

Flood Impact and Risk Assessment

The Ponds High School

Prepared for NSW Department of Education / 17 September 2025

241650

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1.0 Introduction

This Flood Impact and Risk Assessment (FIRA) report has been prepared by TTW (NSW) Pty Ltd on behalf of the NSW Department of Education (The Department) to inform a Review of Environment Factors (REF) for upgrades to The Ponds High School (the activity) located at 180 Riverbank Drive, The Ponds (the site).

The Ponds High School, located in northwest Sydney is a coeducational comprehensive high school that opened in 2015.

1.1 Proposed Activity

The proposed activity would provide for upgrades to the existing school, including the following:

- Construction of two new permanent school buildings Building E and F, of three and four storeys, respectively. The buildings comprise classrooms/teaching spaces and amenities.
- Reconfiguration of external areas, including demolition of hardstand and landscaped spaces, construction of fencing, new natural and synthetic turf playing fields, and relocation of cricket nets and outdoor shelters, with ancillary landscaping works including tree removal and planting.
- Removal of demountable buildings following completion of new permanent learning spaces.
- Expansion and reconfiguration of car parking areas to improve circulation, access, and capacity, with ancillary works.
- Upgrades to site infrastructure, including stormwater management, the existing substation, and ancillary works.

The proposed activity does not seek to increase staff or student numbers at the high school.

The purpose of the REF is to assess the potential environmental impacts of the activity prescribed by State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) as “development permitted without consent” on land carried out by or on behalf of a public authority (i.e. The Department) under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The activity is to be undertaken pursuant to Chapter 3, Part 3.4, Clause 3.37 of the T&I SEPP.

The REF describes the activity, documents the examination and consideration of all matters affecting, or are likely to affect, the environment, and details safeguards to be implemented to mitigate impacts.

This document has been prepared in accordance with the Guidelines for Division 5.1 assessments (the Guidelines) by the Department of Planning, Housing and Infrastructure (DPHI) as well as the Addendum guidelines for schools. The purpose of this report is to identify the existing flooding conditions (due to overland flow) at the proposed activity areas and determine the likely flood impacts that the proposed activity works will have to the surrounding properties (i.e. in the post-development conditions). The details of this report are based on currently available information and correspondence undertaken at the time of writing

The Department is the proponent and the determining authority for the project under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

1.2 Reference Documents

The following documents have been reviewed and referenced in preparing this report:

- Australian Institute of Disaster Resilience (AIDR) Guideline 7-3: Flood Hazard, 2017;
- Blacktown City Council (BCC) Development Control Plan (DCP), 2015;
- Blacktown City Council (BCC) Local Environmental Plan (LEP), 2015;

- Blacktown City Council (BCC) Water Sensitive Urban Design (WSUD) Developer Handbook MUSIC Modelling and Design Guide, 2020;
- Blacktown City Council (BCC) Engineering Guide for Development (EGD), 2005;
- Blacktown City Council (BCC) First Ponds Creek Flood Assessment, 2021;
- Blacktown City Council (BCC) Flood Advice Letter: 180 Riverbank Drive The Ponds, Lot 11 in DP 1200915, 2024;
- Blacktown City Council (BCC) 'New neighbourhood park – Reserve 882 – Ken Birdsey Park, Schofields', 2024;
- Department of Planning and Environment (DPE) Considering Flooding in Land Use Planning Guideline, 2021;
- Department of Planning and Environment (DPE) Flood Impact and Risk Assessment – Flood Risk Management Guide LU01, 2023;
- Department of Planning and Environment (DPE) Flood Risk Management Manual, 2023;
- Department of Planning, Housing and Infrastructure – Planning Circular PS 24-001, Update on addressing flood risk in planning decisions, 1st March 2024; and
- NSW Planning Portal Spatial Viewer (Spatial Collaboration Portal - Map Viewers (nsw.gov.au)).

2.0 Site Characteristics

2.1 Site Description

The site is identified in Figure 1 and the activity is shown in Figure 2.

The site is located in the suburb of The Ponds in the Blacktown City Council (BCC) local government area (LGA), approximately 2.25km east of Schofields Station. The site is bounded by low density residential development to the east, west, and south, and Little Trolly Park to the north.

The site is legally described as Lot 11 in Deposited Plan 1200915 and is zoned R2 Low Density Residential in the *Alex Avenue and Riverstone Precinct Plan 2010*, which forms Appendix 7 to *State Environmental Planning Policy (Precincts—Central River City) 2021*. The proposed alterations and additions are situated within this Lot, which has an area of approximately 8.62 hectares. The site forms part of a larger school lot containing both Riverbank Public School and The Ponds High School.

The main vehicular and pedestrian access to the site is via Riverbank Drive. Vehicular access is also available on Wentworth Street along the eastern side of the site. The site lot is bounded by regional stormwater treatment system to the north, Wentworth Street to the east, Riverbank Drive to the south and Hambledon Road to the west.



Figure 1: Site location plan (Source: Mecone)

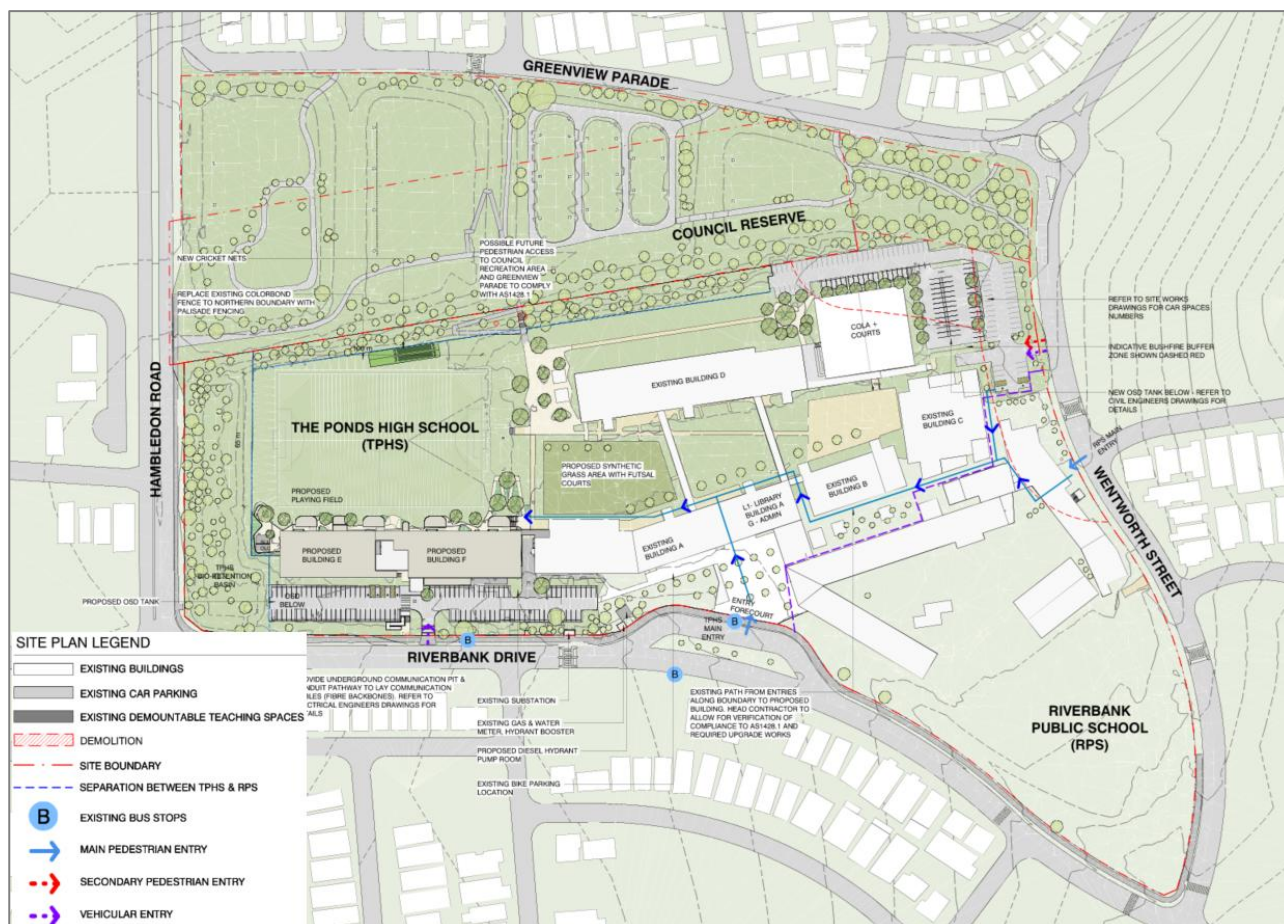


Figure 2: The Ponds High School (Proposed) - indicative only, subject to detailed design (Source: DJRD)

2.2 Hydrological Context

The site is situated within the First Ponds Creek catchment, which is currently undergoing significant development, including new residential subdivisions and new/upgraded roadways to support the increasing population. These developments have the potential to alter catchment runoff characteristics and flood behaviour along the Creek.

Blacktown City Council commissioned Catchment Simulations Solutions (CSS) to conduct a Flood Assessment for First Ponds Creek in 2021 to determine whether these developments may have adverse impacts on flood behaviour. In the updated report, the TUFLOW hydraulic model domain extends from just upstream of Schofields Road to downstream of Windsor Road.

Although the site is situated upstream of the study area, the study acknowledges the substantial development in the area via an 'ultimate development' assessment that includes planned flood detention basins (based on design terrain plus outlet details) provided by Blacktown City Council. The report indicates that there are plans for a new detention basin south of Schofields Road, at the northern end of the proposed Ken Birdsey Park.

Located at Reserve 882, the Ken Birdsey Park project aims to transform the 20-hectare plot in Schofield into a multifunctional open space with recreational facilities that will provide flood and stormwater management infrastructure. The project will include alterations to the existing ground profile and nearby creek alignment to accommodate the development. Figure 3 presents a plan of the proposed works of the project, including a stormwater harvesting pond, wetlands, and a bioretention basin.

There has been similar reconfiguration of the watercourse north of the site, which has been replaced by a series of detention basins, as shown in Figure 4, which presents a comparison of aerial imagery of the site in December 2016 and August 2024, taken from Nearmap.



Figure 3: Proposed site layout plan for Ken Birdsey Park Project (Source: taken from Blacktown City Council website)



Figure 4: Development and watercourse reconfiguration surrounding the site between 2016 and 2024 (Source: Nearmap)

The site is located within close proximity to the upstream end of First Ponds Creek (i.e. upstream end of the proposed Ken Birdsey Park). A second order creek which drains into First Ponds Creek lies approximately 50m south-west of the site near Hambledon Road (refer to Figure 4). With the recent residential developments and urbanisation to the east of the site and Hambledon Road, this second order creek has been replaced with urban underground stormwater network and overland flow paths. Hence, overland flow flooding would be the main cause of flooding in the site area, especially when the underground stormwater network and detention system design capacities are exceeded. As the Ken Birdsey Park development is situated downstream of the TPHS & RPS site, flows from the detention ponds north of the site and the site itself will be fed into this park via a culvert system under Hambledon Road, approximately 70m north of the site's north-west corner.

2.3 Site Elevation

To assess the topography of wider area, the latest available elevation data (2019) was obtained from the Elevation Information System (ELVIS) portal, with a spatial resolution of 1 metre. As presented in the Digital Elevation Model (DEM) in Figure 5, the site is located on the flank of a hill, with higher elevations east of the site (approximately 66mAHD), falling with proximity to the nearby First Ponds Creek west of the site. Similarly, elevations drop to the north of the site at the drainage basins, falling to around 46.0mAHD.

A detailed survey of the site was completed by Stantec on 18 December 2023, with ground elevation within the site boundary ranging from a high of 60.4mAHD at the southeast corner of the site, to a low of 48.5mAHD at the northwest corner of the site. Figure 6 presents a cross-sectional profile through the site, from the southeast towards the detention ponds to the north.

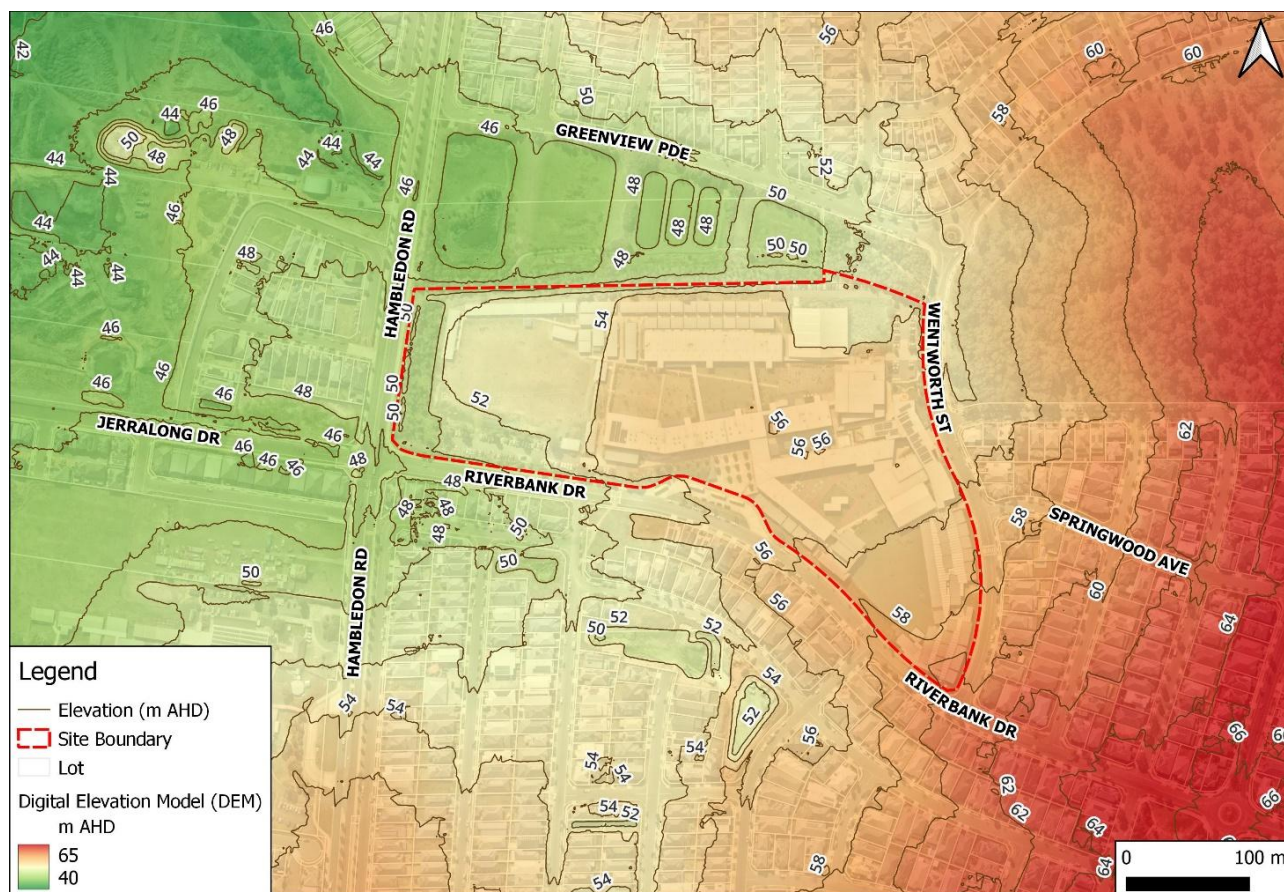


Figure 5: Topography of the site and its surrounding area based on 2019 LiDAR data (Source: ELVIS).



Figure 6: Elevation profile through the site from southeast to north

3.0 Flood Planning Requirements

While compliance with the Development Control Plan (DCP) is not required under the REF pathway, relevant DCP provisions have been reviewed and are acknowledged in this study to demonstrate consideration of Council's planning objectives.

3.1 Blacktown Development Control Plan

The current Development Control Plan (DCP) in place for the site is the Blacktown DCP (2015), which provides planning and design guidelines to support the planning controls set out in the City of Blacktown Local Environmental Plan (LEP) 2015. Part A Section 9 of the Blacktown Development Control Plan (DCP) 2015 outlines the controls relevant to development on flood prone land (i.e. land impacted by overbank discharge from a stream, river, estuary, lake or dam), while Section 10 outlines the controls related to local overland flooding.

As indicated in Figure 7, Blacktown City Council DCP defines the 'designated flood level' as the 1% Annual Exceedance Probability (AEP) flood event. The DCP specifies a 'design floor level' to be 500mm above the designated flood level for residential buildings, and 300mm above the designated flood level for commercial and industrial buildings. The DCP does not specify any flood controls specific to schools or educational facilities.

Designated flood level means the designated flood level is the level of a flood having an Average Recurrence Interval of 100 years. That is, the flood level that will have one chance in a hundred on average of being equalled or exceeded in any one year period.

Design floor level means a level which is 500mm above the designated flood level for residential buildings and 300mm above that level for commercial and industrial buildings.

Figure 7: Design flood level and floor level definitions contained within Blacktown Development Control Plan, 2015.

However, it should be noted that the above generally applies to site impacted by riverine flooding. Section 10 of the DCP distinguishes between two types of overland flooding:

- 1) Local drainage: direct surface runoff, surcharges and overflows from smaller stormwater pits / pipes and low points in kerbs. Council has adopted the term 'local runoff' to describe the incidence of inundation from local drainage.
- 2) Major drainage is defined as follows:
 - The floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity has been exceeded
 - Water depths generally in excess of 0.3m (in the 1% AEP event). These conditions may result in danger to personal safety and property damage to both premises and vehicles
 - Major overland flow paths through developed areas outside of defined drainage reserves.

The DCP outlines the following considerations for land impacted by overland flooding:

- Minimum finished habitable floor levels based on specific site conditions and flood risk
- Restricting cut or fill and limiting concrete 'slab on ground' floors
- Flood compatible building footing design and/or materials
- Extent and/or location of the building footprint to ensure adequate provision for movement of overland

flow and site drainage

- Limiting the type and location of fencing to ensure unobstructed overland flows
- Restricting filling / regrading within the defined overland flowpath
- Restricting future landscaping in medium density and non-residential developments which might raise flood levels and/or adversely redirect overland flows
- Restrictions as to user and/or positive covenants on the property title under Section 88B of the Conveyancing Act 1919.

3.2 Blacktown Water Sensitive Urban Design (WSUD)

Section 15.3.1 of the Water Sensitive Urban Design (WSUD) developer handbook (2020) provides guidance on design standards for Flood Planning Levels (FPLs).

The document notes that while the 1% AEP event is the design flood standard for most general development, some developments should consider the Probable Maximum Flood (PMF) event, as shown in the excerpt in Figure 8. The WSUD identifies schools as sensitive activities that require a higher standard of flood protection due to the age of and potential risk to the occupants. For these activities, “sufficient area above the PMF” may need to be demonstrated for all occupants to shelter-in-place, and emergency back-up generators (if provided) must be installed above the PMF. This documents also notes “where shelter-in-place is specified as a flood management strategy then a structural engineer, registered on NER, is to certify that the structure is safe to the PMF level.”

Therefore, based on Blacktown Council's Water Sensitive Urban Design guide, a school site must have **sufficient area above the PMF** for the purpose of sheltering-in-place.

