REPORT

Legacy Property Group

Caddens Hill

Stormwater and Flood Management Strategy

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1 EXECUTIVE SUMMARY

J. Wyndham Prince has been engaged by Legacy property Group Pty Ltd to prepare a stormwater and flood management strategy for the proposed Caddens Hill subdivision development.

The proposed development is located at 89-115 O'Connell Street in the suburb of Caddens which is within the Penrith City Council (PCC) Local Government Area. The development will redevelop a 7.8 ha site into a 121 lot subdivision, a residue lot, bio-retention raingarden, detention basin together with supporting road and drainage infrastructure.

The site is located within the Werrington Creek catchment and was considered in the Penrith City Council College, Orth and Werrington Creeks Catchment Overland Flow Flood Study (COWFS). The COWFS 2017 formed the basis for the flood assessment of the subject site.

A stormwater quality model has been prepared using Penrith City Council MUSIC Link information. The modelling confirms that a Gross Pollutant Trap (GPT), together with a 700 m² bio-retention raingarden will achieve the statutory pollution reduction targets applicable to the site. This device also confirms that the post development duration of stream forming flows is 1.4 times the pre-development duration of stream forming flows, which is less than the maximum allowable 3.5 by PCC.

A hydrologic model has been prepared to confirm that developed conditions peak discharges from the site are no greater than existing conditions peak stormwater discharges. The modelling confirms that an 2,495 m³ detention basin together with a discharge control pit will ensure that the statutory peak flow management targets are met.

The flood assessment defined the existing behaviour along the Werrington Creek surrounding the site. The flood impact map found in Appendix A shows that in 1% AEP event the proposed basin works on the north-west corner of the site will not have flood impacts external to the site. Further discussion on flood mitigation and impacts is provided in Section 6.4. The assessment confirms that the flood planning level for the site would range from 49 m AHD to 46.5 m AHD moving south to north along the western boundary.

The stormwater management arrangement together with the flood assessment demonstrates that the development of this site can be acheived and the assessment confirms that a functional stormwater management system that considers the environmental needs of the surrounding area will deliver a stormwater quality and quantity system that is fit for purpose.

2 INTRODUCTION

This report has been prepared to demonstrate that Penrith City Council's stormwater quality and quantity targets associated with the proposed Caddens Hill subdivision development are achieved. A flood assessment has also been undertaken to ensure that flooding from the adjacent Werrington Creek is understood and can be managed.

The site is located at 89 – 115 O'Connell Street, Caddens and is within the Penrith City Council Local Government Area (LGA). The 7.8 ha site is is zoned R1 under PCC's local environment plan 2010 and is suitable to support general residential development.

The elevation of the site ranges from approximately 66 m AHD in the north eastern corner of the site on O'Connell Street and 59 m AHD in the south eastern corner of the site and generally grades to the north west direction to a natural low point of approximately 46.0 m near the intersection of O'Connell Lane and O'Connell Street. Plate 2-1 below provides an overview of the site locality and the existing landform (prior to rezoning).

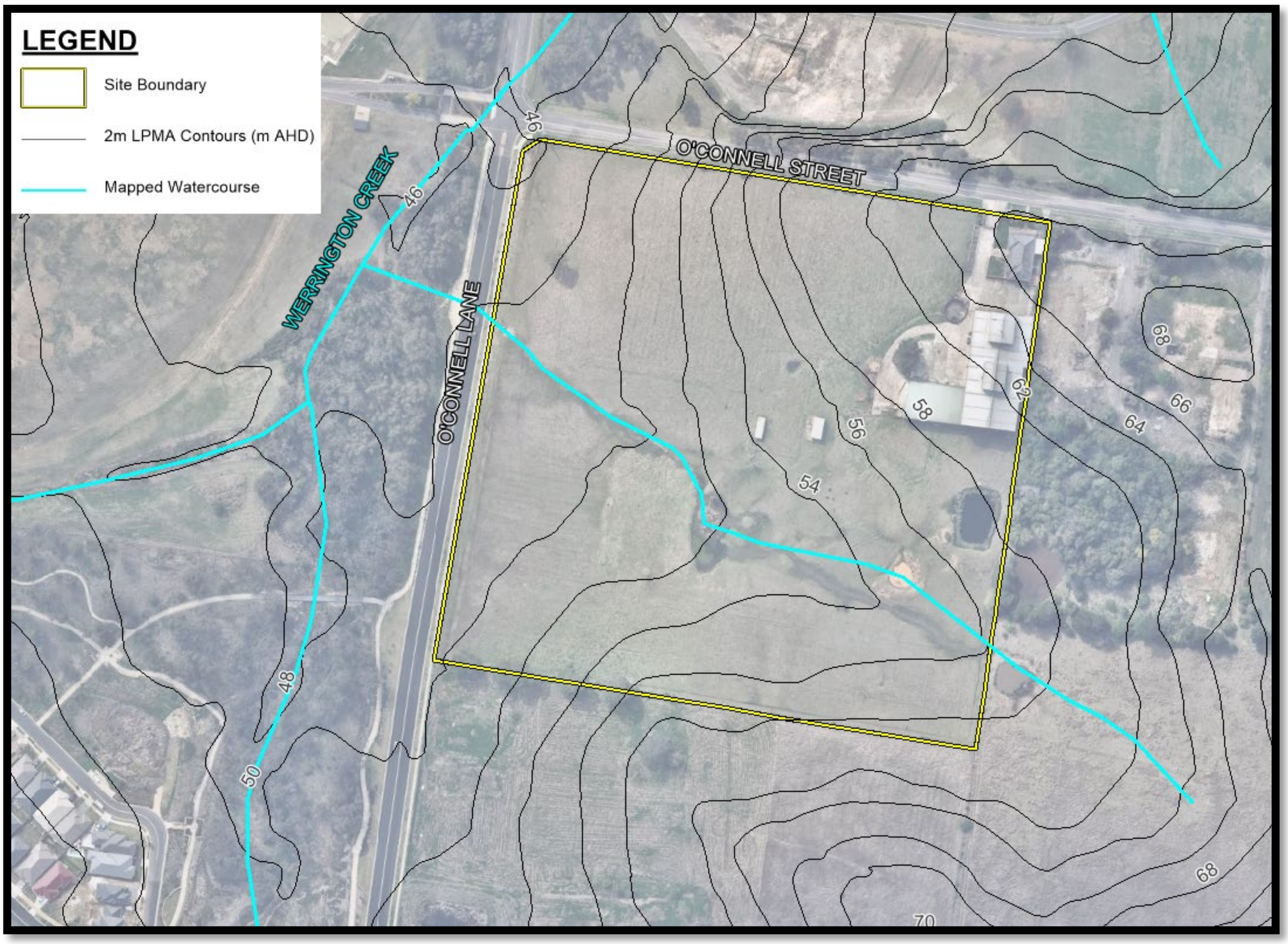

Plate 2-1 – Site Locality

2.1 Proposed Development

The proposed development includes a residential subdivision which will provide 121 residential lots, one (1) residue lot, together with supporting roads, utility services and drainage infrastructure. Plate 2-2 below provides an overview of the proposed development. A bio-retention raingarden and detention basin are proposed on Lot 797 in the north west corner of the site. Further details are provided in engineering drawings 110358-09-DA001 to DA402.

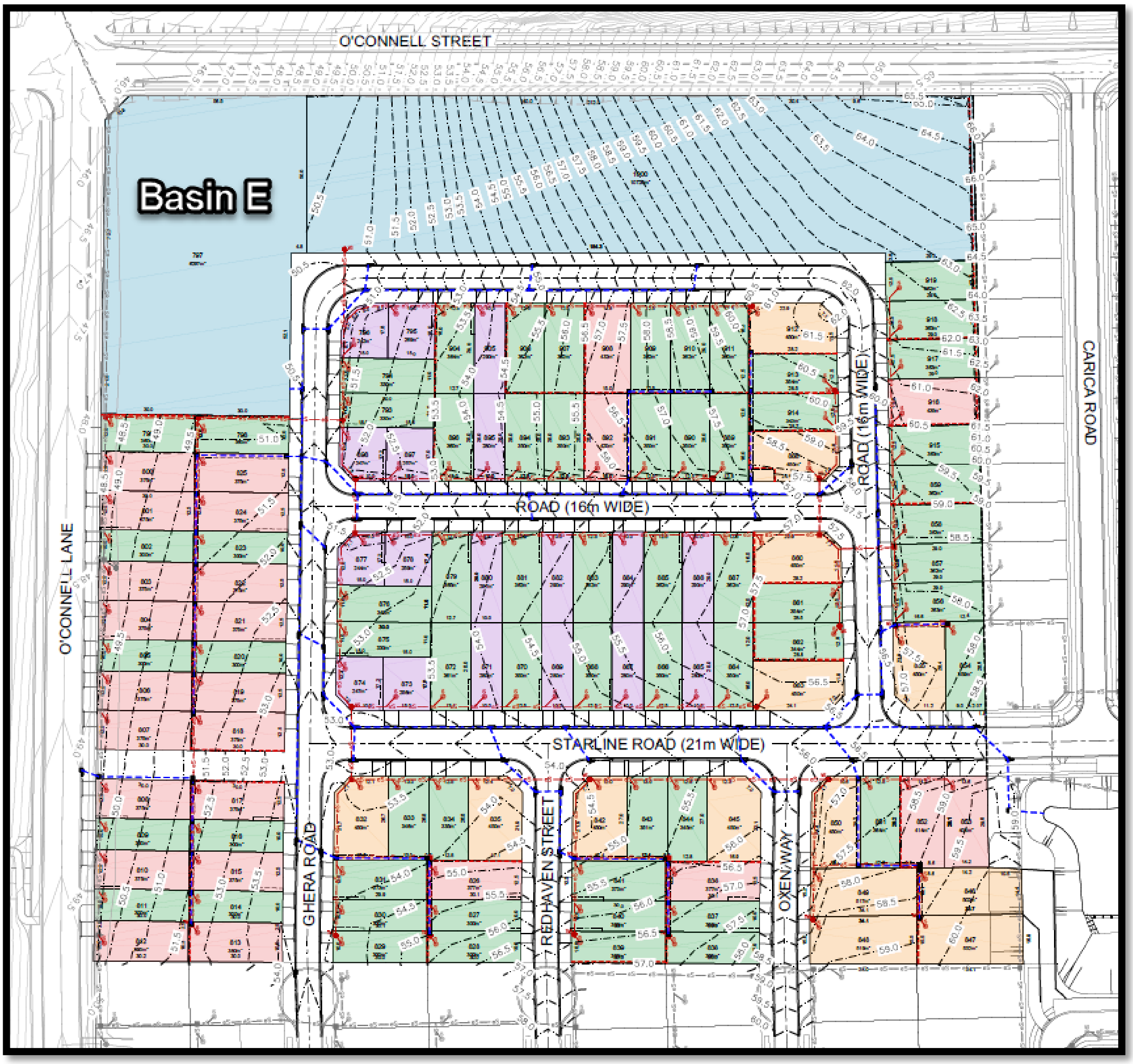

Plate 2-2 – Proposed Development

The assessment has included the following specific tasks:

- Review the existing stormwater management strategies relevant to the site;
- Prepare a stormwater quality model using Penrith City Council MUSIC-Link to determine the treatment train required to ensure that the statutory stormwater pollution reduction and Stream Erosion Index (SEI) targets are met.
- Undertake a hydrologic assessment to determine the stormwater detention requirements to ensure peak post development stormwater discharge from the site is no greater than existing conditons peak discchharges.
- Update the College Orth and Werrington Creek flood model to reflect the proposed develepent, assess flood impacts of the proposed land form modification

The assessment completed in support of the proposed Caddens Hill development is described in the following sections.

3 PREVIOUS RELEVANT STUDIES

A number of relevant studies have been undertaken that relate to stormwater management and flooding within the vicinity of the proposed works, either directly associated with the rezoning of the site or adjacent subdivisions. These studies are listed below.

3.1 WELL Precinct – Hydrology and Catchment Management Study

The Werrington Enterprise Living and Learning (WELL) Precinct covers approximately 670 hectares and includes the Caddens Release area. The WELL Precinct – Hydrology and Catchment Management Study (2006) was undertaken by Cardno/Willing on behalf of Penrith City Council.

