2 and 2a Bullecourt Avenue, Milperra
Flood Impact and Risk Assessment

Client
Mirvac Residential (NSW) Development Pty Ltd

Issued
20/03/2026

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Project Management

Revision Table

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B	Update per Client Comments & Issued for DA	**27/08/2025**	**SG**
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E	Draft Issued to Client for Review	**17/03/2026**	**SG**
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1 INTRODUCTION

This Flood Impact and Risk Assessment is submitted to the Department of Planning, Housing and Infrastructure (the Department) on behalf of Mirvac Residential (NSW) Pty Ltd (the Applicant) in support of a State Significant Development Application (SSDA) for a staged residential development at 2 and 2A Bullecourt Avenue (the site). The assessment has been conducted in accordance with the *Guidelines for Development in Flood Affected Areas (DELWP, 2019)* and *Flood Risk Management Manual, Department of Planning and Environment* (June 2023).

Proposed works will be carried out in stages with the ultimate development to include up to 430 small and medium sized residential lots, commercial lots, three active open space area (two which contain stormwater management facilities), and one drainage reserves to include on-site detention (OSD) and water sensitive urban design (WSUD) infrastructure. Staging details including a staging plan are provided in **Section 3.2**.

1.1 Objective

The objectives of this report are as follow:

- Carry out hydrology modelling to assess the flood behaviour in and around the site for the existing and proposed conditions
- Determine if the proposed development results in offsite flood impacts
- Prepare an evacuation management strategy with consideration to the modelled flood behaviour of the site in line with local emergency management plan
- Assess any additional flood risk and provide appropriate mitigations
- Assess the potential effects of climate change

The flood conditions have been assessed with consideration to local flooding and regional flooding, modelling details are provided **Sections 5** and **6**, respectively. The intent of the local flooding assessment is to assess overland flows within and around the site as well as impacts to surrounding areas resulting from the proposed works, this model was based on the Kelso Swamp flood model provided by Council. The intent of the regional model is to understand the implications of the development with consideration for the backflows from George's River which the site is subjected to, modelling and reporting was prepared by JWP (2023). Each of these flooding scenarios, local and regional, have been modelled separately given that the mechanisms and timing of each are independent; the implications of each are considered both independently and wholistically; the discussion is presenting in **Section 7.**

This report is to be read in conjunction with the following documents:

- Stormwater Systems Report, City of Canterbury Bankstown, 09 Jul 2025 (**Appendix A**)
- Flood and Risk Impact Assessment, J. Wyndham Prince, Rev C May 2023, and addendum letter dated 13 Nov 2023 (**Appendix F**)
- Water Cycle Management Strategy, Beveridge Williams, dated 14 Nov 2025

2 RELEVANT REQUIREMENTS

2.1 SEARs

This Flood Impact and Risk Assessment addresses the following relevant Secretary's Environmental Assessment Requirements (SEARs) set out in the table below.

Table 1: SEARs Compliance Table

SEARS REQUEST		RESPONSE / LOCATION IN REPORT
The flood extent and velocity up to the Probable Maximum Flood and risk on-site having regard to adopted flood studies and, floodplain risk management studies and plans		**Appendix B** and **Appendix C** show the flood depth, flood velocity and flood hazard category up to PMF.
Evacuation and egress routes		**Section 8.1.1** and **Figure 12**
The potential effects of climate change		**Section 8.3**
Any relevant provisions of the NSW Flood Risk Management Manual, and any other relevant guidelines	*Canterbury-Bankstown Development Control Plan Chapter 2.2, Schedule 3* Habitable floor levels to be no lower than the 100-Year flood level plus freeboard.	DCP, Ch 2.2, Schedule 3 specifies flood effects item 3 as the only additional control for subdivision land-use; per item 3, flood impacts have been addressed in **Section 7.2**. Flood storage is addressed in the WCMP prepared by BW, 2025. The proposed development has also been designed with consideration for future residential land-use, as such the habitable floor levels, accordingly The future finished floor levels of the houses will be above the Flood Planning Level (FPL) based on the 1% AEP flood level of 5.55 m AHD reported in the JWP FIRA and 500mm freeboard (see **Section 6,** full report provided in **Appendix F**) (i.e. FPL = 5.55m+0.5m=6.05m). Evacuation requirements have also been assessed with discussion provided in **Section 8**.
Flood effects item 3	*Canterbury-Bankstown Development Control Plan Chapter 2.2, Schedule 3,* Flood impacts to be considered in the case of major development if Council advise that the development may generate flood impact, such as significant loss of storage or conveyance. Any assessment may also be asked to demonstrate that the proposed development is structurally sound.	The assessment of flood Impacts to adjoining properties is provided in **Sections 7.2.** The assessment of Compensatory Storage is provided in the WCMP Report (2025). All retaining walls will be designed structurally and will be designed to meet the stormwater flow velocities of all flooding events.

2.2 SSDA1 Feedback

Table 2 provides a response to relevant comments received from Canterbury-Bankstown Council (Council), State Emergency Service (SES), Conservation Programs, Heritage and Regulation Group (CPHR) and the Department of Planning, Housing and Infrastructure (DPHI) following the SSDA1 submissions. It is recognised that the submission comments did not consider the Regional Flood Impact Assessment prepared by J Wyndham Prince (JWP) as part of the rezoning. This report was missing from the original submission. This report has now been incorporated into this updated report which helps address most agency comments.

Table 2: SSDA1 Feedback

COMMENT		RESPONSE
Council Submission Comments	Flooding • A detailed assessment shall be undertaken by comparing the pre- and post-development 1% AEP peak flood levels at the Ashford Avenue and Flanders Avenue intersection against the surveyed property levels of No. 1 and 2 Flanders Avenue. This is to confirm that any increase in post-development flood levels does not encroach onto these residential properties, as currently shown in Figure C4. If adverse flood impacts are found within these properties, appropriate mitigation measures shall be implemented as part of the proposed development to ensure there is no worsening of existing flood conditions for these residential properties. • Clarify why rainfall was excluded from the residential lots in the modelling of the post-development scenario	Additional details of the afflux assessment is provided in **Section 7.2.1** which notes water level increases of 4-6 cm encroaching within the 1 Flanders Ave building footprint are demonstrated; this is a consequence of limitations of the modelling which does not include modelling of the building walls. A cross-check with Google Street View demonstrated no water level increase occurs at the garage door or at other entrances to the house therefore no additional damage above the floor levels is anticipated from these water level increases. With respect to 2 Flanders Ave, afflux is maintained within the adjacent unopened road and reserve and not within the property boundary. See **Section 5.1** - Hydrology was based on a catchment area for the entire site (including lots and roads) and for the post-developed scenario, applied as rainfall concentrated within the roads only, not lots; this approach produces maximum flows (worst-case) for areas of interest, i.e. roads and public spaces as well as downstream locations of concern noted by Council.
	Note to Development Engineer: • There is an increase of flows discharged through the M5 Motorway culverts during the 1% AEP event. Recommend applicant to liaise / seek approval from TfNSW	Basins reduce flows to less than pre-developed flows in all storm events, this is noted in the WCMP (BW, 2025). Conservative flood modelling results (which assumed all basin outlets are blocked) demonstrates a flow increase of 0.05 m^3/s (50L/s) for the 1% AEP event through the M5 culverts, this equates to less than 0.5% increase compared to existing flows (approx. 12 m^3/s) (12,000L/s) through these culverts. This is considered acceptable because it is only a result of emergency flow in the case of a catastrophic blockage.
	Applicant is required to demonstrate that the proposed lots are capable of achieving an FFL for the future dwellings at minimum or above	The final Civil Plans demonstrate the FFL for each lot and considers the FPL. See **Section 6** - The future finished floor levels of the houses will be above the Flood Planning

COMMENT		RESPONSE
	the Flood Planning Level (FPL) which is 0.5m freeboard above the 1% AEP flood level.	Level based on the 1% AEP flood level of 5.55 m AHD reported in the JWP FIRA (provided in **Appendix F**) (i.e. FPL = 5.55m+0.5m=6.05m). The minimum top of slab level in the SSDA1 submission is for Lots 1206, 1207 and 1208 which has a Level of 6.185 which is 0.135m above the FPL. It is noted that in the future SSDA2 application, future Lot 4111 will have the same slab level of 6.185. All other lots in SSDA2 have a top of slab levels above RL7.205 which is 1.155m above the FPL.
	Refer to Section 5.1 of Civil Engineering Design Report, Version A issued on 30/7/2025 by BW – clarification is required on the determination of the 1% AEP flood level of the site being RL 5.55m AHD and whether it is consistent with Council's Stormwater System Report.	Determination of the 1% AEP flood level of 5.55 m AHD is based on the JWP FIRA (provided in **Appendix F** which is more conservative that the level specified in the Stormwater System Report. It is noted that Council's Stormwater Systems report includes levels of the Overland Flow on the existing site not just the local flooding levels based on the local Kelso Swamp flood model. It is further noted that the SSR does not consider the regional Georges River Flood levels. As such, the SSR can be considered irrelevant for this assessment.
	71. The following are comments related to the Civil Engineering Plans, • Management Plan shall be required to prevent usage of sports court and fitness zone at Basin No. 1 during rain or flood event • Flood signs shall be installed at/proximity of all basins and floodways	Flood risk management for basin 1 is discussed in **Section 8.2**. Flood signs will be installed to advise that the area is susceptible to flash flooding and use during storm events is not advised. Flood signs are shown in the plans to be provided in all basins.
Conservation Programs, Heritage and Regulation Group Submission Comments	**Emergency Management** The FIRA proposes off-site self-evacuation as the primary emergency management strategy which is facilitated by an internal road network that provides rising access to flood-free land. However, CPHR's review of the flood hazard mapping indicates that one internal street is subject to high flood hazard (H5) during the probable maximum flood (PMF). Under H5 conditions, vehicle access would be unsafe and residents who have not evacuated prior to flood hazard reaching H2 would become isolated. CPHR notes that the flood hazard mapping was derived using general flood hazard vulnerability curves which provide a practical and widely adopted tool for assessing hazard levels for people, vehicles, and buildings by using a single consolidated set of curves. CPHR advises that a more detailed assessment of an individual hazard category is required.	Flood model results have been assessed with consideration for vehicle evacuation; all internal roads are demonstrated to be hydraulically safe for vehicles up to the PMF for local storms (see **Section 8**). Additional assessment of overland flow within the road carriageways was carried out for critical locations which confirmed conditions to be hydraulically safe for vehicles (see **Section 5.3**). In the regional storm event, the lower roads are inundated as a result of the backwater effects from the Georges River but evacuation will occur prior to these becoming inundated – the overland flow for evacuation routes will be no different than in the local PMF storm.
SES	Advise the consent authority to request that a fit for purpose FIRA, consistent with the NSW	The FIRA uses a combined impacts assessment approach. The assessment considered JWP

COMMENT		RESPONSE
	Government Guidelines,2 is resubmitted to consider: • flood risks from all flooding mechanisms impacting the site, including mainstream flooding of the Georges River; • the full range of flood events (from the more frequent ones and up to and including the PMF); • time to onset and duration of inundation of any flooding; • flooding impacts on access/egress roads, including any proposed internal roads and any risk of isolation. The analysis of the impact of flooding on the roadways should go beyond immediately adjacent to the site to fully understand any isolation risks and evacuation constraints.	reporting (provided in **Appendix F** , see summary in **Section 6**) of backwater flows from George's River, overland flows were considered separately using results from TUFLOW modelling and manning's 'n' overland flow calculations (See **Section 5**) which included modelling up to the PMF and climate change sensitivity assessment. The evacuation strategy is documented in **Section 8.1.1** which discusses: • time to onset and duration of inundation of any flooding • flooding impacts on access/egress roads • risk of isolation • demonstrates self-evacuation is achievable up to a PMF event, connecting into the designated SES evacuation route via Beaconsfield Street
	Note the Council adopted studies are 16 years old (Kelso Stormwater FS) and 21 years old (Georges River FSMP) and recommend referring to the Georges River Flood Study (BMT, 2020) to ensure the best available information is used to determine the flood risk on the site and inform appropriate mitigation measures. This study indicates that the southern part of the proposed development site is impacted by flooding that can exceed 5 metres depth and H6 flood hazard level in a Georges River Extreme Flood Event scenario, while the current FIRA notes that in the modelled overland flow PMF event the site experiences a maximum depth of 2.2 metres in the south-western part and H5 flood hazard level.	The original BW report addressed Local Flooding as requested by Council in all pre-development discussions. The JWP FIRA prepared for the Rezoning addressed the regional flooding but was not originally provided as part of this SSDA submission. The updated FIRA (this document) uses a combined impacts assessment approach with consideration for both local and regional flooding (see **Section 4** and **5**, respectively) Modelling reported in the JWP FIRA (provided in **Appendix F** , see summary in **Section 5**) is based on the Georges River Flood Study (BMT, 2020). Discussion is presented in **Section 7**
	Recommend consulting with the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) in relation to the modelling approach and regarding the impacts of the proposed development on flood behaviour at the site and adjacent areas, noting that the proposed site filling disturbs the overland flow resulting in localised water level increases at the intersection of Flanders Avenue and Ashford Avenue.	See **Section 7.2.1** - Flood behaviour for the developed condition is demonstrated to be largely consistent with that in the existing condition. While some water level increases were noted in the developed condition for the 1% AEP event, there is no loss of trafficability along Ashford Avenue. Hazard levels were reduced from H5 to H4 for a large area in Ashford Avenue for the developed condition.
	Note the FIRA proposes a shelter in place strategy for lots affected by inundation, and advise that the strategy of isolation or sheltering in buildings surrounded by flood water are not equivalent, in risk management terms, to evacuation and it should not be used to justify future development… we advise that noting the different flood mechanisms and durations	See **Section 8** – the emergency management strategy does not propose shelter in place. The assessment demonstrated self-evacuation is necessary and achievable for all residents up to a regional PMF event, this is consistent with existing emergency management strategies for the area.

COMMENT		RESPONSE
	affecting the site this development is not suitable for sheltering in place. Should shelter in place be proposed, the consent authority should request the proponent to demonstrate consistency with the Shelter in Place Guideline, prior to granting consent…	For the Local PMF Event, the PMF level is RL6.16 which is below the Finished Floor Level of the lowest residential lots. Where a flash flooding local storm event occurs within 90 minutes residents can stay within their homes during this local PMF event.

3 BACKGROUND

3.1 Site Overview

The site is currently owned by Western Sydney University and is located within the Canterbury Bankstown LGA at 2 and 2A Bullecourt Avenue, Milperra, being legally described as Lot 2 in DP1291984 and Lot 1 in DP101147 (refer **Figure 1**).

The total site has an area of approximately 19.64ha and is the subject of numerous easements affecting the site, including two easements to drain water, easements for electricity and other purposes, and a right of carriageway.

Since the demolition of the previous buildings on the site, the site currently comprises:

- Existing at-grade car park (within Zone 4) repurposed as parking and hardstand area for the temporary sales office.
- Existing at-grade car park for the Childcare Centre (generally within the location of the future Road 2B).
- At-grade roads off Bullecourt Avenue.
- A large oval to the south.
- The Western Sydney University Early Learning Centre (Child-care centre).
- Vegetation of varying significance, including Cumberland Plain Woodland.

The site is bound by the M5 Motorway to the south, Ashford Avenue / existing residential dwellings to the west, Bullecourt Avenue / existing industrial development to the north, and Horsley Road / existing industrial development to the east. Adjoining the site along the southeastern boundary is Mount St Joseph Catholic College.

A substantial number of bus stops are located along Bullecourt Avenue and Horsley Road, servicing routes that connect passengers both within and beyond the LGA, including direct links to Bankstown Central (approximately 8.5km drive from the site), Westfield Burwood, and Westfield Miranda. While the nearest train line is the T8, accessible via East Hills, Panania, and Revesby stations, the T6 line at Bankstown Station can also be reached via bus services operating near the site.

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Locality Plan

Figure Number: 1

Rev: 1

0 100 200 300 m

3.2 The Proposed Development

The project will be delivered in stages and across two separate SSDA Projects, and comprises the construction of approximately 385 dwelling houses, dual occupancies and attached dwellings, three (3) public parks, new roads and shared paths, civil infrastructure, a car park, and the management of conservation land.

Specifically, across the two SSDAs, consent is sought for:

- Tree removal
- Site remediation (excluding works carried out as category 2 remediation works)
- Construction of bulk earthworks, public roads and landscaping, and services
- Augmentation of existing services and road infrastructure
- Construction of three (3) public parks
- Construction of 385 dwelling houses
- Construction of a carpark to service the existing childcare centre and E1 Local Centre zoned land
- Subdivision resulting in 385 residential lots, infrastructure lots, and the creation of a community title lot for land zoned C2 Environmental Conservation and E1 Local Centre
- Conservation works including the management of >2Ha Cumberland Plain Woodland Species.

This SSDA comprises all civil works across the entirety of the site as well as the construction of all 62 dwellings in Stages 1 and 2 only, which are as follows:

- Stage 1 – Commencement of site-wide tree removal and land remediation, creation of two (2) super lots and total of 22 residential lots, and construction of 22 dwelling houses fronting Ashford Avenue. This will be the first stage to be delivered and will connect into the existing infrastructure that located within Ashford Avenue.
- Stage 2 – Creation of four (4) super lots, a new lot (Lot 25) across the RE1 Public Recreation zoned land, and 40 residential lots. This stage also involves the construction of 40 dwellings within Stage 2, and the construction of new roads and the new public park referred to in the Civil Plans as the 'Central Park'.
- Stage 3a – Creation of a new super lot, and the construction of perimeter roads surrounding the existing childcare centre, construction of a new car park to service the childcare centre and C2 Environmental Conservation zoned land. It is proposed all associated civil works required to enable the operation of the existing childcare centre will be delivered under this stage. The new traffic intersections at both Bullecourt Avenue and Horsley Road will be constructed.
- Stage 3b – Creation of three (3) lots to be delivered under a Community Title Scheme for the E1 Local Centre zoned land.
- Stage 4 – Creation of eight (8) super lots, a new lot (Lot 50) across the RE1 Public Recreation zoned land, and a new lot (Lot 49) across the SP2 Infrastructure zoned land. This stage also involves the construction of new roads, the stormwater infrastructure Basin 1 and Basin 2, and the new public park referred to in the Civil Plans as the 'Southern Park', all to be dedicated to Council.
- Stage 5 – Creation of six (6) super lots and construction of new roads and civil works.
- Stage 6 – Creation of nine (9) super lots and a new lot (70) across the RE1 Public Recreation zoned land. This stage also involves the construction of new roads and civil works, and the new public park referred to in the Civil Plans as the 'Northern Park', all to be dedicated to Council.
- Stage 7 – Creation of six (6) super lots and construction of road and civil works.

The second SSDA will seek consent for all outstanding works in stages 3 to 7, which are as follows:

- Stage 3 – Construction of the Childcare Alterations and Additions and Construction of a permanent structure for Commercial use.
- Stage 4 – Creation of the subsequent subdivision into 107 residential lots and construction of dwellings.
- Stage 5 – Creation of the subsequent subdivision into 65 residential lots and construction of dwellings.
- Stage 6 – Creation of the subsequent subdivision into 92 residential lots and construction of dwellings.
- Stage 7 – Creation of the subsequent subdivision into 59 residential lots and construction of dwellings.

4 AVAILABLE DATA & SUPPORTING STUDIES

The following data was available and obtained for the flood impact and risk assessment.

- Rainfall on grid TUFLOW model of Kelso Stormwater Catchment provided by Council
- Detailed Survey conducted by BW on 28th February 2024 at the subject site (**Appendix A**)
- Design surface from BW for the proposed development.
- George's River Floodplain Risk Management Study and Plans prepared by Molino Stewart (2023)
- Site specific flood risk impact assessment prepared by J. Wyndham Prince (May 2023)

5 HYDRAULIC MODELLING – LOCAL FLOODING (KELSO SWAMP CATCHMENT)

The purpose of this modelling is to determine the flooding conditions to inform the emergency management strategy and evacuation procedures as well as the flood impacts external of the site resulting from the proposed development, specifically to the western neighbour and downstream of the site. Local overland flows were assessed using TUFLOW modelling based on the Kelso Stormwater Catchment Flood Model originally developed by BMT WBM Pty Ltd (2009) and provided by Council. TUFLOW is robust and widely accepted unsteady-state flood simulation software with combined 1D and 2D design capabilities. The procedures and model inputs for this assessment are consistent with the *Australian Rainfall and Runoff (2019)* and the *Floodplain Development Manual (2023*).

The 5mx5m grid size adopted from the 2009 TUFLOW model is a resolution that may not accurately capture abrupt changes in levels for example, in kerbs or retaining walls, further, modelling assumed the internal drainage system to be blocked; as such, hazards within internal roadways may not be accurately depicted and are expected to be overly conservative.

5.1 Model Inputs and Parameters

Modelling details retained from the 2009 model include rainfall data, the 5x5 grid resolution and offsite details including the DEM, roughness, as well as culvert and drainage networks. Updates to the provided model are noted below:

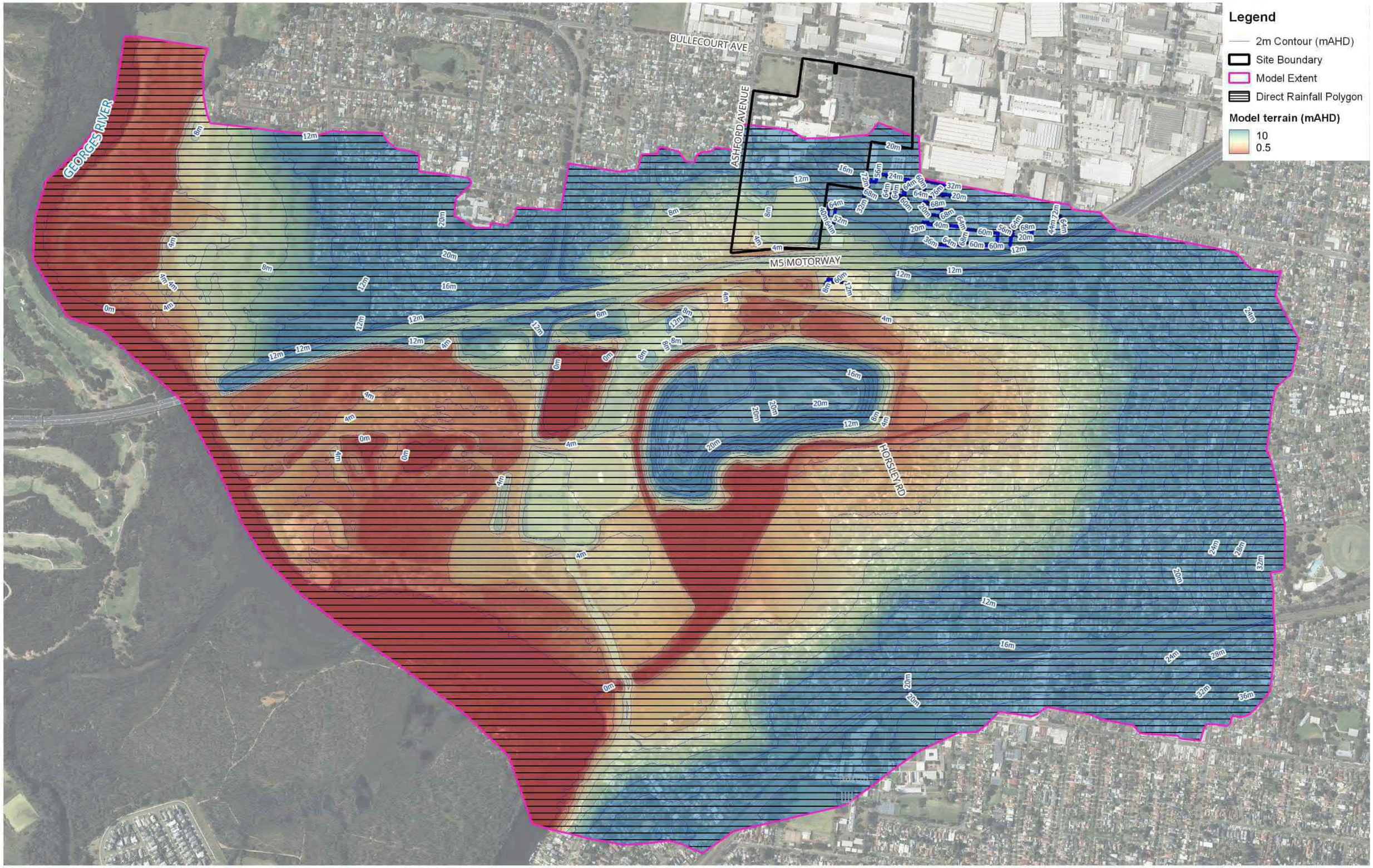
- Software Version – Upgraded TUFLOW engine software from 2008-08-DB to 2023-03-A
- Existing scenario
    - Incorporated latest site survey data conducted by BW, date on 28th February 2024 refer to **Section 4** this is because the original data was based on Lidar and not on actual Topographic survey data
- Proposed Scenario refer to **Section 3.2**
    - Integrated BW's design surface for the proposed development
    - Updated material layers to reflect proposed changes
    - Site inflow adjustments to match the proposed drainage network and earthworks.

The model extents, topography, and 2D inflows are shown in **Figure 2** and **Figure 3** for the existing and proposed scenario, respectively. Hydrology in the post-developed scenario was based on a catchment area for the entire site (including lots and roads) and rainfall applied within the roads only, not lots; this approach produces maximum flows (worst-case) for areas of interest, i.e. roads and public spaces as well as downstream locations of concern noted by Council.

Hydraulic roughness associated with buildings has been incorporated into the urban block to replicate the increased flow impedance within developed areas, hydraulic roughness is shown for the existing and proposed scenarios in **Figure 4 and Figure 5**, respectively.

Blockage parameters were considered to produce the worst-case results for the specific areas of interest. Modelling assumed the internal stormwater pit and pipe systems as well as basin outlets to be fully blocked, noting internal roads are designed to convey flows up to the 1% AEP to the basins, and the downstream M5 culverts were modelled as unblocked.

Modelling was carried out for the critical durations only for the 1% AEP and PMF storm events, 120 min and 60 minutes, respectively. Sensitivity testing was also carried out for the 1% AEP event which assessed the proposed compared to the existing scenario with a the regional tailwater of 5.55 m AHD as reported by JWP (2023), as this is much higher than the local Kelso Swamp tailwater of the adopted model.



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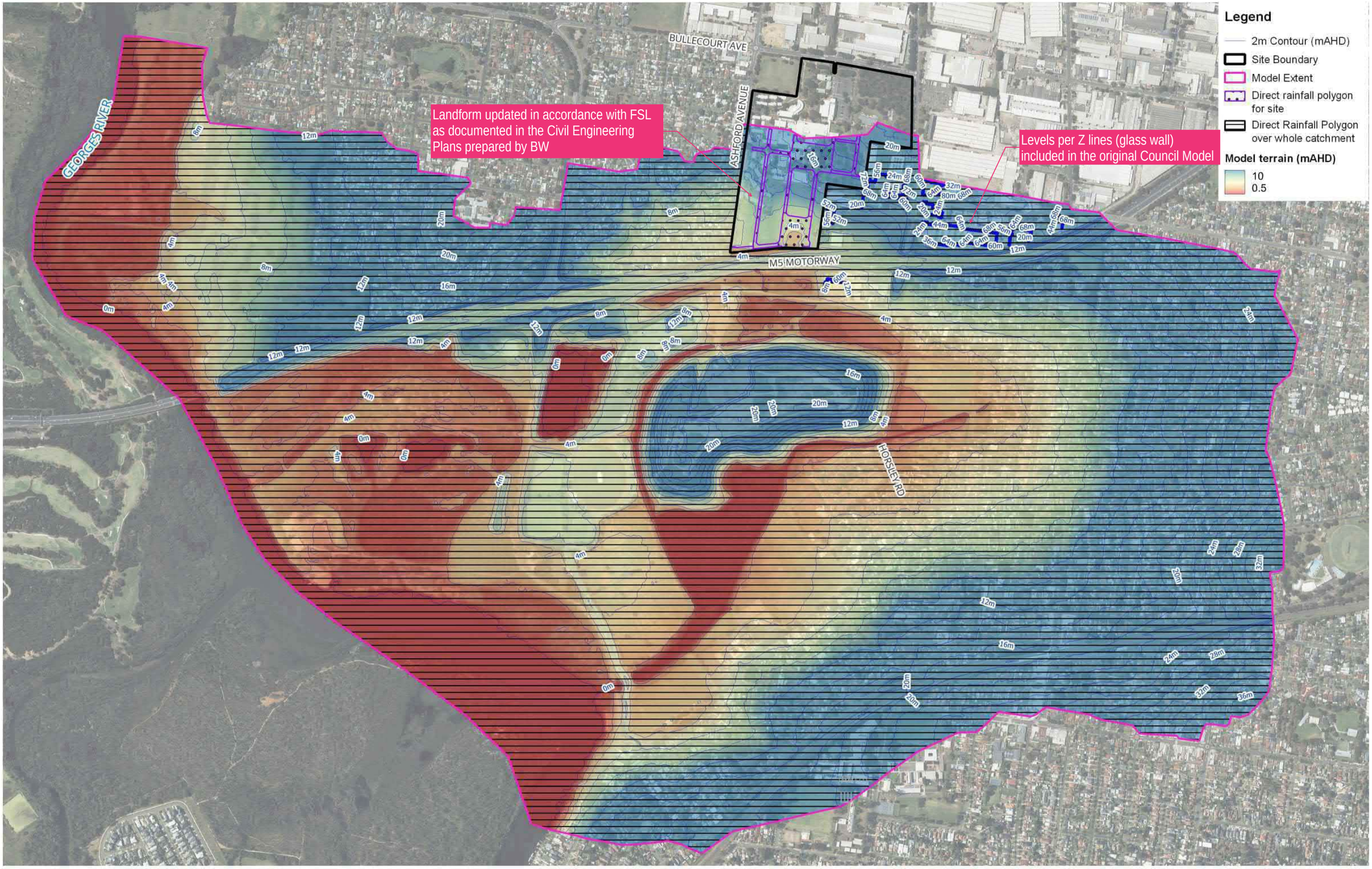
Existing Model Setup

Figure Number: 2 Rev: 1

0 200 400 600 m



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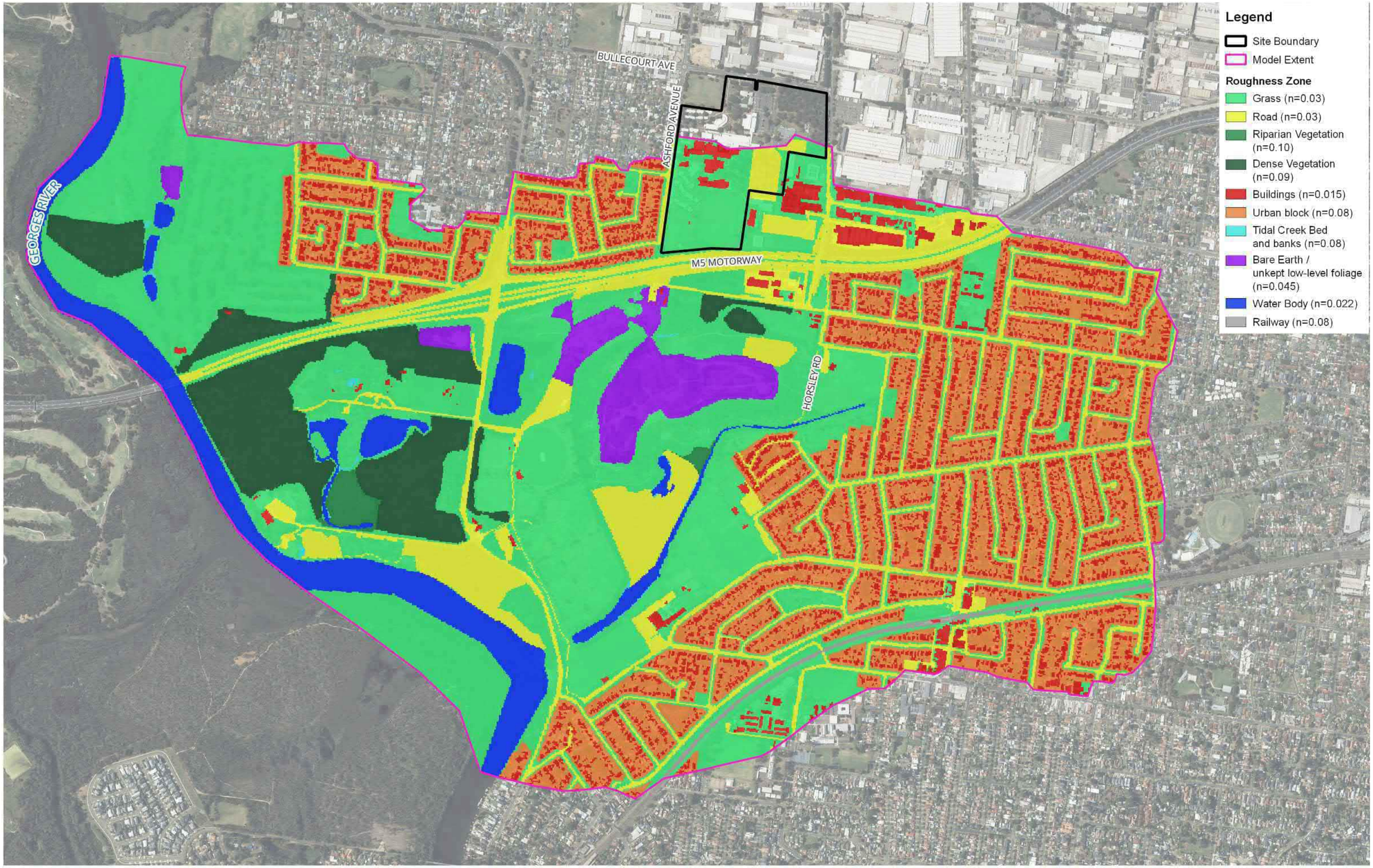
Proposed model setup

Figure Number: 3 Rev: 1



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Project Number: 2301879
Drawn by:YL
Checked by: FG
Issued: 20/08/2025

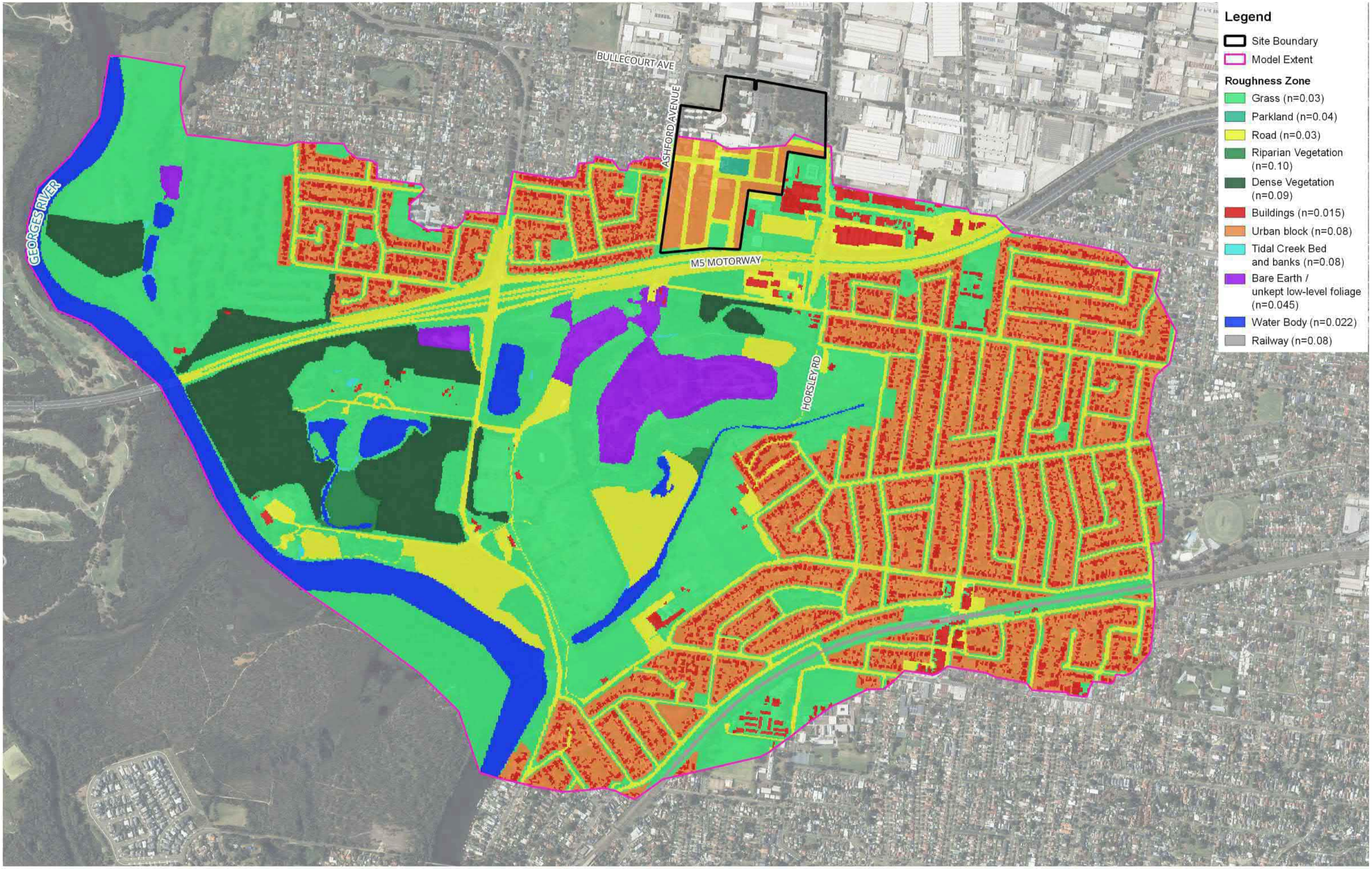
Project: 2 and 2a Bullecourt Avenue, Milperra
Flood Impact Assessment

Client: Mirvac Residential (NSW) Development Pty Ltd

Existing Roughness Zone Overall

Figure Number: 4 Rev: 1

0 200 400 600 m



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Flood Impact Assessment

Client: Mirvac Residential (NSW) Development Pty Ltd

Proposed Roughness Zone Overall

Figure Number: 5 Rev: 1

0 200 400 600 m

5.2 Model Results

Flood maps for the 1% AEP and PMF events showing the flood level, depth, velocity, and flood hazard for the base case, existing scenario, and the proposed scenario are presented in **Appendix B** and **Appendix C**, respectively. The 1% AEP Water Level Difference for sensitivity test is shown in **Appendix D**.

5.2.1 Flow Path

For the 1% AEP event, the main overland flow path differs. Currently, flow is conveyed from Flanders Avenue/Ashford Avenue through the southwest corner of the site to a swale near the M5 motorway, primarily affecting the southern part of the site due to the natural terrain grade. In the proposed scenario, the flow is conveyed from Flanders Avenue/Ashford Avenue through the bottom portion of Ashford Avenue which is unformed road reserve consisting of grass and trees before entering into the southern swale.

For drainage, the current M5 motorway culverts (modelled as unblocked) provide sufficient conveyance for all AEP design events in both existing and proposed scenarios.

5.2.2 Flood Depth

Regarding flood depth, the existing scenario shows that Ashford Avenue and Flanders Avenue adjoining the site are mainly limited to a flood depth of less than 0.25m. The proposed scenario shows a similar pattern except for the intersection of Flanders and Ashford Avenues which slightly exceeds 0.25m to just above 0.30m. For the PMF event, the existing condition has a maximum depth of 2.2m in the south-western corner, with the intersection and areas along the M5 motorway heavily inundated by over 1.0m of water. The proposed scenario improves depths within the site to mainly under 0.25m, but the intersection and M5 areas remain heavily inundated.

5.2.3 Flood Velocities

Flood velocities in the existing 1% AEP event exceed 1m/s on Ashford and Flanders Avenues and locally in the south-western corner. The proposed scenario reduces velocities generally to under 1m/s along Ashford and Flanders Avenues. For the PMF, existing velocities exceed 1.5m/s on roadways and reach 2m/s in the south-western corner, while the proposed scenario sees velocities reduced to under 1.5m/s for most of along Ashford and Flanders Avenues.