The 1% AEP flood planning level is the design flood standard for most general development.

It is also the design flood standard for the following developments **subject to consideration of the PMF for elements of the design:**

- Critical developments that provide support or essential services to the community such as hospitals, telecommunication towers, large power supply stations, police, ambulance and fire stations. Protection of critical elements to the PMF may be required.
- **Sensitive developments that require a higher standard of flood protection due to the age of and potential risk to the occupants, such as nursing homes, aged hostels, preschools, primary schools, or child care centres. In most of these, sufficient area above the PMF may need to be demonstrated for all occupants to shelter-in-place. Emergency back-up generators (if provided) and flood related infrastructure are to be installed above the PMF.**
- Provision of a second storey or attic, or raising the floor level for non-critical developments where the PMF is more than 0.5 m above the habitable floor level (but less than the record floor level). Also where there is no continually rising evacuation route (escape path) from the door, and the recommendation is to shelter-in-place.
- **Where shelter-in-place is specified as a flood management strategy then a structural engineer, registered on NER, is to certify that the structure is safe to the PMF level.**

In some sites subject to overland flows a true PMF level may not have been determined through the available modelling. For small scale developments consideration may be given to a simplified approach using an Extreme Flood considered as 3.5 times a 1% AEP flood flow.

Figure 8: Excerpt of Section 15.3.1 'Design flood/flood planning level' of the Blacktown WSUD, 2020.

While minimum floor levels for educational establishments are not explicitly provided, Section 15.3.2 of the WSUD provides minimum floor levels for residential properties (habitable floors) and business/industrial uses. This is presented in Figure 9.

15.3.2 Minimum floor levels (residential-habitable, business/industrial)

- General (local drainage, no flood affectation) – minimum 0.225 m above finished ground level.
- Local runoff - 0.3 m above the 1% AEP flood level.
- Local overland flooding-major drainage – 0.3 m above the 1% AEP flood level.
- Mainstream flooding (business/industrial) - 0.3 m above the 1% AEP flood level.
- Mainstream flooding (residential – outside growth centres) - 0.5 m above the 1% AEP flood level.
- Mainstream flooding (residential – growth centres) - 0.5 m above the 1% AEP flood level with climate change (15% extra flow).
- Mainstream flooding (residential behind levees) - 0.5 m above the 1% AEP flood level.
- Flood planning level - 0.5 m above the 1% AEP flood level.
- Flood refuge where required (shelter-in-place) – the PMF level (no freeboard).

Figure 9: Excerpt of Section 15.3.2 'Minimum floor levels (residential-habitable, business/industrial' of the Blacktown WSUD, 2020.

3.3 Blacktown City Council Flood Advice Letter

TTW obtained a Flood Advice Letter from Blacktown City Council to confirm the flood risk to the site, including floor level requirements. The full letter is attached in Appendix A.

The letter (dated 18 October 2024) reiterates the flood level requirements set out in the WSUD handbook, recommending that a preliminary minimum floor level must be the higher of:

- A minimum of 225 mm above finished ground levels, or
- The highest adjacent 1% Annual Exceedance Probability (AEP):
 - riverine flow level plus 500 mm, or
 - overland flow level plus 300 mm.

3.4 Flood Risk Management Manual

The 'Support for Emergency Management Planning' (EM01) Flood Risk Management Manual (FRMM) document states that where shelter-in-place is the proposed emergency management response strategy, 'new secondary school classrooms should also be located above the PMF level' (refer Figure 10) where possible. However, at a minimum there should be access to adequate space above the PMF within a school building for school students, staff and visitors where the facility is not intended to be evacuated outside the floodplain'.

Key consideration	EM response strategy	
	Evacuation	Shelter in place
Primary and secondary schools and day hospitals	All new day hospitals and primary and secondary school facilities should be located in areas of the floodplain that can be readily evacuated within the available time and resources. Assessment should be supported by an evacuation capability assessment where identified by the consent authority or NSW SES	Where possible, new day hospitals and primary and secondary school classrooms should also be located above the PMF level. However, at a minimum there should be access to adequate space above the PMF within a day hospital and school building for patients, school students, staff and visitors where the facility is not intended to be evacuated outside the floodplain.

Figure 10: Excerpt of Table 12 'Recommended emergency management issues for councils to consider in strategic decision-making' of the Support for Emergency Management Planning' (EM01) Flood Risk Management Manual (FRMM) document

The available flood information for the site is summarised in Section 4.0 and 6.0, and an assessment of the proposed activity against the above controls is reviewed in Section 7.0 for information.

4.0 Existing Flood Information

4.1 Blacktown City Council Flood Maps

Flood mapping available on Blacktown City Council's website indicates that the northeastern portion of the school boundary is situated within the "SEPP Flood" zone (refer to Figure 11). The SEPP (State Environmental Planning Policy) maps indicate the extent of flood prone land based on existing conditions at the time of preparing the precinct planning, and do not include changes resulting from subsequent development or infrastructure works.

While the school site is mostly located outside any flood risk precincts with only the northeastern corner of the site being mapped within the "SEPP Flood" zone, it is important to complete further site investigations to confirm the flood affectation of the site given the area has undergone significant urbanisation since the SEPP flooding mapping is completed. In particular, the watercourses to the north and south-west of the site have now been replaced with urban stormwater system and overland flow paths. Therefore, further assessment will need to be carried out for the area to confirm overland flow flooding conditions for the site and its surrounding areas.

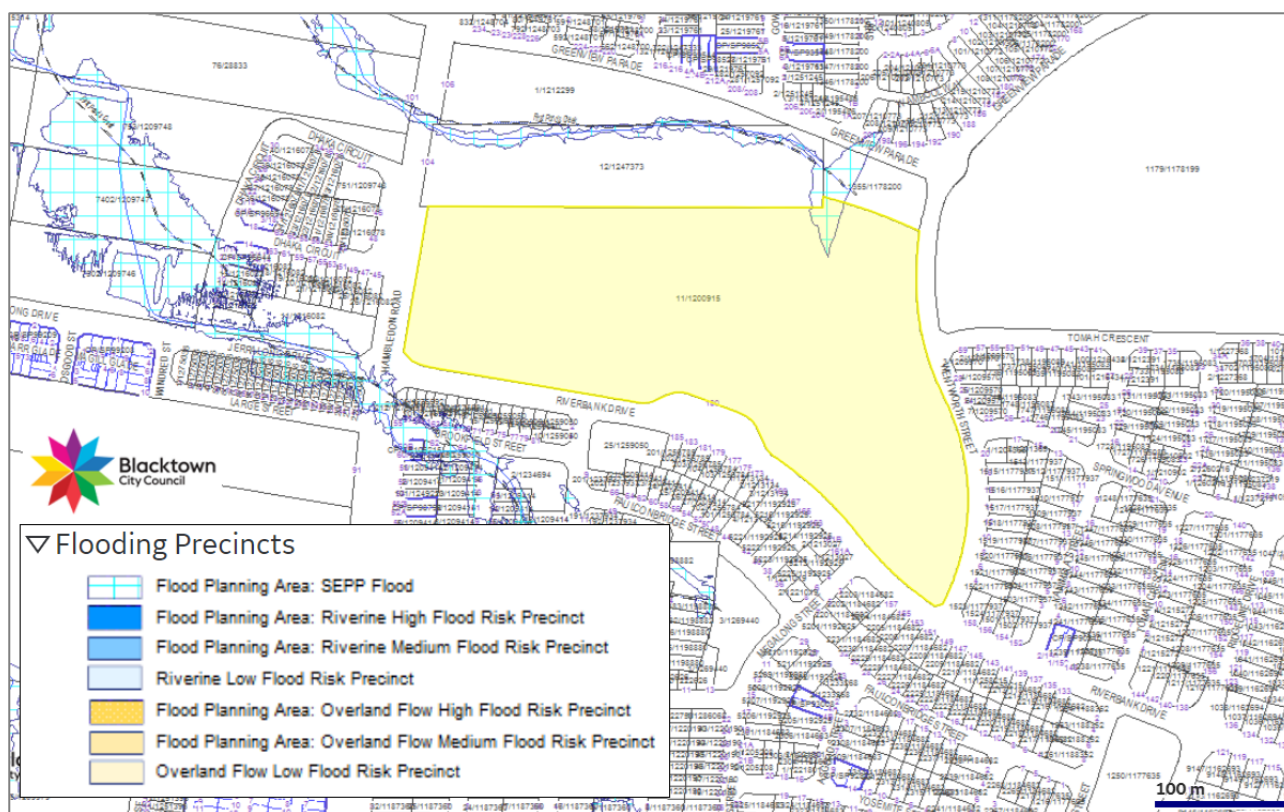


Figure 11: Flooding precincts at and around the site (Source: Blacktown City Council Interactive Maps)

4.2 First Ponds Creek Flood Assessment

Blacktown City Council commissioned Catchment Simulations Solutions (CSS) to conduct a Flood Assessment for First Ponds Creek (FPC) in 2021, to determine whether developments (due to urbanisation of catchment) of the creek catchment have any likely adverse impacts on flood behaviour. The project includes an assessment of the following:

‘Pre-Development’ conditions based on 2010 topographic and catchment development information.

'Ultimate Catchment Development' conditions, that assumes full development across the FPC catchment, incorporating proposed changes in land use (i.e. increasing impervious surfaces to reflect the projected increase in development), water management infrastructure (i.e. addition of proposed flood detention basins based on design terrain plus outlet details provided by Council), terrain modifications and hydraulic structure upgrades.

CSS' model is cut off at downstream of Jerralong Drive and Hambledon Road, with the site subsequently excluded from the flood study. Additionally, the modelling within CSS' flood assessment uses LiDAR survey with limited representation of specific site details. Further modelling of the site with higher resolution survey data for the site is necessary to confirm the flood risk to the site in both existing and post-development conditions. Nonetheless, consultation with Council confirmed that based on the subdivision works that have occurred in the area, no mainstream flood related development controls would apply to the lot. However, further flooding assessment would be required to confirm the overland flow flooding conditions at the site and its surrounding areas. As the site is not located within the Blacktown City Council's Local Overland Flow Flood Study (2020) study area, information regarding overland flooding for the site area is limited. Therefore, there's a need to develop and site specific overland flow flood model to assess and determine the overland flooding conditions for the site and its surrounding areas. This is discussed further in the subsequent section of the report.

5.0 TTW Hydraulic Model Setup

Given that the site is not included in the Council's Local Overland Flow Flood Study model and the modification of the watercourses north and south-west of the site, there is a need to develop a site specific 1D-2D hydraulic model to assess overland flow flood behaviour at the site. It is also worth noting that the surrounding areas of the school have undergone significant developments and the current Council's adopted flood mapping no longer applicable to the site and its immediate surrounding areas (i.e. north and south-west of site), given the significant urbanisation that has occurred (i.e. stormwater drainage systems plus overland flow on roads as opposed to natural drainage lines).

The model was developed using TUFLOW software and the following sections discuss the hydraulic model parameters adopted, with Table 1 summarises the key modelling parameters adopted for this assessment. The methodology applied in TTW's modelling is consistent with latest NSW flood modelling guidelines and Australian Rainfall and Runoff 2019 (ARR2019).

Table 1: Key TUFLOW model parameters adopted

Model Domain	Dynamic 1D (pipe network) and 2D (floodplain)
Solver	TUFLOW HPC 2023-03-AE
Grid size	2m cell with sub grid sampling (0.5m)
DEM	2019 LiDAR + topographical survey for site area (by Stantec dated 27 May 2024 and complimented by survey taken by TSS in 2021)
Model Inflows	Direct rainfall applied to full model area
Map Cutoff Depth	50mm
Events Analysed	50%, 10%, 1%, 0.2% AEP and PMF

5.1 2D Model Domain

The model boundary was delineated based on the latest available LiDAR (2019) data obtained from ELVIS, which set the base topography of the TUFLOW model and catchments that contribute to the site. The model extends approximately 600m downstream of the site (i.e. north-west of site) along First Ponds Creek with model downstream boundary set just upstream of Schofields Road, with approximately 2km² of model area adopted in this assessment. The model extent adopted in this assessment is shown in Figure 12.

Although a 2-metre grid cell was used for this study, this was refined using sub-grid sampling (SGS). SGS improves the accuracy of hydraulic modelling by refining the spatial resolution within a given grid cell without significantly increasing the simulation time. TUFLOW ordinarily samples the digital terrain model (DTM) by taking a singular value at the centroid of each grid cell, which can often misrepresent the topography and potential variation within each cell especially when the adopted grid cell size is not sufficiently fine.

With sub-grid sampling, the underlying DTM cell elevations are used to determine a water surface elevation vs volume relationship for each grid cell. This is also performed along the cell faces, using the full topography across the cell face to represent fluxes between adjacent cells. The full array of information in the DTM is therefore being utilised within the 2D hydraulic modelling even where grid resolution is lower, improving the accuracy of simulated results in terms of storages available for each model cell (i.e. note that the improvement of accuracy achieved is dependent on the resolution of the sub-grid sampling distance and the underlying Lidar/survey data used).



Figure 12: TUFLOW model extent and downstream boundary adopted

5.2 Model Downstream Boundary

As discussed above, the downstream TUFLOW model boundary has been set at First Ponds Creek, approximately 600m downstream (and north-west) of the site and just upstream of Schofields Road. A fixed tailwater condition has been applied at the model downstream boundary, based on the estimated flood level for the relevant AEP events estimated in the CSS study discussed in Section 3.2. The adopted tailwater levels for the respective AEP events assessed for this assessment are summarised in Table 2.

Table 2: TUFLOW model tailwater levels adopted

Event	Adopted Tailwater Level (mAHD)
50% AEP	39.99
10% AEP	40.73
1% AEP	41.60
0.2% AEP	41.75
PMF	42.84

5.3 1D Model Domain

No underground stormwater network system data is available for the model area, at the time of the assessment. Therefore, no pits and pipes have been adopted on the urban areas within the TUFLOW model for this assessment. However, key outlet pipes of the regional stormwater basin north of the site have been

incorporated into the TUFLOW, based on available WAE plans for the basin system. This is to provide free flowing conditions at the stormwater basin north of the site. All pipes adopted in the model have been represented in the 1D domain. Figure 12 shows the location of the pipes adopted in TUFLOW model for this assessment.

It is worth noting that the above approach (i.e. modelling without existing Council's stormwater network systems) will provide conservative overland flow flooding results, especially for the more frequent events assessed (i.e. 50% and 10% AEP events) where majority of the excess stormwater runoff would have otherwise being collected and discharged to the creek via underground stormwater systems instead of via overland flows as shown in the mappings presented in this report. Nonetheless, the presence of these existing stormwater systems in the TUFLOW model is irrelevant for the more severe events (i.e. 1% AEP or more severe events) given the significant portion of excess stormwater runoff will be discharged via overland flows. Therefore, this approach is considered appropriate for the assessment.

5.4 Topography

In addition to incorporating 2019 LiDAR from ELVIS, the base case (Pre-Development scenario) hydraulic model included topographical survey data collected and provided by Stantec (i.e. dated 27 May 2024) for the site. Survey data collected by TSS in 2021 for the site has also been incorporated into the TUFLOW model to complement areas not surveyed by Stantec. The Stantec survey included the stormwater basin system north of the site. Therefore, incorporating the site survey data provides better topographical representation of the site and the northern stormwater basin area in the modelling. Figure 13 shows the site survey data adopted in the TUFLOW model for this assessment, and the survey shows that larger areas of the site currently slope towards the site's north-west property boundary with the remaining areas sloping towards the south-west property boundary. The northern end of the site is more than 4m higher than the stormwater basin system areas at the north.

As discussed earlier, the area has experienced significant growth over the last few years, hence the 2019 LIDAR data adopted in the TUFLOW model might not captured changes made after 2019. For example, temporary sediment ponds, incomplete road construction as well as residential pads appeared to be captured in the 2019 LiDAR, at few residential developments surrounding the site. To provide a closer topographical representation to the current conditions, manual manipulation of model surface elevations has been carried out (i.e. fill up temporary sediment ponds on areas where aerial images show construction already completed, removal of temporary construction access roads, etc.). Further, existing buildings present within the school site have been blocked out (i.e. raised up in model to prevent water from flowing through). This would present the worst flooding situations for the site as far as overland flow flooding is concerned and represent a conservative approach.



Figure 13: Site survey topographical data adopted in TUFLOW model

5.5 Hydraulic Roughness and Losses

The hydraulic roughness of a material is an estimate of the resistance to flow and energy loss due to friction between a surface and the flowing water. A higher hydraulic roughness indicates more resistance to the flow. Roughness in TUFLOW model is modelled using the Manning's (n) roughness co-efficient.

Manning's zones were set by analysing the latest Nearmap aerial photography of the site and surrounding areas. The material types adopted in the TUFLOW model and the corresponding Manning's n value applied to each are outlined in Table 3, together with the adopted initial loss (IL) and continuing loss (CL) for each land use type. It is worth noting that two sets of IL/CL were adopted in the TUFLOW model for this assessment, whereby higher losses were adopted for the 50% AEP and 10% AEP events assessed and no losses for the more severe events assessed to account for saturated conditions during severe events.

Table 3: Land use roughness coefficient, initial loss and continuing loss values adopted

Land use category	Manning's 'n' Adopted	For 50% AEP & 10% AEP Events		For 1% AEP, 0.2% AEP & PMF Events	
		Initial Loss (mm)	Continuing Loss (mm/hr)	Initial Loss (mm)	Continuing Loss (mm/hr)
Waterways – vegetated	0.06	0	2	0	0
Concrete lined channels, sports courts, footpath, etc	0.015	0	2	0	0
Grass and light vegetated areas	0.05	15	2	0	0

Thick vegetation (dense vegetation)	0.09	15	2	0	0
Road corridor and carpark	0.02	0	2	0	0
General urban/built up areas	0.12	15	2	0	0

5.6 Hydrological Inputs

A rainfall-on-grid (ROG) hydrology approach has been adopted using a direct rainfall boundary condition, in which rainfall is applied to each active cell in the 2D mesh. Hydrologic losses and runoff are therefore calculated for each cell and routed through downstream cells to evaluate flood depths and velocities.

Hydrological inputs were derived from the Australian Rainfall and Runoff 2019 (ARR2019) data hub for the 50%–0.5% AEP events, and the Probable Maximum Precipitation (PMP) rainfall data was estimated by following the procedure as detailed in the Generalised Short Duration Method (GSDM) report. This assessment has considered and assessed the 50% AEP, 10% AEP, 1% AEP, 0.2% AEP and PMF events.

As outlined in the new ARR2019 Climate Change Considerations chapter (i.e. Book 1 Chapter 6), the effects of climate change that has occurred since the development of the current set of rainfall IFDs (Intensity-Frequency-Duration data) should be considered and accounted for in the assessment of present time flooding conditions (i.e. the year of 2025 at the time of assessment). For this assessment, all rainfall intensities adopted have been upscaled to the year 2025 based on the Shared Socioeconomic Pathway (SSP) 2-4.5 Scenario, which represents the intermediate Greenhouse Gas Emissions Scenario. Specifically, this study adopted an 18% increase in rainfall intensities for all storms extracted directly from the ARR Data Hub, with duration 1hr or shorter. The increase in rainfall intensity factors (i.e. IFDs upscale factors) for various design storm durations, as extracted from the ARR Data Hub for the site area, and adopted in this assessment are summarised in Table 4.