The purpose of the study was to provide input for planning of the WELL Precinct, by identifying the basic water quality and quantity management principles and key management issues.

It is noted that the study was undertaken at a strategic level, and indicated that the results in the report are subject to review during future, more detailed planning investigations.

3.2 Caddens Release Area – Catchment Management, Hydrology and Water Quality Report

In 2007, Hughes Trueman were commissioned by Landcom to prepare a Catchment Management, Hydrology and Water Quality Report to assist with the rezoning and masterplanning infrastructure investigation for the Caddens release area at Penrith. The report built upon the WELL Precinct – Hydrology and Catchment Management Study (2006) by Cardno and subsequently the report (HT, 2007) developed water management strategies for the Caddens release area.

Regional detention basins were re-sized across the Caddens release area with volumes significantly reduced from those defined in the WELL Precinct study (Cardno, 2006).

Hughes Trueman provided discussion that a) the basin sizes are significantly smaller than the sizing put forth by Cardo (2006) b) the basin sizing by Cardno was not based upon hydrologic modelling; and c) the Upper Parramatta River Catchment Trust method adopted by Cardno may overestimate the required basin sizes.

3.3 Stormwater Management Strategy Report – Stage 1

In July 2016, J. Wyndham Prince prepared the “Stormwater Management Strategy – Stage 1 Report” to support of Stage 1 works (99 lot subdivision) fronting O’Connell Lane, located to the south of the proposed Caddens Hill subdivision.

The report presented a stormwater strategy surrounding “Basin A” (see Plate 3-1 for details) to ensure that peak post development flows do not exceed pre-development flows at key locations. The strategy encompassed “Basin A” (constructed by others) as follows:

- Detention Basin with total active storage of 3790 m3
- Total Raingarden filter bed area of 1250 m2.

Results demonstrated that the existing “Basin A” would receive flows both from Stage 1 and the adjacent development to the south which fronts Caddens Road to achieve Council’s stormwater requirements.

3.4 Stormwater Management Strategy Report Stages 2 to 4

In December 2016, J. Wyndham Prince prepared the *Stormwater Management Strategy – Stages 2 to 4 Report* for Legacy property Group to support the subdivision development of 257 residential lots to the south east of the proposed Caddens Hill subdivision.

The stormwater management strategy considered the future development of Stages 5 and 6 and documented an 860 m² bio-retention raingarden and 1,300 m³ detention basin to cater for the subdivision immediately upstream of the proposed Caddens Hill sub-division.

The discharge from these devices (Basin B) will cascade into the proposed Caddens Hill subdivision street drainage system and into the proposed Basin E bio-retention and detention basin in the north west corner of the subject Caddens Hill residential subdivision site near the intersection of O'Connell Lane and O'Connell Street. Plate 2 is an extract of the detention basin strategy documented in the Stages 2 to 4 stormwater management strategy report (JWP, Dec. 2016).

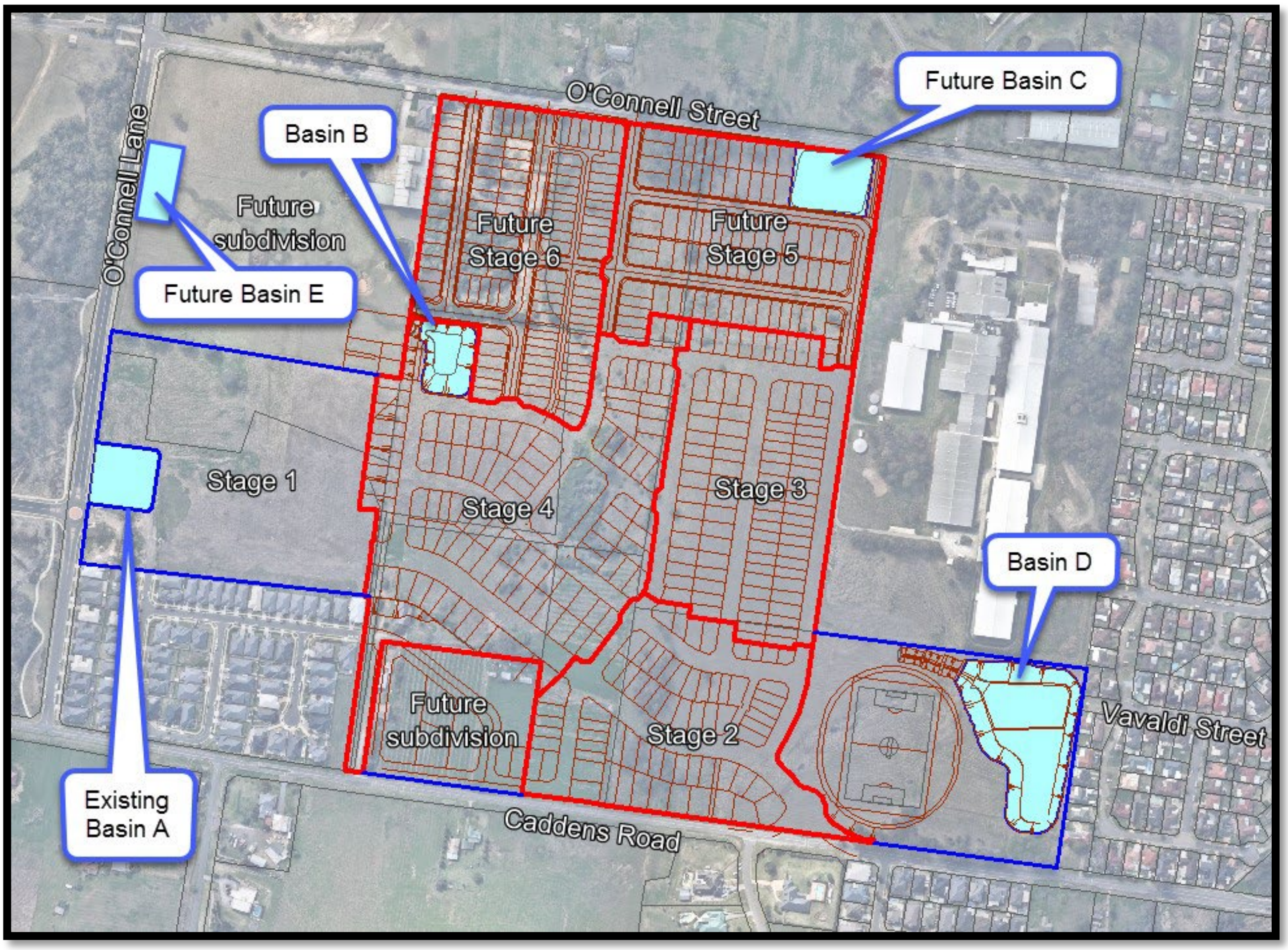

Plate 3-1 – Stages 2 to 4 Detention Basin Strategy

3.5 Stormwater Management Strategy Report Stages 5 to 6

J. Wyndham Prince prepared the *O'Connell Street Caddens Stormwater Management Strategy – Stages 5 to 6 Report* for Legacy Property Group in January 2017 to support the subdivision development of 182 residential lots immediately to the east of the proposed Caddens Hill subdivision.

The stormwater management strategy confirmed that the previously documented 860 m² bio-retention raingarden and 1,300 m³ detention basin would cater for part of the Stage 4 and Stage 6 subdivision.

As Basin B is located upstream of the proposed Caddens Hill subdivision, the discharge from Basin B has been considered in the street drainage network and sizing of detention Basin E which will receive these flows, ensuring that the statutory stormwater quality and quantity management targets are achieved at the natural discharge location on O'Connell Lane in the north west corner of the site. See Plate 2-2 for the current proposed location of Basin E.

3.6 College, Orth and Werrington Creeks catchment Overland Flow Study (Catchment Simulation Solutions, 2017)

In June 2017, Council engaged Catchment Simulation Solutions (CSS) to prepare the College, Orth and Werrington Creeks Catchment Overland Flow Flood Study (COWFS). This flood study formed the first of four (4) stages which are set out under the NSW State Government's Flood Prone Land Policy.

The assessment covered a study area of approximately 12 km^2 which included suburbs of Werrington, Werrington County, Cambridge Park, Kingswood, Caddens and parts of Orchard Hills. Most notably, the study area included the central portion of the proposed Orchard Hills North site - which forms the uppermost reach of Werrington Creek.

One of the main objectives of the study (CSS, 2017) was to serve as a guide for future development across the catchment in a way that is cognisant of the flood risk.

The Flood Study provided information on flood discharges (flows), levels, depths and velocities, for a range of flood events under existing topographic and development conditions. This information can then be used as a basis for identifying those areas where the greatest flood damage is likely to occur, thereby allowing a targeted assessment of where flood mitigation measures would be best implemented as part of the subsequent Floodplain Risk Management Study and Plan."

Plate 3-2 shows extracts of Council's flood maps which shows the extents of 1% Annual Exceedance Probability (AEP) flooding across Werrington Creek. It is noted that there are numerous farm dams which have been included in the Council's model with existing flood storage being considered.

Plate 3-2 – 1% AEP Flood Level in the Vicinity of Site

(Source: Figure 28.4 COWFS, 2017)

4 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 for the development including:

- It is able to model the potential nutrient reduction benefits of Gross Pollutant Traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems, ponds and it incorporates mechanisms to model stormwater reuse as a treatment technique.
- 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 that comply with Penrith City Council's WSUD targets.

Council's WSUD Policy EH003 (PCC, 2013) requires the following stormwater quality targets to be achieved:

- 90% reduction of Gross Pollutants > 5 mm
- 85% reduction of Total Suspended Solids (TSS)
- 60% reduction of Total Phosphorous (TP)
- 45% reduction of Total Nitrogen (TN)
- Stream Erosion Index – the post-development duration of stream forming flows is to be no greater than 3.5 times the duration of pre-development stream forming flows

4.1 Catchments

A MUSIC model was established to represent the total catchment draining to the north western corner of the site where a bio-retention device is proposed.

An overview of the MUSIC model arrangement is provided in Plate 4-1 below. A MUSIC Catchment plan is provided in Figure 4-1 in Appendix A, and details of the catchment breakdown are provided in Appendix B.

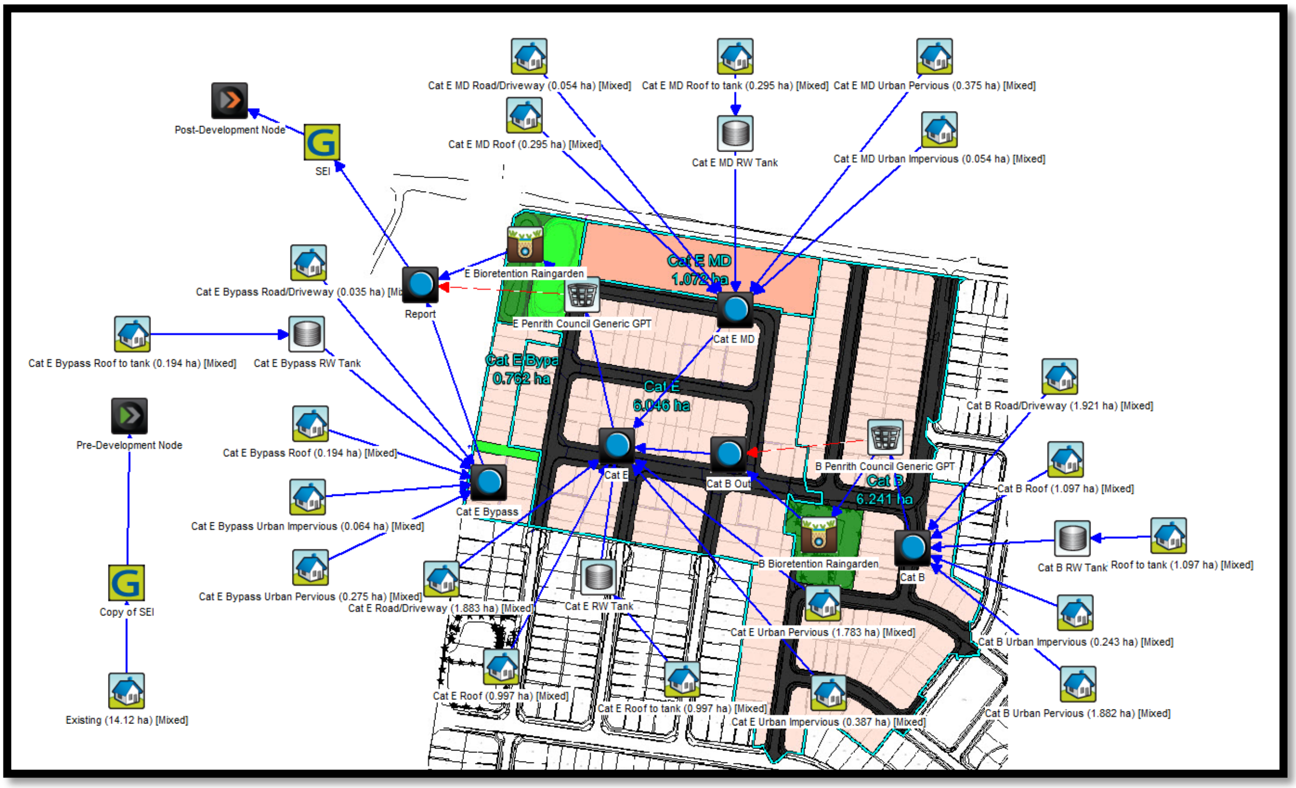

Plate 4-1- MUSIC Model Layout (Model Ref: 110358-09_MU03.sqz)

