REPORT

CKDI Bringelly Pty Ltd

South Creek West

Belmore Road Precinct

Watercycle Management Report

June 2022

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1. EXECUTIVE SUMMARY

As part of the ongoing development of the South Creek West (SCW) Precinct, it is proposed to rezone a 190.66 hectare (ha) portion of land in Bringelly, located within the Camden Local Government Area (LGA). The proposed South Creek West Bringelly Sub-Precinct 2 (Belmore Road Precinct) has frontages to Greendale Road and The Northern Road and includes the existing local Bringelly shopping centre, while the remainder of the Precinct is predominantly rural farmland to the south and west.

J. Wyndham Prince Pty Ltd has prepared the Belmore Road Precinct Water Cycle Management Strategy (WCMS) report to support the proposed rezoning of this land. The WCMS report presents background details on the planning proposal for the Belmore Road Precinct, hydrologic, hydraulic and water quality analysis, riparian corridor assessment, and considers existing ecological constraints.

Our assessment demonstrates that the proposed five (5) detention basins located throughout the Belmore Road Precinct) with a total storage of approximately 69,350 m^3 will ensure that peak post-development discharges are restricted to less than the pre-development levels at all key comparison locations. The strategy includes three (3) online basins within the central riparian corridor and two (2) traditional offline detention basins in the north and east of the Belmore Road Precinct) respectively.

Water quality will be managed by various controls, including on-lot rainwater tanks, gross pollutant traps, and bio-retention rain gardens to deliver Council's required water quality objectives. Medium and high-density residential areas, together with industrial and commercial areas and the local school, are proposed to manage their own water quality needs onsite.

Nine (9) bio-retention raingardens are located along the central riparian corridor to manage stormwater quality runoff before discharge to the adjoining watercourse. Two (2) bio-retention raingardens are proposed to be co-located within Basins 1 and 5.

The WCMS report also provides a hydraulic assessment of the Belmore Road Precinct. The assessment defined the flood behaviour within the Belmore Road Precinct, providing information on flood depths, flood levels and flood hazards for the 50%, 20%, 5%, 1% AEP and Probable Maximum Flood (PMF) events.

The flood impact maps (refer to Appendix B) show that there will be no adverse flood impact external to the Belmore Road Precinct in the 50% and 1% AEP events. Further refinement to the basin outlet structures to manage the intermediate 20% and 5% AEP events at Bringelly Road will be required as part of future assessments. A reduction in flood level adjacent to the existing Bringelly Public School is evident in all modelled events.

There are some isolated flood level changes in Thompson's Creek just downstream of Greendale Road, but these are minor. Further discussion on the suitability of these impacts is provided in Section 7.5.

The Stormwater Management Strategy proposed for the Belmore Road Precinct is therefore functional; it delivers the required technical performance, lessens environmental degradation and pressure on downstream ecosystems and infrastructure and provides for a 'soft' sustainable solution for water cycle management within the Belmore Road Precinct.

2. BACKGROUND

2.1. Site

The SCW land release area extends from Bringelly/Greendale Road at Bringelly in the north, South Creek to the east and Cobbitty to the south. The western boundary varies, extending west along Greendale/Bringelly Road approximately 260 m past the intersection with Tyson Road.

The proposed Belmore Road Precinct is approximately 190.66ha in size with frontages to Greendale Road to the north, The Northern Road to the east, a private road to the south (approximately 400 m south of the intersection of The Northern Road and Carrington Road) and the PGH brickworks/quarry to the west. The location of the Belmore Road Precinct within the SCW Release Area is shown on Plate 2-1.

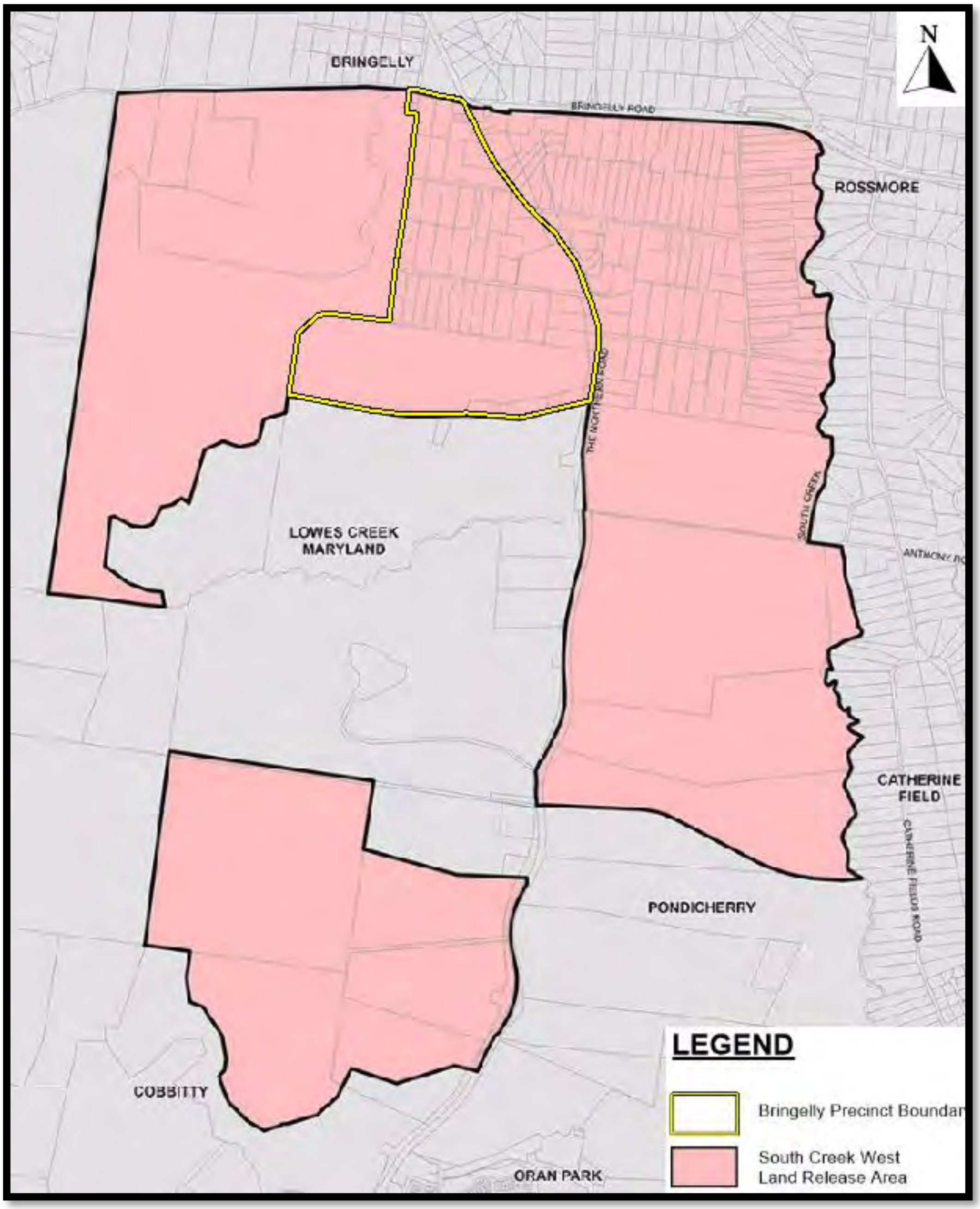

Plate 2-1 – Proposed Rezoning Area

The existing site comprises a number of large lot rural residential dwellings and farm sheds; the Bringelly Village shops are at the intersection of The Northern Road and Greendale Road, and an electricity sub-station is located approximately 270 m west of The Northern Road. An overview of the site locality is shown on Plate 2-2.

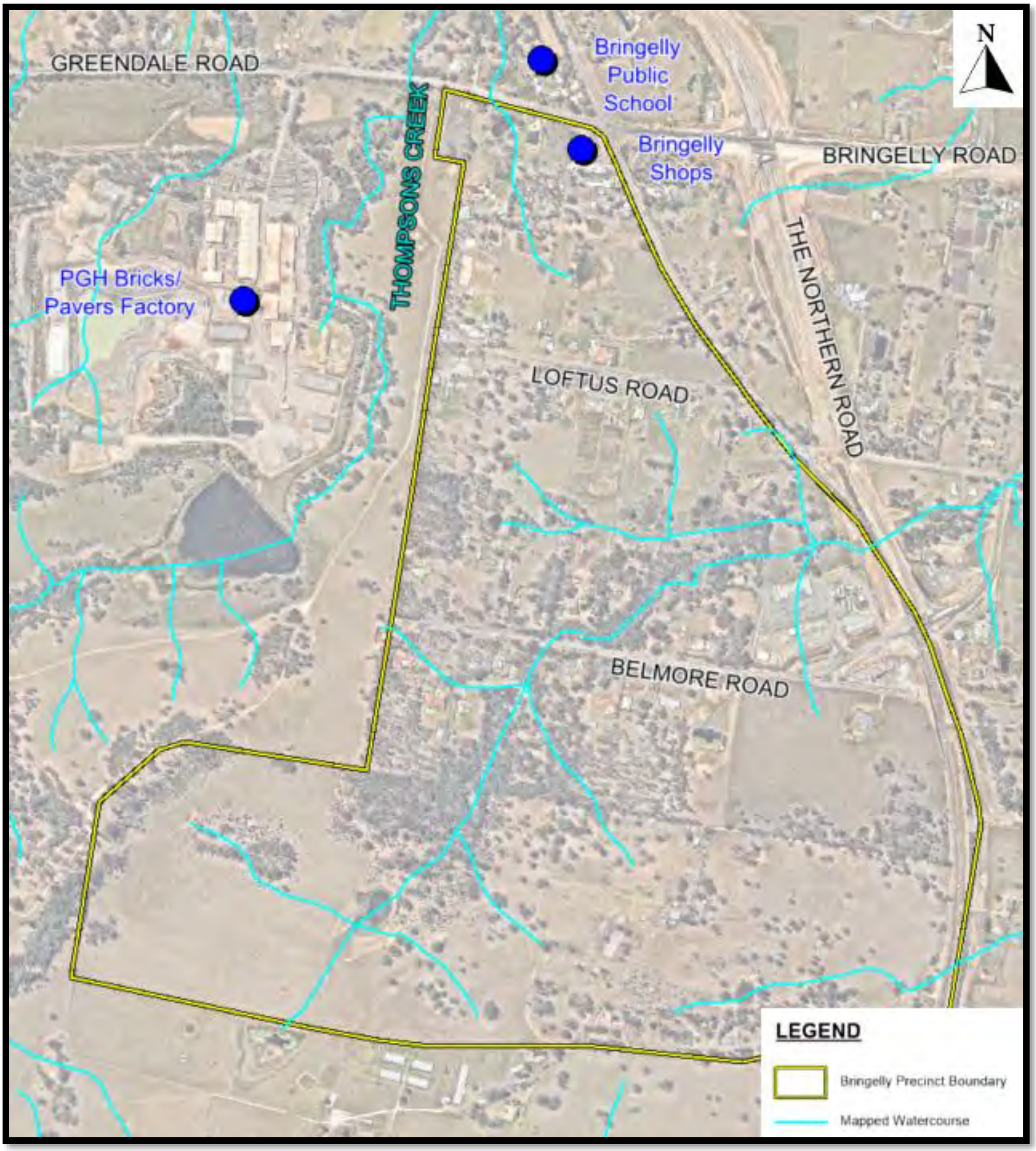

Plate 2-2 – Site Locality

2.2. Objective

The objective of this study is to prepare a WCMS that supports the rezoning of the land for urban development. The study includes an assessment of flooding impact within the Belmore Road Precinct, together with the stormwater quantity and quality management required to ensure that there are no adverse impacts external to the Belmore Road Precinct. This assessment has included liaison with Camden Council to ensure compliance with relevant Council development standards and project specific requirements.

