questions regarding the above, please do not hesitate to contact the undersigned.

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Appendix A

FIGURES

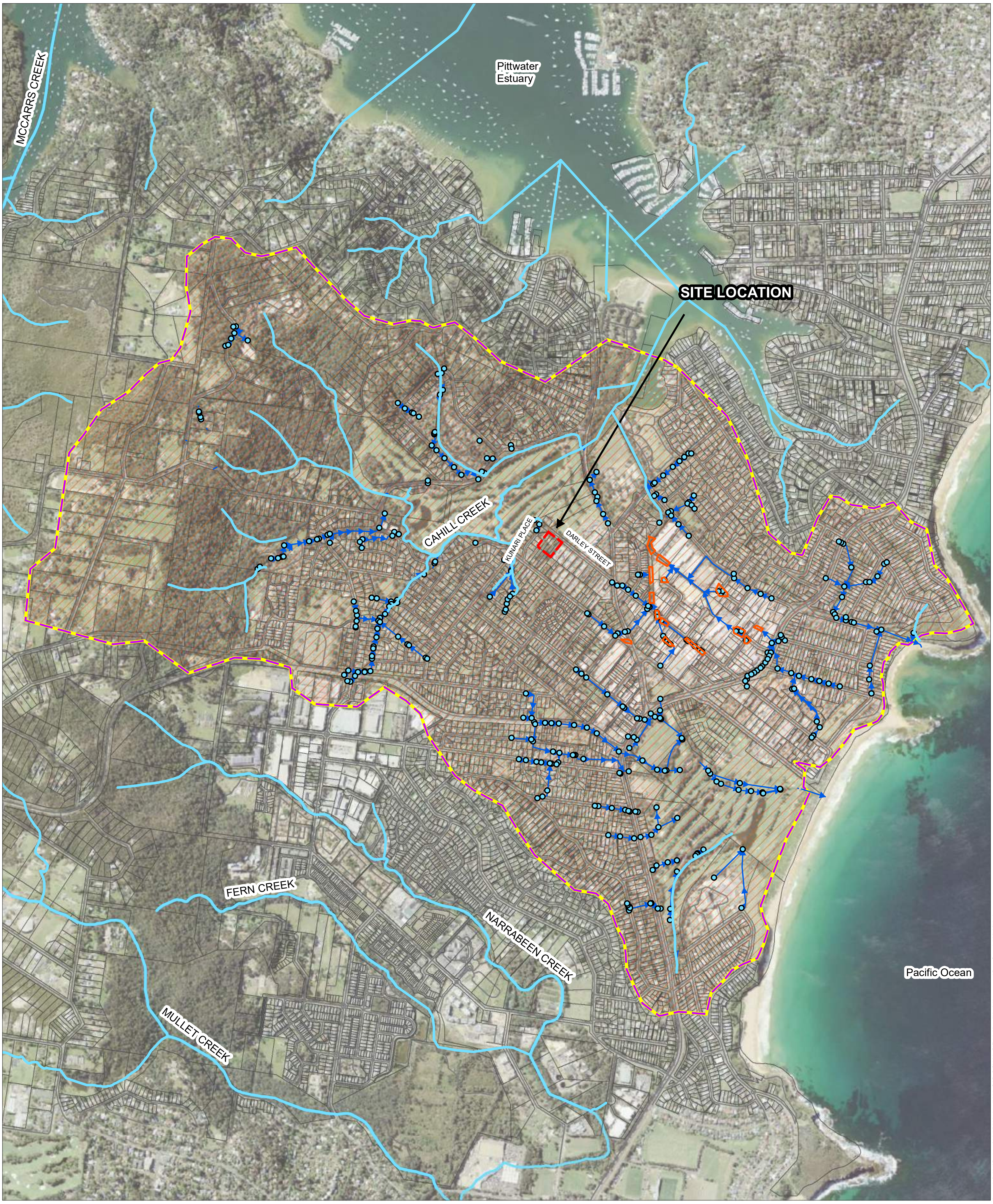

FIGURE 1: TUFLOW HYDRAULIC MODEL LAYOUT

Legend

- Site Boundary
- TUFLOW Model Extent
- TUFLOW Inflow Boundary
- TUFLOW Inflow Boundary - Industrial
- TUFLOW Outflow Boundary
- 1D Pits
- 1D Pipe/Culvert
- Watercourse
- Cadastre
- Roads