5.2.4 Hazard Category

The hazard category for the existing 1% AEP event is mostly category 1, in the majority of Ashford and Flanders Avenues including the intersection of Ashford and Flanders falls into category 1. The exception to this is further west along Flanders which has a category 3 at the low point in the intersection with Dernancourt Parade. Along the southern site boundary, the swale in the M5 Motorway falls into categories 4 and 5 and areas across the M5 culverts are category 3 and above. In the proposed scenario, the 1% AEP event shows the majority of Ashford and Flanders Avenues remains as category 1 except that a small section in the intersection of Ashford and Flanders increases to Category 2. In the swale within the M5 Motorway, the Hazard Category changes as a result of the OSD Basin discharging water at a different location. A portion of the swale reduces categories while another section immediately downstream increases categories, but the swale never exceeds the maximum categories 4 and 5 shown in the existing condition.

For the PMF, the existing scenario the existing residential lots along the bottom portion of Ashford Avenue and along Flanders Avenue are impacted by varying hazard categories ranging from 1 to 4. The swale in the M5 Motorway boundary is primarily category 5 with some minor areas of category 6. For the PMF in the proposed scenario, the hazard category reduces along Ashford Avenue in particular at the intersection with Flanders Avenue where a portion is reduced from category 5 back to category 4. The other high-hazard areas remaining unchanged from the existing condition.

5.3 Additional Overland Flow Assessment

The resolution adopted in the TUFLOW model of a 5mx5m grid size is too course to capture abrupt level changes like road kerbs. Additional calculations have therefore been carried out for critical locations (see **Figure 6**) to validate the modelled PMF flows and confirm hydraulic conditions in the roads are safe for vehicles. This assessment assumes pits

and pipes are blocked, consistent with the TUFLOW model assumptions, and the entire PMF flows will be carried through the roads. Critical locations were selected as the low points of internal sub catchments where flows are expected to be the largest. Using the specific cross-section of the road and modelling flowrate for each point of interest, the velocity-depth product was calculated using the Mannings equation.

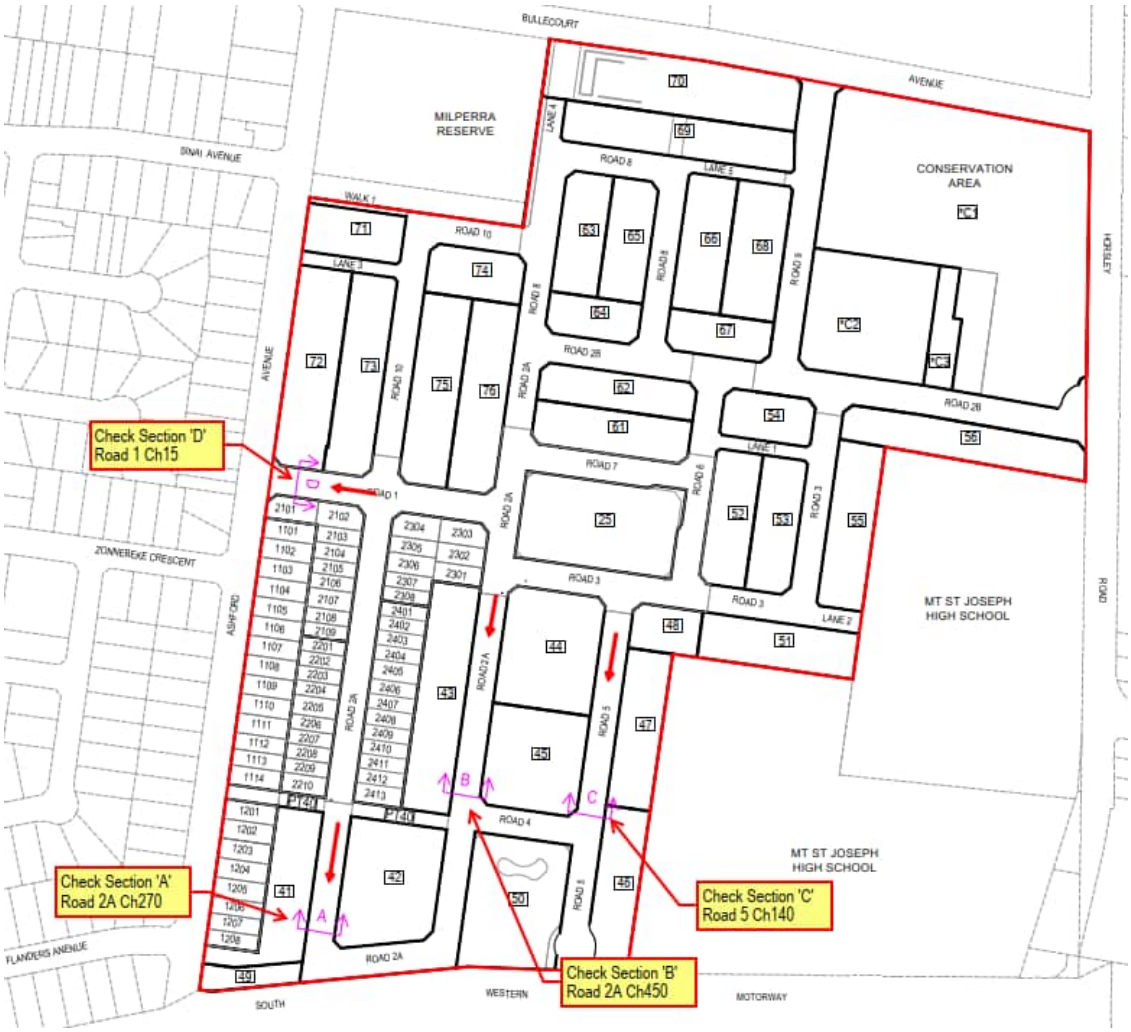


Figure 6: Location of Overland Flow checks along evacuation route

The velocity-depth product for each critical location is provided in **Table 3** and calculations provided in **Appendix E**. Calculations are consistent with modelled results and confirm that hydraulic conditions within internal roads are safe for vehicles (and pedestrians) up to the PMF event. As such, all internal roads can be used as evacuation routes up to a PMF event.

Table 3: Overland Flow Assessment of Evacuation Roads using Manning's Equation

LOCATION	PMF FLOW	D MAX	V MAX	VxD MAX	HAZARD LEVEL - VEHICLES	HAZARD LEVEL - PEOPLE
A - Road 2A Ch270	0.238 m³/s	0.131	1.146	0.150	Low Hazard	Low Hazard
B - Road 2A Ch450	0.356 m³/s	0.120	2.141	0.258	Low Hazard	Low Hazard
C - Road 5 Ch140	0.398 m³/s	0.117	2.568	0.301	Low Hazard	Low Hazard
D - Road 1 Ch15	0.147 m³/s	0.099	0.037	0.128	Low Hazard	Low Hazard

6 HYDRAULIC MODELLING – REGIONAL FLOODING

A separate flood risk impact assessment was prepared by J. Wyndham Prince (May 2023) which assess regional flooding (provided in **Appendix F**). This assessment approach differs from hydraulic modelling described in **Section 5** as the intent of this assessment was to simulate the passage of a flood through the George's River catchment to understand the flood impacts of a regional flooding event on the site. This assessment included hydraulic modelling using TUFLOW based on the *Georges River Flood Study (BMT, 2020)*, covering a catchment area of approximately 960 km^2. Modelling was carried out for the 1% AEP up to a PMF event and regional critical flow durations of 24 hours adopted to find the worst-case regional flood levels at the site.

Results demonstrated no significant changes in the flood behaviour were demonstrated external of the site as a result of the proposed development. Encroachment of the 1% AEP up to PMF regional flood was observed to the southern portion of the site, consistent with the existing regional flood level. North-eastern parts of the site were generally demonstrated to be flood free up to the PMF event as well as Bullecourt Avenue and Horsley Road which could serve as evacuation routes for residents.

Key parameters documented in the report have been summarised below:

Table 4: Regional Flood Levels (JWP, 2023)

EVENT	REGIONAL FLOOD LEVEL
1% AEP	5.55 m AHD
0.5% AEP	5.68 m AHD
0.2% AEP	5.85 m AHD
PMF level	11.8 m AHD

The report concluded with the following regarding the development and impact on and by the Georges River Regional Flood.

- *A flood assessment was undertaken using the hydraulic model that supported the 'Georges River Flood Study' (BMT, 2020) to determine the flood risk and impact for storm events ranging from the 1% AEP to the PMF event.*
- *The regional 1% AEP flood level at the site is 5.55 m AHD in both the existing and developed condition. Freeboard of 0.5 m is required to finished floor levels and this the minimum floor levels for the proposed dwellings would be 6.05m AHD.*
- *Flood level difference mapping provided in Figure 7-12 in Appendix D indicates that there are no adverse flood level impacts external to the site.*
- *A climate change assessment was undertaken utilising the 0.5% AEP and 0.2% AEP events as proxies for 1% AEP climate change. 200 mm freeboard would still be available to the finished floor levels of proposed dwellings in the 0.2% AEP and therefore flood risk increases due to climate change are low.*
- *The site is affected by regional flooding in the 1% AEP event. The flood surface and terrain information have been interrogated for the existing and developed condition site. There is no net loss of floodplain storage due to the proposed development in the 1% AEP event.*
- *A flood evacuation plan is provided demonstrating that a continuous rising grade to areas above the PMF level can be achieved.*

In addition, an addendum letter was prepared and issued 13th November 2023 which addressed State Emergency Service (SES) submission comments regarding evacuation warning times, adjoining impacts and containment of less frequent storm events in the recreation and drainage reserve areas. Further discussion regarding evacuation during the regional flood events is included below.

7 DISCUSSION

7.1 Flood Storage

A compensatory storage assessment was undertaken in 12D to ensure that adequate compensatory flood storage was provided within the proposed development, the details of which are provided in the Water Cycle Management Study prepared by BW (Nov, 2025). Results demonstrated that the required compensatory flood storage below RL 5.55 is provided within OSD Basins 1 and 2.

7.2 Flood Impacts

7.2.1 Existing Western Residential Area

Modelling results indicate that the proposed site filling introduces a minor disturbance to the existing overland flow path along Flanders Avenue towards the M5 swale. This results in some localised water level increases at the intersection of Flanders Avenue and Ashford Avenue for the 1% AEP event, and within the M5 corridor for both the 1% AEP and PMF event.

The 1% AEP results shown in **Figure C4** in **Appendix C**, demonstrate water level increases maintained at less than 70mm, predominantly confined within the road carriageway. Some water level increases of 40-60mm are demonstrated within the property boundary of 1 Flanders Ave, noting modelling does not include modelling of the building walls; a cross check of the afflux locations against Google Street View determined that no increases are demonstrated at the garage door or at other entrances to the house, as such, no additional damage above the floor levels is anticipated from the afflux. Water level increases were also demonstrated within the unopened road and reserve adjacent to 2 Flanders Ave, noting no afflux is demonstrated within the property boundary.

A review of the hazard mapping (**Figures B3** in **Appendix B** and **Figure C3** in **Appendix C**) demonstrates that, in 1% AEP event, under existing conditions, Ashford Avenue is predominantly classified as Hazard Category 1. Under the proposed development scenario, the road continues to fall within hazard category 1, with only a small number of cells transitioning to hazard category 2. Accordingly, the trafficability of Ashford Avenue and the intersection with Flanders Avenue remains unchanged.

The PMF map (**Figure C8** in **Appendix C**), shows the swale in the M5 corridor to have an afflux range from 50mm to 100mm. Since it remains confined within the swale area and the hazard category for the swale remains in category 5 under proposed conditions it is considered a negligible impact. In the same map there is small patch of increase just above 50mm in Ashford Avenue north to the intersection of Flanders Avenue and Ashford Avenue. The maximum hazard category remains unchanged as category 3 in the lots and 5 in the road, but improvement is seen especially in Ashford Avenue and at the intersection, as shown in **Figures B6** in **Appendix B** and **Figure C7** in **Appendix C**.

A sensitivity analysis adopting an elevated tailwater of 5.55 m AHD (consistent with JWP, 2023) confirms the results are robust: impacts remain localised and negligible, with no off-site afflux, no change to road trafficability, and no material change to flood hazard. As shown in **Figures D1** in **Appendix D**, for 1% AEP event, the predicted afflux remains within the site boundary, with only scattered increases in the swale; elsewhere in the model domain, flood-level differences are within ±50 mm, which is considered negligible.

On this basis, it is concluded that flood impact risk caused from the proposed development is negligible on flood behaviour under 1% AEP and PMF events. Road trafficability is unchanged, no afflux within existing residential allotments for 1% AEP event, and no increased implications for structural, vehicle, or community safety in the PMF. The current design is considered sufficient to manage and mitigate the potential flood-related impacts identified in this assessment. Accordingly, no additional mitigation or management measures are required.

7.2.2 To M5 Crossings

Conditions at the existing M5 motorway culverts have been reviewed and assessed for flood related impacts. The location of these two culverts is shown in **Figure 7**.

For Culverts Cul_001b, the flow are velocity are essentially the same for existing and proposed scenario, as shown in **Figure 8** and **Figure 9,** which demonstrates that the proposed development with OSD does not imply extra flow through the culvert and the proposed basin on site will retain the flow as per existing condition.

For Culverts C16134A, as shown in **Figure 10** and **Figure 11**, the flows in proposed scenario and existing scenario are 1.97m³/s and 2.02m³/s, respectively, in 1% AEP event. The increase of the flow is only 0.05m³/s and this will only be caused by minor water level increase in at the pit inlets. The velocity increased from 1.74 m/s to 1.79 m/s, when comparing the existing and proposed scenarios. The velocity still remains under 2m/s, and it is believed this is unlikely to create any structural damage to the drainage network.

The current design is considered sufficient to manage and mitigate the potential flood-related impacts identified in this assessment; accordingly, no additional mitigation or management measures are required.

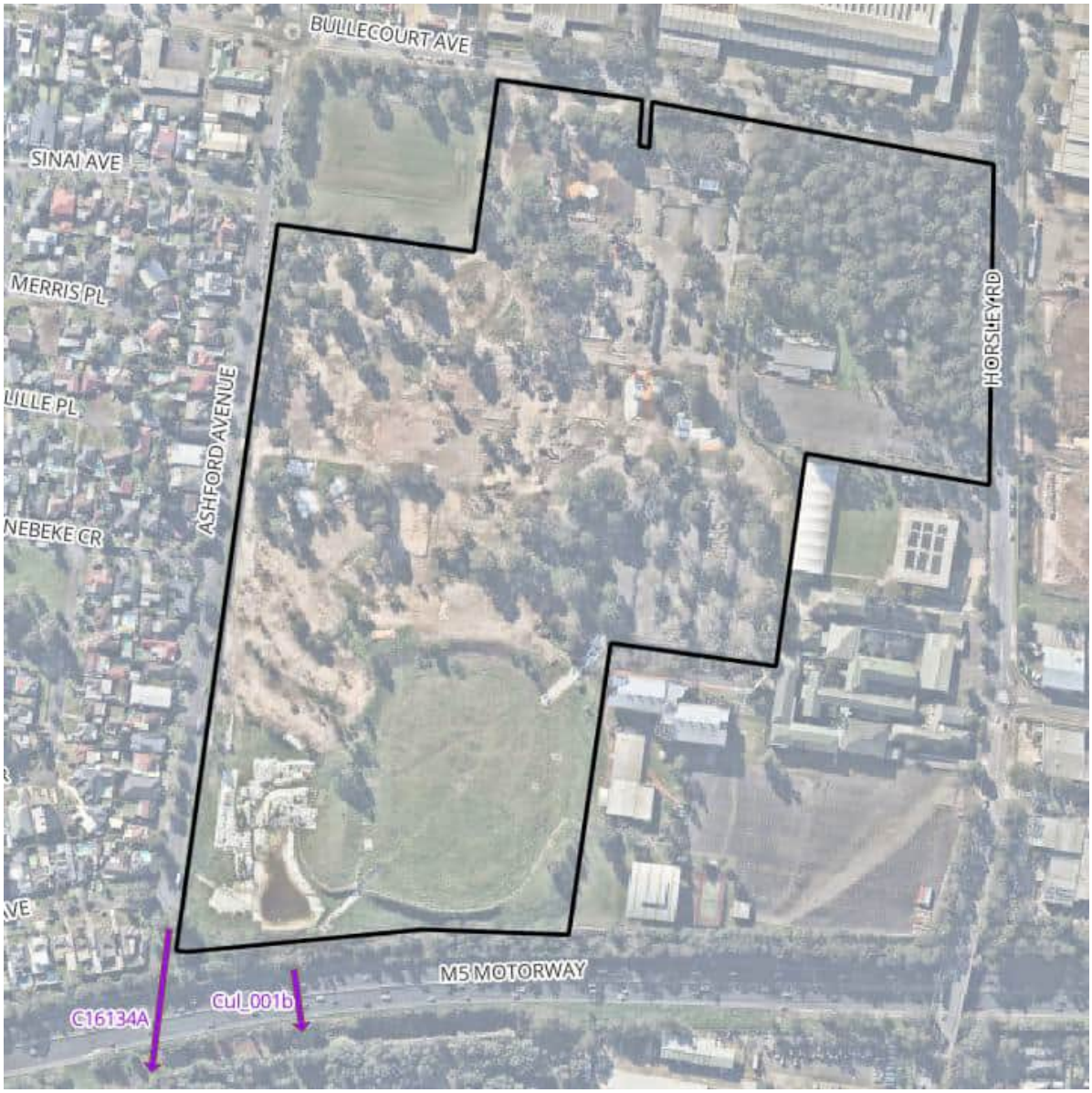


Figure 7 M5 Motorway Culverts Location

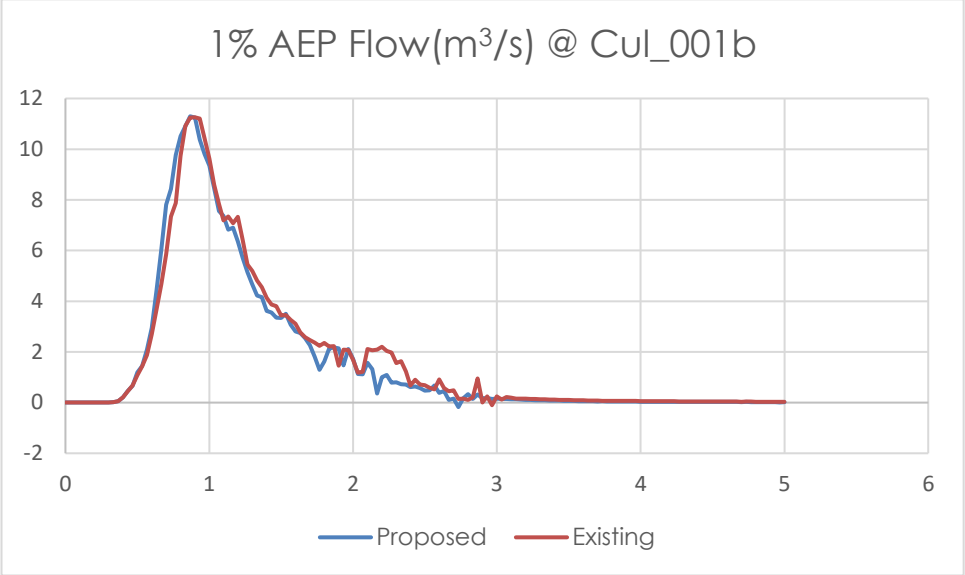


Figure 8 1% AEP flow in M5 Motorway Culverts-Cul_001b between Existing and Proposed Scenario

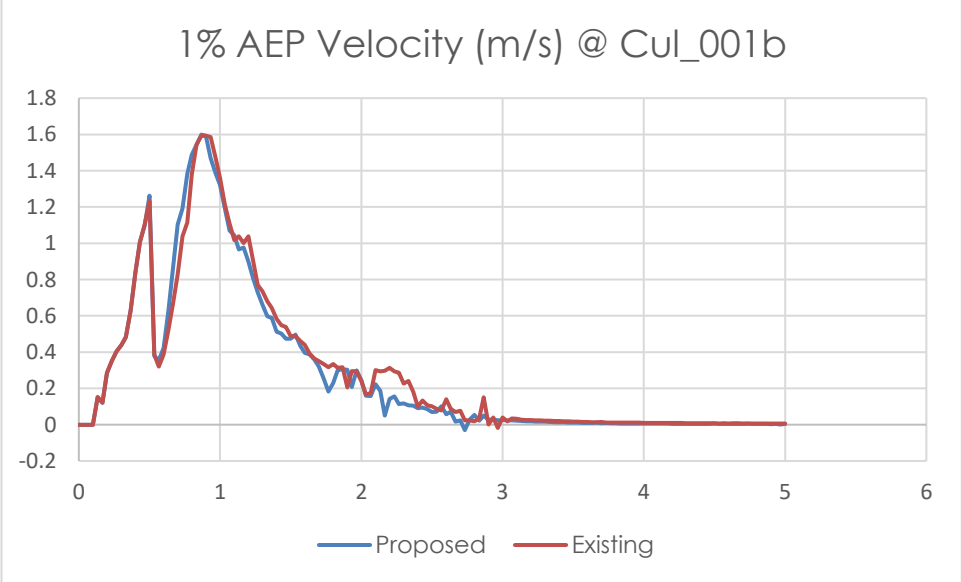


Figure 9 1% AEP flood velocity in M5 Motorway Culverts-Cul_001b between Existing and Proposed Scenario

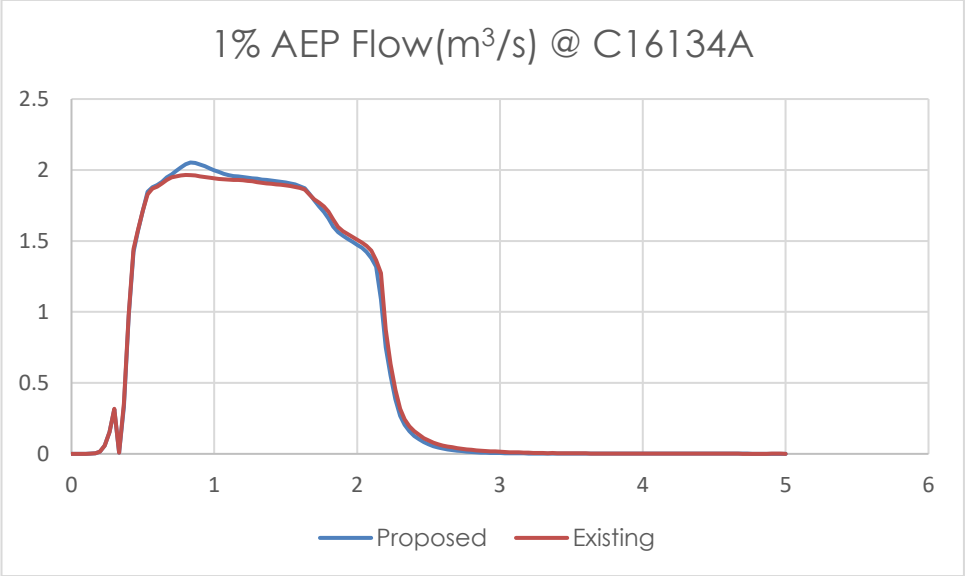


Figure 10 1% AEP flood Flow in M5 Motorway Culverts-C1613A between Existing and Proposed Scenario

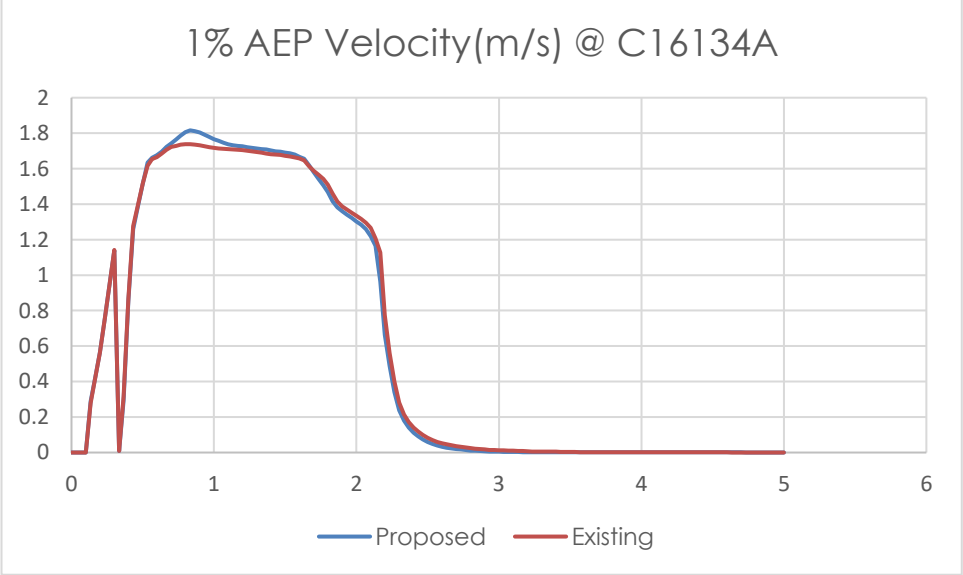


Figure 11 1% AEP flood velocity in M5 Motorway Culverts- C16134A between Existing and Proposed Scenario

7.2.3 Flood Impacts on the Downstream Floodplain i.e. Kelso Park / Swamp

Downstream of the culverts flood level increases of less than 10mm are demonstrated for both 1% AEP and PMF event, this is considered negligible. Flood hazard is maintained, per the existing conditions, within category H3 and H5 for the 1% AEP event and PMF events, respectively. It can therefore be concluded that the proposed development does not impose any detriment to the downstream Kelso Park/Swamp area.

The current design is considered sufficient to manage and mitigate the potential flood-related impacts identified in this assessment; accordingly, no additional mitigation or management measures are required.

Refer to **Figures C4** and **Figure C8** in **Appendix C**.

8 FLOOD RISK AND EMERGENCY MANAGEMENT

Safety of residents during significant flood events is a critical design consideration for the proposed development. The determination of a flood risk and emergency management strategy included a review of regional flooding from George's River catchment (see **Section 5**) as well as local storm events (see **Section 4**) and resulting overland flows. This was necessary to ensure the complex contributing risks factors and overall flood behaviour of the site was effectively and wholistically considered.

Key considerations of the emergency management strategy are summarised below:

- All lots are above the local 1% AEP and PMF overland flows
- All lots are above the regional 1% AEP water level of 5.55 m AHD, with a Flood Planning Level of 6.05 m AHD and minimum top of slab level of 6.185 m AHD.
- All lots are above the regional flood level for the 0.5% (5.68 m AHD) and 0.2% AEP events (5.85 m AHD)
- Part of the site is subjected to flooding up to 11.8 m AHD in a PMF storm event.
- For the George's River Floodplain, the BoM has a target warning lead time of 12 hours for floods greater than 4.0 m for the Milperra Bridge Gauge (*George's River Floodplain Management Study, D25 Best Practice Flood Evacuation, Molino Stewart, 10/02/2022*).

8.1.1 Evacuation Strategy

Part of the residential areas within the site is subjected to flooding in a regional PMF event, for the remainder of the site, residents may still be vulnerable to indirect consequences of flooding, it is therefore necessary that the development enables safe evacuation for all residents. This assessment considers safe evacuation via vehicles, particularly given that the travel distance to reach safe conditions would require a vehicle, and give the circumstances, it is expected that evacuating residents would opt to evacuate with a vehicle is one is available to them. The proposed evacuation route shown in **Figure 12** connects into the Georges River Evacuation route for the region via Beaconsfield Street (see **Figure 13**). This is in line with the local emergency management strategy.

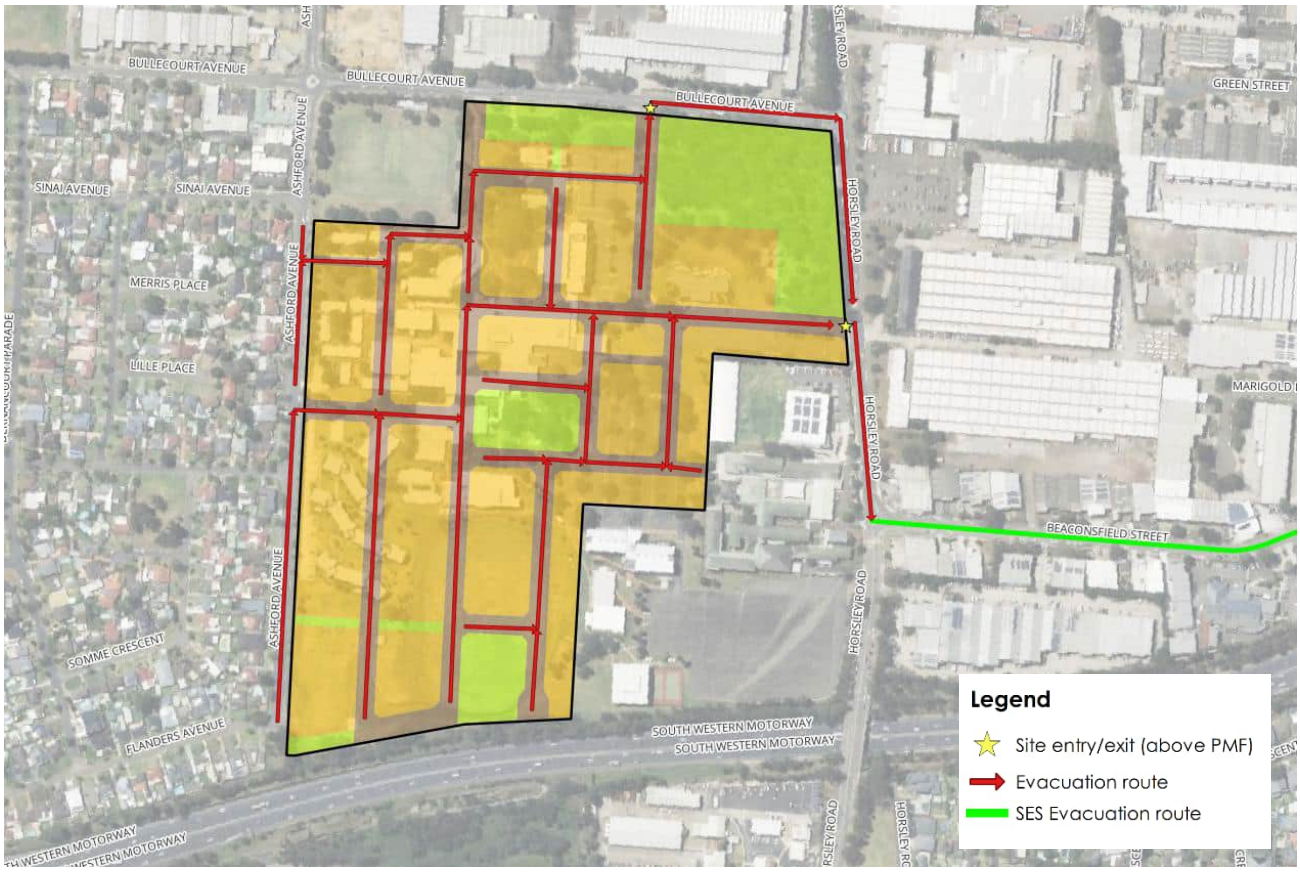


Figure 12: Flood Evacuation Plan

Figure 13: Exhibit of the Georges River Evacuation: Subset Map 4 from the Molino Stuart Flood Evacuation Plan with Markups of safe vehicular evacuation routes leaving the site

It is noted that the SES typically requires at least 6 hours to mobilise an evacuation. (*A Technical Guideline for the Use of the SES Timeline Evacuation Model in Flood Evacuation Planning, Molino Stewart, 2013*). Given the relative warning times and time to onset for the regional and local events, it is understood that an evacuation could be coordinated for a regional flooding event with a warning time of 12 hours (*(George's River Floodplain Management Study, D25 Best Practice Flood Evacuation, Molino Stewart, 10/02/2022*) however, there is insufficient warning time to coordinate an evacuation effort for the local storm event which is less than 6 hours and constitutes flash flooding. The proposed development has therefore been designed to ensure all lots are flood free for local storm events up to the PMF and that all residents have access to a hydraulically safe evacuation route that is continually rising for the regional event.

To enable safe evacuation up to a PMF storm event, the proposed development has been designed to ensure all dwellings have access to a continuous, rising evacuation route without localised depressions to either Horsley Street or Bullecourt Ave, further, the development aims to minimise or eliminate hydraulic hazards along the evacuation routes where practicable to enable safe connection to the designated SES evacuation route is via Beaconsfield Street. **Figure 17** and **Figure 18** show modelled hazards from the local and regional events, respectively.

Internal Roads

Within the site, modelling of the regional events demonstrated flood encroachment from the 1% AEP event to the southern portion of the site, consistent with existing conditions. For the 1% AEP event, all lots are above the flood level and evacuation routes for all residents remain accessible and safe. The number of dwellings which experience inundation/ evacuation cut off for larger storm events is noted in **Table 5** which includes inundation of some dwellings in the PMF event; the expected warning time for cut-off or inundation for a regional flood is 12 hours (*George's River Floodplain Management Study, D25 Best Practice Flood Evacuation, Molino Stewart, 10/02/2022*) which is sufficient time for the SES to coordinate an evacuation.

Table 5: Regional Flood Dwellings Inundated/Cut-Off

EVENT	REGIONAL FLOOD LEVEL	DWELLINGS INUNDATED	DWELLING DRIVEWAYS CUT OFF FROM EVACUATION
1% AEP	5.55 m AHD	0	7
0.5% AEP	5.68 m AHD	0	8
0.2% AEP	5.85 m AHD	0	8
PMF level	11.8 m AHD	136	147

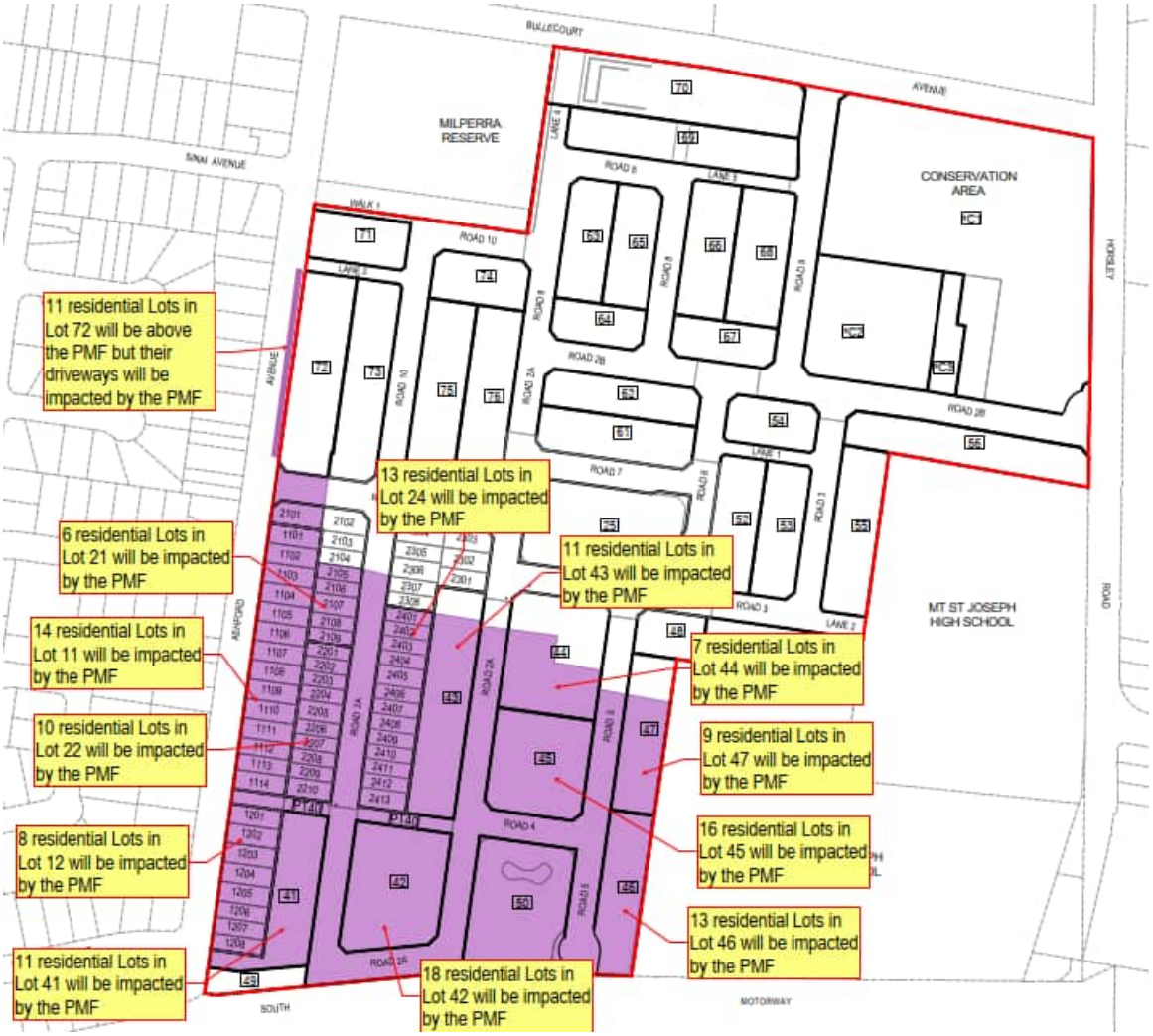


Figure 14: illustration of approximate number of ultimate residential lots impacted by the Regional PMF Flood

Modelling of the local events demonstrated hydraulic conditions within all internal roads to be hydraulically safe for vehicles (and pedestrians) up to the local PMF (see **Figure 17**), therefore all residents that rely on the internal road network for evacuation can safely do so even in a worst-case scenario where a local flooding event may coincide with a regional flood event.

Ashford Ave – Local Flood

For flood conditions at the southern portion of Ashford Ave, modelling of the local 1% AEP and PMF event demonstrated the proposed conditions to be generally consistent with the existing conditions. The 1% AEP local flooding conditions were predominantly maintained at a H1 hazard level with some H2 flooding noted in discrete locations, and hydraulically safe for vehicles (and pedestrians). The PMF local flood (Kelso Swamp) model demonstrated flood depths above the safe threshold for vehicles (and pedestrians), cutting off 8 dwellings along Ashford Avenue for approximately 90 minutes (see **Figure 15**).

Evacuation during a PMF event would require an additional operational step for these residents, where if flooding is present in Ashford Avenue, residents would take temporary refuge in their homes noting this could be done safely given that the minimum finished floor levels at RL 6.185m is above the local PMF level of 6.165 m AHD at this location; evacuation could commence once local flooding in the road has subsided. In a worst-case scenario where a local and regional PMF event coincide, the time of for the regional PMF to reach unsafe depths for vehicles (approximately 300mm) in Ashford Avenue is approximately 8 hours from the commencement of the storm as shown in **Figure 16,** this would provide sufficient allowance for the interim refuge period of approximately 90 minutes.