In accordance with Penrith City Council's Development Control Plan for the Caddens Release Area (PCC, DCP 2014, App. E1), the minimum soft landscape area that needs to be provided on the residential lots is 35%. Therefore, a fraction impervious of 65% has been adopted, which is broken down into roof, road, impervious and pervious areas as follows:

- Residential lots – 65% impervious
  - Roof – 55% (27.5% to rainwater tank, 27.5% bypass);
  - Road (driveways) – 5%;
  - Other impervious areas (courtyards, paths) – 5%;
  - Pervious Areas – 35%
- Park/Active Open Space – 50%
- Road Reserve – 95%
- Passive Open Space – 10%

4.2 Assumptions and Parameters

The following assumptions and parameters were adopted in the MUSIC modelling for the proposed Caddens Hill subdivision works, consistent with the requirements of Penrith City Council's WSUD Technical Guidelines (PCC, Oct. 2020):

- Except for a small amount of bypass area (0.762 ha) that is appropriately compensated for, it is assumed that trash and gross sediments will be removed prior to entering the raingarden via a Gross Pollutant Trap (GPT). A GPT with only 90% gross pollutant removal (i.e. no TSS, TP or TN removal) has been modelled, consistent with the approved Basin B modelling as part of the Stages 5 to 6 assessment (JWP, Jan 2017). However, it is noted that a vortex style GPT could be considered in the future to provide additional TSS and TP reduction and potentially reduce the size of the bio-retention device.
- Bio-retention raingardens consist of a sandy loam media filtration bed and an extended detention zone of 300 mm deep designed to detain and treat first flush flows from the upstream catchment. The media bed of the raingardens is proposed to be 500 mm deep.
- Orthophosphate content of filter media was modelled at 40 mg/kg while TN content of filter media was modelled at 800 mg/kg. Saturated hydraulic conductivity was modelled at 125 mm/hr to reflect the average hydraulic conductivity over the life of the raingarden.
- The 4 EY (3-month ARI) treatable flow and was determined to be 0.61 m³/s using the Urban Rational Method and adopted in the MUSIC model. Notwithstanding, the detention basin arrangement described in Section 5 delivers existing condition 0.5 EY (2 year ARI) flows to the bio-retention raingarden which is a similar order of magnitude as the developed condition 4 EY flow off the development. At future construction certificate stage, it is recommended that the treatable flow is calculated as part of the formal street drainage network design to confirm that the modelled treatable flow (or more) will be delivered to the device. Please refer to the MUSIC breakdown included in Appendix B for further details.

An overview of the raingarden modelling parameters is provided in Table 4-1.

Table 4-1: Summary of Raingarden Parameters

Parameter	Exist Basin B	Basin E
High Flow Bypass (m³/s)	100	100
Extended Detention Depth (m)	0.3	0.3
Average surface Area (m²)	860	770
Filter Area (m²)	860	700
Filter Depth (m)	0.50	0.50
Unlined Filter Mdia Perimeter (m)	0.01	0.01
Saturated Hydraulic Conductivity (mm/hr)	125	125
TN content of Filter Media (mm/kg)	800	800
Orthophosphate Content of Filter Media (mg/kg)	40.0	40.0
Exfiltration rate (mm/hr)	0.00	0.00
Overflow Weir Width (m)	7	12

4.3 Pollutant Load Estimates

Total annual pollutant load estimates were derived from the results of the MUSIC models based on a stochastic assessment of the developed site. It was found that a generic GPT together with a 700 m^2 bio-retention raingarden at Basin E is required to achieve the statutory pollution reduction targets. Table 4-2 provides details of the stormwater quality modelling results.

Table 4-2: Summary of Estimate Mean Annual Pollutant Loads and Reductions

Pollutant	Total Developed Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	10300	8755	1530	8770.0	85.0%	85.1%
TP	20.40	13.3	5.91	14.5	60.0%	71.0%
TN	140	63.0	57.5	82.5	45.0%	58.9%
Gross Pollutants	1620	1458	62.6	1557	90.0%	96.1%

A copy of the *MUSIC*-Link report is included in Appendix C.

4.4 Stream Erosion Index

A stream erosion index assessment was undertaken in accordance with Penrith City Council's WSUD Technical Guidelines (PCC, Oct. 2020) to ensure that the post development duration of stream forming flows are no greater than 3.5 times the pre-developed duration of stream forming flows as required by PCC's WSUD Policy (PCC, 2013). Results of the SEI assessment are provided in Table 4-3.

Table 4-3: 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
Site Discharge Location	0.1412	0.36	22	51	0.444	0.889	0.444	2.11	3.01	1.4

4.5 Discussion of MUSIC Modelling Results

MUSIC water quality modelling results indicate that the generic gross pollutant trap and a raingarden media bed area of 700 m^2 is sufficient to achieve the required pollutant reduction targets.

The Stream Erosion Index assessment indicates that the post development duration of stream forming flows are 1.4 times the pre-developed duration of stream forming flows, which is less than the upper limit of 3.5 and therefore meets the statutory requirements.

4.6 Life Cycle Costs

The indicative cost to construct / install and maintain the stormwater management have been adopted from the water quality MUSIC modelling completed as part of the Development Application process. The accuracy of these estimates are not guaranteed and all quantities are to be checked and confirmed by the contractor or Council.

The rates adopted for these estimates are based on the average unit rate provided in the MUSIC software. The actual contract awarded for the work will be based on the market conditions at the time of the contract and therefore all rates will be subject at that time to rise and fall.

Tables 4-4 and 4-5 indicate the probable cost for construction / installation of the GPTs and bio retention raingarden systems servicing the Caddens Hill subdivision development.

Table 4-4 – Indicative GPT Costing

GPT Costing	Basin E
Life Cycle (yrs)	30
Acquisition Cost	$46,526
Typical Annual Maintenance Cost ($)	$1,623
Annualized Renewal / Adaption Cost ($)	$459
Renewal/ Adaption Period (yrs)	1
Decommissioning Cost ($)	$10,482

Table 4-5 – Indicative Bio-retention Raingarden Costing

GPT Costing	Basin E
Life Cycle (yrs)	30
Acquisition Cost	$82,673
Typical Annual Maintenance Cost ($)	$10,084
Annualized Renewal / Adaption Cost ($)	$2,260
Renewal/ Adaption Period (yrs)	10
Decommissioning Cost ($)	$45,182

4.7 Maintenance Schedules

Draft maintenance schedules for the above mentioned devices are provided in Appendix D.

5 STORMWATER QUANTITY MANAGEMENT

An hydrologic analysis has been undertaken to ensure that peak developed conditions flows are no greater than peak existing conditions flows at the site discharge locations into O'Connell Lane and Werrington Creek.

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).

The existing conditions XP-RAFTS model that supported the Stages 5 to 6 Stormwater Management Strategy (JWP, Jan. 2017) has been adopted as a base and refined for the site using Australian Rainfall and Runoff (ARR) 1987 techniques.

5.1 XP-RAFTS Parameters

The adopted intensity-frequency-duration (IFD) data for assessment are provided in Table 5-1 below.

Table 5-1 – Adopted Rainfall Intensities

Rainfall Intensity (mm/hr)			
ARI	Duration		
	1 hr	12 hr	72 hr
50y	60.12	14.03	4.66
2y	24.8	7	2

G = 0.02, F2 = 4.3, F50 = 15.82

Similarly, the Mannings 'n' roughness values and initial & continuing losses parameters are also consistent with the Stages 5 to 6 assessment (JWP, Jan. 2017) assessment are provided in Tables 4-2 and 4-3 respectively.

Table 5-2 – XP-RAFTS Catchment Roughness

	Mannings 'n' Value	
	Pre-Development	Post-Development
Pervious Catchments	0.05	0.025
Impervious Catchments	0.015	0.015

Table 5-3 – XP-RAFTS Loss Parameters

	Initial/Continuing Losses	
	Initial Loss	Continuing Loss
Pervious Catchments	10.0 mm	2.5 mm/hr
Impervious Catchments	1.0 mm	0.0 mm/hr

5.2 Sub-catchments

The existing conditions catchments have been refined for this site and reflect Aerial Laser Survey (ALS) information together with specific site survey. The developed conditions catchments have been defined by adjacent (east) Stage 6 drainage catchments shown on approved engineering drawing 110358/CC610 (Rev. B) and the Caddens Hill Stormwater drainage catchments shown on engineering drawing 110358-300-DA300 (Rev. 1).

Catchment boundaries for existing and developed conditions are shown in Figures 5-1 and 5-2 respectively in Appendix A.

The Stage 6 development (Catchment B, 6.24 ha) discharges into Basin B to the east of the site. The outflow from this basin is then routed through the Caddens Hill development and discharges into Basin E. Due to the nature of the existing grading of O'Connell Lane, approximately 1.34 ha of catchment will drain directly to O'Connell Lane and bypass the detention basin, however the bypassing catchment has been compensated in the assessment to ensure that developed conditions flows are no greater than existing conditions flows at the existing discharge location on O'Connell Lane.

Eight (8) lots fronting Ghera Road (0.284 ha, identified as Cat E Int below in Plate 5-1) have an Inter-Allotment Drainage (IAD) line delivering flows to the street drainage system/basin. In events larger than the 0.2 EY event, it is assumed that flow in excess of the IAD capacity will bypass the basin and travel overland to O'Connell Lane.