2.3. Proposed Development

The Planning Proposal for the Belmore Road Precinct aims to rezone the 190.66 ha site from predominantly rural land to mixed land uses, forming around 119.5 ha of residential land, with the remainder comprising employment land and open space land uses.

As identified through the development of an indicative layout plan, it is anticipated that the Precinct will accommodate in the order 3,300 dwellings, which will result in an estimated future population of around 10,500. The Precinct will support approximately a village centre and numerous areas of open space. An Indicative Layout Plan (ILP) of the Precinct is shown in Plate 2-3. A larger version of the ILP is provided in Appendix A.

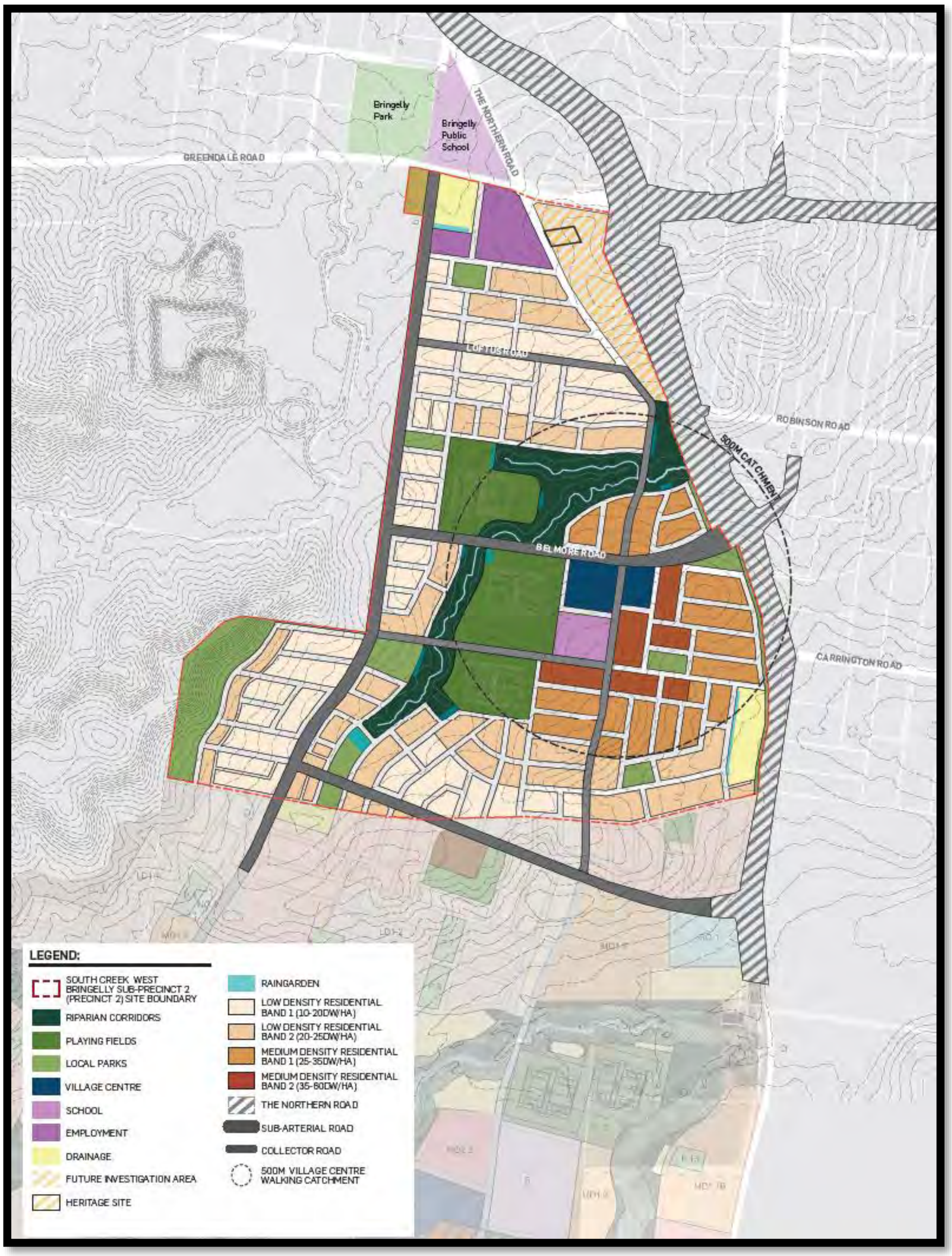

Plate 2-3 – Final ILP (Rev B, URBIS 14/06/2022)

The proposed detention management will utilise the current passive storages within the riparian corridor and integrate more formal management into the existing riparian function. The existing culvert crossing at Belmore Road will form the outlet control from Basin B3 with a further future road crossing upstream to provide the outlet control for Basin B4. It is not intended to modify the land within either B3 or B4 in order to achieve the required storage needs. The north/south road crossing of the existing riparian corridor will form Basin B2 and complete the management of 50%, and 1% AEP flows just upstream of The Northern Road. Plate 2-4 provides an overview of the proposed basin locations. Full details of the stormwater management strategy are provided in Section 5 and Section 6 of this report.

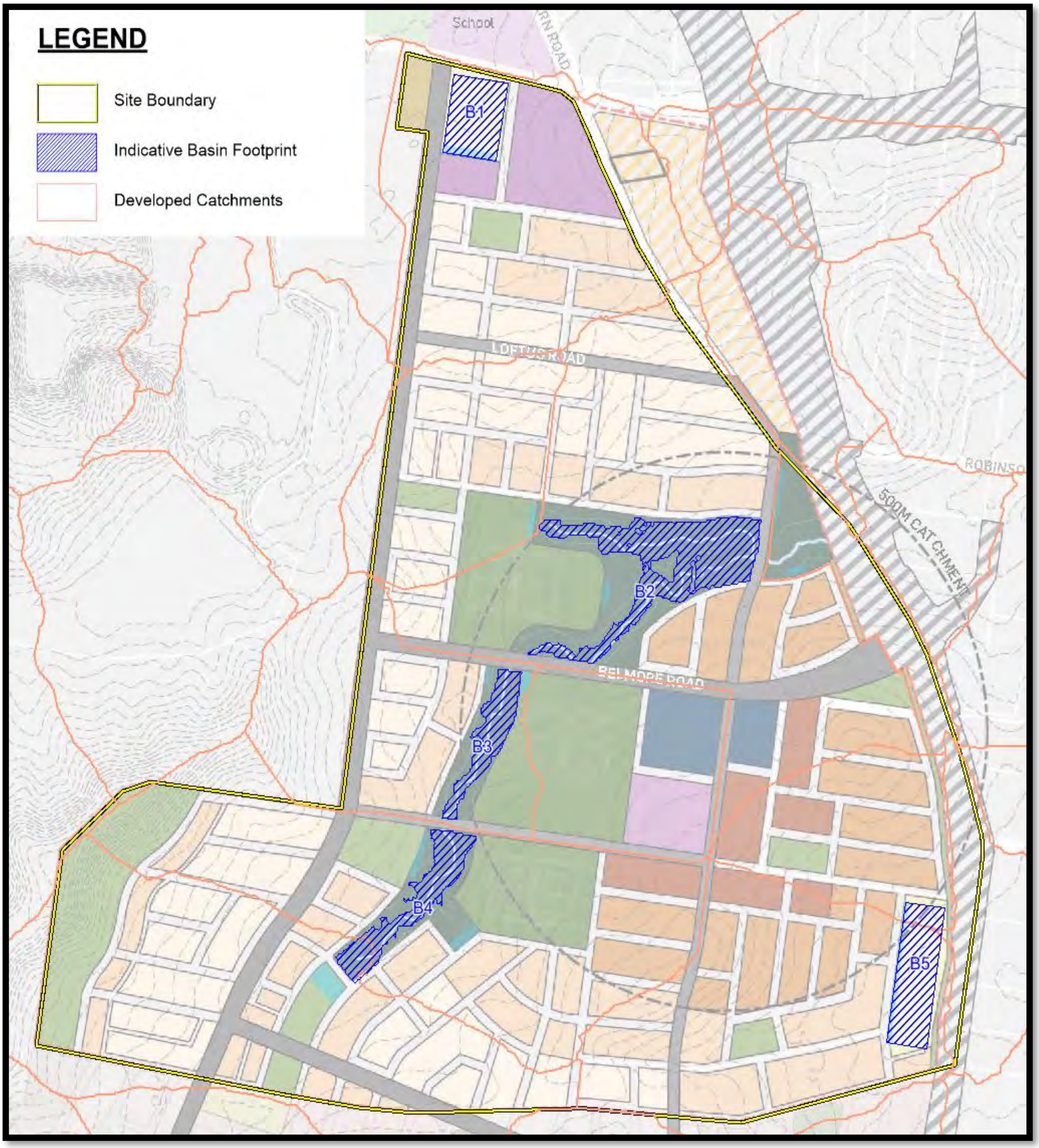

Plate 2-4 – Indicative Location of Proposed Detention Basins

3. PREVIOUS STUDIES AND RELEVANT GUIDELINES

The following control documents have been considered in the development of the Water Cycle Management Strategy for the SCW Belmore Road Precinct:

- Camden Council Development Control Plan (DCP) (2019);
- Oran Park Precinct Growth Centres Development Control Plan (DCP, 2016); and
- Camden Council Engineering Design Specification (2009).

A review of other investigations in the vicinity of the Belmore Road Precinct, together with Council advice, is summarised in the following sections.

3.1. Lowes Creek Maryland Precinct WCMS (Cardno, 2018)

Cardno prepared the Lowes Creek Maryland Water Cycle Management Strategy (LCM WCMS) report in September 2018 for the Department of Planning to support the proposed rezoning of approximately 531 ha of land immediately to the south of the Belmore Road Precinct. The LCM WCMS report included hydrologic analysis, water quality analysis and riparian corridor assessment.

The report demonstrated that six (6) offline and two (2) online detention basins would ensure that peak post-development flows are restricted to less than the existing flow at all key comparison locations. A number of gross pollutant traps, together with 21 bioretention rain gardens, deliver the required water quality outcomes for the Precinct.

3.2. Meeting with Camden Council (March 2020)

The project team met with Camden Council on 9 March 2020 to discuss the proposed rezoning and gain an appreciation of Council's expectations for the Belmore Road Precinct rezoning.

Council noted that the Water Cycle Management brief was no longer valid and needed to be updated. Importantly, the Upper South Creek (USC) Flood model has been updated to reflect Australian Rainfall & Runoff (AR&R) 2019 procedures and now considers existing farm dams at full supply level. Council subsequently supplied the updated USC hydrology and flood model for use in the Belmore Road Precinct rezoning assessment.

Discussion regarding playing fields serving a dual purpose as detention basins and open space was discussed Council subsequently provided the newly endorsed *Dedication of Constrained Lands Policy* which potentially permits the dual use of open space. While the current study has avoided the use of playing fields as basins, this may be a future option pending Natural Resources Access Regulator (NRAR) advice on online basins within the riparian corridor. Council noted a preference for online detention basins to blend into the environment, with gentle batters and no walls or pit/pipe outlet structures.

Council also confirmed that cut/fill on the site is acceptable as long as there are no flood impacts. Catchments in the order of 20 – 25 ha were suggested before formal trunk drainage elements are required, and Council indicated that smaller catchments would be preferred due to drainage issues in other precincts where trunk drainage was not provided. Therefore, road and drainage capacity is to form part of the design considerations post rezoning.