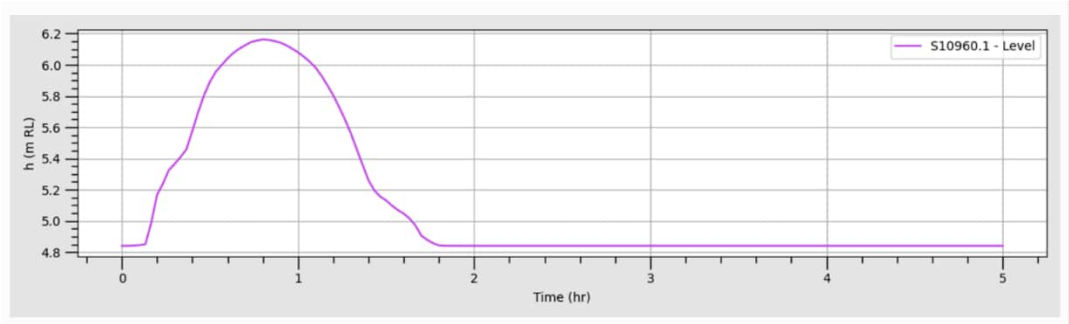


Figure 15: Ashford Avenue – Duration of Inundation (Local PMF)

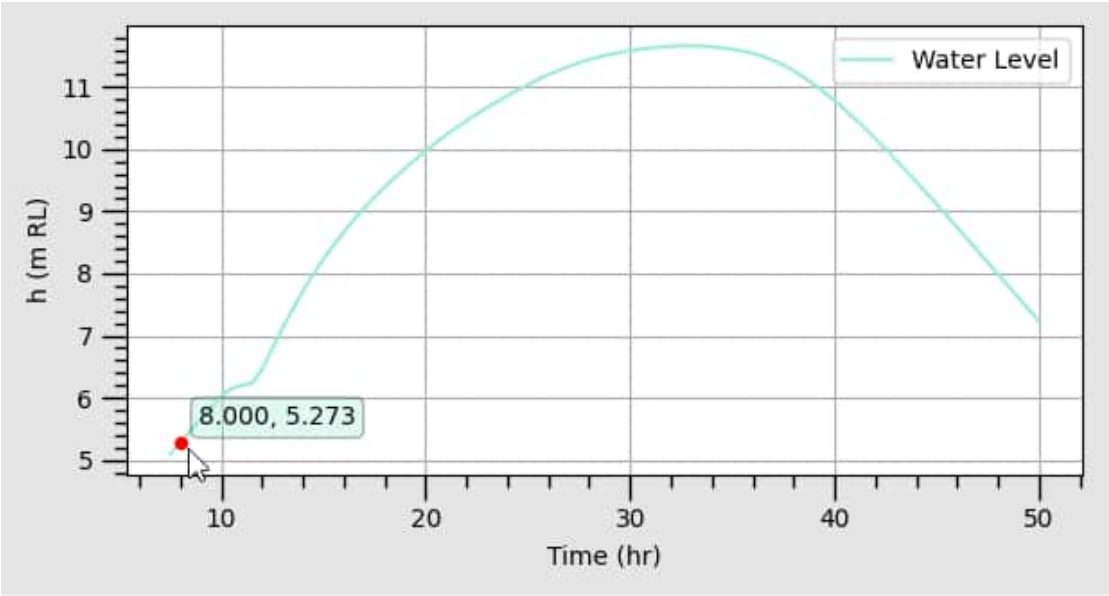


Figure 16: Regional PMF - Time of Inundation at Ashford Avenue

It should be noted that residents evacuating the site must take caution when travelling in adverse weather, particularly for the 2 locations noted along the SES nominated evacuation route which are identified as cut-off location in the 1% AEP event on Beaconsfield St and River Road (*George's River Floodplain Management Study, 1193 D21 PMF Evacuation Maps Final, Map 4, Molino Stewart, 21/01/2022*).

Overall, self-evacuation is considered achievable up to a PMF event for all residents and the flood emergency management strategy is consistent with existing emergency management strategies for the area, and the proposed development is not anticipated to impose any additional burden on the State Emergency Service (SES).

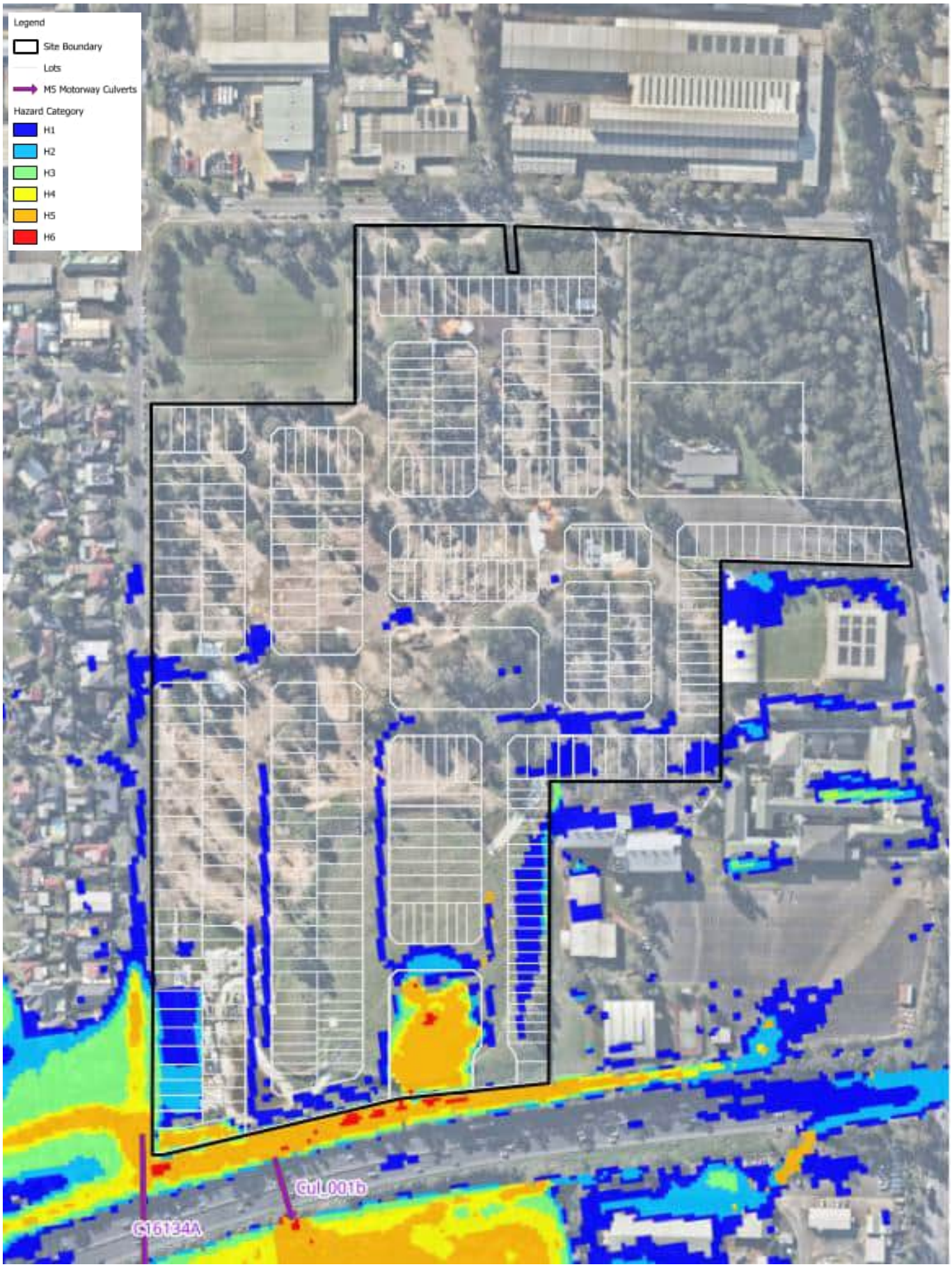


Figure 17: Local PMF Hazard Category

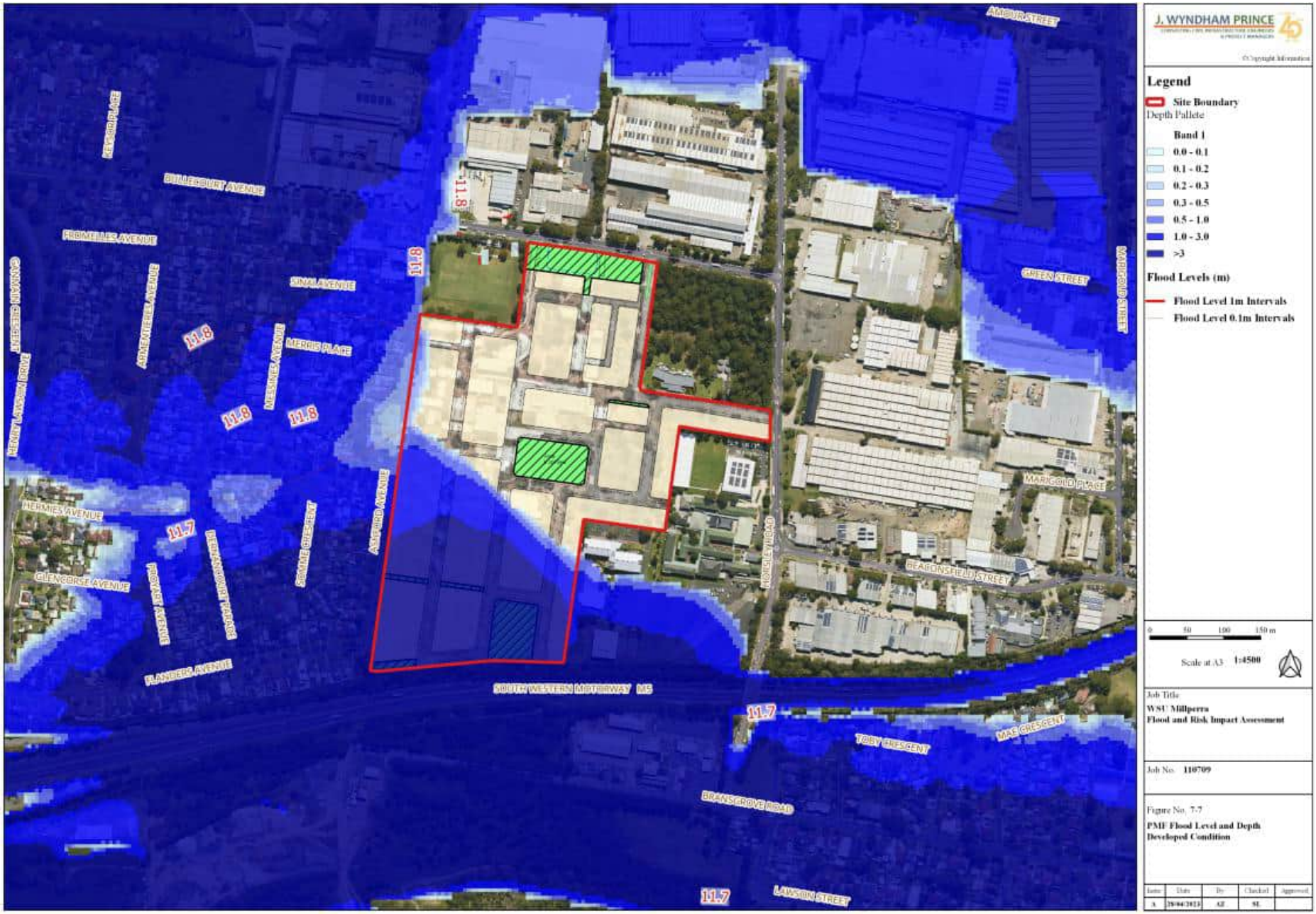


Figure 18: Regional PMF Flood Level and Depth (JWP, 2023)

8.2 Additional Flood Risk Management

The proposed multi-purpose hardstand sports court within Basin 1 is located in an area subject to flooding and rapidly rising floodwater. To manage the flood risk to users, the surrounding parkland has been designed so that the moat adjoining the court is inundated first, acting as an early-warning indicator of rising water. Upon moat inundation, users of the court are to evacuate promptly via the designated footpath egress to exit the basin. Based on the hydraulic assessment, there is approximately 16.9 minutes from when water first reaches the moat invert (RL 3.40 m AHD) to the 1% AEP peak flood level (RL 4.62 m AHD). This becomes a maximum of 1.12m deep from the level of the grassed area and court in a 1%AEP. Users should exit the court immediately once the moat is fully inundated (≈ RL 3.50 m AHD), following the signed egress route.

To support safe operation, clear and durable flood warning signage will be installed which notifies that the area is susceptible to rapid flooding and warns against use during storm events; egress wayfinding and signage indicating the evacuation route should also be included. Signage should be positioned at court entries and along the egress path where practicable.

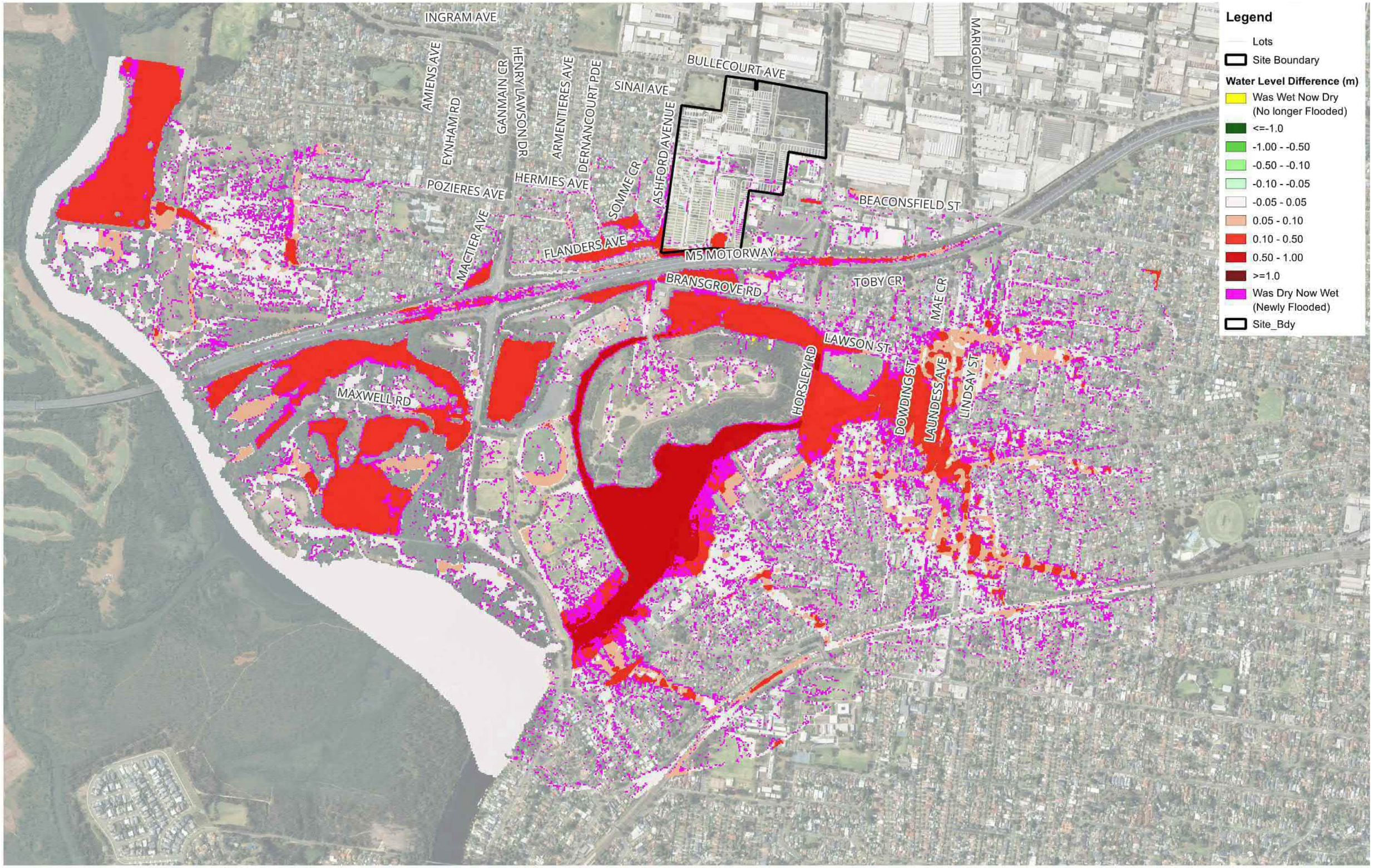
8.3 Climate Change Scenario

A climate change assessment was undertaken to address the requirements outlined in the Secretary's Environmental Assessment Requirements (SEARs) table. The TUFLOW model was originally developed using ARR1987 design rainfall data with a rainfall-on-grid approach. To incorporate the latest climate change consideration, the centroid of the two-dimensional model domain was extracted, and the corresponding ARR2019 rainfall intensities were obtained. The climate change scenario is selected as SSP5-8.5, 2090, which is considered as the worst-case climate change scenario. The climate change multipliers are summarised in the table below and were applied to provide a conservative assessment. Rainfall and loss parameters were adjusted in accordance with this multiplier, while the tailwater boundary conditions were maintained consistent with the base model setup.

Table 6 Climate Change Multiplier

SELECTED SSP	TARGET/DESIGN YEAR	INITIAL LOSS MULTIPLIER	CONTINUING LOSS MULTIPLIER	BURST DURATION MULTIPLIER FOR 2 HOUR
SSP5-8.5	2090	1.08	1.16	1.64

The water level difference between proposed climate change case and proposed base case is presented in **Figure 19**, indicates that when compared to the proposed base case, the climate change scenario generally results in water level increases of less than 0.5 m, which is typically considered within the acceptable threshold for climate change impact. The water level increase in the proposed basin is less than 0.3m and it is showed that the freeboard is sufficient to cover the uncertainties imposed by the worst-case climate change scenario. Localised increases exceeding 0.5 m are observed within the swale adjacent to the M5 Motorway and downstream of the M5 culverts; however, these changes are confined to limited areas and do not result in significant changes to overall flood behaviour.



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Tel: (02) 4625 5055

Project Number: 2301879
Drawn by:YL
Checked by: FG
Issued: 28/10/2025

Project: 2 and 2a Bullecourt Avenue, Milperra
Flood Impact Assessment

Client: Mirvac Residential (NSW) Development Pty Ltd

Water Level Difference
Proposed Climate Change Less Proposed Base Case
1% AEP

Figure Number: 19 **Rev: 1**

0 200 400 600 m

9 CONCLUSIONS

In conclusion:

- Hydraulic modelling has been carried out with consideration for the complex flood influences on the site, modelling demonstrated the site is subject to flash flooding from local catchment storms and backflows from George's River in a regional storm event.
- TUFLOW modelling of local catchments has been carried out as part of this report
- TUFLOW modelling of the regional George's River Catchment has been carried out by JWP and documented in a separate FIRA report (2023) which is provided in **Appendix F.**

- Modelling of offsite impacts determined the following:
  - Flood behaviour for the developed condition in and around the site is largely consistent with that in the existing condition
  - No afflux resulting from the proposed development affects existing residential allotments for both the 1% AEP and PMF event.
  - There is no loss of trafficability along Ashford Avenue as a result of the proposed development for both the 1% AEP and PMF events; minor increases in water levels at the Ashford Avenue at the intersection with Flanders Avenue generally do not result in increased hazard levels.
  - There is no detrimental impact to the existing M5 motorway resulting from the proposed development and the M5 Motorway culverts provide sufficient conveyance capacity for both existing and proposed scenarios across all modelled design events.
  - The proposed development has generally no impact on the Kelso Park/Swamp with flood level increases of less than 10mm in 1% AEP event and PMF event.
- Results from sensitivity testing with a higher tailwater of 5.5 m AHD demonstrated this increase tailwater to have negligible impacts to the safety of structures, vehicles, or the community.

- Assessment of the flood emergency conditions determined the following:
  - Evacuation of the site is necessary given that the southern portion of the site, including dwellings, is inundated for the regional PMF event.
  - In the regional storm event:
    - The BoM has a target warning lead time of 12 hours for the area.
    - The 1% AEP flood encroaches on the site
    - All dwellings are above the regional flood level up to the 0.2% AEP event,
    - Flooding at the southern end of Ashford Avenue will result in the cut-off of 7 dwellings in the 1% AEP event, and 8 dwellings for the 0.5% AEP and 0.2% AEP event.
    - PMF water level reaches 11.8 m AHD resulting in inundation of 136 dwellings and vehicular access cut-off of an additional 11 lots which front Ashford Avenue.
  - In the local storm event:
    - flash flooding peaks at 30 minutes with a time of inundation of approximately 90 minutes.
    - all finished floor levels will be above the local PMF water levels.
    - all internal roads were demonstrated to be hydraulically safe up to the PMF.
    - flooding to the southern portion of Ashford Ave is demonstrated to be hydraulically safe for vehicles (and pedestrians) in the 1% AEP event, but unsafe in a PMF event. As an additional operational step evacuation during a PMF event, residents would take temporary refuge in their homes and could commence evacuation once local flooding in the road has subsided (expected 90-minutes).
  - Self-evacuation is considered achievable up to a PMF event for all residents including in a worst-case scenario where a local and regional PMF event coincide.
  - The proposed development is not anticipated to impose any additional burden on the State Emergency Service (SES)
  - The flood emergency management strategy is consistent with existing emergency management strategies for the area

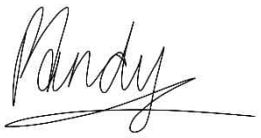
- The proposed multi-purpose hardstand sports court within Basin 1 is subject to rapidly rising floodwater. The proposed design includes a moat which will act as an early warning sign, modelling indicated users would

have approximately 16.9 minutes from when water first reaches the moat invert (RL 3.40 m AHD) to 1% AEP peak water depths (RL 4.62 m AHD)

- Climate change sensitivity modelling of an SSP5-8.5, 2090 scenario demonstrates water level increases are generally maintained below 0.5 m, this is considered within the acceptable threshold for climate change impact
- The current design is considered sufficient to manage and mitigate the potential flood-related impacts identified in this assessment. Accordingly, no additional mitigation or management measures are required.

It is recommended:

- Within Basin 1, clear and durable flood warning signage is installed, deterring users from occupying the space during storm conditions, and egress wayfinding including to manage the flood risk to the community.
- The proposed FIRA be adopted for the proposed development of the site, 2 and 2A Bullecourt Avenue, Milperra (Lot 2 of DP1291984).



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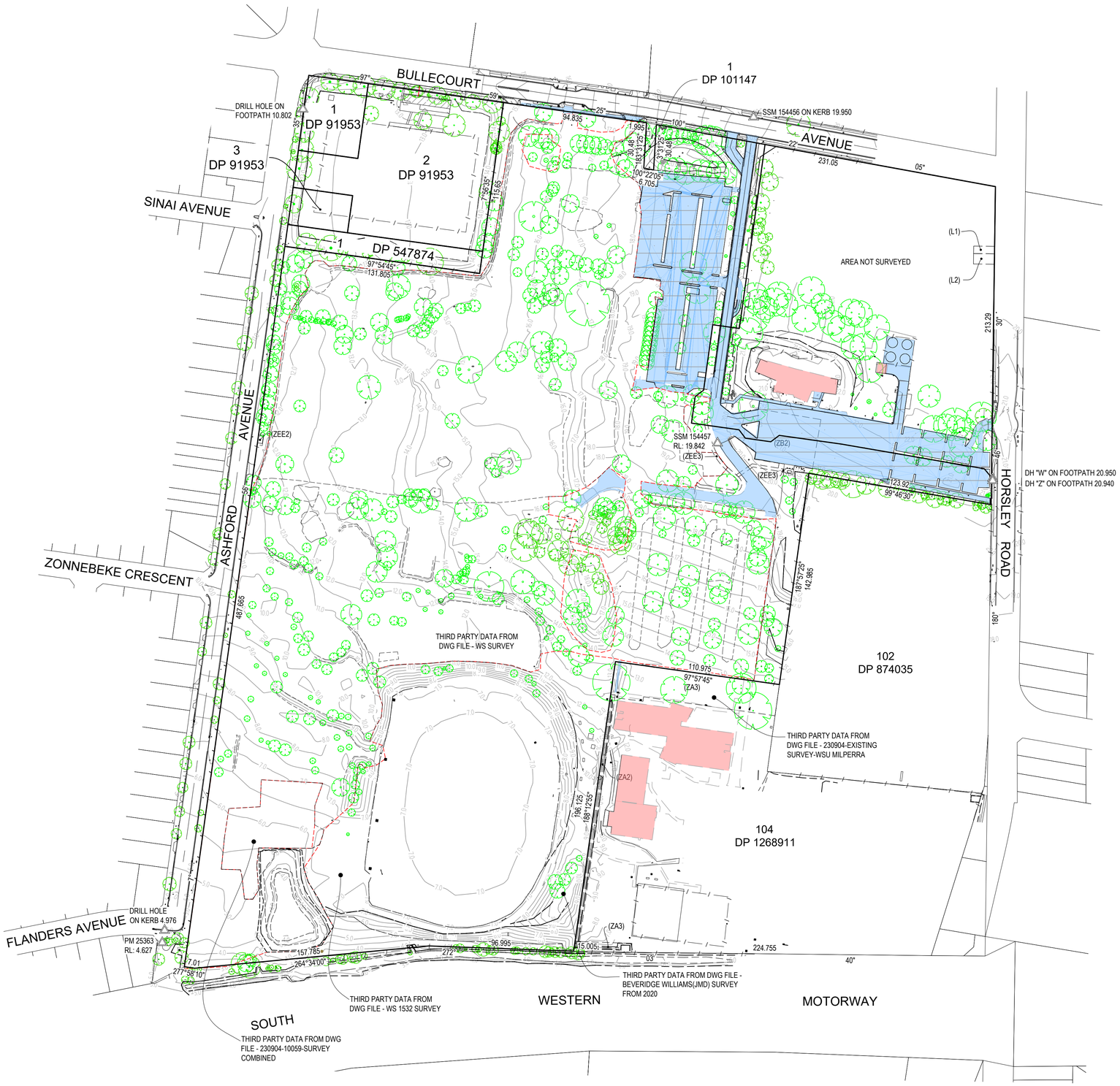

GENERAL NOTES

1A THESE NOTES AND LEGEND (IF SHOWN) FORM PART OF THE PLAN AND SURVEY AND MUST REMAIN WITH THE PLAN IN ANY REPRODUCTION IN WHOLE OR PART.

1B THE CAD FILE USES METRES AS ITS BASE UNIT AND IS IN A "GROUND" COORDINATE SYSTEM. IF THE SURVEY IS STATED AS MGA, ANY POINT IN THE FILE WILL BE AN APPROXIMATE MGA COORDINATE.

1C SOME SYMBOLS REPRESENTING PHYSICAL STRUCTURES SUCH AS POWER POLES AND PITS ARE DIAGRAMMATIC ONLY AND DO NOT NECESSARILY REPRESENT THE ACTUAL SIZE AND EXTENT OF THESE FEATURES.

1D THE SURVEY INFORMATION SHOWN HERE WAS PREPARED FOR A SPECIFIC PURPOSE FOR THE CLIENT SHOWN. THIS INFORMATION IS NOT INTENDED TO BE USED FOR ANY OTHER PURPOSE OR BY ANYONE NOT AUTHORISED BY THIS CLIENT.

2A BOUNDARY DIMENSIONS AND AREAS HAVE BEEN DETERMINED BY CURRENT CADASTRAL SURVEY AND THE BOUNDARY AND EASEMENT LINES IN THE ELECTRONIC FILE HAVE BEEN INCLUDED USING THOSE SURVEYED DIMENSIONS. THE TITLE DIMENSIONS SHOWN ON THE HARD COPY PLAN TAKE PRECEDENCE OVER THE LINES IN THE ELECTRONIC FILE.

3A THE TITLES TO THE SUBJECT LAND HAS BEEN REVIEWED AND THE POSITION OF ALL EASEMENTS AFFECTING THE LAND ARE SHOWN. THE TERMS OF ANY EASEMENT, RESTRICTION ON THE USE OF LAND OR COVENANT AFFECTING THE LAND HAVE NOT BEEN INVESTIGATED. LEASES AND OTHER NOTATIONS MAY ALSO EXIST WHICH AFFECT THE LAND.

4A UNDERGROUND SERVICES OTHER THAN THOSE SHOWN HAVE NOT BEEN INVESTIGATED PRIOR TO DEMOLITION, EXCAVATION OR CONSTRUCTION WORK ON THE SITE. THE RELEVANT SERVICE AUTHORITY SHOULD BE CONTACTED TO ESTABLISH DETAILED LOCATION AND DEPTH.

5A THIS SURVEY IS LIMITED TO IMPROVEMENTS AND OTHER DETAIL WHICH WERE VISIBLE AND ACCESSIBLE AT THE TIME OF SURVEY. THE LOCATION OF DETAIL SUCH AS PRIVATE UNDERGROUND SERVICE LINES AND BUILDING FOUNDATIONS WITHIN THE SITE IS UNKNOWN.

5B THE COORDINATES WITHIN THIS DRAWING RELATE TO THE DATUM SHOWN IN THE TITLE BLOCK. REFER TO A REGISTERED LAND SURVEYOR FOR FURTHER CLARIFICATION. CAUTION SHOULD BE TAKEN WHEN IMPORTING INFORMATION OBTAINED FROM OTHER SUB-CONSULTANTS OR SOURCES TO ENSURE THAT THE DATA IS ON A MATCHING COORDINATE SYSTEM.

5C CONTOURS SHOWN HEREON DEPICT THE GENERAL TOPOGRAPHY ONLY EXCEPT AT SPOT LEVELS SHOWN, THEY DO NOT NECESSARILY REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT.

5D ANY GUTTER, RIDGE, ROOF AND WINDOW DETAILS AND LEVELS SHOWN HAVE BEEN OBTAINED VIA INDIRECT SURVEY METHODS WHERE VISIBLE FROM GROUND LEVEL AND ARE SHOWN ON THIS PLAN IN THEIR APPROXIMATE LOCATION FOR THE PURPOSE OF GENERAL SITE ANALYSIS ONLY.

5E ANY TREE CANOPIES, TRUNK DIAMETERS AND HEIGHTS SHOWN ARE APPROXIMATE ONLY AND SHOULD BE VERIFIED BY FURTHER SURVEY WORKS IF CRITICAL TO DESIGN OR SITE ANALYSIS.

5F SMALL TREES, SHRUBS, GARDEN FEATURES, PATHWAYS AND OTHER MINOR DETAIL MAY NOT BE SHOWN ON THIS PLAN, FOR THE PURPOSES OF THIS SURVEY.

5G SOME UNDERGROUND SERVICE LINES (IDENTIFIED ON THE PLAN IN GREY) HAVE BEEN PLOTTED FROM THIRD PARTY DATA PROVIDED BY THE CLIENT AND ARE APPROXIMATE.

BEFORE YOU DIG www.byda.com.au

LEGEND

- BOLLARD
- TRAFFIC SIGNAL POLE
- TRAFFIC SIGNAL PIT
- GATE
- ELECTRICAL PILLAR
- POWER POLE
- LIGHT POLE
- COMMS JUNCTION PIT
- MANHOLE
- MAINTENANCE SHAFT
- INSPECTION OPENING
- TAP
- HYDRANT
- STOP VALVE
- WATER METER
- RECYCLED WATER HYDRANT
- RECYCLED WATER STOP VALVE
- GAS VALVE
- GRATED PIT
- PIT/LINTEL
- SAG PIT
- BENCHMARK
- 8/0.4/15 TREE, SPREAD/DIAMETER/HEIGHT
- BANK

The symbols depicted are purely illustrative and should not be interpreted as exact representations. The scale and orientation of these symbols may not accurately reflect the actual size or orientation of the corresponding features.

- UNDERGROUND POWER
- OVERHEAD POWER
- COMMUNICATIONS
- OVERHEAD COMMUNICATIONS
- SEWER
- WATER
- RECYCLED WATER
- GAS
- SERVICE HYDRANT
- DRAINAGE
- CONTOUR
- UNDERGROUND POWER
- COMMUNICATIONS
- SEWER
- WATER
- SEWER
- STORM WATER
- FIRE HYDRANT
- THIRD PARTY DATA BOUNDARIES

Services shown in gray have been provided by others, location and connectivity not verified.

All Overhead Comms and Electrical are approximate only.

- BUILDING/STRUCTURES
- HARD SURFACES

THIRD PARTY DATA FROM DWG FILE - 2301879-010-LAY

(L1) LEASES TO CROWN CASTLE (AH574654, AH574655, AH574656, AH574657)

(L2) LEASES TO AMPLITEL (AH208745 AND AH208746) AND LEASES TO CROWN CASTLE (AH574654, AH574655, AH574656. AH574657)

(ZA2) EASEMENT TO DRAIN WATER 3.0 WIDE

(ZA3) EASMENT TO DRAIN WATER VARIABLE WIDTH

(ZB2) RIGHT OF CARRIAGE WAY VARIABLE WIDTH (DP1236474)

(ZEE2) EASEMENT FOR ELECTRICITY AND OTHER PURPOSES (DP1144378)

(ZEE3) EASEMENT FOR ELECTRICITY AND OTHER PURPOSES 2 & 3.3 WIDE (DP1236474)

0 30 60 90

SCALE ON ORIGINAL DRAWING AT 1:1500

PLAN OF CONTOUR AND DETAIL OVER SITE

LOT 2 IN DP1291984, LOT 1 IN DP547874, AND LOTS 1, 2 AND 3 IN DP91953
2 BULLECOURT AVENUE, MILPERRA

Client: MIRVAC

BC	E	22-08-2025	Detail survey after demolition
BC	D	08-05-2025	Addition of extra trees
BC	C	16-09-2024	Updated tree positions
BC	B	28-02-2024	Additional information
BC	A	~	Original Issue
By	Ver	Date	Amendments

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Survey Date: 25-09-2023
Vertical Datum: AHD
Horizontal Datum: GDA 2020
Origin of Levels
SSM: 25363
RL: 4.627

MGA SCIMS

Scale (A3) 1:1500 (A1)

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SHEET KEY

BULLECOURT

AVENUE

ASHFORD

1
DP 91953

2
DP 91953
MILPERRA RESERVE

3
DP 91953

GRASSED AREA

PICNIC SHELTER

ELECTRICAL EQUIPMENT CUPBOARD

MISCELLANEOUS WIRE NOT LOCATED BY SURVEY

BRICK BUILDING

CONCRETE AREA

CONCRETE PATH

AWNING

BIN STORAGE

VEHICLE CROSSING

PIT NOT ACCESSIBLE

SW PIT

SMH TOP RL 12.84
BOTTOM OF BASE 11.64

SMH TOP RL 12.23
BOTTOM OF BASE 11.08

SMH TOP RL 11.89
BOTTOM OF BASE 10.11

INV OUT 9.57

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

0 4 8 12

SCALE ON ORIGINAL DRAWING AT 1:200

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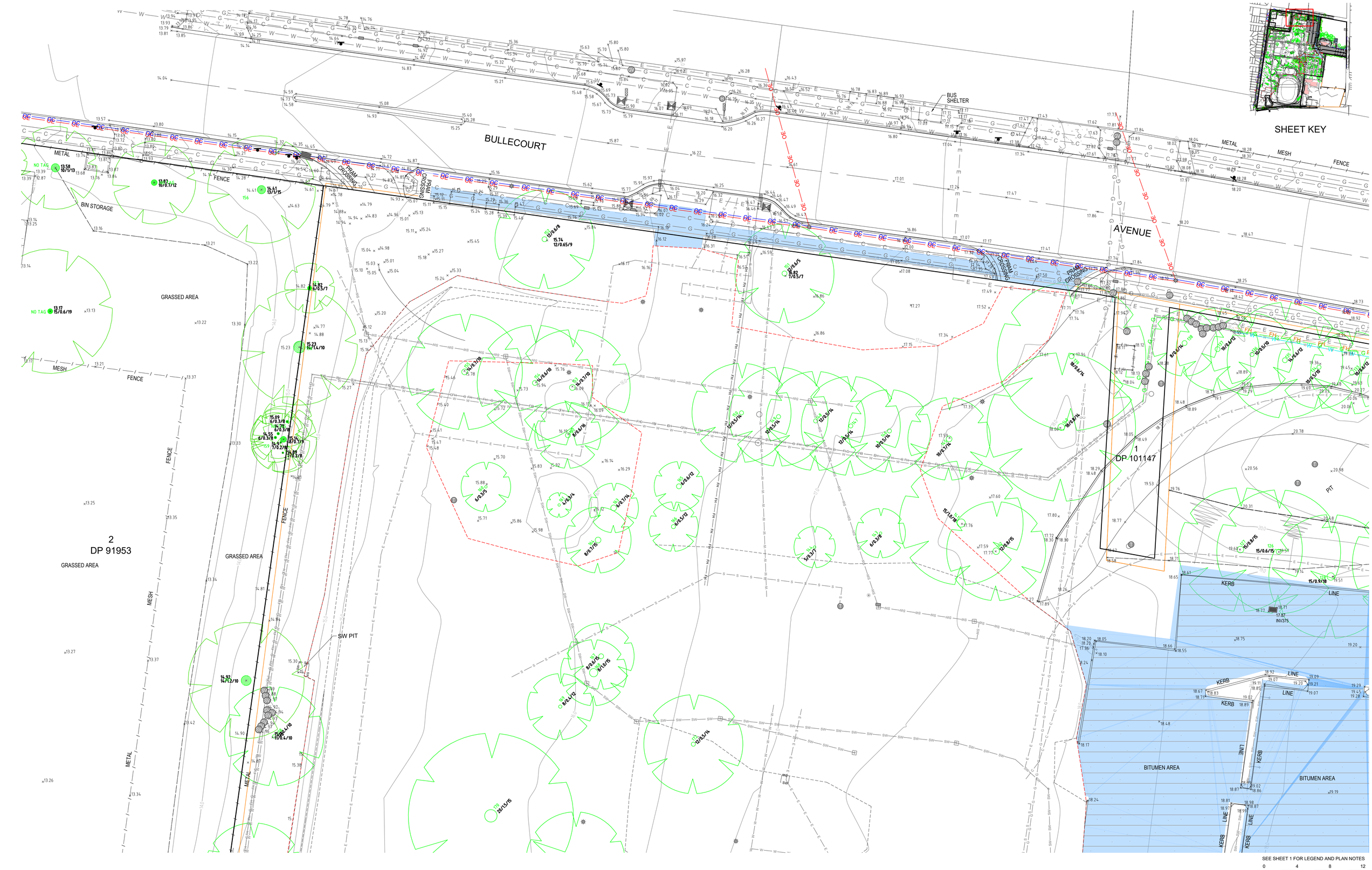

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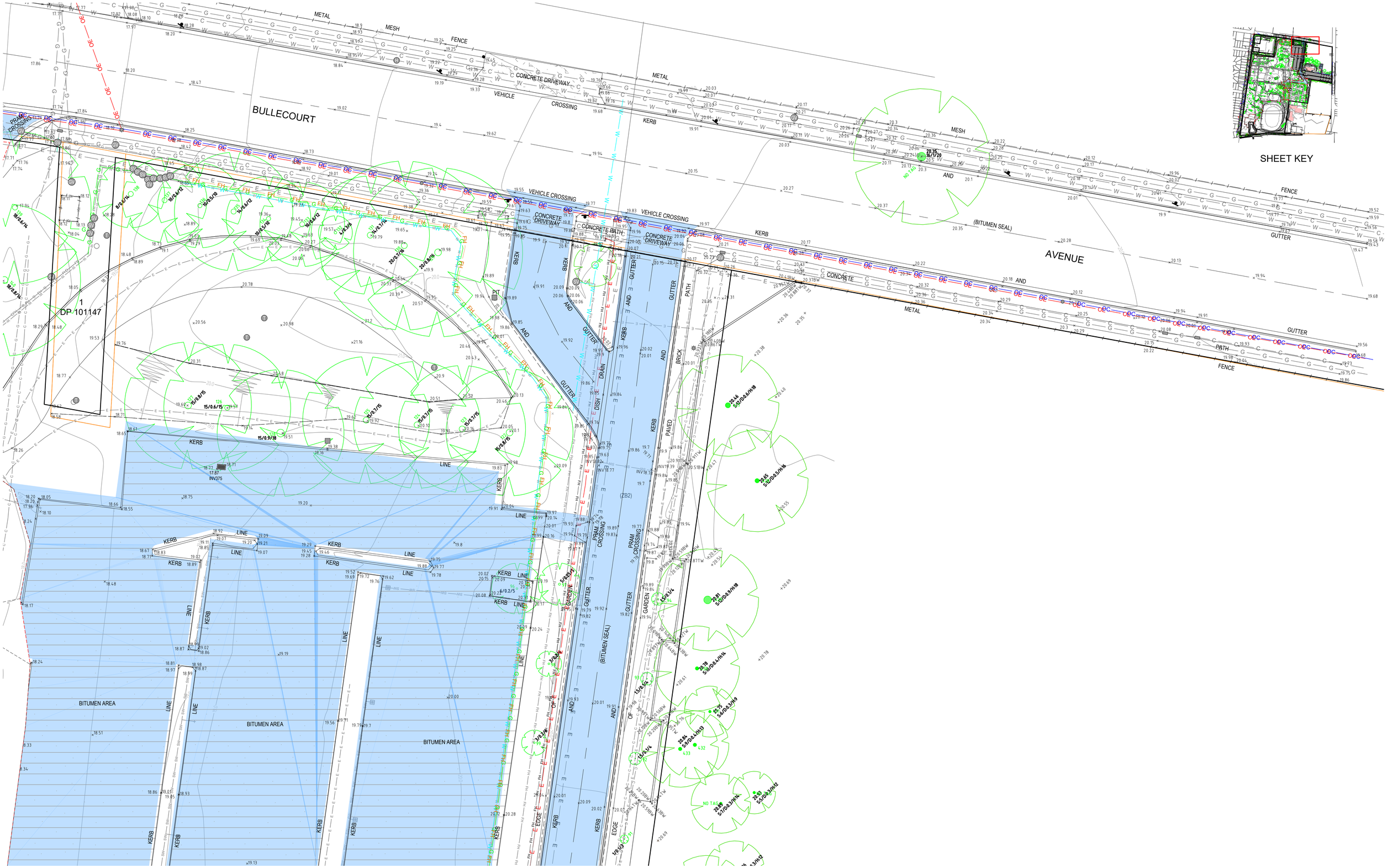