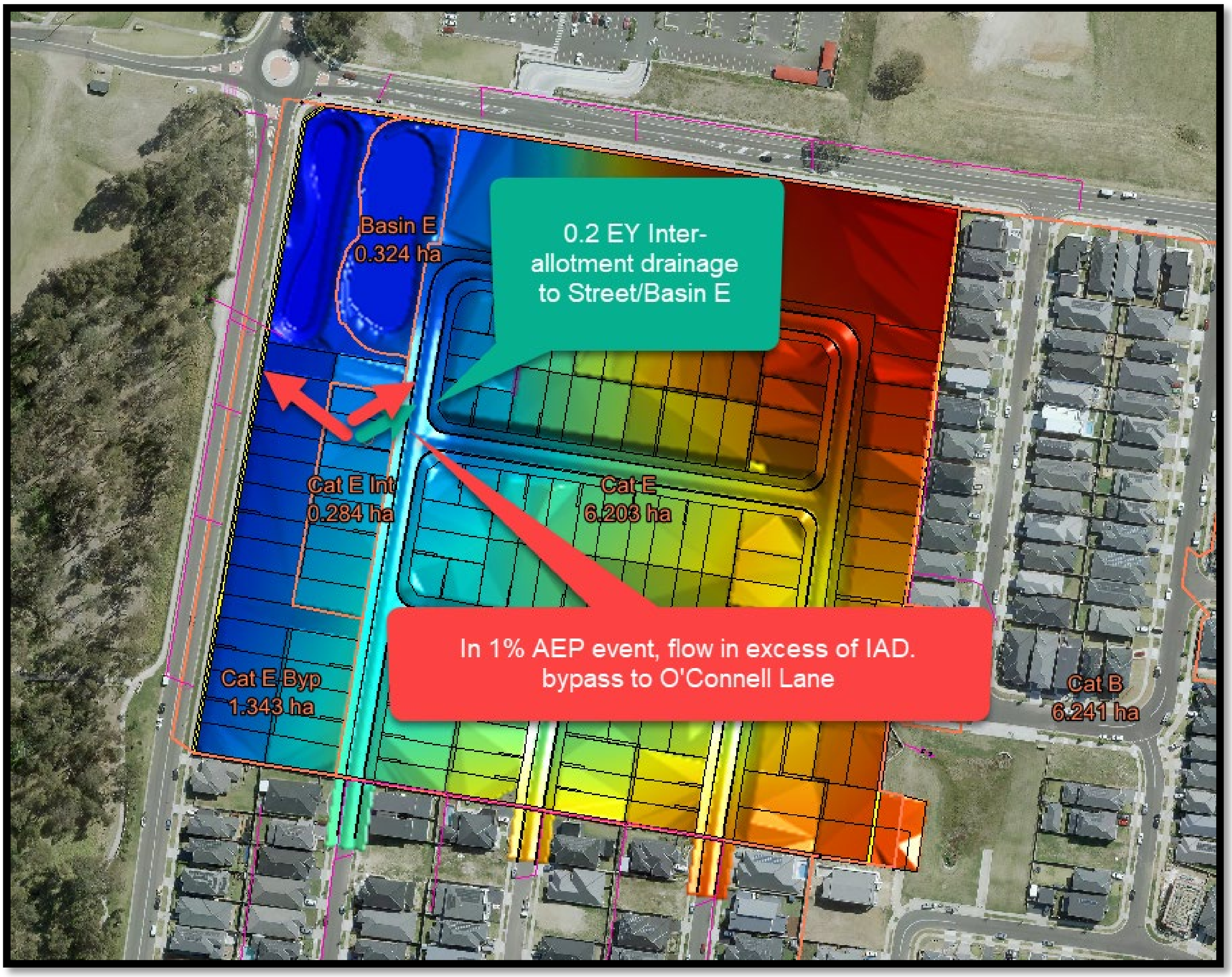

Plate 5-1- Catchment E Interallotment Bypass

5.3 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 to determine existing conditions flow targets at the site discharge to O'Connell Lane.

The XP-RAFTS model was then run for the developed conditions both with and without detention to gain an appreciation of developed conditions flows and to confirm whether stormwater detention was justified for this development (note existing detention Basin B was included in both developed conditions model scenarios. Therefore, only the need for Basin E was tested). Table 4-4 shows the estimated change in peak flows at the site discharge location without detention Basin E.

Table 5-4 – Existing and Developed Peak Flows without Detention Basin E

Comparison Node	Location	0.5 EY			0.2 EY			10% AEP			5% AEP			1% AEP		
		Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
Site Total	O'Connell Lane	0.974	2.212	2.27	1.45	2.845	1.97	1.72	3.229	1.88	2.19	3.888	1.78	3.17	5.138	1.62

The results in Table 4-4 indicate that detention basin E is required. Therefore, a detention basin has been designed to ensure that the developed conditions peak flows at the site discharge to O'Connell Lane are not greater than the existing conditions peak flows. Results of this assessment are presented in Table 4-5.

Table 5-5 – Existing and Developed Peak Flows with Detention

Comparison Node	Location	0.5 EY			0.2 EY			10% AEP			5% AEP			1% AEP		
		Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
Site Total	O'Connell Lane	0.974	0.968	0.99	1.45	1.170	0.81	1.72	1.512	0.88	2.19	2.160	0.99	3.17	3.031	0.96

It was determined that in addition to the existing detention Basin B, detention Basin E with a storage volume of 2495 m^3 is required to ensure that appropriate flow management is provided at the site discharge location. The storage assumes that the 0.3 m raingarden EDZ is already full at the beginning of the storm event, and the preliminary outlet arrangement considers the EDZ tailwater impacts on the detention basin performance. Table 4-6 provides details of the basin performance.

Table 5-6 –Basin E Performance

Event	Inflow (m^3/s)	Outflow (m^3/s)	Active Storage Used (m^3)	Basin Stage (m AHD)	Storage Depth (m)
0.5 EY	1.94	0.79	1112	48.05	0.55
0.2 EY	2.47	1.02	1618	48.27	0.77
5% AEP	3.37	1.99	1991	48.44	0.94
1% AEP	4.49	2.54	2495	48.66	1.16

The preliminary outlet arrangement considers management of 0.5 EY flows via an orifice control to the bio-retention raingarden, while less frequent storm events up to the 1% AEP are catered for in a separate discharge control pit and pipe system which connects to an existing 1800 mm x 600 mm culvert under O'Connell Lane. In the event that the basin outlet becomes blocked or in a rare/extreme storm event, an emergency weir will direct flows safely away from the residential development overland to O'Connell Lane.

Full details of the detention basin are provided on J. Wyndham Prince engineering drawings 110358-09-DA400 which are included in the DA submission material.

6 FLOOD ASSESSMENT

A fully dynamic one and two dimensional (1D/2D) hydraulic model prepared as a part of the College, Orth and Werrington Creek Catchment Flood Study (COWFS) 2017 and has formed the basis for the flood impact assessment to support this application. The flood simulations were completed using TUFLOW build 2016 with direct rainfall on the grid approach consistent with the COWFS study. The flood results presented for this study are trimmed where depth is less than 0.15 m and pockets of ponding area (puddles) less than 100m^2 as stated in COWFS.

The TUFLOW modelling is used to assess the mitigation option for the subject site to prevent mainstream flood inundation from the Werrington Creek in 1% AEP event entering the site and to ensure that there are no impacts of the mitigation option to the neighbouring environment in 1% AEP event. All model parameters have stayed consistent with those in Council's provided model unless otherwise specified.

Our approach to the flood impact assessment is as follows:

- Re-run the COWFS 1% AEP 120 min duration flood model using TUFLOW build 2016 to confirm that flood results from COWFS are replicated. The COWFS 2017 report suggests that the 120 minutes duration is critical in the site surrounding;
- The COWFS model has been trimmed to focus on the Werrington Creek, adopting HQ slope boundaries where necessary to reflect the hydraulic grade of the broader model flood results;
- The trimmed COWFS model was run in TUFLOW build 2016 for the 1% AEP event to confirm consistent results with the larger COWFS, 2017 model as supplied by Council;
- The trimmed COWFS model was then run for the 1% AEP event in the latest release of TUFLOW build 2020-10-AB using the HPC option as the TUFLOW build used in COWFS 2017 is now considered outdated and a number of significant enhancements in the modelling approach now form part of the latest 2020 version. It is our view that this approach provides an improved understanding of the local flood impact and a better representation than the 2016 version of TUFLOW. This model is considered the base case model for the flood assessment; and
- The base case model was then augmented to reflect the existing conditions model for the site (89 – 115 O'Connell Street, Caddens).

The TUFLOW modelling is described in further detail below:

6.1 Available Data

The following data was used to inform the modelling:

- Hydraulic model inputs from the College, Orth and Werrington Creeks Catchment Overland Flow Flood Study (COWFS) 2017 flood model from Penrith City Council;
- O'Connell Street and O'Connell Lane design surface from Cadden's development (JWP, 2018);
- Site Survey undertaken by Vince Morgan Surveyors dated 10 August 2021;

6.2 Existing Condition Model

The COWFS 2017 TUFLOW model assessed the Werrington Creek catchment which includes the subject site. The COWFS TUFLOW model is updated to represent the site-specific existing condition. There has been no change in the COWFS model parameters unless otherwise stated.

To establish a site-specific existing condition model for the site, the following amendments were made:

- Use of the latest released TUFLOW HPC model version TUFLOW_2020-10-AB for the assessment;
- The surface of the O'Connell Street to the north of the site and O'Connell Lane to the west of the site from Cadden's development (JWP, 2018) has been incorporated which were originally not covered by COWFS;
- The terrain based on the site survey undertaken by Vince Morgan Surveyors in 2021 was incorporated:
- The two (2) O'Connell Lane crossing structures were supplemented in the TUFLOW model based on a site survey. One (1) is box culverts of size 1800mm x 800 mm and the other is 675 mm dia. pipe crossing

O'Connell Lane discharging to Werrington Creek. These structures are modelled with 50% blockage in accordance with COWFS ;

- TUFLOW model boundary was trimmed nearly one (1) km downstream of the subject site near Great Western Highway;
- The downstream boundary at the Werrington Creek is based on the automatically generated stage discharge curve based on the slope of 1% derived from the existing terrain.

In Appendix A, Figure 6-1 provides an insight into the existing condition TUFLOW model information. The existing terrain of the site and its surroundings are shown in Figure 6-2.

6.2.1 Model Validation

Four (4) model validation runs were completed to enable comparison to the COWFS, 2017 TUFLOW model.

Validation 1 – Replicate COWFS Model Results

The 1% AEP 120-minute duration storm was run and compared with the gridded results provided by Council. Plate 6-1 below provides a flood level difference map which confirms that there are no measurable flood level differences and therefore, the COWFS results have been successfully replicated.

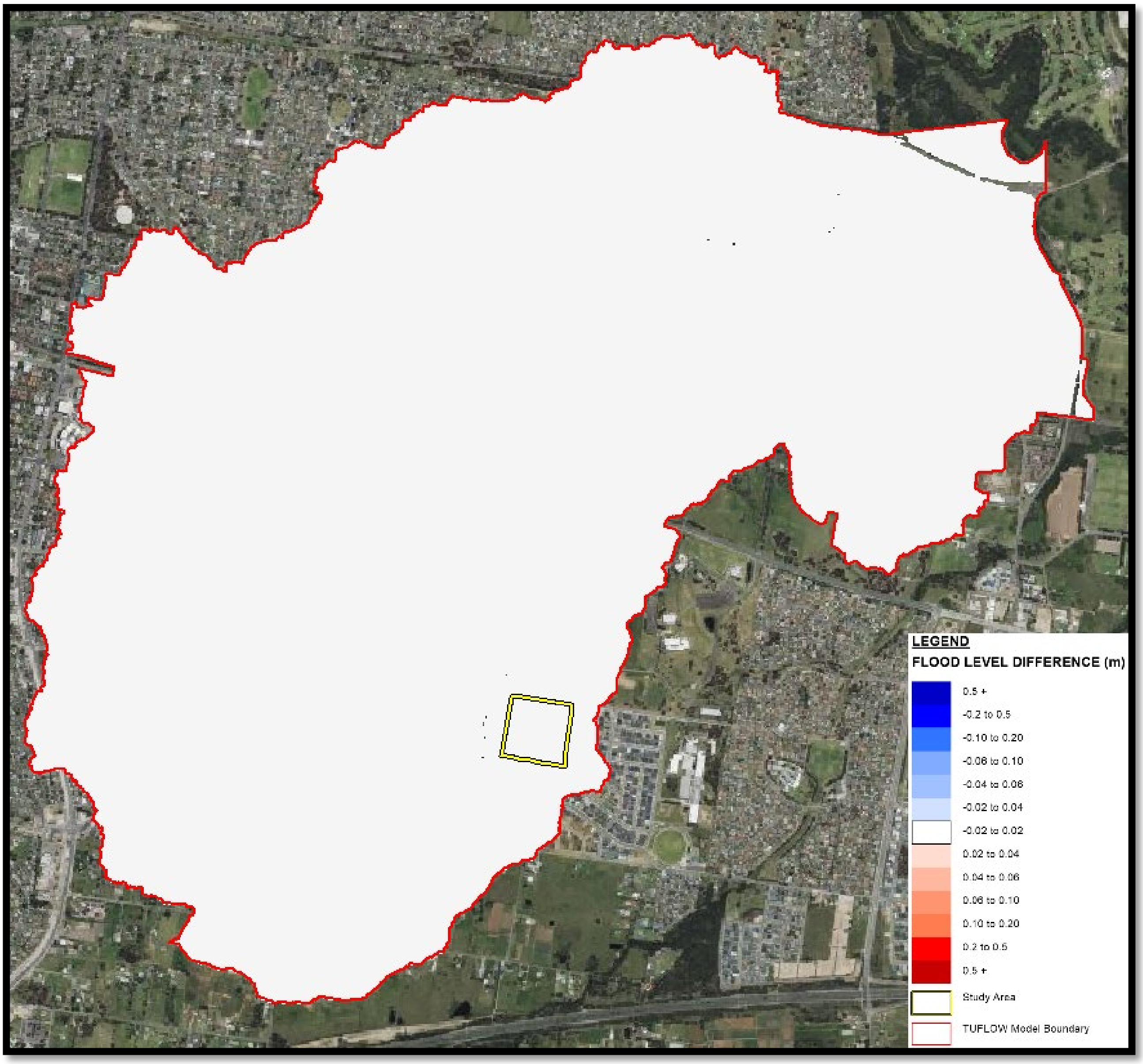

Plate 6-1 – Replicate 1% AEP 120 Minute Duration COWFS Model Results

Validation 2 – Compare trimmed model with COWFS results

The peak 1% AEP existing conditions trimmed model results have also been compared with the peak 1% AEP results from COWFS model. The flood difference map shown in Plate 6-2 confirms that, with the exception of the boundary locations themselves, there are no observable flood level differences within and in the vicinity of the site. Given that the location of the flood level difference at the new boundary locations are more than one (1) km from the subject site, the adopted boundary conditions will not influence flood levels surrounding the subject site of interest.