Table 4: IFDs upscale factors adopted for Year 2025

Climate Change Scenario	Climate Change Increase Factor Adopted for Various Design Storm Durations							
	<1hr	1.5hrs	2hrs	3hrs	4.5hrs	6hrs	9hrs	12hrs
SSP2-4.5 – Year 2025	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11

As the ROG method is typically associated with substantial shallow sheet flow, depths of less than 0.05m have been filtered out of the hydraulic model outputs for all events assessed to determine defined overland flow paths.

5.7 Critical Duration Storm Assessment and Adoption

Except for the PMF event, standard design storm durations (i.e. ranging from 10min to 720min) have initially being simulated for all the 10 temporal patterns (TPs) of each of the AEP event adopted for this assessment. Statistical analysis was then carried out for all simulated TPs of each storm duration of each AEP event to determine the median TP storm that is applicable to the site area for each storm duration of each AEP event. The selected TP storms were then used for subsequent modelling to determine the critical storm/s that cause the worst flooding conditions for the site and its immediate surrounding areas, for each AEP event assessed.

Similarly, standard design storm durations between 15min and 360min were initially simulated for the PMF event, to assist with the determination of the critical storm/s for the site and its immediate surrounding areas.

Table 5 summarises the median temporal pattern and storm duration combination adopted for each AEP event assessed as part of this assessment. These selected design storms are considered to be critical for the site and its surrounding areas where worst flooding conditions are anticipated for the respective AEP events assessed.

As there will be more than one storm duration being simulated and assessed for each AEP event, post-processing has been carried out to determine the maximum results for the entire modelled area for each AEP event (i.e. maxmax of maximum results of all storms simulated for each AEP event). The results and mapping discussed and presented in the subsequent sections are based on the maxmax results for each AEP event assessed.

Table 5: TP and storm duration combination adopted for the assessment

Event	Storm Durations Selected	TP Selected
50% AEP	25min	TP8
	120min	TP10
	270min	TP10
	360min	TP9
10% AEP	15min	TP4
	90min	TP4
	180min	TP4
	360min	TP10
1% AEP	10min	TP5
	25min	TP1
	120min	TP6
	360min	TP9
0.2% AEP	10min	TP5
	60min	TP6
	90min	TP7
	360min	TP9
PMF	15min	N/A
	30min	N/A
	45min	N/A
	60min	N/A

5.8 Flood Hazard Assessment

The relative vulnerability of the community to flood hazard has been assessed by using the flood hazard vulnerability curves set out in 'Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia' of the Australian Disaster Resilience Handbook Collection (2017).

These curves assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. The flood hazard categories are outlined in Figure 14, ranging from a level of H1 (generally safe for people, vehicles and buildings) to H6 (unsafe for vehicles and people, with all buildings considered vulnerable to failure). Table 6 outlines the threshold limits used to derive each hazard category.

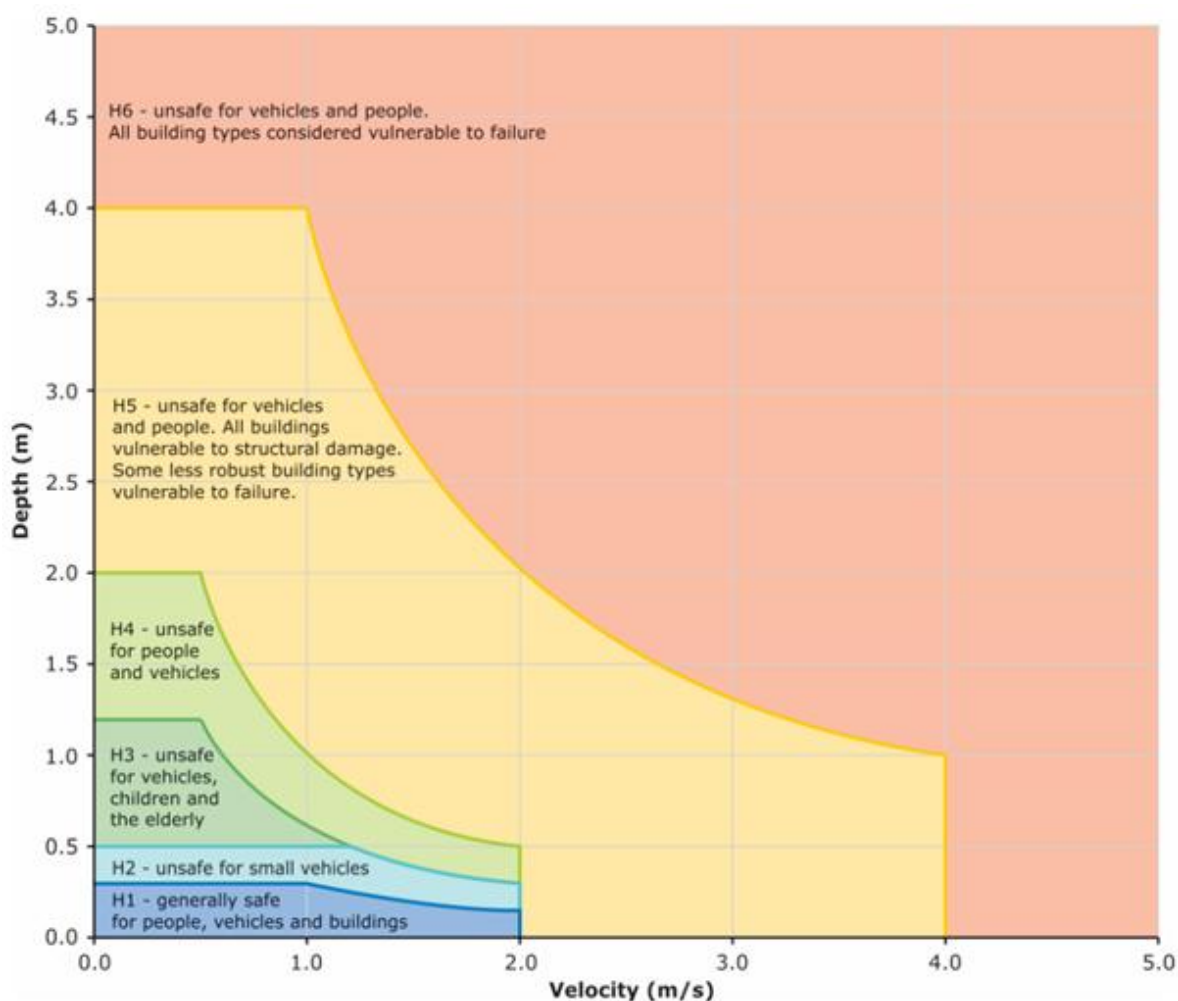


Figure 14: Flood hazard vulnerability curve (Source: Flood Risk Management Guide FB03 - Flood Hazard, NSW Department of Planning and Environment, 2022)

Table 6: Hazard vulnerability threshold limits

Hazard	Description	Classification Limit (m ² /s)	Limiting still water depth (D) (m)	Limiting velocity (V) (m/s)
H1	Generally safe for people, vehicles and buildings	$D \times V \leq 0.3$	0.3	2.0
H2	Unsafe for small vehicles	$D \times V \leq 0.6$	0.5	2.0
H3	Unsafe for vehicles, children and the elderly	$D \times V \leq 0.6$	1.2	2.0
H4	Unsafe for people and vehicles	$D \times V \leq 1.0$	2.0	2.0
H5	Unsafe for people and vehicles. All buildings vulnerable to structural damage.	$D \times V \leq 4.0$	4.0	4.0
H6	Unsafe for people and vehicles. All building types considered vulnerable to failure.	$D \times V > 4.0$	No Limit	No Limit

5.9 Modelling Scenario

Two modelling scenarios have been carried out as part of this assessment, namely:

- Pre-Development Scenario (i.e. base case), where the site remains as is at the time of the assessment;
- Post-Development Scenario, where the proposed activity within the site is assumed to be fully developed.

In the Post-Development Scenario, the following changes have been made to the Pre-Development Scenario TUFLOW model:

- The 90% Schematic Design TIN of the proposed surface levels (designed and provided by WSP) has been incorporated into the TUFLOW model to represent the proposed surface elevations of the new school and north-east car park areas. The sports field has been designed to have crest at the centre (i.e. sloping towards north and south). The proposed north-east car park has been designed to slope towards the site's northern property boundary and involved some filling. A synthetic grass area is also included within the design surface to the northeast of the proposed Building F;
- Proposed Building E and Building F have been modelled as obstruction (i.e. raised up in model to prevent water from flowing through);
- Existing demountable teaching units or structures within the proposed activity areas modelled as obstruction have been removed from the TUFLOW model; and
- The surface roughness of the proposed activity areas has also been updated to reflect the proposed land use surface.

Figure 15 shows the design surface tin adopted, the proposed buildings that were incorporated into the model, and the existing buildings that were retained.



Figure 15: Proposed activity design topographical data adopted in TUFLOW model

6.0 Flood Modelling Results

As discussed in Section 4.7, post-processing has been carried out to produce the maximum flooding results for each AEP event from the various set of storm durations simulated. The results discussed in the following sections are based on the 'maxmax' (i.e. maximum of all individual storm maximum results) flooding results derived for each AEP event assessed.

Section 5.1 below discusses the Pre-Development Scenario results for the 10% AEP, 1% AEP and PMF events while Section 5.2 discusses the Post-Development Scenario results. Results for the 50% AEP and 0.2% AEP events are contained within Appendix B. The flood impact assessment is discussed in Section 5.3 while consideration of climate change effects is presented in Section 5.4.

6.1 Pre-Development Flood Behaviour

6.1.1 10% AEP Event

The maximum depths, levels, velocity and hazard classification in the 10% AEP event are illustrated in Figure 16, Figure 17 and Figure 18, respectively. The following observations can be made:

- Flood affectation within The Ponds HS site in the 10% AEP is relatively low, with some ponding evident around the demountable buildings to the northwest, peaking at approximately 0.16m (flood level of approx. 52.2m AHD). This ponding is low hazard at H1 (generally safe for people, vehicles and buildings).
- Depths within the bio-retention basin to the west generally peak around 0.45m, rising to 0.55m at the south (flood level of approximately 49.4m AHD). Hazard is mostly H2 (unsafe for small vehicles).
- There is notable ponding adjacent to the northeastern car park with peak depths of 0.64m (53.2m AHD level), reaching H3 hazard (unsafe for vehicles, children and the elderly).
- Velocity is low at mostly less than 0.5 m/s across the whole site.



Figure 16: 10% AEP event – flood depths and levels surrounding the site – Pre-Development Scenario



Figure 17: 10% AEP event – flood velocities surrounding the site – Pre-Development Scenario



Figure 18: 10% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario

6.1.2 1% AEP Event

The maximum depths, levels, velocity and hazard classification in the 1% AEP event are illustrated in Figure 19, Figure 20 and Figure 21, respectively.

- In the 1% AEP event, ponding around the demountable buildings to the northwest increases to approximately 0.25m (flood level of approx. 52.3m AHD). This ponding is still low hazard at H1.
- Depths within the bio-retention basin to the west generally peak around 0.55m, rising to 0.63m at the south (flood level of approximately 49.5m AHD). Hazard is mostly H3.
- There is some sheet flow evident just north of the southwestern carpark, close to the proposed location of Building E and F. Depths peak at approximately 0.2m.
- There is notable ponding adjacent to the northeastern car park with peak depths of 0.68m (53.2m AHD level). Hazard remains at H3.
- Velocity is mostly less than 0.5 m/s across the whole site, though this increases at the southwestern car park (i.e. close to the proposed buildings), reaching over 1.3 m/s. Despite this, hazard here is H1 due to the shallow depths.



Figure 19: 1% AEP event – flood depths and levels surrounding the site – Pre-Development Scenario



Figure 20: 1% AEP event – flood velocities surrounding the site – Pre-Development Scenario



Figure 21: 1% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario

6.1.3 PMF Event

The maximum depths, levels, velocity and hazard classification in the PMF event are illustrated in Figure 22, Figure 23 and Figure 24, respectively.

- In the PMF event, ponding depths around the demountable buildings have notably increased, peaking at approximately 0.53m (flood level of approx. 52.6m AHD). Ponding hazard is between H1-H3.
- Depths within the bio-retention basin to the west generally peak around 0.85m, reaching a peak of 0.92m (flood level of approximately 49.82m AHD). Hazard is mostly H3.
- Flood depths at the southwestern carpark, close to the proposed location of Building E and F, peak at over 0.3m. Hazard is between H1-H2.
- There is notable ponding adjacent to the northeastern car park with peak depths of around 0.77m (53.3m AHD level). Hazard remains at H3.
- Velocity at the southwestern car park reaches around 1.6 m/s, peaking at over 2.0 m/s to the west. There is also a flow path evident across the sports field to the west, with flows directed to the northwest (forming the area of ponding at the demountable buildings). Velocity within this flow path is generally 0.5 – 0.7 m/s.



Figure 22: PMF event – flood depths and levels surrounding the site – Pre-Development Scenario

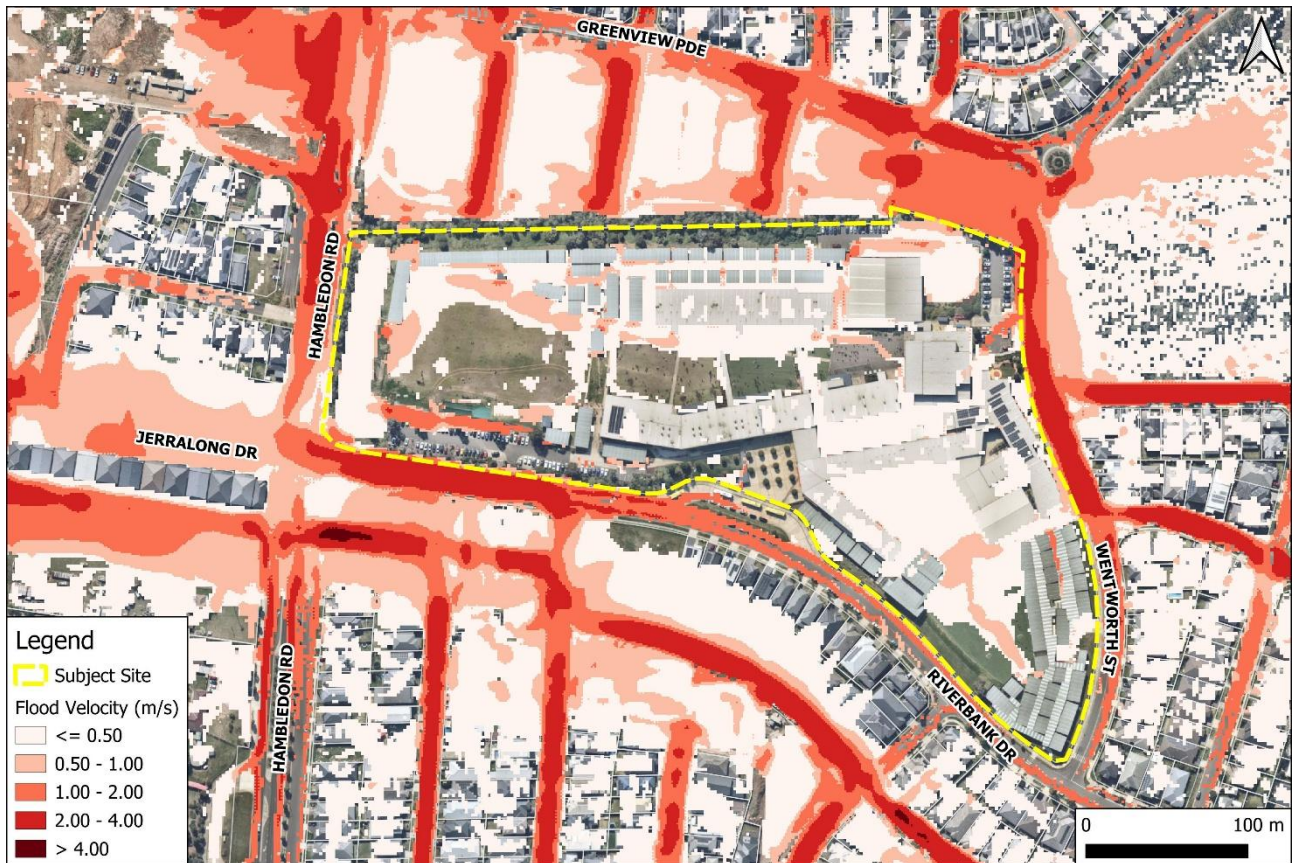


Figure 23: PMF event – flood velocities surrounding the site – Pre-Development Scenario

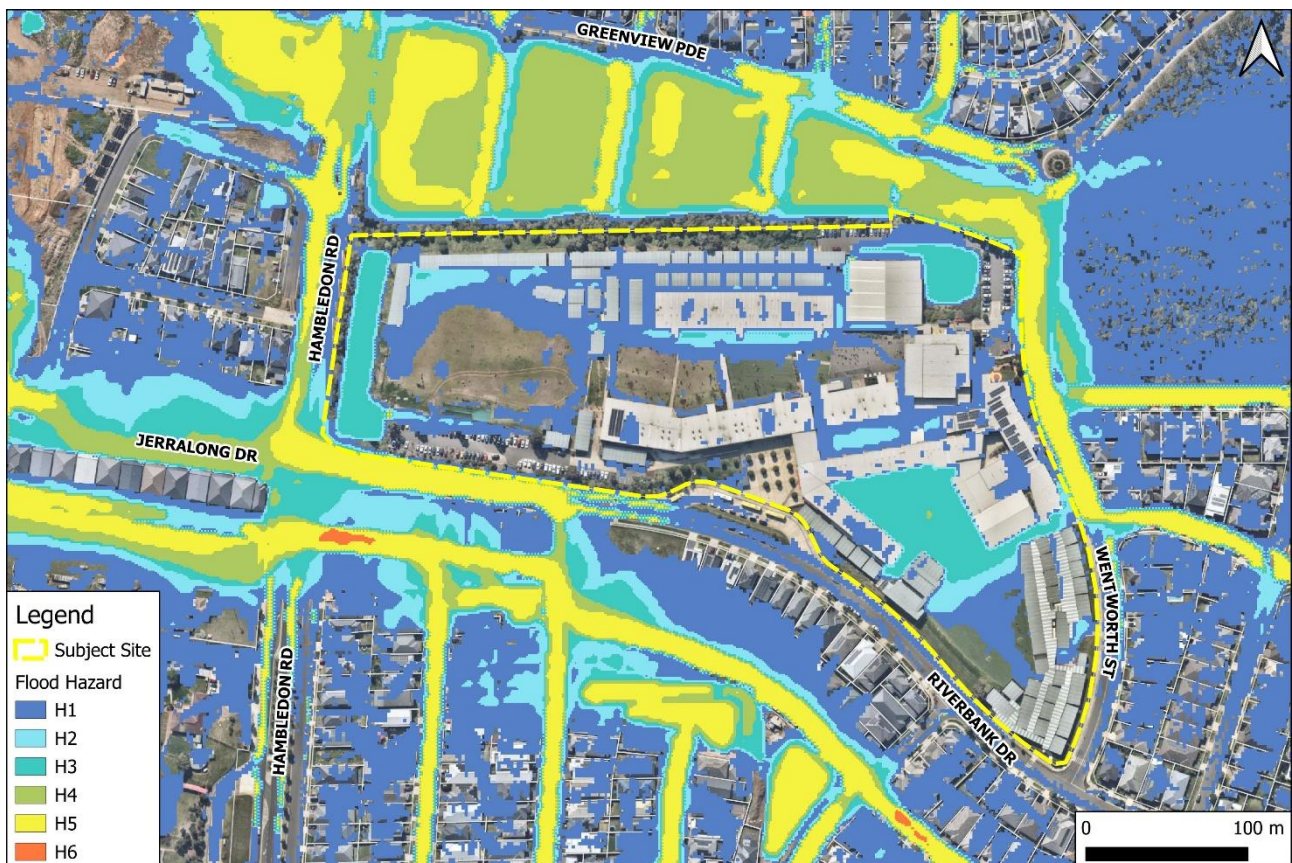


Figure 24: PMF event – flood hazard classification surrounding the site – Pre-Development Scenario

6.2 Post-Development Flood Behaviour

6.2.1 10% AEP Event

The flood depths and levels in the 10% AEP event for the Post-Development Scenario are presented in Figure 25, with flow velocity and hazard classification depicted in Figure 26 and Figure 27, respectively.