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BULLECOURT AVENUE

HORSLEY ROAD

FOREST AREA

(L1)

(L2)

SHEET KEY

NO TAG 21.69
NO TAG 21.35
21.17
21.28
NO TAG
NO TAG 21.45
21.24
21.85 NO TAG
21.98 NO TAG
21.69
NO TAG
NO TAG
NO TAG
NO TAG
19.82

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SHEET KEY

GRASSED AREA

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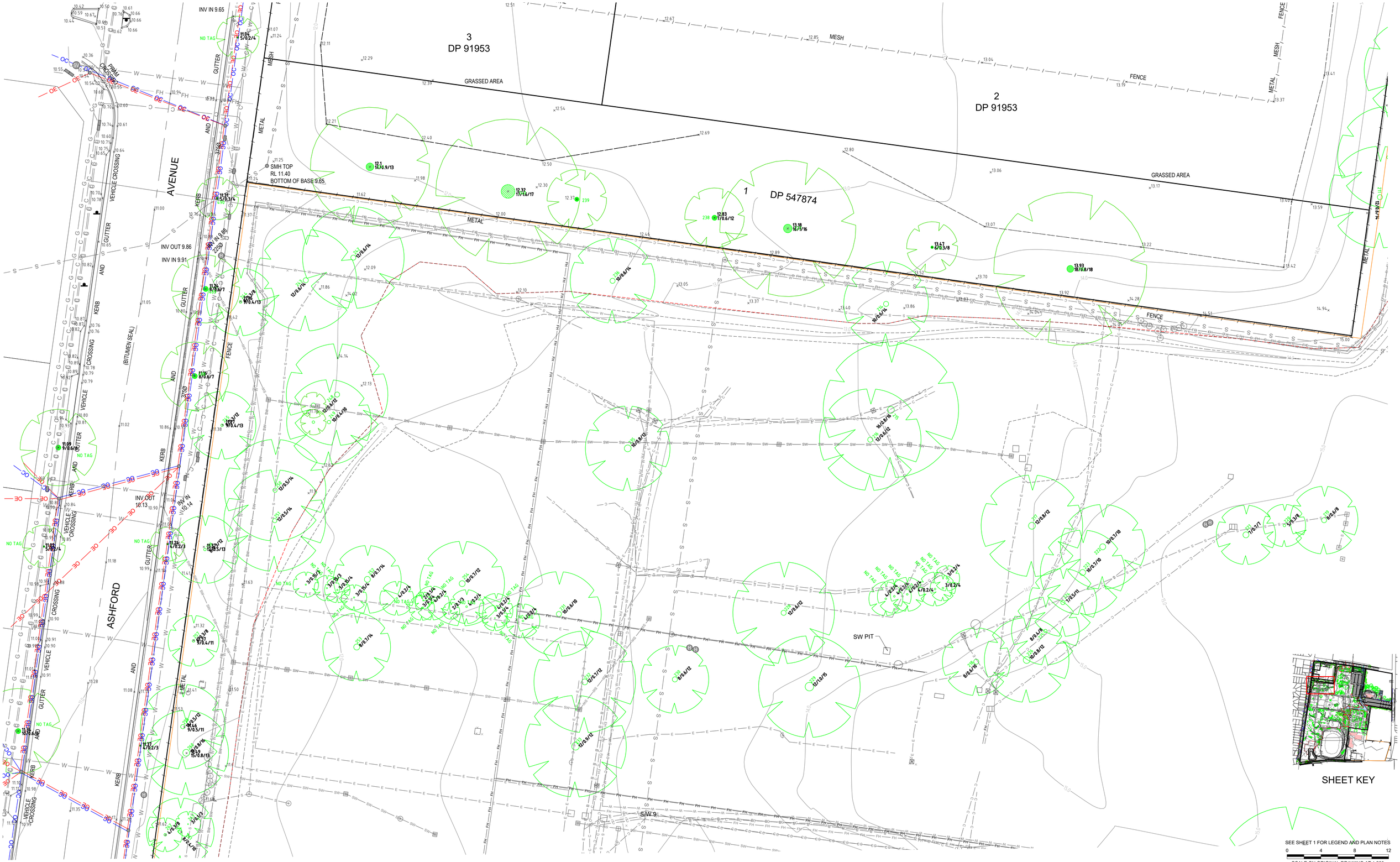

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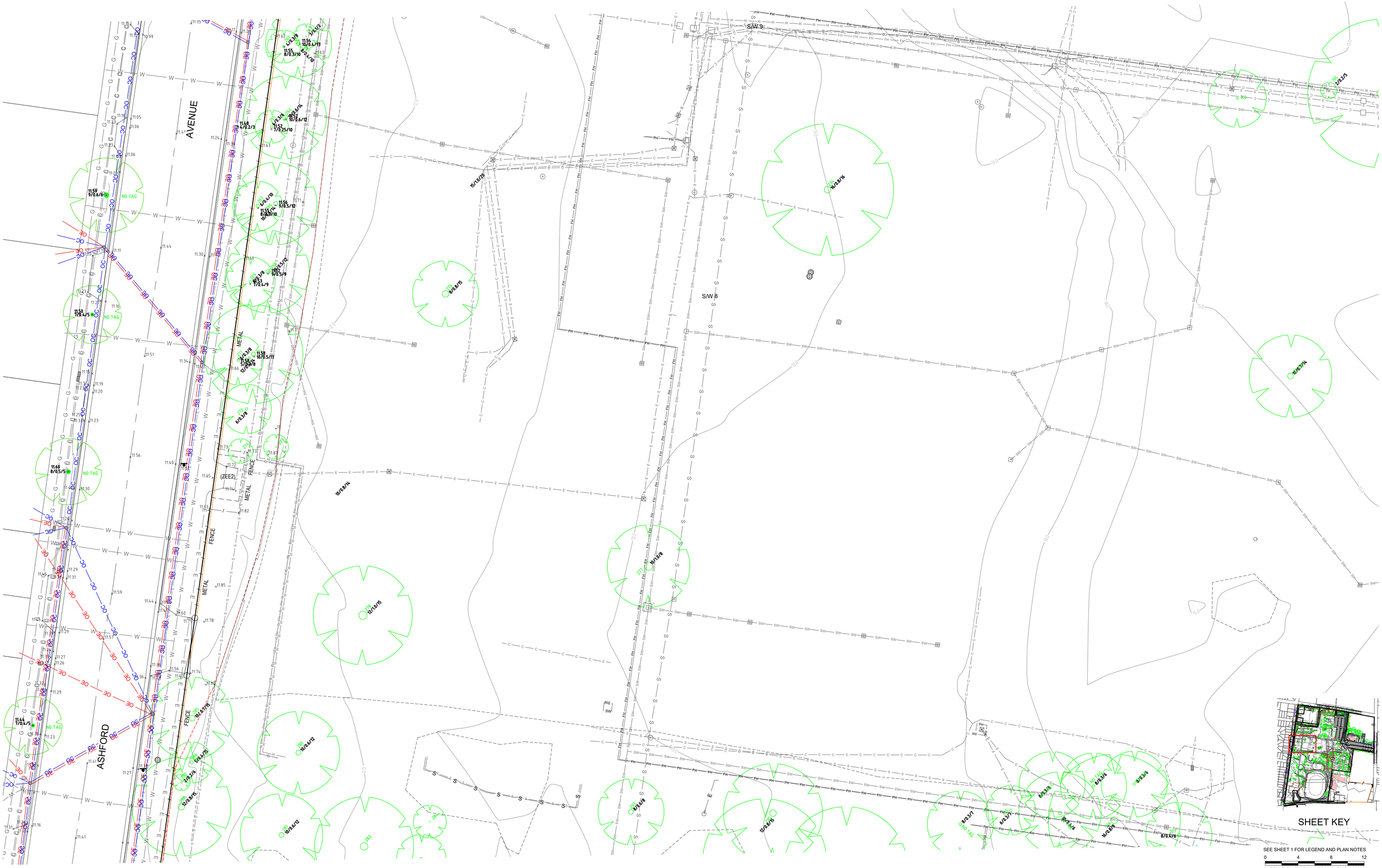

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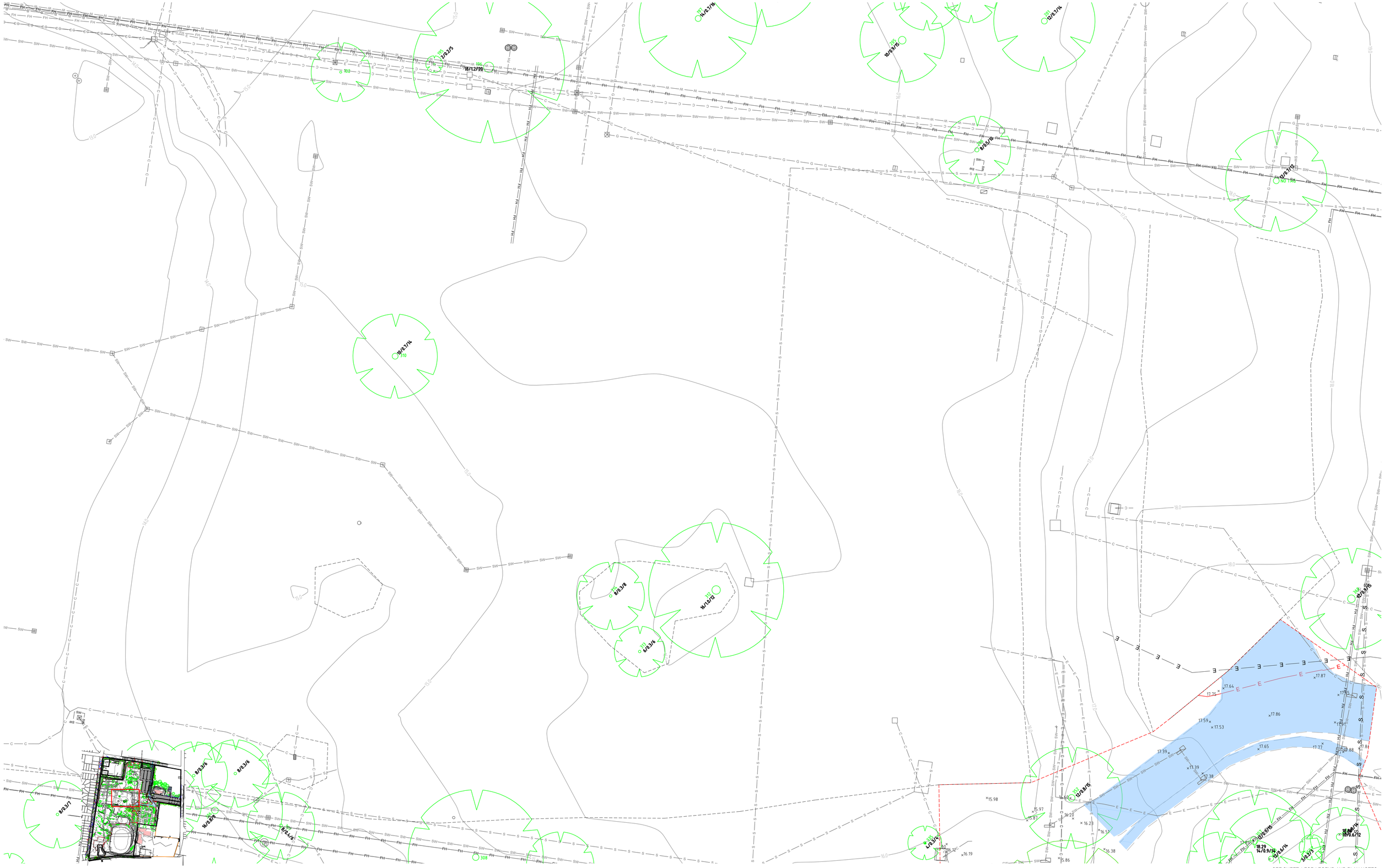

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MGA SCIMS

Scale (A3) (A1) 1:200

S:\JOBS\23\2301879 - 2 Bullecourt Avenue Milperra_Sur\EMW\2301879-DET\3 Drafting\current CAD file\2301879-DET.dwg

SHEET KEY

KERB
LINE
BITUMEN AREA
SMH TOP RL 19.48
INV IN 17.77
INV OUT 17.73
GUTTER AND KERB
PRAM CROSSING
PATH
BRICK PAVED
BITUMEN
EDGE
DRIVEWAY
GRASSED AREA
ISSED AREA
(ZB2)
(ZEE3)
OF

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

0 4 8 12

SCALE ON ORIGINAL DRAWING AT 1:200

PLAN OF CONTOUR AND DETAIL OVER SITE

LOT 2 IN DP1291984, LOT 1 IN DP547874, AND LOTS 1, 2 AND 3 IN DP91953
2 BULLECOURT AVENUE, MILPERRA

Client: MIRVAC

mirvac

Beveridge Williams
Development and Infrastructure Consultants
Western Sydney ph: (02) 4625 5055
www.beveridgewilliams.com.au

By	Ver.	Date	Amendments
BC	E	22-08-2025	Detail survey after demolition
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BC	B	28-02-2024	Additional Information
BC	A	-	Original Issue

Survey Date: 25-09-2023
Vertical Datum: AHD
Horizontal Datum: GDA 2020
Origin of Levels
SSM: 25363
RL: 4.927

MGA SCIMS

Scale (A3)
(A1) 1:200

Sheet 12 of 22

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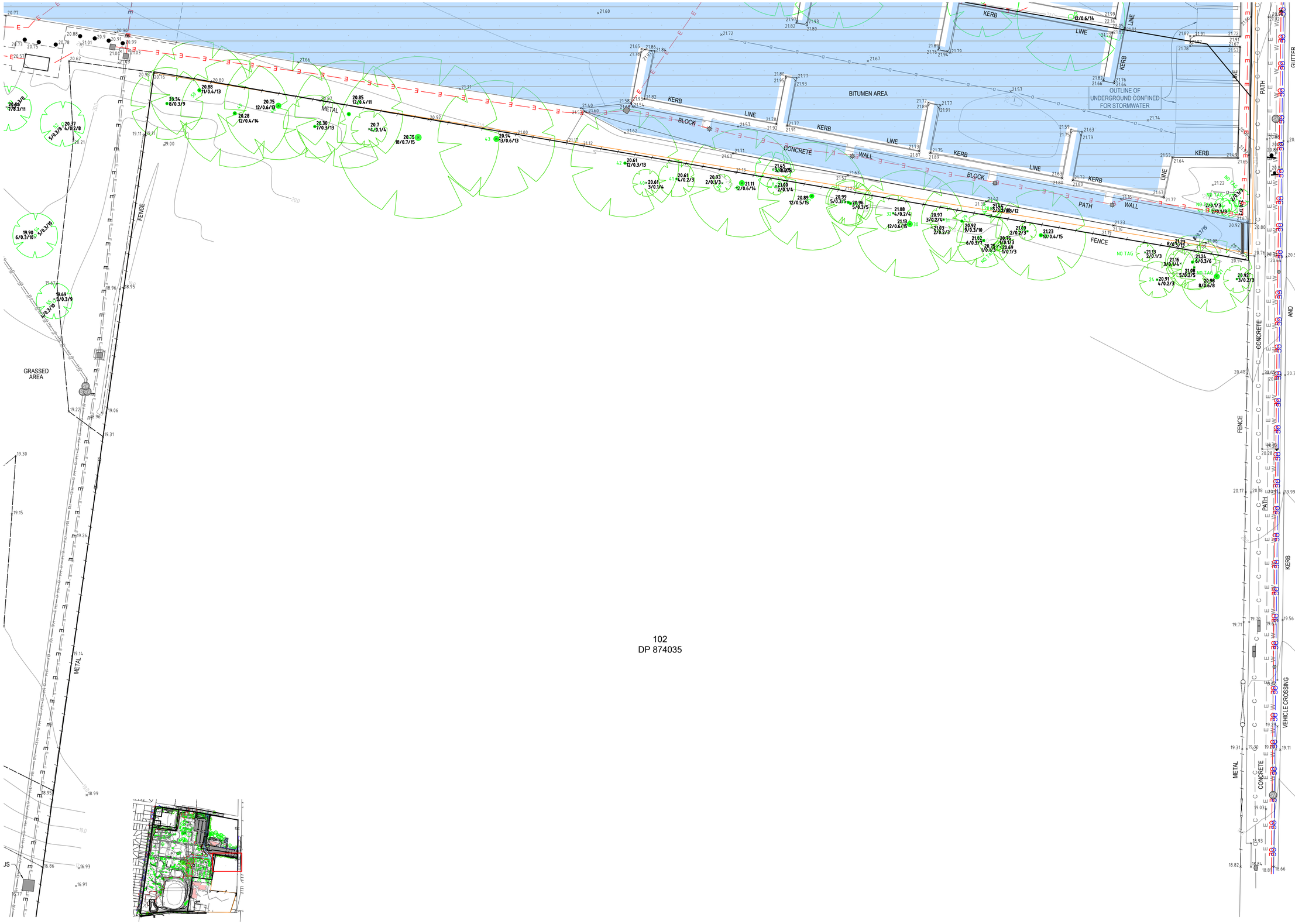

SHEET KEY

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MGA SCIMS

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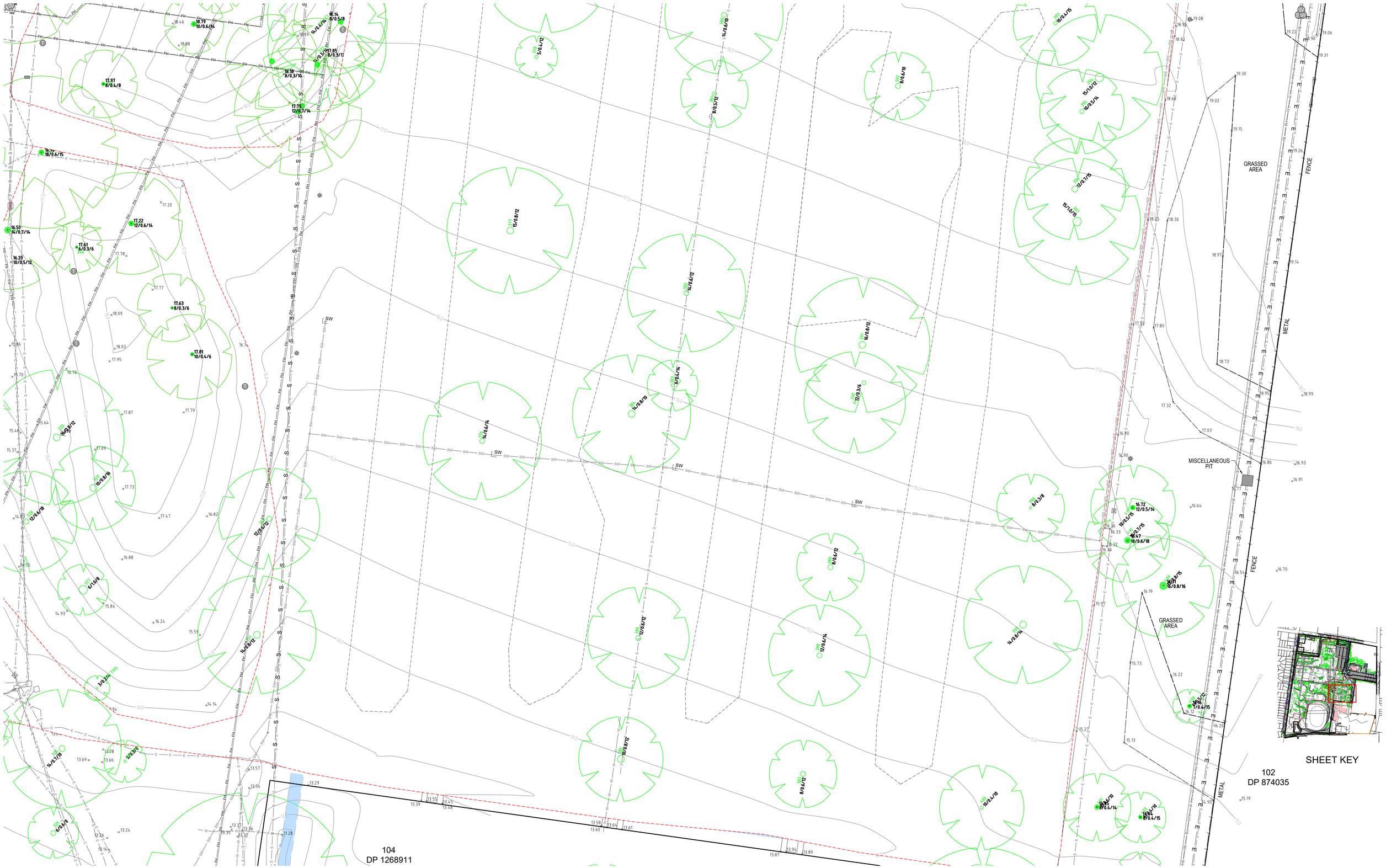

SHEET KEY

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PLAN OF CONTOUR AND DETAIL OVER SITE

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MGA SCIMS

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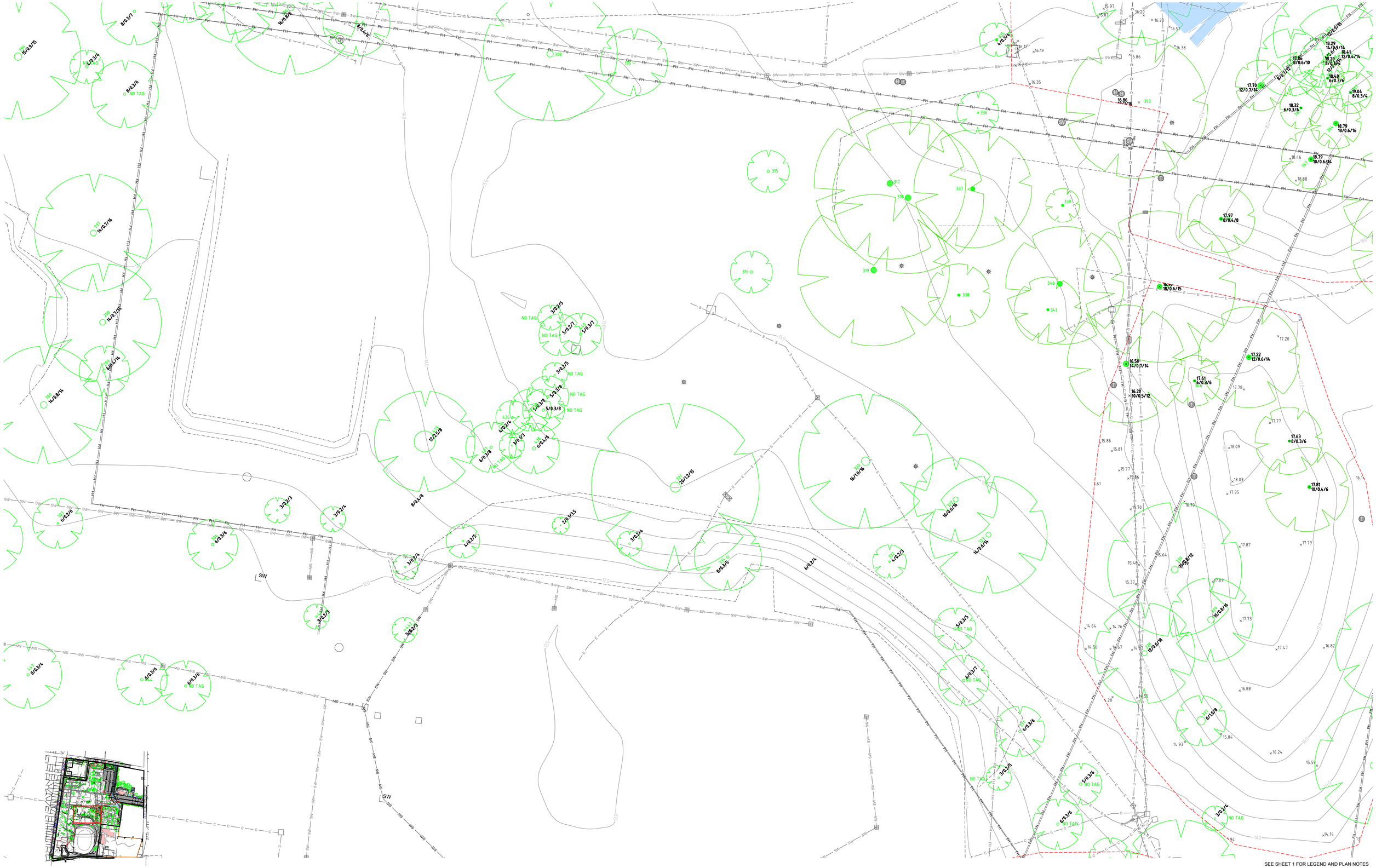

SHEET KEY

PLAN OF CONTOUR AND DETAIL OVER SITE

LOT 2 IN DP1291984, LOT 1 IN DP547874, AND LOTS 1, 2 AND 3 IN DP91953
2 BULLECOURT AVENUE, MILPERRA

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MGA SCIMS

Scale (A3) (A1) 1:200

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SHEET KEY

AVENUE

ASHFORD

VEHICLE CROSSING

GUTTER AND KERB

(BITUMEN SEAL)

INV IN 5.82
INV OUT 5.77

INV IN 5.79
INV IN 5.77

INV IN 5.84
PVC PIPES
INV OUT 5.62

INV IN 4.80
INV OUT 4.79

INV IN 4.36
INV OUT 4.34

GRASS OVAL

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

0 4 8 12

SCALE ON ORIGINAL DRAWING AT 1:200

PLAN OF CONTOUR AND DETAIL OVER SITE

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MGA SCIMS

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INV IN 4.80
INV OUT 4.79
INV OUT 5.82
INV OUT 5.95
INV OUT 6.16
INV OUT 5.97
INV/IN 6.21
INV100 OULET
GRASS OVAL
GRASSED AREA
(ZA2)
(ZA3)
(ZA2)(ZA3)
PAVED
BRICK
PATH
NO TAG

SHEET KEY

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

0 4 8 12

SCALE ON ORIGINAL DRAWING AT 1:200

PLAN OF CONTOUR AND DETAIL OVER SITE

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SHEET KEY

GRASS OVAL

GRASSED AREA

GRASSED AREA

GRASSED AREA

CONCRETE

CONCRETE

CONCRETE

PATH

PATH

PATH

PAVED - BRICK

INV OUT 5.97

INV IN 6.21

225Ø

STEP

(ZA2)

104
DP 1268911

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

0 4 8 12

SCALE ON ORIGINAL DRAWING AT 1:200

PLAN OF CONTOUR AND DETAIL OVER SITE

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MGA SCIMS

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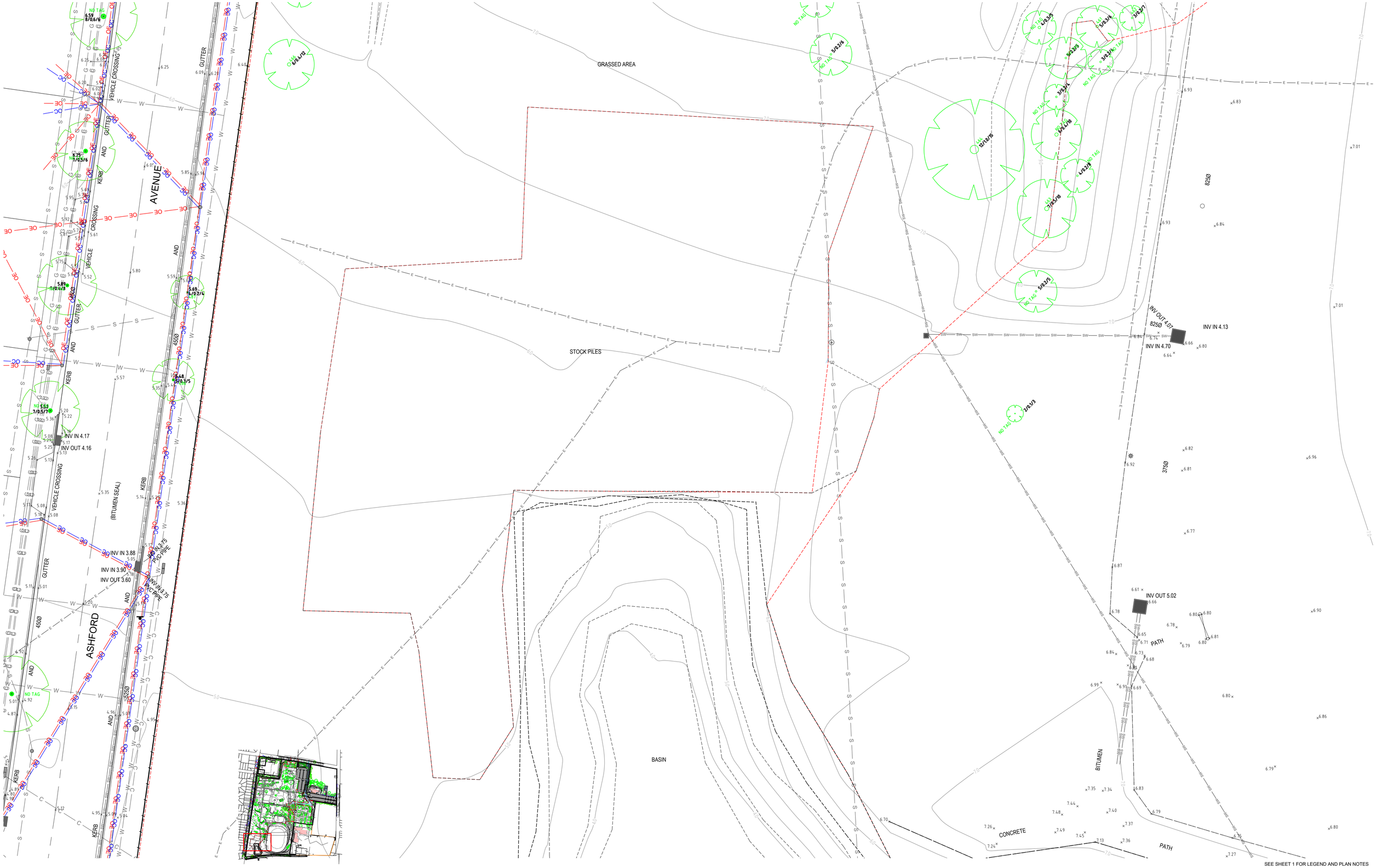

SHEET KEY

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MGA SCIMS

Scale (A3) 1:200
(A1)

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Scale (A3) 1:200 (A1)

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GRASS OVAL

GRASSED AREA

GRASSED AREA

PATH

CONCRETE

MONITORING WELL

MONITORING WELL

EDGE OF CONCRETE

(ZA2)

(ZA3)

HEADWALL

SMH TOP RL 4.03

METAL

MESH

FENCE

METAL

MESH

FENCE

HEADWALLS

SOUTH

WESTERN

MOTORWAY

SHEET KEY

SEE SHEET 1 FOR LEGEND AND PLAN NOTES

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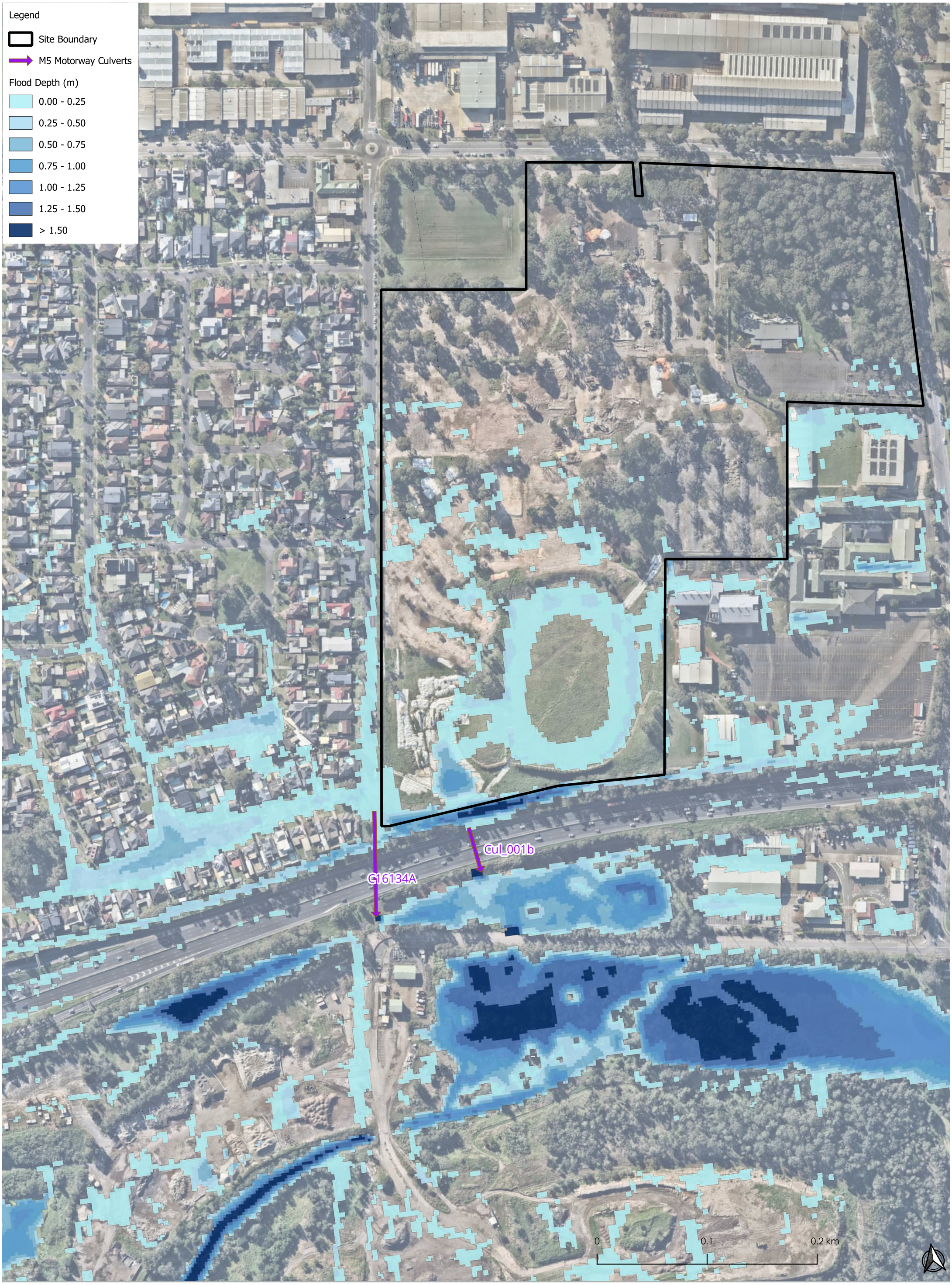
APPENDIX B: BASE CASE EXISTING FLOOD MAPS



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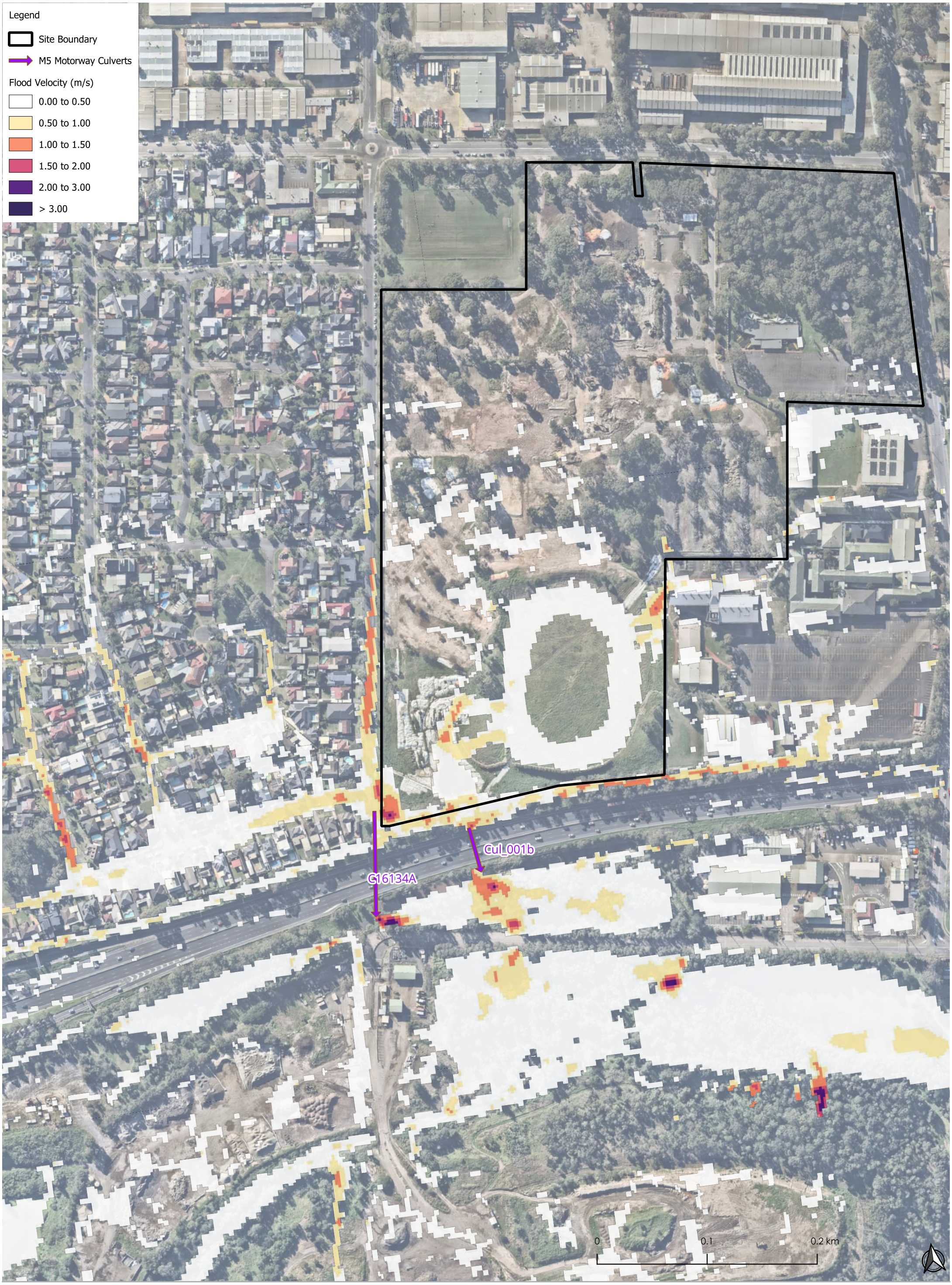
Suite 4.05, 3 Fordham Way
Oran Park, NSW 2570
Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Flood Depth
100 Year ARI
Base Case Existing
Figure B1

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11



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Flood Velocity
100 Year ARI
Base Case Existing
Figure B2