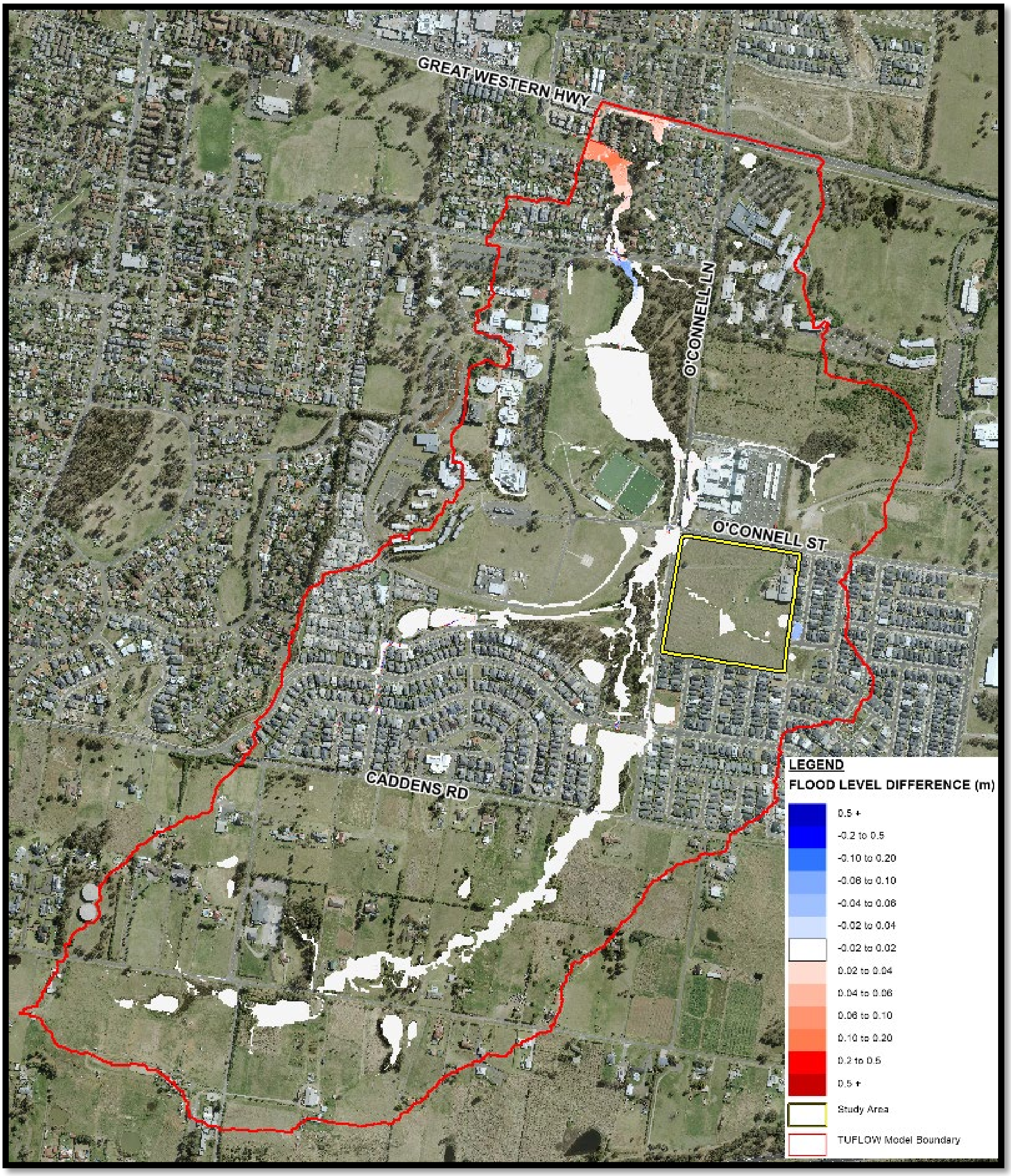

Plate 6-2 – Compare 1% AEP Trimmed Model Results with COWFS Model Results

Validation 3 – Compare trimmed latest TUFLOW build model with COWFS results

The peak 1% AEP existing conditions trimmed model results assessed in TUFLOW build 2020 have also been compared with the peak 1% AEP results from COWFS model (Validation 2) to understand the difference as a result of different TUFLOW build. The flood difference map shown in Plate 6-3 shows the flood level increase downstream of the Caddens Road and decrease in flood level along the Werrington Creek.

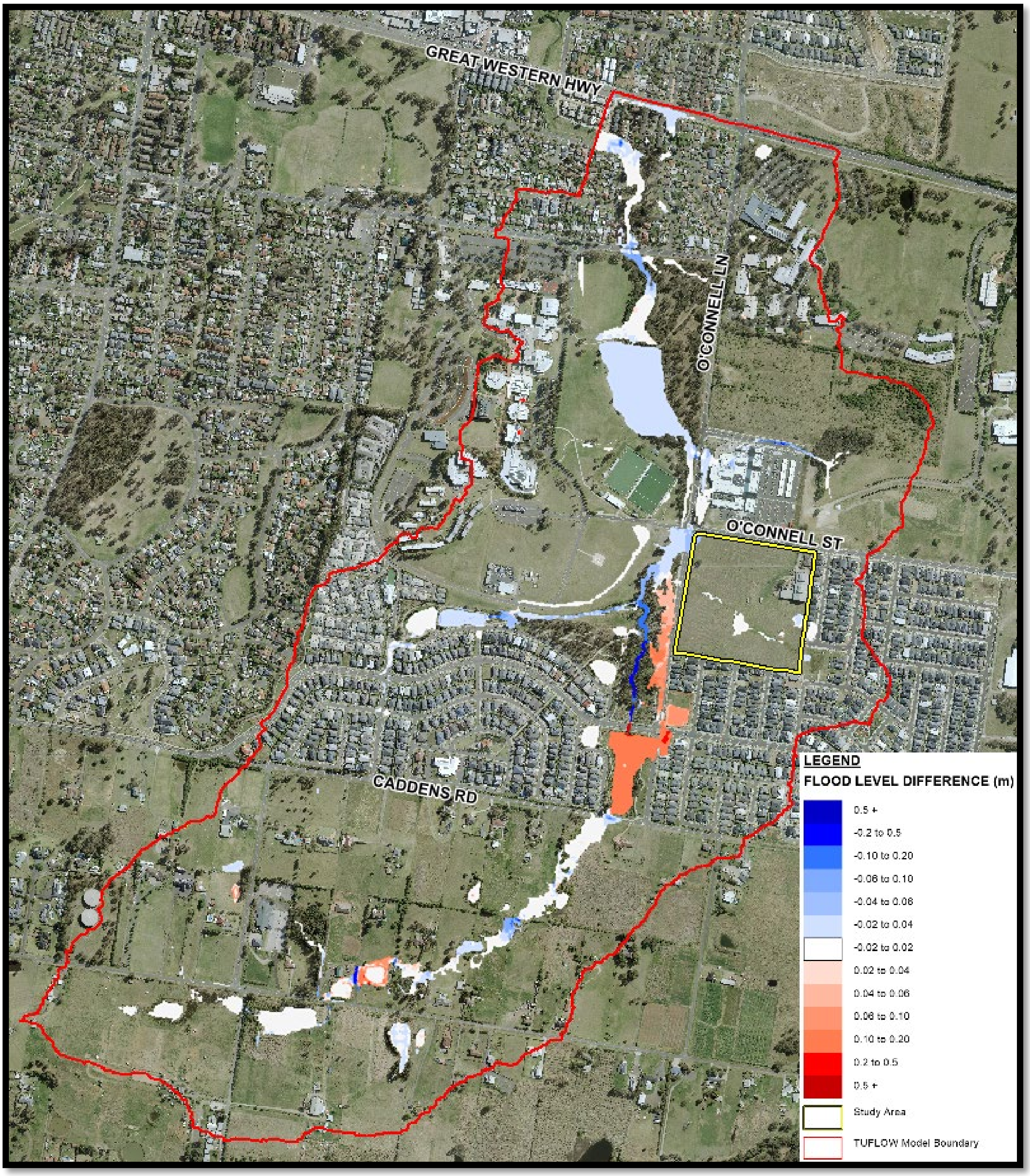

Plate 6-3 – Compare 1% AEP Trimmed Latest TUFLOW Build Model Results with COWFS Model Results

For models that utilise depth-varying Manning's n values approach, it is possible for the model to experience rapid transitions in bed friction values from one timestep to the next and COWFS has depth-varying Manning's n values approach. The latest build limits the relative rate of change of Manning's n value to no more than 10% per time step. Also, it defaults to a new eddy viscosity (turbulence) model that combines both 2D and 3D turbulence effects.

Turbulence is pronounced in areas of highly transient flow (high velocities, bends, ledges, flow contraction/expansion) where there are strong spatial velocity gradients. As a result of this update, there is an increase in flood levels of up to 0.2 m is seen at the basin downstream of the Caddens Road. Also, the new viscosity formulation provides better representation particularly in narrow channels, which can be noticed in Werrington Creek downstream of the Caddens Road basin, where flood levels are decreased up to 0.3 m.

Given the enhancement in the modelling techniques, new default settings and bug fixes in TUFLOW build 2020-10-AB compared to COWFS TUFLOW build 2016, differences between COWFS model are anticipated.

Validation 4 – Compare Existing Conditions model with Latest TUFLOW build COWFS results

As discussed in Section 6.2, there has been an update to the TUFLOW build, the surveyed terrain of the site, specifically O'Connell Lane and O'Connell Street design surface plus the inclusion of the two (2) culverts at O'Connell Lane. As such, differences between the existing condition model are anticipated when compared with to COWFS model.

