Flood Impact Assessment

24 Forsyth Place, Oatlands

Macquaire Lawyers

18 June 2024

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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

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1 INTRODUCTION

In March 2020 the City of Parramatta Council approved a development application for the demolition of an existing dwelling at 24 Forsyth Place, Oatlands (Lot 11 DP 263267) and the construction of a new 2-storey dwelling. Dream Drafting Sydney has since submitted a new development application (DA) to Council that also included an inground swimming pool and retaining walls. This DA was refused on 14 March 2024 for several reasons, including that there was insufficient information regarding the impact of the development on flood behaviour.

The site is shown to be impacted by overland flooding in events above the 20% Annual Exceedance Probability (AEP) flood, with floodwaters flowing eastwards through the site towards Vineyard Creek, 250 m south-east of the property.

Council provided the following comments in its assessment report for the most recent DA:

> *The site will be heavily impacted by flooding with flood depths of more than 1 metre in both 5% and 1% AEP events. A major overland flow path has also been identified which passes through a significant area of the site.*
>
> *Comments received by Council's Catchment Management Team dated 26 February 2024 have confirmed the proposed dwelling and pool area may result in significant impact to the identified overland flow path. Without a flood study demonstrating the relationship between the proposal and overland flow path as well as the resulting impacts to adjoining properties, Council is unable to confirm if the proposal will not result in an increase of hazards to adjoining sites in a flood event.*
>
> *On 6 March, a meeting was held between the assessing officer, Senior Catchment and Development Engineer and Catchment Referral Engineer. During this meeting the points of the proposal were discussed together with the site history and past DA approvals including DA/704/2019 for a dwelling house. It was considered that the proposed dwelling although similar to the approved, still maintained separate design features and included provisions for an inground pool to be located completely within the identified flow area. As a result, it was considered the proposal will result in undefined impacts to overland flow which are separate to the previously approved dwelling and remain a point which must be addressed. As the proposal was not supported by a flood study, Council cannot be satisfied the proposal appropriately responds and addresses flooding hazards.*

This following Flood Impact Assessment (FIA) has been prepared in response to the council comments in order to determine the flood impact of the proposed development upon the surrounding area and surrounding properties.

1.1 Subject Site

The subject site is situated within the Oatlands suburb of Parramatta and Western Sydney (Figure 1-1). It is surrounded by residential development to the east, west and north, with a main road to the south. It is located within an overland flow path travelling from west/northwest to east/southeast, towards New Settlers Park, under Kissing Point Road towards Vineyard Creek to the south which then flows further south towards the Parramatta River.

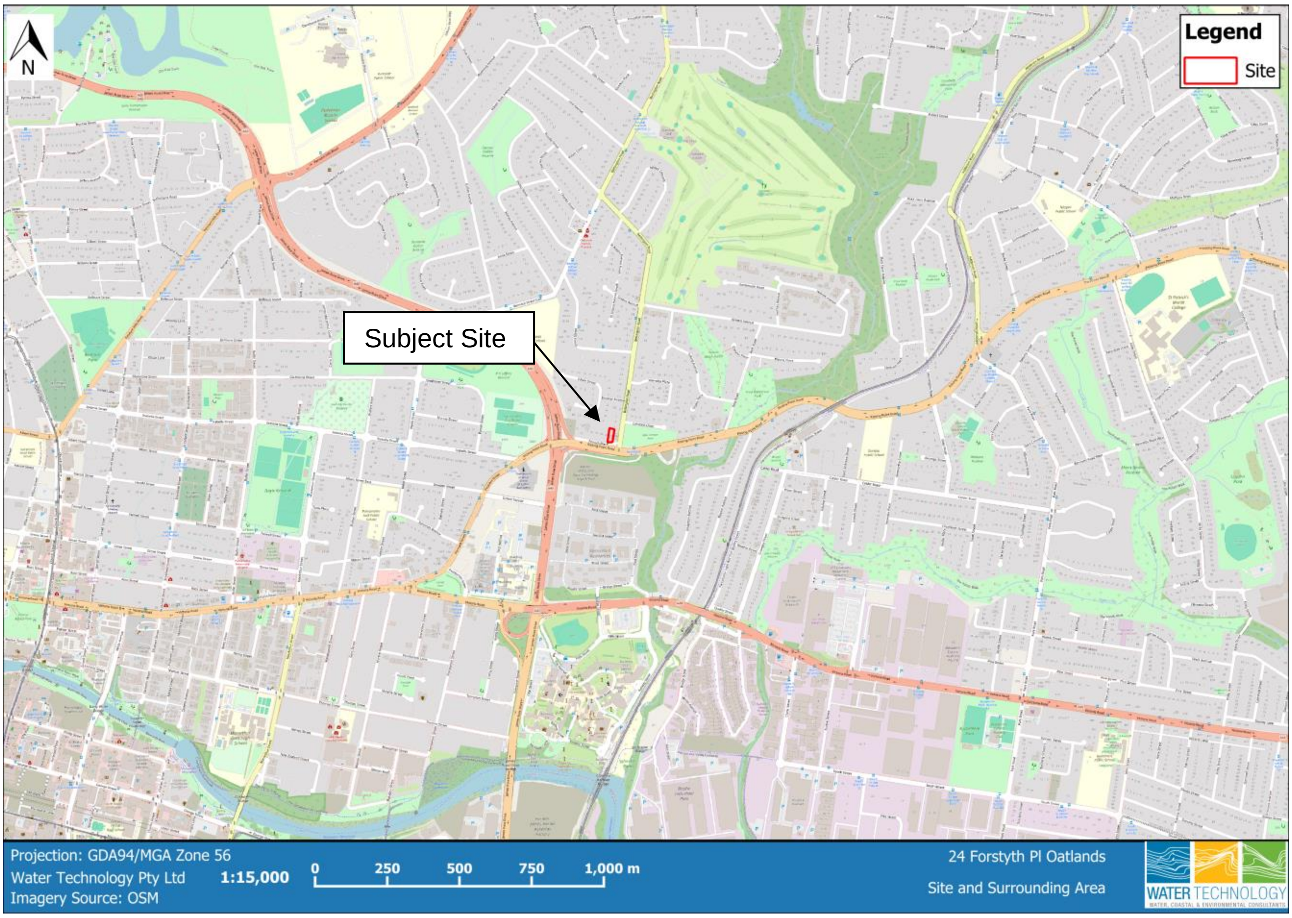

Figure 1-1 Site and Surrounding Area

Review of available data indicates a stormwater network traversing from the west towards and behind the site, before connecting to a non-pipe within New Settlers Park and outflowing towards Vineyard Creek. This stormwater network passes under a main road to the east (James Ruse Drive) and under a sports field. Vineyard Creek is located to the east of the site, with this traveling from further northeast below Kissing Point Road (to the east) before moving west and reaching the outlet of the stormwater system just below New Settlers Park.

The site has been demolished with no buildings currently on site. Based on prior planning approval it is understood that a residential development existed on site, before being demolished prior to building commencement. As part of the assessment we have assumed the prior residential development at the site which will be used as the base case scenario to determine the impact of the proposed development on the area.

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2 METHODOLOGY

2.1 Hydrological Model Development

2.1.1 WBNM Hydrological Model

To inform the hydrology and basin inflows for this assessment, WT developed a local Watershed Bounded Network Model (WBNM). The modelling undertaken is consistent with Australian Rainfall and Runoff 2019 (ARR 2019) methodologies. The latest ARR19 methodology considers multiple temporal patterns of rainfall, such as those that occur during a flood event, to provide a more accurate representation of the potential hydrologic response of the catchment. Storm Injector software was used to set up and simulate the design rainfall ensembles.

The WBNM sub-catchment boundary layout is shown in Figure 2-1. The sub-catchment labels are shown, with respective impervious percentages estimated based on aerial imagery.

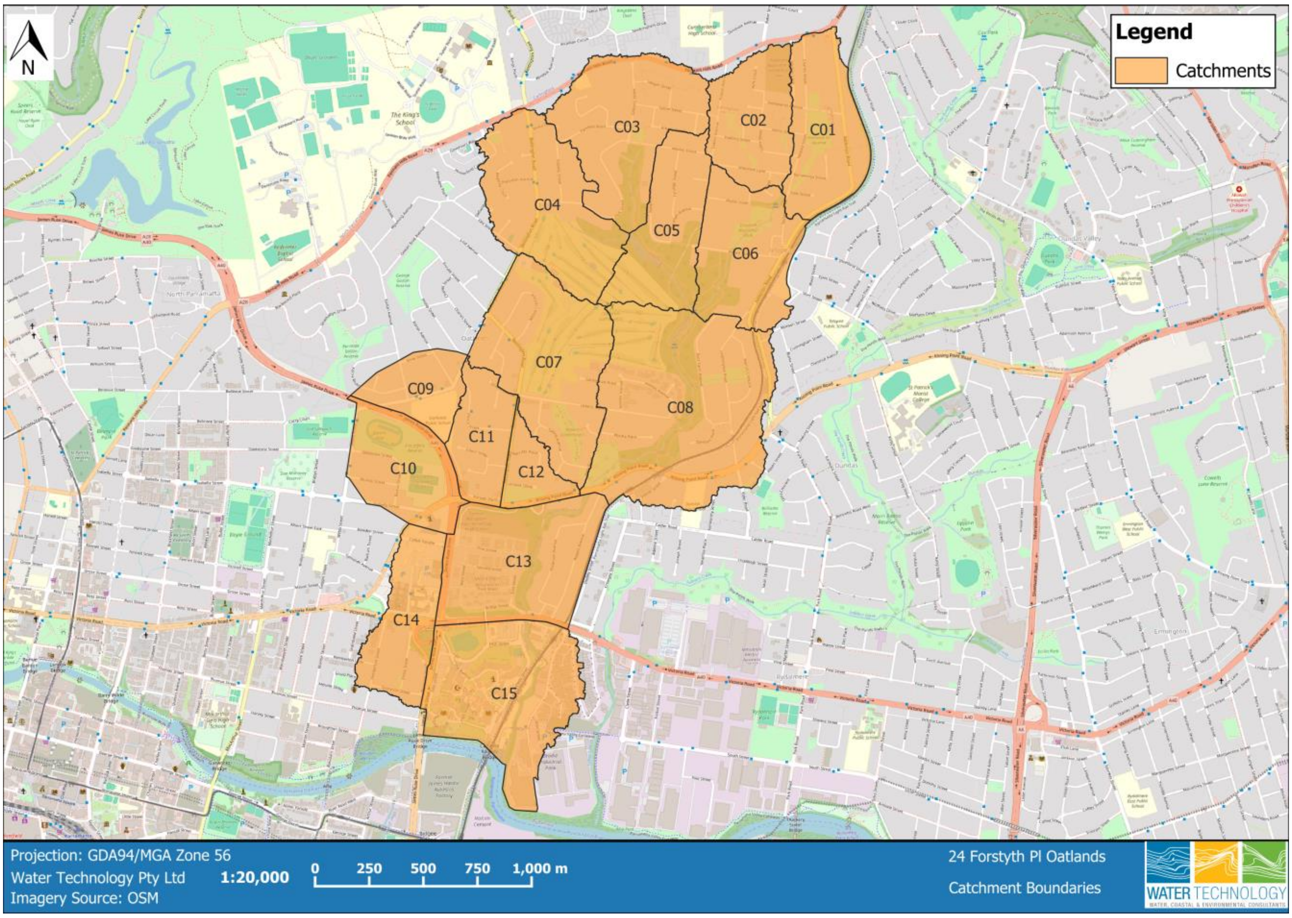

Figure 2-1 Catchment Boundaries

2.1.2 Design IFD Rainfall Data and Losses

The Intensity-Frequency-Duration (IFD) is a set of data that describes the frequency and magnitude of rainfall events for a specific location. This data are used to estimate the design rainfall for different magnitude events, such as the 1% AEP (1 in 100). The IFD data is based on long-term meteorological observations and is provided by the Bureau of Meteorology (BoM) for different regions of Australia. In this study, the IFD data was sourced from the BoM and applied to each sub-catchment in the hydrologic model.

The input IFD's were factored by 19% to be consistent with the Parramatta River Flood Study (PRFS)(Stantec 2023) and with other assessments undertaken by Water Technology for neighbouring Councils, including within this catchment (the greater Parramatta River catchment). Upscaling IFDs ensures that the design flow estimates are not underestimated. Further to this, a 75th percentile pre-burst amount has been incorporated into the start of each temporal pattern and distributed over the initial ten (10) timesteps. An initial loss of 30 mm and a continuing loss of 0.5 mm consistent with the PRFS (Stantec 2023) was adopted for all events.

Hydrology was derived for the following Annual Exceedance Probability (AEP) events:

- 5% AEP – 20-year ARI
- 1% AEP – 100-year ARI
- Probable Maximum Precipitation (PMP) – equivalent to a probability of 10^{-7} AEP.