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

Legend

Site Boundary

M5 Motorway Culverts

Hazard Category

H1

H2

H3

H4

H5

H6

C16134A

Cul_001b

0 0.1 0.2 km

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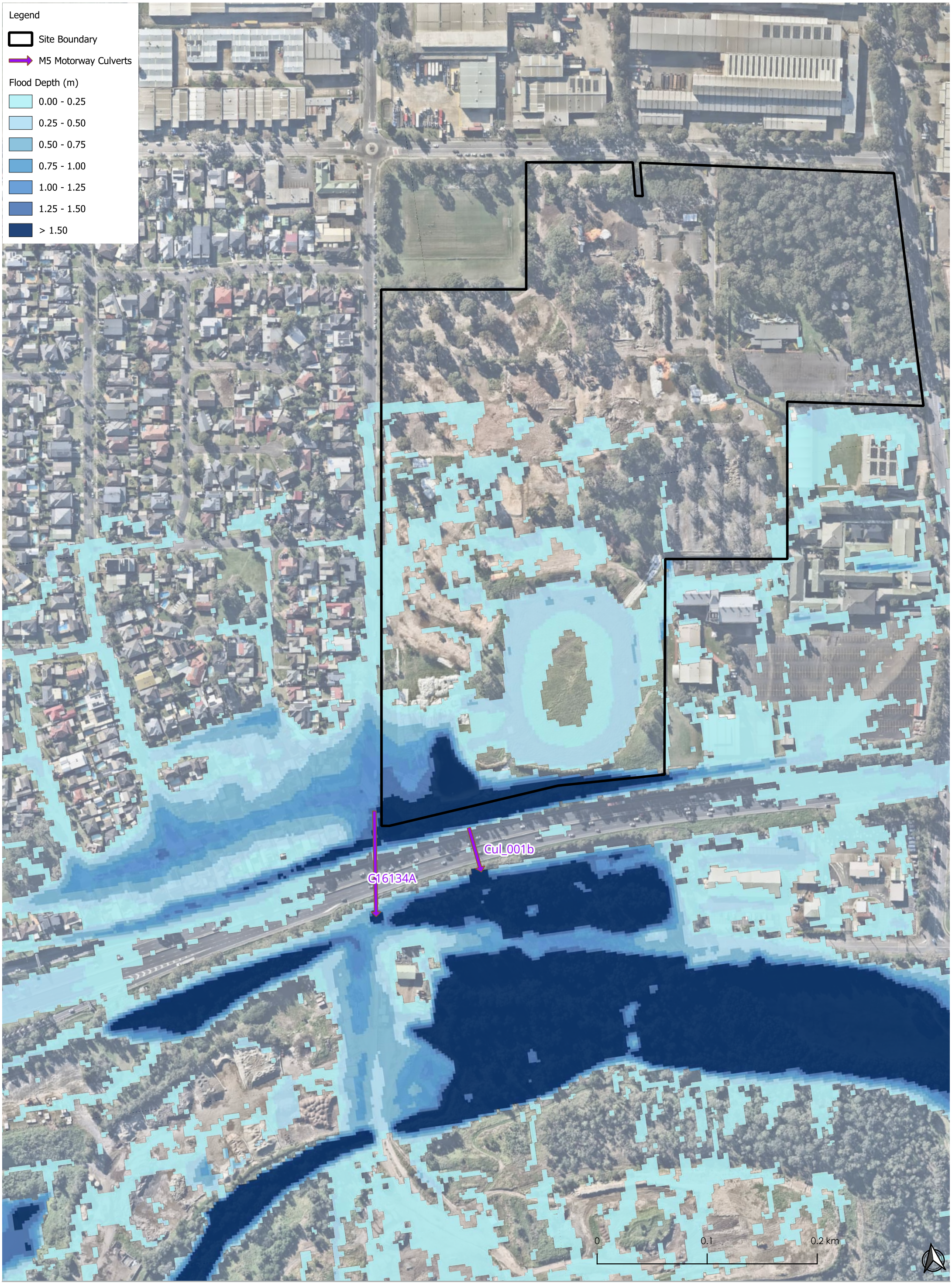
Client:

Mirvac Residential (NSW) Development Pty Ltd

Hazard Category
100 Year ARI
Base Case Existing
Figure B3

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11



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Client:

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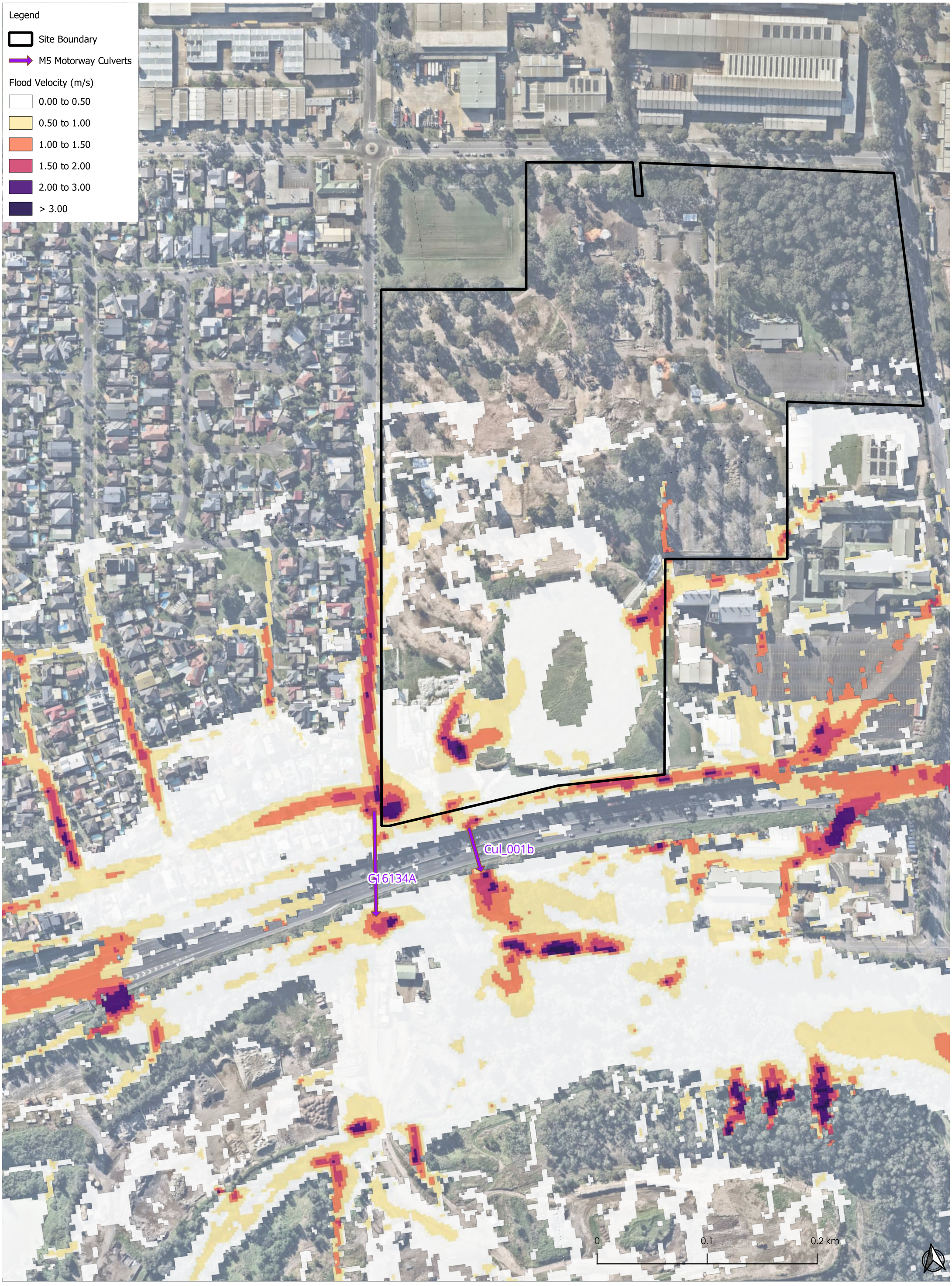
Flood Depth
PMF
Base Case Existing
Figure B4

Project Coordination:	EPSG:7856
Drawn by:	YL
Checked by	FG
Issued:	Date: 2026-03-11



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Client:

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Flood Velocity
PMF
Base Case Existing
Figure B5

Project Coordination:	EPSG:7856
Drawn by:	YL
Checked by	FG
Issued:	Date: 2026-03-11

Legend

Site Boundary

M5 Motorway Culverts

Hazard Category

H1

H2

H3

H4

H5

H6

C16134A

Cul_001b

0 0.1 0.2 km

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Client:

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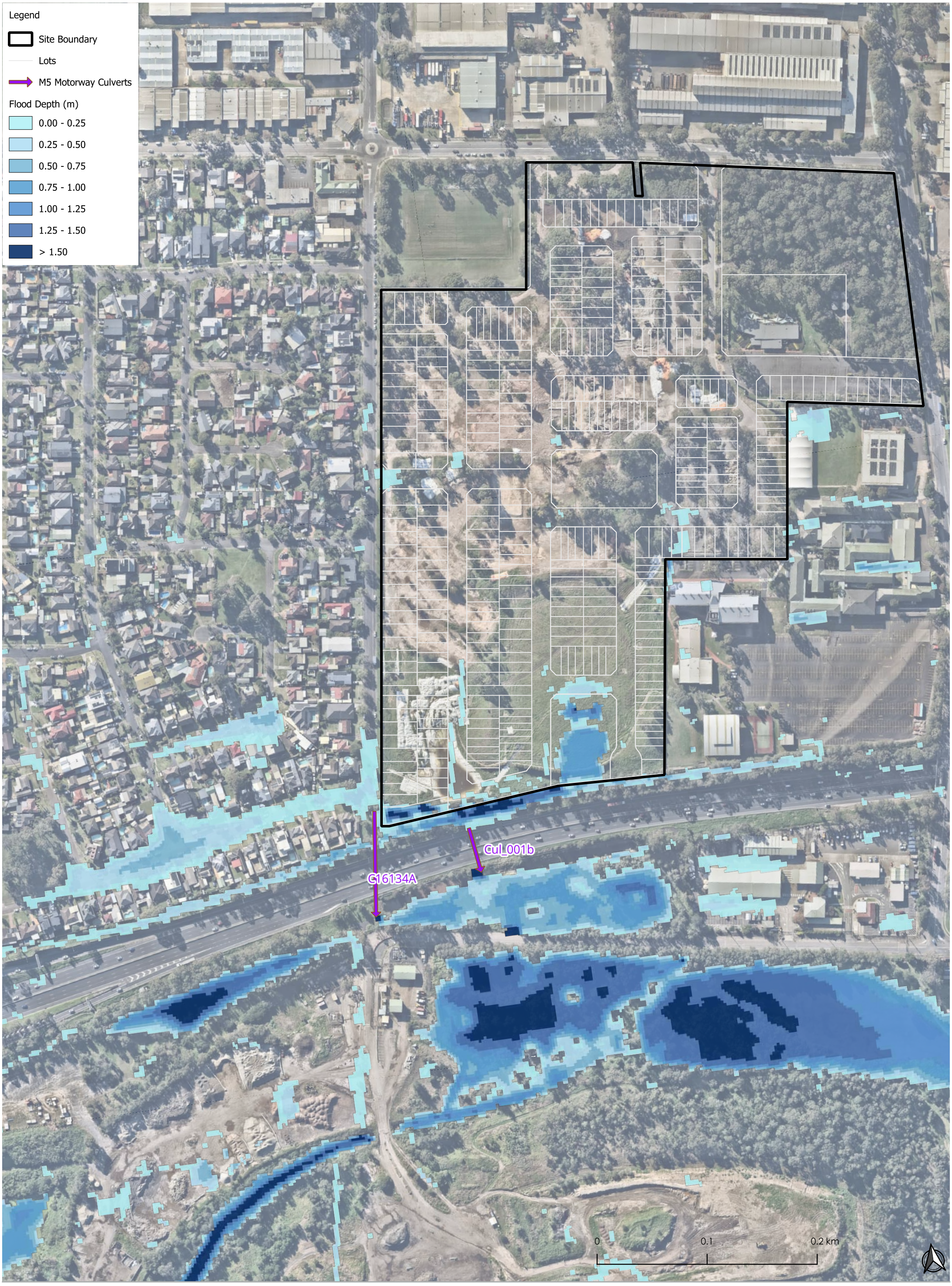
Hazard Category
PMF
Base Case Existing
Figure B6

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

APPENDIX C: BASE CASE PROPOSED FLOOD MAPS



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Client:

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Flood Depth
100 Year ARI
Base Case Proposed
Figure C1

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

Flood Velocity (m/s)

0.00 to 0.50

0.50 to 1.00

1.00 to 1.50

1.50 to 2.00

2.00 to 3.00

> 3.00

C16134A

Cul_001b

0 0.1 0.2 km

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Client:

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Flood Velocity
100 Year ARI
Base Case Proposed
Figure C2

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

C16134A

Cul_001b

0 0.1 0.2 km

Beveridge Williams

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Oran Park, NSW 2570
Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Hazard Category
100 Year ARI
Base Case Proposed
Figure C3

Project Coordination:	EPSG:7856
Drawn by:	YL
Checked by	FG
Issued:	Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

Water Level Difference (m)

Was Wet Now Dry(No longer Flooded)

<=-1.0

-1.00 - -0.30

-0.30 - -0.10

-0.10 - -0.05

-0.05 - 0.05

0.05 - 0.10

0.10 - 0.30

0.30 - 1.00

>=1.0

Was Dry Now Wet(Newly Flooded)

Cul_001b

C16134A

0 0.1 0.2 km

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Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Water Level Difference
100 Year ARI
Base Case Proposed Less Base Case Existing
Figure C4

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
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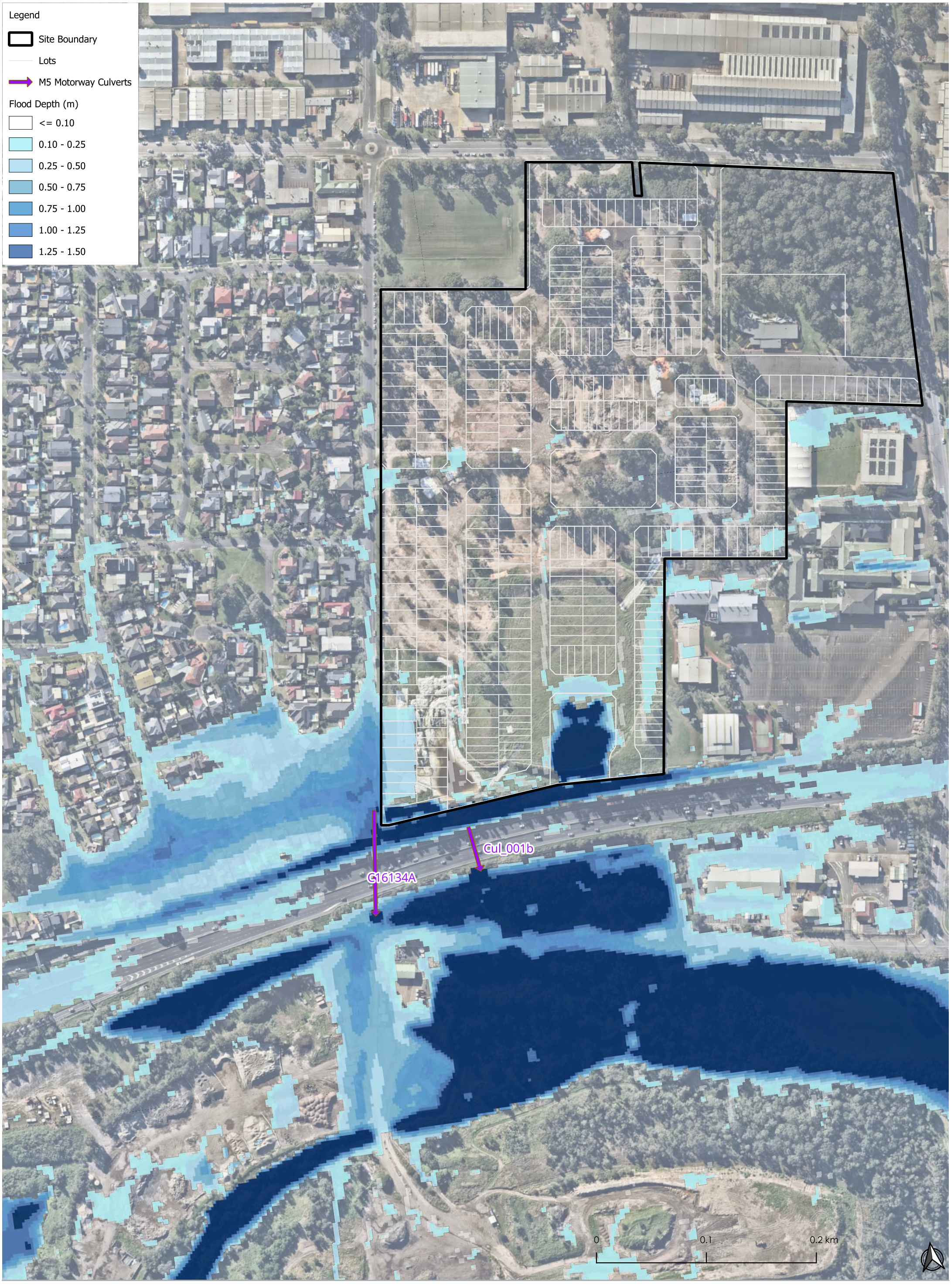

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Client:

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Flood Depth
PMF
Base Case Proposed
Figure C5

Project Coordination:	EPSG:7856
Drawn by:	YL
Checked by	FG
Issued:	Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

Flood Velocity (m/s)

0.00 to 0.50

0.50 to 1.00

1.00 to 1.50

1.50 to 2.00

2.00 to 3.00

> 3.00

C16134A

Cul_001b

0 0.1 0.2 km

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Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Flood Velocity
PMF
Base Case Proposed
Figure C6

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

Hazard Category

H1

H2

H3

H4

H5

H6

Cul_001b

C16134A

0 0.1 0.2 km

Beveridge Williams

Western Sydney Office
Level 4, LPC House,
Suite 4.05, 3 Fordham Way
Oran Park, NSW 2570
Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Hazard Category
PMF
Base Case Proposed
Figure C7

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

Legend

Site Boundary

Lots

M5 Motorway Culverts

C16134A

Cul_001b

0 0.1 0.2 km

Beveridge Williams

Western Sydney Office
Level 4, LPC House,
Suite 4.05, 3 Fordham Way
Oran Park, NSW 2570
Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Water Level Difference
PMF
Base Case Proposed Less Base Case Existing
Figure C8

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

APPENDIX D: SENSITIVITY TEST 1% AEP WATER LEVEL DIFFERENCE

Legend

- Site Boundary
- Lots
- M5 Motorway Culverts

Water Level Difference (m)

- Was Wet Now Dry(No longer Flooded)
- <=-1.0
- -1.00 - -0.30
- -0.30 - -0.10
- -0.10 - -0.05
- -0.05 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 1.00
- >=1.0
- Was Dry Now Wet(Newly Flooded)

C16134A

Cul_001b

0 0.1 0.2 km

Beveridge Williams

Western Sydney Office
Level 4, LPC House,
Suite 4.05, 3 Fordham Way
Oran Park, NSW 2570
Tel: (02) 4625 5055

Client:

Mirvac Residential (NSW) Development Pty Ltd

Water Level Difference
100 Year ARI
Sensitivity Test Proposed Less Sensitivity Test Existing
Figure D1

Project Coordination: EPSG:7856
Drawn by: YL
Checked by FG
Issued: Date: 2026-03-11

APPENDIX E: ADDITIONAL OVERLAND FLOW CALCULATIONS

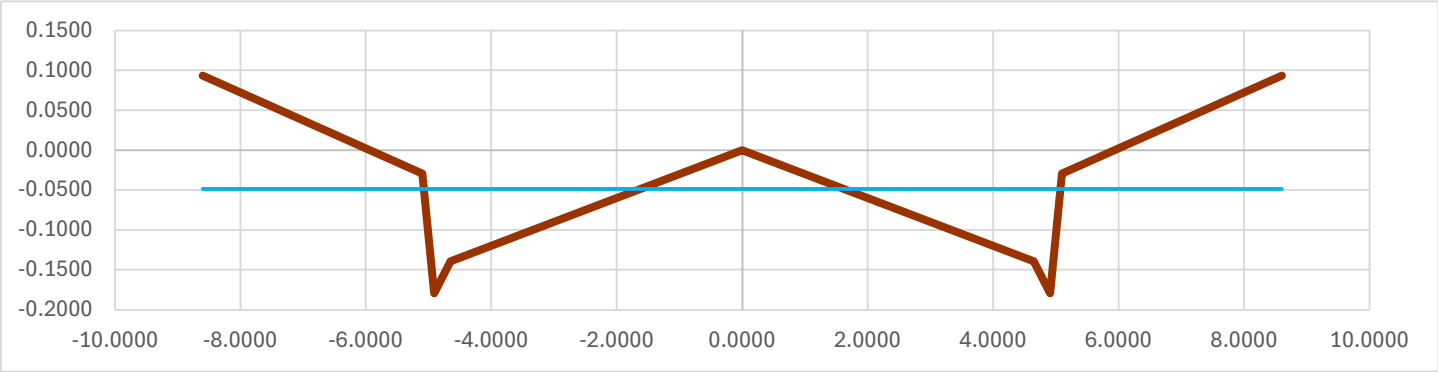
Manning's Calculation

Inputs

Section	A - Road 2A Ch270	
PMF Peak Flow	0.238	cu.m/s
Longitudinal Slope (S)	1	%
Water Level (h)	-0.048	m

Output Summary

Average Velocity (Vavg)	**0.669**	m/s
Max Velocity (Vmax)	**1.146**	m/s
Average Depth (davg)	**0.057**	m
Max Depth (dmax)	**0.131**	m
VxDavg (Z0avg)	**0.038**	sq.m/s
VxDmax (Z0max)	**0.150**	sq.m/s
Average Mannings	**0.020**	



Chainage (m)	Elevation (m)	Manning's Roughness
-8.6000	0.0935	0.035
-5.1000	-0.0295	0.035
-4.9090	-0.1795	0.02
-4.6500	-0.1395	0.02
0.0000	0.0000	0.02
4.6500	-0.1395	0.02
4.9090	-0.1795	0.02
5.1000	-0.0295	0.035
8.6000	0.0935	0.035

Velocity (m/s)	Average Depth (m)	Max Depth (m)	VxDavg (sq.m/s)	VxDmax (sq.m/s)
0.000	**0.000**	**-0.019**	**0.000**	**0.000**
0.396	**0.066**	**0.131**	**0.026**	**0.052**
1.146	**0.111**	**0.131**	**0.127**	**0.150**
0.637	**0.046**	**0.091**	**0.029**	**0.058**
0.637	**0.046**	**0.091**	**0.029**	**0.058**
1.146	**0.111**	**0.131**	**0.127**	**0.150**
0.692	**0.066**	**0.131**	**0.045**	**0.091**
0.000	**0.000**	**-0.019**	**0.000**	**0.000**
END	**END**	**END**	**END**	**END**

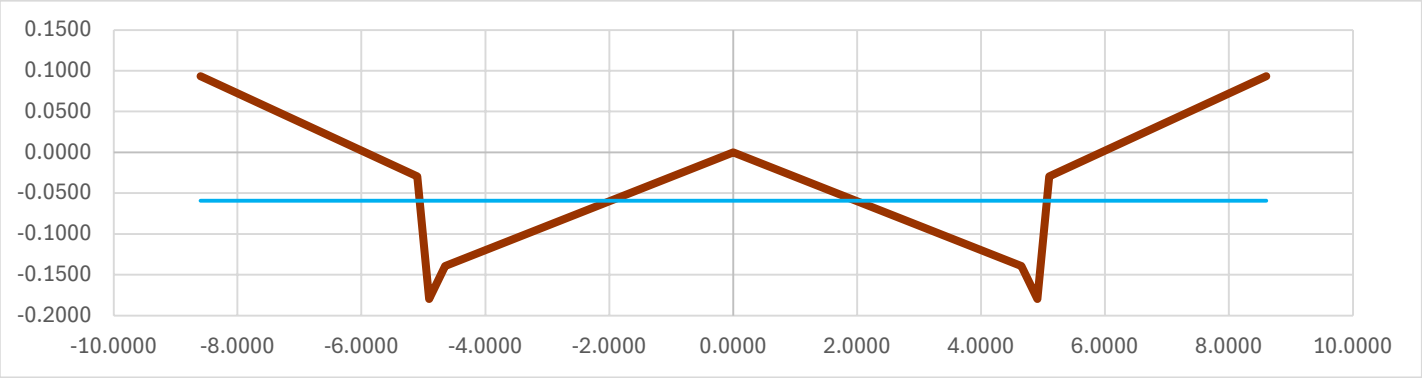
Manning's Calculation

Inputs

Section	B - Road 2A Ch450	
PMF Peak Flow	0.356	cu.m/s
Longitudinal Slope (S)	4	%
Water Level (h)	-0.059	m

Output Summary

Average Velocity (Vavg)	**1.245**	m/s
Max Velocity (Vmax)	**2.141**	m/s
Average Depth (davg)	**0.052**	m
Max Depth (dmax)	**0.120**	m
VxDavg (Z0avg)	**0.065**	sq.m/s
VxDmax (Z0max)	**0.258**	sq.m/s
Average Mannings	**0.020**	



Chainage (m)	Elevation (m)	Manning's Roughness	Velocity (m/s)	Average Depth (m)	Max Depth (m)	VxDavg (sq.m/s)	VxDmax (sq.m/s)
-8.6000	0.0935	0.035	**0.000**	**0.000**	**-0.030**	**0.000**	**0.000**
-5.1000	-0.0295	0.035	**0.747**	**0.060**	**0.120**	**0.045**	**0.090**
-4.9090	-0.1795	0.02	**2.141**	**0.100**	**0.120**	**0.215**	**0.258**
-4.6500	-0.1395	0.02	**1.172**	**0.040**	**0.080**	**0.047**	**0.094**
0.0000	0.0000	0.02	**1.172**	**0.040**	**0.080**	**0.047**	**0.094**
4.6500	-0.1395	0.02	**2.141**	**0.100**	**0.120**	**0.215**	**0.258**
4.9090	-0.1795	0.02	**1.308**	**0.060**	**0.120**	**0.079**	**0.157**
5.1000	-0.0295	0.035	**0.000**	**0.000**	**-0.030**	**0.000**	**0.000**
8.6000	0.0935	0.035	**END**	**END**	**END**	**END**	**END**

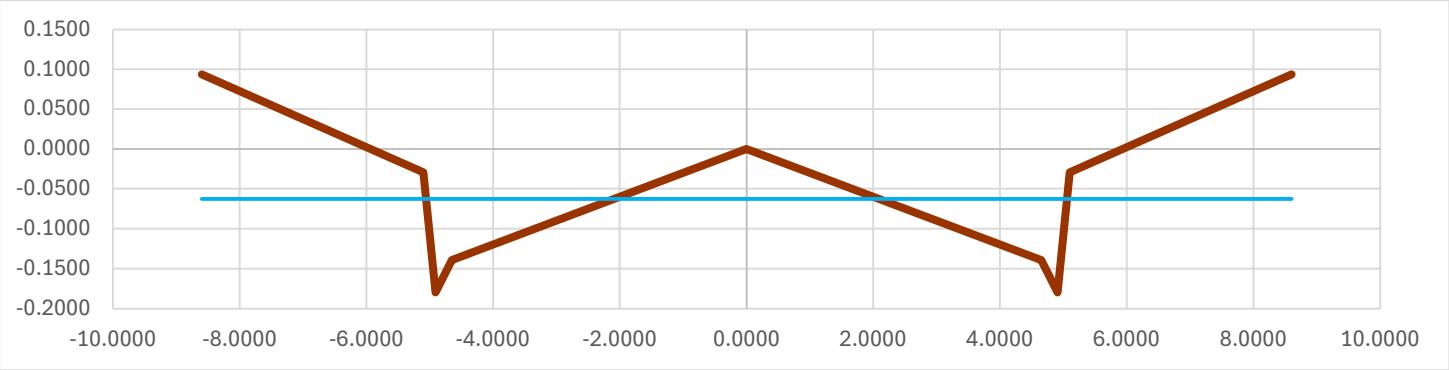
Manning's Calculation

Inputs

Section	C - Road 5 Ch140	
PMF Peak Flow	0.398	cu.m/s
Longitudinal Slope (S)	6	%
Water Level (h)	-0.062	m

Output Summary

Average Velocity (Vavg)	**1.492**	m/s
Max Velocity (Vmax)	**2.568**	m/s
Average Depth (davg)	**0.051**	m
Max Depth (dmax)	**0.117**	m
VxDavg (Z0avg)	**0.076**	sq.m/s
VxDmax (Z0max)	**0.301**	sq.m/s
Average Mannings	**0.020**	



Chainage (m)	Elevation (m)	Manning's Roughness
-8.6000	0.0935	0.035
-5.1000	-0.0295	0.035
-4.9090	-0.1795	0.02
-4.6500	-0.1395	0.02
0.0000	0.0000	0.02
4.6500	-0.1395	0.02
4.9090	-0.1795	0.02
5.1000	-0.0295	0.035
8.6000	0.0935	0.035

Velocity (m/s)	Average Depth (m)	Max Depth (m)	VxDavg (sq.m/s)	VxDmax (sq.m/s)
0.000	0.000	-0.033	0.000	0.000
0.899	0.059	0.117	0.053	0.105
2.568	0.097	0.117	0.250	0.301
1.398	0.039	0.077	0.054	0.108
1.398	0.039	0.077	0.054	0.108
2.568	0.097	0.117	0.250	0.301
1.574	0.059	0.117	0.092	0.184
0.000	0.000	-0.033	0.000	0.000
END	END	END	END	END

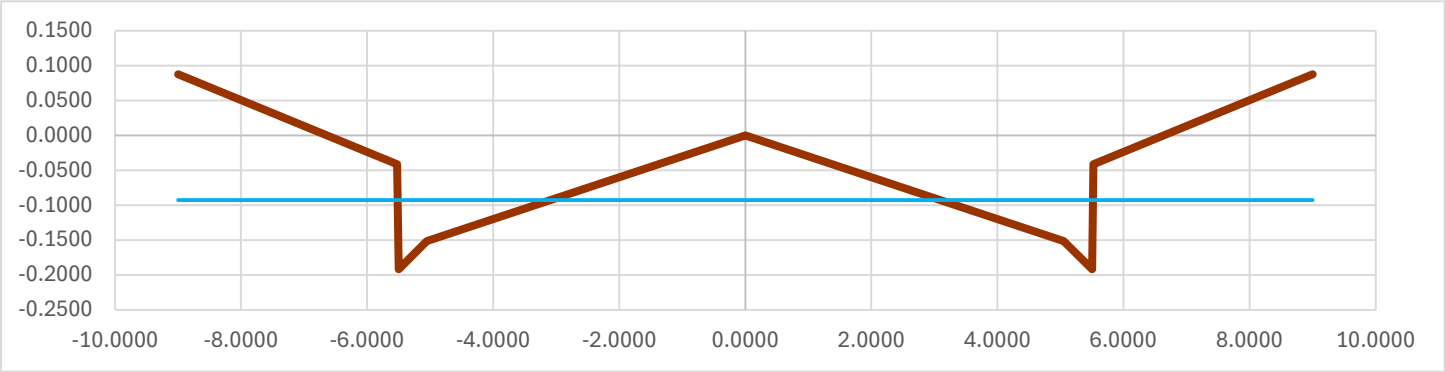
Manning's Calculation

Inputs

Section	D - Road 1 Ch15	
PMF Peak Flow	0.147	cu.m/s
Longitudinal Slope (S)	2	%
Water Level (h)	-0.093	m

Output Summary

Average Velocity (Vavg)	**0.779**	m/s
Max Velocity (Vmax)	**0.037**	m/s
Average Depth (davg)	**0.048**	m
Max Depth (dmax)	**0.099**	m
VxDavg (Z0avg)	**0.038**	sq.m/s
VxDmax (Z0max)	**0.128**	sq.m/s
Average Mannings	**0.020**	



Chainage (m)	Elevation (m)	Manning's Roughness
-9.0000	0.0875	0.035
-5.5250	-0.0415	0.035
-5.5000	-0.1915	0.02
-5.0500	-0.1515	0.02
0.0000	0.0000	0.02
5.0500	-0.1515	0.02
5.5000	-0.1915	0.02
5.5250	-0.0415	0.035
9.0000	0.0875	0.035

Velocity (m/s)	Average Depth (m)	Max Depth (m)	VxDavg (sq.m/s)	VxDmax (sq.m/s)
0.000	0.000	-0.051	0.000	0.000
0.163	0.049	0.099	0.008	0.016
1.297	0.079	0.099	0.102	0.128
0.674	0.029	0.059	0.020	0.040
0.674	0.029	0.059	0.020	0.040
1.297	0.079	0.099	0.102	0.128
0.286	0.049	0.099	0.014	0.028
0.000	0.000	-0.051	0.000	0.000
END	END	END	END	END

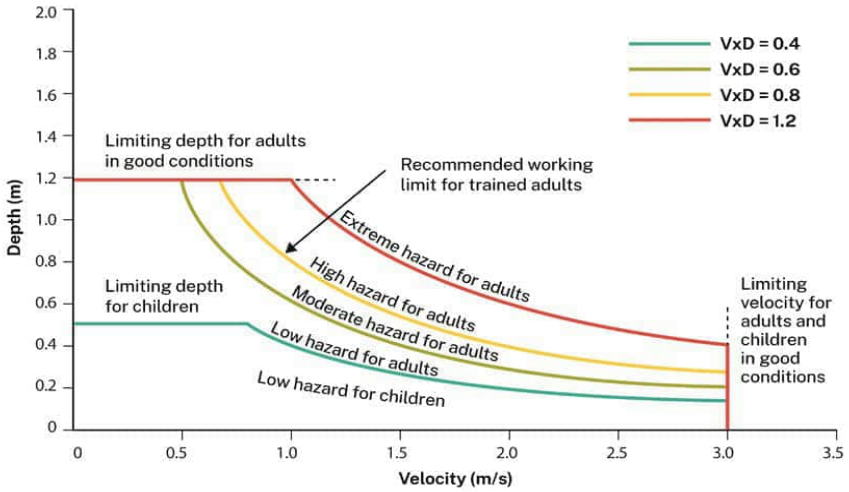


Figure 2 Thresholds for the stability of people in floods

Notes: D.V = VxD = velocity x depth.

Source: Figure 8 AIDR 2017b; modelled after Cox, Shand and Blacka (2010).

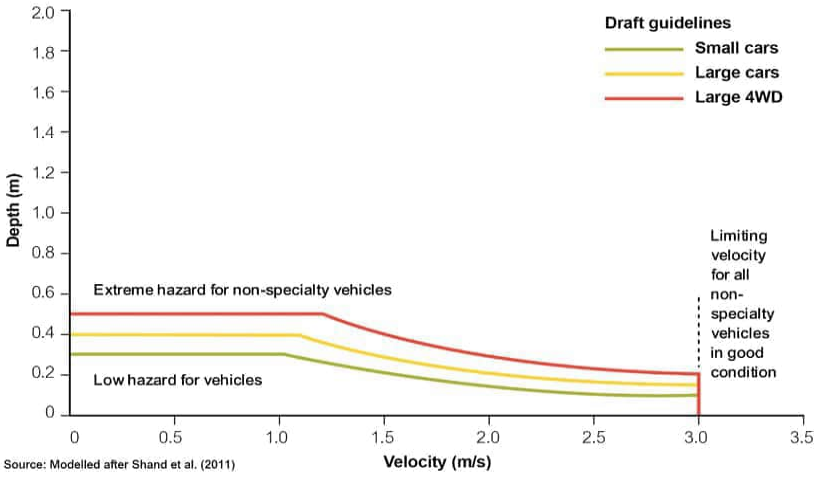


Figure 3 Thresholds for vehicle stability in floods

Source: Figure 9 AIDR 2017b; modelled after Shand et al. (2011).

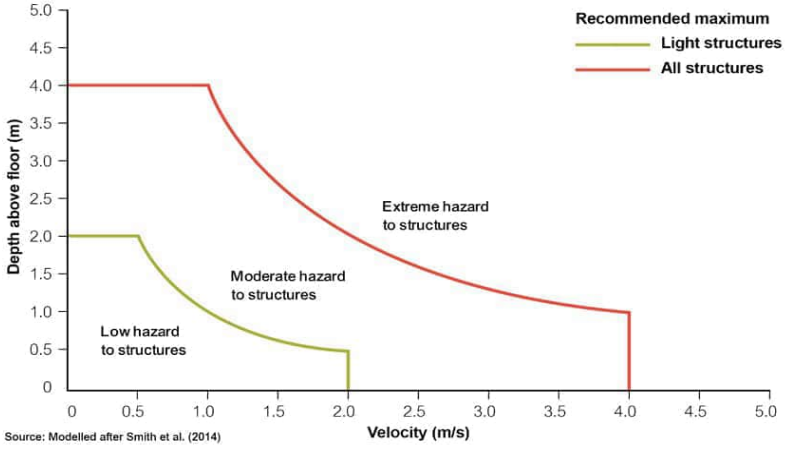


Figure 4 Thresholds for building stability in floods

Source: Figure 10 ADR 2017b; modelled after Smith, Davey and Cox (2014).

APPENDIX F: REGIONAL FLOODING ASSESSMENT – FIRA (JWP, 2023) & ADDENDUM LETTER (JWP, 2023)

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
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Our Ref: 110709-02_ WSU Milperrs FRIA Addendum.docx
SL:sl

13 Nov 2023

Mirvac

Level 28, 200 George Street
Sydney NSW 2000 Australia

Attn: Theo Zotos

Subject: Western Sydney University Campus, Milperra, PP-2021-2837 Flood Risk Assessment Addendum

Dear Theo,

We have reviewed submissions related to the Planning Proposal (PP) application 2021-2837 for the Western Sydney University (WSU) Campus, Milperra from State Emergency Services (SES) in the letter dated 28 September 2023 on flooding. We respond to each point of the DPE submission as follows considering Flood and Risk Impact Assessment (FRIA) report dated May 2023 prepared by J. Wyndham Prince.

- *Recommend carefully re-considering and addressing the increase in risk to life and property due to the rezoning to residential, particularly in parts of the proposed site that become exposed to high hazard (H5) floodwater from events greater than a 1% Annual Exceedance Probability (AEP) event, based on information requested below.*

  J. Wyndham Prince Response – The FRIA 2023 demonstrated that the high hazard for events up to and including the 0.5% and 0.2% AEPs are wholly contained within dedicated drainage reserves which will be managed by appropriate flood warning signage.

- *Recommend establishing a clear trigger for implementing the Flood Evacuation Plan, as this is not clearly stated in the Flood Risk and Impact Assessment provided.*

  J. Wyndham Prince Response –The lowest development pad level is 6 m AHD. The target warning flood level of 4.2 m AHD is applicable for Milperra as set out in Provision and Requirements for Flood Warning in New South Wales (NSWSES, 2019). An extract from Table 1 of this document is provided in Table below which suggests 12 hours will be available to evacuate.

Bureau number	AWRC number	Gauge Name	Station owner	Gauge type	Flood classification (m)			Flood Warnings provided by the Bureau	Target warning lead time		70% of peak forecasts within	Local Flood Advice provided by NSW SES
					Minor	Moderate	Major		Time	Trigger height		
561004	212408	Webbs Creek (Wisemans Ferry)	NSW Office of Environment and Heritage WaterNSW	Automatic	n/a	3.5	4.2	Quantitative	12hrs	>3.5 m	+/- 0.3 m	
213 – Georges River and Sydney Coast												
566054	213400	Liverpool *	NSW Office of Environment and Heritage Sutherland Shire Council	Automatic	2.0	3.0	4.5	Quantitative	6 hrs 12 hrs	>2.0 m >4.0 m	+/- 0.3 m	
66168	213405	Milperra *	NSW Office of Environment and Heritage Sutherland Shire Council	Automatic	2.0	3.3	4.2	Quantitative	6 hrs 12 hrs	>2.0 m >4.0 m	+/- 0.3 m	
566011	213410D	Picnic Point	NSW Office of Environment and Heritage	Automatic	2.0	n/a	n/a	Quantitative	6 hrs	>2.0m	+/- 0.3 m	

The FRIA 2023 demonstrated that proposed development considers continuous rising grade flood evacuation routes to a level above the PMF event for all residents at Horsley Road, a flood evacuation access point to the east of the site, as shown in Plate 1. During this extreme flood event, it is understood that more 12 hours of flood warning time is available for the site. Flood evacuees who consider their own accommodation with family or friends can safely leave the site via Beaconsfield which does not get cutoff or can be directed to travel via the M5 motorway to the Olympic Precinct at Homebush which will operate as a large-scale evacuation centre. Additionally, Mount St Joseph Catholic College and Childcare Centre is also located to the east of the site and could serve as a makeshift shelter in extremis.

Plate 1 – Flood Evacuation Plan

- *Request information regarding the impacts of the proposed development on flooding for surrounding sites between the 1% AEP and the PMF.*

  J. Wyndham Prince Response – The flood level difference for 0.5% AEP and 0.2% AEP is provided in Figure A-1 and A-2 in Attachment. The results shows that there is no adverse flood impact external to the site in 0.5% AEP and 0.2% AEP event.