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N

km

0 0.25 0.5

Source: Nearmap

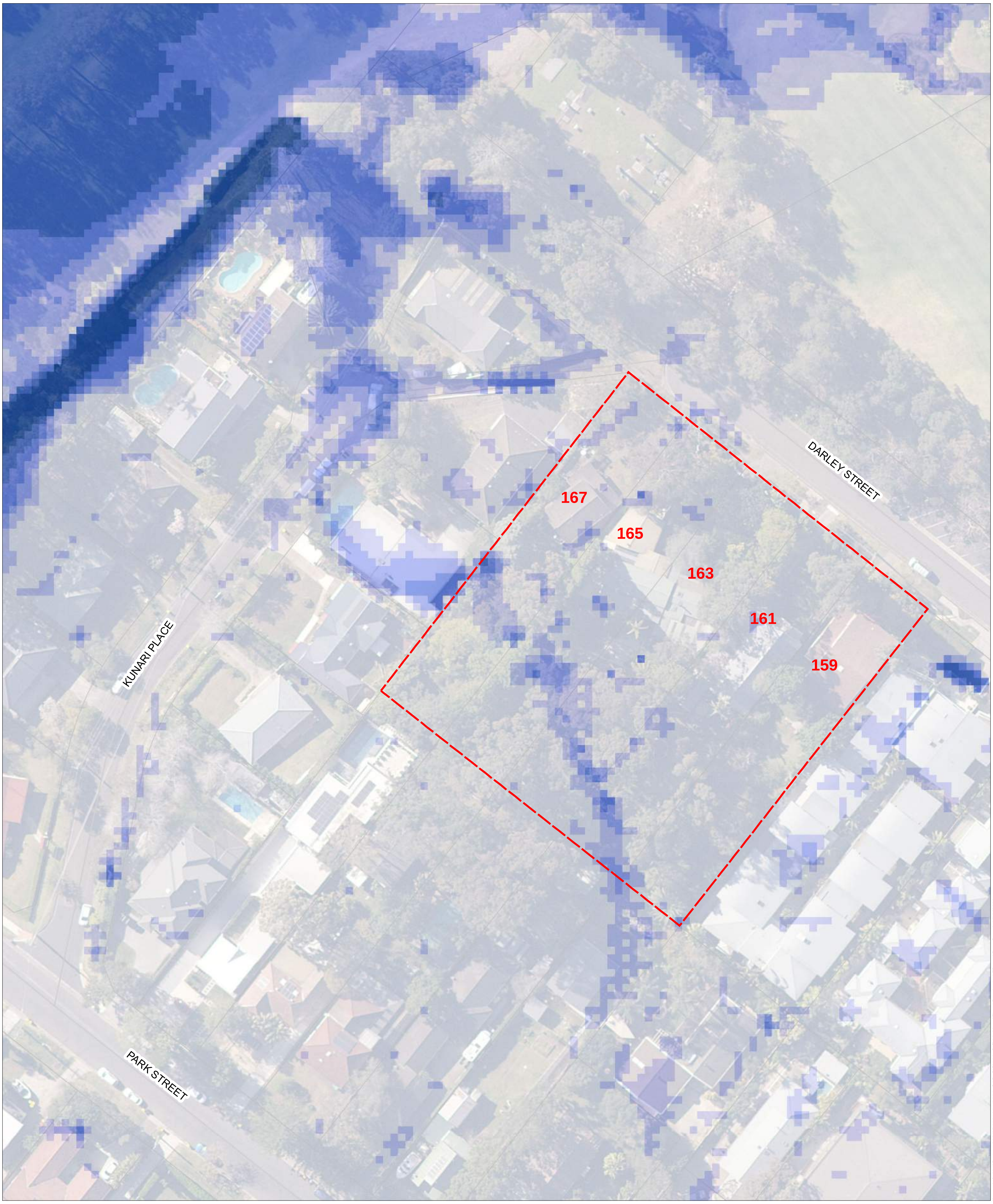

FIGURE 2: PEAK FLOOD DEPTH (20% AEP, 2HR)

AECOM

km
0 0.01 0.02

Legend

Site Boundary	
Cadastre	
Roads	

Peak Flood Depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

Source: Nearmap

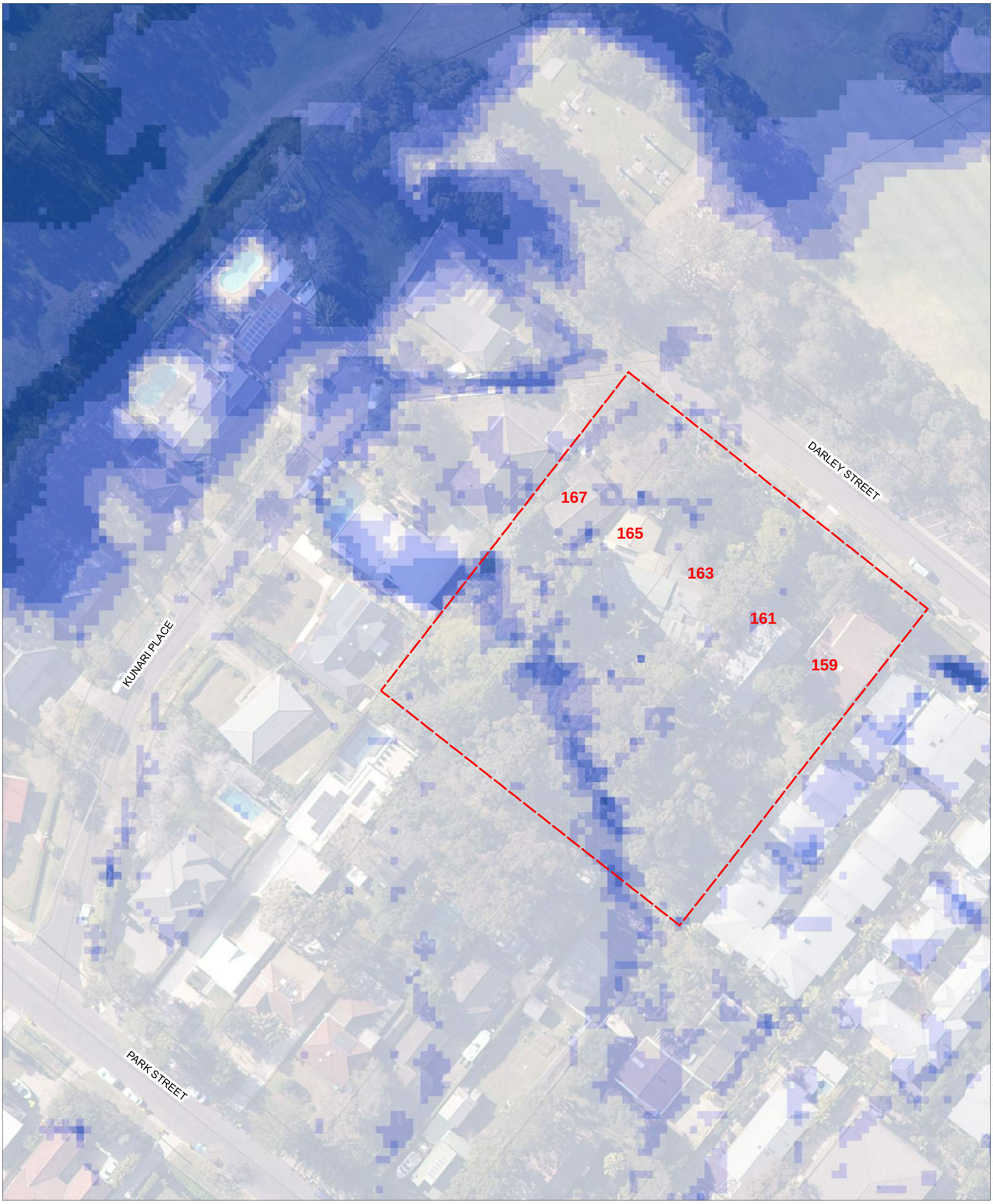

FIGURE 3: PEAK FLOOD DEPTH (1% AEP, 2HR)