The standard procedure for simulating design events includes assessment of the flood event with all ten (10) temporal patterns. The Generalised Short Duration Method (GSDM) methodology was utilised for the PMP hydrology. Each of the flood events (5% AEP, 1% ARP and PMF) was analysed for a range of durations to capture the critical durations for the catchment.

2.2 Hydraulic Model Summary

2.2.1 Overview

A hydraulic model has been developed for the Flood Impact Assessment. This model has been used to establish the impacts of the proposed development on the surrounding area, utilising a base case scenario which has been compared to the proposed developed scenario. The base case scenario has been compared against the council flood study in order to validate the accuracy of the model.

2.2.2 Hydraulic Model Build

The TUFLOW model extent is shown in Figure 2-2. The model extent has been defined to ensure all required inflows are included, and all flows that may impact the site are present. The latest version of TUFLOW (Build 2023-03-AC) with (Heavy Parallelised Compute) HPC Solution Scheme using a GPU solver has been adopted.

2.2.2.1 Topography

Detailed 1m LiDAR flow in 2019 has been utilised for the base topography (Figure 2-3). A 2m model cell size has been adopted for this assessment. Building footprint polygons were included to represent the building surrounds, raising these above ground level to ensure flows are accurately modelled. Fences within the target area were also included as layered flow constrictors, assuming a general level of 1m and a blockage of 30%.

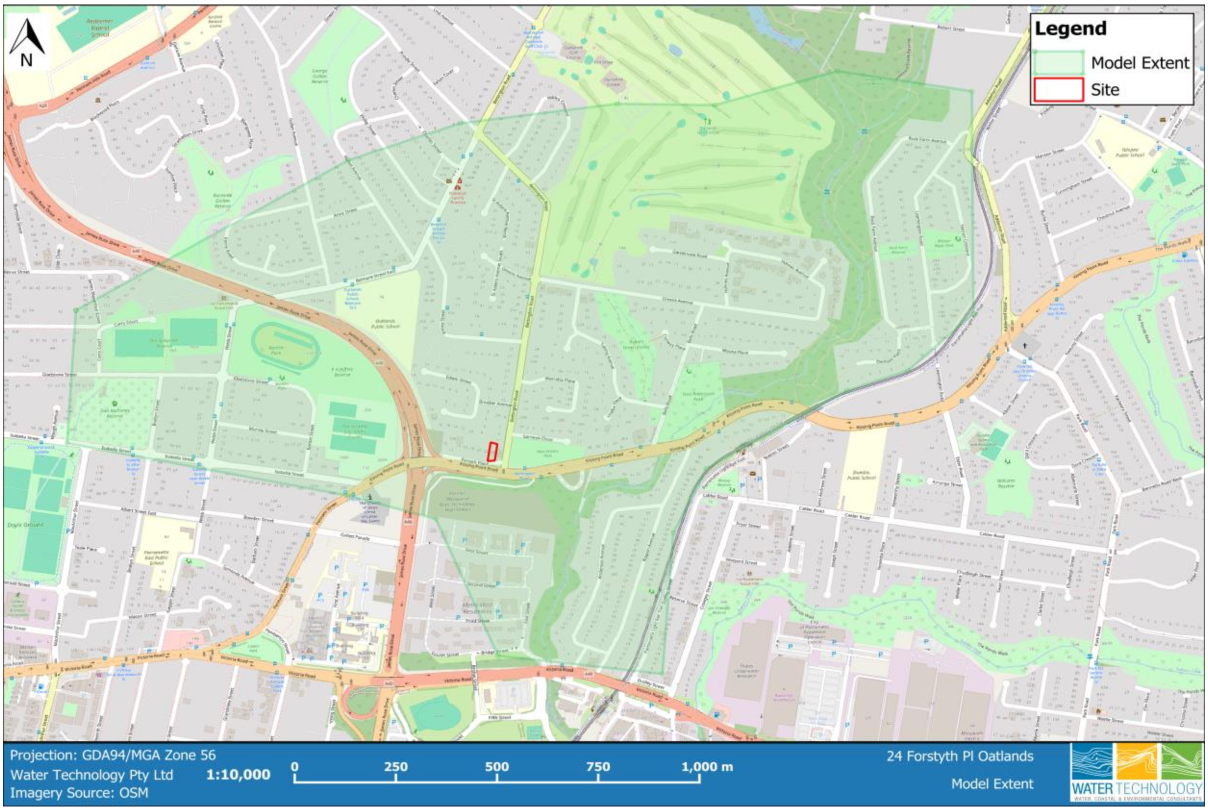

Figure 2-2 TUFLOW Model Extent

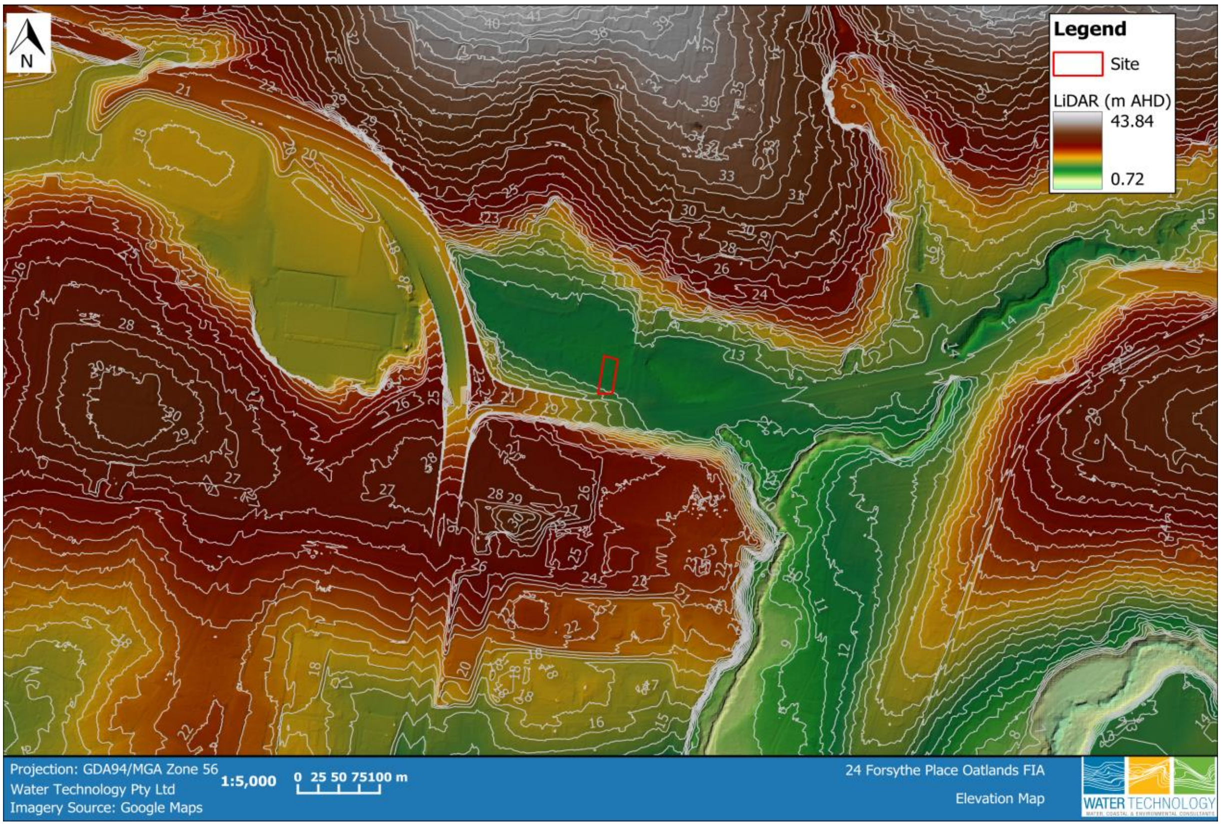

Figure 2-3 Topography of Site and Surrounding Area

2.2.2.1.1 Base Case Representation

The base case representation was based on the size and location of previous buildings onsite. This was based on site plans, which show a main house and shed which were represented as z-shapes raised above the ground with assumed impermeable consistent with other building polygons within the model. The base case layout is displayed in Figure 2-4.

Figure 2-4 Base Case Z-Shape Set Up

2.2.2.1.2 Developed Case Representation

The developed case has been represented through z-shapes and layer flow constriction. Review of the design plans indicated the proposed building to be on stilts with a flow path underneath the building. This flow path was represented as a layer flow constriction with a 25% blockage and a 0.1-layer flow constriction. The plans indicated that other areas beneath the building were blocked with walls, which have been included as blocked z-shapes. Following discussions with Client's structural engineer (from Aussie Structural Engineers Pty Ltd), the garage, the front porch and a part of the higher ground floor located to the front of the site, may also be built on ground (Figure 2-6) to reduce the cost and complexity of the construction, and as such this has also been modelled as a z shape. The pool terrace was represented as a z-shape as it was assumed the pool to be full. Further walls were included within the developed case where deemed necessary.

The developed case layout is displayed in Figure 2-5 and Figure 2-6.

Figure 2-5 Developed Case Z-Shape and Layer Flow Constriction Set Up

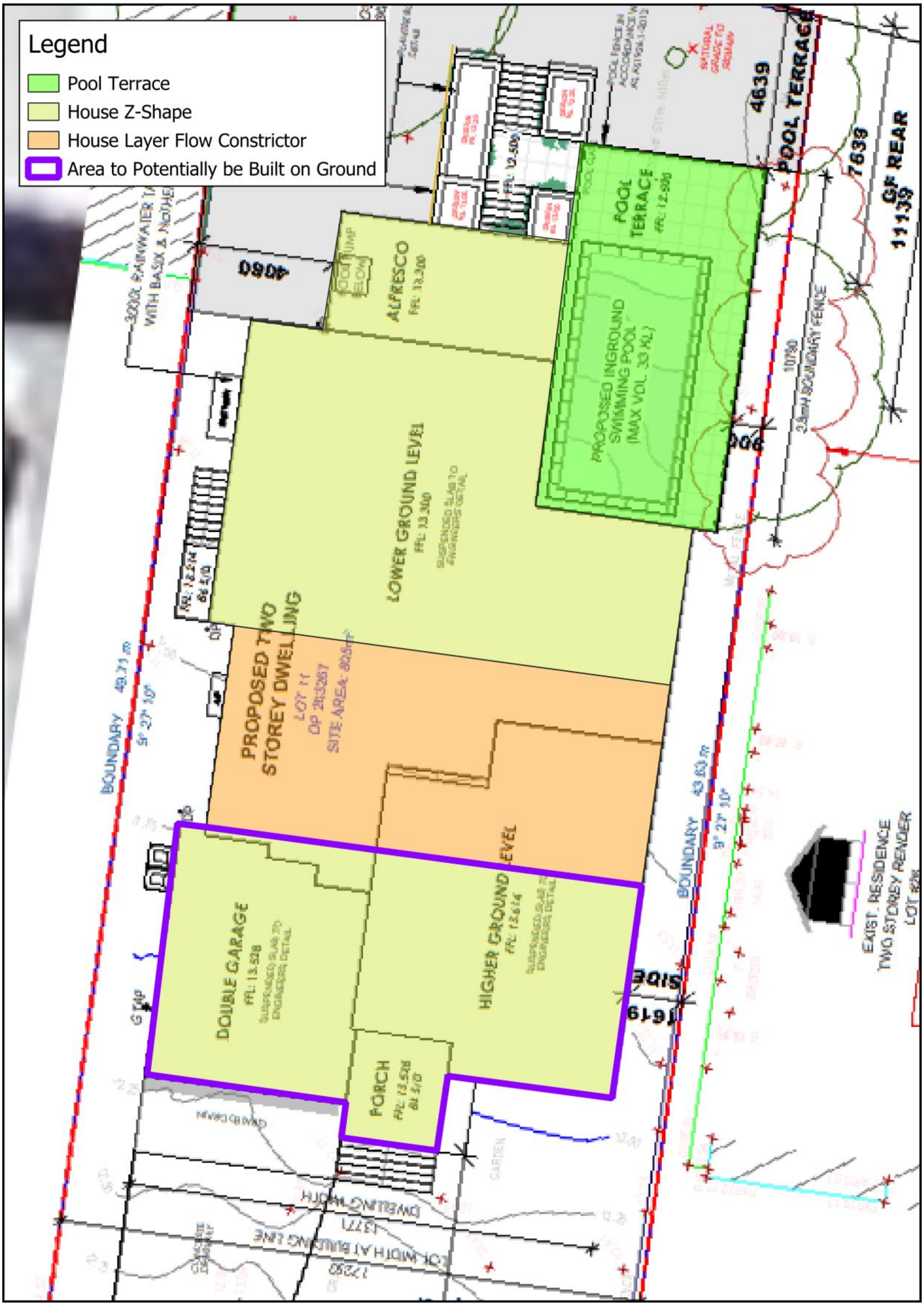

Figure 2-6 Developed Case Building Plans with Area Potentially Built On Ground

2.2.2.2 Mannings 'n' Roughness

The surface roughness values, and spatial delineation were adopted from satellite imagery and cadastre mapping. Table 2-1 presents the adopted values.