With regard to Water Sensitive Urban Design (WSUD), Council advised that their preference is for vortex style GPTs and standard Growth Centres stormwater quality controls to be applied in the Belmore Road Precinct. It was agreed that modelling is to be undertaken using MUSIC software.

Regional flood evacuation is not necessary, however, emergency management for the proposed development for events up to the PMF are to be considered together with the consideration of climate change, consistent with the updated USC flood model needs to be assessed.

3.3. Upper South Creek Flood Study (WMA Water, 2020)

As part of the consultation with Council, it was confirmed that the USC model had been updated to align with the AR&R 2019 procedures. The formal report is still in draft form and at the time of writing, this report is not available. However, the XP-RAFTS hydrologic and TUFLOW hydraulic models, together with a draft user guide, was provided to consultants working in the Camden Council LGA so that rezoning assessments can use the latest study information.

Council facilitated a presentation by WMA Water on 28 April 2020 to a number of consultants, including J. Wyndham Prince, on the use of the model; a number of questions were raised regarding catchment and model parameters. Importantly, it was identified that the spatially varying rainfall within the XP-RAFTS model was incorrectly applying the 'mid' rainfall data across the entire model and not the 'west' and 'east' data where appropriate. As the TUFLOW hydraulic model utilises inflow hydrographs from the XP-RAFTS hydrologic model, this incorrect rainfall data has implications for the broader flood model. Council confirmed that for the Belmore Road Precinct the 'west' rainfall data supplied with the USC model is to be used. WMA Water indicated that the modelling would need to be updated and would be re-issued. At the time of writing this report, an updated model was not available, and therefore, the "west" rainfall data from the USC model has been applied globally for the Belmore Road Precinct.

3.4. Correspondence - Update to the Upper South Creek Flood Study (Camden Council, 23 Feb 2021)

The Upper South Creek Flood Regional Flood Model was provided by Council on 20 March 2020 was utilised to inform the Belmore Road Precinct Water Cycle Management Plan. It is understood that some refinements to the model were made by Council's flood consultant (WMA Water) late in 2020.

J. Wyndham Prince contacted Camden Council to confirm that the March 2020 version of the model was still suitable as a base to inform the Bringelly WCMP. Council received the following advice from WMA water:

"The changes are relatively minor in terms of the effect on the results of impact assessments. Yes the latest one should be used for any new projects that are starting, but if they have already done the design and modelling work with the March 2020 model then I think it would be OK for them to submit those results without updating."

4. RIPARIAN CORRIDOR ASSESSMENT

Ecological Australia Pty Ltd (ELA) has undertaken a desktop riparian watercourse study in support of the precinct planning process and have ground-truthed a number of watercourses where access was available. A number of watercourses within the catchment are mapped as 1st order watercourses and are considered unlikely to be considered a "River" under the Act based on field inspection. Further consultation with the Natural Resources Access Regulator (NRAR) will be undertaken to confirm ELA's assessments. An overview of the stream classification within the site is provided in Plate 4-1.

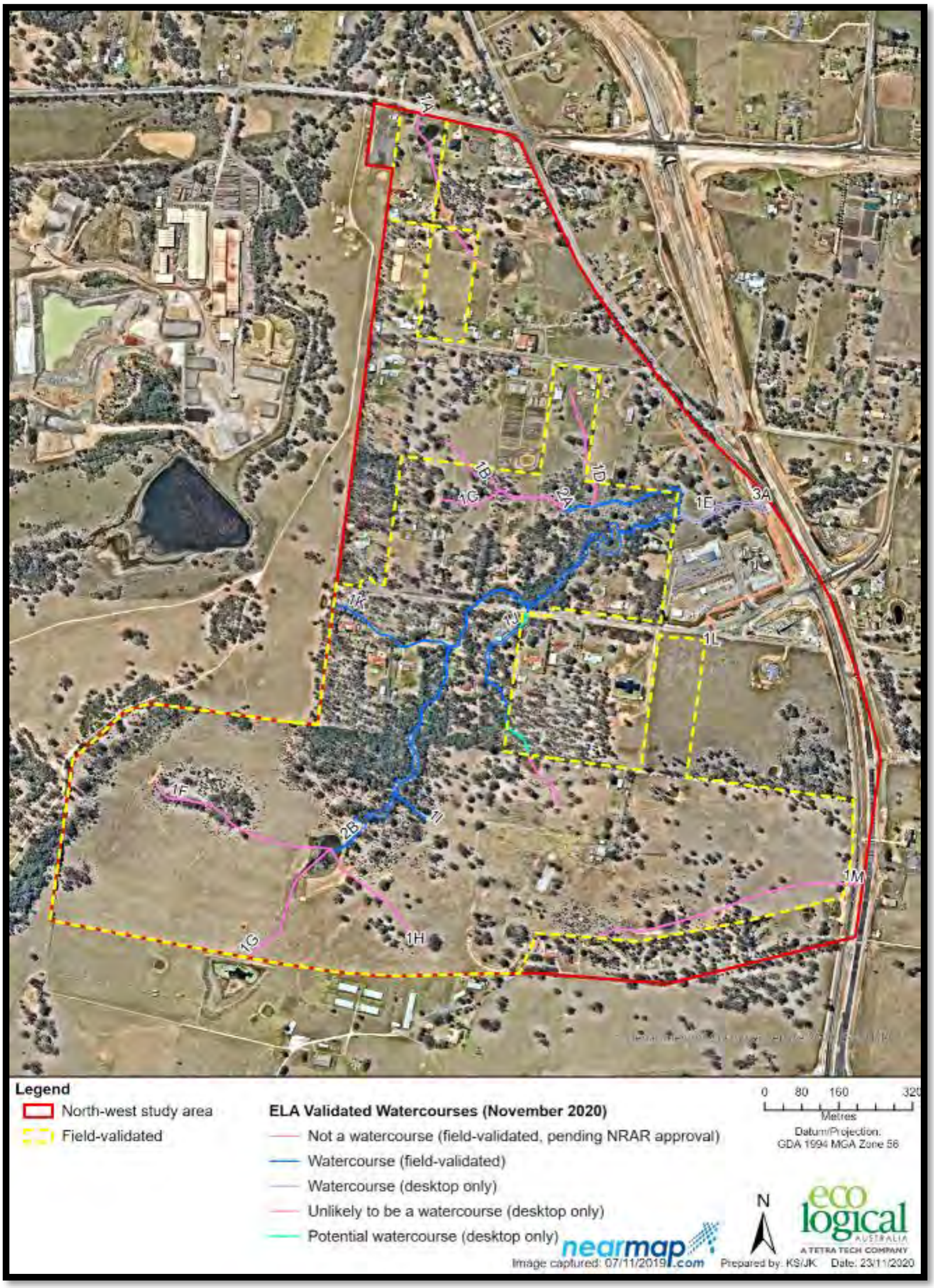

Plate 4-1 – Riparian Mapping (ELA, Nov 2020)

5. WATER QUALITY ASSESSMENT

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 Belmore Road Precinct water quality assessment:

- 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 re-use as a treatment technique.
- It provides mechanisms to evaluate the attainment of water quality objectives.

The modelling was undertaken to ensure that Camden Council's stormwater quality objectives are met.

5.1. Modelling Inputs and Assumptions

In accordance with the meeting held with Council on 9 March 2020, we have prepared the MUSIC model using MUSIC-Link functions to ensure that Council's modelling requirements are adhered to. We have also referenced Camden Council's Engineering Design Specification (2009).

The target pollutant removal rates for this development as required in the Growth Centres DCP shown in Table 5-1.

Table 5-1 –Pollutant Reduction Targets

Pollutant	Reduction Target	Ideal Outcome
Total Suspended Solids (TSS)	85%	95%
Total Phosphorous (TP)	65%	95%
Total Nitrogen (TN)	45%	85%
Gross Pollutants (GP)	90%	100%

A stream erosion index assessment is also required to ensure that the duration of post-development stream forming flows are no greater than 3.5 - 5.0 times the duration of pre-development stream forming flows, with an ideal outcome of 1.0.

The MUSIC Modelling has used a series of default Camden Council MUSIC-Link and assumed parameters. Details are provided in Appendix C.

As the development grading within the Belmore Road Precinct is unknown at this stage, we have modelled an indicative 10 ha low-density residential catchment and a typical 10 ha medium density catchment to inform the anticipated size of the regional devices.

The ILP details provided in Appendix A anticipate 3,600 dwellings within the 119.5 ha residential land area. An average density of 17.7 dwellings per hectare has been calculated for the typical 10 ha low density catchment, and 28.7 dwellings per hectare for the typical 10 ha medium density catchment.

Table 5-2 and Table 5-3 provide details of the assumed breakdown of a typical 10 ha low-density and medium density residential catchments, respectively.

Table 5-2 – Typical 10 ha Low-density Residential Catchment Breakdown

Landuse		% Lot	Area (ha)	% Catchment	% Impervious
Lots	Roof to Tank	30%	1.80	60%	75%
	Roof Bypass Tank	30%	1.80		
	Driveways	10%	0.60		
	Other Impervious	5%	0.30		
	Pervious Areas	25%	1.50		
Roads			3.00	30%	90%
Open Space			1.00	10%	30%
Total			**10.00**	**100%**	**75%**

Table 5-3 – Typical 10 ha Low-density Residential Catchment Breakdown

Landuse		% Lot	Area (ha)	% Catchment	% Impervious
Lots	Roof	60%	3.84	64%	80%
	Driveways	10%	0.64		
	Other Impervious	10%	0.64		
	Pervious Areas	20%	1.28		
Roads			3.00	30%	90%
Open Space			0.60	6%	30%
Total			**10.00**	**100%**	**80%**

An overview of the indicative model layout is shown in Plate 5-1.

Source nodes labelled with "MD" represent the Medium Density Catchment and "LD" represent the Low Density Catchment.

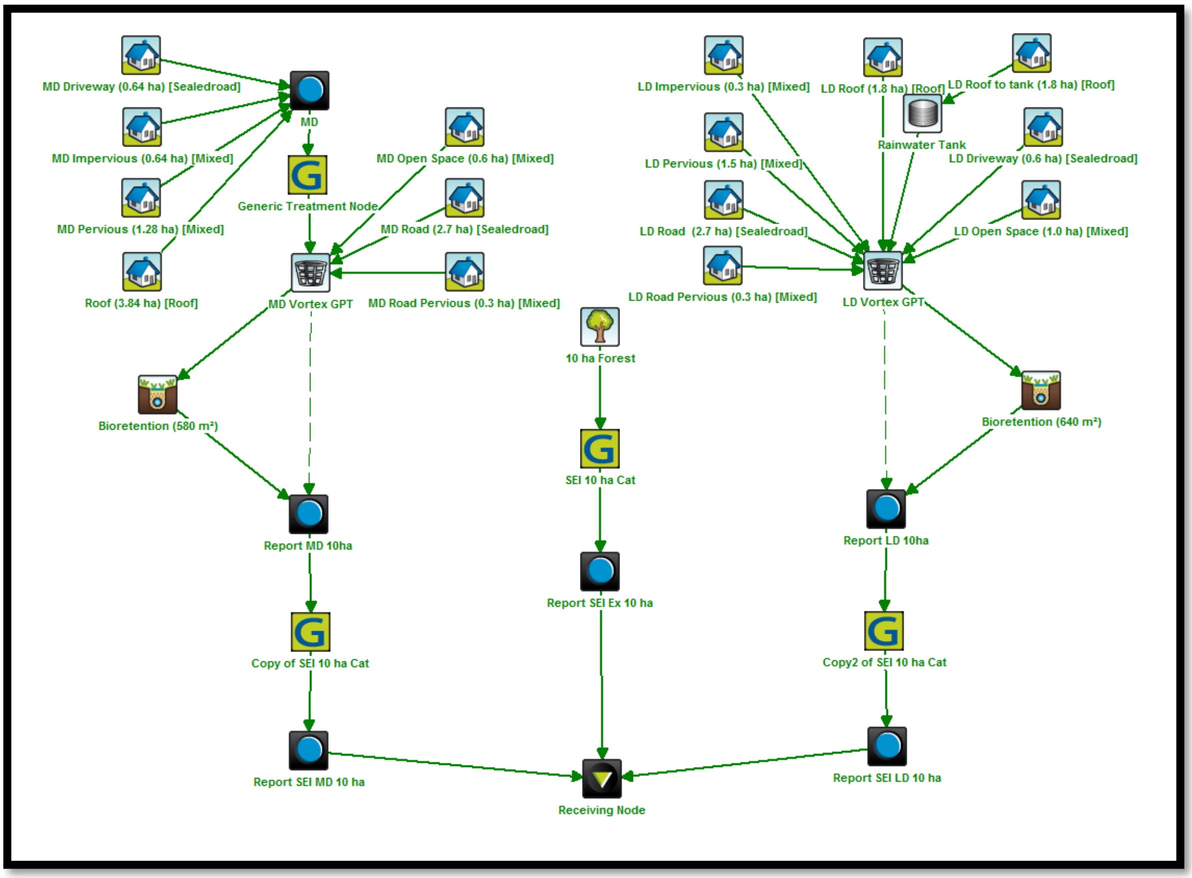

Plate 5-1 – MUSIC Model Overview (110628-03 MU1.sqz)