Legend

Site Boundary

Cadastre

Roads

Peak Flood Depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

N

km 0 0.01 0.02

Source: Nearmap

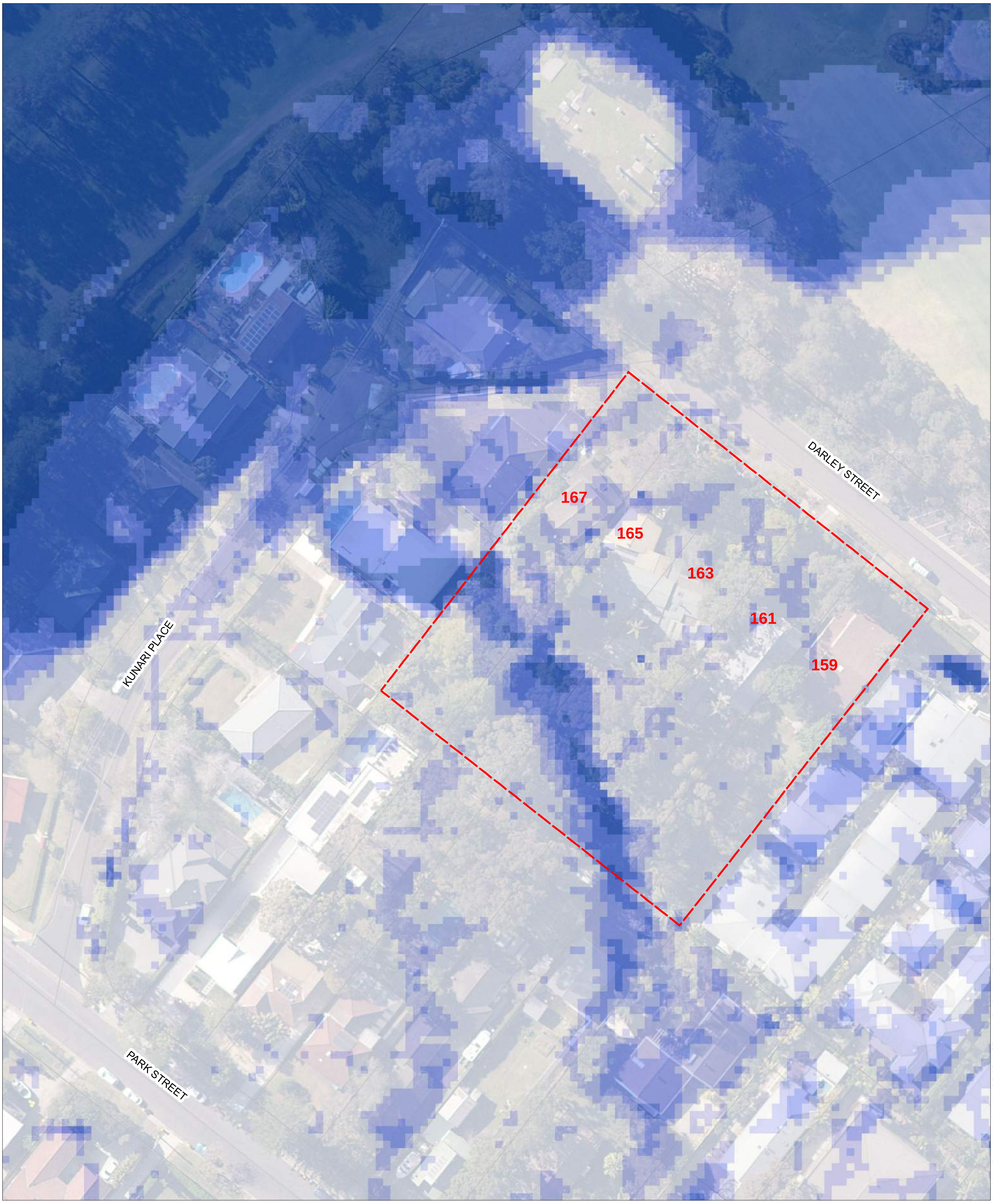

FIGURE 4: PEAK FLOOD DEPTH (PMF, 15MIN)