The following observations can be made:

- Ponding to the northwest is no longer present with the altered grading of the sports field (as noted in Section 5.9, the sports field has been designed to have crest at the centre sloping towards north and south) and the removal of the demountable buildings.
- Flood levels within the bio-retention basin to the west have reduced slightly from the pre-development scenario (approximately -11mm). Hazard here is consistent with the pre-development, at mostly H2.
- There is some negligible sheet flow north of the proposed Buildings E and F with depths between 40-70mm (52.94m AHD peak flood level).
- The proposed addition to the northeastern car park is flood-free. There is some ponding of floodwaters at the driveway to the north (depths peaking at around 140mm), though it should be noted that local stormwater has not been incorporated into the model which would attenuate local flows. These flows remain at H1 and are therefore considered “generally safe for people, vehicles and buildings”.
- Velocity is low at mostly less than 0.5 m/s across the whole site.

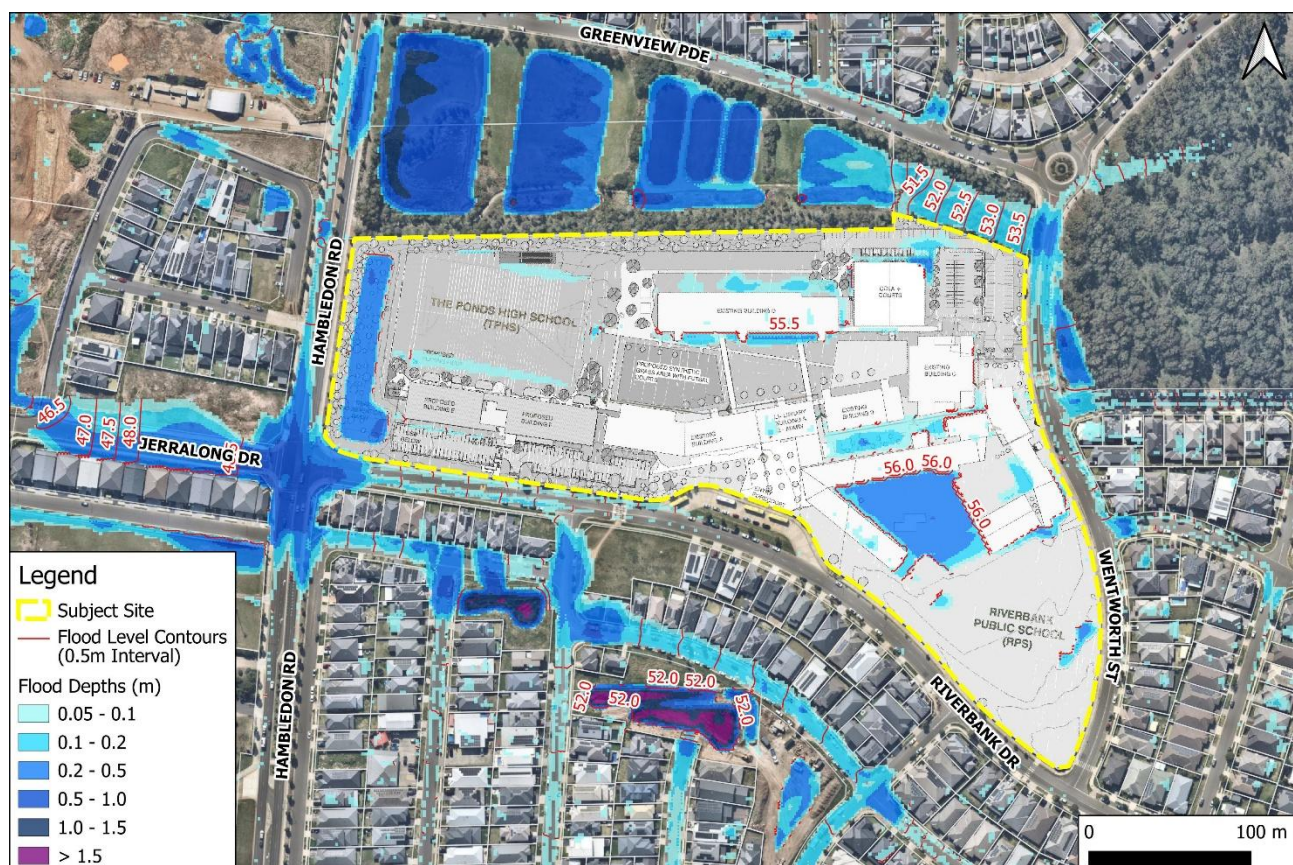


Figure 25: 10% AEP event – flood depths and levels surrounding the site – Post-Development Scenario



Figure 26: 10% AEP event – flood velocities surrounding the site – Post-Development Scenario



Figure 27: 10% AEP event – flood hazard classification surrounding the site – Post-Development Scenario

6.2.2 1% AEP Event

The flood depths and levels in the 1% AEP event for the Post-Development Scenario are presented in Figure 28, with flow velocity and hazard classification depicted in Figure 29 and Figure 30, respectively.

- As in the 10% AEP event, Post-Development 1% AEP levels within the bio-retention basin to the west have reduced slightly from the Pre-Development Scenario (approximately -14mm). Hazard here is consistent with Pre-Development, at mostly H3.
- Sheet flow north of the proposed Buildings E and F peak at depths of 100-140mm (52.97m AHD peak flood level), and remain at H1 hazard. This is considered negligible sheet flow, which will be largely addressed by local stormwater management (which has not been incorporated into the TUFLOW model).
- Ponding of floodwaters at the driveway to the north of the proposed car park peak at around 150-160mm depth. These flows remain at H1 in the 1% AEP.
- Velocity is mostly less than 0.5 m/s across the whole site, and has reduced south of the proposed Building E & F when compared with the Pre-Development Scenario.



Figure 28: 1% AEP event – flood depths and levels surrounding the site – Post-Development Scenario

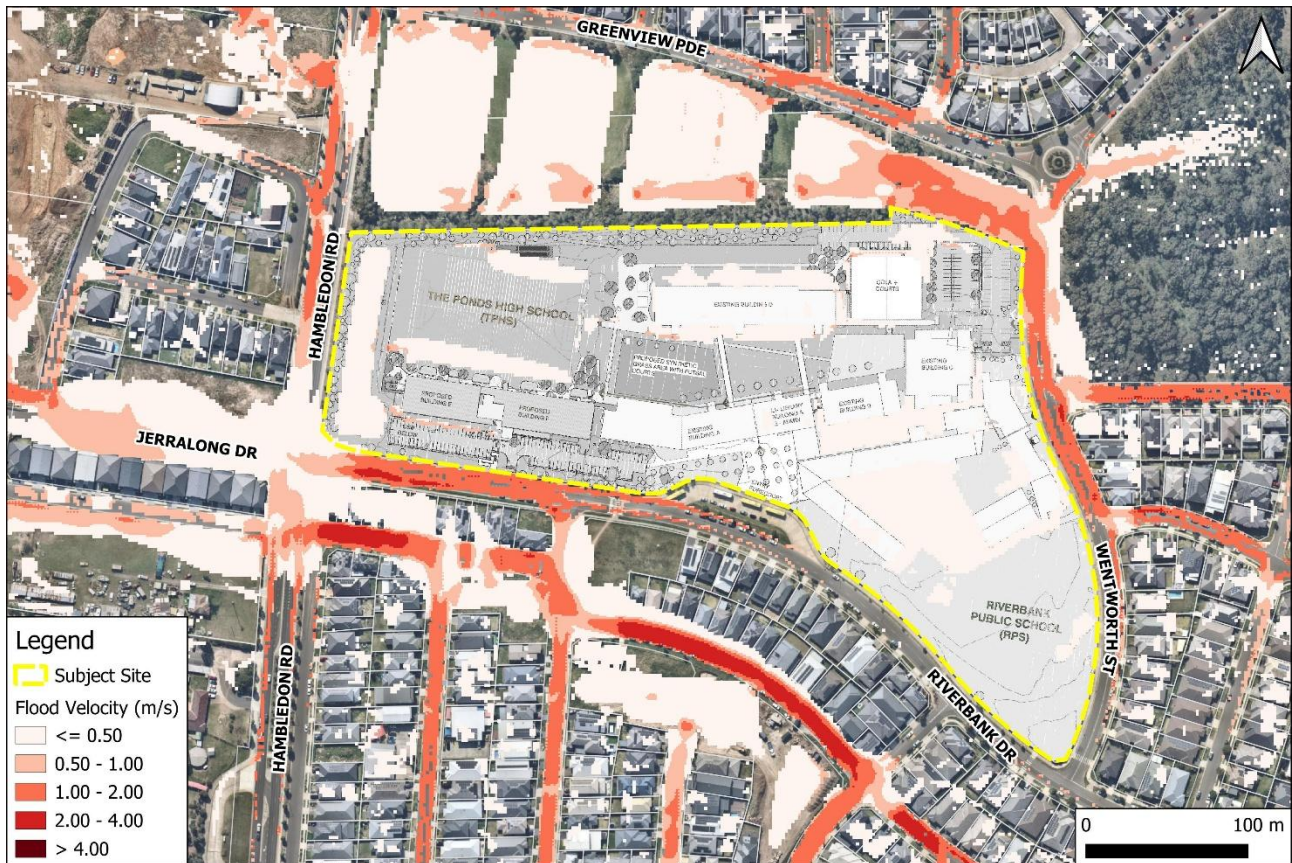


Figure 29: 1% AEP event – flood velocities surrounding the site – Post-Development Scenario



Figure 30: 1% AEP event – flood hazard classification surrounding the site – Post-Development Scenario

6.2.3 PMF Event

The flood depths and levels in the PMF event for the Post-Development Scenario are presented in Figure 31, with flow velocity and hazard classification depicted in Figure 32 and Figure 33, respectively.

- Post-Development PMF levels within the bio-retention basin to the west have reduced slightly from the Pre-Development Scenario (approximately 30 to 35mm reduction). Hazard here is consistent with Pre-Development, at mostly H3.
- As a result of the re-grading of the sports field, there is split flow with ponding to the north of the sports field and to the south (i.e. north of the proposed Buildings E & F). Depths to the north peak at approximately 230mm, and at around 240mm to the south.
- Peak flood level northeast of Building F reaches 53.07m AHD, remaining at H1 hazard.
- Ponding of floodwaters at the driveway to the north of the proposed car park peak at over 250mm depth but remain at H1 hazard in the Post-Development Scenario PMF event.
- Velocity is somewhat reduced in the Post-Development PMF event when compared with the Pre-Development PMF event. Peak velocity south of Building E & F reaches around 1.4 m/s (compared to 1.6-2.0 m/s in the Pre-Development).

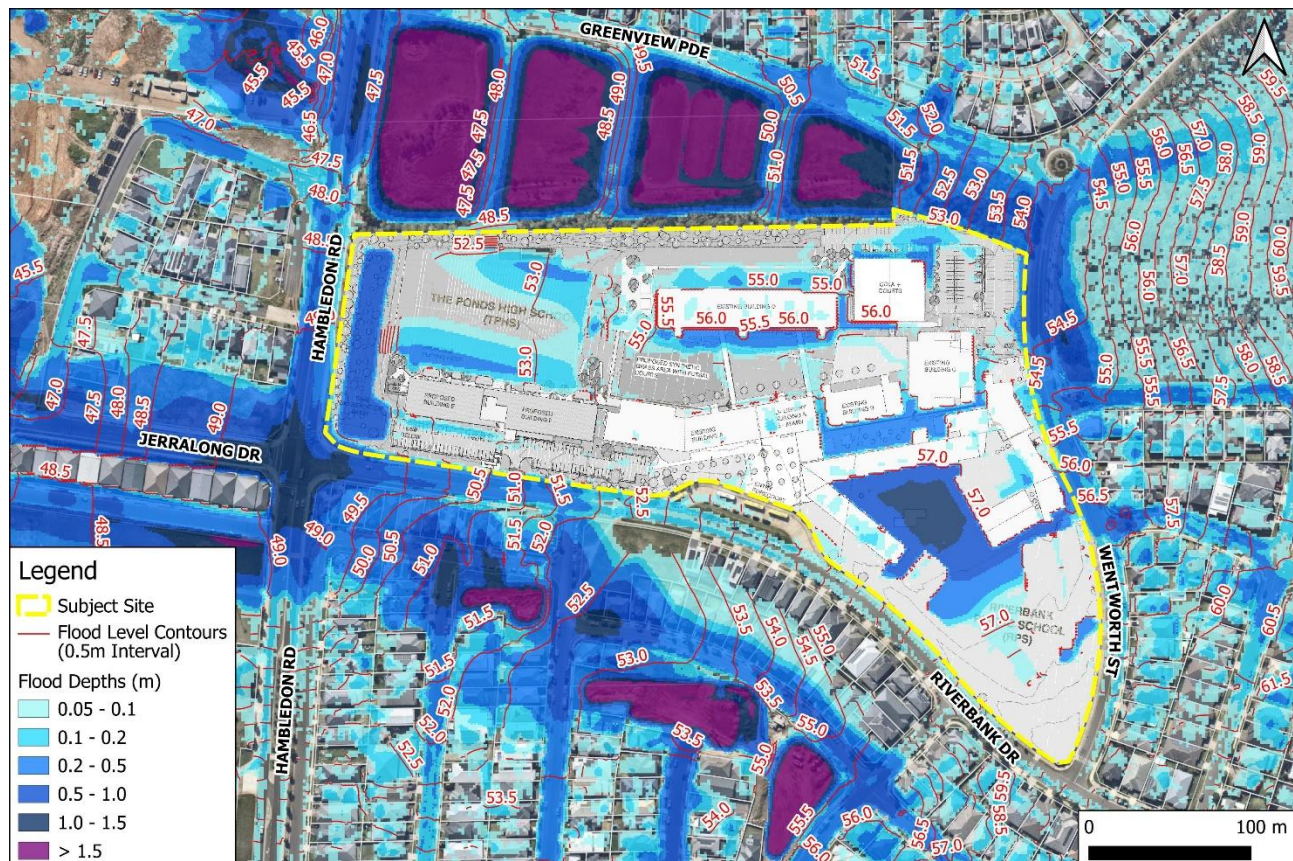


Figure 31: PMF event – flood depths and levels surrounding the site – Post-Development Scenario

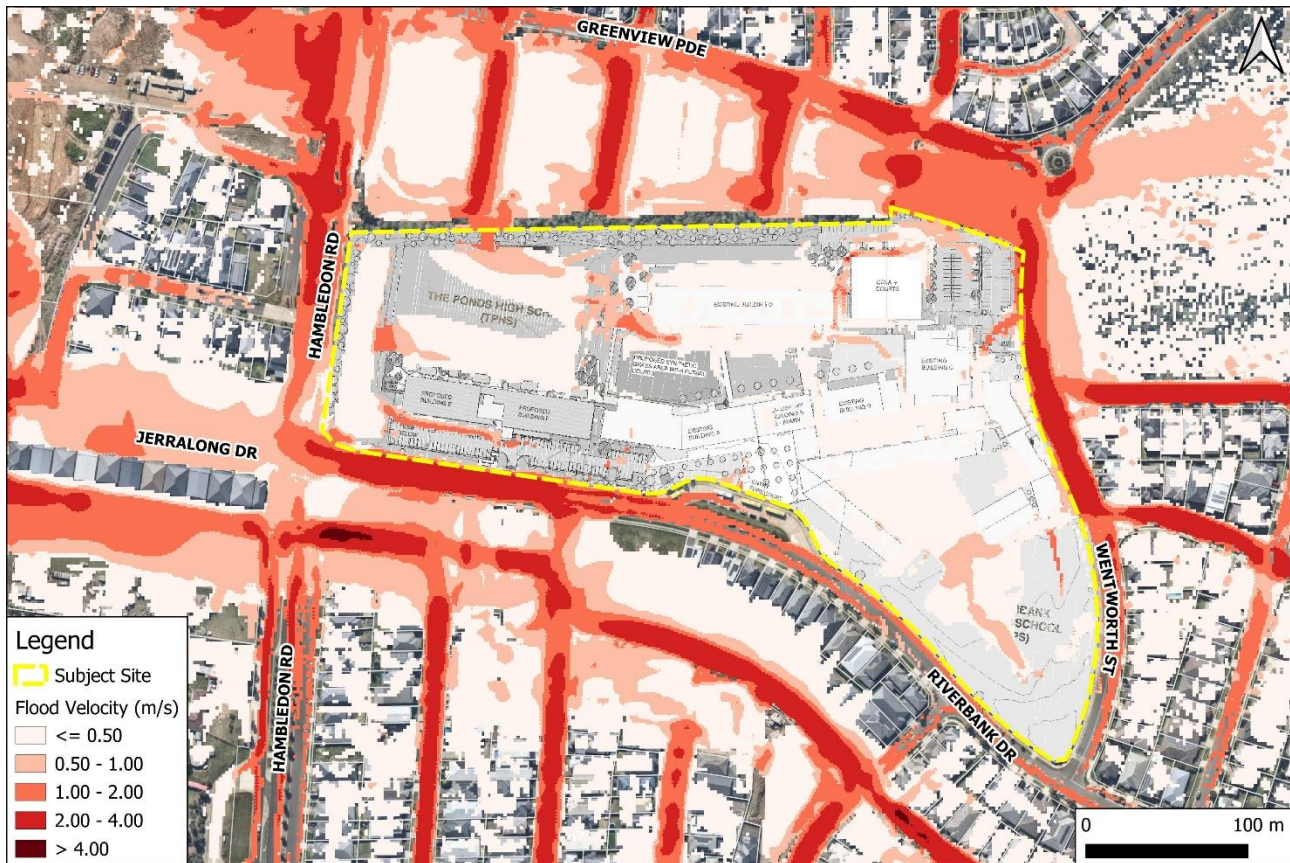


Figure 32: PMF event – flood velocities surrounding the site – Post-Development Scenario