5.2. Water Quality Management Measures

It is proposed that stormwater quality in the Belmore Road Precinct be managed using a treatment train approach. Further details on land use assumptions and parameters are provided in Appendix C. A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals.

- Rainwater harvesting and re-use of residential roof runoff of by utilising rainwater tanks;
- Gross Pollutant Traps (GPT) to pre-treat runoff prior to discharge into bioretention gardens;
- Bioretention Raingarden which will receive flows from the GPTs; and
- On-lot treatment devices for Medium and High-Density zoned land, school sites, together with industrial and commercial areas.

The indicative location of bioretention raingardens are shown in Figure 5-1 in Appendix B.

Further details as to the rainwater tank, Gross Pollutant Traps and Bioretention Raingarden are provided in Appendix C.

5.3. Modelling Results

The MUSIC model was run using the stochastically generated estimated pollution loads from the source catchments. The pollutant reductions achieved for the proposed water quality treatment of a typical 10 ha low density residential catchment is provided in Table 5-4.

Table 5-4 – Summary of MUSIC Model Results for Typical 10 ha Low Density Residential Catchment

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	10100	8585	1510	8590	85.0%	85.0%
TP	20.5	13.3	7.12	13.4	65.0%	65.3%
TN	134	60.3	67.7	66.3	45.0%	49.5%
Gross Pollutants	1460	1314	14.30	1446	90.0%	99.0%
Media Bed area (m^2)	640					
Total Area Managed (ha)	10.00					
Raingarden (% Managed Cat)	0.64%					

Similarly, the pollutant reductions achieved for the proposed water quality treatment of a typical 10 ha medium density residential catchment is provided in Table 5-5.

Table 5-5 – Summary of MUSIC Model Results for Typical 10 ha Medium Density Residential Catchment

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	10400	8840	1550	8850	85.0%	85.1%
TP	21.1	13.7	7.13	14.0	65.0%	66.2%
TN	140	63.0	65.5	74.5	45.0%	53.2%
Gross Pollutants	1540	1386	11.3	1529	90.0%	99.3%
Media Bed area (m^2)	580					
Total Area Managed (ha)	3.60					
Raingarden (% Managed Cat)	1.61%					
Total Area (ha)	10.00					
Raingarden (% Total Area)	0.58%					

The indicative size of the regional bio-retention devices are provided in Table 5-6, which have been determined by conservatively adopting a 0.64% catchment for all areas. Please refer to Figure 5-01 in Appendix B for the bioretention device catchment areas and device locations.

Table 5-6 – Belmore Road Bio-Retention Raingarden Sizes

Raingarden Catchment	Total Area (ha)	Raingarden Sizing*	
		Filter Area (m^2)	Footprint Area (m^2)
RG1	19.2	1,240	1,860
RG2	11.5	740	1,110
RG3	13.0	830	1,250
RG4	6.0	390	590
RG5	13.1	850	1,280
RG6	7.1	460	690
RG7	13.1	840	1,260
RG8	10.7	690	1,040
RG9	16.2	1,040	1,560
RG10	31.6	2,030	3,050
RG11	26.4	1,690	2,540

* Low density residential, parks and all roads will be treated in regional devices.
*Medium and High density residential, together with industrial, commercial lots and school will provide on-lot treatment prior to discharge to the regional system.

Based on experience in other Growth Centre Precincts, the land take required for stand-alone bio-retention rain gardens is approximately 150% of the bio-retention media bed area. This accounts for the required Extended Detention Zone (EDZ), batters, maintenance access tracks and retaining walls/transition to the surrounding terrain.

A Camden Council MUSIC-Link report is provided in Appendix D.

5.4. Stream Erosion Index

A Stream Erosion Index (SEI) assessment has been undertaken to ensure that the proposed typical bio-retention devices reduce the duration of post-development stream forming flows to no greater than 3.5-5 times the duration of pre-development stream forming flows. The methodology used to determine the SEI within this report complies with the NSW MUSIC Modelling Guide (2015).

A forest node has been used to represent the site under existing conditions and the rainfall-runoff/soil parameters remain consistent with Council's MUSIC-Link parameters.

As there are no stream gauge records available for the site, the critical flow has been adopted as 50% of the 50% AEP, 540-minute duration storm flows determined using XP-RAFTS hydrologic software. A summary table of the SEI assessment and results for a typical 10 ha low-density residential catchment is provided in Table 5-7.

Table 5-7 – SEI Assessment for Typical 10 ha Low Density Residential Catchment

	XP-Rafts 50% AEP		Stream Erosion Index		
Assessment Location	Q_2 (m^3/s)	Q_{crit} (m^3/s)	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
Report SEI Low 10ha	0.191	0.096	5.97	12.9	2.2

Similarly, a summary table of the SEI assessment and results for a typical 10 ha medium density residential catchment is provided in Table 5-8.

Table 5-8 – SEI Assessment for Typical 10 ha Medium Density Residential Catchment

Assessment Location	XP-Rafts 50% AEP		Stream Erosion Index		
	Q_2 (m^3/s)	Q_{crit} (m^3/s)	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
Report SEI Med 10ha	0.191	0.096	5.97	16.1	2.7

The SEI results indicate that when sized to achieve pollution reduction targets, the proposed stormwater quality treatment train will ensure that the duration of post development stream forming flows would be no greater than the limit of 3.5 times the duration of existing conditions stream forming flows. Notwithstanding, at the design stage, all development applications should undertake an SEI assessment to confirm that the statutory SEI requirements are achieved.

5.5. Construction Stage

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

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

5.6. Long Term Management

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

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

6. WATER QUANTITY ASSESSMENT

The hydrologic analyses for the Belmore Road Precinct was undertaken using AR&R 2019 methodologies using XP-RAFTS hydrologic modelling software. XP-RAFTS is a non-linear runoff routing model that generates runoff hydrographs from rainfall data. The objective of the hydrologic analysis was to determine the requirement and size of detention basins needed to restrict peak post-development to existing flows at all key locations.

XP-RAFTS models have been created to represent both "Existing" and "Developed" site conditions and are based on the Upper South Creek (USC) XP-RAFTS hydrologic models prepared by WMA Water in 2020. It is important to note that an issue relating to the spatially varying rainfall data and variation in some of the catchment areas utilised in the USC hydrologic model was identified as part of this assessment. Camden Council advised that the 'west' rainfall data is to be utilised for the Belmore Road Precinct, and the catchment areas should reflect calculated spatial areas.

The USC XP-RAFTS model was prepared for the much broader USC floodplain, with catchments varying in size from 0.1 ha to 668.4 ha. To ensure that basins were sized to attenuate flows within the Precinct, catchments have been split where necessary to allow flow reporting at key locations (refer to Plate 6-1), particularly basin outlets and receiving catchments immediately downstream of the Precinct.

As part of this early precinct planning process, our approach is to 'book end' the assessment requirements by determining the detention volumes required to manage the 50% AEP and 1% AEP storm events. Further refinement may be required to ensure the full range of events between the 50% and 1% AEP are managed.

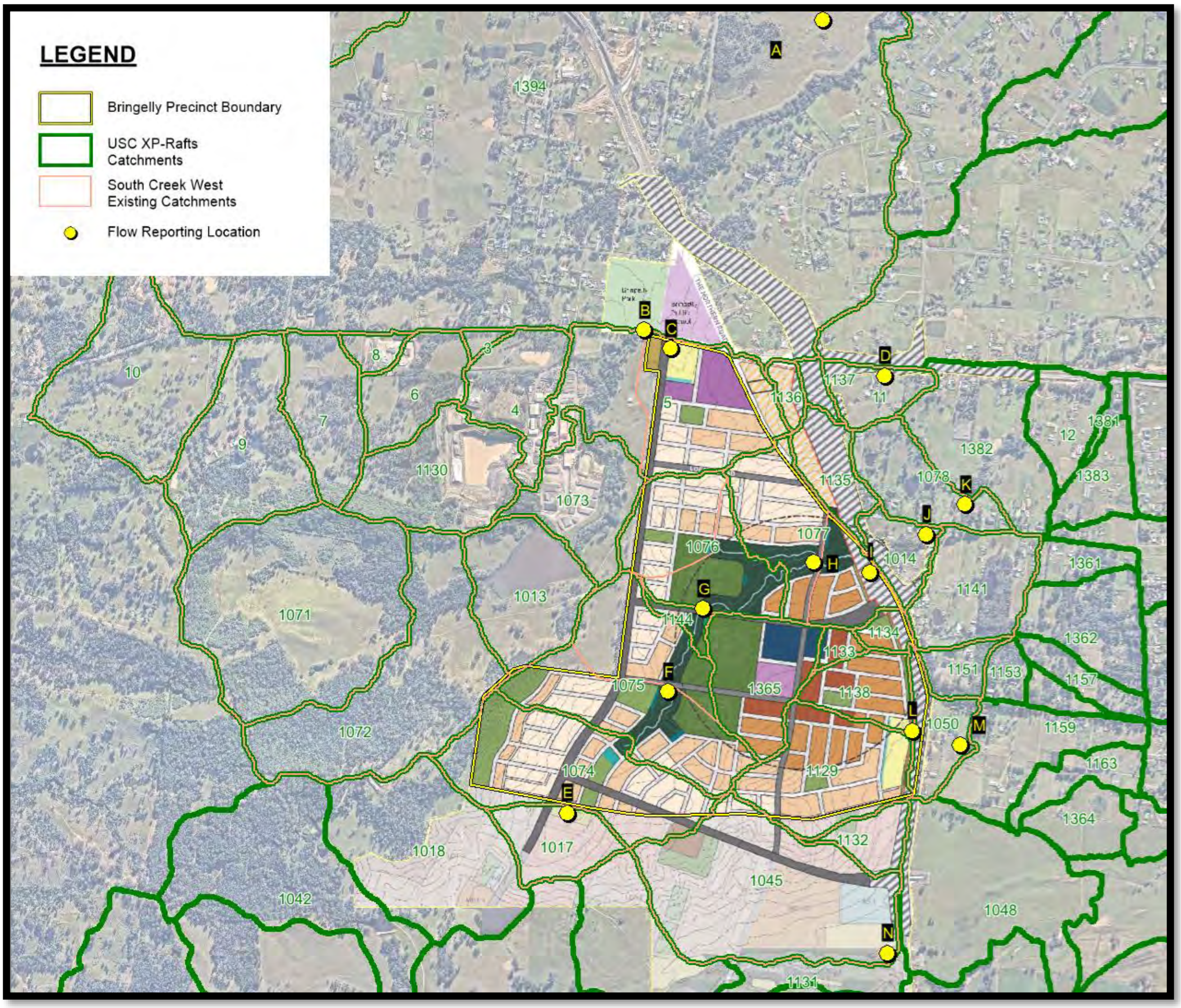

Plate 6-1 – XP-RAFTS Catchments and Reporting Locations

6.1. Existing Site Condition

The XP-RAFTS model from USC Flood Study by WMA Water, 2020 was adopted as the 'base case' model for the hydrologic assessment. Refer to Plate 6-2 for model layout. The existing conditions catchment plan is provided in Figure 6-01 in Appendix B.