Table 2-1 Mannings 'n' Roughness

Roughness Classification	Mannings 'n'
Residential Urban (Higher Density)	0.350
Residential Rural (Lower Density)	0.100
Industrial/Commercial Use	0.300
Significant Drainage Easement	0.050
Open Space or Waterway – minimal vegetation	0.030
Open Space or Waterway – moderate vegetation	0.060
Open Space or Waterway – heavy vegetation	0.080
Open Water (with reedy vegetation)	0.060
Open Water (with submerged vegetation)	0.020
Car Park/Pavement/Driveway/Roads	0.020
Railway Line	0.125
Buildings	0.5

2.2.2.3 Boundary Conditions

The model inflows have been represented as Source Area (SA) polygons, with 4 total inflows included. These inflows were determined to be the main inflows affecting the site, this included an inflow to the east of the site, which was modelled as a total inflow for all catchments above this area, an inflow above the site on the roads that was modelled as local inflow for this catchment, and 2 inflows to the west of the site which included the catchments in this area.

The downstream boundary was represented using a normal slope boundary to the south of the model. The location of the downstream boundary and the inflows are displayed in Figure 2-7.

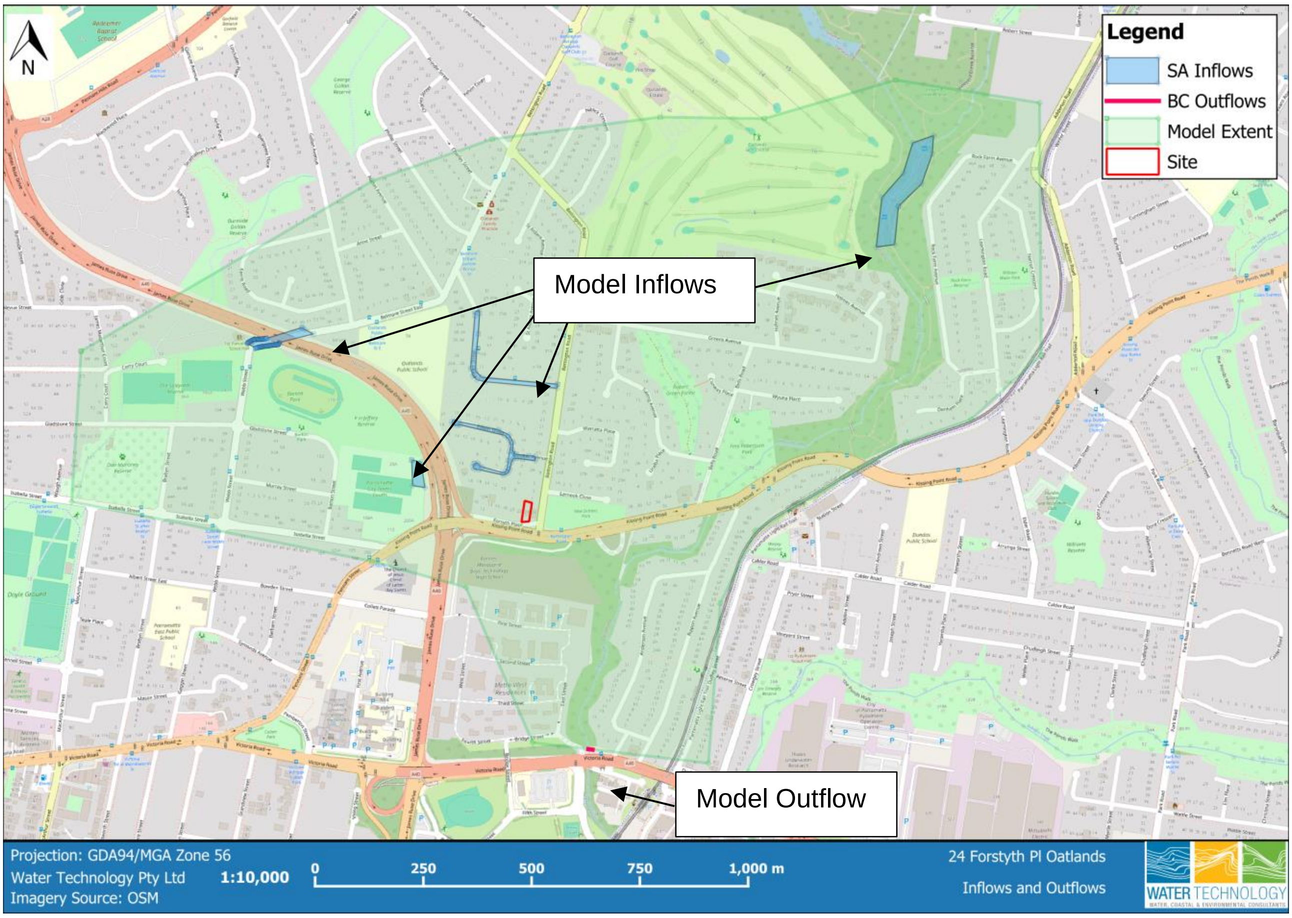

Figure 2-7 SA Inflows and Model Outflows

2.2.2.4 Stormwater Network

A 1d network has been established using stormwater mapping provided from the council. This has been used for approximate locations of pits and width/length of pipes. Detailed invert levels were not provided by the council and as such these were estimated based on sufficient cover and pipe width. The Council stormwater network represented within the model is shown in Figure 2-8.

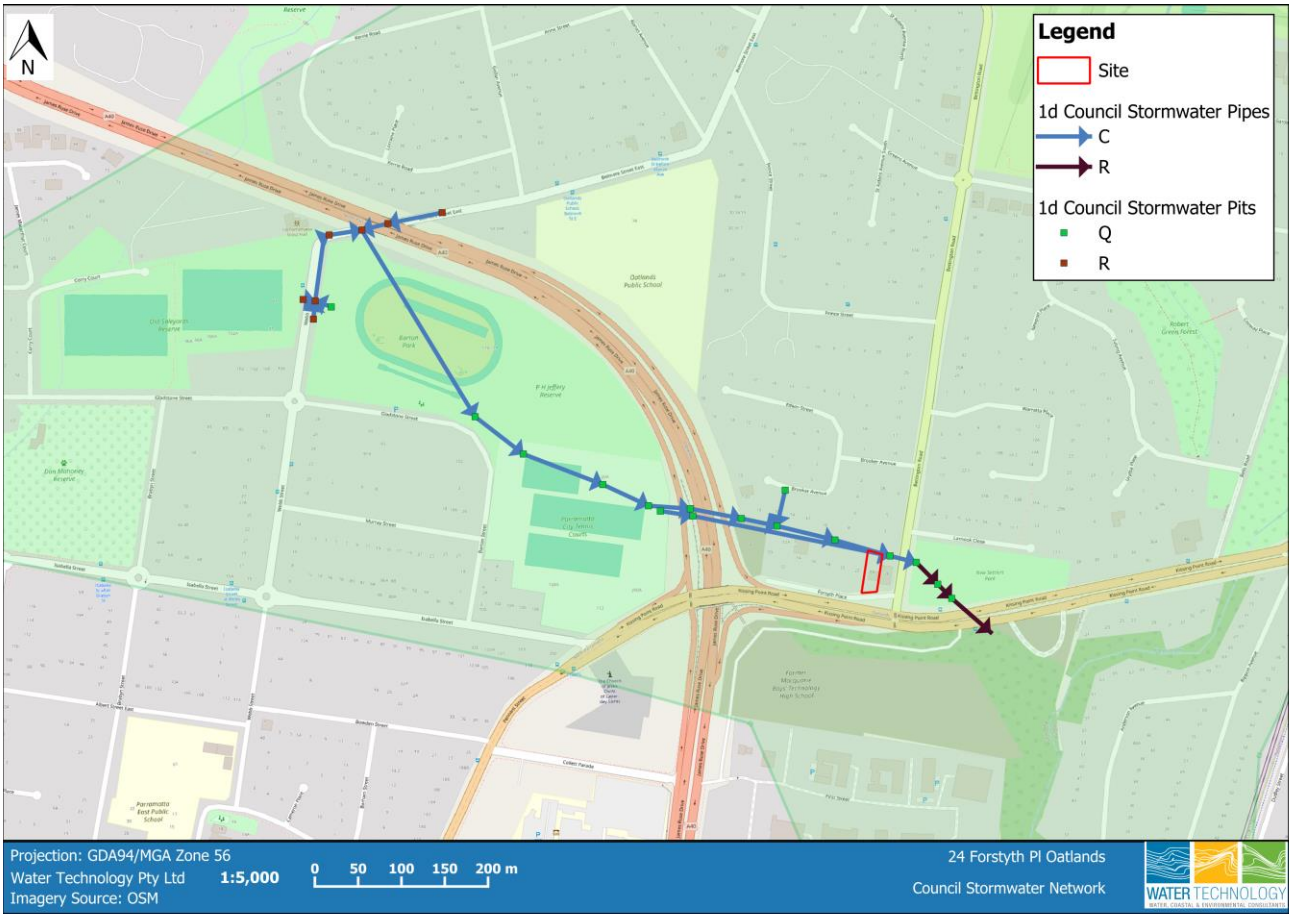

Figure 2-8 Council Stormwater Network Assumed from Flood Maps

Pits have been modelled based on inlet curves, with widths and lengths determined from on-site measurements, satellite mapping, and general assumptions. Other pits have been measured as junction pits based on the site visit and assumptions.

The stormwater network represented in the development plans for the site was included within the developed case model. Pipes and pits were included with invert levels determined based on the plans and on LIDAR, while pipe details were determined based on the plans and LIDAR. The 1d network for the developed case is displayed in Figure 2-9.

The stormwater network represented in the development plans for the site was represented within the developed case model. Pipes and pits were included, with widths, invert levels determined based on the information provided where possible. Other invert levels were assumed through LIDAR and the general pipe system. The 1d network for the developed case is displayed in Figure 2-9.

Drainage on site involves small surface water collection points which then drain to the council stormwater network through a connection. There are two grates set at the front of the property, and one set at the rear.

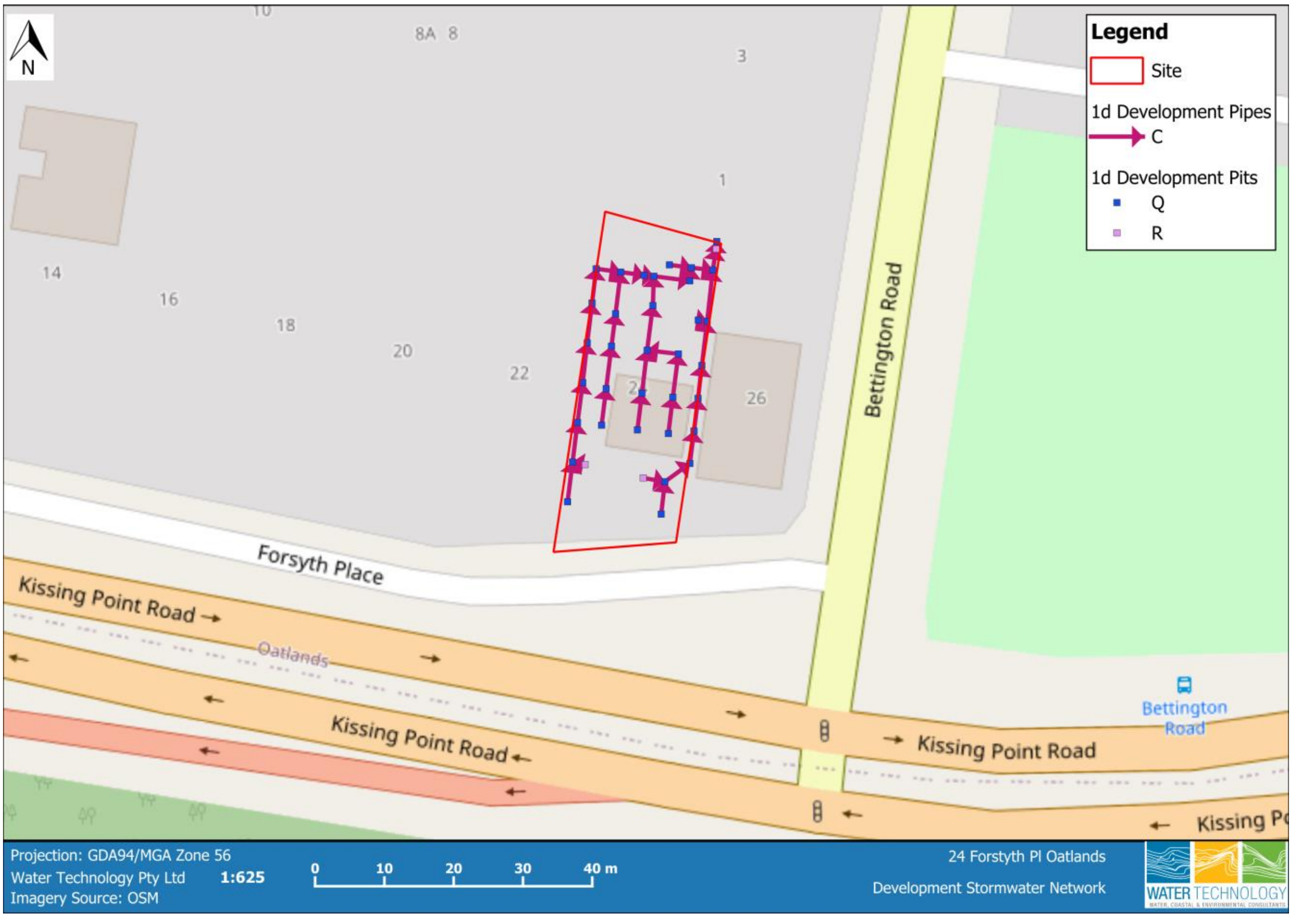

Figure 2-9 Developed Case Stormwater Network from Site Plans

The stormwater network was originally modelled non-blocked to determine the critical duration. All pits and pipes were then blocked 100% as requested by council.