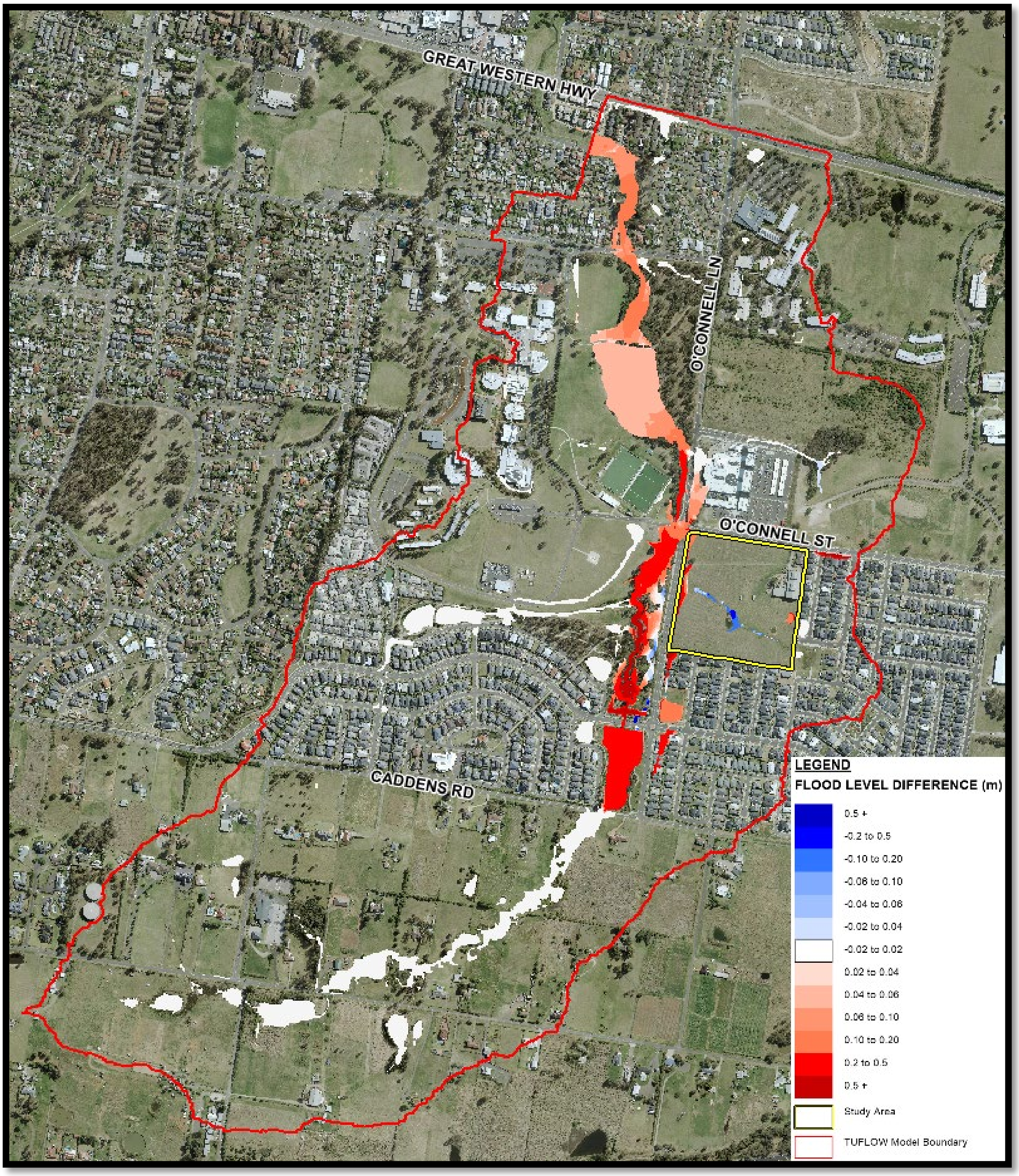

Plate 6-4 – Compare 1% AEP Existing Condition Model with Latest TUFLOW build COWFS results

The comparison of the existing condition model is made with the COWFS model assessed in TUFLOW build 2020 (Validation 3) to ensure a like for like comparison is completed to understand the difference in flood levels after the updates are made to the COWFS model (Validation 3) when creating the existing condition model for this study.

The flood difference map in Plate 6-4 reflects the peak 1% AEP existing conditions results for the site compared with the latest TUFLOW build COWFS results. The updates to O'Connell Lane terrain has eliminated the mainstream flooding of O'Connell Lane up to O'Connell Street in the 1% AEP event.
However, this update has narrowed the Werrington Creek floodplain which has resulted in an increase in flood depth of up to 0.5 m in the Creek. These changes have occurred as a result of other independent approvals and are not associated with any development of this site. The overland flow through the site conveyed in a westerly direction in 1% AEP has also altered as a result of the O'Connell Lane construction this landform change has a limited overland flow to be conveyed to the Werrington creeks via culverts only, which was an overland flow to the Werrington Creek in COWFS model. The decrease in flood level along the overland flow path is due to the change in terrain level as a result of survey data in the existing condition model.

6.3 Discussion of the Existing Condition Flood Behaviour

The flood modelling for this study involved direct rainfall on the 2d domain to each grid cell. Once the rain falling on each grid cell exceeds the rainfall losses, each cell will be "wet". However, water depths across the majority of the catchment will likely be very shallow and would not represent real flooding. Therefore, it is necessary for the results to be "filtered" to distinguish between areas of significant flood depth and flood hazard and those areas subject to negligible shallow depth flooding. As such, flood results presented for this study are trimmed where depth is less than 0.15 m and pockets of ponding area (puddles) less than 100m^2 removed. This approach is consistent with the COWFS.

The existing condition for the subject site (as discussed in Section 6.2, Validation 4) flood level result for 1% AEP event is shown in Figure 6-3 in Appendix A. The results show that the overland flow is conveyed through the site in a westerly direction towards Werrington Creek.

In the 1% AEP event the mainstream flow from Werrington Creek overtops O'Connell Lane near O'Connell Street and inundates the north-west corner of the site, however, O'Connell Lane is not flooded.

6.4 Mitigation of Mainstream Flooding to the Site

The pre-lodgement advice from Penrith City Council dated 2 September 2021 for the site requires the flood modelling to be undertaken in support of this application with the assessment is to determine the impact of the drainage basin works on the existing flooding regimes.

As such the embankment of the proposed basin design has been incorporated along the north-western boundary of the site in order to assess the proposed filling into the existing condition (Validation 4) model.

The flood mitigation option (i.e. existing condition modelling with landform modification only (Validation 4 model) flood level result for 1% AEP event is shown in Figure 6-4 in Appendix A. The result shows that mainstream flows from Werrington Creek overtops the O'Connell Lane near O'Connell Street intersection but do not extend/affect to the site, instead, it is conveyed in a northerly direction.

6.4.1 Impact of Mitigation Option

The flood impact result of the mitigation option for the 1% AEP event is shown in Figure 6-5 in Appendix A as the flood level differences between the mitigation option and the existing condition and is also provided in Plate 6-5.

The result shows that there is no measurable flood impact external to the site. The flood depth within the north-west corner of the site is found to be increased by 0.65 m. This is due to the change in the landform along the north-western boundary of the site.

Plate 6-5 – Compare 1% AEP Flood Mitigation Option with Existing Condition Results

The result confirms that the future basin construction will not result in external flood impacts. In addition, how the change in runoff characteristics of the proposed development site will be managed has been assessed and detailed in Sections 4 & 5.

6.5 Flood Planning Level

The 1% AEP peak flood level along the Werrington Creek ranges from 48.5 m AHD to 46 m AHD towards the western boundary from south to north of the site. Council's development control plan (DCP) requires the residential development to have a habitable floor level to be no lower than 1% AEP flood level plus 0.5 m freeboard. The flood planning level for the site would therefore range from 49 m AHD to 46.5 m AHD moving south to north along the western boundary.

Therefore, by applying Council's standard Flood planning level (FPL) control, the site would provide a flood safe habitat for its future residents from Werrington Creek.

7 GLOSSARY

Term	Definition
Airborne Laser Survey (ALS)	Is a technique for obtaining a definition of the surface elevation (ground, buildings, power lines, trees, etc.) by pulsing a laser beam at the ground from an airborne vehicle (generally a plane) and measuring the time taken for the laser beam to return to a scanning device fixed to the plane. The time taken is a measure of the distance which, when ground-truthed, is generally accurate to ± 150mm.
Annual Exceedance Probability (AEP)	The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually. Normally expressed as a percentage.
Australian Rainfall and Runoff (AR&R)	Refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.
Digital Terrain Model (DTM)	Is a spatially referenced three-dimensional (3D) representation of the ground surface represented as discrete point elevations where each cell in the grid represents an elevation above an established datum.
Exceedances per Year (EY)	The number of times a year that statistically a storm flow is exceeded.
Floodplain Planning Level (FPL)	The FPL is a height used to set floor levels for property development in flood-prone areas. It is generally defined as the 1% AEP flood level plus 0.5m freeboard.
Floodplain Development Manual (FDM) and Guidelines (April 2005)	The FDM is a document issued by the Department of Environment Climate Change and Water (DECCW) that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW Department of Planning (DoP) to clarify issues regarding the setting of FPL's. This document is also the framework for the development of Floodplain Risk Management Studies and Plans.
Floodplain Storage Areas	Parts of a floodplain that are important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Floodway	The areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Hyetograph	The distribution of rainfall over time.
Hydrograph	Is a graph that shows how the stormwater discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
J. Wyndham Prince Pty Ltd (JWP)	Consulting Civil Infrastructure Engineers and Project Managers undertaking these investigations

Term	Definition
MUSIC	A modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by the Cooperative Research Centre (CRC),
Peak Discharge	Is the maximum stormwater runoff that occurs during a flood event
Probable Maximum Flood (PMF)	The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
Triangular Irregular Network (TIN)	A technique used in the created DTM by developing a mass of interconnected triangles. For each triangle, the ground level is defined at each of the three vertices, thereby defining a plane surface over the area of the triangle
TUFLOW	A computer program that provides two-dimensional (2D) and one dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.
XP-RAFTS	Is a runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a sub catchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.

8 REFERENCES

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APPENDIX A

FIGURES

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

LEGEND

MUSIC Catchment

- Site Boundary
- MUSIC Catchments
- Bypassing Catchment
- General Residential Lots
- Medium Density Lots
- Road Reserve
- Active Open Space
- Passive Open Space
- Gross Pollutant Trap

N

0 80
metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 4-1

Caddens Hill Subdivision

MUSIC
Catchment Plan

Date: 19/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig4-1_DEV_All_MUS_A.wor

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& PROJECT MANAGERS

LEGEND

- Site Boundary
- XP-RAFTS Catchments
- 2m LPMA Contours

N

0 80
metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-1

Caddens Hill Subdivision

Existing Conditions Catchment Plan

Date: 19/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig5-1_EX_All_CAT_A.wor

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

LEGEND

- Site Boundary
- XP-RAFTS Catchments
- 2m Design Contours (m AHD)
- 0.5m Contour Intervals

N

0 80
metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-2

Caddens Hill Subdivision

Developed Conditions Catchment Plan

Date: 19/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig5-2_DEV_All_CAT_A.wor

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& PROJECT MANAGERS

LEGEND

TUFLOW MODEL ELEMENTS

- Site Boundary
- TUFLOW Model Boundary
- Direct Rainfall Boundary
- IWL Initial Water Level Area
- 1d-2d Channel Boundary
- HQ Slope Boundary
- Fence
- 1d NWK Culvert
- 1d NWK Channel
- 2d lfcsh Bridge
- 1d NWK Pit