Legend

Site Boundary
Cadastre
Roads

Peak Flood Depth (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

km
0 0.01 0.02

Source: Nearmap

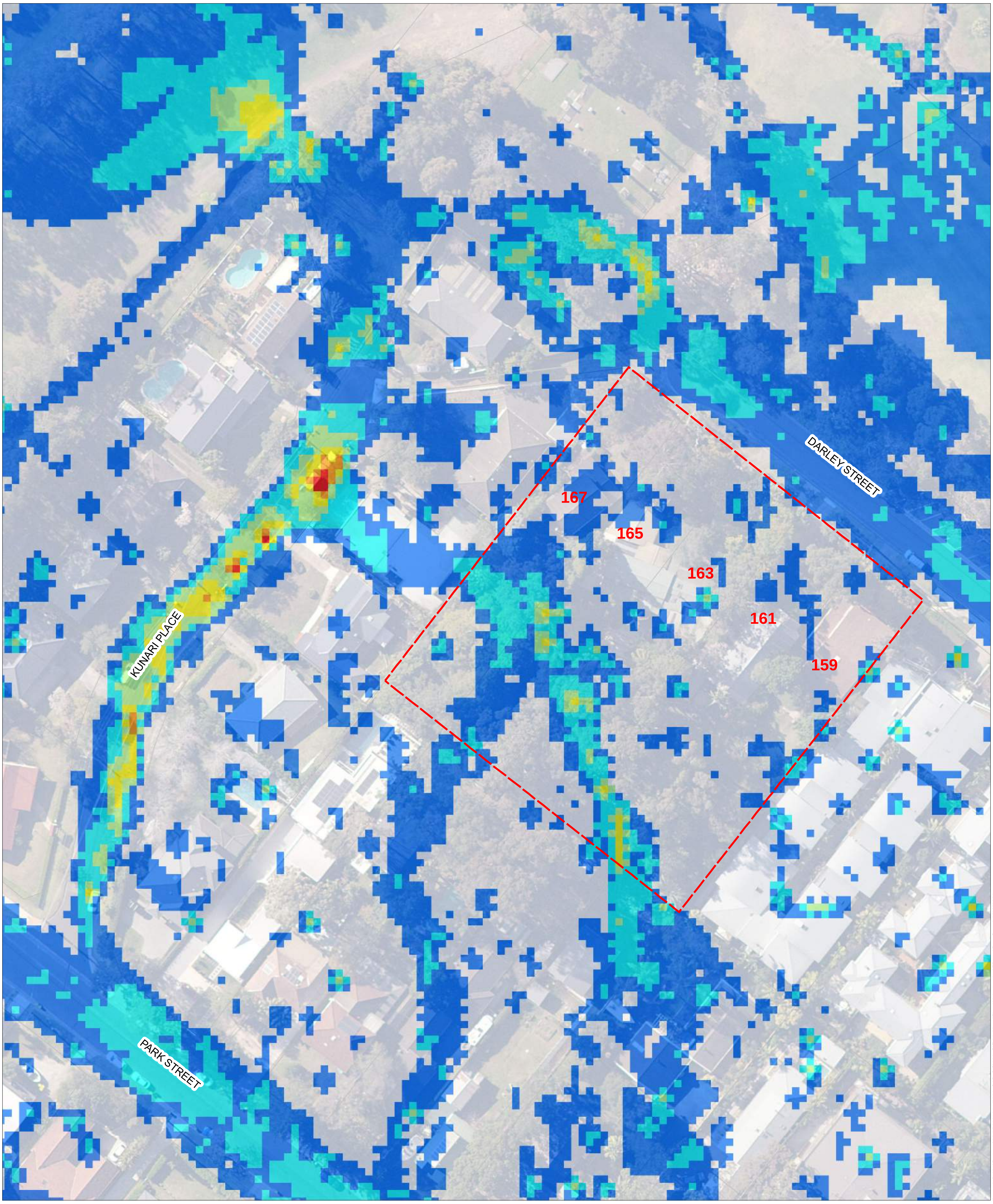

FIGURE 5: PEAK FLOOD VELOCITY (20% AEP, 2HR)

Legend

Legend	Peak Flood Velocity (m/s)
Site Boundary	0 - 0.1
Cadastre	0.1 - 0.25
Roads	0.25 - 0.5
	0.5 - 0.75
	0.75 - 1
	1 - 1.25
	> 1.25

AECOM

N

0 0.01 0.02 km

Source: Nearmap

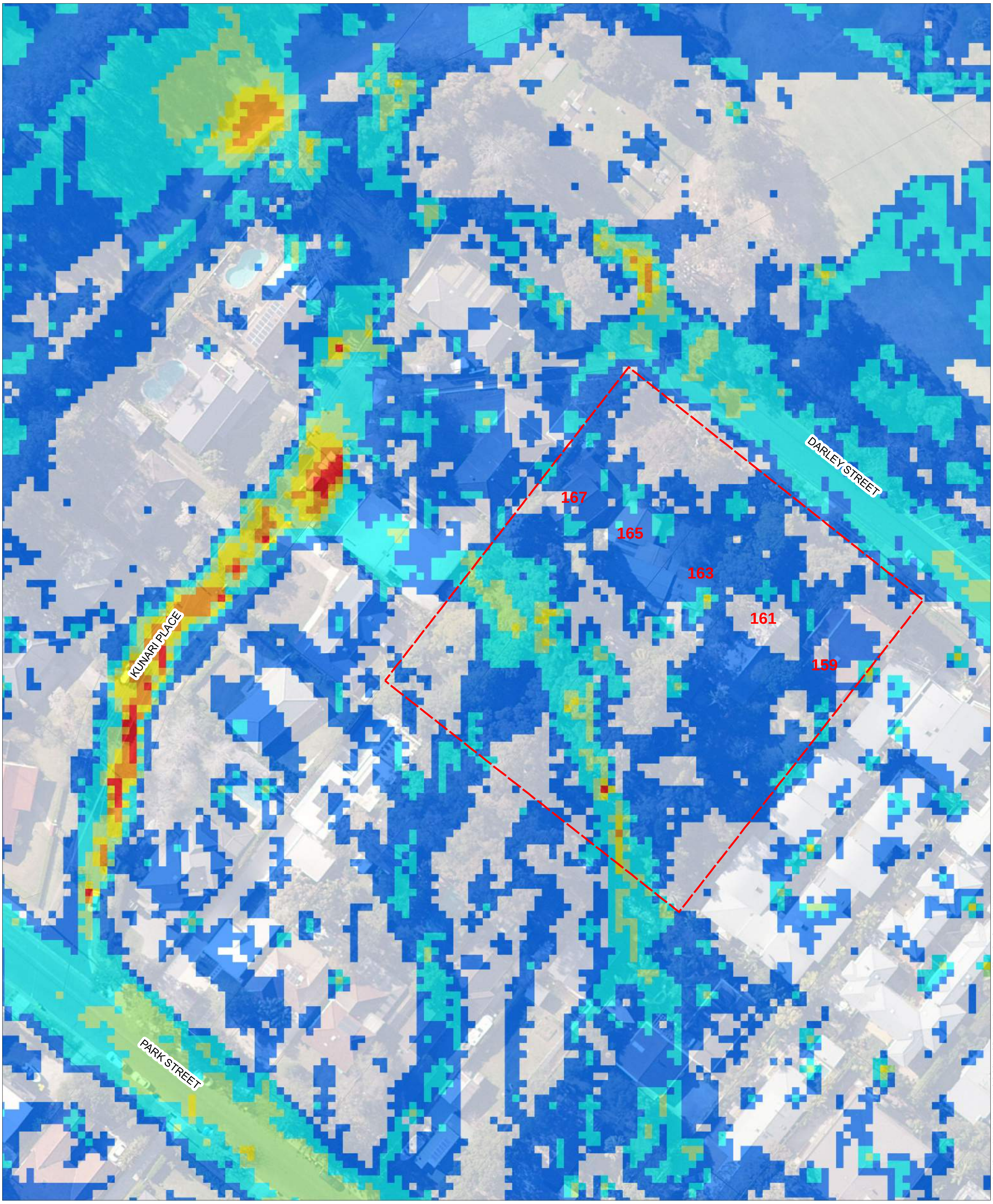

FIGURE 6: PEAK FLOOD VELOCITY (1% AEP, 2HR)