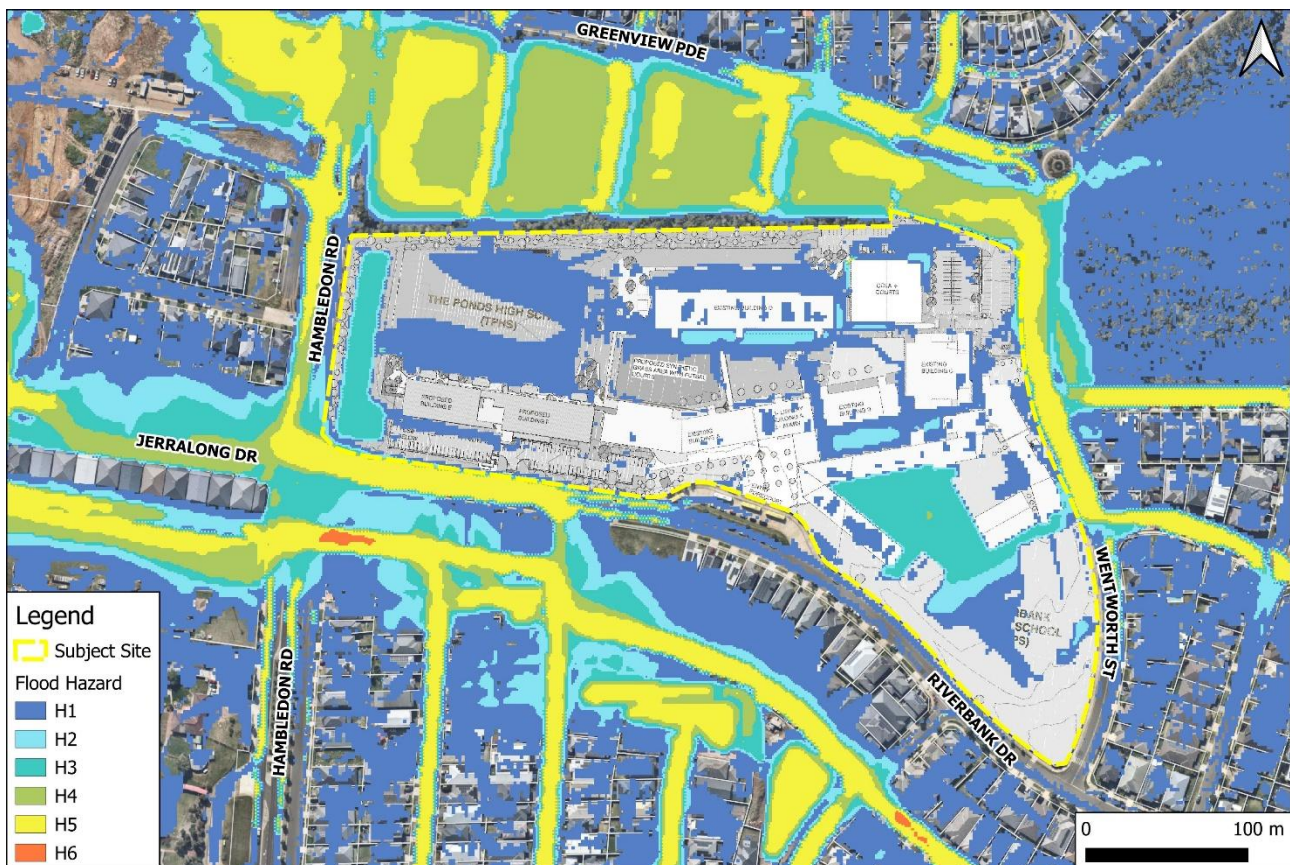


Figure 33: PMF event – flood hazard classification surrounding the site – Post-Development Scenario

6.3 Offsite Flood Impact Assessment

A flood impact assessment was carried out to ensure that the proposed northern car park activity on the subject site would not cause any offsite impacts beyond the accepted +20mm on the surrounding properties (noted in the Blacktown WSUD) for all the assessed events.

6.3.1 1% AEP Event

The 1% AEP flood level impact map for the site and its immediate surrounding area is shown in Figure 34. As indicated in Section 6.2, flood levels within the western bio-retention basin are reduced in all tested AEP events (-14 mm in the 1% AEP, to -35mm in the PMF event). Regrading of the sports field and the removal of the demountables has removed the northwestern ponding (brown area of 'was dry now wet'). As the sports field has been designed with a crest in the centre, there are additional flows directed south (i.e. blue area of 'was dry now wet'). While this lies north of the proposed Building E & F, the flows remain within the proposed playing field.

Given the loss of storage associated with the filling of the northeastern car park, there is an increase in flood level directly adjacent to the car park and within the offsite regional basins to the north of the site. At the northeastern basin ('Basin 4', northeast of the existing Building D), there is a +66mm increase in flood level. At the central basin ('Basin 3', northwest of Building D), there is a +46mm increase in flood level. At the far northwestern basin ('Basin 1'), there is a 1% AEP flood level increase of approximately 87mm.

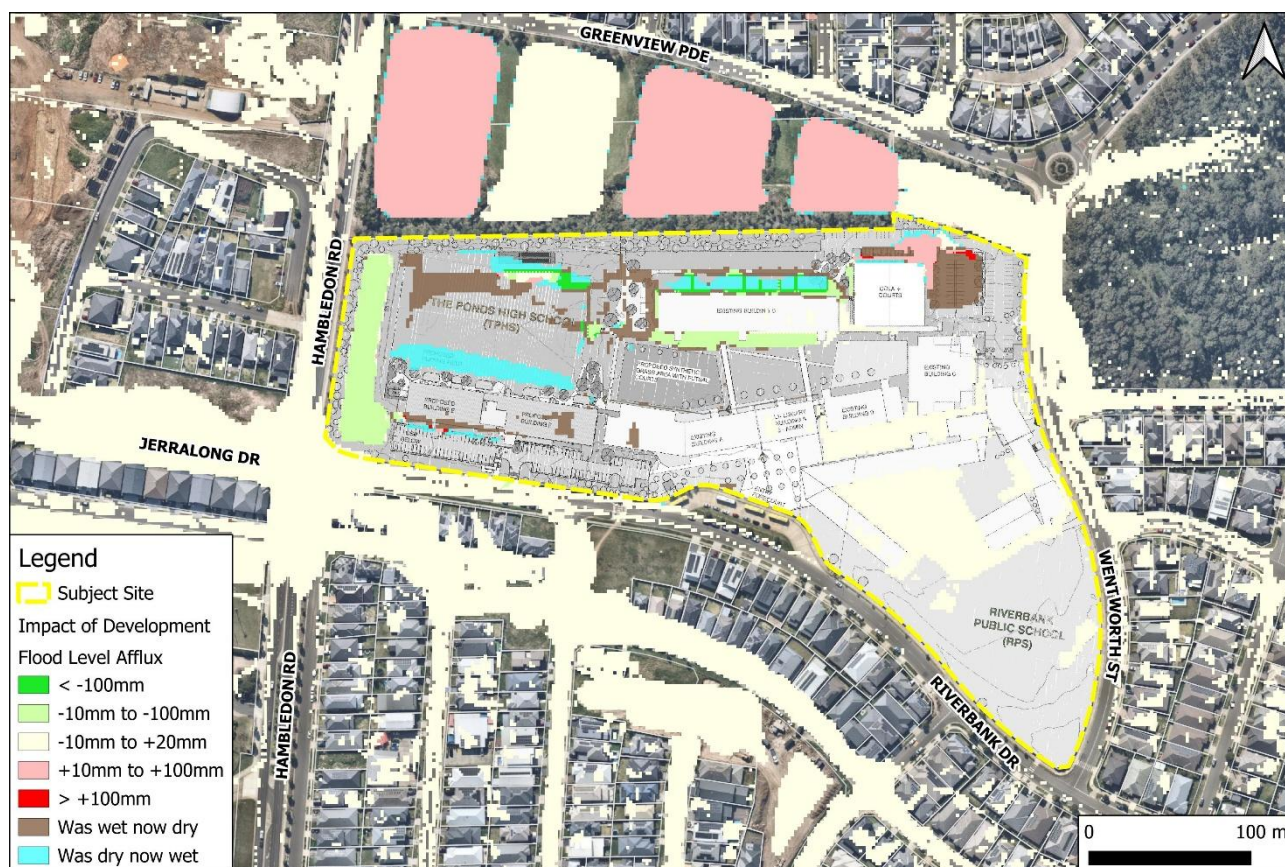


Figure 34: 1% AEP Flood Level Impact (Post-Development Scenario – Pre-Development Scenario)

6.3.2 0.2% AEP Event

The 0.2% AEP flood level impact map for the site and its immediate surrounding area is shown in Figure 35. As in the 1% AEP event, there are some offsite impacts associated with the loss of storage due to filling of the northeastern car park, though less basins are impacted in the 0.2% AEP event. At the northeastern basin

(Basin 4), there is a +76mm increase in flood level.



Figure 35: 0.2% AEP Flood Level Impact (Post-Development Scenario – Pre-Development Scenario)

6.3.3 Discussion of Offsite Impact

While there is an increase of up to 87mm within the regional basins, it should be acknowledged that this increase is contained within the basin area. The basins are designated as a 'SP2 Drainage' land zone and are therefore intended to provide land required for drainage storage and attenuation.

Offsite impacts are only evident within the designated drainage basins, and do not impact adjacent residential properties or the roadways. Similarly, flood hazard within the basin is not significantly changed with the increase and remains in the same hazard category both pre-and post-development.

6.4 Climate Change Consideration and Assessment

Climate change is expected to have an adverse impact on rainfall intensities, which has the potential to have a significant impact on flood behaviour. The ARR2019 guidelines were updated on 27th August 2024 with new guidance on how to consider climate change when planning for future floods, which includes variable rainfall adjustments based on storm duration.

For this assessment, a sensitivity analysis has been carried out to determine the impact of climate change on local flood conditions under the Shared Socioeconomic Pathway (SSP) 2-4.5 Scenario, which represents the intermediate Greenhouse Gas Emissions Scenario. Specifically, this study adopted the long term (at year 2090) SSP2-4.5 climate change factors in the modelling, whereby rainfall intensities are estimated to be increased by 40% in 2090 for the 1hr or shorter storms. The increase in rainfall intensity factors for various design storm durations, as extracted from the ARR Data Hub for the site area, and adopted in this assessment are summarised in Table 7.

Table 7: Adopted increases in climate change factors for the assessment

Climate Change Scenario	Climate Change Increase Factor Adopted for Various Design Storm Durations							
	<1hr	1.5hrs	2hrs	3hrs	4.5hrs	6hrs	9hrs	12hrs
SSP2-4.5 – Long Term (Year 2090)	1.4	1.36	1.34	1.31	1.28	1.26	1.24	1.23

These climate change factors were applied to the 1% AEP and 0.2% AEP event design rainfall intensities, as per the requirements of the Flood Risk Management Guideline LU01 and ARR2019 methodology. The modelling results show that increases in estimated flood levels are generally similar between the 1% AEP and 0.2% AEP events assessed (i.e. when compared to the respective AEP events without climate change consideration).

The respective estimated increases in flood level due to climate change effects in the year 2090, for the 1% AEP and 0.2% AEP events assessed are shown in Figure 36 and Figure 37, respectively.



Figure 36: 1% AEP flood level afflux (m) under the adopted 2090 climate change scenario (Post-Development Scenario)

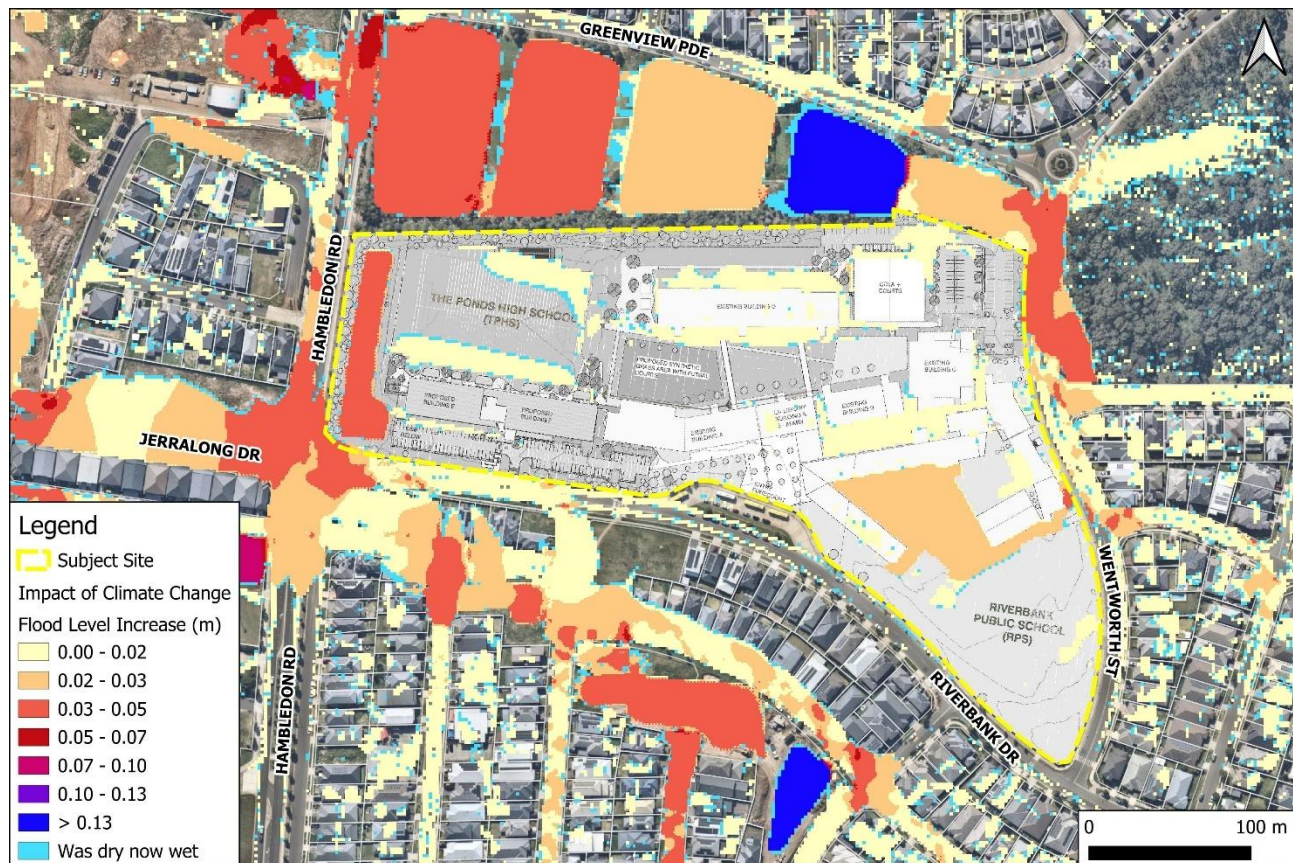


Figure 37: 0.2% AEP flood level afflux (m) under the adopted 2090 climate change scenario (Post-Development Scenario)

The following observations can be made:

- In the 1% AEP, flood level increase within TPHS site is limited. Flood level directly north of the proposed Buildings E& F is generally consistent with the 2025 scenario, with a slight increase in flood extent to the north. This is also the case north of the proposed buildings in the 0.2% AEP.
- Flood level increase within the bio-retention basin is approximately +27mm in the 1% AEP 2090 scenario, while this increases to +35mm in the 0.2% AEP 2090 scenario.
- Flood level increase southwest of the site at the junction of Riverbank Drive, Jerralong Drive and Hambledon Road is between around 30-40mm in the 1% AEP 2090 scenario. Despite this, hazard remains unchanged at this area (H3 hazard in both the 2025 and 2090 scenario).
- In the 0.2% AEP 2090 scenario, flood level increase at this junction compared to the 2025 scenario is similarly between around +30-40mm. As with the 1% AEP, hazard remains unchanged at this area (H3 hazard in both the 2025 and 2090 scenario).

7.0 Compliance with Flood Planning Controls

As outlined in Section 3.0, compliance with the Development Control Plan (DCP) is not required under the REF pathway. Relevant DCP provisions have been reviewed and are acknowledged in this study to demonstrate consideration of Council's planning objectives.

There is some ponding north of the proposed Building E and F in the Post-Development Scenario. This is considered negligible sheet flow, which will be largely addressed by local stormwater management (which has not been incorporated into the TUFLOW model). This ponding is subsequently a stormwater management issue, and is not considered a flood issue.

Despite this, the flood level around the proposed buildings have been assessed against the proposed Finished Floor Level (FFL) of the buildings, which have been set to 53.1m AHD. Figure 38 shows the point locations around the buildings, while the modelled flood levels are detailed in Table 8.

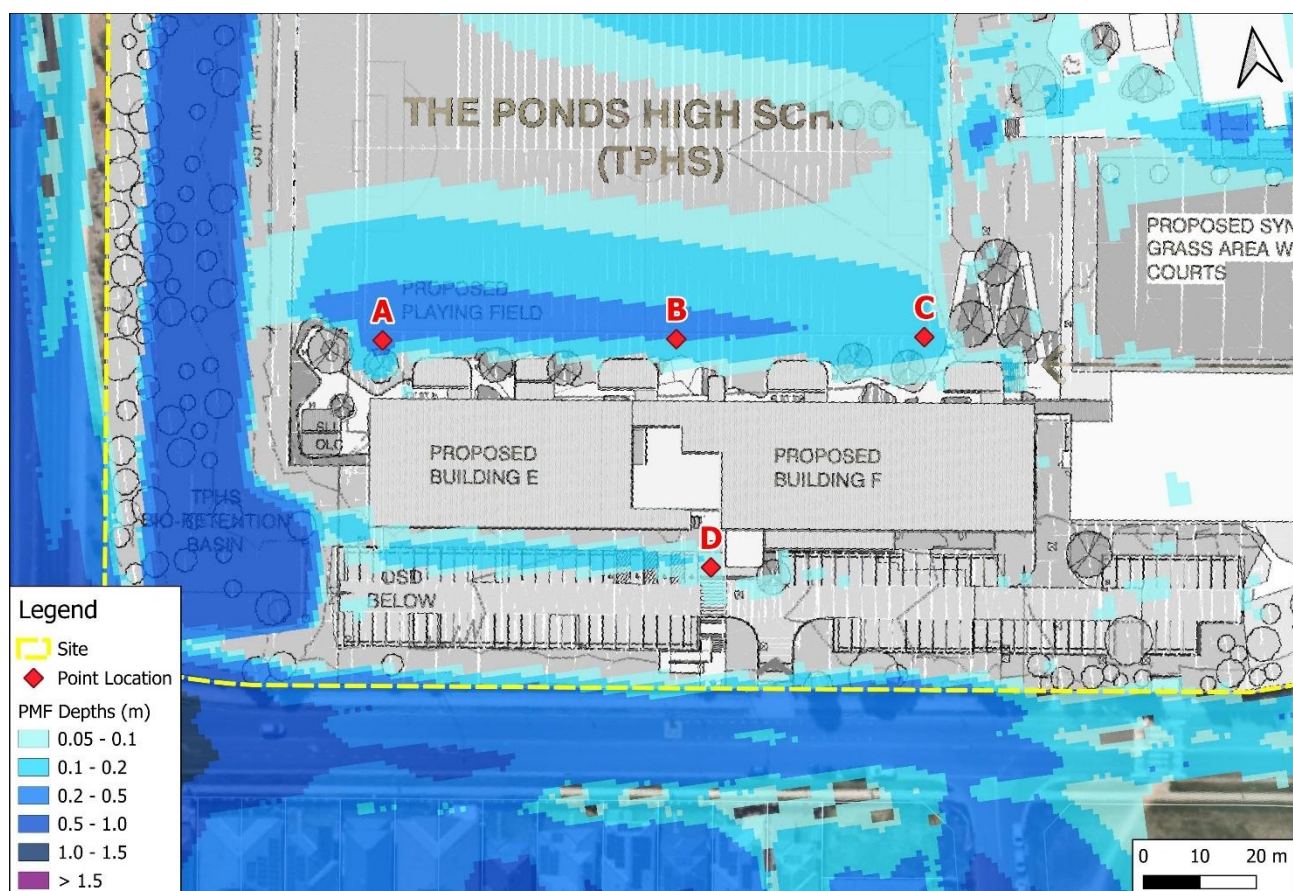


Figure 38: Point locations around the site where flood levels have been assessed, shown against the PMF.