A 1d_nwk culvert was included in the model as a representative of a bridge flowing to the east of the site. This has been modelled non blocked throughout the scenarios, with width and depth assumed was based on satellite imagery.

2.2.2.5 Critical Duration

To determine the critical duration and critical temporal patterns, all simulations (1%, and 5%) were ran for all 10 produced temporal patterns. These were then analysed utilising a median/max approach to determine which patterns and durations affected the site area.

2.2.2.5.1 1% AEP Durations

Analysis showed that for the 1% AEP event, the critical durations affecting the site included the 20-minute, 30-minute, 45-minute and 60-minute. The 120-minute duration was found to be critical to the west of the site; however, this was not determined to impact flooding on site.

Review of the critical duration events indicated varying temporal patterns affecting the site and surrounding area. Within the 20-min duration, temporal pattern (TP) 4 was determined to be the median pattern affecting the site. For the 30-min duration, TP3 and TP6 were deemed the median patterns, with TP3 affecting the site area itself and TP6 affecting just upstream. This was deemed important to flooding on site and as such was included within the critical duration scenario. Within the 45-min duration, TP10, TP9 and TP8 were the median patterns affecting the site and surrounding upstream area. For the 60-min duration, the median temporal patterns were TP2, TP6 and TP8. Again, these additional temporal patterns were deemed important to determine the impact of flooding from the site and as such were included within the critical duration runs. A summary of the median temporal patterns for each of these critical durations can be found in Table 2-2.

These have been utilised in the 100% blockage scenario to determine the impacts of the development to the surrounding area.

Table 2-2 1% AEP Median Temporal Patterns

Duration	Median Temporal Patterns
20-min	TP4
30-min	TP3, TP6
45-min	TP8, TP9, TP10
60-min	TP2, TP6, TP8

2.2.2.5.2 5% AEP Durations

Critical duration analysis showed that for the 5% AEP event, the critical durations affecting the site were the 20-minute, 30-minute, and 45-minute events. TP4 was identified as the median pattern for the 20-minute duration, while TP3 and TP6 affected the site area during the 30-minute duration. For the 45-minute duration, TP10, TP9, and TP8 were the predominant patterns. A summary of the median temporal patterns for each of these critical durations can be found in Table 2-3. As above, these additional temporal patterns were deemed important to flooding on site and within the surrounding area that may be impacted and as such were included within the critical duration runs.

These have been utilised in the 100% blockage scenario to determine the impacts of the development to the surrounding area.

Table 2-3 5% AEP Median Temporal Patterns

Duration	Median Temporal Patterns
20-min	TP4
30-min	TP3, TP6
45-min	TP8, TP9, TP10

2.2.2.5.3 PMF Durations

PMF scenarios were ran for event durations including the 15m, 30m, 45m, 90m, 120m, 150m, 240m and 300m. The critical duration of the PMF event was identified as the 90m which was used to review the impacts on site within a 100% blockage scenario.

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3 RESULTS

3.1 Base Case Results

Flood depth results for the 5% AEP event are presented in Figure 3-1, with flood results for the 1% AEP and PMF presented in Figure 3-2 and Figure 3-3 respectively. These results indicate that during the 1% AEP event under existing base case conditions that maximum depths onsite reach up to 1.23 metres.

Flood heights or each of the respective modelled events are shown in Figure 3-4, Figure 3-5, and Figure 3-6. The site is shown to be impacted during all modelled events, with a visible flow path through the property. This flow path increases with the magnitude of the AEP event.

Table 3-1 displays the maximum flood depth and maximum flood height found on site within the base case results for the 5% AEP, 1% AEP and PMF events. Results indicate a maximum flood depth on site of 1m within the 5% AEP event, 1.23m within the 1% AEP event and 3.42m within the PMF event.

Table 3-1 Maximum Flood Depth and Flood Height on Site within the Base Case Scenarios

Event	Maximum Flood Depth (m)	Flood Height (m AHD)
5% AEP	1.00	12.23
1% AEP	1.23	12.45
PMF	3.42	14.65

3.2 Developed Case Results

Figure 3-7 displays the flood depths for the 5% AEP event, with Figure 3-8 and Figure 3-9 displaying the flood depths for the 1% AEP and PMF flood events. Flood heights are shown in Figure 3-10, Figure 3-11 and Figure 3-12. The site is shown to be impacted within all modelled events, with a visible flow path throughout the site. It is noted that the orientation of the flow path through the site has been shifted as a result of the proposed site layout. This flow path is also shown to increase within each AEP. Results indicate changes in flood behaviour within the developed case, with an increase in depth shown behind the retaining wall within the rear of the site.

Table 3-2 displays the maximum flood depth and flood height found on site within the developed case results for the 5% AEP, 1% AEP and PMF events. Results indicate a maximum flood depth on site of 1.02m within the 5% AEP event, 1.23m within the 1% AEP event and 3.42m within the PMF event, indicating a slight increase from the base case scenario.

Table 3-2 Maximum Flood Depth and Flood Height on Site within the Developed Case Scenarios

Event	Maximum Flood Depth (m)	Flood Height (m AHD)
5% AEP	1.02	12.26
1% AEP	1.23	12.46
PMF	3.42	14.65