- *Request information regarding the flood hazard on the site for events more frequent than the 1% AEP event (e.g. 20% AEP, 5% AEP), noting that parts of the site are already affected by high hazard (H5) flooding in the proposed development 1% AEP event.*

  J. Wyndham Prince Response – The FRIA 2023 assessment demonstrated that flood depths for storm events up to the 0.5% and 0.2% AEP are wholly contained within the ultimate stormwater management infrastructure including stormwater pipes and drainage reserves. As such, it is anticipated that the events including 20% AEP and 5% AEP would also be contained within the reserve with similar hazard rating.

Should you have any queries regarding this matter please do not hesitate to contact me.

Yours faithfully

SABINA LOHANI

Technical Lead – Stormwater & Flooding

Attachment - Figures

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

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Legend

- Site Boundary

Flood Level Difference (m)

- <= -1.00
- -1.00 - -0.50
- -0.50 - -0.30
- -0.30 - -0.15
- -0.15 - -0.08
- -0.08 - -0.04
- -0.04 - -0.02
- -0.02 - 0.02
- 0.02 - 0.04
- 0.04 - 0.08
- 0.08 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- >1
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. A-2
0.5% AEP Flood Level Difference

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

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Legend

- Site Boundary

Flood Level Difference (m)

- <= -1.00
- -1.00 - -0.50
- -0.50 - -0.30
- -0.30 - -0.15
- -0.15 - -0.08
- -0.08 - -0.04
- -0.04 - -0.02
- -0.02 - 0.02
- 0.02 - 0.04
- 0.04 - 0.08
- 0.08 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- >1
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **A-1**
0.2% AEP Flood Level Difference

Flood and Risk Impact Assessment

WSU Campus Milperra

Planning Proposal

May 2023

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

Prepared by

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Mirvac
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Version control

SUSTAINABLE CERTIFICATION ISO 9001 AS/NZS 4801 ISO 14001

Issue	Author	Reviewer	Approver	Date approved
A	Francis Lane Amir Zalnezhad Ahmad Albaba	Sabina Lohani	Sabina Lohani	28/04/2023
B	Francis Lane Amir Zalnezhad	Sabina Lohani	Sabina Lohani	03/05/2023
C	Francis Lane	Sabina Lohani	Sabina Lohani	04/05/2023

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1. EXECUTIVE SUMMARY

J. Wyndham Prince has been engaged by Mirvac to undertake a Flood and Risk Impact Assessment in support of a Planning Proposal to rezone approximately 19.62 ha of land at 2 and 2A Bullecourt Avenue, Milperra. The site is formally identified as lot 105 of DP1268911 and is currently zoned as SP2 Infrastructure Educational Establishment and was previously utilised as the Western Sydney University (WSU) Milperra Campus. It is proposed to rezone the site to support residential development, roads, parks and stormwater drainage infrastructure.

This report has been prepared to determine what stormwater quality and quantity measures are required to ensure that pollution reduction targets are achieved and that there is no increase in stormwater runoff due to the proposed development when compared to the existing site. A flood impact assessment has also been undertaken to confirm that there are no adverse flood impacts external to the site due to the proposed residential development of the site.

The investigation has determined that two (2) detention basins in the southern portion of the site with a combined 1% AEP detention volume of approximately 2,310 m³ will ensure that developed conditions flow are no greater than existing conditions flows external to the site. The site regrading has reduced the overall catchment in the north-western portion of the site and the hydrologic assessment confirms that no detention is required in that portion of the site. The future detailed design of the site will need to consider the various site constraints and ensure that appropriate freeboard is provided from the basin top water level to the finished floor and garage levels of the adjacent residential dwellings (both existing and proposed dwellings).

Four (4) Gross Pollutant Traps (GPTs) and three (3) bio-retention raingardens provide stormwater quality management for the proposed subdivision to ensure pollutant removal targets are met prior to discharge from the site. The bio-retention raingardens also ensure that developed conditions durations of stream forming flows are no greater than 3.5 – 5.0 times the duration of existing conditions stream forming flows.

A frequency of inundation assessment was undertaken for the large southern detention Basin 1 which is proposed to predominantly be utilised as open space. Utilising historic rainfall information within MUSIC modelling software, the inundation analysis indicates that on average Basin 1 would empty within approximately 0.5 of an hour. For 95% of the historic rainfall events, the assessment indicates that Basin 1 would hold water for less than 2.5 hours. Considering the limited number of days exceeding a 1 mm depth on average per annum, combined with the limited duration in which the basin holds water, the predominant use of the southern open space is for recreation. It is anticipated that the combined use of this open space area as a detention basin would not result in the closure of the playing field any differently from other playing fields within the Bankstown LGA when relatively large storm events occur.

A flood assessment was undertaken using the hydraulic model that supported the Georges River Flood Study (BMT, 2020), as required by Department of Planning and Environment (DPE) - Environment and Heritage Group (EHG), to determine the flood depth, level and hazard for storm events from the 1% Annual Exceedance Probability (AEP) to the Probable Maximum Flood (PMF) storm events. The flood assessment indicates that the existing site is impacted by the Georges River mainstream flooding 1% AEP event up to 5.55 mAHD with approximately 6,400 m³ of floodplain storage within the site during this event.

The flood assessment indicates that the proposed development will not adversely affect the flood behaviour external to the site. In the developed condition, the flood assessment confirms that the proposed detention basins ensure that flows are not increased external to the site, and there is the capacity to provide regional flood storage of 9600 m³ during 1% AEP flood events without affecting detention basin performance. Therefore, there is no net loss of floodplain storage due to the proposed development. Similarly, there is insignificant change in flood behaviour during proxy climate change scenarios of 0.5% AEP and 0.2% AEP up to PMF flood events.

The southwestern portion of the site is inundated in PMF flood events, and evacuation routes are provided to show the safe evacuation during this event. North-eastern parts of the site are generally flood free during PMF events.

This stormwater management strategy for the proposed development provides a basis for the future detailed design and development of the site to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site discharge are achieved.

2. INTRODUCTION

2.1. Background

The proposed residential development site is located at 2 Bullecourt Avenue, Milperra and is within Canterbury-Bankstown Council (CBC) local government area (LGA). The site is formally identified as Lot 105 of DP1268911.

The site has an approximate area of 19.62 ha and is currently zoned as SP2 Infrastructure Educational Establishment. Previous development of the site is evident and includes a number of large buildings and car parks due to its previous use as a university campus. Plate 2-1 provides an overview of the locality of the existing site.

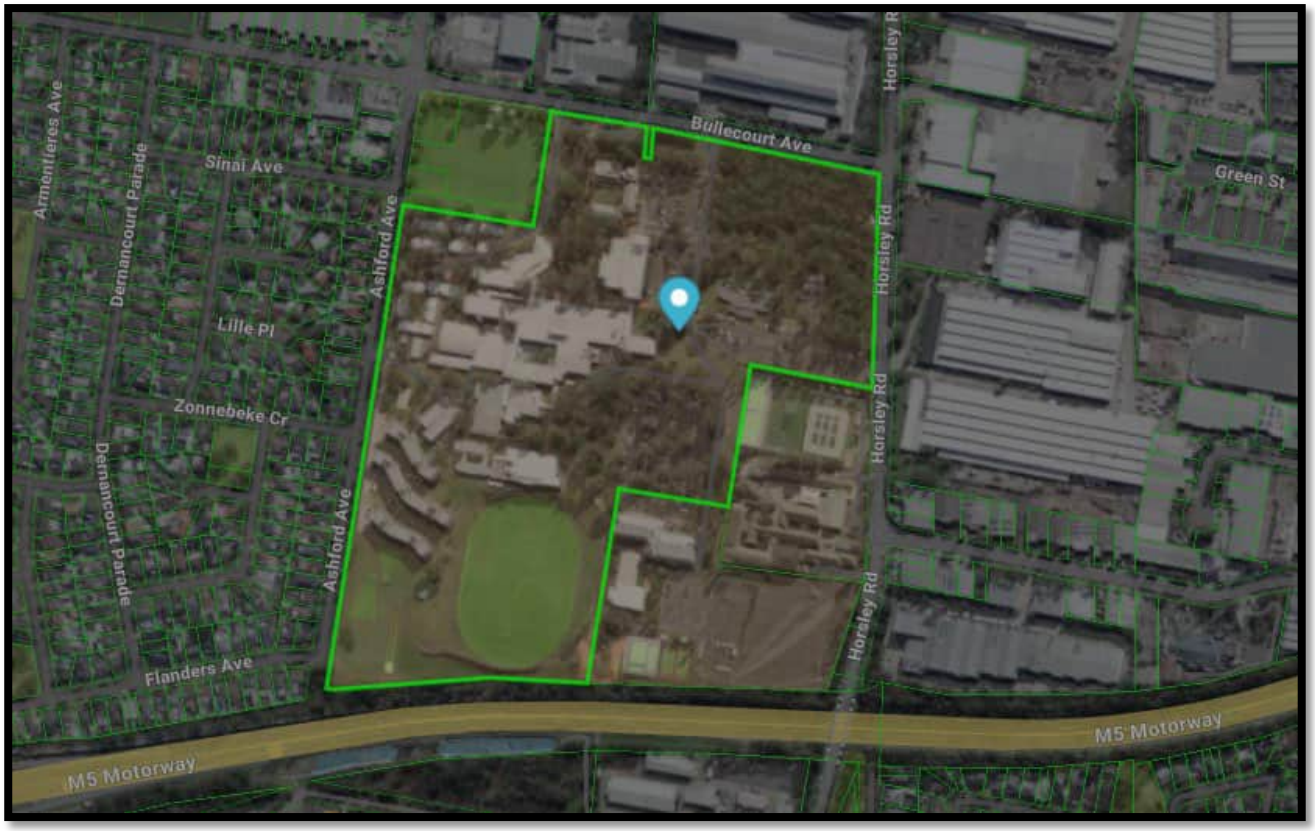


Plate 2-1 – Site Locality

2.2. Objective

The study aims to support the lodgement of the planning proposal of the proposed development at 2 Bullecourt Avenue, Milperra addressing the Gateway Determination (Department Ref: PP-2021-5837) dated 1 June 2022 and Environment and Heritage Group (EHG) comments (DOC22/956174) dated 20 December 2022 from Department of Planning and Environment.

To achieve the study objective following specific tasks are undertaken.

- Prepare stormwater quality modelling to confirm the treatment train required to meet industry best practice pollutant removal targets.
- Undertake a Stream Erosion Index assessment to ensure that the developed conditions stream forming flow durations are no greater than 3.5 – 5 times the existing conditions stream forming durations;
- Undertake a hydrologic analysis using ARR 1987 methods to determine the peak flows for the 0.5 EY, 0.2 EY, 10% AEP, 5% AEP, and 1% AEP (2y, 5y, 10y, 20y and 100y ARI) events under existing and developed conditions. Determine the minimum detention storage requirements to ensure developed condition flows are no greater than the existing condition.

- Prepare a flood impact assessment to confirm that there are no unacceptable flood impacts external to the site, no loss in floodplain storage due to the proposed development and to confirm that flood hazard and evacuation requirements in accordance with the NSW Floodplain Development Manual are satisfied.

2.3. Proposed Development

It is proposed that the site is rezoned as R1 General Residential development which will support the subdivision of land and create new residential lots, together with supporting road and drainage infrastructure. The vegetated area shown are Woodland Area in Plate 2-2 below will be retained and enhanced as a conservation area.

The masterplan provides an overview of the proposed development and is provided in Plate 2-2.

Plate 2-2 – Masterplan

Details of the proposed bio-retention raingardens and detention basins are provided on sketch drawings 110709-02-SK06 and SK07 which are provided in Appendix A.

3. PREVIOUS STUDIES AND COUNCIL LIAISON

3.1. WSU Milperra Rezoning Stormwater Concept Plan (Calibre, 2020)

The *Western Sydney University, Milperra Rezoning Stormwater Concept Plan* was prepared for Mirvac by Calibre Professional Services Pty. Ltd in June 2020 to support the proposed rezoning of the site.

The stormwater strategy for the site included three (3) detention basins with co-located bio-retention basins to ensure that stormwater quality and quantity targets were achieved. This assessment has been further refined as part of the current investigation and has been augmented to include a flood impact assessment.

3.2. Flood and Stormwater Advice (JWP, 2022)

J. Wyndham Prince (JWP) prepared flood and stormwater advice for the proposed development at WSU campus Milperra. The advice provided an assessment of the flood affectation to the future re-development of the site and addressed the Department of Planning and Environment gateway determination letter (ref: PP-2021-5837) dated 1 June 2022. As a part of the flood analysis following studies were reviewed:

- Milperra Flood Study (BMT WBM, 2015)
- Mid Georges River Floodplain Risk Management Study and Plan (BMT WBM, 2017)

The review concluded that the site is located at the upper reach of Milperra and Kelso Swamp catchment, as such overland flooding would not an issue for the proposed development which has no upstream external catchment that drains through the site and flood impact assessment was not deemed necessary. Furthermore, it was adviced that the proposed development is located within the low flood risk precinct and 1% AEP flood fringe would not result in change in flood behaviour and impact external to the site, given that the developed condition flows are managed within the site by restricting the peak flow rate to existing condition flows up to 1% AEP storm events.

The 2022 flood advice formed part of the exhibition of the Planning Proposal for the rezoning of land at Western Sydney University Campus at Milperra. EHG from DPE provided feedback on JWP 2022 flood advice as a part of the planning proposal exhibition on 22 December 2022 to consider the Georges River Flood Study of 2020 prepared by Liverpool City Council in the flood assessment. Furthermore, EHG required the flood assessment to consider the flood impact of the proposed development, within and outside the subject site, for both mainstream and overland flooding for the full range of floods from 1% AEP up to the PMF event together with 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity due to climate change. Hence, the Georges River Flood Study, 2020 has been adopted to undertake the flood and risk assessment of the proposed development at WSU campus Milperra.

3.3. Georges River Flood Study (BMT, 2020)

The Georges River Flood Study (GRFS) was prepared by BMT Commercial Australia on behalf of the Liverpool City Council and was completed in 2020. This flood study covers the Georges River catchment extending from East Hills Railway Line at Casula to downstream of the Salt Pan Creek confluence at Lugarno. The total study area as shown in Plate 3-1 is about 960 km^2 and lies mostly within the five Councils covering 90% of the catchment area including Wollondilly Shire Council, Campbelltown City Council, Liverpool City Council, Fairfield City Council, and Canterbury- Bankstown Council.

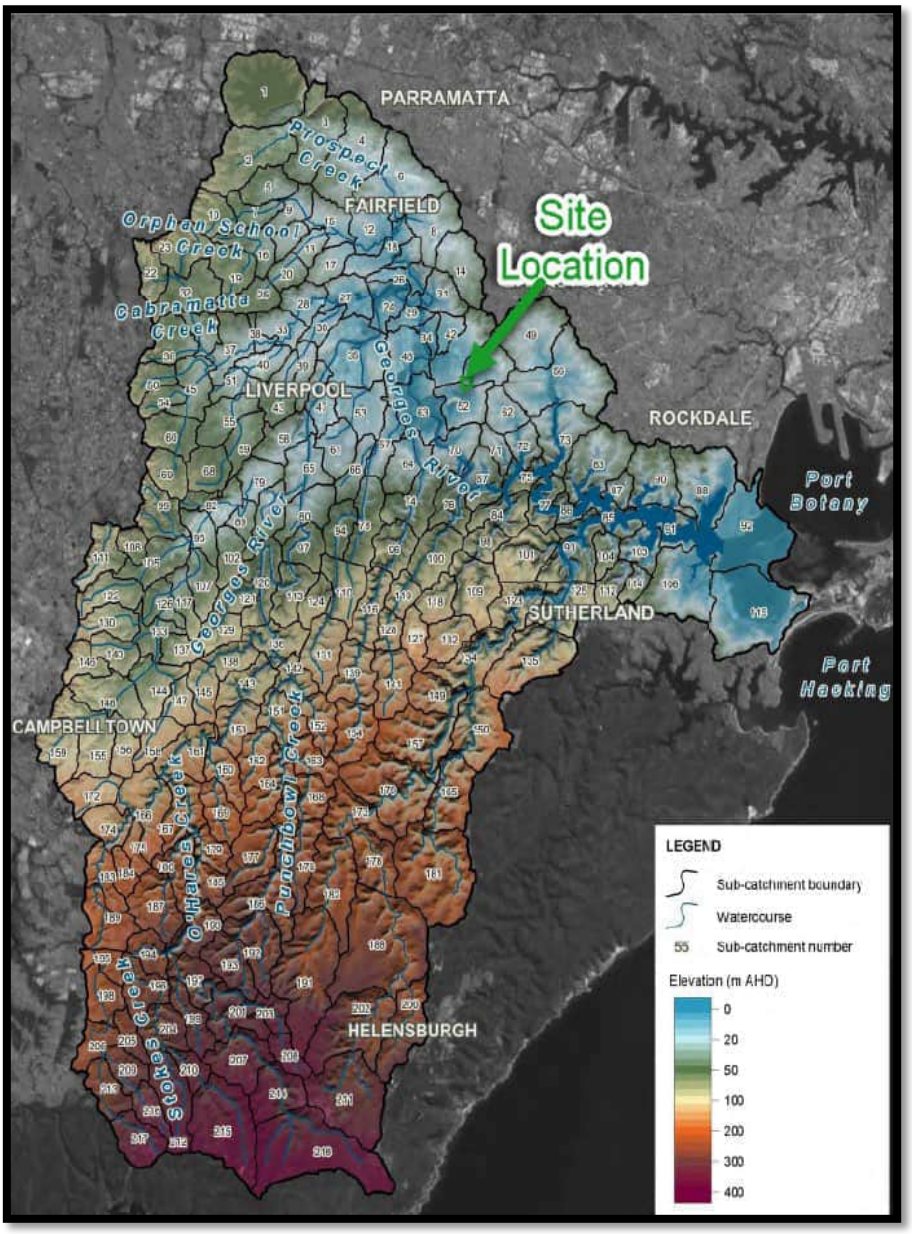


Plate 3-1- Georges River Flood Study 2020 and Subject Site Location

Based on the results of the GRFS (BMT, 2020):

- The subject site is not affected by regional flooding during 1%AEP, 0.5%AEP and 0.2% AEP flood events;
- The results indicate that areas to the south of M5 are affected by regional flooding to a level of 5.55 m AHD during 1% AEP flood events.
- The results indicate that during PMF flood events, the site and surroundings are affected by regional floodings to the level of 11.8 m AHD.
- Interrogation of the TUFLOW hydraulic model that supported the GRFS (BMT, 2020) revealed that a significant culvert under the M5 Motorway was not considered to allow regional flooding to enter the site.

The WSU Milperra assessment has used the GRFS (BMT, 2020) TUFLOW model as a base and has now included 4 x 1450mm diameter reinforced concrete pipes (RCPs) under the M5 Motorway based on survey information to understand the mainstream flood behaviour in the vicinity of the existing site.

4. STORMWATER QUANTITY MANAGEMENT

The hydrologic analysis from this study was undertaken using the rainfall–runoff flood routing model XP-RAFTS version 2018.1 (Runoff and Flow Training Simulation with XP Graphical Interface).

An existing conditions hydrologic model was prepared for the site to determine the peak flows at key discharge locations for a range of storm events. This model was then amended to reflect the proposed development and determine what detention storage is required to ensure that flows from the proposed development are no greater than existing conditions.

4.1. XP-RAFTS Parameters

The adopted intensity-frequency-duration (IFD) data for assessment is consistent with CBC's Development Engineering Standards (June, 2009) and is provided in Table 4-1.

Table 4-1 – Adopted Rainfall Intensities

Rainfall Intensity (mm/hr)			
ARI	Duration		
	1 hr	12 hr	72 hr
50y	72	15.1	5.2
2y	35.5	7.6	2.5

G = 0.00, F2 = 4.29, F50 = 15.80

The adopted pern (n) values and initial & continuing losses parameters are provided in Tables 4-2 and 4-3 respectively.

Table 4-2 – XP-RAFTS Catchment Roughness

Mannings 'n' Value	Post-Development
Catchment Surface	Mannings 'n'
Pervious Catchments	0.025
Impervious Catchments	0.015

Table 4-3 – XP-RAFTS Loss Parameters

Initial / Continuing Losses	
Catchment Surface Type	Loss
Pervious Catchments	
Initial Loss	15.0 mm
Continuing Loss	2.5 mm/hr
Impervious Catchments	
Initial Loss	1.0 mm
Continuing Loss	0.0 mm/hr

4.2. Sub-catchments

The existing condition catchments for this site have been determined using LiDAR information flown in June 2019, accessed from the ELVIS website (https://elevation.fsdf.org.au/). The developed condition catchments are considered a preliminary site grading.

Approximately 5.77 ha of the existing site discharges to the northwest, and approximately 11.00 ha discharges to the south. In the developed condition, the proposed site grading reduces the overall catchment to the northwest, and the increased southern catchments are graded to two (2) proposed detention basins.

Catchment boundaries for the existing and developed conditions are shown in Plate 4-1 and 4-2 respectively.

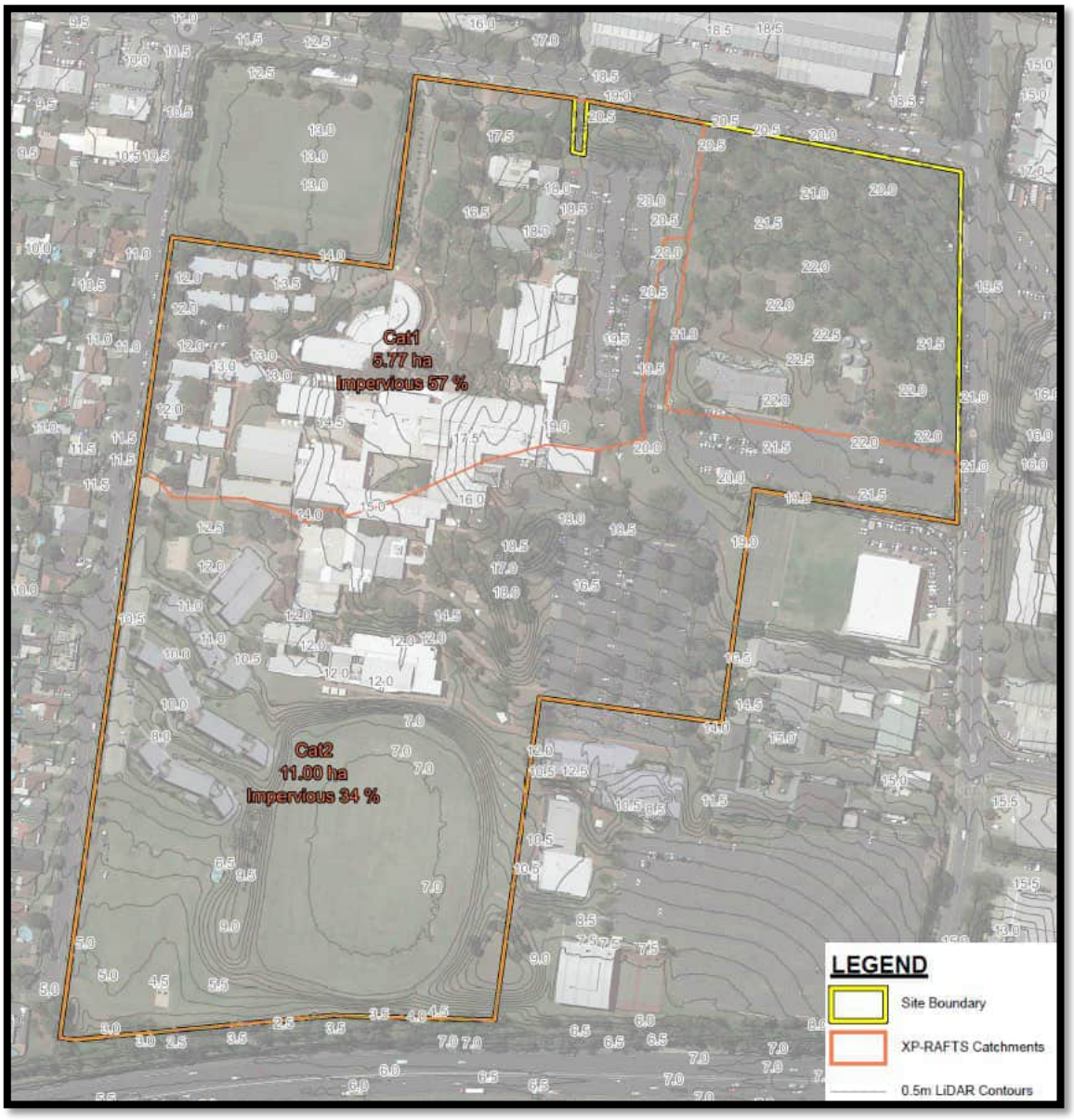


Plate 4-1- Existing Condition Catchment Plan

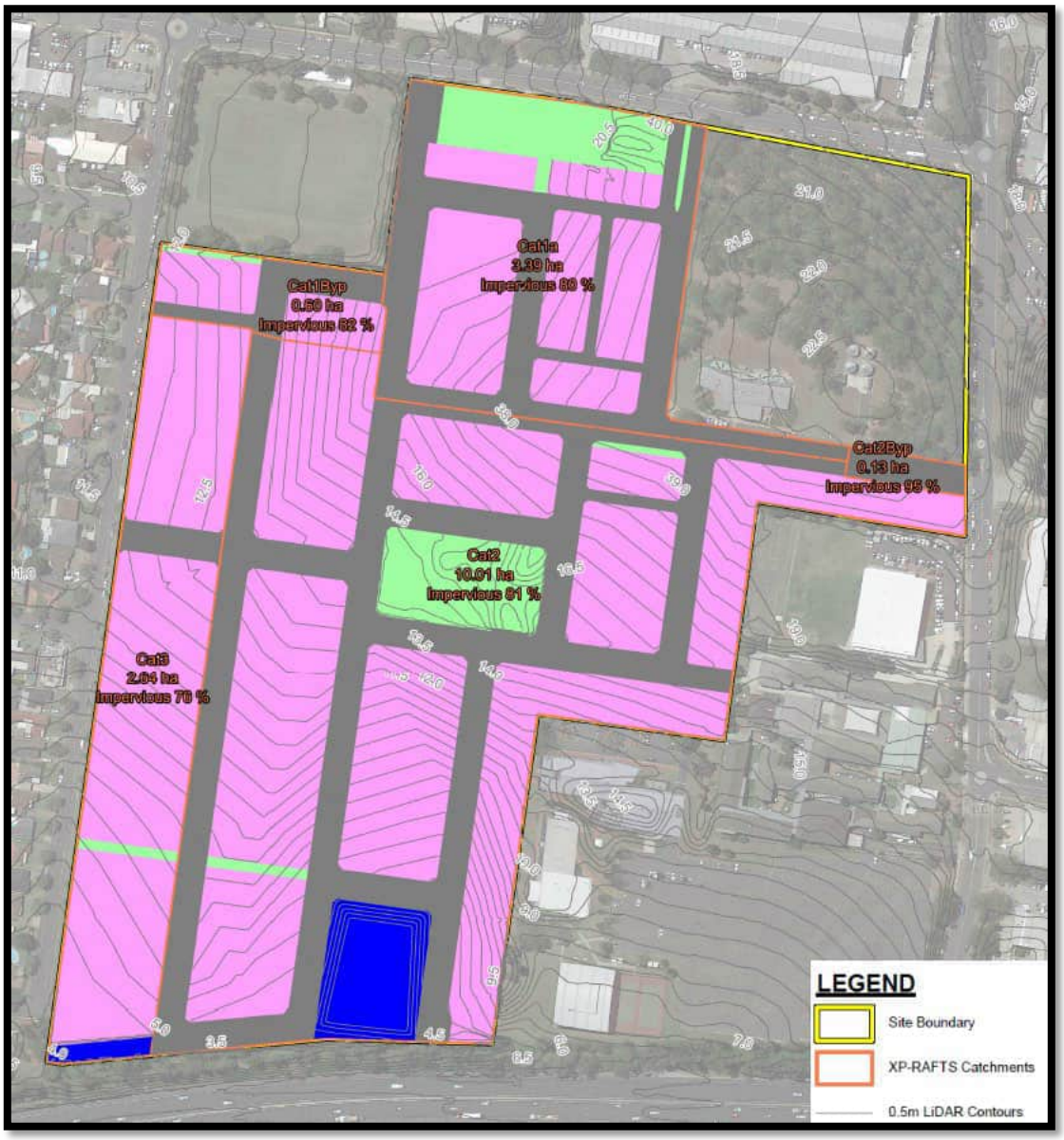


Plate 4-2- Developed Condition Catchment Plan

4.3. Modelled Events

The existing conditions XP-RAFTS hydrologic model was run using the AR&R 1987 techniques for the 0.5 EY, 0.2 EY. 10% AEP, 20% AEP and 1% AEP storm events in accordance with the CBC Development Engineering Standards (as amended June, 2009) to determine existing conditions flow targets from the existing site.

The XP-RAFTS model was then run for the developed condition to confirm whether stormwater detention is required to maintain existing conditions flows. Table 4-4 shows the estimated change in peak flow without detention basins.

Table 4-4 – Existing and Developed Peak Flows (m^3/s) Without Detention

Comparison Node	Location	0.5 EY			20% AEP			10% AEP			5% AEP			2% AEP			1% AEP		
		Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
RptNth	Northwestern Portion	1.229	1.076	0.88	1.80	1.458	0.81	2.12	1.667	0.79	2.51	1.947	0.78	2.80	2.140	0.77	3.14	2.394	0.76
RptSth	Southern Portion of Site	1.734	3.397	1.96	2.78	4.630	1.67	3.39	5.305	1.56	4.15	6.183	1.49	4.73	6.809	1.44	5.37	7.626	1.42
Total	Total Site	2.962	4.473	1.51	4.58	6.088	1.33	5.51	6.973	1.27	6.66	8.129	1.22	7.54	8.950	1.19	8.52	10.019	1.18

The results in Table 4-4 indicate that detention is not required for the north-western portion of the site. Developed condition stormwater discharge is no greater than the existing condition due to the regrading of the site which has reduced the overall catchment discharging to the north-west. However, the southern portion of the site will require detention to ensure that developed condition flows are no greater than existing the condition. The model was updated to include the detention basins shown on engineering sketch SK006 and SK007 in Appendix A and re-run for the range of storm events. Table 4-5 shows the estimated change in peak flow with the inclusion of the southern detention basins.

Table 4-5 – Existing and Developed Peak Flows (m^3/s) With Detention

Comparison Node	Location	0.5 EY			20% AEP			10% AEP			5% AEP			2% AEP			1% AEP		
		Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
RptNth	Northwestern Portion	1.229	1.076	0.88	1.80	1.458	0.81	2.12	1.667	0.79	2.51	1.947	0.78	2.80	2.140	0.77	3.14	2.394	0.76
RptSth	Southern Portion of Site	1.734	1.637	0.94	2.78	2.526	0.91	3.39	3.376	0.99	4.15	3.801	0.92	4.73	4.692	0.99	5.37	5.354	1.00
Total	Total Site	2.962	2.672	0.90	4.58	3.886	0.85	5.51	4.300	0.78	6.66	5.737	0.86	7.54	6.664	0.88	8.52	7.583	0.89

Details of the basin performance are provided in Table 4-6 for Basin 1, and Table 4-7 for Basin 2 respectively below.

Table 4-6 – Basin 1 Detention Performance

Event	Active Storage Used (m^3)	Storage Depth (m)
0.5 EY	504	0.25
20% AEP	842	0.36
10% AEP	1084	0.43
5% AEP	1423	0.54
2% AEP	1582	0.58
1% AEP	1779	0.64

110709-02_RA03_Dev.xp

Table 4-7 – Basin 2 Detention Performance

Event	Active Storage Used (m^3)	Storage Depth (m)
0.5 EY	251	0.55
20% AEP	451	0.98
10% AEP	482	1.05
5% AEP	505	1.10
2% AEP	512	1.12
1% AEP	529	1.16

110709-02_RA03_Dev.xp

Full details of the detention basins and outlet structures will be determined and provided as part of the future subdivision works application. Provided that the stormwater management objectives are achieved, alternate detention basin configurations could be investigated as part of the detailed design phase. The assessment confirms that sufficient land is available to provide the required detention storage.

4.4. Freeboard

In the future detail design phase of the development, the detention basin design and adjacent subdivision grading will need to ensure that a freeboard is provided between the 1% AEP basin top water level and any adjacent finished floor level. CBC's Development Engineering Standards (June 2009) require the following freeboard from the maximum design basin top water level and spillway level of the detention basin:

- 0.3 m to finished floor levels of existing and new buildings.
- 0.1 m to garage floor levels.

Schedule 3 in Part B12 of the Bankstown Development Control Plan (DCP, 2015) requires the following floor-level controls for residential development in the Georges River Floodplain Medium Flood Risk Precinct:

- Habitable floor levels to be no lower than the 100-year (1% AEP) flood level plus freeboard of 0.5 m.
- Non-habitable floor levels to be no lower than the 20-year (5% AEP) flood unless justified by site-specific assessment.
- A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the undercroft area is not to be enclosed. The use of roller shutters or similar measures (such as hit and miss brickwork) to enclose this area is however permissible.

Based on the flood assessment described in Section 7 of this report, the southern portion of the site is affected by regional Georges River flooding. Therefore the requirements of Schedule 3 in Part B12 of the Bankstown Development Control Plan (DCP, 2015) will take precedence in that portion of the site.

Chapter 2 of the draft consolidated Canterbury-Bankstown DCP 2021 has also been reviewed and Schedule 3 relating to development controls for land affected by the Georges River Flooding is consistent with the current DCP 2015.

5. STORMWATER QUALITY MANAGEMENT

The stormwater quality analysis for this study was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for catchment hydrology, which is based at Monash University and was first released in July 2002. Version 6.3 was adopted for this study.

The model provides a number of features relevant to the development including:

- It is able to model the potential nutrient reduction benefits of GPTs, constructed wetlands, grass swales, Bio-retention systems, sedimentation basins, infiltration systems, ponds and it incorporates mechanisms to model stormwater reuse as a treatment technique; and
- It provides mechanisms to evaluate the attainment of water quality objectives.

The MUSIC modelling was undertaken to demonstrate that the stormwater management system proposed for the development will result in reductions in overall post-development pollutant loads. As CBC does not currently have adopted stormwater quality pollution removal targets, the target pollutant removal rates of 90 % Gross Pollutants (GP), 85 % Suspended Solids (TSS), 65 % Total Phosphorus (TP) and 45 % Total Nitrogen (TN) has been adopted, consistent with the adjacent Liverpool City Council WSUD Technical Guidelines (Alluvium, 2016). It is noted that these pollution removal targets are consistent with current industry best practices and are adopted by a number of Councils in Western Sydney.

5.1. MUSIC Model Development

A MUSIC model was prepared to reflect the proposed development. The model considers all catchments discharging to the bio-retention basins and compensates for a relatively small amount of bypassing catchment in the east and west.

Plate 5-1 provides an overview of the MUSIC model arrangement.

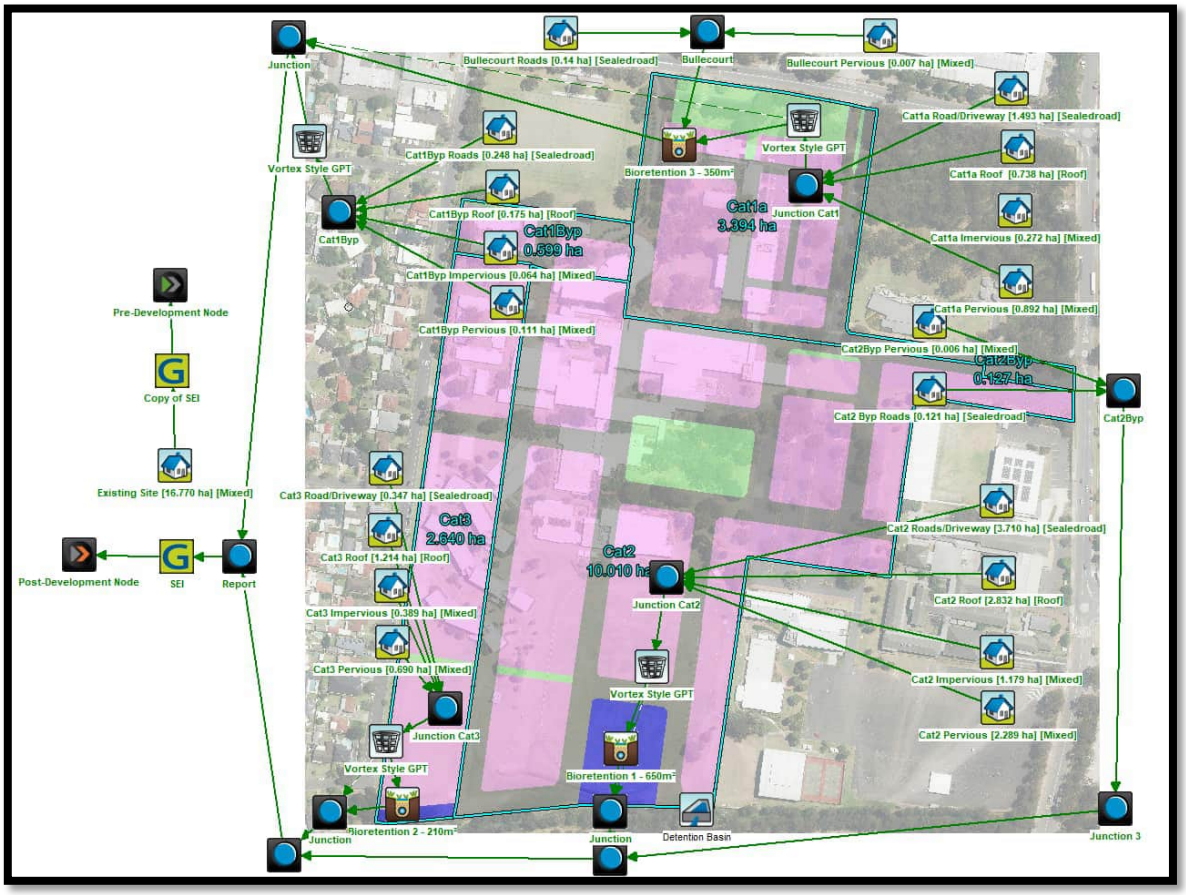


Plate 5-1 – MUSIC Model Layout (110709-02_MU03.sqz)

5.2. Modelling Parameters and Assumptions

The following catchment assumptions were adopted in the MUSIC model:

- Proposed catchment areas have adopted a total percentage impervious of 75% for the residential lots and are broken up as follows:
  - Roof Area = 50% of lot area
  - Road Area (driveways) = 10% of lot area
  - Other Impervious area = 15% of lot area
  - Pervious area = 25% of lot area
- Road Reserve = 95% Impervious
- Active Open Space = 50% Impervious
- Passive Open Space = 10% Impervious
- At the request of CBC, treatment of a portion (0.147 ha) of Bullecourt Avenue has been considered in the sizing of the northern bio-retention raingarden (Bio 3). The future detail design will need to consider the existing drainage constraints and capture as much of Bullecourt Avenue as possible in Bio 3.
- While rainwater tanks will need to be provided to meet BASIX requirements, Council requested that the stormwater quality modelling conservatively exclude rainwater tanks from the stormwater treatment train.
- Vortex style Gross Pollutant Traps will be provided upstream of the bio-retention raingardens. Details of the assumed GPT pollution removal performance is provided in Table 5-1 below.

Table 5-1 – Assumed GPT Pollutant Removal Performance

Parameter			
Gross Pollutants	Input (kg/ML)	Output (kg/ML)	Reduction (%)
	0	0	0%
	100	2	98%
Total Suspended Solids	Input (mg/L)	Output (mg/L)	Reduction (%)
	0	0	0%
	75	75	0%
	1000	300	70%
Total Phosphorous	Input (mg/L)	Output (mg/L)	Reduction (%)
	0	0	0%
	0.5	0.5	0%
	10	7	30%
Total Nitrogen	Input (mg/L)	Output (mg/L)	Reduction (%)
	0	0	0%
	50	50	0%

- Stormwater inflow in excess of the 4EY (3mth ARI) event will bypass the GPTs and bio-retention raingardens.
- Modelled raingarden parameters are provided in Table 5-2. Typically, the average surface area is in the order of 20% to 30% larger than the media bed area due to 1:4 batters within the extended detention zone. It was conservatively assumed that the average surface area is 10% larger than the media bed area for bio-retention Basins 1 & 3. Due to the relatively small footprint, bio-retention Basin 2 will likely be formed via retaining walls. Hence the average surface area is conservatively assumed to be the same as the media bed area for that basin.