Legend

Site Boundary
Cadastre
Roads

Peak Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- > 1.25

km 0 0.01 0.02

Source: Nearmap

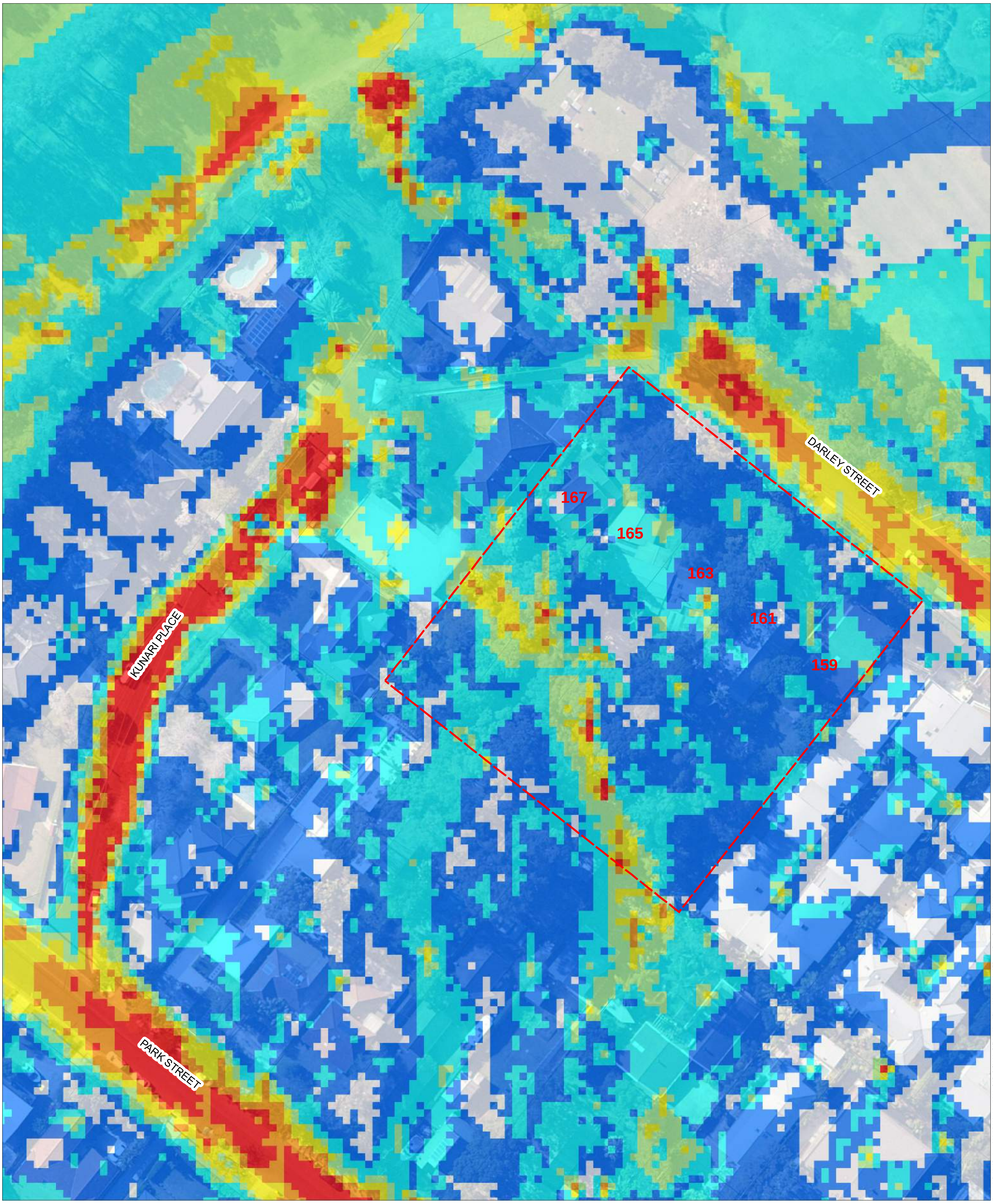

FIGURE 7: PEAK FLOOD VELOCITY (PMF, 15MIN)

Legend

	Site Boundary	Peak Flood Velocity (m/s)	
	Cadastre		0 - 0.1
	Roads		0.1 - 0.25
			0.25 - 0.5
			0.5 - 0.75
			0.75 - 1
			1 - 1.25
			> 1.25

AECOM

N

0 0.01 0.02 km

Source: Nearmap

FIGURE 8: RESULT SAMPLE LOCATIONS

Legend

- Site Boundary
- Level & Velocity Sample Locations
- Flow Plot-Output Lines
- Channel Cross-section
- Cadastre
- Roads