N

0 360
metres
Scale 1:9,000 @ A3

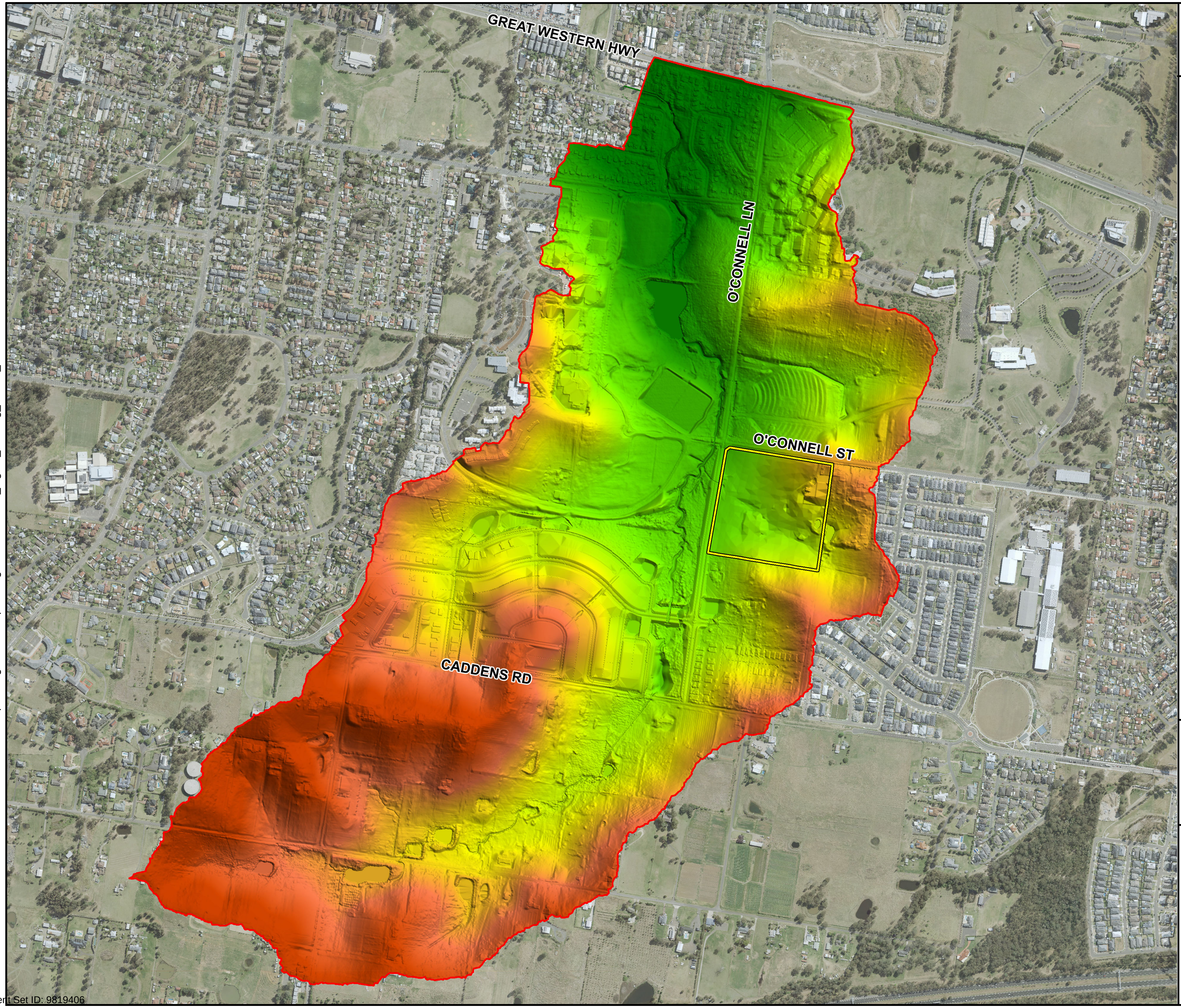
Projection: GDA 1994 MGA Zone 56

Figure 6-1
Caddens Hill Subdivision

Existing Conditions
TUFLOW Elements

Date: 21/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig6-1_Existing_TUFLOW_Elements_A.wor



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LEGEND

Terrain Level (m AHD)

- < 40
- 40.0 to 50.0
- 50.0 to 60.0
- 60.0 to 70.0
- 70.0 to 80.0
- > 80
- Site Boundary
- TUFLOW Model Boundary

N

0 360 metres

Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-2

Caddens Hill Subdivision

Existing Conditions Terrain

Date: 21/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig6-2_Existing_Terrain_A.wor

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LEGEND

- Site Boundary
- Flood Extent
- 0.5 m Flood Level Contour

N

0 80 metres
Scale 1:2,000 @ A3

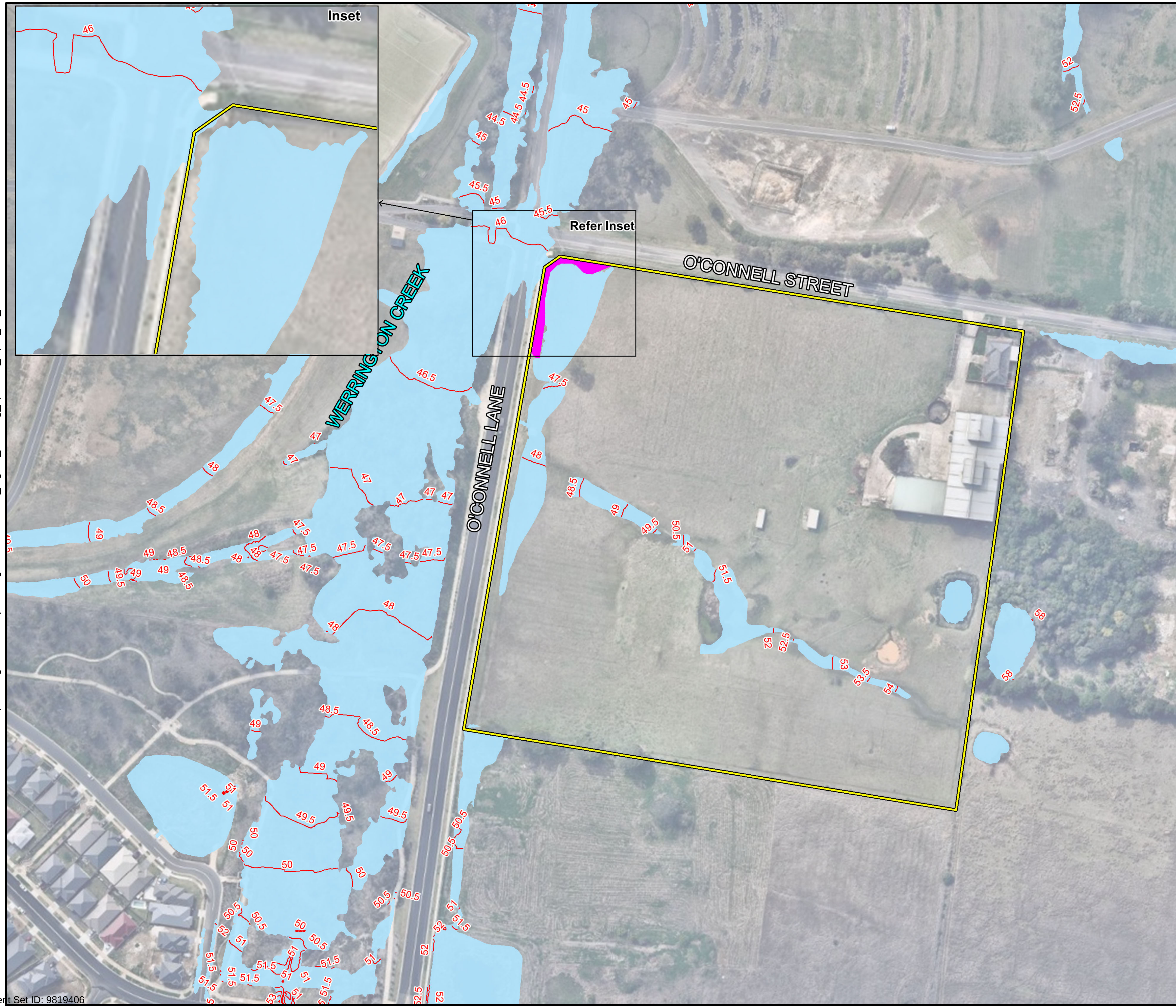
Projection: GDA 1994 MGA Zone 56

Figure 6-3
Caddens Hill Subdivision

1% AEP Flood Level Existing Condition

Date: 21/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig6-3_Existing_1pcAEP_FL_A.wor



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LEGEND

- Site Boundary
- Flood Extent
- 0.5 m Flood Level Contour
- Site Fill Area

N

0 80 metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-4
Caddens Hill Subdivision

1% AEP Flood Level
Existing Condition
Flood Mitigation Option

Date: 21/10/2021 Issue: A

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig6-4_Existing_1pcAEP_Opt1_FL_A.wor

Filename: J:\110358 - OConnell Lane Caddens\09 - Masterplanning\SW&E\MapInfo\Figures\110358-09_Fig6-5_FloodDepthDiff_1pcAEP_Ex01Opt1_MINUS_EX01_A.wor

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& PROJECT MANAGERS

LEGEND

FLOOD LEVEL DIFFERENCE (m)

- 0.5 +
- -0.2 to 0.5
- -0.10 to 0.20
- -0.06 to 0.10
- -0.04 to 0.06
- -0.02 to 0.04
- -0.02 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.10
- 0.10 to 0.20
- 0.2 to 0.5
- 0.5 +
- Study Area
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6-5
Caddens Hill Subdivision

Flood Depth Difference
Flood Mitigation option Minus Existing Condition

Date: 21/10/2021 Issue: A

Document Set ID: 9819406
Version: 1, Version Date: 24/11/2021

APPENDIX B

MUSIC AREA BREAKDOWN

	Input
	MUSIC Input

110358 - MUSIC MODELLING WORKSHEET
Caddens - STAGES 8-10

	Catchment Division (MapInfo)					Node Inputs (MUSIC)							
Catchment	**Total Catchment Area (ha)**	**Residential Lot Area (ha)**	**Road Reserve (ha)**	**Active Open Space (ha)**	**Passive Open Space (ha)**	**Road/ Driveway (ha)**	**Roof to Tank (ha)**	**Roof Bypass (ha)**	**Urban Impervious**	**Urban Pervious**	**%Imp**	**RG Size (ha)**	**RG Size (% cat)**
Cat B	6.241	3.990	1.812		0.438	1.921	1.097	1.097	0.243	1.882	68%	860	1.38%
Cat E	6.046	3.624	1.791	0.357	0.273	1.883	0.997	0.997	0.387	1.783	69%	700	0.89%
Cat E MD	1.072	1.072				0.054	0.295	0.295	0.054	0.375	65%		
Cat E Bypass	0.762	0.705		0.057		0.035	0.194	0.194	0.064	0.275	64%	Assumed Not Treated	
	14.120											1560	1.10%

% Impervious Assumptions		
Residential	65%	impervious
Roof	55%	of lot
Driveway	5%	of lot
Landcape	35%	of lot
Other	5%	of lot
Park	50%	impervious
Road	95%	impervious
Passive OS	10%	impervious

	Flow to GPT/Raingarden			
	Area (ha)	**Tc (min)**	**1yr Flow (m^3/s)**	**3mth Flow (m^3/s)**
Cat B	6.24	7	0.66	0.34
Cat E	13.36	11	1.18	0.61
Cat E Bypass	Assumed Not Treated			

RAINWATER TANK											
					Overflow Pipe Dia		**High Flow By-pass**	**Daily Demand**	**PET - RAIN**		**Tank Surface Area**
Catchment	**Lots**	**Avg Lot Size (m^2)**	**Equivalent Pipe Area (m^2)**	**Equivalent Pipe radius (m)**	**Equivalent Pipe dia (mm)**	**Total Area of Roof to Tank (Ha)**	**1yr flow on roof (m^3/s)**	**Daily Demand (kL)**	**Annual Demand (kL/yr)**	**Total Tank Volume (m^3)**	**Tank Surface Area (m^2)**
Cat B	104	384	0.204	0.255	510	1.097	0.229	10.4	5200	249.6	195.0
Cat E	102	355	0.200	0.252	505	0.997	0.208	10.2	5100	244.8	191.3
Cat E MD	54	198	0.106	0.184	367	0.295	0.061	4.32	1350	129.6	101.3
Cat E Bypass	18	391	0.035	0.106	212	0.194	0.040	1.8	900	43.2	33.8

	Lots		
	>320 m²	**<320 m²**	
PET - Rain for landscape area	50	25	kL/year/dwelling
Assumed Daily Demand	100	80	L/day
Adopted Tank Size	3		kL
Assumed 80% is useable (w/o topups)	80		%
Useable tank	2.4		kL
Assumed Tank height	1.6		m
I5min/1yr	75		mm/hr

APPENDIX C

MUSIC-LINK REPORT

PENRITH CITY COUNCIL

music@link

MUSIC-*link* Report

Project Details		Company Details	
Project:	Caddens Hill Subdivision Development Application	**Company:**	J. Wyndham Prince
Report Export Date:	21/10/2021	**Contact:**	Francis Lane
Catchment Name:	110358-09_MU03	**Address:**	77 Union Road Penrith NSW 2750
Catchment Area:	14.122ha	**Phone:**	4720 3385
Impervious Area*:	197.1%		
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Penrith		
Scenario:	Penrith 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	20%	Rain Water Tank Node	4	Urban Source Node	21
TSS	85%	Bio Retention Node	2		
TP	71%	GPT Node	2		
TN	59.1%	Generic Node	2		
GP	96.1%				

Comments

Rainwater tank re-use demand not appliccable. BASIC requirements will apply.