In order to create the site-specific Existing" conditions model for the Belmore Road Precinct, the WMA, 2020 XP-RAFTS model was amended with the following changes:

- Node 5 has been split into two (2) nodes, 5a and 5b, at the north western portion of the site to enable flow comparisons at the precinct boundary;
- Catchments 1075, 1076 and 1077 have been split within the site to enable flows at future road crossing locations to be confirmed;
- All catchment areas have been updated to reflect calculated areas (spherical); and
- Model parameters for all new catchments have been kept consistent with the calibrated model provided by WMA Water. This includes adopting existing initial and continuing loss, vectored slopes and assumed fraction imperviousness.

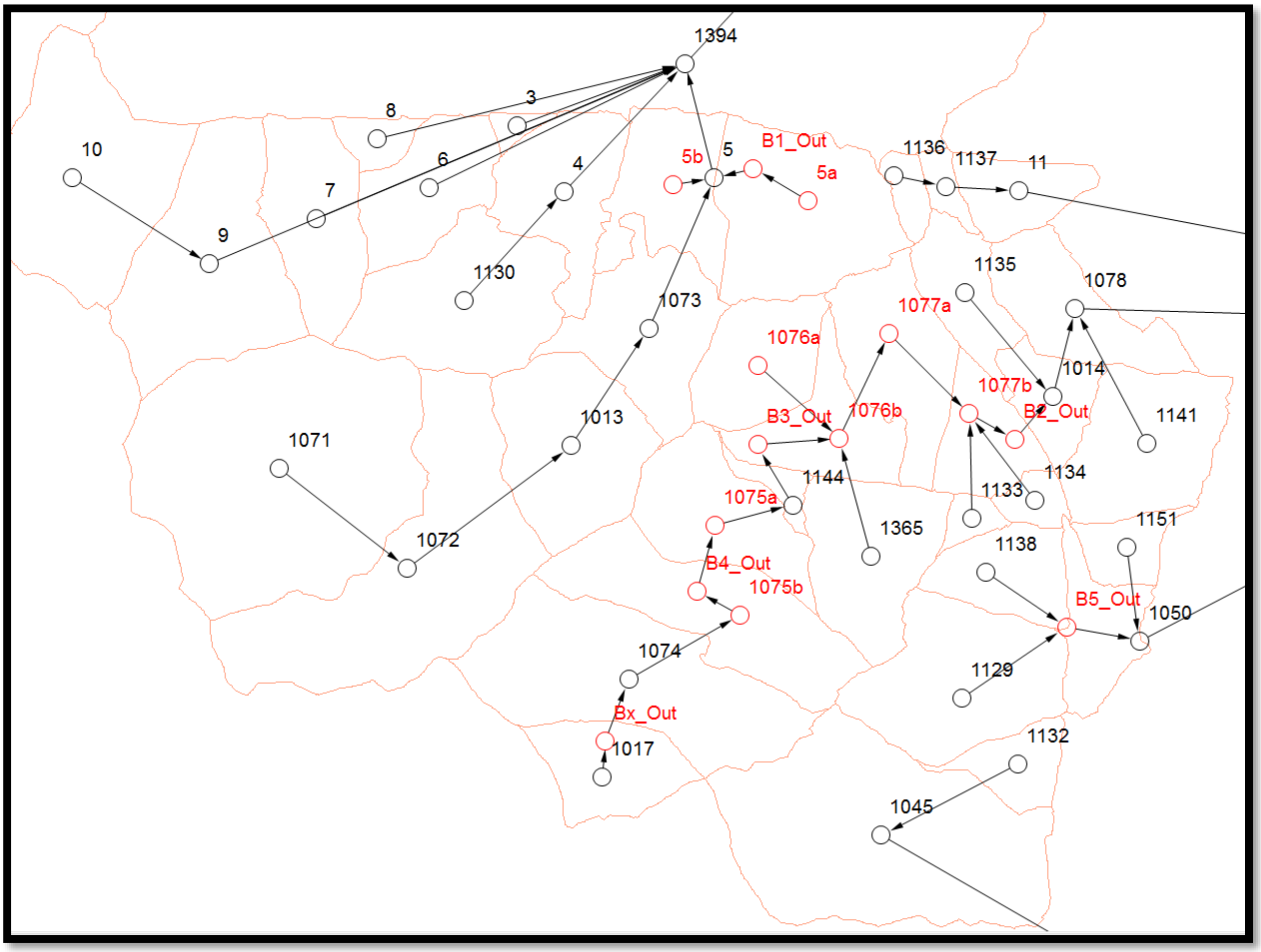

Plate 6-2 – Existing Conditions XP-RAFTS Catchments Model Layout (110628-03_Ex_002.xp)

6.2. Developed Site Conditions

A "Developed" site conditions model has been created by updating the existing site conditions model to represent the ILP land uses. Refer to Plate 6-3 for model layout and Figure 6-02 for the developed catchment plan in Appendix B.

The developed condition model was established by updating the existing condition model with the following changes:

- The existing catchment delineation will be generally be retained. The only exceptions are:
  - Catchment 1365, which reflects the commercial area and playing fields in the centre of the site, are assumed to grade west toward the playing field/corridor;
  - Existing catchments 1133, 1134 and most of 1077b are assumed to discharge to Basin B2 and have therefore been consolidated into catchment 1077a.

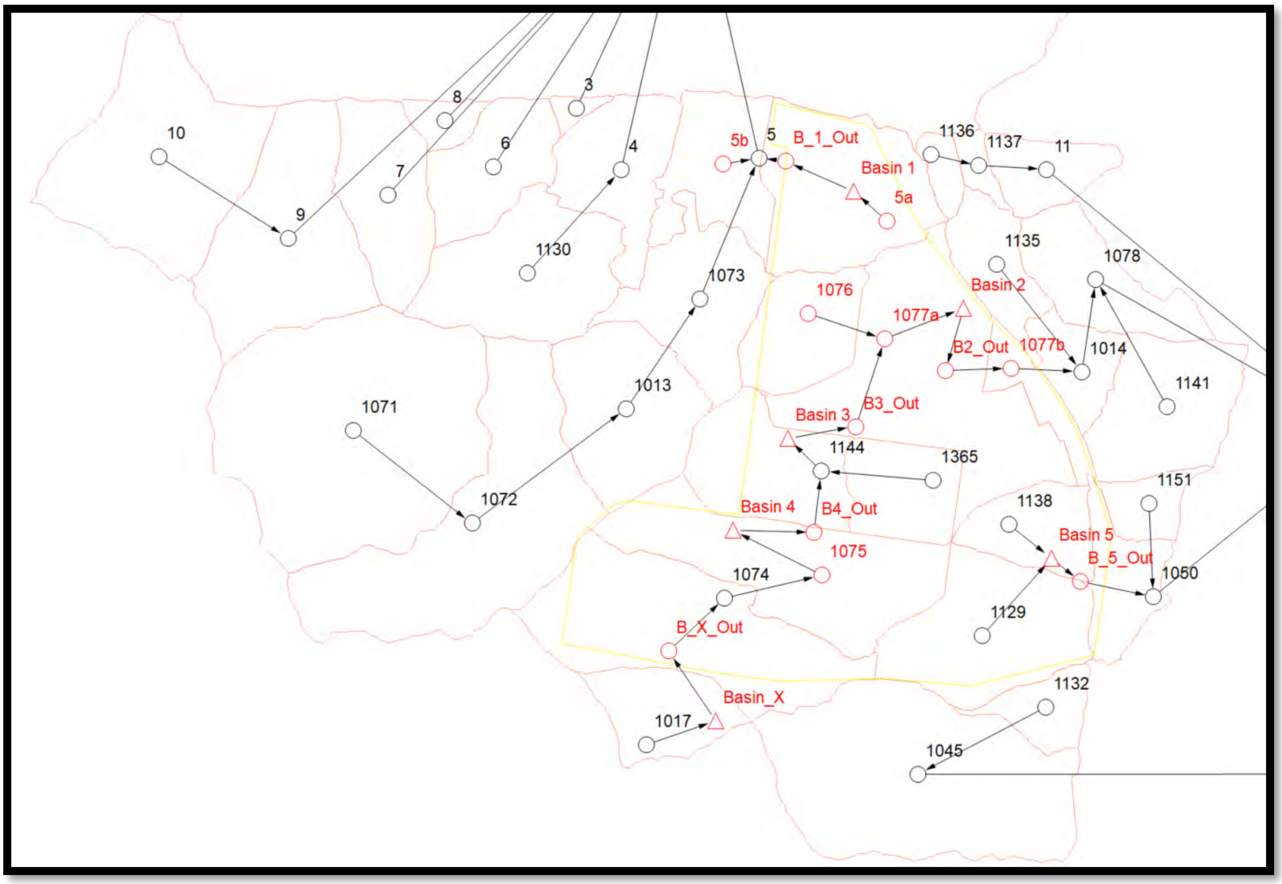

Plate 6-3 – Developed Conditions XP-RAFTS Catchments Model Layout (110628-03_Dev_004.xp)

- In accordance with Council guidelines, fraction impervious values were applied based on the proposed land-use zoning within the ILP. Details of the percentage impervious applied to the model are shown in Table 6-1;
- Developed conditions catchments have been increased in area by 5% to ensure that there is some flexibility in the final catchment arrangement as the design of the Precinct evolves.

  It should also be noted that the modelling for the developed site condition XP-Rafts and developed site condition hydraulic modelling in section 7 are based on the February 2022 ILP. The overall fraction impervious and resulting stormwater runoff characteristics associated with the June 2022 ILP are likely to be marginally reduced give the increase in open spaces area adjacent to the existing riparian corridor. An assessment of the overal ILP suggest that there is a 4 % reducation imperviousness across the Precinct, and the hydrological and hydraulic assessments are therefore considered suitable to support the initial public exhibition process.

Table 6-1 – Developed Conditions Fraction Impervious

Landuse	% Impervious
Low Density	75%
Medium Density	80%
High density	90%
Industrial	90%
Commercial	90%
School	75%
Active Open Space	30%
Passive Open Space	10%
Basins/SP2 Drainage	80%

- Detention basins have been incorporated to attenuate developed conditions flows for the 50% AEP and 1% AEP flood events to ensure there are no increase in peak flow external to the precinct boundary;
- Lag links within the riparian corridor and catchment slopes have been maintained as per the existing condition model; and
- Mannings 'n' of 0.025 and 0.015 has been adopted for pervious and impervious catchment areas, respectively within the Belmore Road Precinct.