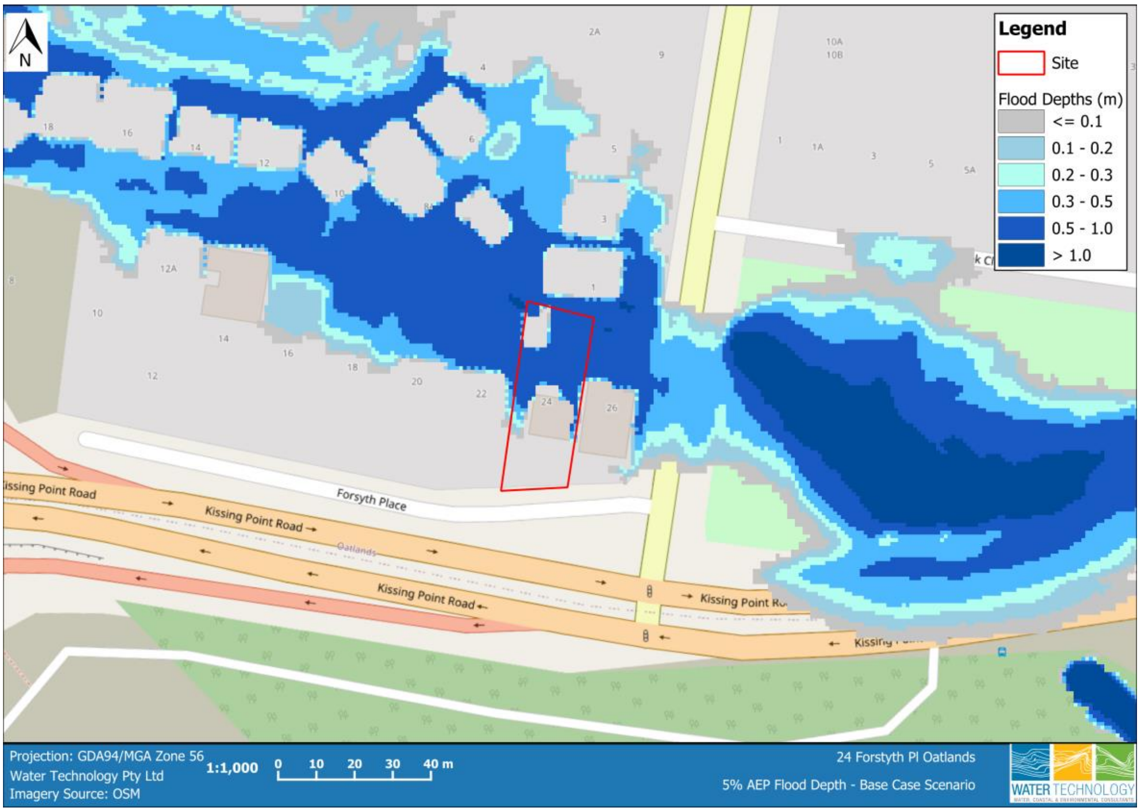

Figure 3-1 5% AEP Base Case Flood Depths

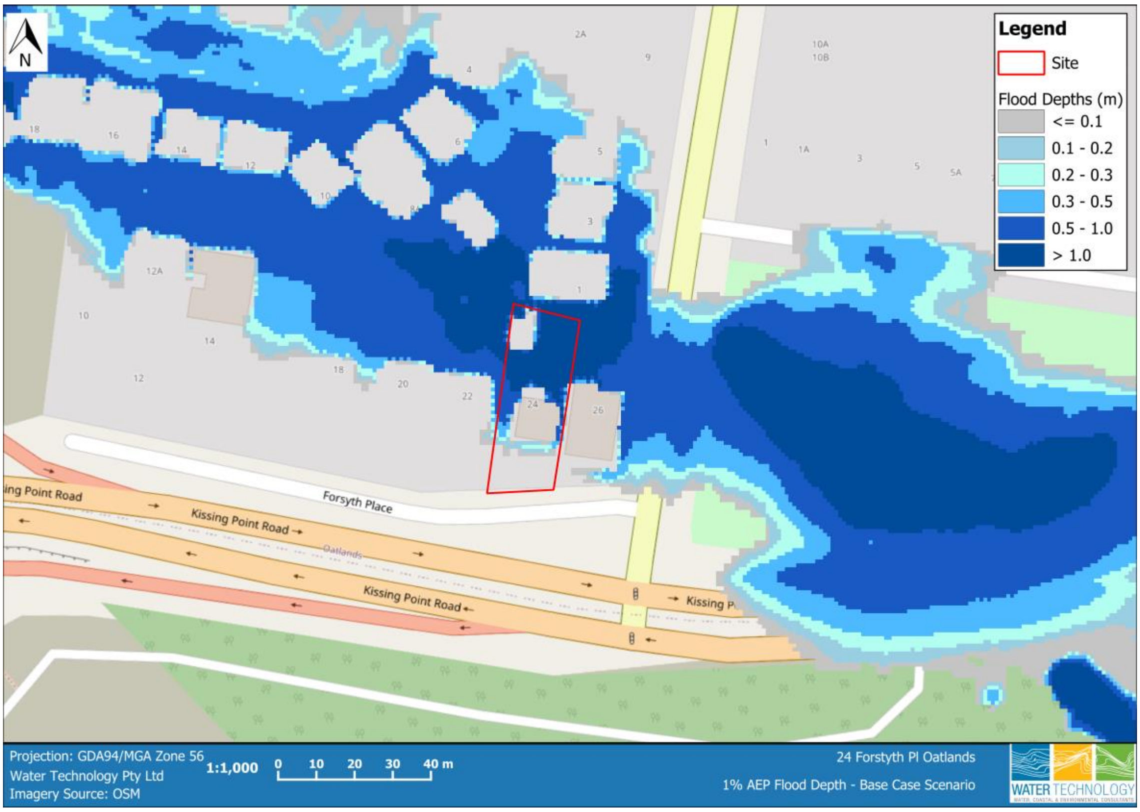

Figure 3-2 1% AEP Base Case Flood Depths

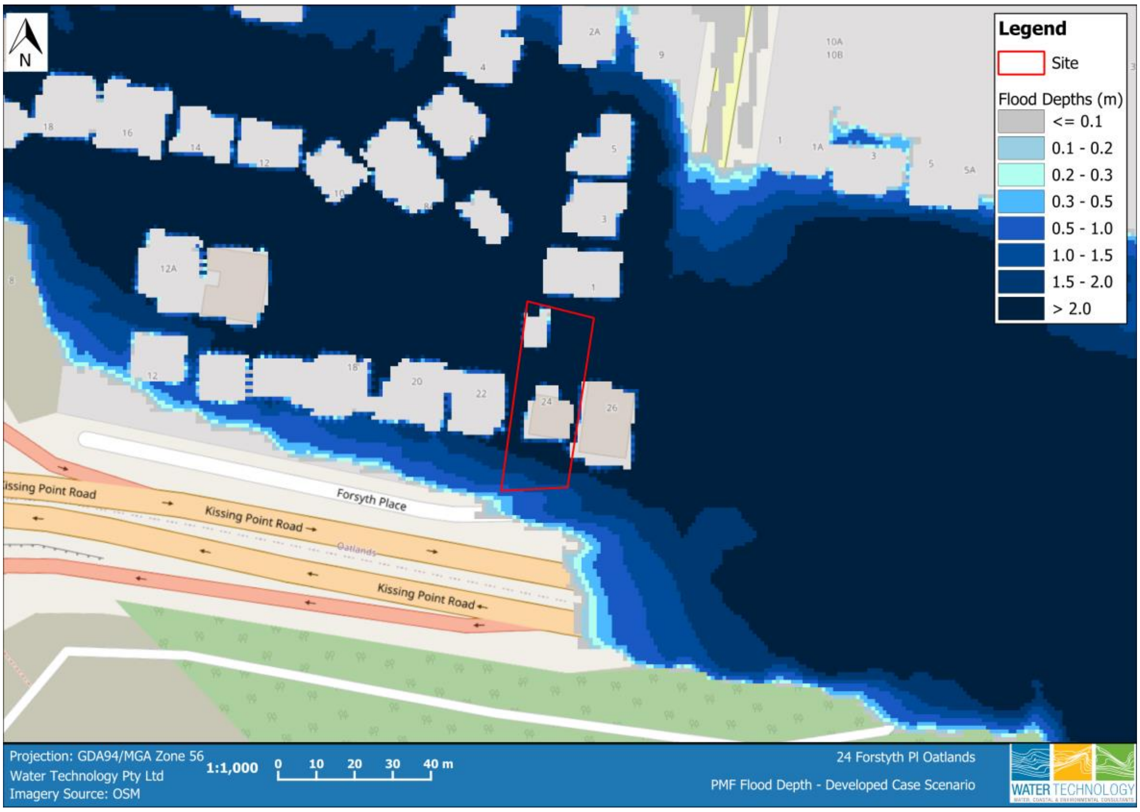

Figure 3-3 PMF Base Case Flood Depths

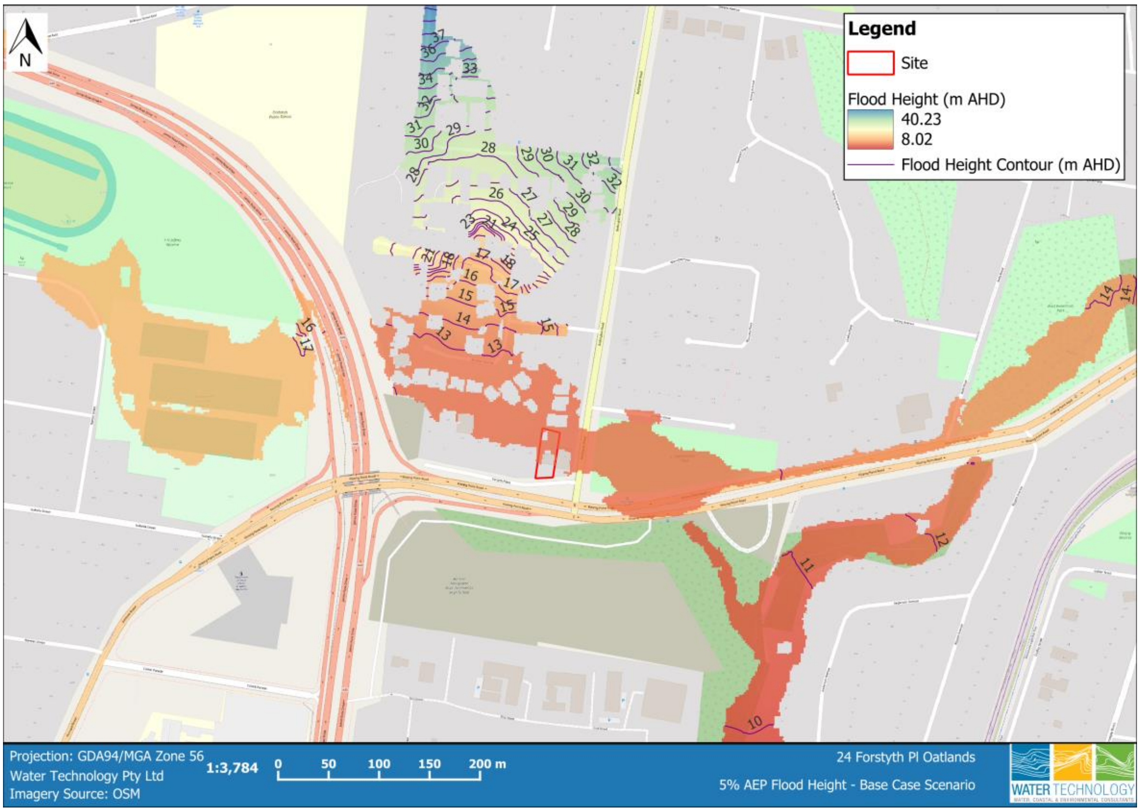

Figure 3-4 5% AEP Flood Height – Base Case Scenario

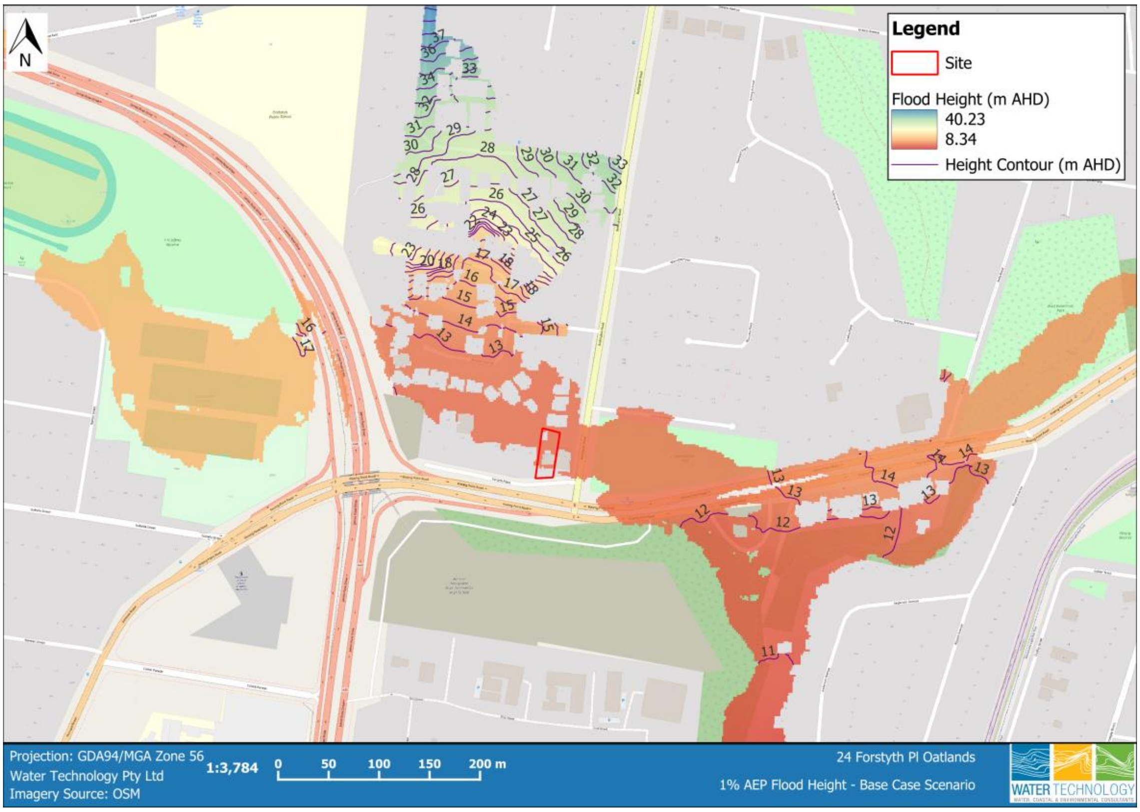

Figure 3-5 1% AEP Flood Height – Base Case Scenario

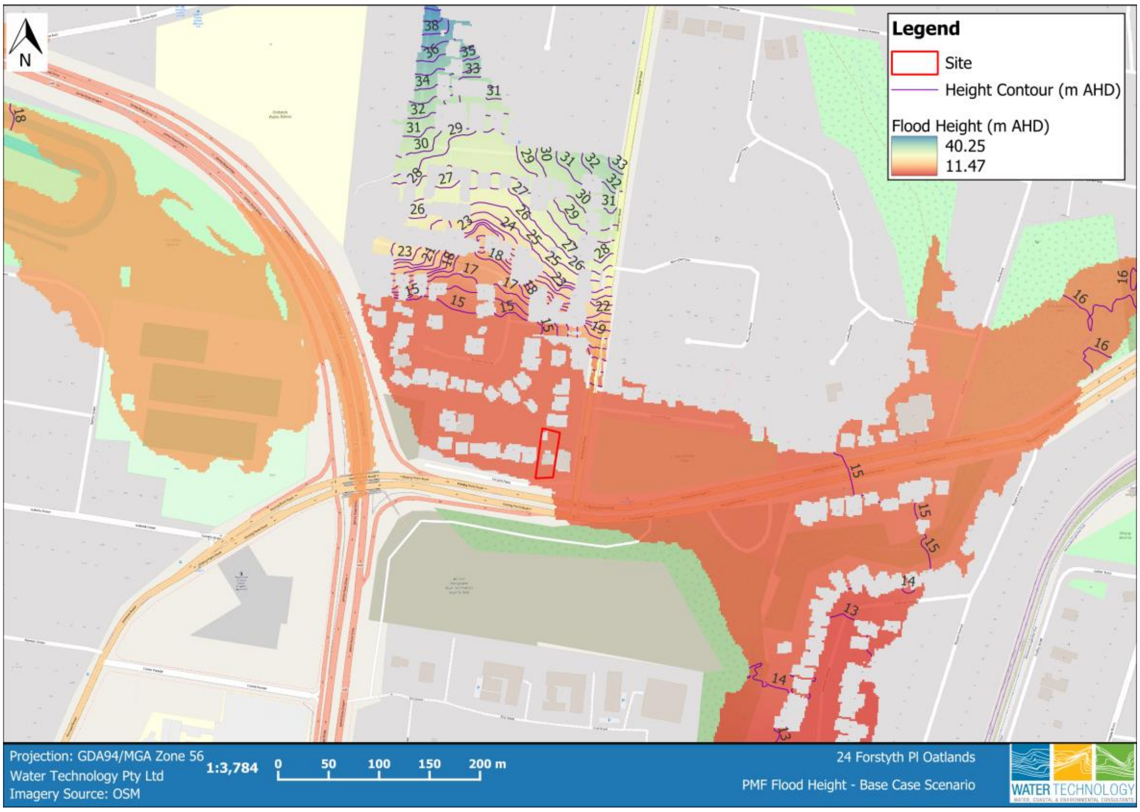

Figure 3-6 PMF Flood Height – Base Case Scenario

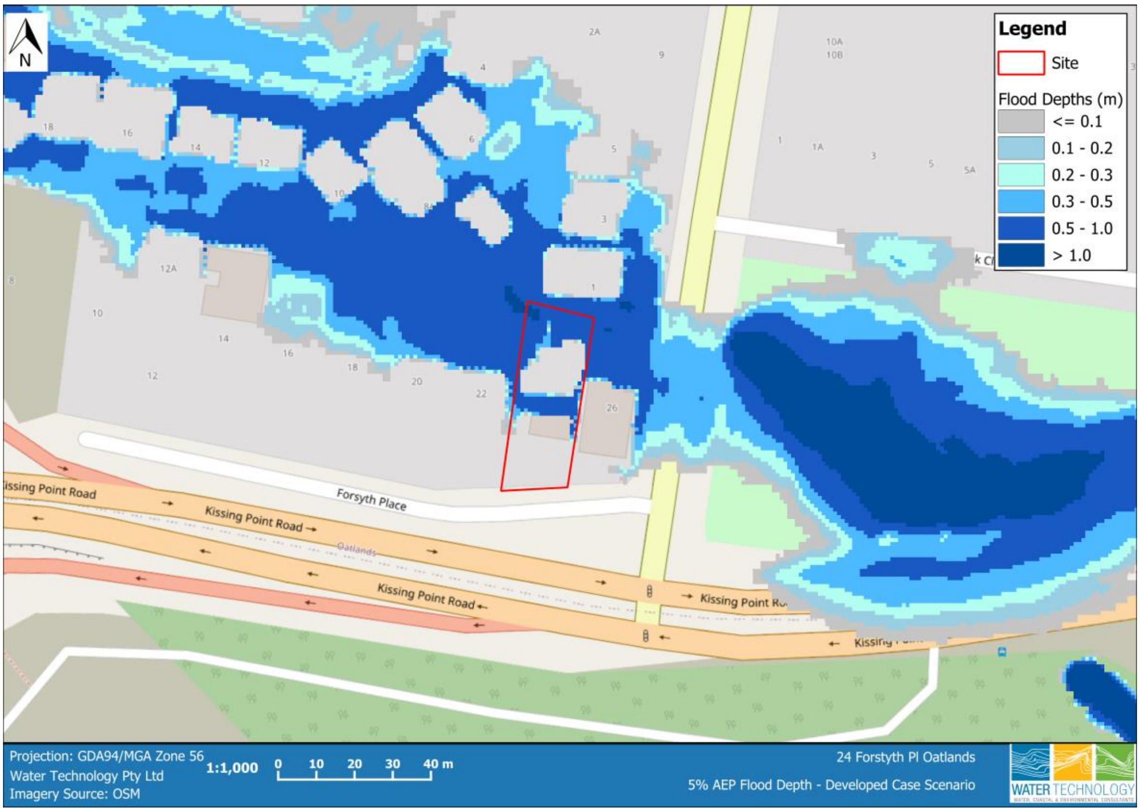

Figure 3-7 5% AEP Developed Case Flood Depths

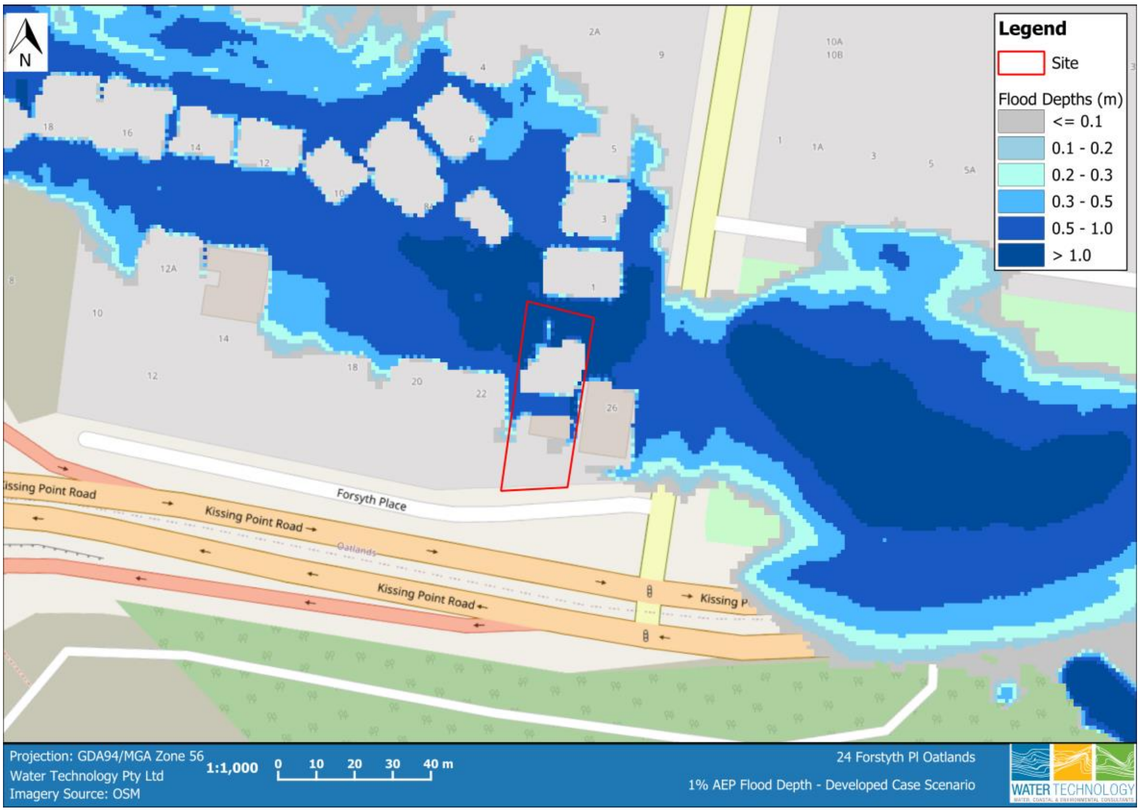

Figure 3-8 1% AEP Developed Case Flood Depths

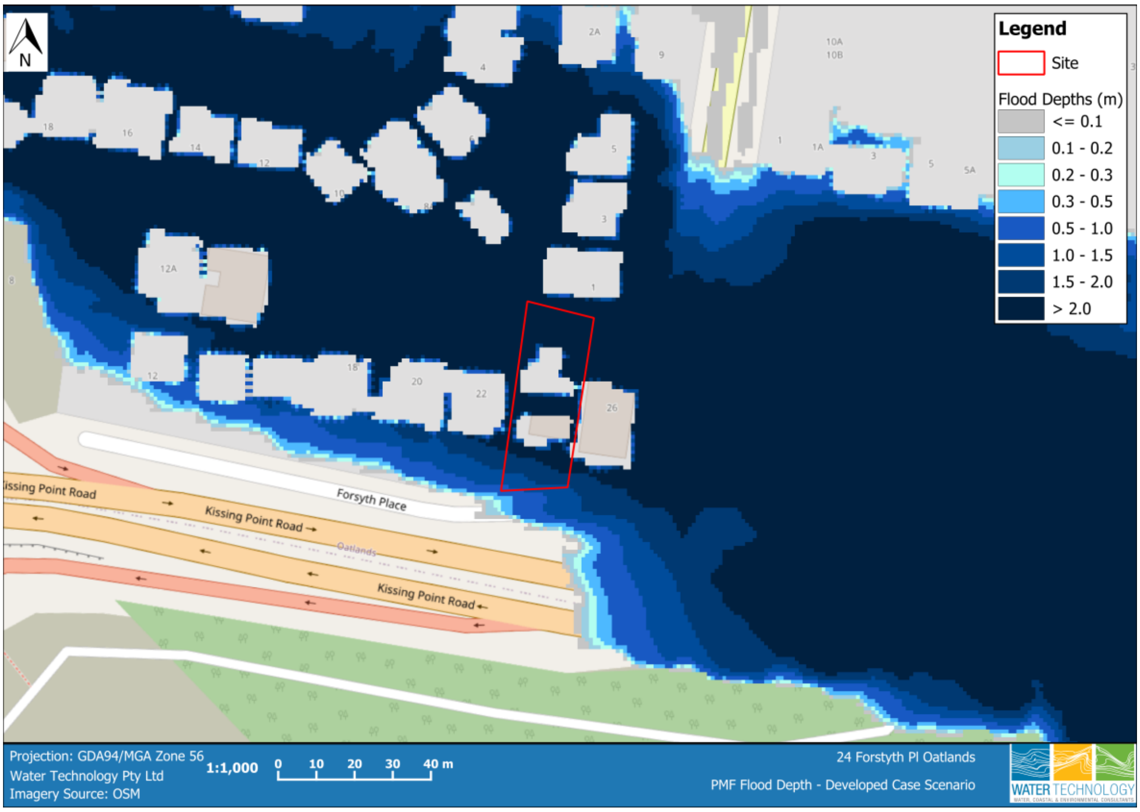

Figure 3-9 PMF Developed Case Flood Depths

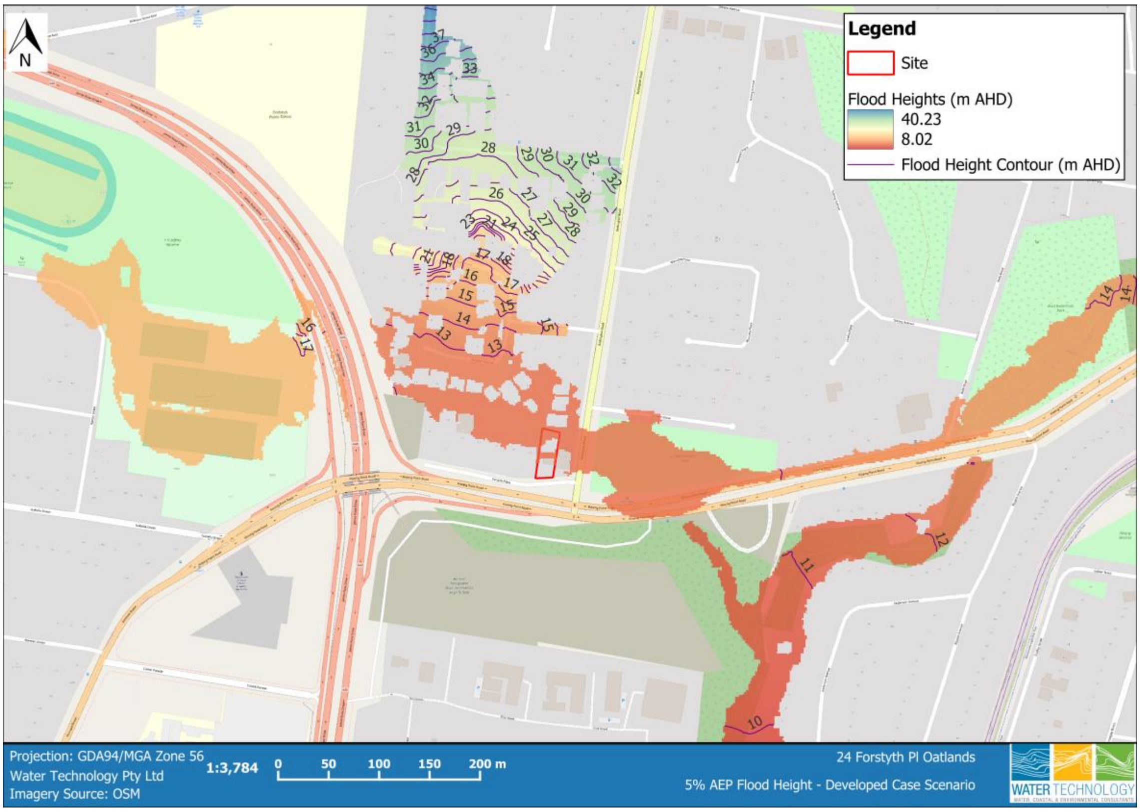

Figure 3-10 5% AEP Flood Height – Developed Case Scenario

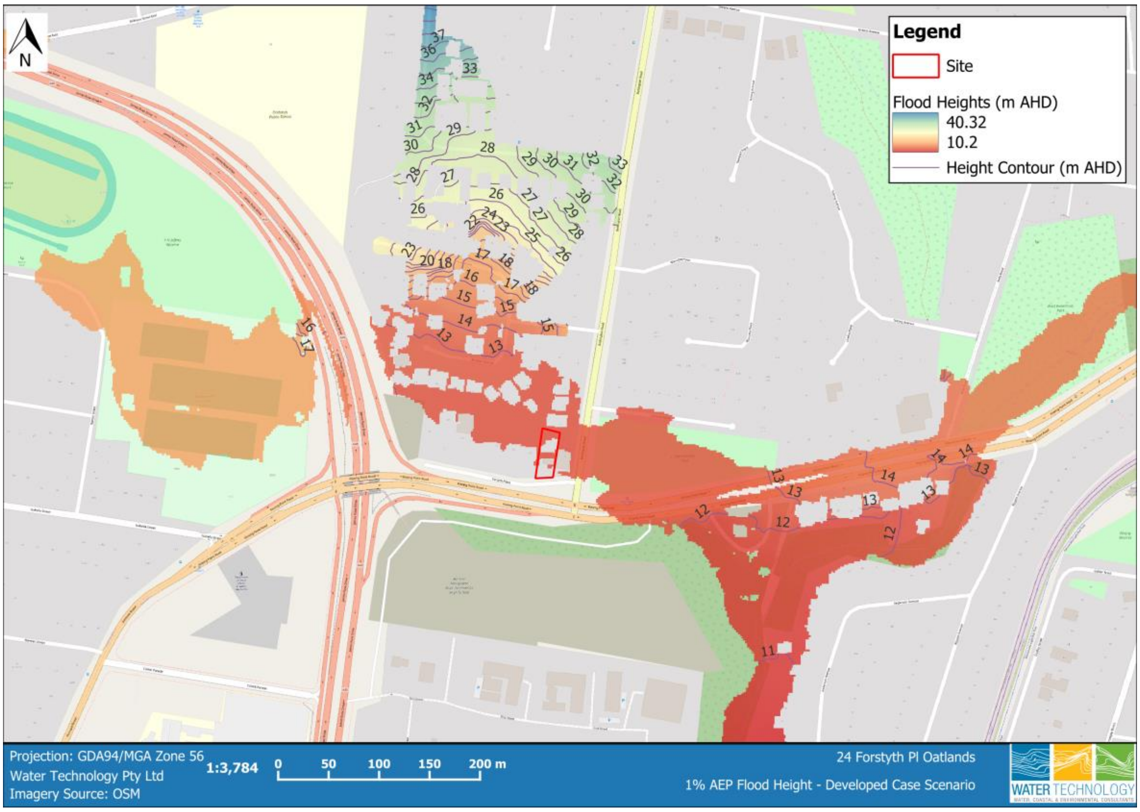

Figure 3-11 1% AEP Flood Height – Developed Case Scenario

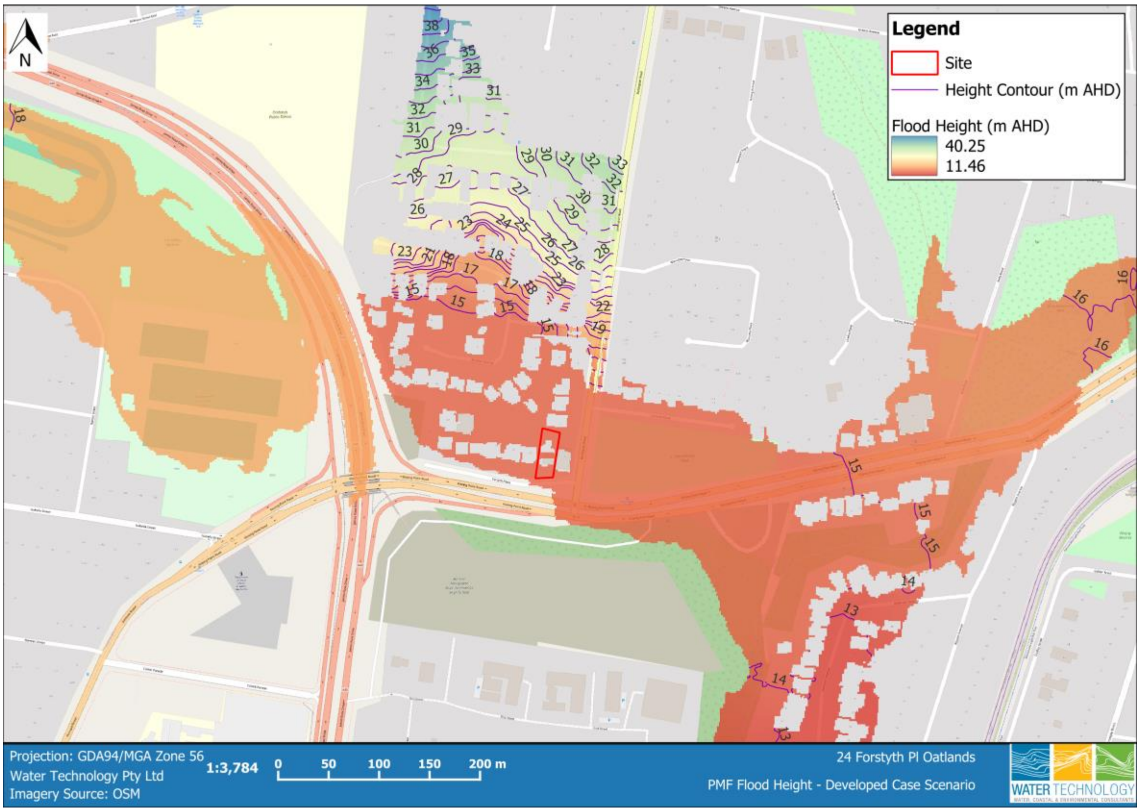

Figure 3-12 PMF AEP Flood Height – Developed Case Scenario

3.3 Flood Height Difference