Table 8: Modelled flood levels surrounding the proposed development site

Point	Post Development Flood Level (m AHD)					Compliance	
	1% AEP	1% AEP CC2090	0.2% AEP	PMF	PMF CC2090	FFL	FFL above flood level?
A	52.57	52.59	52.59	52.71	52.73	53.1	Y
B	52.80	52.82	52.82	52.92	52.94	53.1	Y
C	52.98	52.99	52.99	53.06	53.08	53.1	Y
D	N/A	N/A	N/A	51.48	51.50	53.1	Y

With a proposed FFL of 53.1m AHD, the proposed Buildings E & F are set above both the PMF level (peak ponding level of 53.06m AHD) and the PMF CC2090 scenario, which peaks at 53.08m AHD. With the CC2090 scenario equating to a 40% increase in rainfall intensities, this indicates that the site is resilient against climate change, even when applied to the Probable Maximum Flood.

The proposed activity is therefore set above the PMF level, as detailed in the Blacktown WSUD (refer Figure 8) and in the Support for Emergency Planning (EM01) Flood Risk Management Manual (refer Figure 10).

Sufficient drainage provisions should be provided around the buildings to fully contain and divert anticipated stormwater runoff away from the buildings.

8.0 Conclusions and Recommendations

TTW have assessed flood behaviour at The Ponds High School site. As the site was not included in the Council's Local Overland Flow Flood Study model, a site specific 1D-2D hydraulic model was produced to assess overland flow flood behaviour at the site.

In summary:

- A rainfall-on-grid (ROG) hydrology approach has been adopted using a direct rainfall boundary condition, in which rainfall is applied to each active cell in the 2D mesh. The ROG method is typically associated with substantial shallow sheet flow, so depths below 0.05m have been filtered out of the results.
- Modelling was completed for both the Pre-Development and Post-Development Scenario for the 50% AEP, 10% AEP, 1% AEP, 0.2% AEP and PMF event.
- Modelling of the Post-Development Scenario incorporated proposed changes to the TPHS site, including the proposed Buildings E & F at the southwest of the site, a sports field to the north, and a synthetic grass area to the northeast of the proposed Building F. The 90% Schematic Design TIN of the proposed surface levels (designed and provided by WSP) was incorporated into the TUFLOW model to represent the proposed surface elevations.
- A climate change assessment was conducted to determine the impact of climate change on local flood conditions under the Shared Socioeconomic Pathway (SSP) 2-4.5 Scenario, which represents the intermediate Greenhouse Gas Emissions Scenario. Specifically, this study adopted the long term (at year 2090) SSP2-4.5 climate change factors in the modelling, whereby rainfall intensities are estimated to be increased by 40% in 2090 for the 1hr or shorter storms.
- Sheet flow is present north of the proposed Buildings E & F. In the 1% AEP, this peaks at 100-140mm depth and remains at H1 hazard. This is considered negligible sheet flow, which will be largely addressed by local stormwater management (which has not been incorporated into the TUFLOW model).
- The proposed Buildings E & F have a proposed FFL of 53.1m AHD and are shown to be set above both the PMF level and the PMF CC2090 scenario.
- With the CC2090 scenario equating to a 40% increase in rainfall intensities, this indicates that the site is resilient against climate change, even when applied to the Probable Maximum Flood.
- Given the loss of storage associated with the filling of the northeastern car park, there is an offsite increase in flood level within the regional basins to the north of the site.
- Offsite impacts are only evident within the designated drainage basins, and do not impact adjacent residential properties or the roadways. Similarly, flood hazard within the basin is not significantly changed with the increase and remains in the same hazard category both pre-and post-activity.

Subject to implementing the mitigation measures set out below, the conclusion of this assessment is that the proposed activity is not likely to significantly affect the environment in relation to flood matters.

Mitigation Measures

Mitigation measures identified as necessary are outlined in Table 9.

Table 9: Mitigation Measures

Project Stage	Mitigation Measure	Reason	Relevant Section of Report
Design	Sufficient drainage provisions should be provided around the proposed buildings	To fully contain and divert anticipated stormwater runoff away from the buildings.	7.0

Prior to commence of operation	Prepare a final operational FERP. A preliminary Flood Emergency Response Plan has been produced and submitted alongside this report.	The preliminary FERP must be reviewed prior to the commence of operation, with roles assigned to relevant staff members. It must also reflect any updates made in the detailed design stage.	N/A
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Evaluation of Environmental Impacts

The offsite flood impact assessment found that given the loss of storage associated with the filling of the northeastern car park, there is an offsite increase in flood level within the regional basins to the north of the site. However, offsite impacts are only evident within the designated drainage basins, and do not impact adjacent residential properties or the roadways. Similarly, flood hazard within the basin is not significantly changed with the increase and remains in the same hazard category both pre-and post-activity.

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed activity, it is determined that:

- The extent and nature of potential impacts are low and will not have significant adverse effects on the locality, community and the environment.
- Potential flood risks and impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community through recommended measures as outlined above.
- The activity is not considered to produce a significant impact.

Prepared by
TTW (NSW) PTY LTD



RACHEL CALDWELL
Civil Flood Modeller

Reviewed & Authorised By
TTW (NSW) PTY LTD



MICHAEL KOI
Associate (Flood)

Appendix A

Blacktown City Council – Flood Advice Letter

File Number: 367148

18 October 2024

Taylor Thomson Whiting (Pty Ltd)

Dear Taylor Thomson Whiting (Pty Ltd)

Flood advice: 180 Riverbank Drive The Ponds being Lot 11 in DP 1200915

I refer to your request for flood advice on 25/09/2024 and provide the following flood information for the above property.

Do flood planning controls currently apply?

- | | | |
|----|--|-----|
| 1. | Flood planning area controls – Riverine | No |
| 2. | Flood planning area controls – Overland | No |
| 3. | State Environmental Planning Policy controls | Yes |

What other considerations may apply?

- | | | |
|----|-----------------------------|----|
| 4. | Special flood consideration | No |
| 5. | Drainage constraints | No |

What this means for your property

If we have answered 'Yes' to any of the Flood planning controls at 1, 2 or 3 above, a flood study will be required for development.

If we have answered 'Yes' at 4 above, a flood study will be required if your development is considered sensitive or hazardous and is located within any part of the floodplain.

If we have answered 'Yes' at 5 above, a flood study may be required.

Where to find more information

The following pages set out more detailed information on the above where it relates to your property, along with other relevant flood related information. If you have any queries on this, please contact one of our Floodplain Officers by phoning 02 9839 6350 or emailing floodadvice@blacktown.nsw.gov.au

If you have any queries on development of your land, please contact one of our Planners by phoning 02 5300 6000, or emailing gateway.team@blacktown.nsw.gov.au.

Yours faithfully



Naomi Harris
Coordinator Floodplain and Stormwater

Attachments

1. Details on our flood information for your property
2. Flood modelling and floor levels
3. General flood information, including definitions
4. Flood maps

Disclaimer

The information contained in this letter is only valid on the date of issue. This letter has been prepared with all due care and in good faith using the best information available to us.

We provide no warranties in relation to the completeness or accuracy of the information contained in this letter, and do not accept liability for any loss or damage resulting from, or in connection with, its contents or its use.

There may be other non-flood related matters that might impact on the use of the land.

We strongly recommend that, in all cases, you seek independent professional advice to supplement your enquiries. A more detailed assessment at development application stage may result in modifications and/or additions to these comments. This advice is not a guarantee of approval.

We can supply additional information, such as ALS/Lidar data for a fee. Contact floodadvice@blacktown.nsw.gov.au for this information.

From the 3 July 2024, our flood risk precincts in this area were updated to reflect new information in the Blacktown Overland Flow Flood Study. Further information can be found here: <https://www.blacktown.nsw.gov.au/Our-environment/Waterways/Flooding-in-the-Blacktown-local-government-area/Flood-studies>. We may have draft information about other flood studies that has not been included in this letter.

Attachment 1: Details on our flood information for your property

1. Flood planning area controls – Riverine

This property is not identified as being in any of the flood precincts of the First Ponds Creek floodplain. Maps showing the extent of adopted riverine flooding are at attachment 4.

The 1% AEP flood information in the basins adjacent to the site are included in the drawing at attachment 5.

2. Flood planning area controls – Overland flow

This property is not identified as being in the overland flow precincts. Maps showing the extent of adopted overland flow flooding are at attachment 4.

We do not warrant that information provided or made available to you is complete. We strongly recommend that, in all cases, you seek independent professional advice to supplement your enquiries.

3. Flood planning area controls - State Environmental Planning Policy

This property is located within an area identified as being part of the State Environmental Planning Policy (Sydney Region Growth Centres) 2006, known as the SEPP, flood mapping for the rezoning and redevelopment of the area.

The flood maps attached are based on the results of Engineering Flood Studies commissioned by NSW Government authorities and Blacktown City Council. These maps indicate that the subject land lies partly or wholly within the SEPP Mapping Area provided by the Department of Planning, Housing and Infrastructure.

The SEPP Mapping Area is the area of land situated below the Flood Planning Level, which is defined as the 1% AEP.

As a Flood Control Lot, it does not meet the criteria of an exempt or complying development as detailed by the [State Environmental Planning Policy \(Exempt and Complying Development Codes\) 2008 – Section 3.36C](#).

General requirements for the use of this land are outlined in the [Blacktown City Council Priority Precincts Development Control Plan](#) as prepared by the Department of Planning, Housing and Infrastructure. The property must meet the controls set out prior to approval of development.

Where proposed development extends into the SEPP Mapping Area, a flood study may be required to ensure no adverse impacts occur.

Flood modelling requirements are detailed in our [Water Sensitive Urban Design Developer Handbook](#). Further details are in the [NSW Government Floodplain Risk Management Manual](#).

4. Special flood consideration

Special flood considerations apply to certain types of development that have been identified as having a higher risk to life and warranting the consideration of the impacts of rarer flood events on land located outside the flood planning area.

Controls apply to the following sensitive or hazardous development being undertaken on any part of the floodplain.

Hospitals, telecommunication towers, large power supply stations, emergency services facilities (police, ambulance and fire stations, centre-based child care, early education and care facilities, correctional centres, educational establishments, residential care facilities, respite day-care centres, seniors housing, group homes.

5. Drainage constraints

	Present on property	Details
Pipes	No	N/A
Drainage easements	No	N/A
Waterways or channels	No	N/A

Attachment 2: Flood modelling and floor level requirements

Recommendations

Based on the filling for the subdivision Council's Asset Design section's only requirement relating to flooding or drainage would be for the habitable floor level to be the higher of; a minimum of 225 mm above finished ground levels of 500mm above the 1% Annual Exceedance Probability (AEP) level for the site.

Flood studies must comply with general requirements for flood modelling

These are outlined in:

- Blacktown Development Control Plan 2015, Part A, Chapter 9.
This document is published on our website:
https://www.blacktown.nsw.gov.au/files/assets/public/v/2/building-and-planning/dcps-amp-lap/part-a-introduction-and-general-guidelines_waste.pdf
- General requirements for Flood Modelling are outlined in our Water sensitive urban design developer handbook. Chapter 15.3: Design Standards outlines a number of different developments, and states minimum requirements with regards to flooding.
This document is published on our website:
<https://www.blacktown.nsw.gov.au/Plan-build/Stage-2-plans-and-guidelines/Developers-toolkit-for-water-sensitive-urban-design-WSUD/MUSIC-modelling>

In addition to a flood study

A preliminary minimum floor level would be required to be the higher of:

- a minimum of 225 mm above finished ground levels, or
- the highest adjacent 1% Annual Exceedance Probability (AEP)
 - riverine flow level plus 500 mm, or
 - overland flow level plus 300 mm.

A development application must provide a detail survey to Australian Height Datum and be certified (signed) by a registered surveyor. The survey is to include:

- sufficient spot levels with contours
- any existing floor levels
- the origin and level of the benchmark used and a local benchmark on top of kerb installed for use during construction.

Any future development within the 1% AEP flood area would have to prove that it does not increase the flood risk to life or the surrounding area and it must maintain an appropriate overland flow path.

We will not allow the importing of any fill within the 1% AEP flood area.

You must submit a copy of this Flood Advice Letter, the Flood Study Report and electronic files of the Flood Model with any development application for the site.

Attachment 3: General flood information

Definitions

AEP	stands for 'Annual Exceedance Probability'. This is the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. A 1% AEP flood has a 1% chance of occurring in any given year.
PMF	stands for 'Probable Maximum Flood' The PMF is the largest flood that could conceivably be expected to occur at a given location. The PMF defines the maximum extent of flood prone land, that is, the floodplain.
Flood level	is the elevation of the flood surface above Australian Height Datum (AHD). Australian Height Datum is the official national vertical datum for Australia which is a plane of level corresponding approximately to mean sea level.
Flood depth	is calculated by subtracting the Flood Level from the ground elevations defined by 2018 LiDAR aerial survey data
Velocity	is the speed of the flowing flood water
Hazard	is defined in Figure 6.7.9 Book 6 Chapter 7 of Australian Rainfall and Runoff 2019 and identifies the potential risk that floodwaters pose to people, property and vehicles. A copy of Figure 6.7.9 is below.
Freeboard	is a factor of safety expressed in metres above a flood level for purposes of floodplain management

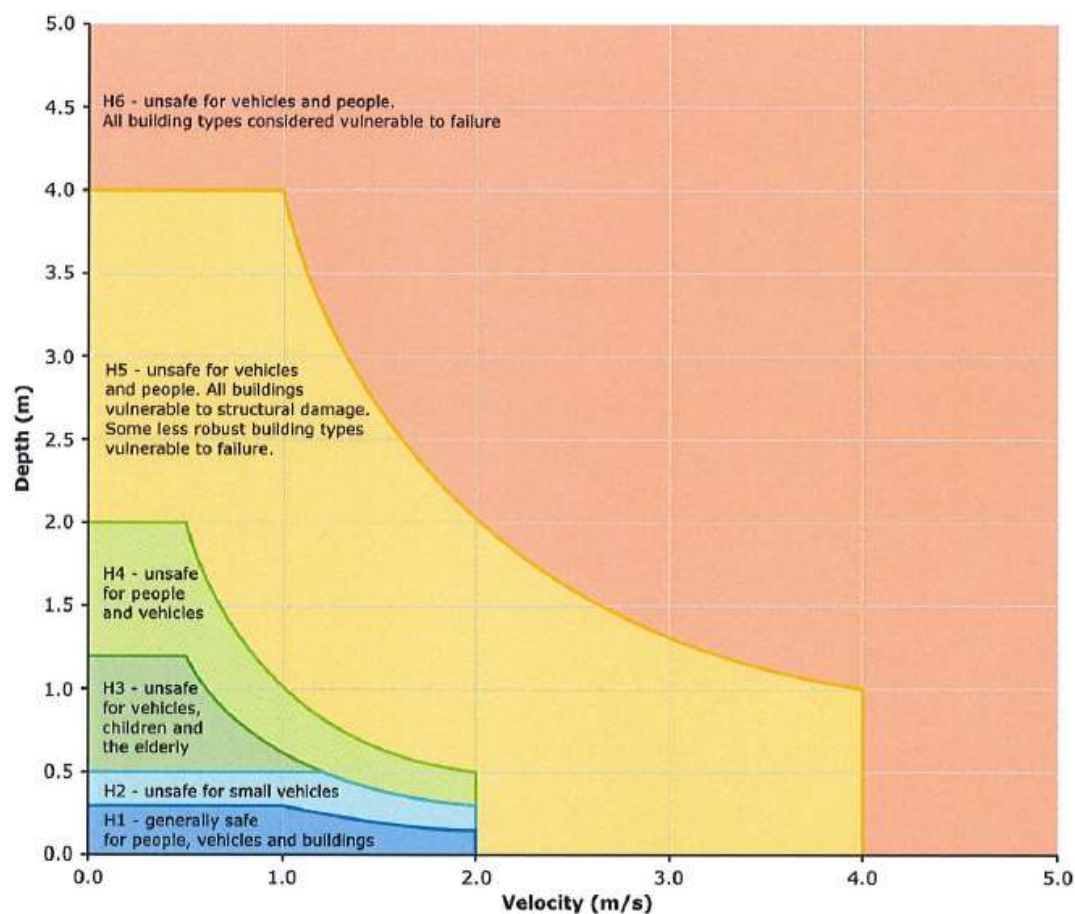


Figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

The flood levels supplied are for the pre-developed existing conditions	The flood levels supplied do not take climate change into consideration. These flood levels should not be used to set floor levels or to identify the extent of flooding over the property as our current flood models may not have included blockage factors nor changes in land-use and landform since the date of the study.
Flood Planning Area	Land which lies below the Flood Planning Level. Properties that lie either partially or wholly within the extent of the Flood Planning Area are subject to a s10.7 certificate flood affectation notification, and as such are subject to the flood related development controls set out in the Blacktown Local Environmental Plan 2015 and the Development Control Plan relevant to the property.
Flood Planning Level	The Flood Planning Level for Blacktown City is a combination of defined flood event and freeboard. We use 1% AEP for the defined flood event, and include a freeboard appropriate for the land use. For residential properties in Blacktown City, this is 500mm metres for riverine flooding and 300mm for overland flow.
Flood risk precincts	Precincts have been defined based on hydraulic and survey information available to Council for both local overland and riverine flooding. In many cases a more definitive indication of flood risk precinct extents can be determined by relating surveyed ground levels at AHD to the relevant hydraulic and/or flood level criteria. The Low Flood Risk Precinct is equivalent to the floodplain and flood prone land. This includes all land that is flood affected by flooding in some capacity, up to and including the PMF, except for areas that have already been identified as being within the high or medium flood risk precinct. The Medium Flood Risk Precinct is equivalent to the flood planning area, except for areas that have already been identified as being within the high flood risk The High Flood Risk Precinct includes areas of the floodplain which convey a significant discharge of water during floods. They often align with naturally defined channels and are equivalent to the floodway or high hazard areas.