The GPT determines the high flow bypass around the bio-retention via a secondary link. Therefore, default high flow bypass value of 100 (flagged as out of range >99) in the bio-retention node is irrelevant.

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	B Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
Bio	E Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
GPT	B Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.34
GPT	E Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.61
Post	Post-Development Node	% Load Reduction	None	None	95.2
Post	Post-Development Node	GP % Load Reduction	90	None	99.4
Post	Post-Development Node	TN % Load Reduction	45	None	95.6
Post	Post-Development Node	TP % Load Reduction	60	None	95.7
Post	Post-Development Node	TSS % Load Reduction	85	None	96.2
Pre	Pre-Development Node	% Load Reduction	None	None	84.7
Pre	Pre-Development Node	TN % Load Reduction	45	None	83.4
Pre	Pre-Development Node	TP % Load Reduction	60	None	82.8
Urban	Cat B Road/Driveway (1.921 ha)	Area Impervious (ha)	None	None	1.921
Urban	Cat B Road/Driveway (1.921 ha)	Area Pervious (ha)	None	None	0
Urban	Cat B Road/Driveway (1.921 ha)	Total Area (ha)	None	None	1.921
Urban	Cat B Roof (1.097 ha)	Area Impervious (ha)	None	None	1.097
Urban	Cat B Roof (1.097 ha)	Area Pervious (ha)	None	None	0
Urban	Cat B Roof (1.097 ha)	Total Area (ha)	None	None	1.097
Urban	Cat B Roof to tank (1.097 ha)	Area Impervious (ha)	None	None	1.097
Urban	Cat B Roof to tank (1.097 ha)	Area Pervious (ha)	None	None	0
Urban	Cat B Roof to tank (1.097 ha)	Total Area (ha)	None	None	1.097
Urban	Cat B Urban Impervious (0.243 ha)	Area Impervious (ha)	None	None	0.243
Urban	Cat B Urban Impervious (0.243 ha)	Area Pervious (ha)	None	None	0
Urban	Cat B Urban Impervious (0.243 ha)	Total Area (ha)	None	None	0.243
Urban	Cat B Urban Pervious (1.882 ha)	Area Impervious (ha)	None	None	0
Urban	Cat B Urban Pervious (1.882 ha)	Area Pervious (ha)	None	None	1.882
Urban	Cat B Urban Pervious (1.882 ha)	Total Area (ha)	None	None	1.882
Urban	Cat E Bypass Road/Driveway (0.035 ha)	Area Impervious (ha)	None	None	0.035
Urban	Cat E Bypass Road/Driveway (0.035 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Bypass Road/Driveway (0.035 ha)	Total Area (ha)	None	None	0.035
Urban	Cat E Bypass Roof (0.194 ha)	Area Impervious (ha)	None	None	0.194
Urban	Cat E Bypass Roof (0.194 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Bypass Roof (0.194 ha)	Total Area (ha)	None	None	0.194
Urban	Cat E Bypass Roof to tank (0.194 ha)	Area Impervious (ha)	None	None	0.194
Urban	Cat E Bypass Roof to tank (0.194 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Bypass Roof to tank (0.194 ha)	Total Area (ha)	None	None	0.194
Urban	Cat E Bypass Urban Impervious (0.064 ha)	Area Impervious (ha)	None	None	0.064
Urban	Cat E Bypass Urban Impervious (0.064 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Bypass Urban Impervious (0.064 ha)	Total Area (ha)	None	None	0.064
Urban	Cat E Bypass Urban Pervious (0.275 ha)	Area Impervious (ha)	None	None	0

Only certain parameters are reported when they pass validation

PENRITH CITY COUNCIL

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat E Bypass Urban Pervious (0.275 ha)	Area Pervious (ha)	None	None	0.275
Urban	Cat E Bypass Urban Pervious (0.275 ha)	Total Area (ha)	None	None	0.275
Urban	Cat E MD Road/Driveway (0.054 ha)	Area Impervious (ha)	None	None	0.054
Urban	Cat E MD Road/Driveway (0.054 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E MD Road/Driveway (0.054 ha)	Total Area (ha)	None	None	0.054
Urban	Cat E MD Roof (0.295 ha)	Area Impervious (ha)	None	None	0.295
Urban	Cat E MD Roof (0.295 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E MD Roof (0.295 ha)	Total Area (ha)	None	None	0.295
Urban	Cat E MD Roof to tank (0.295 ha)	Area Impervious (ha)	None	None	0.295
Urban	Cat E MD Roof to tank (0.295 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E MD Roof to tank (0.295 ha)	Total Area (ha)	None	None	0.295
Urban	Cat E MD Urban Impervious (0.054 ha)	Area Impervious (ha)	None	None	0.054
Urban	Cat E MD Urban Impervious (0.054 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E MD Urban Impervious (0.054 ha)	Total Area (ha)	None	None	0.054
Urban	Cat E MD Urban Pervious (0.375 ha)	Area Impervious (ha)	None	None	0
Urban	Cat E MD Urban Pervious (0.375 ha)	Area Pervious (ha)	None	None	0.375
Urban	Cat E MD Urban Pervious (0.375 ha)	Total Area (ha)	None	None	0.375
Urban	Cat E Road/Driveway (1.883 ha)	Area Impervious (ha)	None	None	1.883
Urban	Cat E Road/Driveway (1.883 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Road/Driveway (1.883 ha)	Total Area (ha)	None	None	1.883
Urban	Cat E Roof (0.997 ha)	Area Impervious (ha)	None	None	0.997
Urban	Cat E Roof (0.997 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Roof (0.997 ha)	Total Area (ha)	None	None	0.997
Urban	Cat E Roof to tank (0.997 ha)	Area Impervious (ha)	None	None	0.997
Urban	Cat E Roof to tank (0.997 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Roof to tank (0.997 ha)	Total Area (ha)	None	None	0.997
Urban	Cat E Urban Impervious (0.387 ha)	Area Impervious (ha)	None	None	0.387
Urban	Cat E Urban Impervious (0.387 ha)	Area Pervious (ha)	None	None	0
Urban	Cat E Urban Impervious (0.387 ha)	Total Area (ha)	None	None	0.387
Urban	Cat E Urban Pervious (1.783 ha)	Area Impervious (ha)	None	None	0
Urban	Cat E Urban Pervious (1.783 ha)	Area Pervious (ha)	None	None	1.783
Urban	Cat E Urban Pervious (1.783 ha)	Total Area (ha)	None	None	1.783
Urban	Existing (14.12 ha)	Area Impervious (ha)	None	None	0
Urban	Existing (14.12 ha)	Area Pervious (ha)	None	None	14.12
Urban	Existing (14.12 ha)	Total Area (ha)	None	None	14.12

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	B Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	100
Bio	E Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	100
Pre	Pre-Development Node	GP % Load Reduction	90	None	0
Pre	Pre-Development Node	TSS % Load Reduction	85	None	80.1
Rain	Cat B RW Tank	% Reuse Demand Met	80	None	42.57
Rain	Cat E Bypass RW Tank	% Reuse Demand Met	80	None	43.07
Rain	Cat E MD RW Tank	% Reuse Demand Met	80	None	44.6474
Rain	Cat E RW Tank	% Reuse Demand Met	80	None	41.09

Only certain parameters are reported when they pass validation

APPENDIX D

DRAFT MAINTENANCE SCHEDULES

ON-SITE DETENTION SYSTEM MAINTENANCE SCHEDULE

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Discharge Control Pit (DCP)			
Inspect & remove any blockages of orifice	Six Monthly	Maintenance Contractor	Remove grate and screen to inspect orifice. Refer to the plan for the location of the DCP
Inspect screen and clean	Six Monthly	Maintenance Contractor	Remove grate and screen as required to clean screen
Inspect DCP sump and remove any sediments/sludge	Six Monthly	Maintenance Contractor	Remove grate and screen. Remove sediment/sludge buildup and check orifice and flap valve is clear
Inspect grate for damage or blockage	Six Monthly	Owner	Check both sides of grate for corrosion, damage or blockage
Inspect outlet pipe and remove any blockage	Six Monthly	Maintenance Contractor	Remove grate and screen. Remove any blockages in pipe. Check for sludge/debris build-up at both ends of the line.
Check fixing of step irons is secure	Six Monthly	Maintenance Contractor	Remove grate and ensure fixings are secure prior to placing weight on step iron
Check attachment of orifice plate to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure plate is mounted securely, tighten fixings as required. Seal gaps as required
Check attachment of screen to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure screen fixing is secure. Repair as required
Check screen for corrosion	Annually	Maintenance Contractor	Remove grate and examine screen. Ensure screen fixings are secure. Repair as required
Inspect DCP walls for cracks or spalling	Annually	Maintenance Contractor	Remove grate to inspect internal wall. Repair as required. Clear vegetation from external walls as necessary and repari as required.
Check orifice diameters are correct and retain sharp edges	Five Yearly	Maintenance Contractor	Compare diameter to design as shown in Work-As-Executed plans and ensure edge is not pitted or damaged
Main Storage Basin Area			
Inspect storage area and remove debris/mulch/litter etc likely to block screen or grates	Six Monthly	Owner	Remove debris and floatable material from surrounding area likely to be washed into grates
Inspect overflow weir and remove any blockage	Six Monthly	Owner	Remove debris and ensure weir is clear of blockages. Refer to the plan for the location of the weir
Inspect inlet areas for damage or blockage	Six Monthly	Owner	Check basin area around discharge points for erosion damage, sediment build-up or blockage obstructions
Inspect grates for damage or blockage	Six Monthly	Owner	Check both sides of grate for corrosion, damage or blockage
Compare storage volume to approved volume (Rectify if loss >5%)	Annually	Maintenance Contractor	Compare actual storage available with Work-As-Executed plans. If volume loss is greater than 5%, arrange for reconstruction to replace the volume lost. Council to be notified of the proposal
Inspect storage area for subsidence near pits	Annually	Maintenance Contractor	Check along drainage lines and at pit locations for subsidence likely to indicate leakages

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J. Wyndham Prince Pty Ltd

STORMWATER TREATMENT DEVICE MAINTENANCE SCHEDULE - HUMEGARD UNIT

REFER TO THE ACCOMPANYNG OWNERS MANUAL PREPARED BY THE MANUFACTURER

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Humegard			
Inspect gross pollutant storage chamber for need of maintenance	Quarterly	Owner	Remove maintenance cover and visually inspect to check litter amount
Inspect for depth of sediment captured	Quarterly, or after a total of 20 mm or more of rainfall has fallen within a 24 hour period, whichever comes first.	Owner	Remove maintenace cover and use sediment depth measurement device (sediment sampler) as indicated in the owners manual. Sediment removal is required if sediment depth is greater than 400mm.
Inspect for obstructions within device	Quarterly, or after a total of 20 mm or more of rainfall has fallen within a 24 hour period, whichever comes first.	Owner	Remove maintenace cover and visually inspect boom and inlet pipe locations for blockages or obstructions.
Remove captured litter and sediment	As necessary through inspection advice (Annually at a minimum and immediately after oil or hazardous material spillage)	Maintenance Contractor	If there is a requirement to remove build-up of captured pollutants or remove obstructions, contact the Maintenance Contractor to carry out maintenance. Maintenance carried out using an eductor truck as detailed in Owners Manual
Remove captured oil or hazardous material after spillage	Immediately after oil or hazardous material spillage	Owner to contact Fire Brigade (HAZMAT) and liquid waste contractor	Immediately contact Fire Brigade (HAZMAT Unit) and a licensed liquid waste contractor, then inform Council and Department of Environment and Climate Change.
Inspect area around device for subsidence	Annually	Maintenance Contractor	Check along drainage lines and at pit locations for subsidence likely to indicate leakages
Inspect for secure fixture of internal fittings in chamber	Annually	Maintenance Contractor	Check for loose fittings or securing bolts and general integrity of unit