The base case and developed case water elevations results were compared for the 5% AEP, 1% AEP and PMF events in order to highlight the impact of the proposed development on the surrounding area and properties. The comparison was determined by subtracting the base case condition water level from the developed case and comparing the difference.

Flood difference results for all events indicate an increase in flooding upstream of the proposed development.

The most extreme impact is visible within the 5% AEP event, with an increase of 50mm visible behind the retaining wall of the development, resulting in further increases in flood levels to the north and west of the development of between 10mm - 30mm. The 5% AEP event results indicate a small benefit shown downstream at the stormwater outlet location of 20mm. This is not shown within the 1% AEP or PMF events.

Within the 1% AEP event results, a small increase of 10mm is shown behind the retaining wall within the garden. Increase upstream of the property are shown to be less than 10mm (there is a 7mm increase throughout this area up towards Brokers Street to the north).

Results of the PMF event indicates very minor changes to the flood levels within the site and adjoining properties. Review of the results indicates this is likely due to the flood depths being greater than the size of both the retaining wall and the pool terrace and as such, these are both overtopped. As such, there is less impact to the flow route within the PMF event and therefore less impact to flooding in the surrounding area.

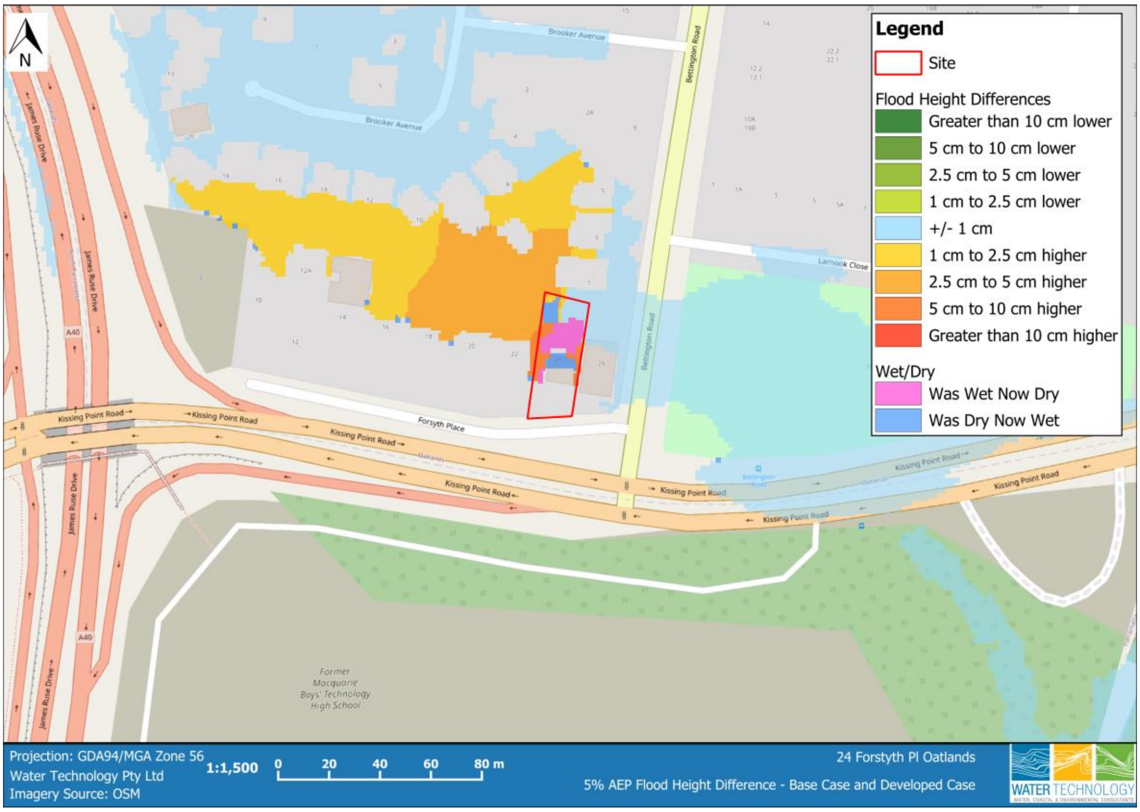

Figure 3-13 5% AEP Flood Differences between the Base Case and Developed Case Scenarios

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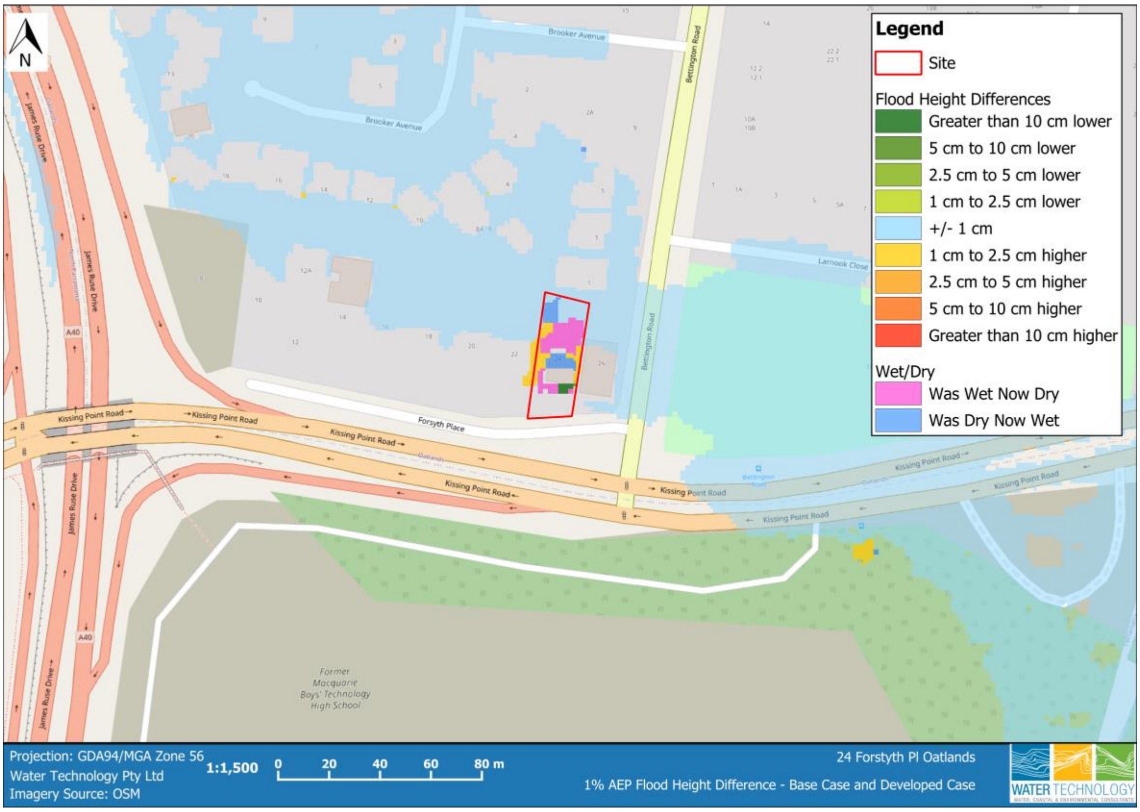

Figure 3-14 1% AEP Flood Differences between the Base Case and Developed Case Scenarios

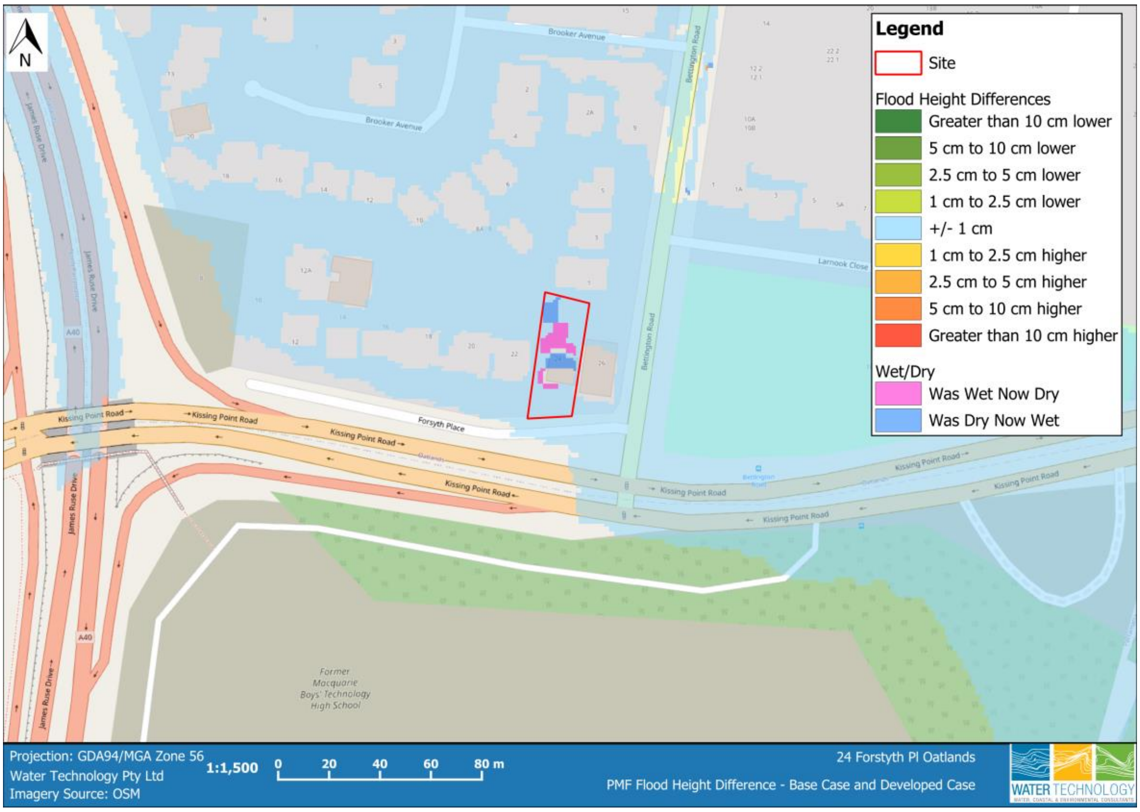

Figure 3-15 PMF Flood Differences between the Base Case and Developed Case Scenarios

3.4 Flood Hazard Ratings

Flood hazard is used to determine if overland flows are considered safe for people and vehicles to evacuate during a flood event. The recommended criteria for assessing flood hazard are outlined in ARR2019 and the Australian Emergency Management handbook. The flood hazard curve, shown in Figure 3-16, specifies safety/risk levels for floodplain management.