Table 5-2 – Bio-retention Raingarden Node Inputs

Parameter	Bio 1	Bio 2	Bio 3
High Flow Bypass (m³/s)*	100	100	100
Extended Detention Depth (m)	0.3	0.3	0.3
Average surface Area (m²)	715	210	385
Filter Area (m²)	650	210	350
Filter Depth (m)	0.40	0.40	0.40
Unlined Filter Mdia Perimeter (m)	0.01	0.01	0.01
Saturated Hydraulic Conductivity (mm/hr)	200	200	100
TN content of Filter Media (mm/kg)	600	600	600
Orthophosphate Content of Filter Media (mg/kg)	30.0	30.0	30.0
Exfiltration rate (mm/hr)	0.00	0.00	0.00
Overflow Weir Width (m)	12.8	3.4	4.5

*A diversion link at the GPT directs stormwater flow in excess of the 4EY (3mth ARI) around the bio-retention raingarden.

Full details of the MUSIC area breakdown and node inputs are provided in Appendix B.

5.3. Pollutant Load Estimates

Total annual pollutant load estimates were derived from the results of the MUSIC model based on a 'mean' assessment of the developed site incorporating the proposed water quality treatment system. It was found that GPTs upstream of a 650 m² (Bio 1), a 210 m² bio-retention raingarden (Bio 2) in the south and a 350 m² bio-retention raingarden (Bio 3) in the north together with a GPT on the bypassing north-western catchment (Cat1Byp) would be required to ensure that the adopted pollutant reduction targets are met prior to discharge from the site. Table 5-3 details the results of the assessment.

Table 5-3 – Summary of Pollutant Loads and Reductions

Pollutant	Total Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	19700	16745	2850	16850	85.0%	85.5%
TP	37	24	10.1	27	65.0%	72.8%
TN	234	105	113	121	45.0%	51.7%
Gross Pollutants	2570	2313	47	2524	90.0%	98.2%

A MUSIC-Link report demonstrating compliance with the adopted Liverpool City Council WSUD Technical Guidelines (Alluvium, 2016) is provided in Appendix C.

5.4. Stream Erosion Index

The potential for stream erosion is assessed by estimating the increase in the relative frequency of flows from the site greater than the identified "stream forming flow" resulting from urbanisation of the catchment. This measure is referred to as the Stream Erosion Index (SEI) and is considered to be an appropriate means of assessing and addressing the impacts of urbanisation on the frequency of regular flows.

Consistent with the adjacent Liverpool City Council WSUD Guidelines, an assessment has been undertaken in accordance with the NSW MUSIC Modelling Guidelines (BMT, 2015) to ensure that the developed condition stream forming flows are not greater than 3.5 - 5 times the duration of existing condition streaming flows from the site.

Details of the SEI assessment is provided in Table 5-4.

Table 5-4 – SEI Results

	Determination of Critical Flow							Stream Erosion Index		
Assessment Location	Area (km^2)	$t_c = 0.76A^{0.38}$ (hour)	t_c (minutes)	I_2 (mm/hr)	C_2	Q_2 (m^3/s)	Q_{crit} (m^3/s)	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
Overall Site	0.169169	0.39	23	59.8	0.444	1.249	0.6243	4.53	8.04	1.8

Results indicate that the SEI for the proposed development is a maximum of 1.8. This is less than the typically adopted maximum targets of 3.5 to 5.0 in western Sydney. The provision of WSUD elements within the development will assist in minimising the impact of urbanisation on the waterway stability of the receiving watercourse.

As part of the future detailed design process, if required, alternate GPT and bio-retention configurations could be implemented, provided that the pollution reduction and stream erosion index targets are achieved.

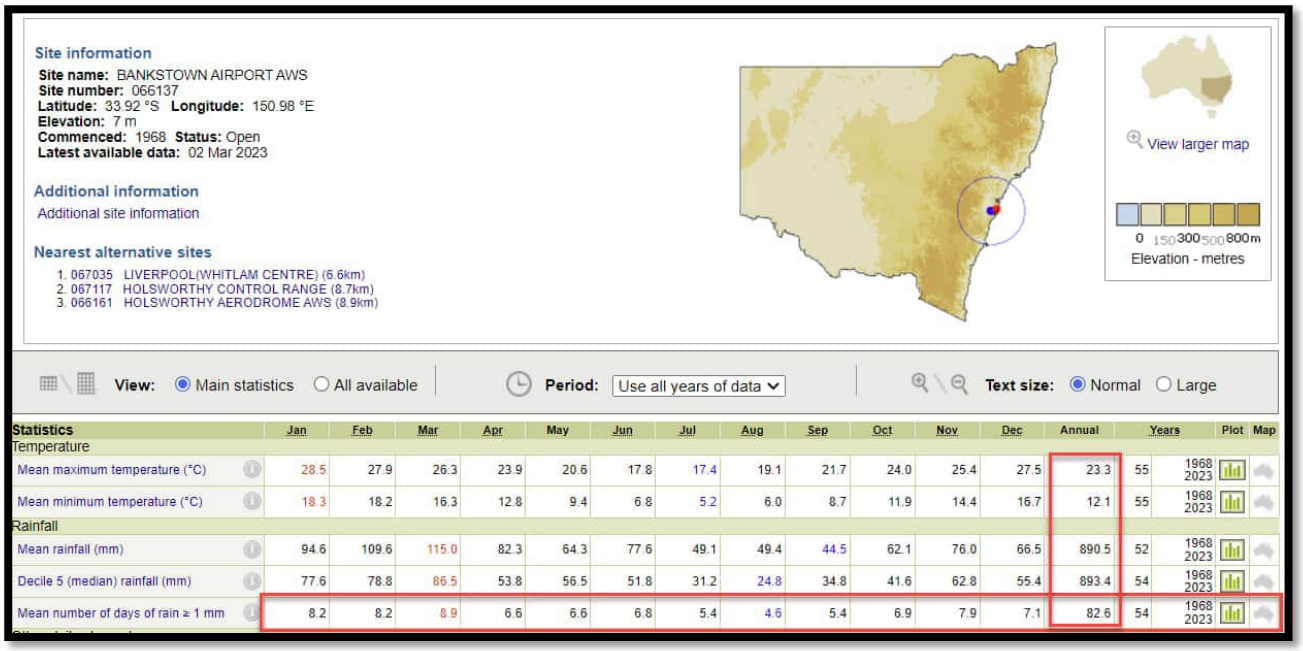
5.5. Frequency of Inundation Assessment

A basin inundation assessment was undertaken for Basin 1 using historic rainfall information in MUSIC software. A detention basin node was included in the MUSIC model which reflects the storage and discharge properties for Basin 1 from the XP-Rafts modelling described in Section 4. The following methodology was adopted:

- The Australian Bureau of Meteorology data for the nearby Bankstown Airport was reviewed to determine how frequently rainfall events occur.
- The flux file for the basin node was written using 6-minute timestep data and the water level has been analysed to determine how long the basin is inundated when a rainfall event occurs.

5.5.1 Rainfall Frequency

The BoM data for Bankstown Airport covers the years 1968 to 2023 and indicates that, on average, there are 83 days of rainfall depth >= 1mm per year. Please see Plate 5-2 below for further details.



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years		Plot	Map
Temperature																	
Mean maximum temperature (°C)	28.5	27.9	26.3	23.9	20.6	17.8	17.4	19.1	21.7	24.0	25.4	27.5	23.3	55	1968 2023		
Mean minimum temperature (°C)	18.3	18.2	16.3	12.8	9.4	6.8	5.2	6.0	8.7	11.9	14.4	16.7	12.1	55	1968 2023		
Rainfall																	
Mean rainfall (mm)	94.6	109.6	115.0	82.3	64.3	77.6	49.1	49.4	44.5	62.1	76.0	66.5	890.5	52	1968 2023		
Decile 5 (median) rainfall (mm)	77.6	78.8	86.5	53.8	56.5	51.8	31.2	24.8	34.8	41.6	62.8	55.4	893.4	54	1968 2023		
Mean number of days of rain ≥ 1 mm	8.2	8.2	8.9	6.6	6.6	6.8	5.4	4.6	5.4	6.9	7.9	7.1	82.6	54	1968 2023		

Plate 5-2 – BoM Data Bankstown Airport

5.5.2 Inundation Assessment

Analysis of the Basin 1 flux file data from the MUSIC model indicates that, on average, the basin only holds water for 0.54 hours (32 minutes), and during 95% of the rainfall events the basin holds water for less than 2.23 hours (134 minutes). The maximum recorded time of inundation was 9.6 hours with a maximum basin depth of 0.42 m. Based on correlation with XP-Rafts data (see Table 4-6 in Section 4 above), this would suggest that a storm in the order of a 10% AEP event occurred within the historic dataset utilised by MUSIC software. It should be noted that the rainfall dataset in the MUSIC modelling reflects a relatively wet 10-year period from 1967 to 1976 and therefore the assessment is considered conservative.

The inundation analysis confirms that the basin will empty relatively quickly in local storm events, and therefore it is not anticipated that the combined use of this open space area as a detention basin would result in the closure of the playing field any differently to other playing fields within the Bankstown LGA when relatively large storm events occur.

It is noted that regional floodwater from the Georges River would take some days to recede. However, as per the above discussion on local inundation, we do not anticipate that this would affect the open space nature of Basin 1 any differently to the closure of parks and playing fields within the Bankstown LGA when significant rainfall events within the catchment occur.

Considering the limited number of days exceeding a 1mm depth on average per annum, combined with the limited duration in which the basin holds water in local catchment events, the predominant use of the southern open space is for recreation.

5.6. Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Council and the guidelines set out by Landcom (the "Blue Book" 2004).

As the operation of 'bio-retention' (raingarden) water quality treatment systems are sensitive to the impact of sedimentation, construction phase controls should generally be maintained until the majority of site building works (approximately 80%) are complete.

6. OPERATION AND MAINTENANCE MANUAL

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish and monitor plant establishment and health. Some sediment build-up may occur on the surface of the raingardens and may require removal to maintain the high standard of stormwater treatment. Regular management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. A site-specific Operation and Maintenance (O & M) Manual has been prepared for the system and should be updated as part of future Development Applications. The O & M manual provides information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices.

The manual provides site-specific management procedures for:

- Maintenance of the GPT structures, including rubbish and sediment removal;
- Management of the raingarden, including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal); and
- Indicative costing of maintenance over the life of the device.

For detail refer to the Operation and Maintenance manual for the stormwater quality and quantity management devices prepared by J. Wyndham Prince in April 2023.

7. FLOOD IMPACT ASSESSMENT

TUFLOW modelling software has been utilised to determine the flood depths, levels, and impacts within the study area due to the proposed development. TUFLOW has the ability to accurately model the complex interaction of pipe drainage networks on the adjoining floodplain. TUFLOW has the ability to dynamically link 1D and 2D flow regimes together with mainstream and local overland flows all in one model, making it an ideal software package for the assessment of flood impacts for the proposed development.

The GRFS (BMT, 2020) has formed the basis of the WSU Milperra flood impact assessment. The GRFS (BMT, 2020) adopted the following approach/parameters:

- An XP -RAFTS hydrologic model was developed to simulate the rate of storm runoff from the catchment. The model predicts the amount of runoff from rainfall and the attenuation of the flood wave as it travels down the catchment.
- A TUFLOW-HPC hydraulic model with 10 x 10 metre grid was then developed to simulate the passage of a flood through the catchment to Botany Bay at the downstream end of the system.
- Initial and continuing losses are:
  - Urban catchments – initial loss 15 mm, continuing loss 1.5 mm/h; and
  - Rural catchments – initial loss 25 mm, continuing loss 2.5 mm/h.
- Manning's 'n' roughness value for hydraulic model (floodplain) ranging from 0.03 to 0.15 was used in this study, these values were adjusted locally (within reasonable bounds) to provide the best fit for peak water level profiles. Variability largely reflects degree of vegetation and land use on the floodplain (developed, cleared and forested)

Amendments to the GRFS (BMT, 2020) TUFLOW hydraulic model have been made to support the WSU Milperra flood impact assessment and are described below.

7.1. Existing Conditions Model Development

7.1.1 Existing Conditions Model

The GRFS (BMT, 2020) flood model was amended to reflect existing conditions for the WSU Milperra site as follows:

- Detailed survey information for the site in DEM format was read over the top of the underlying terrain used in the Georges River Model.
- The XP-RAFTS models described in Section 4 of this report were run for all storm durations to determine the critical storm durations occurring within the study area. The critical local flow duration adopted in the TUFLOW modelling was the 90-minute duration storm. The regional critical flow duration of 24 hours was adopted to find the worst-case regional flood levels at the site.
- Existing condition hydrographs for the site from the XPRAFTS model described in Section 4 were applied to reflect basin inflows in the south and site discharge in the north.
- An existing 4 x 1450mm diameter RCP culvert crossing under the M5 Highway to the south of the site has been added to the model. Invert levels were adopted based on ALS/survey terrain information.
- All other model parameters are consistent with the GRFS model (BMT, 2020).

The resultant flood mapping provided as part of this report considers the 'peak of peaks' flood levels from the suite of modelled durations. The existing condition TUFLOW model setup and adopted parameters are presented in Figures 7-1 and 7-2 in Appendix D.

7.2. Development Conditions Model Development

The existing conditions WSU Milperra flood model was then augmented to reflect the proposed development. The following model refinements were made:

- Updated terrain with a developed conditions surface was read over the top of the detailed survey for the site. A terrain modification within the TUFLOW model was applied to ensure that the level of the proposed lots has 0.5 m freeboard to the regional 1% AEP flood level of 5.55 m AHD (i.e. lots >=6.05 m AHD).

- Developed condition hydrographs for the site from the XPRAFTS model described in Section 4 were applied to reflect basin inflows in the south and site discharge in the north. The 90-minute and 24 hour critical flow durations were adopted in the TUFLOW modelling.
- Detention basin outlet structures for the site were included to ensure the operation of the detention basins was represented in the flood modelling in both local and regional flooding.

The developed Condition TUFLOW model setup and adopted parameters are presented on Figure 7-3 in Appendix D.

7.3. Flood Mapping and Discussion on Results

7.3.1 Model Validation

The GRFS (BMT, 2020) TUFLOW model supplied by Council was run for the 1% AEP event to confirm that Council's results are replicated. Plate 7-1 below provides a comparison between the re-run of the GRFS and the results provided by Council and confirms that the results have been replicated in the 1% AEP event. The regional 1% AEP flood level to the south of the site during a 1% AEP flood event is approximately 5.55 m AHD.

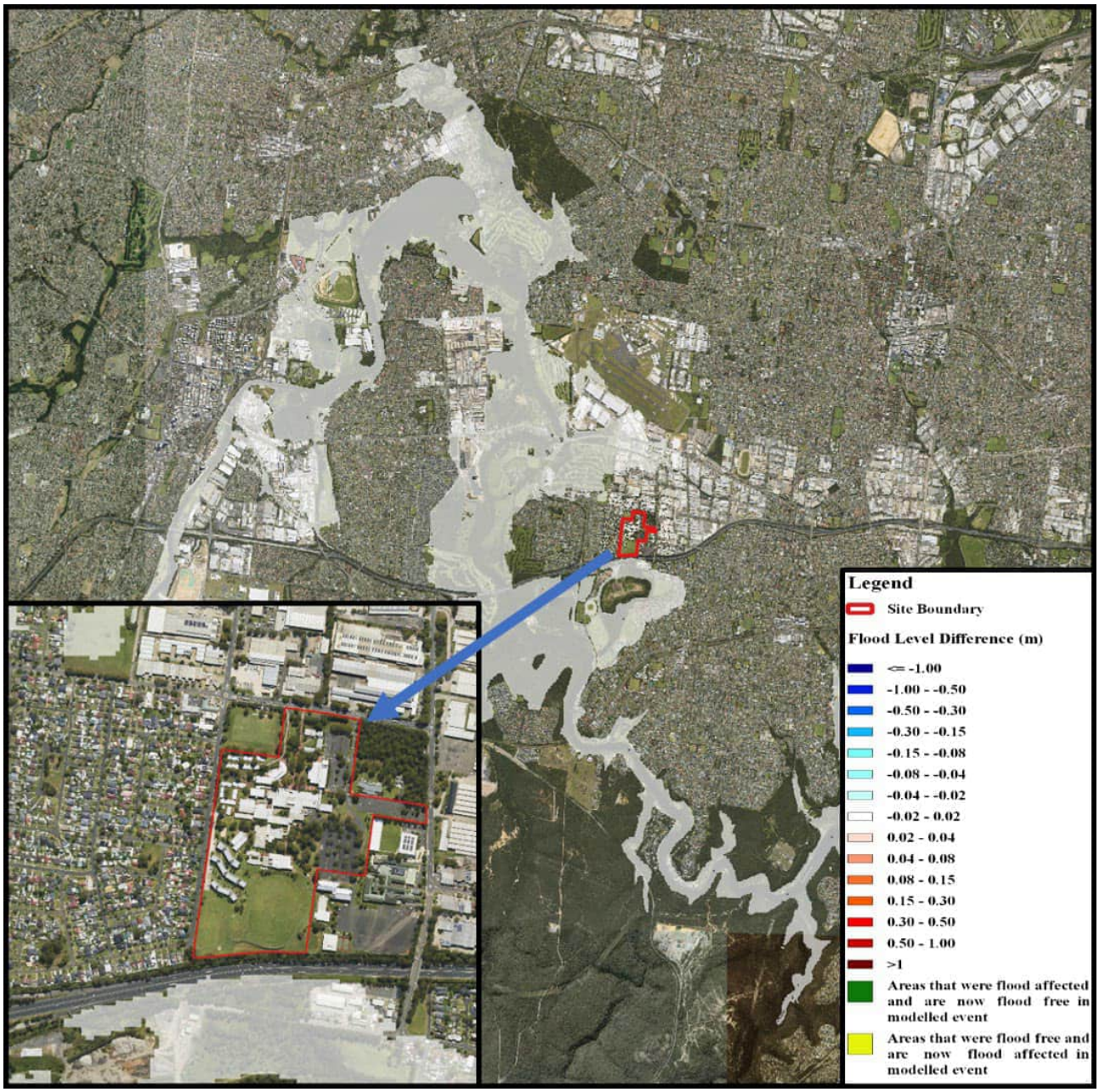


Plate 7-1 – Replication of the GRFS (BMT, 2020) Results for the 1% AEP Event

The GRFS model was then updated to reflect the existing condition WSU Milperra site as described in Section 7.1.1. Flood level difference mapping provided in Plate 7-2 compares flood levels in the existing site model with the GRFS (BMT, 2020) model. The results indicate a new flood-affected area due to amended inflow hydrograph locations on the site and the inclusion of the 4 x 1450mm diameter RCPs under the M5 motorway. Generally, flood levels are consistent with the GRFS (BMT, 2020). The regional 1% AEP flood level now encroaches the WSU Milperra site due to the inclusion of the culvert crossing under the M5 motorway and is approximately 5.55 m AHD.

This has been adopted as the base condition for the flood assessment of the site.

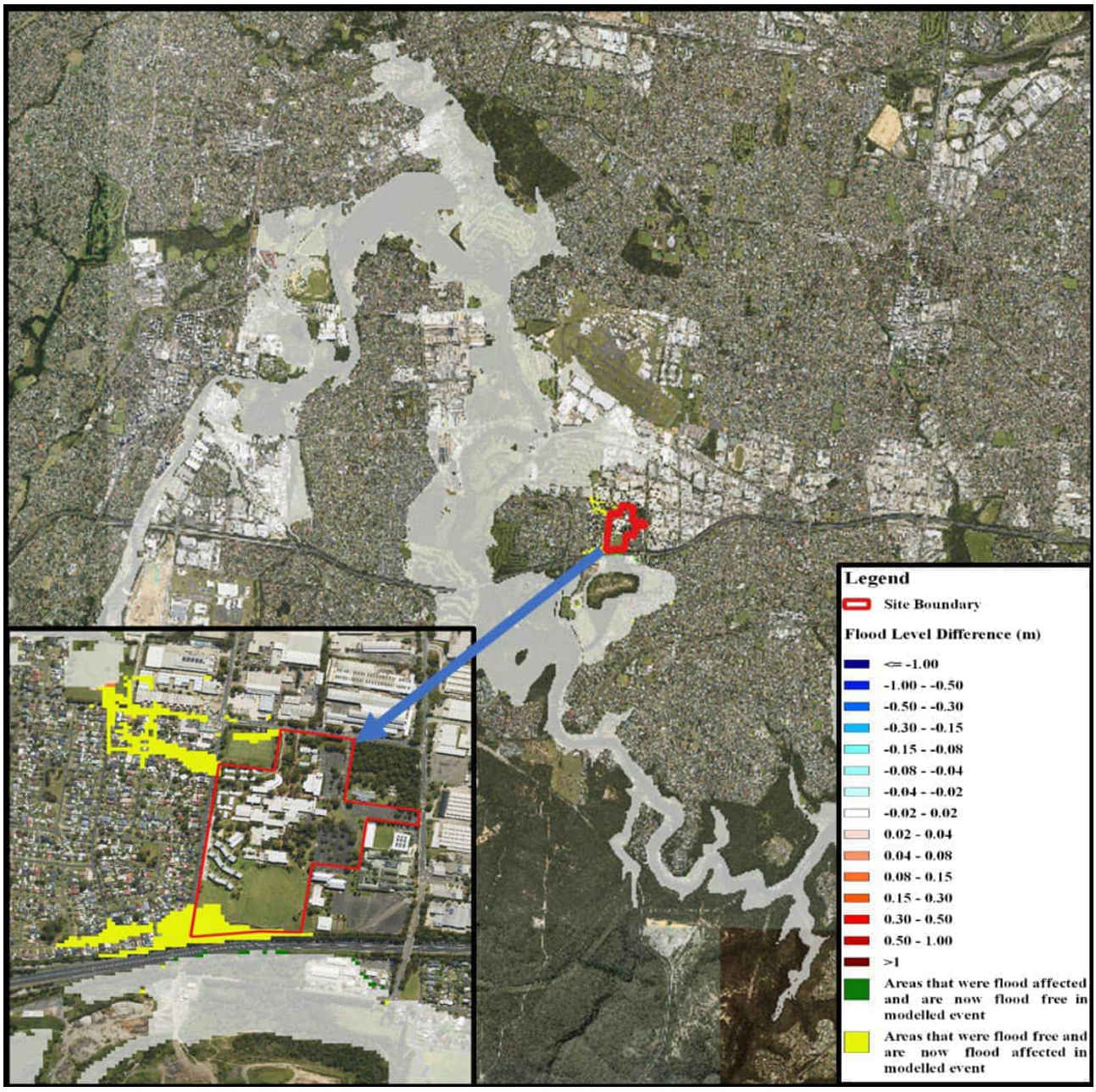


Plate 7-2 – Existing WSU Model vs GRFS (BMT, 2020) Flood Difference for 1% AEP Event

7.3.2 Existing Condition Flood Behaviour

Existing condition flood depth and level mapping for the 1% AEP event is provided in Figure 7-4 in Appendix D. The results indicate that the southern portion of the site is affected by regional flooding to a level of 5.55 m AHD. Some minor overland flow at existing site discharge locations are evident in the northern portion of the site. Figure 7-5 in Appendix D shows the existing condition flood depth and level mapping for PMF flood events. The results indicate flood levels of 11.8 m AHD at and around the site, which is consistent with the GRFS (BMT, 2020).

7.3.3 Developed Condition Flood Behaviour

Developed condition flood depth and level mapping for the 1% AEP event provided in Figure 7-6 indicates that flow from the site is adequately managed within the proposed detention basins. The 1% AEP flood level in the southern portion of the site is 5.55 m AHD, consistent with the existing regional flood level. Figure 7-7 in Appendix D shows the developed condition flood depth and level mapping for PMF flood events. The results indicate flood levels of 11.8 m AHD at and around the site, which is consistent with the existing condition.

There is no significant change in the flood behaviour as a result of the development external to the site when compared to the existing conditions.

7.3.4 Flood Impact

The flood level difference mapping provided in Figure 7-8 in Appendix D indicates that there are no adverse flood level impacts external to the site in the 1% AEP event. Some minor areas of new flood affectation are where depth are less than 50 mm on lots which are already flood affected and therefore inconsequential. Results confirm that flood level reductions in the order of 26 mm would occur downstream of the site to the northwest of the site.

7.3.5 Floodplain Storage

It is noted that the site is affected by regional flooding in the 1% AEP event. The flood surface and terrain information was interrogated and a 1% AEP flood storage volume of approximately 6,400 m³ is available on the existing site.

In the developed condition, the flood level difference mapping results described in Section 7.4.5 reflects the operation of the detention basins and confirm that there is the capacity to provide regional flood storage without affecting detention basin performance.

The developed condition flood surface and terrain information was also interrogated and a 1% AEP flood storage volume of approximately 9,600 m³ is available on site in developed condition. Therefore, there is no net loss of floodplain storage due to the proposed development.

7.4. Climate Change Assessment

The climate change guideline provided in the Australian Rainfall and Runoff (AR&R) 2019 Chapter 6 of Book1 has been used to understand the potential climate hazards surrounding the Subject site.

A six-step process is suggested in AR&R 2019 to incorporate climate change risks into the decision-making process and involve the estimation of design flood characteristics. Following the guideline, the site is within the catchment located in the East Coast South Natural Resource Management (NRM) Clusters (as presented in Figure 1.6.1 of AR&R 2019).

As a part of Step 3 there needs to be consideration of the “Purpose and Nature of the Asset or Activity and Consequences of its Failure”. AR&R 2019 states that the ‘purpose of the asset’ can refer to flow conveyance, improved safety, and reduced frequency of exposure and damage. The consequences of failure can be rated as either low, medium or high. The low consequence is defined as “some probability that asset performance will be impacted but the delivery of services will be only partially or temporarily compromised, or alternative sources of services (e.g. availability of different power sources) are readily available”. Given that the proposed developed floor level is above 1% AEP storm event, the consequence risk rating is therefore considered “low” for the subject site.

Application of Step 4 in the six-step process indicates for the 1% AEP event, the practitioner could consider the impact of the 0.5% and 0.2% AEP events to gain an understanding of the extent to which the risks of climate change may exceed the coping capacity of the facility to perform its intended function. The flood level, depth results for 0.5% AEP and 0.2% AEP in the existing and developed condition are provided in figure 7-9 to 7-12 in Appendix D.

Modelled peak flood levels for the 1% AEP, 0.5% AEP and 0.2% AEP events at the southern portion of the site are presented in Table 7-1. It is noted that the adopted lot level of 6.05 m AHD is 200 mm higher than 0.2% AEP flood level.

Table 7-1 – Flood Levels Comparison

Event	Flood Level (m AHD)
1%AEP	5.55
0.5%AEP	5.68
0.2%AEP	5.85

The 0.5% AEP flood level is around 0.13 m higher than the 1% AEP, whilst the 0.2% AEP flood level is only 0.30 m higher than the 1% AEP. These flood level differences are considered as a reasonable order of potential increases in peak flood levels that might eventuate from future climate change and associated increases in design rainfall intensities.

The incremental flood level impact in 0.5% AEP and 0.2% AEP events suggests low flood risk consequences to the site, particularly given that the FPL (i.e. 6.05 m AHD) for the proposed developemnt is greater than the 0.2 % AEP flood event.

Hence, it is concluded that the increases in flood levels are minimal and the exposure risk to the impacts of climate change is considered “low”.

Therefore, it is our view additional climate change considerations are not needed in support of this planning proposal. Furthermore, this approach is consistent with the EHG requirements from DPE for this development as a part of climate change assessment.

7.5. Flood Hazard Mapping

Hazard maps are useful to obtain an appreciation of the relative depth and velocity of floodwater within a locality. Flood hazard mapping has been prepared for the existing and developed conditions scenarios. Plate 7-3 below provides an overview of the velocity depth product corresponding with each of the H1 – H6 hazard categories which are further described in Pate 7-4.

The hazard zones consistent with the Australian Rainfall and Runoff Revision 2019 (ARR, 2019).

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Plate 7-3 – ARR 2019 Hazard Vulnerability Threshold

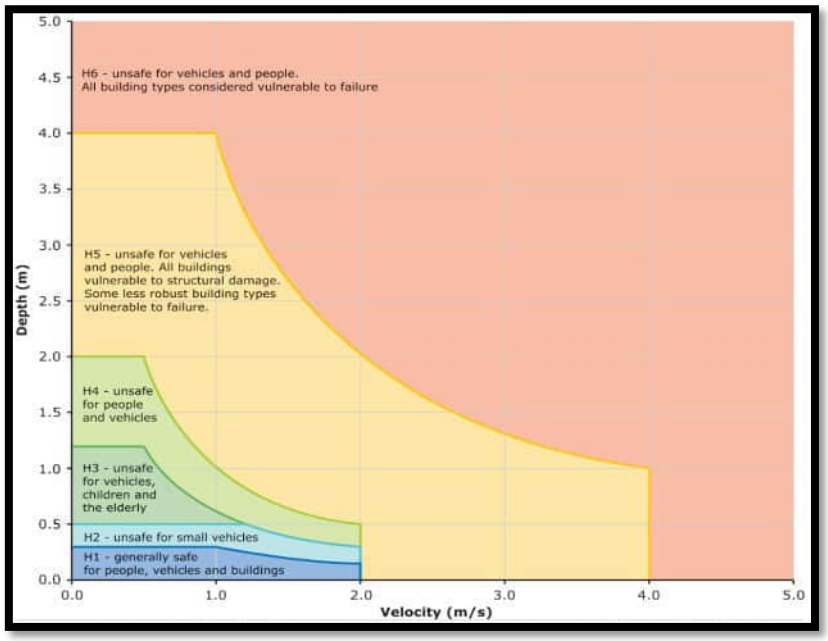


Plate 7-4 – ARR 2019 Hazard Categories

Existing condition flood hazard mapping for the 1% AEP flood event shown in Figure 7-13 in Appendix D indicates that flood hazard within the site and surrounds generally ranges from the H1 safe category to H3 (unsafe for children and the elderly) in the southwest portion of the site. Isolated high hazards (up to H5) are noted at the swale at M5 Highway corridor, south of the site which is unsafe for vehicles and people, with building subject to structural damage. High hazard is expected in dedicated drainage areas and can be managed via the use of appropriate flood warning signage.

Existing condition flood hazard mapping for the rarer 0.5% AEP, 0.2%AEP as climate change proxies along with the extreme PMF events are provided in figures 7-14 to 7-16, respectively, in Appendix D. In the PMF event, High hazard (H5) encompasses a large area of the south-western portion of the site.

Developed condition flood hazard mapping for 1% AEP flood event shown in Figure 7-17 in Appendix D indicates that, flood hazard within the site and surrounds is generally within the H1 safe category with hazard of H5 and H4 contained within the Basin 1 and Basin 2 respectively. Appropriate signage will be installed to mitigate this risk in high hazard (>H3) within the proposed detention basins. Furthermore, up to H5 hazard is seen at the swale at M5 Highway corridor, south of the site similar to existing condition in 1% AEP event.

Developed condition flood hazard mapping for 0.5% AEP, 0.2%AEP as climate change proxies along with the PMF events are provided in figures 7-18 to 7-20, respectively, in Appendix D. The high flood hazard (>H3) is contained within detention basins for events up to the 0.2% AEP. In the PMF event, High hazard (H5) encompasses a large area of the south-western portion of the site, consistent with existing condition PMF hazard.

Based on the flood hazard results, there is no significant change to flood hazard external to the site for 1% AEP, 0.5% AEP up to PMF events in developed condition compared to existing condition.

7.6. FLOOD EVACUATION PLAN

The safe evacuation of people from flood-affected areas during a PMF event is a vital consideration for the planning of the proposed development. The proposed development must allow residents to be able to leave their homes during the Probable Maximum Flood (PMF) event and travel safely to higher ground. The flood evacuation routes must follow a continuous rising grade to a level above the PMF event for all residents. The proposed flood evacuation routes have been determined using the low flood risk precinct extent from the results of this study which represents PMF extents as shown in figures 7-5 and 7-7 in Appendix D. The result suggests that Bullecourt Avenue and Horsley Road are flood-free in PMF events and can be flood evacuation access points for the proposed development if required. It should be noted that an existing childcare facility in the north-west portion of the site is not affected by PMF flooding and therefore evacuation of the proposed development will not adversely impact this existing facility.

The flood evacuation routes identified for the proposed development is provided in Plate 7-5.

Plate 7-5 – Flood Evacuation Plan

Furthermore, the Canterbury Bankstown Flood Emergency Sub-plan 2021 prepared in accordance with the provisions of the State Emergency Service Act 1989 (NSW) outlines the multi-agency arrangements for the emergency management of flooding in the Canterbury-Bankstown Local Government Area (LGA). The community specific roles and responsibilities from sub-plan is summarised below:

- Preparedness
  - Understand the potential risk and impact of flooding.
  - Prepare homes and property to reduce the impact of flooding.
  - Understand warnings and other triggers for action and the safest actions to take in a flood.
  - Households, institutions and businesses develop plans to manage flood risks, sharing and practicing this with family, friends, employees and
  - neighbours.
  - Have an emergency kit; and
  - Be involved in local emergency planning processes.
- Recovery

- Assist with community clean-up if required and able to do so.
- Participate in After Action Reviews if required.

8. SUMMARY/CONCLUSION

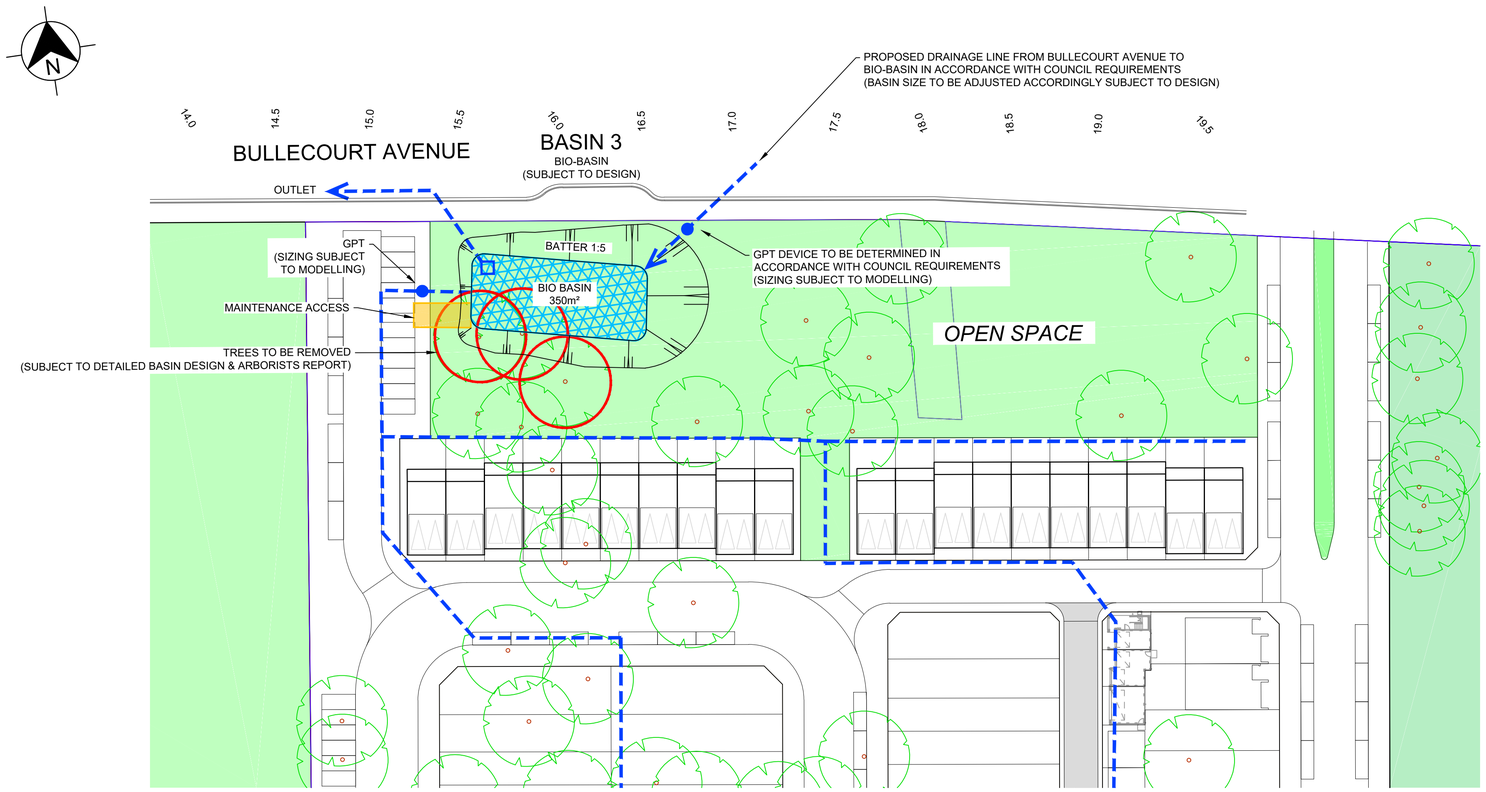
J. Wyndham Prince has been engaged by Mirvac to undertake a Flood and Risk Impact Assessment in support of a Planning Proposal to rezone approximately 19.62 ha of land at 2 and 2A Bullecourt Avenue, Milperra.

- Stormwater detention is not required for the north-western portion of the site due to the regrading of the site which has reduced the overall catchment discharging to the north-west. However, the southern portion of the site will require detention to ensure that developed condition flows are no greater than existing the condition. The investigation has determined that two (2) detention basins in the southern portion of the site with a combined 1% AEP detention volume of approximately 2,310 m³ will ensure that developed conditions flow are no greater than existing conditions flows external to the site.
- Four (4) Gross Pollutant Traps (GPTs) and three (3) bio-retention raingardens provide stormwater quality management for the proposed subdivision to ensure pollutant removal targets are met prior to discharge from the site. The bio-retention raingardens also ensure that developed conditions durations of stream forming flows are no greater than 3.5 – 5.0 times the duration of existing conditions stream forming flows.
- A frequency of inundation assessment was undertaken for the large southern detention Basin 1. For 95% of the modelled historic rainfall events, the assessment indicates that Basin 1 would hold water for less than 2.5 hours. Bureau of Meteorology data for the nearby Bankstown Airport indicates that, on average, rainfall events with a depth of >=1mm depth occur 85 days per annum. Therefore, the predominant use of the Basin 1 southern open space is for recreation.
- A flood assessment was undertaken using the hydraulic model that supported the Georges River Flood Study (BMT, 2020) to determine the flood risk and impact for storm events ranging from the 1% AEP to the PMF event.
- The regional 1% AEP flood level at the site is 5.55 m AHD in both the existing and developed condition. Freeboard of 0.5 m is required to finished floor levels and this the minimum floor levels for the proposed dwellings would be 6.05m AHD.
- Flood level difference mapping provided in Figure 7-12 in Appendix D indicates that there are no adverse flood level impacts external to the site.
- A climate change assessment was undertakn utilising the 0.5% AEP and 0.2% AEP events as proxies for 1% AEP climate change. 200 mm freeboard would still be available to the finished floor levels of proposed dwellings in the 0.2% AEP and therefore flood risk increases due to climate change are low.
- The site is affected by regional flooding in the 1% AEP event. The flood surface and terrain information have been interrogated for the existing and developed condition site. There is no net loss of floodplain storage due to the proposed development in the 1% AEP event.
- A flood evacuation plan is provided demonstrating that a continuous rising grade to areas above the PMF level can be achieved.