‘Development on Flood Prone Land’ guidelines

Our guidelines can be found in Blacktown Development Control Plan 2015 Part A.

This document is on our website [Blacktown Development Control Plan 2015 – Chapter 9 ‘Development on Flood Prone Land’](#) This publication is currently under review in respect of floodplain planning issues.

Council’s flood mapping is available on our website

To start, click Discover Blacktown tab on the home page and then select Maps Online and follow the instructions.

Our flood mapping only covers the areas where we have information.

A property that is not identified does not mean that there are no flood issues.

It is the responsibility of the person enquiring to check the natural fall of the land and to ensure that the subject property is not affected by local stormwater overland flows that might affect existing or future development on this land.

State Environmental Planning Policy (SEPP) flood mapping

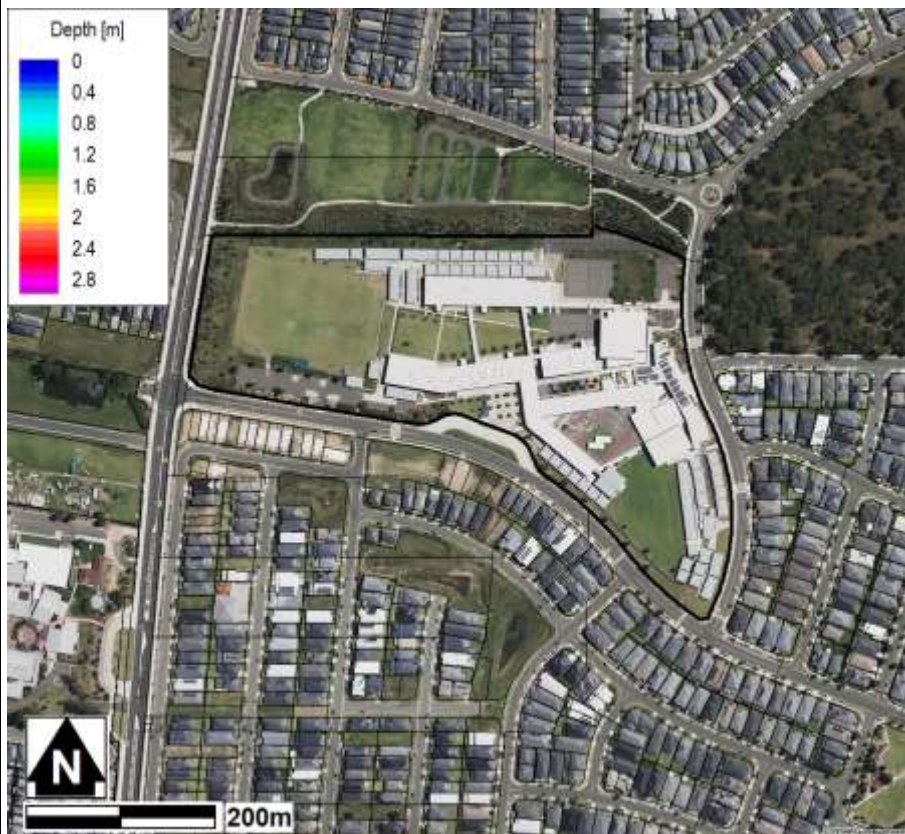
The property is subject to *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*. It is identified on the Development Control Map as ‘Flood Prone and Major Creeks Land’.

Clause 19 of the Growth Centres SEPP provides heads of consideration when a development application is lodged on land affected by ‘Flood Prone and Major Creeks Land’.

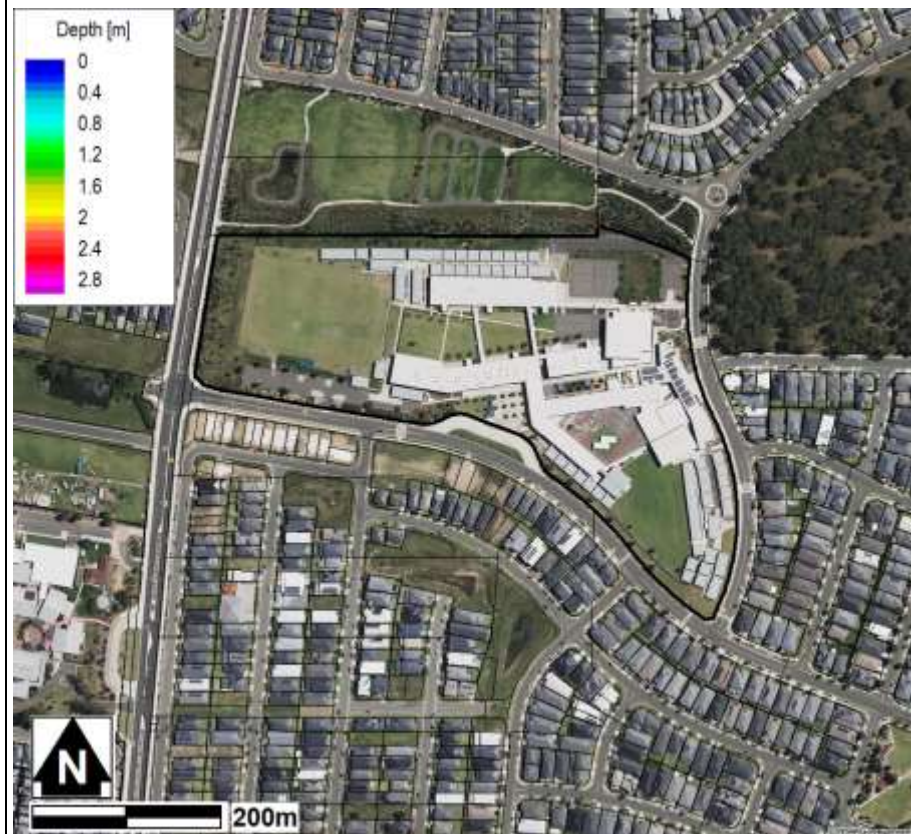
The SEPP maps (shown as light blue hatching) indicate the extent of flood prone land based on existing conditions at the time of preparing the precinct planning. Therefore, they may not include any changes resulting from subsequent development or infrastructure works.

Attachment 4: Flood maps

1% AEP Riverine Flood Depths



PMF Riverine Flood Depths



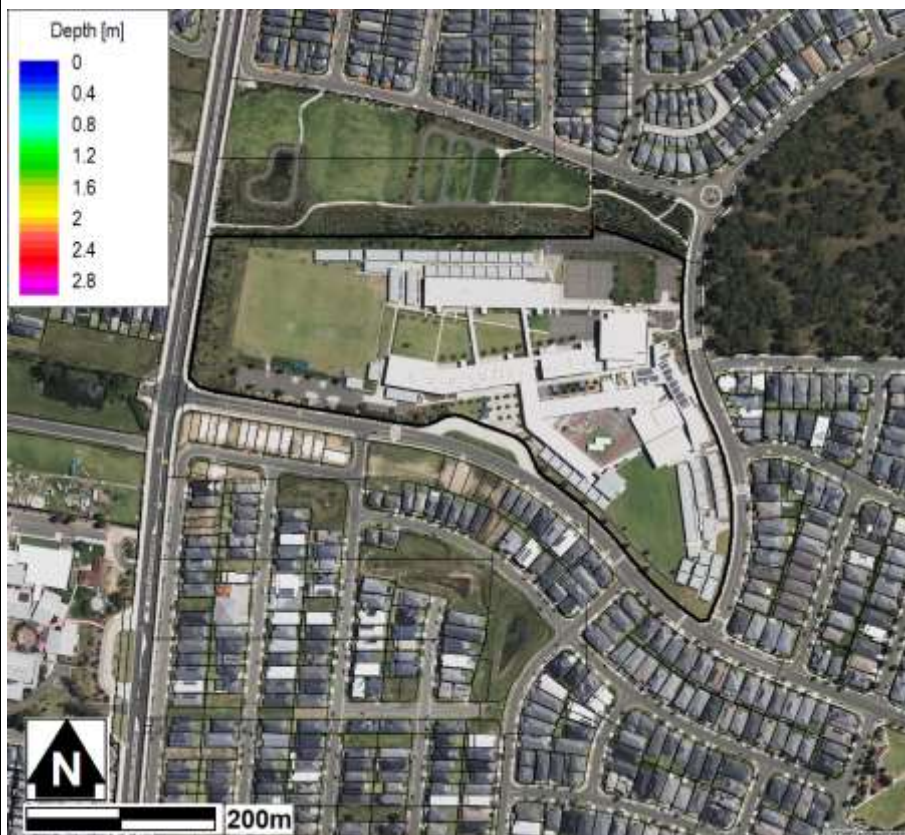
1% AEP Riverine Flood Hazard



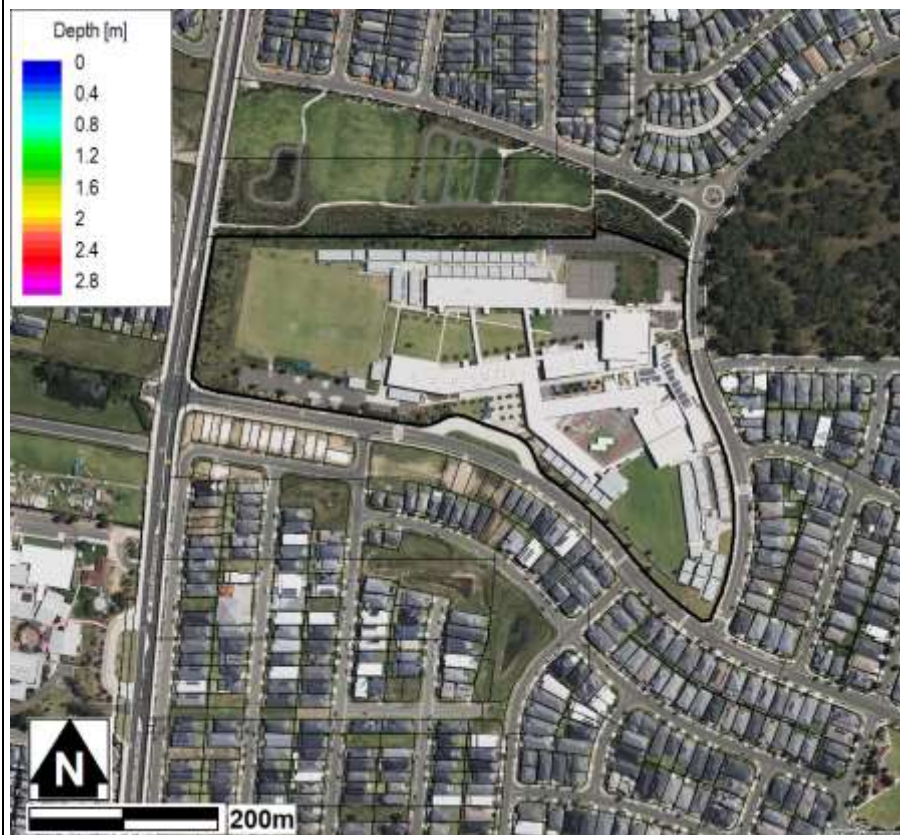
PMF Riverine Flood Hazard



1% AEP Overland Flow Flood Depths



PMF Overland Flow Flood Depths

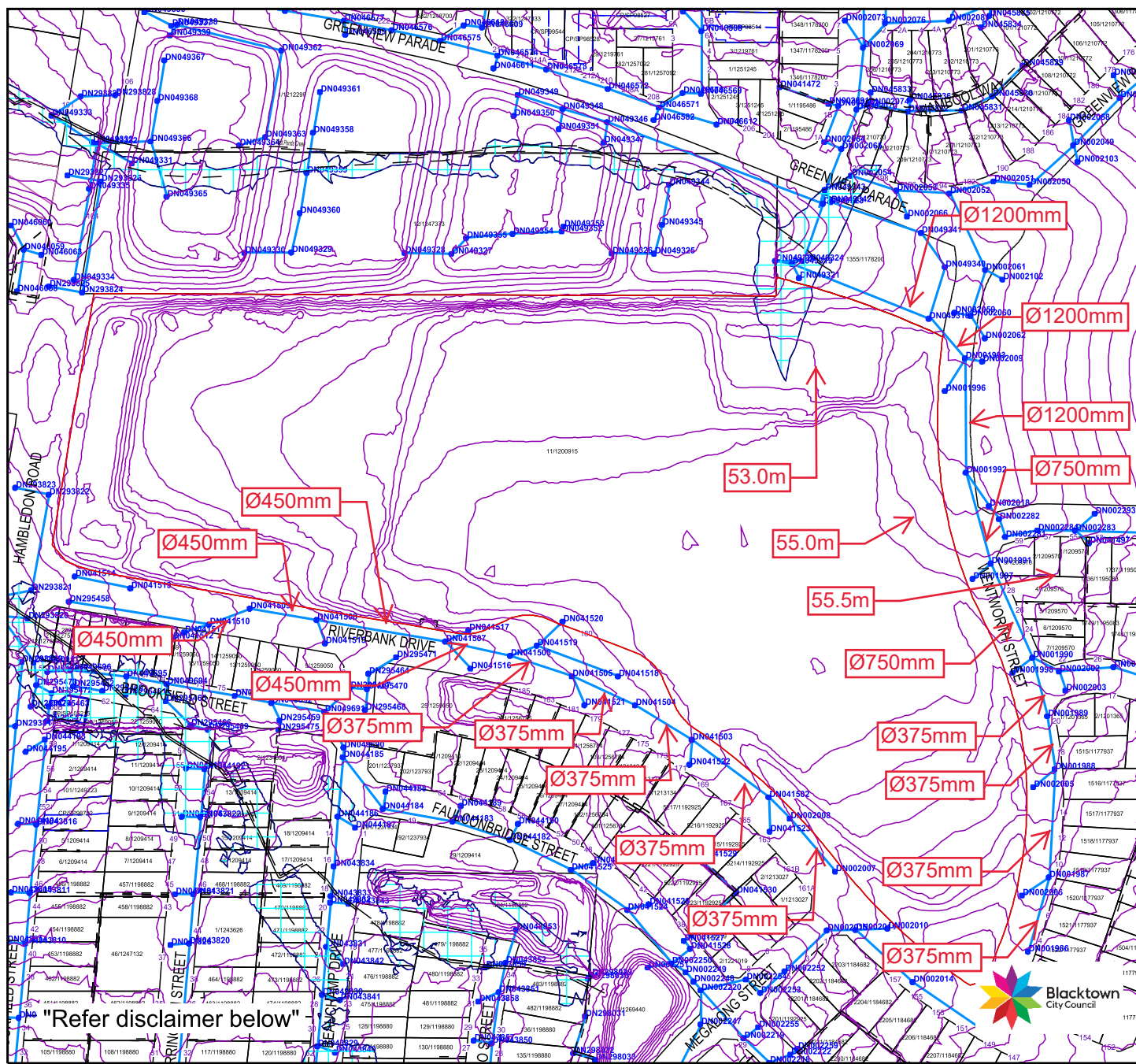


1% AEP Overland Flow Flood Hazard



PMF Overland Flow Flood Hazard





Copyright NSW Land Information Centre 1996

Plot Date: 30/09/2024

Copyright Blacktown City Council

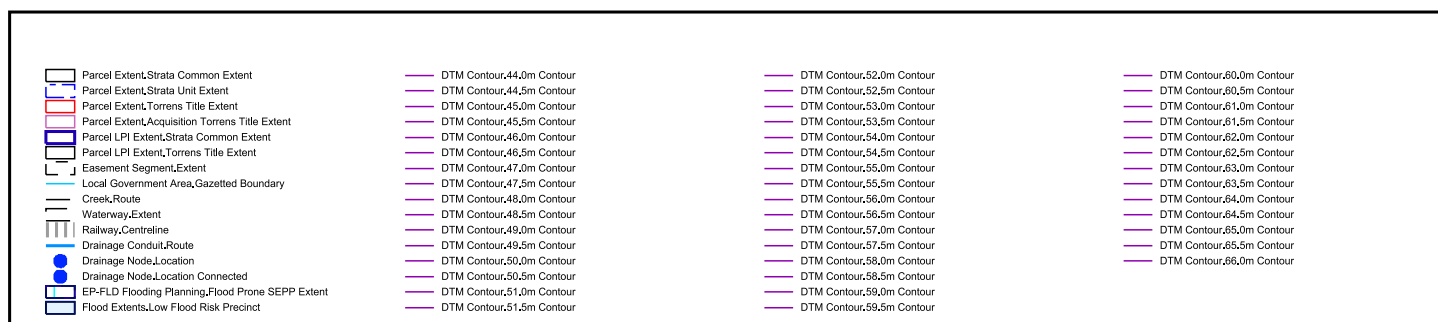
BLACKTOWN CITY COUNCIL

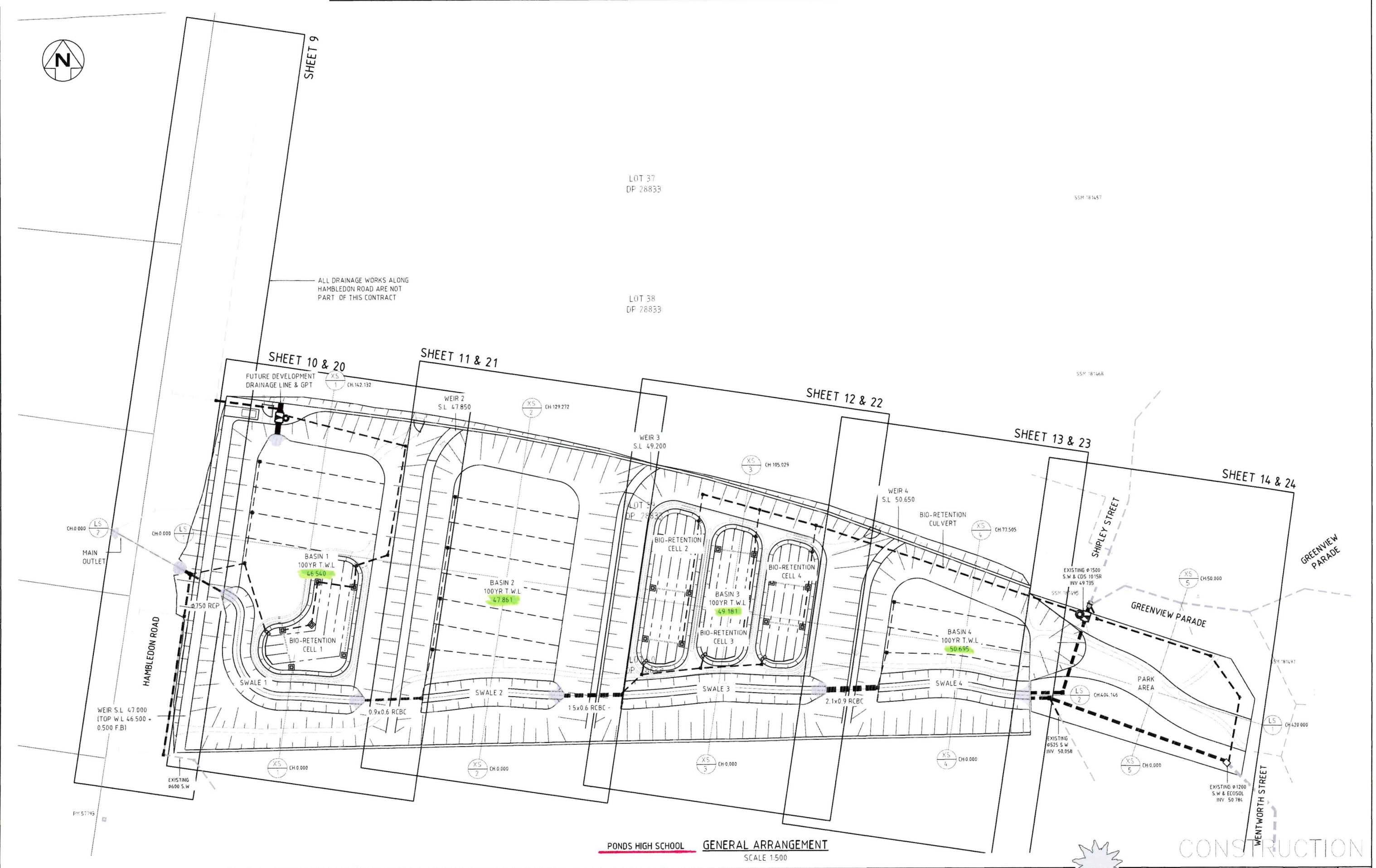
Flood Risk Map

DISCLAIMER: The flood risk precincts shown are based on information available to Council and should be regarded as an indicative guide only. A more accurate indication of the extent of the respective flood risk precincts can be determined by relating surveyed ground levels at Australian Height Datum (AHD) to the hydraulic and/or flood level criteria determining flood risk precinct boundaries. This information may be obtained by a written request to Council accompanied by a ground level survey to AHD prepared by a Registered Surveyor. Should flood risk precinct extents be required for the purpose of a financial transaction of any nature, then the parties to that transaction should apply to Council for formal certification and/or seek independent legal or professional advice.