The behaviour of flood waters within the proposed development are located within an area of H3 in the 5% AEP and 1% base case scenarios (Figure 3-17, Figure 3-18, Figure 3-19, Figure 3-20). This does not increase with the inclusion of the proposed development, with H3 still the prominent rating within the site and surrounding area.

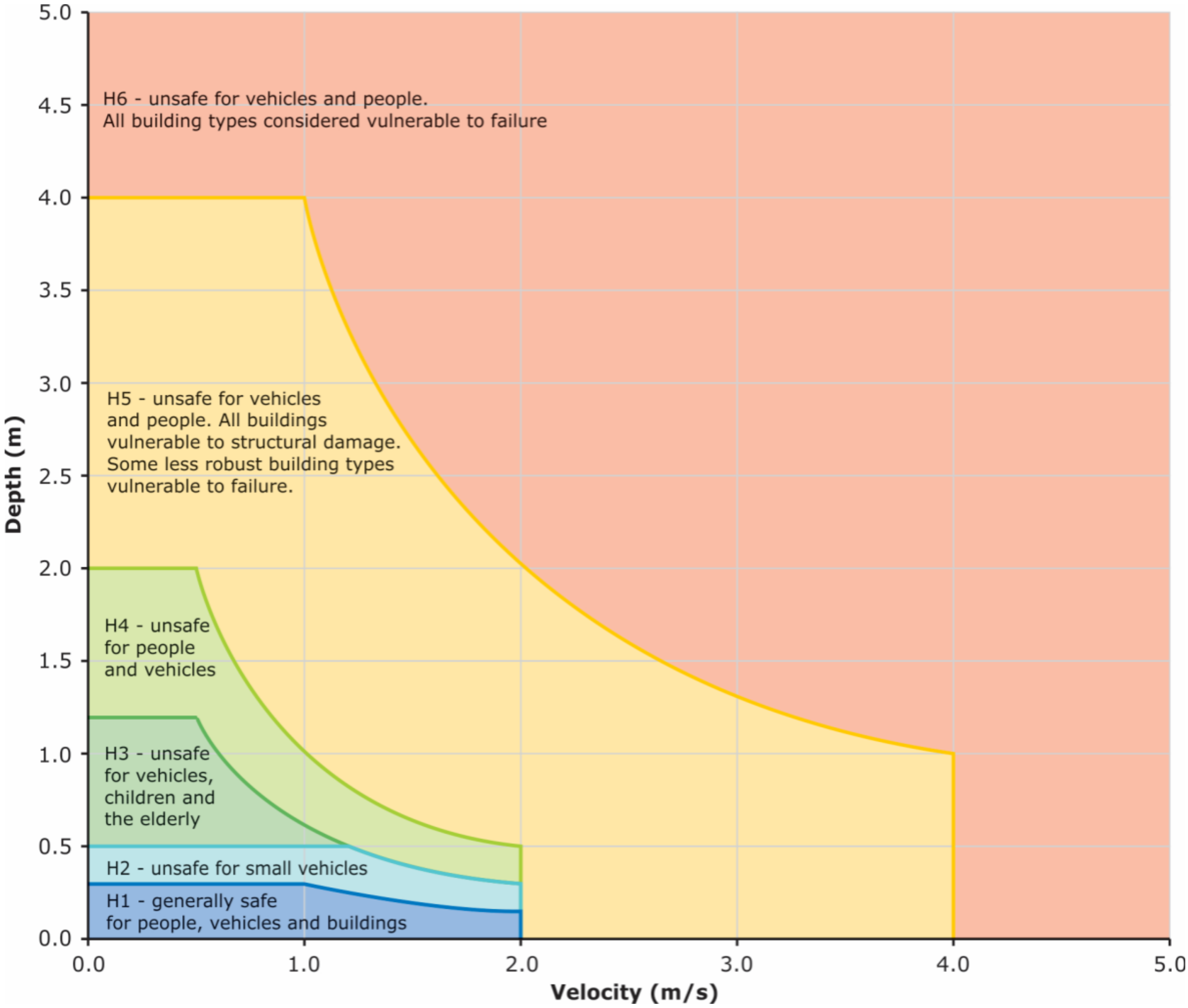

Figure 3-16 Flood Hazard Curves (Smith et al., 2014)

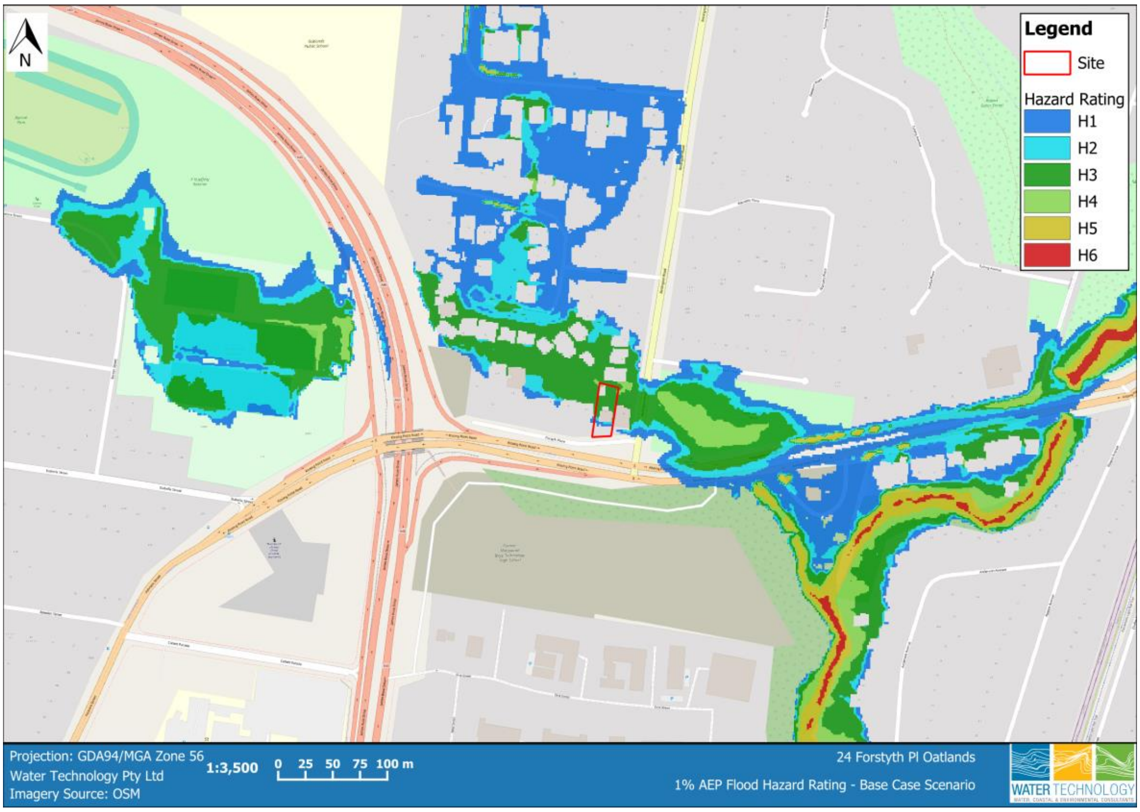

Figure 3-17 1% Base Case Scenario Hazard Rating

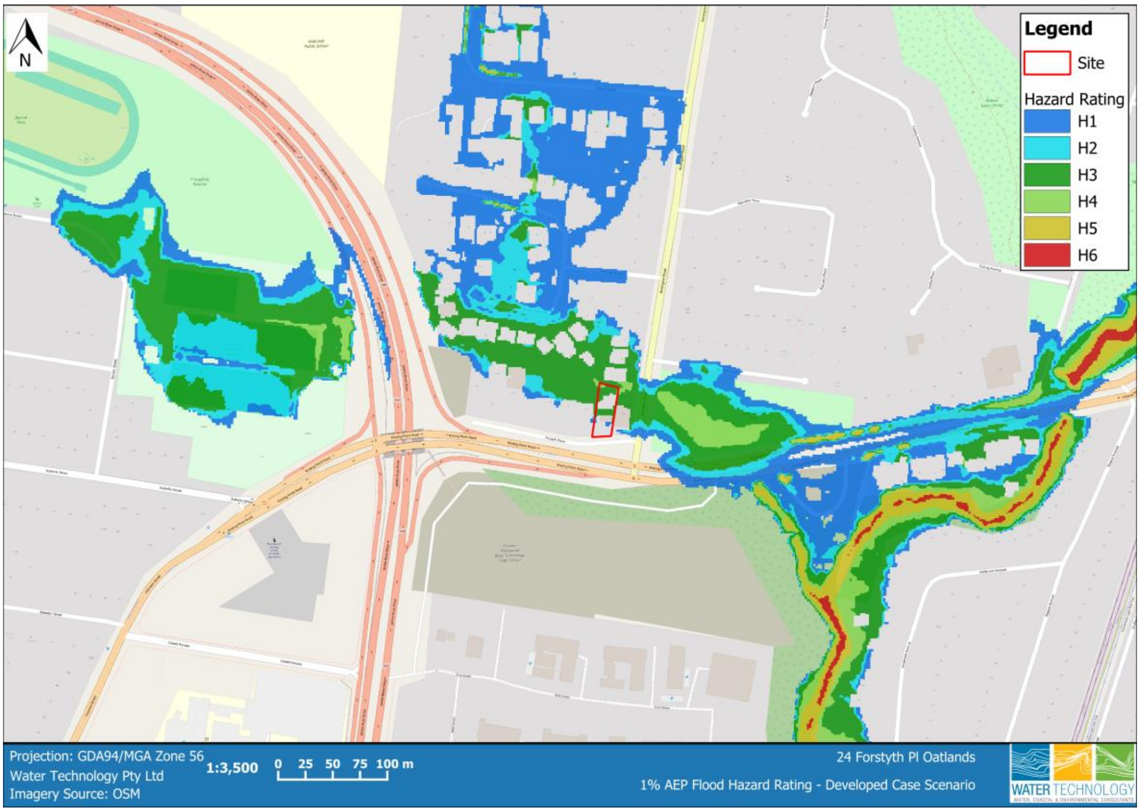

Figure 3-18 1% AEP Developed Case Scenario Hazard Rating

Figure 3-19 5% AEP Base Case Scenario Hazard Rating

Figure 3-20 5% AEP Developed Case Scenario Hazard Rating

4 SUMMARY

A hydraulic model was developed to assess the impact of the proposed development at 24 Forsyth Place, Oatlands on flood risk to the surrounding area and properties. A hydrological model was created utilising a WBNM approach to simulate rainfall adjusted as per council specific requirements. The 1% AEP, 5% AEP and PMF events were simulated for use within the hydraulic model.

The hydraulic model employs TUFLOW software to assess the impacts on flooding. Topography was obtained from 1m LIDAR for the area, with topographic edits incorporated for building footprints. The stormwater network was requested from the council but was not submitted in time and as such, the network was assumed based on flood and network mapping provided by council previously.

A base case scenario was created using the previously knocked down house and shed footprint, while the developed case included the new proposed building and pool area, and the presented onsite stormwater system.

The critical duration was determined using the base case scenario, with the critical durations determined used within a 100% blockage scenario for the base and developed cases as required by council.

Results for the 1% AEP, and 5% AEP events indicates an increase in flooding upstream of the development across all events. The most significant impact was observed during the 5% AEP event, showing a 50mm increase in water levels behind the retaining wall impacting properties to the west and north of the site. Additionally, slight improvements are noted downstream for the 5% AEP event. The 1% AEP event results exhibit a smaller but still notable increase to water levels, particularly affecting the northern area.

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