6.3. Detention Basins

The proposed stormwater management strategy encompasses a total of five (5) detention basins to manage stormwater runoff at all key locations across the Belmore Road Precinct. The indicative location of proposed detention basins is shown in Plate 2-4, and the key flow reporting locations are shown in Plate 6-1. The reporting locations generally represent Precinct boundaries and locations where the existing terrain naturally grades into surrounding properties.

The catchment assumption for the basin design is that the nearby road network will be designed to allow both minor (piped) and major (overland) flows to discharge to the basins.

As details of the detention basin provided at the southern boundary of the Belmore Road Precinct from the LCM study was not available, Basin X (as shown in Plate 6-3) has been sized to manage the residential development during 50% and 1% AEP event flows back to existing conditions prior to discharge into the Belmore Road Precinct.

Basin 2, 3 and 4 all use the existing flood storage available in the existing riparian corridor and surrounding flood prone land to provide the required detention storages. The basin outlets have been configured to ensure 0.5 m freeboard to the likely road, and adjoining urban development is available. Refinement of both the detention storage arrangement and basin outlet configuration will be required to support the future design phases to accommodate the 20% and 5% AEP events.

6.4. Results

The existing and developed conditions catchment peak flow for the 50% and 1% AEP storm events were derived from the XP-RAFTS model. The storm durations as specified in the USC model user guide were assessed. Table 6-2 shows a comparison between "existing" and "developed" condition peak flows with the proposed detention basin at each of the key comparison locations shown in Plate 6-1.

Table 6-2 – Comparison of Existing and Developed Flows

Report Location	Comparison Node	50% AEP					1% AEP				
		Ex	Durn	Dev	Durn	Dev/Ex	Ex	Durn	Dev	Durn	Dev/Ex
A	1394	12.00	1440 (6)	11.95	1440 (6)	1.00	51.99	360 (5)	51.97	360 (5)	1.00
B	5	3.56	1440 (6)	3.52	1440 (6)	0.99	15.57	360 (5)	15.47	360 (5)	0.99
C	B1_Out	0.52	1440 (6)	0.42	30 (9)	0.81	2.36	360 (5)	2.29	360 (5)	0.97
D	11	0.29	540 (5)	0.29	540 (5)	1.00	2.49	30 (1)	2.49	30 (1)	1.00
E	Bx_Out	0.23	1440 (6)	0.23	1440 (6)	1.00	1.07	360 (5)	1.07	360 (5)	1.00
F	B4_Out	1.41	1440 (6)	3.10	30 (9)	2.20	6.43	360 (5)	7.89	30 (1)	1.23
G	B3_Out	1.79	1440 (6)	2.99	30 (9)	1.67	8.13	360 (5)	8.09	360 (5)	1.00
H	B2_Out	3.33	1440 (6)	2.59	540 (5)	0.78	14.81	360 (5)	12.19	360 (5)	0.82
I	1077b	3.33	1440 (6)	2.68	540 (5)	0.80	14.81	360 (5)	12.69	360 (5)	0.86
J	1014	3.66	1440 (6)	2.96	540 (5)	0.81	16.19	360 (5)	14.30	360 (5)	0.88
K	1078	4.32	1440 (6)	3.54	540 (5)	0.82	18.90	360 (5)	17.51	360 (5)	0.93
L	B5_Out	0.73	1440 (6)	0.73	30 (9)	1.00	3.54	360 (5)	3.14	360 (5)	0.89
M	1050	1.03	1440 (6)	0.97	1440 (6)	0.94	5.11	360 (5)	4.60	360 (5)	0.90
N	1045	0.97	540 (5)	0.95	540 (5)	0.98	4.21	360 (5)	4.14	360 (5)	0.98

It is noted that there are some flow increases within the site at reporting locations F and G. These local flow increases are within the Precinct and are further managed by Basin 2 to ensure that there is no increase in peak flows at the Belmore Road Precinct boundary.

It is important to note that the primary function of the XP-RAFTS model was to provide indicative detention storage requirements and to provide inflow hydrographs for use in the TUFLOW hydraulic model. The TUFLOW hydraulic model described in Section 7 provides a more accurate reflection of flow routing and confirms that there are no adverse flood impacts in the receiving catchments in the 50% and 1% AEP events.

The summary of the preliminary detention volumes and storage characteristics required at each basin to ensure that post developed flows do not exceed pre-developed flows are provided in Table 6-3. The simple basin outlet arrangements documented in Table 6-4 are preliminary only and assume a high level weir to manage the 1% AEP event. It is anticipated that the outlet arrangements will need to be refined as part of the DA design, particularly for Basin B2 as the high flow outlet will likely need a secondary culvert to manage 1% AEP flows without overtopping the adjacent road. In TUFLOW, the Basin 2 weir has been modelled as a large box culvert to reflect this intention.

Table 6-3 – Summary of Proposed Detention Volumes

Basin	Invert (m AHD)	50% AEP			1% AEP		
		Stage (m AHD)	Depth (m)	Storage (m³)	Stage (m AHD)	Depth (m)	Storage (m³)
B1	77.00	78.22	1.22	1721	79.19	2.19	10619
B2	70.48	72.93	2.45	11782	73.55	3.07	24321
B3	75.84	77.09	1.25	1325	78.22	2.38	8667
B4	78.89	80.36	1.47	3459	81.39	2.50	11239
B5	74.20	75.29	1.09	3065	76.2	2.00	14381

Table 6-4 – Preliminary Basin Outlet Assumptions

Basin Outlet Details		
Basin	**Low Flow Outlet**	**High Flow Outlet**
B1	2 x 375mm RCP @ 1.0% Grade. I.L. 77.00 m AHD	21 m weir @ 79.05 m AHD
B2	1 x 900mm RCP @ 0.5% Grade. I.L. 70.48 m AHD	21.6 m weir @ 73.15 m AHD; reflected in TUFLOW model as: 6 x 3600 x 600mm RCBC @ 0.3% Grade. I.L. 73.15 m AHD
B3	1 x 1800 x 1200mm RCBC @ 0.7% Grade. I.L. 75.84 m AHD	50 m weir @ 78.50 m AHD reflects road.
B4	1 x 1500 x 1500mm RCBC @ 0.4% Grade. I.L. 78.89 m AHD	50 m weir @ 82.50 m AHD reflects road
B5	3 x 375mm RCP @ 1.0% Grade. I.L. 74.20 m AHD; modelled in TUFLOW as separate 2 x 375 and 1 x 375 RCPs at two (2) basin outlet locations	21 m weir @ 76.05 m AHD; Modelled in TUFLOW as two (2) separate weirs at two basin outlet locations

The hydrological modelling results confirm that the proposed five (5) detention basins within the Belmore Road Precinct will ensure that post-development flows do not exceed existing flows at all key comparison locations external to the Precinct for the 50% and 1% AEP storm events. The hydraulic impacts within the Precinct detailed in Section 7.

7. FLOOD IMPACT ASSESSMENT

The USC TUFLOW hydraulic model was updated by WMA Water in 2020 to reflect the AR&R 2019 procedures. At the time of writing this report, only the user guide associated with the model has been provided, as such it is not possible to provide a detailed model report review.

J. Wyndham Prince has been provided both the USC TUFLOW model and results for comparison purposes. As discussed in Section 6 of this report, some issues relating to catchment areas and rainfall data were identified, which will have flow on effect for the hydrographs adopted in the TUFLOW hydraulic modelling.

Our approach to the flood impact assessment is as follows:

- Re-run the USC flood model to confirm that flood results provided by Council are replicated;
- The USC model has been trimmed to focus on the Belmore Road Precinct, adopting HQ slope boundaries where necessary to reflect the hydraulic grade of the broader model flood results;
- The trimmed USC model was run for the 50% AEP and 1% AEP event to confirm consistent results with the larger USC WMA, 2020 model as supplied by Council;
- The trimmed existing conditions Belmore Road Precinct model was then run with inflow hydrographs that utilise the 'west' IFD data for reasons as discussed in Section 6 of this report. Some minor modifications described in Section 7.2 below were also made. This model is considered the base case model for the 9recinct; and
- The base case model was then augmented to reflect the existing condition and developed condition model with detention basins.

The TUFLOW modelling is described in further detail below:

7.1. Available Data

The following data was used to inform the modelling:

- Hydrology model (XPRAFTS) used for stormwater management strategy (Section 6);
- Upper South Creek TUFLOW flood model (WMA, 2020);
- The Belmore Road Precinct ILP supplied by URBIS; and
- Aerial photography of the site recorded by Nearmap, 2020.

7.2. Events and Durations

The TUFLOW model was run in model build 2018-03-AE_iSP for the events and durations in Table 7-1 in accordance with the USC model user guide (WMA, 2020).

Table 7-1 Modelled TUFLOW Events and Durations

<table>
<tr><th></th><th>Duration</th><th>Temporal Pattern</th></tr>
<tr><td rowspan="3">50% AEP
20% AEP</td><td>30m</td><td>9</td></tr>
<tr><td>540m</td><td>5</td></tr>
<tr><td>1440m</td><td>6</td></tr>
<tr><td rowspan="3">5% AEP</td><td>60m</td><td>6</td></tr>
<tr><td>360m</td><td>1</td></tr>
<tr><td>1080m</td><td>6</td></tr>
<tr><td rowspan="3">1% AEP</td><td>30m</td><td>1</td></tr>
<tr><td>360m</td><td>5</td></tr>
<tr><td>720m</td><td>8</td></tr>
<tr><td rowspan="3">PMF</td><td>60m</td><td rowspan="3">n/a</td></tr>
<tr><td>120m</td></tr>
<tr><td>240m</td></tr>
</table>

7.3. Existing Condition Model

To establish an existing condition model for the Belmore Road Precinct, the following amendments were made:

- The TUFLOW model boundary was trimmed to the east and south of the site, and appropriate boundary conditions were adopted;
- Inflow hydrographs which reflect changes to rainfall data and calculated catchment areas as discussed in section 6 of this report were adopted;
- Culverts are modelled with a zero blockage scenario; and
- An initial water level for farm dams within the site were set to the spill level based on the terrain within the TUFLOW model.

An existing conditions TUFLOW model setup plan, together with a Mannings 'n' roughness plan are provided in Figures 7-01 and 7-02, respectively in Appendix B.

7.3.1 Model Validation

Three (3) model validation runs were completed to enable comparison to the USC WMA, 2020 TUFLOW model results provided by Council.

Validation 1 – Replicate Council Model Results

The 1% AEP 720-minute duration storm was run and compared with the gridded results provided by Council. Plate 7-1 below provides a flood level difference map which confirms that there are no measurable flood level differences and therefore, the USC results have been successfully replicated.