9. REFERENCES

1. BMT WBM Pty Ltd (2015). NSW MUSIC Modelling Guidelines
2. BMT WBM Pty Ltd (2018). TUFLOW User Manual
3. Bankstown Local Environmental Plan (LEP, 2015)
4. Bankstown Development Control Plan (DCP, 2015)
5. Botany Bay & Catchment Water Quality Improvement Plan (Sydney Metropolitan Catchment Management Authority, 2011)
6. Canterbury-Bankstown Council Development Engineering Standards (2006, as amended June 2009)
7. Draft Canterbury Bankstown Development Control Plan 2021 (DCP, 2021).
8. Georges River Flood Study (BMT, 2020)
9. Greater Metropolitan Regional Environmental Plan No.2 – Georges River Catchment (2020)
10. Liverpool City Council WSUD Technical Guidelines (Alluvium, 2016)
11. Willing & Partners Pty Ltd (1994). Runoff Analysis & Flow Training Simulation – Detailed Documentation and User Manual, Version 4.0
12. Willing & Partners Pty Ltd (1996). Runoff Analysis & Flow Training Simulation – Addendum Version 5.0
13. City of Canterbury Bankstown Council (2021) Canterbury Bankstown Flood Emergency Sub-plan

APPENDIX A – ENGINEERING PLAN



BASIN 3 PRELIMINARY LAYOUT PLAN
(INDICATIVE ONLY SUBJECT TO DESIGN)

TYPICAL BIO-BASIN PERCHED WITH OUTLET TO OSD
(INDICATIVE ONLY)

EXAMPLE BIO-BASIN INTEGRATED BETWEEN
ROADWAY AND PLAYGROUND AREA
(INDICATIVE ONLY)

1:500 (AT A1)
1:1000 (AT A3)

10 0 10 20 30 40 50
METRES

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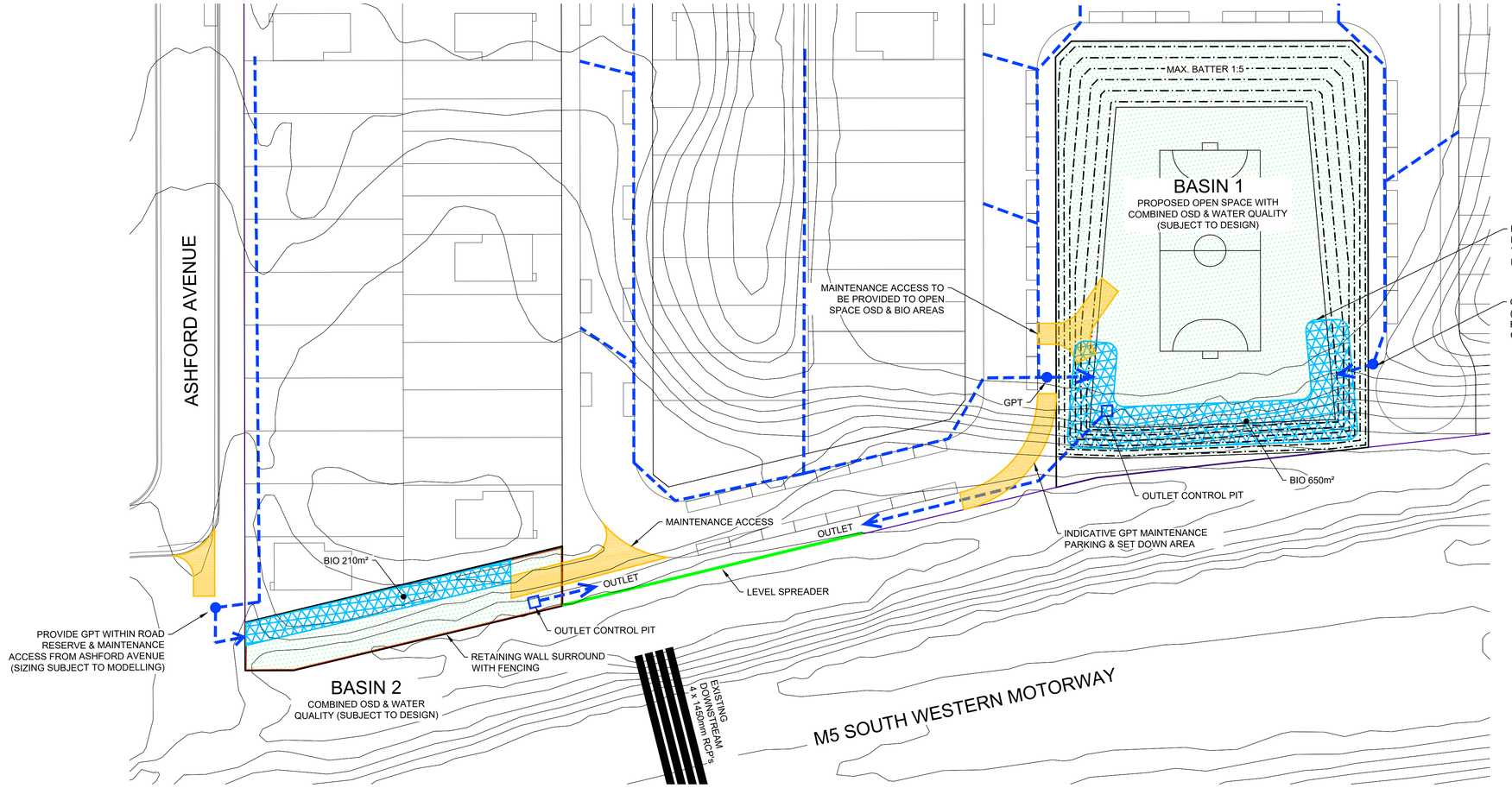
WSU MILPERRA
PRELIMINARY BASIN 3 LAYOUT
INDICATIVE ONLY

Client: mirvac

110709-02-SK006
Rev B 14/04/23



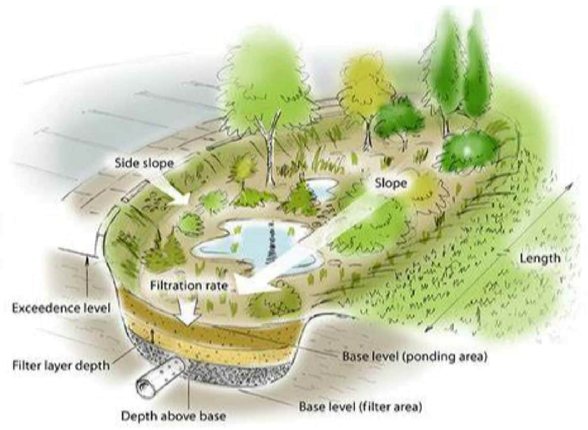
BASINS 1 & 2 PRELIMINARY LAYOUT PLAN
(INDICATIVE ONLY SUBJECT TO DESIGN)

PROPOSED HARD EDGING TO RAINGARDEN - SANDSTONE BLOCK WALL OR SIMILAR TO COUNCIL REQUIREMENTS

GPT
(SIZING SUBJECT TO MODELLING)
RESTRICTED PARKING WITHIN
CULDESAC FOR GPT ACCESS

IEXAMPLE BIO-BASIN INTEGRATED BETWEEN ROADWAY AND PLAYGROUND AREA
(INDICATIVE ONLY)

BIO-BASIN WITH ACCESS, SANDSTONE BLOCK WALLS & OPEN SPACE USE ADJOINING
(INDICATIVE ONLY)



TYPICAL BIO-BASIN PERCHED WITH OUTLET TO OSD
(INDICATIVE ONLY)

1:500 (AT A1)
1:1000 (AT A3)
10 0 10 20 30 40 50
METRES

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WSU MILPERRA
PRELIMINARY BASIN 1 & 2 LAYOUTS
INDICATIVE ONLY

Client: mirvac

110709-02-SK007
Rev B 14/04/23

APPENDIX B – MUSIC MODEL DATA

MUSIC MODELLING WORKSHEET

	Catchment Division							Node Inputs Catchment Split Road/Roof/Impervious/Pervious				
Catchment	**Total Catchment Area (ha)**	**R2 Lot Area (ha)**	**R2 No. Lots**	**Avg Lot Size (m^2)**	**Road Reserve Area (ha)**	**Active Open Space**	**Passive Open Space/RG**	**Road/Driveway (ha)**	**Roof (ha)**	**Other Impervious (ha)**	**Pervious Areas (ha)**	**Effective % Impervious**
Cat1a	3.394	1.476	88	168	1.416		0.502	1.493	0.738	0.272	0.892	73.7%
Cat1Byp	0.599	0.350	15	233	0.225	0.024		0.248	0.175	0.064	0.111	81.5%
Cat2	10.010	5.664	233	243	3.309	0.565	0.472	3.710	2.832	1.179	2.289	77.1%
Cat2Byp	0.127				0.127			0.121			0.006	95.0%
Cat3	2.640	2.427	82	296	0.110	0.036	0.066	0.347	1.214	0.389	0.690	73.9%
Existing Bullecourt Avenue	0.147				0.147			0.140			0.007	95.0%
Total	16.917											

		Urban Rational					0.1
	Cat. Area (ha)	**Flow Path Length (m)**	**Tc* (min)**	**%Imperv.**	**1yr Flow (m^3/s)**	**3mth Flow (m^3/s)**	**Weir Length**
Cat1a (GPT 3)	3.394	430	7.1	74%	0.462	0.240	4.5
Cat2 (GPT 1)	10.010	540	8.0	77%	1.323	0.688	12.8
Cat3 (GPT 2)	2.640	475	7.5	74%	0.352	0.183	3.4
Cat1Byp	0.599	140	5.0	82%	0.097	0.050	1.0

*Tc calculated based on Kinematic wave equation for a typical 370 m^2 lot plus flowpath travel time @ 2 m/s

= Adopted GPT High Flow Bypass

%Impervious	
R2 and R3 Lots	75%
Road	95%
Passive Open Space	10%
Active Open Space	50%
% Breakdown of lot area	
Roof	50%
Driveways	10%
Other Impervious	15%
Pervious Areas	25%

APPENDIX C – MUSIC-LINK REPORT

LIVERPOOL CITY COUNCIL

music@link

MUSIC-*link* Report

Project Details		Company Details	
Project:	WSU Milperra Rezoning	**Company:**	J. Wyndham Prince
Report Export Date:	19/04/2023	**Contact:**	Francis Lane
Catchment Name:	110709-02_MU03	**Address:**	Level 2/50 Belmore Street Penrith NSW 2750
Catchment Area:	16.917ha	**Phone:**	02 4720 3385
Impervious Area*:	148.3%	**Email:**	flane@jwprince.com.au
Rainfall Station:	67035 LIVERPOOL(WHITLAM		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1967 - 31/12/1976 11:54:00 PM		
Mean Annual Rainfall:	857mm		
Evapotranspiration:	1171mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Liverpool Clay Soil		
Scenario:	Liverpool Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Report	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	2.37%	Bio Retention Node	3	Urban Source Node	21
TSS	85.4%	Detention Basin Node	1		
TP	72.7%	GPT Node	4		
TN	51.3%	Generic Node	2		
GP	98.2%				

Comments

Pre-development node only in model for SEI assessment. Pollution reductions are not appliccable to this node.

Rainwater tanks excluded as requested by Council.

LIVERPOOL CITY COUNCIL

music@link

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention 1 - 650m²	Exfiltration Rate (mm/hr)	0	None	0
Bio	Bioretention 1 - 650m²	Hi-flow bypass rate (cum/sec)	0	None	100
Bio	Bioretention 1 - 650m²	Orthophosphate Content in Filter (mg/kg)	0	55	30
Bio	Bioretention 1 - 650m²	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention 1 - 650m²	Total Nitrogen Content in Filter (mg/kg)	1	800	600
Bio	Bioretention 2 - 210m²	Exfiltration Rate (mm/hr)	0	None	0
Bio	Bioretention 2 - 210m²	Hi-flow bypass rate (cum/sec)	0	None	100
Bio	Bioretention 2 - 210m²	Orthophosphate Content in Filter (mg/kg)	0	55	30
Bio	Bioretention 2 - 210m²	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention 2 - 210m²	Total Nitrogen Content in Filter (mg/kg)	1	800	600
Bio	Bioretention 3 - 350m²	Exfiltration Rate (mm/hr)	0	None	0
Bio	Bioretention 3 - 350m²	Hi-flow bypass rate (cum/sec)	0	None	100
Bio	Bioretention 3 - 350m²	Orthophosphate Content in Filter (mg/kg)	0	55	30
Bio	Bioretention 3 - 350m²	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention 3 - 350m²	Total Nitrogen Content in Filter (mg/kg)	1	800	600
Detention	Detention Basin	% Reuse Demand Met	None	None	0
GPT	Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.05
GPT	Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.24
GPT	Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.688
GPT	Vortex Style GPT	Hi-flow bypass rate (cum/sec)	None	99	0.183
Post	Post-Development Node	% Load Reduction	None	None	92.3
Post	Post-Development Node	GP % Load Reduction	90	None	99.4
Post	Post-Development Node	TN % Load Reduction	45	None	92.8
Post	Post-Development Node	TP % Load Reduction	65	None	94.1
Post	Post-Development Node	TSS % Load Reduction	85	None	95.7
Pre	Pre-Development Node	% Load Reduction	None	None	80.6
Pre	Pre-Development Node	TN % Load Reduction	45	None	82.5
Pre	Pre-Development Node	TP % Load Reduction	65	None	80.8
Urban	Bullecourt Pervious [0.007 ha]	Area Impervious (ha)	None	None	0
Urban	Bullecourt Pervious [0.007 ha]	Area Pervious (ha)	None	None	0.007
Urban	Bullecourt Pervious [0.007 ha]	Total Area (ha)	None	None	0.007
Urban	Bullecourt Roads [0.14 ha]	Area Impervious (ha)	None	None	0.14
Urban	Bullecourt Roads [0.14 ha]	Area Pervious (ha)	None	None	0
Urban	Bullecourt Roads [0.14 ha]	Total Area (ha)	None	None	0.14
Urban	Cat1a Imervious [0.272 ha]	Area Impervious (ha)	None	None	0.272
Urban	Cat1a Imervious [0.272 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1a Imervious [0.272 ha]	Total Area (ha)	None	None	0.272
Urban	Cat1a Pervious [0.892 ha]	Area Impervious (ha)	None	None	0
Urban	Cat1a Pervious [0.892 ha]	Area Pervious (ha)	None	None	0.892
Urban	Cat1a Pervious [0.892 ha]	Total Area (ha)	None	None	0.892

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat1a Road/Driveway [1.493 ha]	Area Impervious (ha)	None	None	1.493
Urban	Cat1a Road/Driveway [1.493 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1a Road/Driveway [1.493 ha]	Total Area (ha)	None	None	1.493
Urban	Cat1a Roof [0.738 ha]	Area Impervious (ha)	None	None	0.738
Urban	Cat1a Roof [0.738 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1a Roof [0.738 ha]	Total Area (ha)	None	None	0.738
Urban	Cat1Byp Impervious [0.064 ha]	Area Impervious (ha)	None	None	0.064
Urban	Cat1Byp Impervious [0.064 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1Byp Impervious [0.064 ha]	Total Area (ha)	None	None	0.064
Urban	Cat1Byp Pervious [0.111 ha]	Area Impervious (ha)	None	None	0
Urban	Cat1Byp Pervious [0.111 ha]	Area Pervious (ha)	None	None	0.111
Urban	Cat1Byp Pervious [0.111 ha]	Total Area (ha)	None	None	0.111
Urban	Cat1Byp Roads [0.248 ha]	Area Impervious (ha)	None	None	0.248
Urban	Cat1Byp Roads [0.248 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1Byp Roads [0.248 ha]	Total Area (ha)	None	None	0.248
Urban	Cat1Byp Roof [0.175 ha]	Area Impervious (ha)	None	None	0.175
Urban	Cat1Byp Roof [0.175 ha]	Area Pervious (ha)	None	None	0
Urban	Cat1Byp Roof [0.175 ha]	Total Area (ha)	None	None	0.175
Urban	Cat2 Byp Roads [0.121 ha]	Area Impervious (ha)	None	None	0.121
Urban	Cat2 Byp Roads [0.121 ha]	Area Pervious (ha)	None	None	0
Urban	Cat2 Byp Roads [0.121 ha]	Total Area (ha)	None	None	0.121
Urban	Cat2 Impervious [1.179 ha]	Area Impervious (ha)	None	None	1.179
Urban	Cat2 Impervious [1.179 ha]	Area Pervious (ha)	None	None	0
Urban	Cat2 Impervious [1.179 ha]	Total Area (ha)	None	None	1.179
Urban	Cat2 Pervious [2.289 ha]	Area Impervious (ha)	None	None	0
Urban	Cat2 Pervious [2.289 ha]	Area Pervious (ha)	None	None	2.289
Urban	Cat2 Pervious [2.289 ha]	Total Area (ha)	None	None	2.289
Urban	Cat2 Roads/Driveway [3.710 ha]	Area Impervious (ha)	None	None	3.71
Urban	Cat2 Roads/Driveway [3.710 ha]	Area Pervious (ha)	None	None	0
Urban	Cat2 Roads/Driveway [3.710 ha]	Total Area (ha)	None	None	3.71
Urban	Cat2 Roof [2.832 ha]	Area Impervious (ha)	None	None	2.832
Urban	Cat2 Roof [2.832 ha]	Area Pervious (ha)	None	None	0
Urban	Cat2 Roof [2.832 ha]	Total Area (ha)	None	None	2.832
Urban	Cat2Byp Pervious [0.006 ha]	Area Impervious (ha)	None	None	0
Urban	Cat2Byp Pervious [0.006 ha]	Area Pervious (ha)	None	None	0.006
Urban	Cat2Byp Pervious [0.006 ha]	Total Area (ha)	None	None	0.006
Urban	Cat3 Impervious [0.389 ha]	Area Impervious (ha)	None	None	0.389
Urban	Cat3 Impervious [0.389 ha]	Area Pervious (ha)	None	None	0
Urban	Cat3 Impervious [0.389 ha]	Total Area (ha)	None	None	0.389
Urban	Cat3 Pervious [0.690 ha]	Area Impervious (ha)	None	None	0

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat3 Pervious [0.690 ha]	Area Pervious (ha)	None	None	0.69
Urban	Cat3 Pervious [0.690 ha]	Total Area (ha)	None	None	0.69
Urban	Cat3 Road/Driveway [0.347 ha]	Area Impervious (ha)	None	None	0.347
Urban	Cat3 Road/Driveway [0.347 ha]	Area Pervious (ha)	None	None	0
Urban	Cat3 Road/Driveway [0.347 ha]	Total Area (ha)	None	None	0.347
Urban	Cat3 Roof [1.214 ha]	Area Impervious (ha)	None	None	1.214
Urban	Cat3 Roof [1.214 ha]	Area Pervious (ha)	None	None	0
Urban	Cat3 Roof [1.214 ha]	Total Area (ha)	None	None	1.214
Urban	Existing Site [16.770 ha]	Area Impervious (ha)	None	None	0
Urban	Existing Site [16.770 ha]	Area Pervious (ha)	None	None	16.77
Urban	Existing Site [16.770 ha]	Total Area (ha)	None	None	16.77

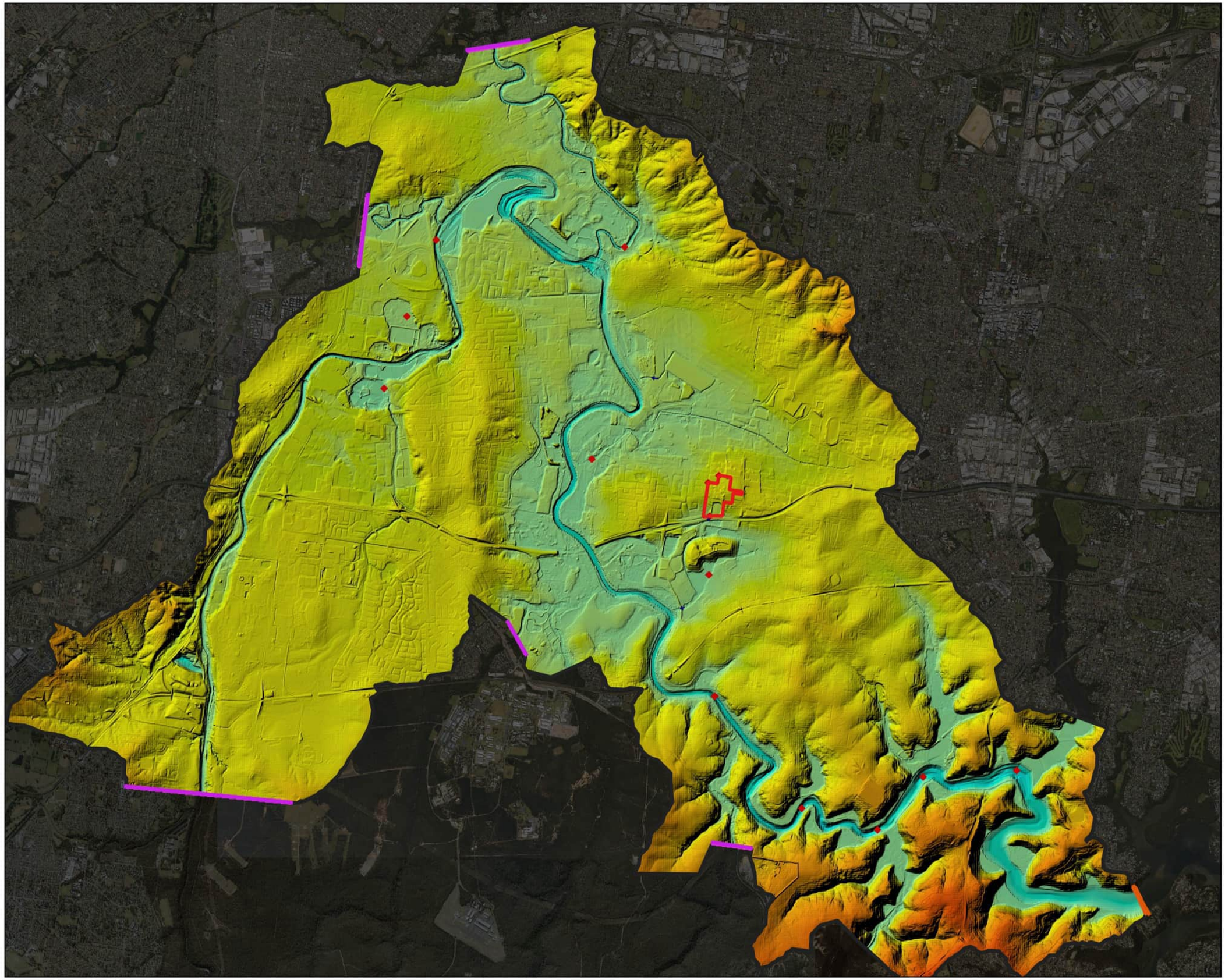
Only certain parameters are reported when they pass validation

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Pre	Pre-Development Node	GP % Load Reduction	90	None	0
Pre	Pre-Development Node	TSS % Load Reduction	85	None	78.6

Only certain parameters are reported when they pass validation

APPENDIX D – FIGURES



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Legend

- Site Boundary

Terrain Elevation (m AHD)

- <= 0
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- > 60

TUFLOW Elements

- Model Boundary
- Inflow Location
- Upstream Inflow Locations
- Downstream Boundary
- Drainage Network

0 600 1,200 1,800 m

Scale at A3 **1:50000**

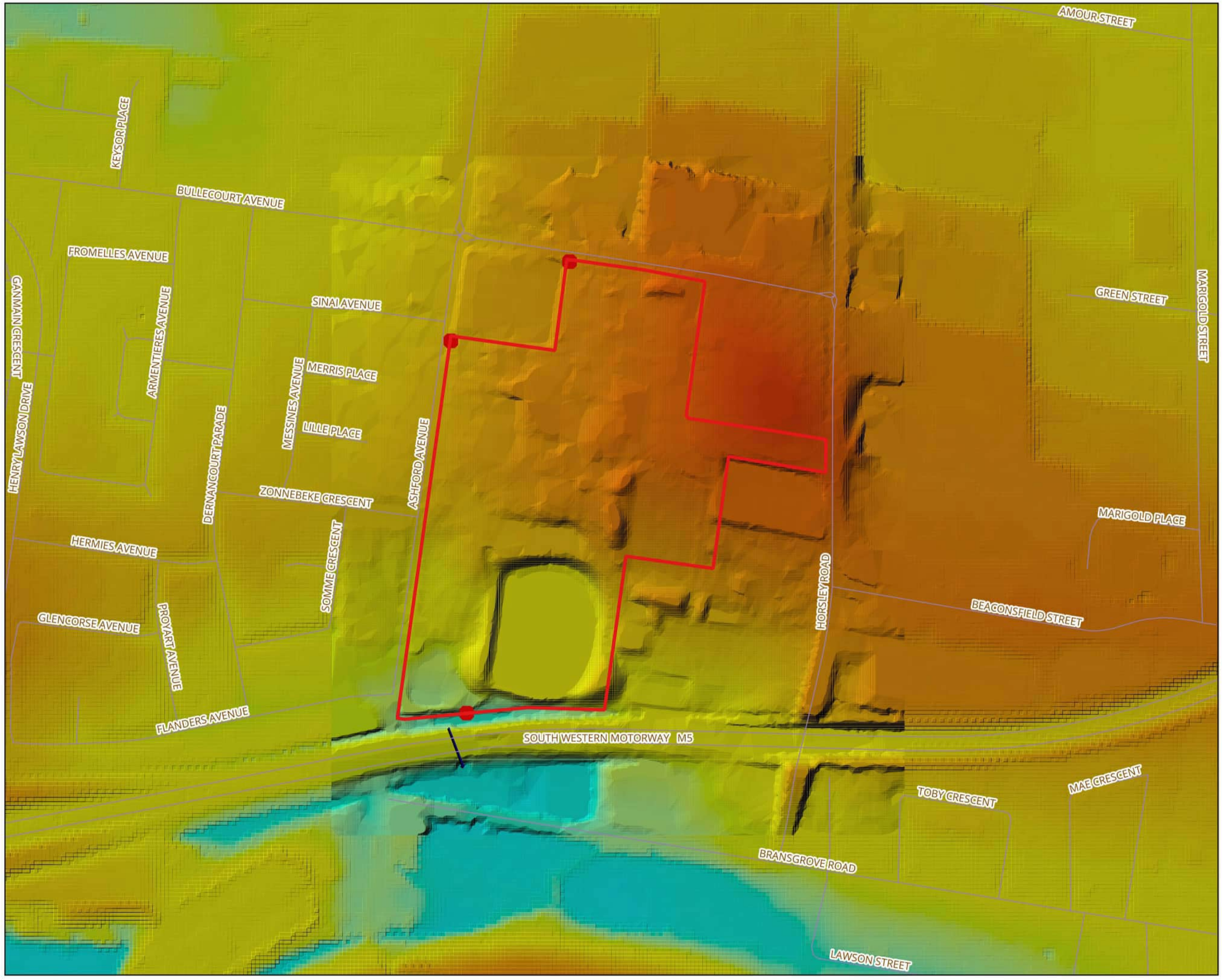
Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-1**

Existing Terrain and TUFLOW Elements

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	



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- Site Boundary

Terrain Elevation (m AHD) Site

- <= 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

TUFLOW Elements

- Inflow Location
- Drainage Network

0 50 100 150 m

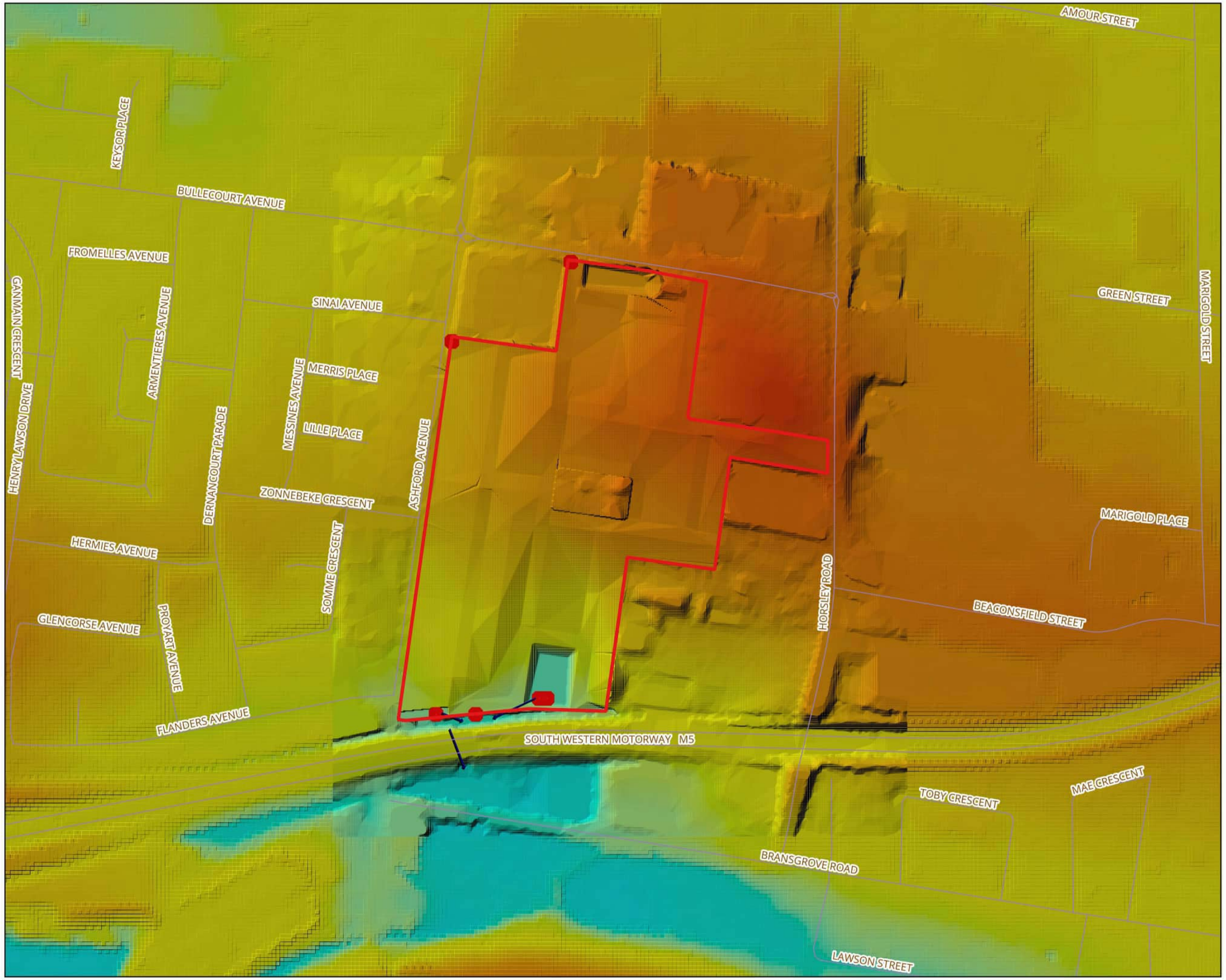
Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-2**
Existing Terrain and TUFLOW Elements (Site)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	



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- Site Boundary

Terrain Elevation (m AHD) Site

- <= 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

TUFLOW Elements

- Inflow Location
- Drainage Network

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-3**

Developed Terrain and TUFLOW Elements (Site)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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Site Boundary

Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
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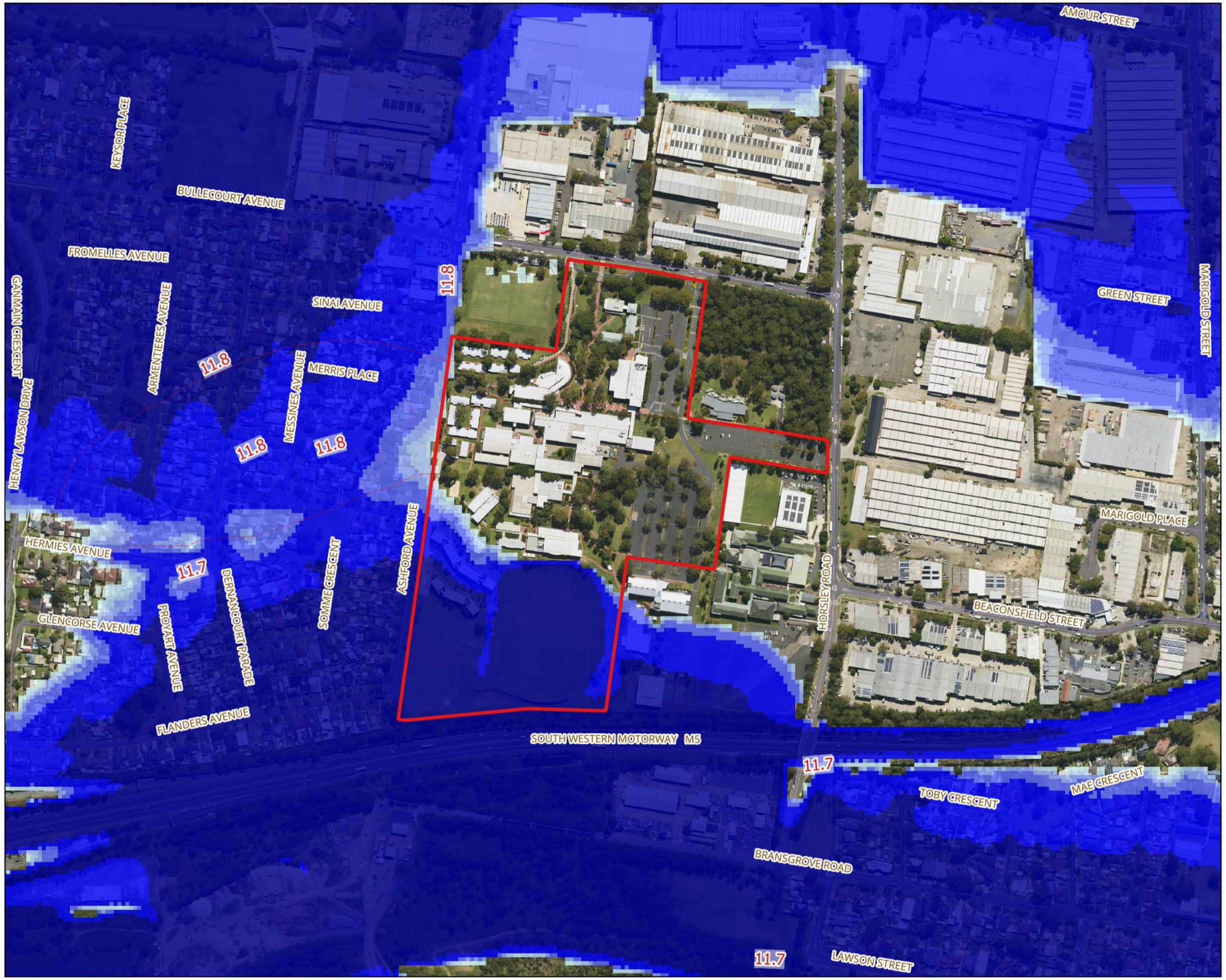
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-4**
1% AEP Flood Level and Depth
Existing Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	



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Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-5**
PMF Flood Level and Depth
Existing Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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- Site Boundary

Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

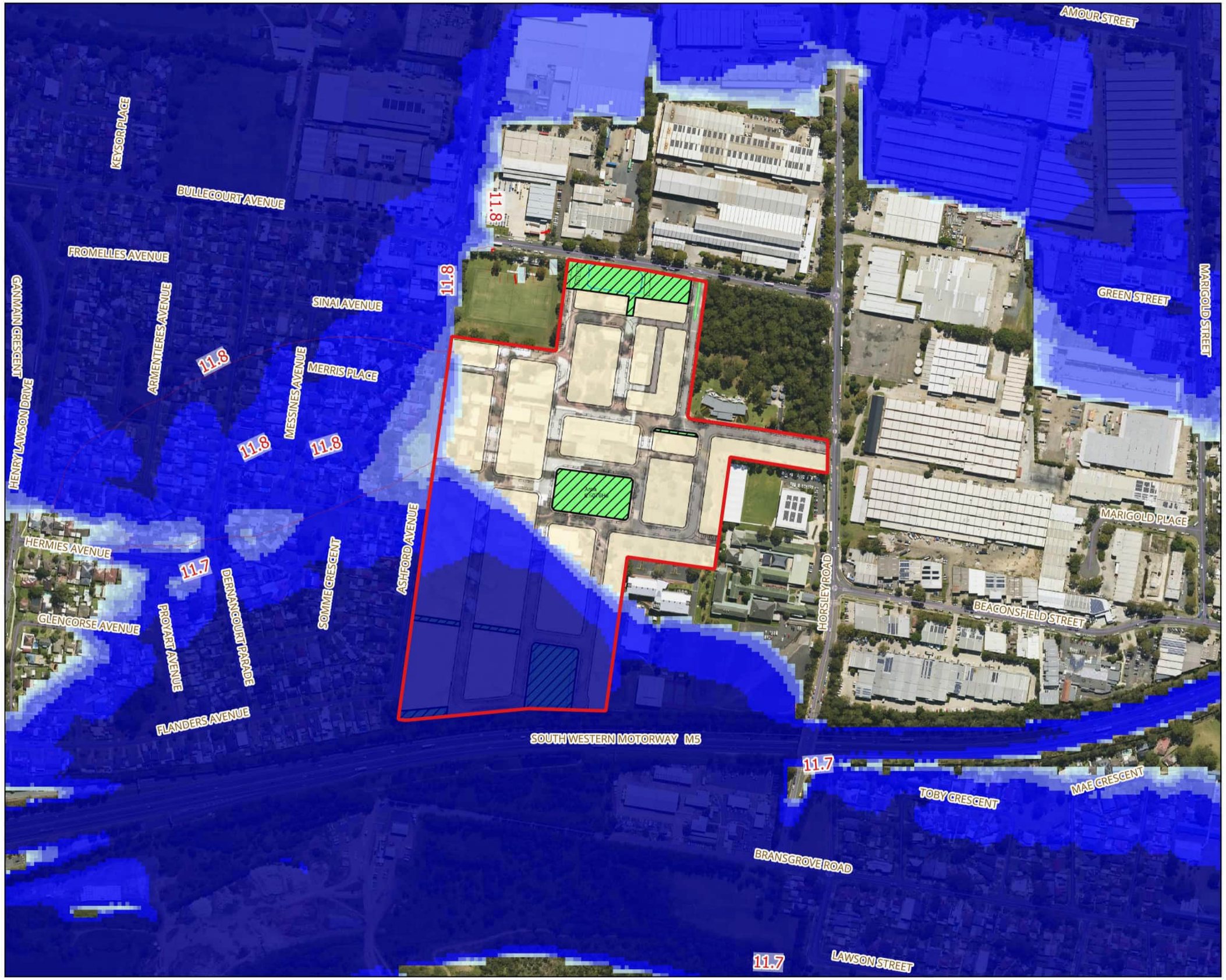
Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-6**
1% AEP Flood Level and Depth
Developed Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	



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Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. 7-7
PMF Flood Level and Depth
Developed Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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- Site Boundary

Flood Level Difference (m)

- <= -1.00
- -1.00 - -0.50
- -0.50 - -0.30
- -0.30 - -0.15
- -0.15 - -0.08
- -0.08 - -0.04
- -0.04 - -0.02
- -0.02 - 0.02
- 0.02 - 0.04
- 0.04 - 0.08
- 0.08 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- >1
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-8**
1% AEP Flood Level Difference

Issue	Date	By	Checked	Approved
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Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-9**

0.5% AEP Flood Level and Depth
Existing Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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Site Boundary

Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-10**

0.2% AEP Flood Level and Depth
Existing Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-11**

0.5% AEP Flood Level and Depth
Developed Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

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Depth Pallete

Band 1

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 3.0
- >3

Flood Levels (m)

- Flood Level 1m Intervals
- Flood Level 0.1m Intervals

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-12**

0.2% AEP Flood Level and Depth
Developed Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-13**
1% AEP Flood Hazard
Existing Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-14**

0.5% AEP Flood Hazard
Existing Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-15**

0.2% AEP Flood Hazard
Existing Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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Legend

- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-16**
PMF Flood Hazard
Existing Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-17**
1% AEP Flood Hazard
Developed Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-18**

0.5% AEP Flood Hazard
Developed Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-19**

0.2% AEP Flood Hazard
Developed Condition
(Climate change Scenario)

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	

Note: The hazard map prepared has been processed using the waterRIDE tool so insignificant differences in the flood extent can be seen.

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- Site Boundary

Flood Hazard

- Generally safe for vehicles, people and buildings
- Unsafe for small vehicles
- Unsafe for vehicles, children and the elderly
- Unsafe for vehicles and people
- Unsafe for vehicles and people All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- Unsafe for vehicles and people All building types considered vulnerable to failure

0 50 100 150 m

Scale at A3 **1:4500**

Job Title
WSU Millperra
Flood and Risk Impact Assessment

Job No. **110709**

Figure No. **7-20**
PMF Flood Hazard
Developed Condition

Issue	Date	By	Checked	Approved
A	28/04/2023	AZ	SL	