N

0 0.0075 0.015 km

Source: Nearmap

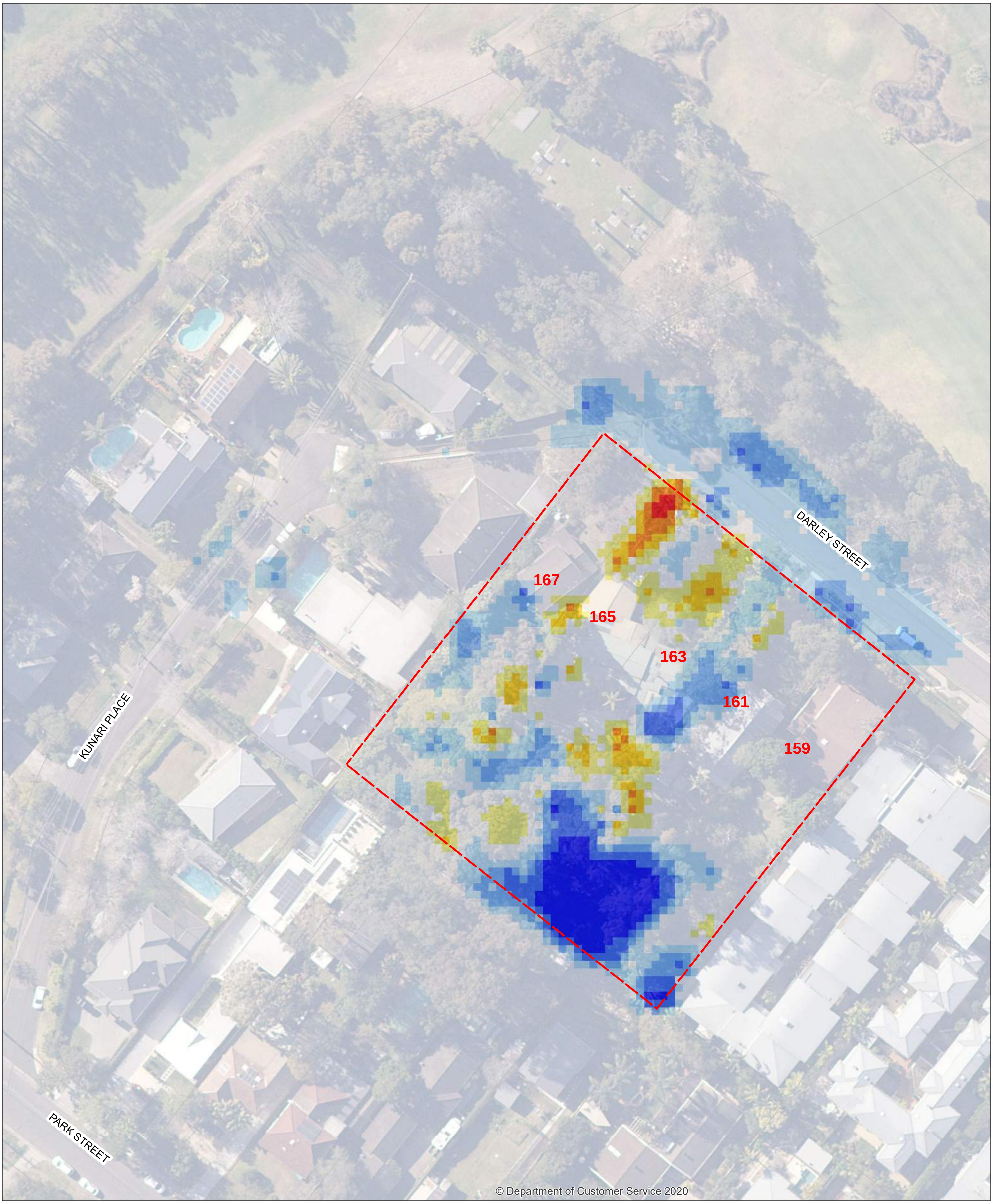

FIGURE 9: UPDATED TERRAIN IMPACT ON PEAK FLOOD LEVEL (20% AEP, 2HR)

Legend

- Site Boundary
- Cadastre
- Roads

Updated Terrain Level Impact (m)

- < -0.5
- -0.5 to -0.25
- -0.25 to -0.15
- -0.15 to -0.05
- -0.05 to 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.5
- > 0.5

AECOM

N

0 0.01 0.02 km

Source: Nearmap

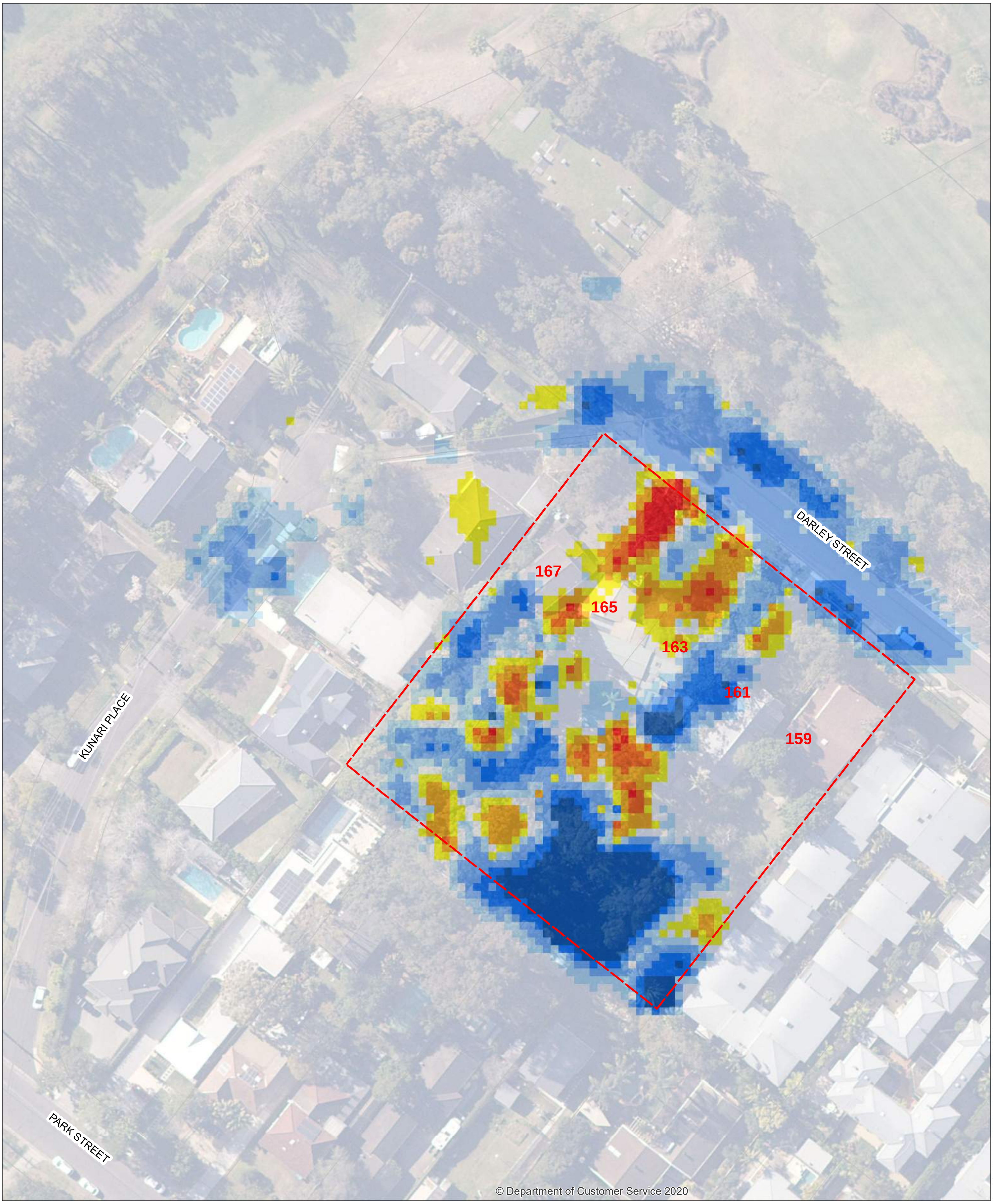

FIGURE 10: UPDATED TERRAIN IMPACT ON PEAK FLOOD LEVEL (1% AEP, 2HR)

Legend

- Site Boundary
- Cadastre
- Roads

Updated Terrain Level Impact (m)