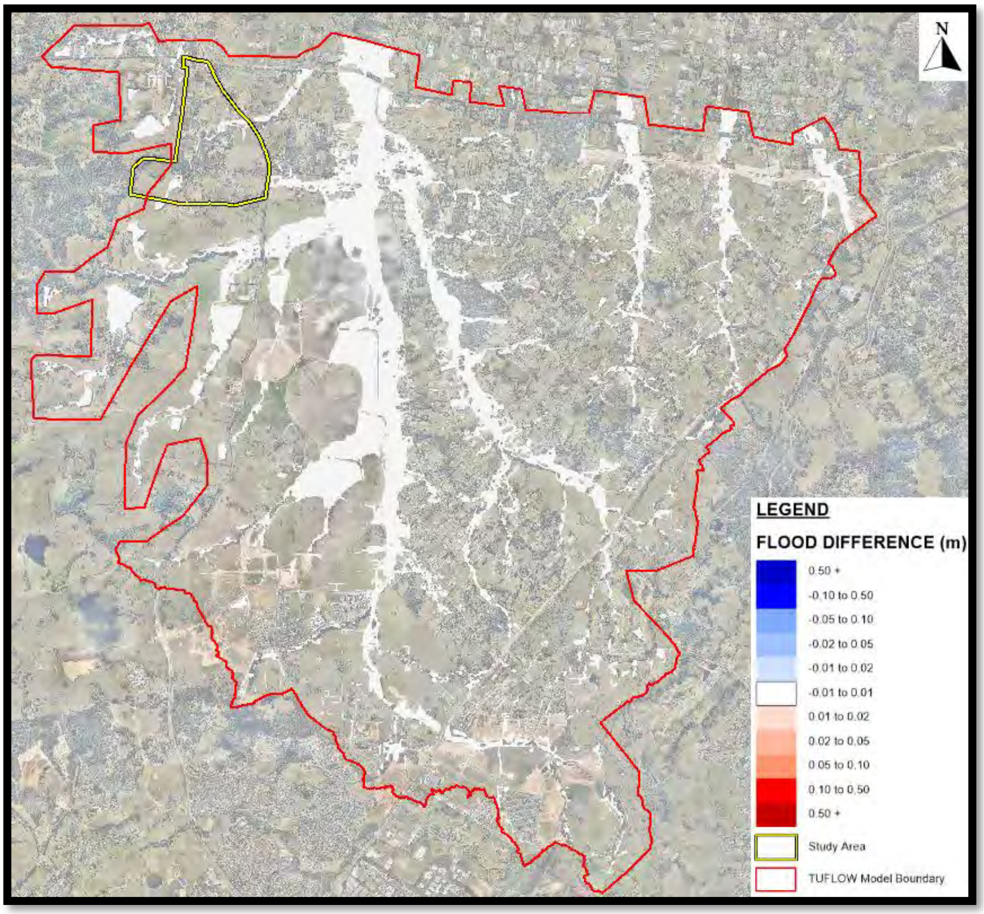

Plate 7-1 – Replicate 1% AEP 720 Minute Duration Council Model Results

Validation 2 – Compare trimmed model with Council results

The peak 1% AEP existing conditions trimmed model results have also been compared with Council's peak 1% AEP results. The flood difference map shown in Plate 7-2 confirms that, with the exception of the boundary locations themselves, there are no observable flood level differences within and in the vicinity of the Precinct. Given that the location of the flood level difference at the new boundary locations is more than 400 m from the Precinct, the adopted boundary conditions will not influence flood levels within the area of interest.

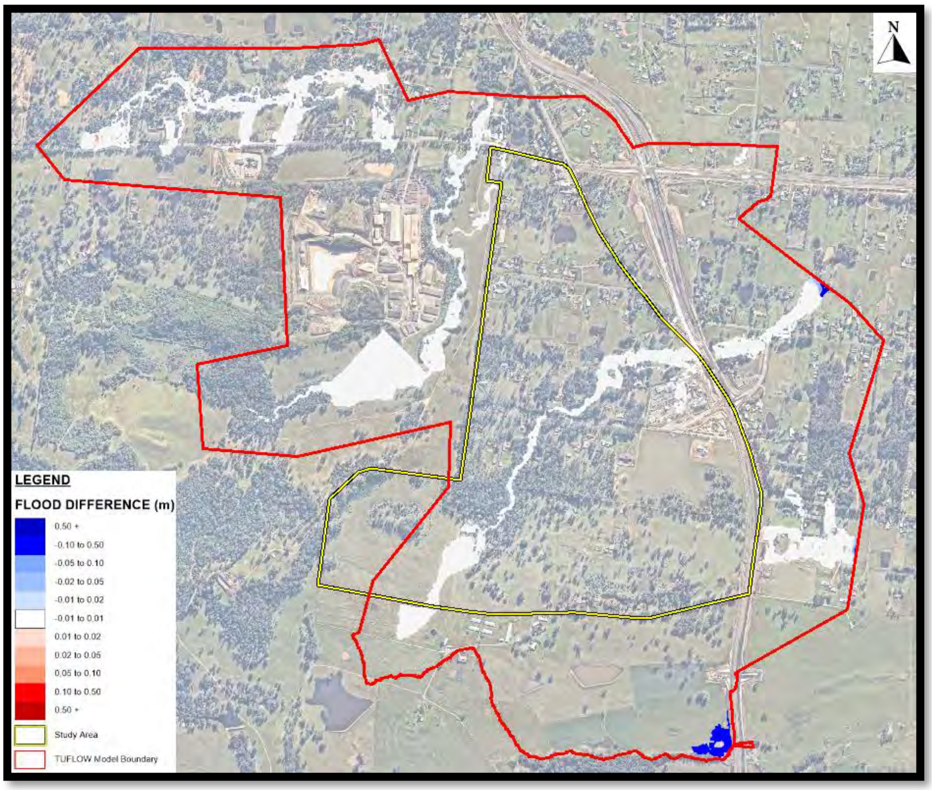

Plate 7-2 – Compare 1% AEP Trimmed Model Results with USC WMA, 2020 Results

Validation 3 – Compare Existing Conditions site model with Council Results

Given that initial water levels with all dams within the corridors are now included and updated inflow hydrograph data has been adopted, some differences between Council's model are anticipated. This assessment sets the base conditions for the Belmore Road Precinct modelling. The flood difference map in Plate 7-3 reflects the peak 1% AEP existing conditions results for the site compared with Council's model results.

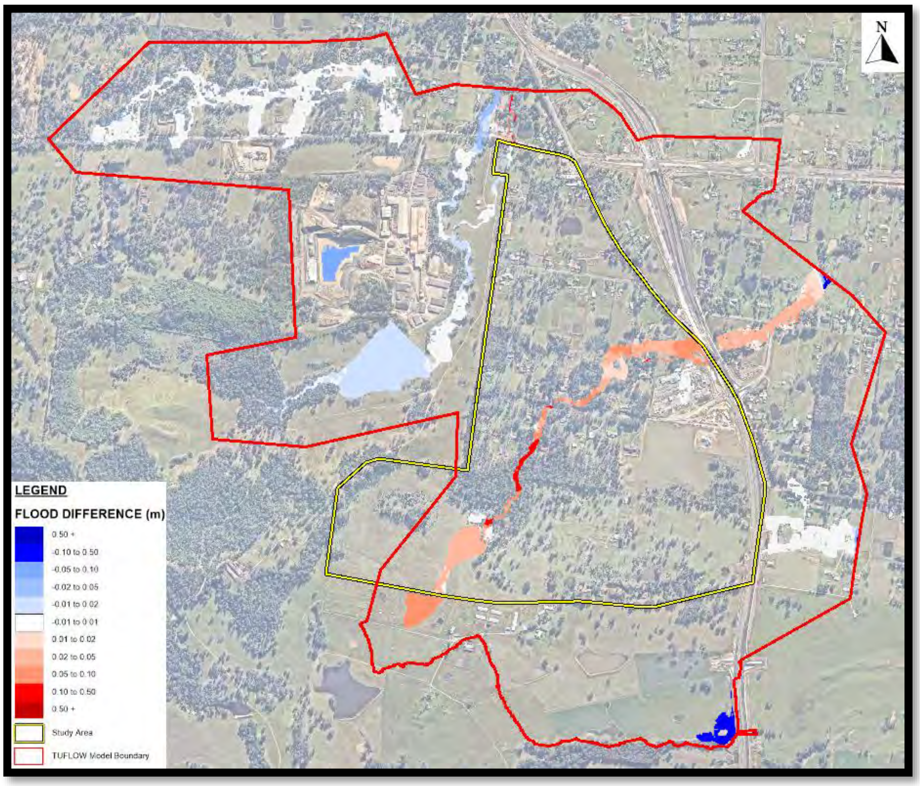

Plate 7-3 – Compare 1% AEP Existing Conditions Model Results with Council Results

Flood level decreases external to the site are due to the 'west' rainfall data adopted in the inflow hydrographs, which also suggests a reduced runoff volume in this western portion of the South Creek floodplain. For example, the peak local inflow for 59.6 ha catchment 1071 to the west of the site (see Plate 6-2) was 4.96 m^3/s in Council's original model and is now 4.83 m^3/s.

Flood level increases within the corridor through the Precinct are a result of a reduction in the available passive storage due to the existing farm dams being filled to their spillway levels.

Flood level reductions at the TUFLOW model boundary are similar to those observed in Plate 7-2 and are due to the adopted HQ flood model boundary at these locations. These boundary conditions do not have any influence on flood behaviour within the Belmore Road Precinct.

7.3.2 Developed Condition Model

An assessment of the developed condition was undertaken by amending the existing condition model with an indicative landform surrounding the proposed detention basins. The developed (unmitigated) flows from XP-RAFTS model were applied to the riparian corridors to assess the performance of the WCMS.

The ILP was used to update the land use for the proposed development model (Appendix A). The roughness value adopted for the proposed land-use external to the site are consistent with the values adopted in the USC WMA, 2020 flood model. Table 7-2 provides details of Mannings' n' values adopted within the model.

Table 7-2 – Roughness Value

Mannings Roughness 'n'	
Landuse	**Value**
Bare Earth	0.02
Maintained Grass/Park/Ovals	0.03
Floodplain Grass/Pasture	0.04
Light Vegetation	0.045
Medium Vegetation	0.06
Dense Vegetation	0.08
Dense Riparian Vegetation	0.12
Creeks and Open Water/Basins	0.03
Roads	0.02
Road Corridor	0.035
Paved Areas	0.02
Low Density Residential	0.045
Medium Density Residential	0.06
Industrial /Commercial /Schools	0.03
Railway	0.06
Bringelly Low Density Residential	0.1
Bringelly Medium Density Residential/School	0.2
Bringelly High Density Residential/Commercial/Industrial	0.3
Bringelly Riparian Corridor	0.12 < 0.5m depth 0.03 > 1.0m depth

A developed conditions TUFLOW model setup plan, together with a Mannings' n' roughness plan, are provided in Figure 7-03 and 7-04, respectively in Appendix B.

The TUFLOW model was assessed for a series of AEPs and storm durations to understand the impacts of the proposed development may have on the receiving catchments.

7.4. Discussion of Results

7.4.1 Existing Scenario Flood Behaviour

The existing condition flood depth and level results for the 50%, 20%, 5% and 1% AEP events, together with the PMF are shown on Figures 7-05, 7-08, 7-11, 7-14 and 7-17 in Appendix B respectively. Overland flooding from an existing farm dam in the north of the site generally flows in a north-westerly direction across Greendale Road towards the main watercourse, and ponding of floodwater behind Bringelly Public School is also evident in both flood events.

Flooding within the central riparian corridor is generally contained within the creek lines, except for existing farm dam locations where flood extents increase due to the spillway embankments and find alternate overland routes back to the watercourse.

The existing condition flood depths and extents generally reflect well-defined watercourses through and adjacent to the Belmore Road Precinct.

7.4.2 Developed Scenario Flood Behaviour

The developed conditions flood depth and level results for the 50%, 20%, 5% and 1% AEP events, together with the PMF are shown in Figures 7-06, 7-09, 7-12, 7-15 and 7-18 in Appendix B respectively. Flood extents external to the site are generally consistent with existing conditions, with some reductions behind Bringelly Public School north of the precinct boundary being evident.

Flood extents are contained within the central riparian corridor up to the 1% AEP, with no evidence of 1% AEP flows entering developable areas. Flood hazard mapping presented in Figure 7-19 in Appendix B indicates that there are no unsafe areas within the proposed urban portion of the Belmore Road Precinct.

In the PMF event, some minor encroachment onto lots is noted, with depths of 0.3 – 0.5 m present adjacent to the Basin 2 road crossing outlet. H2 flood hazard mapping in Figure 7-20 indicates that the urban portion of the floodplain is generally safe to occupy. Future refinements to the modelling and design of the detention basins will ensure that these impacts can be managed.