Scale 1:3500





PREPARED BY:

REV	DATE	DESCRIPTION	CHECKED	APPROVED	DATE
1	APR '16	CONSTRUCTION	R.F.	T.A.	APR '16

PUBLIC UTILITIES LEGEND

WATER MAINS	GAS	TELSTRA
HYDRANT	GAS VALVE	TELSTRA PIT
STOP VALVE	ELECTRICITY	TELSTRA PILLAR
WATER METER	ELECTRICITY PIT	TELSTRA POLE
WATER TAP	POWER POLE	
SEWER	POWER LIGHT POLE	
SEWER LAMPHOLE	LIGHT POLE	
SEWER MANHOLE	STAY POLE	

DATUM

AHD

GRID

MGA

SHEET SIZE

A1

TITLE BLOCK

VERSION

A

SURVEYED

JWP

DESIGNED

LT

CADD

LT

VERIFIED

RP

DATE

APR '16

APPROVED

MANAGER ASSET DESIGN

DATE

APR '16

CLIENT

DATE

BlacktownCityCouncil

CORRUG CHAMBERS 67 FLUSHCOMBE ROAD BLACKTOWN
ALL MAIL: GENERAL MANAGER PO BOX 63 BLACKTOWN NSW 2148
TELEPHONE: (02) 9639 6000 FAX: (02) 9631 1961
DX: 8177 BLACKTOWN

PROJECT TITLE:

DETENTION BASIN F3.1

LOT 104-106 HAMBLEDON ROAD, ALEX AVENUE

OVERALL ARRANGEMENT

SHEET TITLE:

E39/10V.dwg

FILE No

F16/758

PLAN No

E39/10V

ASSET DESIGN

QUALITY ASSURED COMPANY ISO 9001

International Standards Certification Ltd. No. 0420/163

ASSET DESIGN

SHEET 7 OF 63 SHEETS

REV A

Appendix B

Pre-Development Scenario – 50% AEP Event



50% AEP event – flood depths and levels surrounding the site – Pre-Development Scenario



50% AEP event – flood velocities surrounding the site – Pre-Development Scenario



50% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario

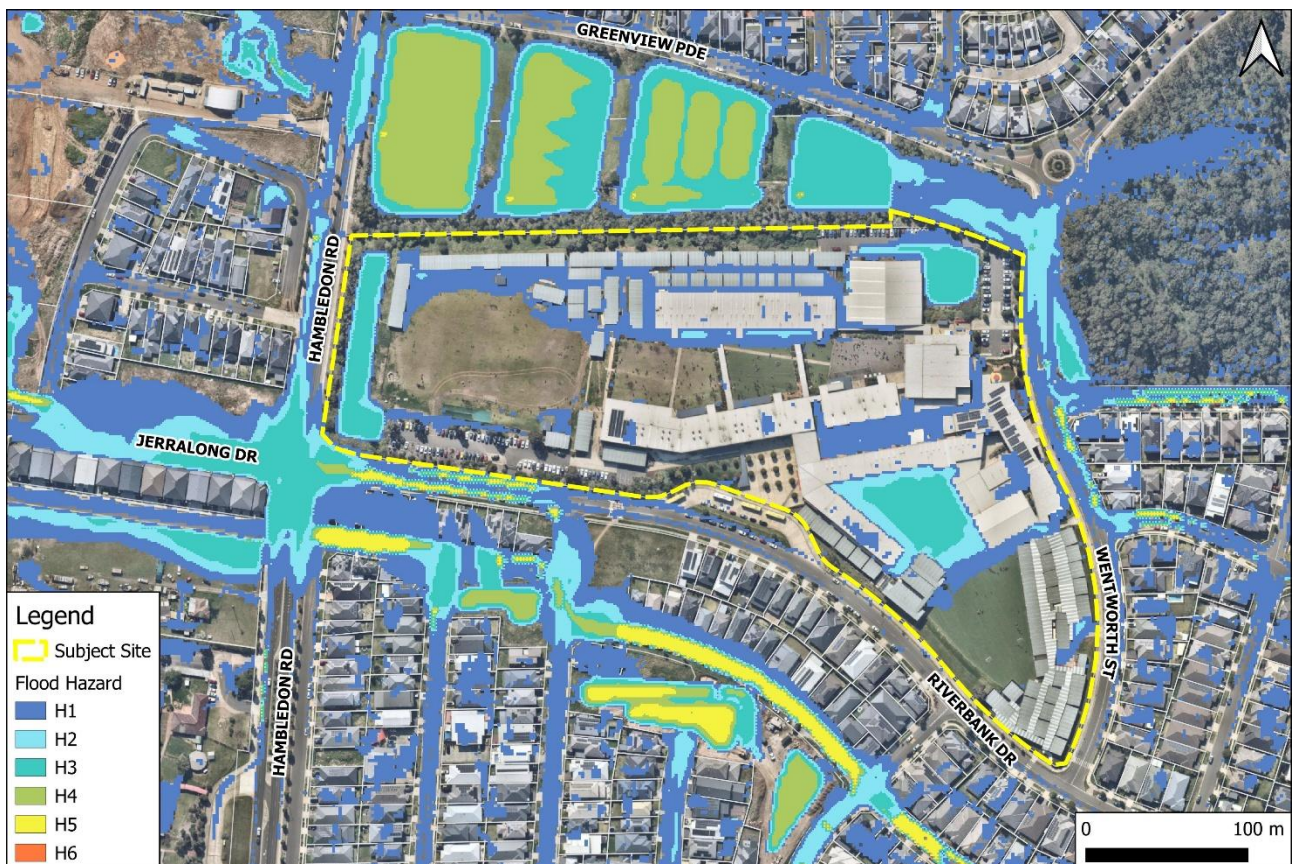
Pre-Development Scenario – 0.2% AEP Event



0.2% AEP event – flood depths and levels surrounding the site – Pre-Development Scenario

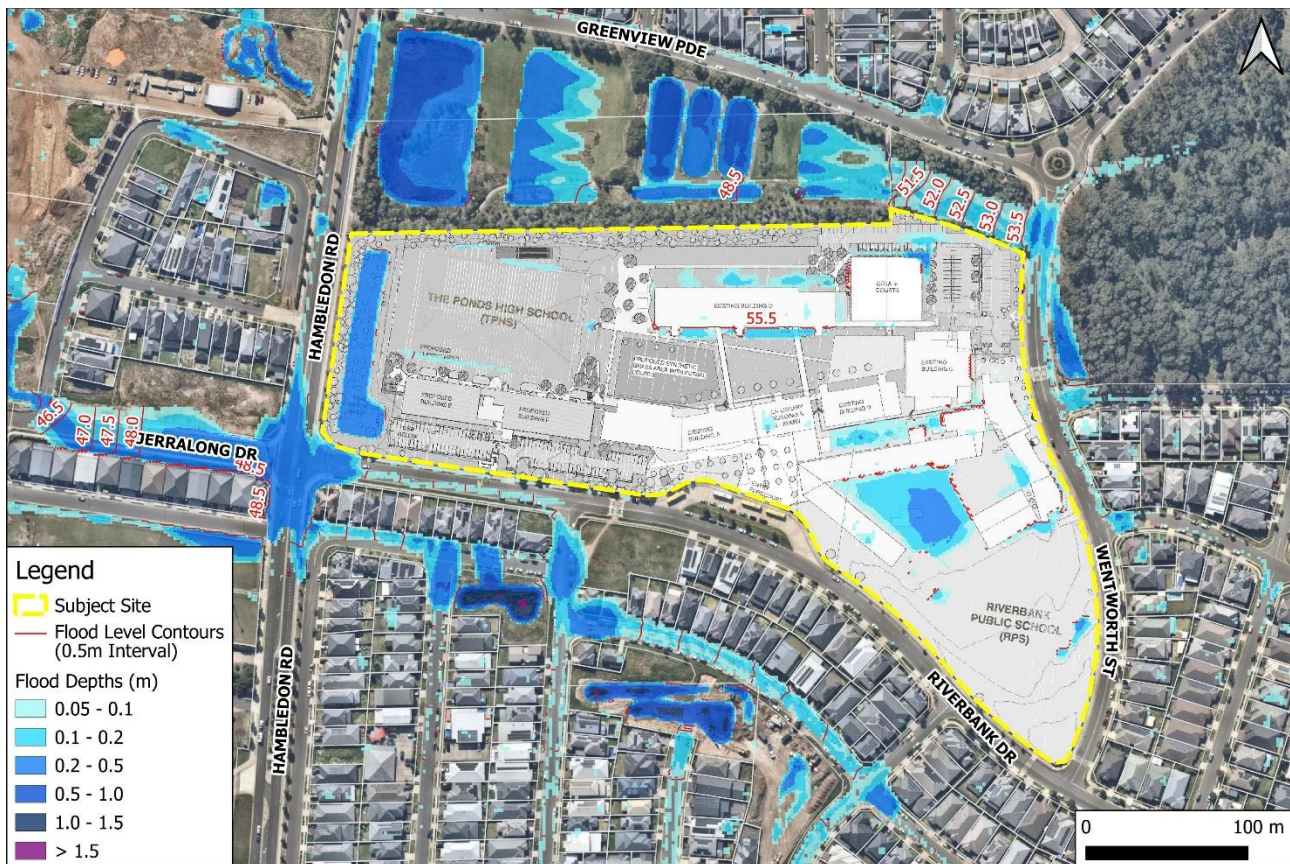


0.2% AEP event – flood velocities surrounding the site – Pre-Development Scenario

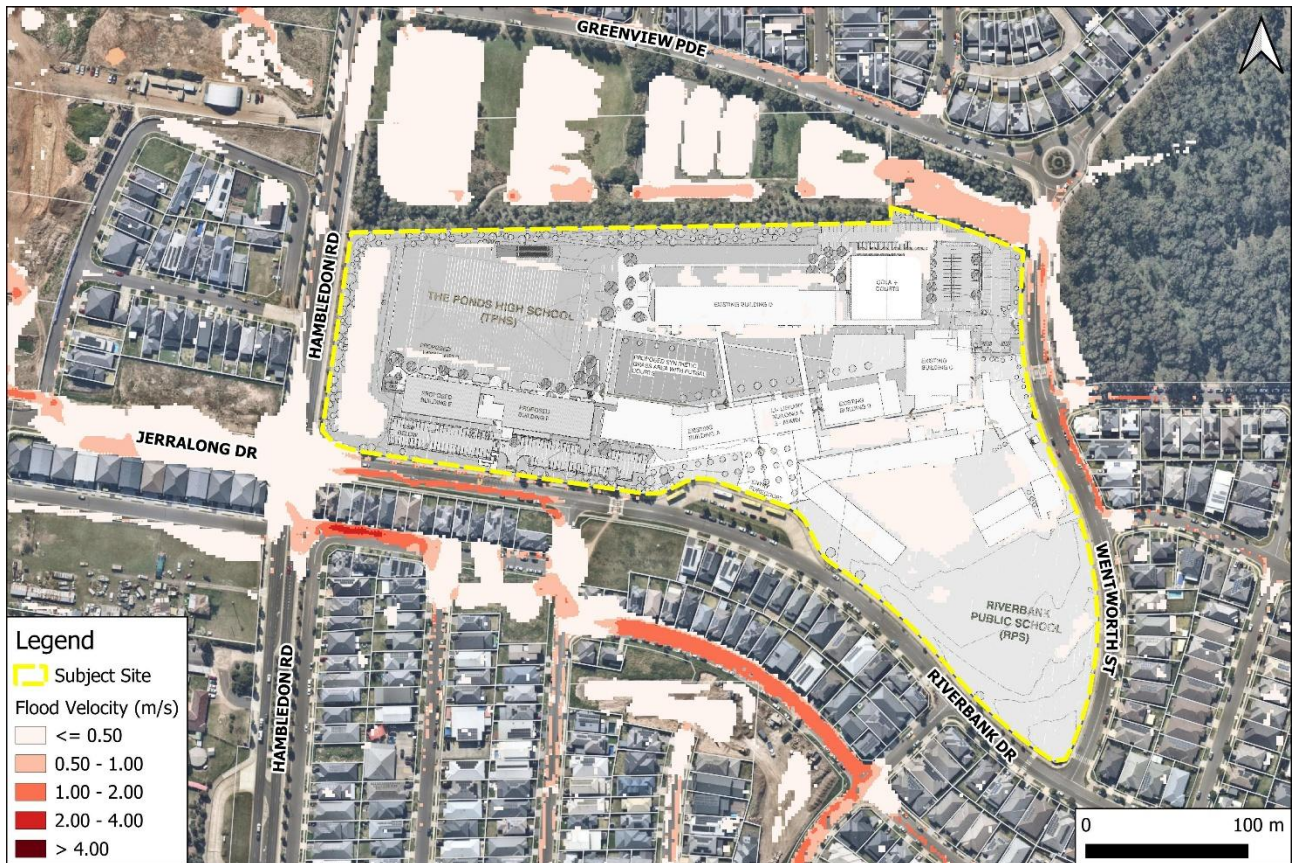


0.2% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario

Post-Development Scenario – 50% AEP Event



50% AEP event – flood depths and levels surrounding the site – Post-Development Scenario



50% AEP event – flood velocities surrounding the site – Post-Development Scenario

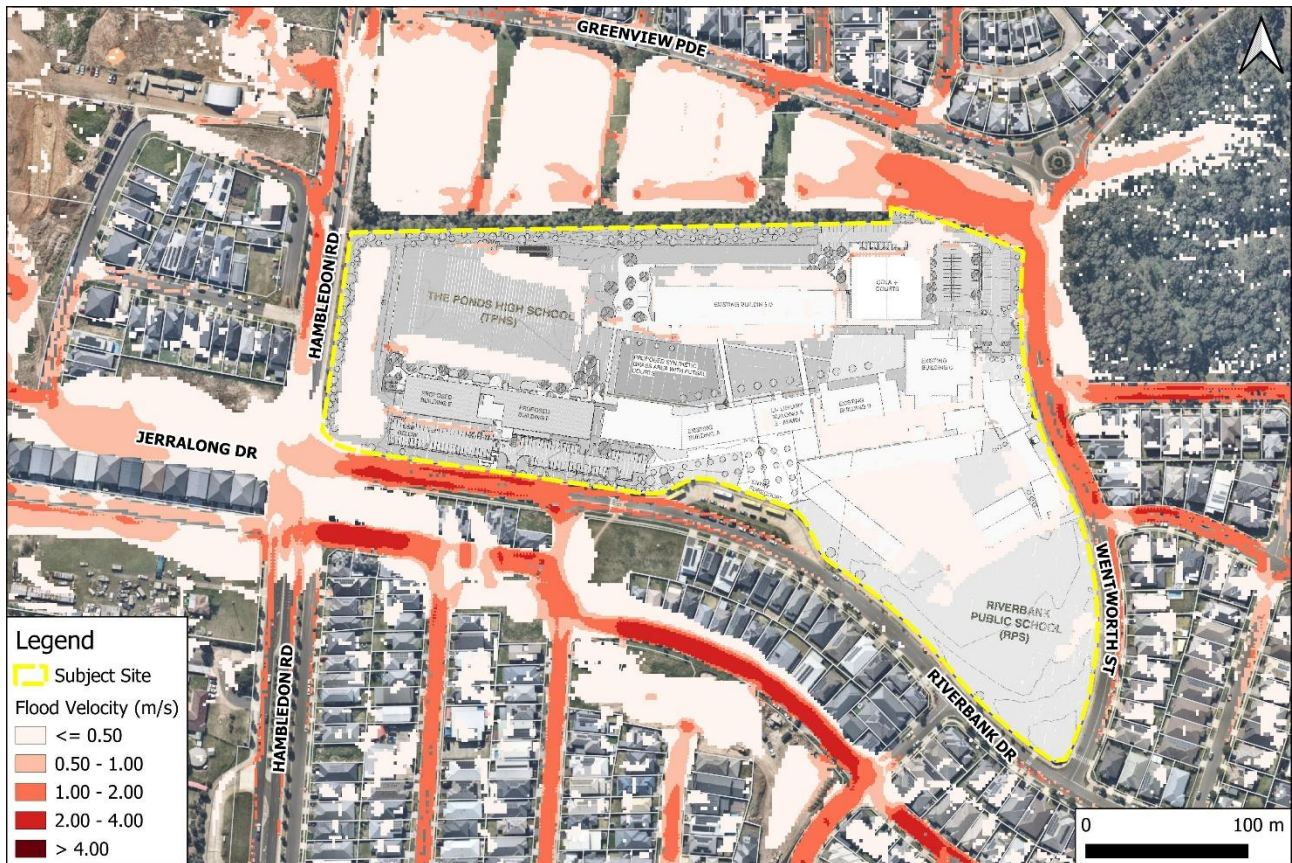


50% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario

Post-Development Scenario – 0.2% AEP Event



0.2% AEP event – flood depths and levels surrounding the site – Post-Development Scenario



0.2% AEP event – flood velocities surrounding the site – Post-Development Scenario



0.2% AEP event – flood hazard classification surrounding the site – Pre-Development Scenario