- < -0.5
- -0.5 to -0.25
- -0.25 to -0.15
- -0.15 to -0.05
- -0.05 to 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.5
- > 0.5

km 0 0.01 0.02

Source: Nearmap

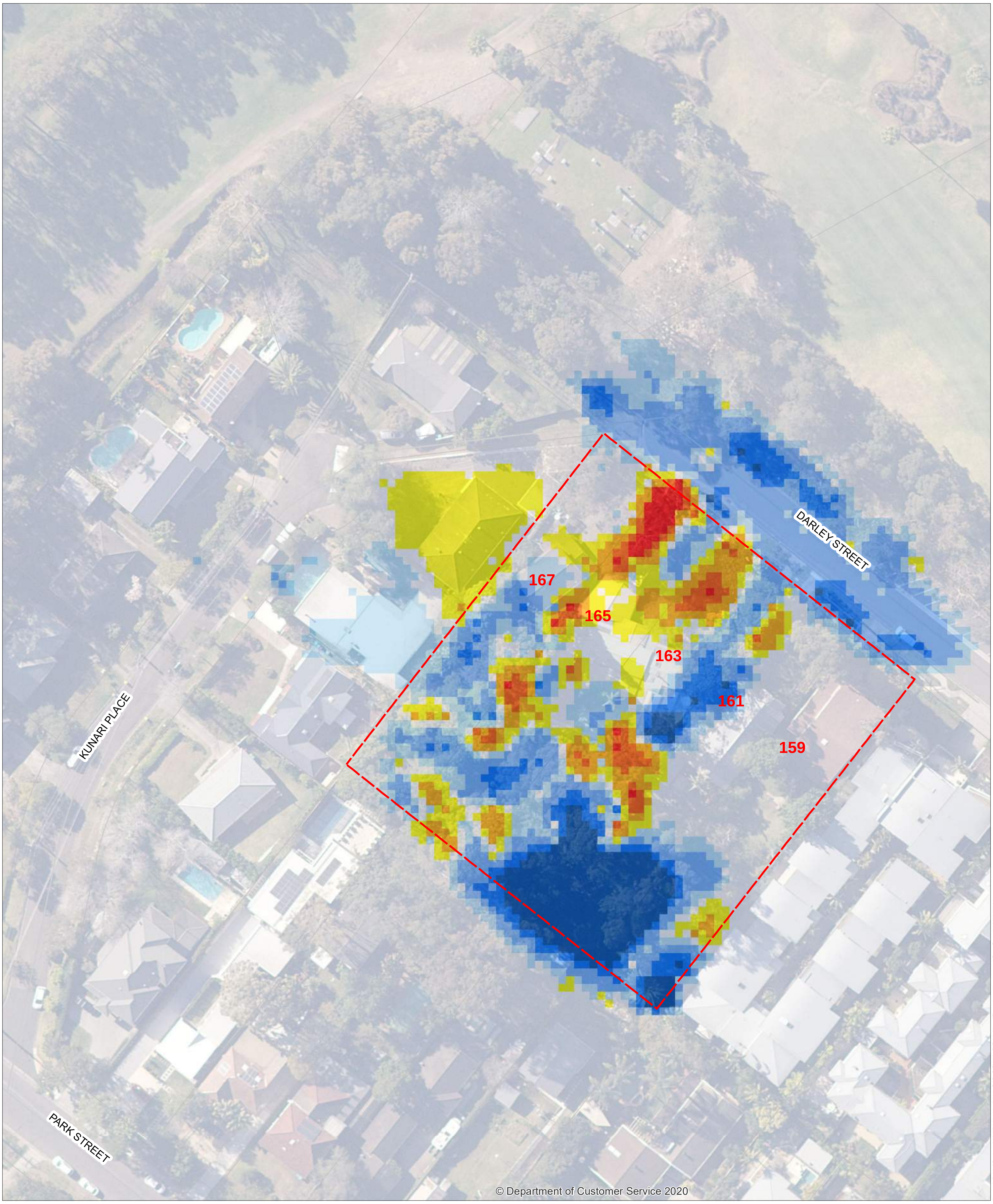

FIGURE 11: UPDATED TERRAIN IMPACT ON PEAK FLOOD LEVEL (PMF, 15MIN)

Legend

- Site Boundary
- Cadastre
- Roads

Updated Terrain Level Impact (m)

- < -0.5
- -0.5 to -0.25
- -0.25 to -0.15
- -0.15 to -0.05
- -0.05 to 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.5
- > 0.5

AECOM

N 0 0.01 0.02 km

Source: Nearmap

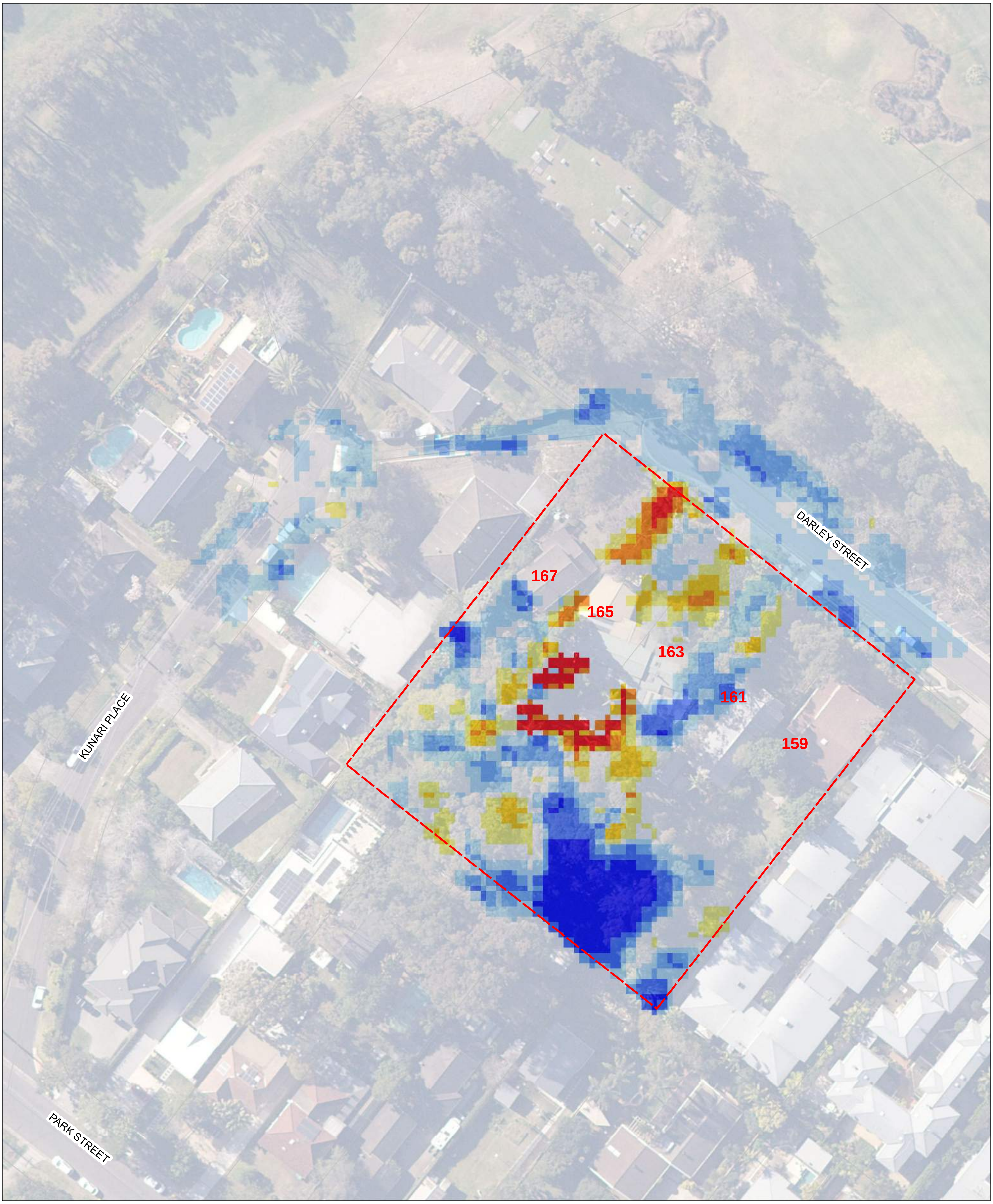

FIGURE 12: DIFFERENCE IN TERRAIN BETWEEN BASE CASE AND SUPPLIED MODEL

Legend

- Site Boundary
- Cadastre
- Roads

Difference between Base Case and Supplied Model Terrain(m)

- < -0.5
- -0.5 to -0.25
- -0.25 to -0.15
- -0.15 to -0.05
- -0.05 to 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.5
- > 0.5

Source: Nearmap

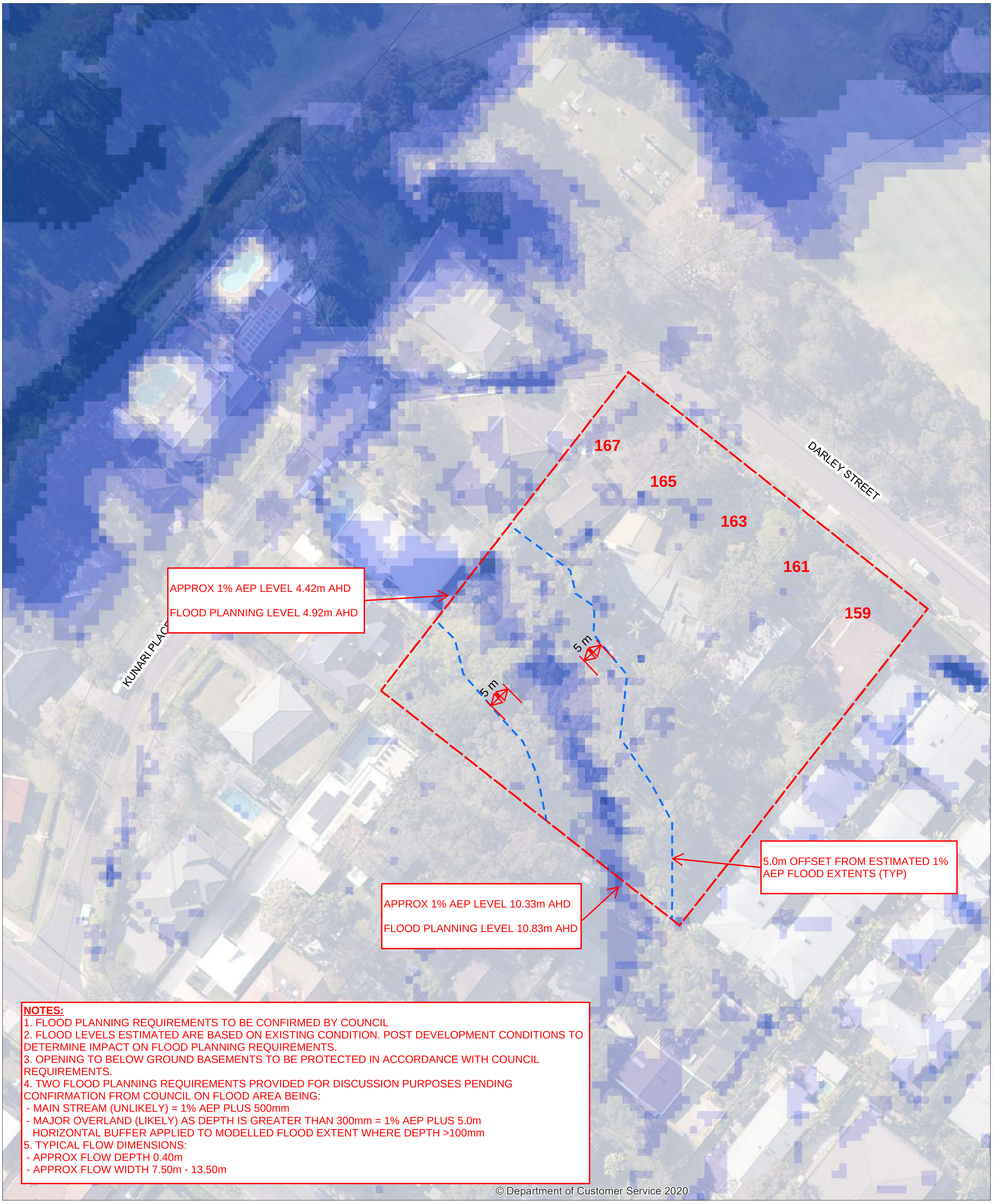

FIGURE 14: INDICATIVE FLOODING CONSIDERATIONS - FOR INFORMATION ONLY

SUBJECT TO APPROVAL AUTHORITY REVIEW

AECOM

N
0 0.01 0.02 km

Legend

Site Boundary
Cadastre
Roads

1% AEP Peak Flood Depth (m)
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1

Source: Nearmap