It is important to note that a blockage assessment has not been undertaken at this stage. However, given that the PMF is generally well contained within the corridor, it is anticipated that a 1% AEP blockage scenario is unlikely to affect the proposed lots greater than PMF event affectation.

7.5. Flood Impact Assessment

Flood difference mapping for the 50%, 20%, 5% and 1% AEP events are presented in Figures 7-07, 7-10, 7-13 and 7-16, respectively, in Appendix B.

Generally, there are no adverse flood level impacts external the Belmore Road Precinct in the 50% and 1% AEP events. Flood level reductions to the north of the site near Greendale Road result from the improved management of flow from Basin 1 low flow outlet to the Thompson's Creek watercourse in the west. Some isolated minor flood level increases (less than 20 mm) due to the change in hydraulic connectivity are noted just downstream of Greendale Road, however, given the benefit of the broader flood level reductions behind Bringelly Public School, these minor increases within Thompson’s Creek within Bringelly Park are considered acceptable.

Local flood level increases within the Belmore Road Precinct due to the proposed development are expected. The results confirm that the proposed detention basins within the Precinct appropriately manage flows back to existing conditions at the precinct boundary in the 50% 1% AEP events. Some further refinement to the basin outlet structures will be needed to manage impacts in the 20% and 5% AEP events.

7.5.1 Flow Comparison

A comparison of peak existing and developed condition flows just downstream of the site boundary is provided in Table 7-3. Flow increases in the 50% and 1% AEP events are relatively minor and did not result in any adverse flood level increases. Refinement to the outlet structures will be undertaken as part of future assessments to ensure that the 20% and 5% AEP events are appropriately managed. Plate 7-4 provides an overview of the reporting locations.

Table 7-3 – TUFLOW Flow Comparison

Location	Report Node	50% AEP		20% AEP		5% AEP		1% AEP		PMF	
		Ex	Dev	Ex	Dev	Ex	Dev	Ex	Dev	Ex	Dev
North	PO Line R042_Q	0.33	0.00	0.52	0.00	1.63	1.21	5.85	5.78	134	129
	Culvert Survey_18	2.26	2.50	3.76	3.95	4.98	5.04	5.02	5.07	6.63	6.68
	PO Line G154	2.47	2.49	4.22	3.95	6.22	6.16	10.6	10.7	141	136
East	PO Line G149	2.89	2.92	4.86	5.62	10.5	11.7	14.8	14.0	167	177
	Culvert C10.58	2.91	2.95	4.88	5.65	10.5	11.8	14.8	14.0	108	109
	Culvert C09.89	0.23	0.26	0.49	0.27	1.19	0.33	1.98	0.91	4.47	4.42
	Culvert C09.70	0.51	0.51	0.75	0.55	2.07	0.89	2.35	2.18	13.4	13.1

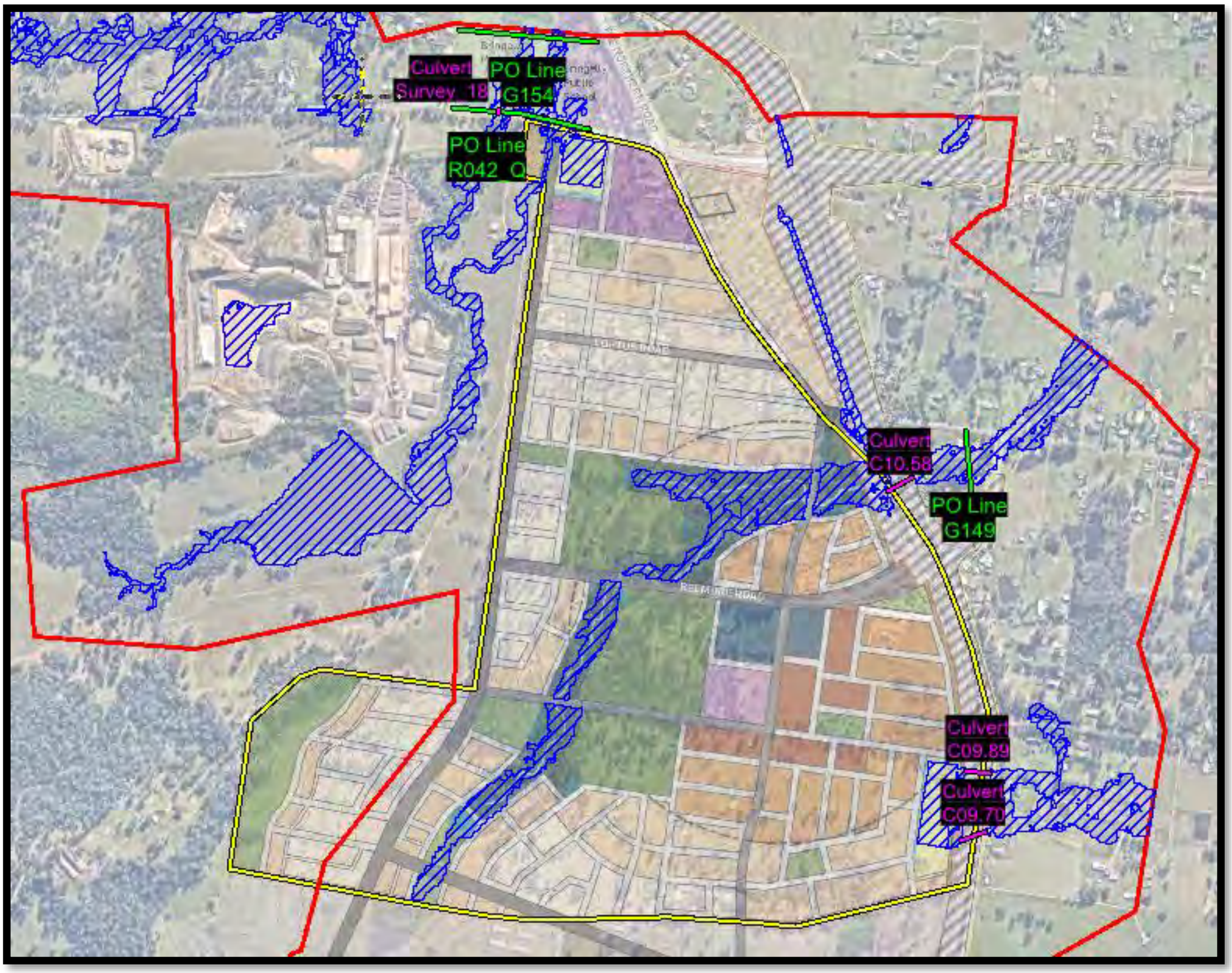

Plate 7-4 – TUFLOW Flow Comparison Locations

7.6. Climate Change Sensitivity

The 1% AEP developed conditions flood behaviour shown in Figure 7-15 is contained within the riparian corridor and the preliminary surface grading of the Precinct ensures that a minimum of 0.5 m freeboard is achieved to the adjacent development.

Future assessments will consider a climate change sensitivity assessment as part of the full suite of events and durations to be run in accordance with the USC model guide to support future development applications. Notwithstanding, given that the PMF results indicate minimal encroachment on lots, it is unlikely that a climate change sensitivity assessment will have an impact on the developable portion of the Belmore Road Precinct. Thus the need for a separate climate change assessment is not seen as necessary at this time.

8. GLOSSARY

Term	Definition
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.
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.
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
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.

Term	Definition
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.

9. REFERENCES

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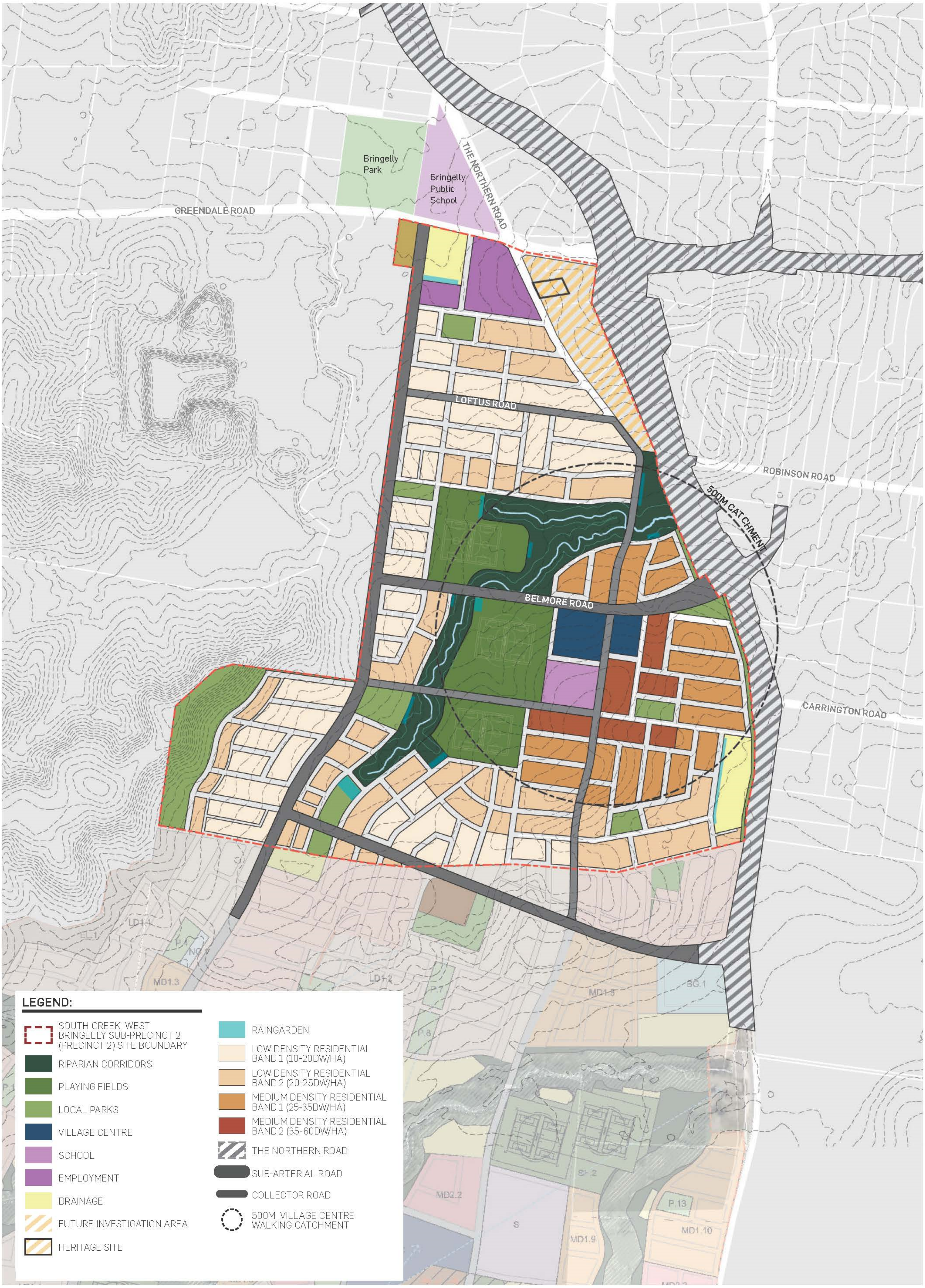
7. Willing & Partners Pty. Ltd. (1994). *Runoff Analysis & Flow Training Simulation*. Detailed Documentation and User Manual, Version 4.0

APPENDIX A – SOUTH CREEK WEST BELMORE ROAD PRECINCT INDICATIVE LAYOUT PLAN



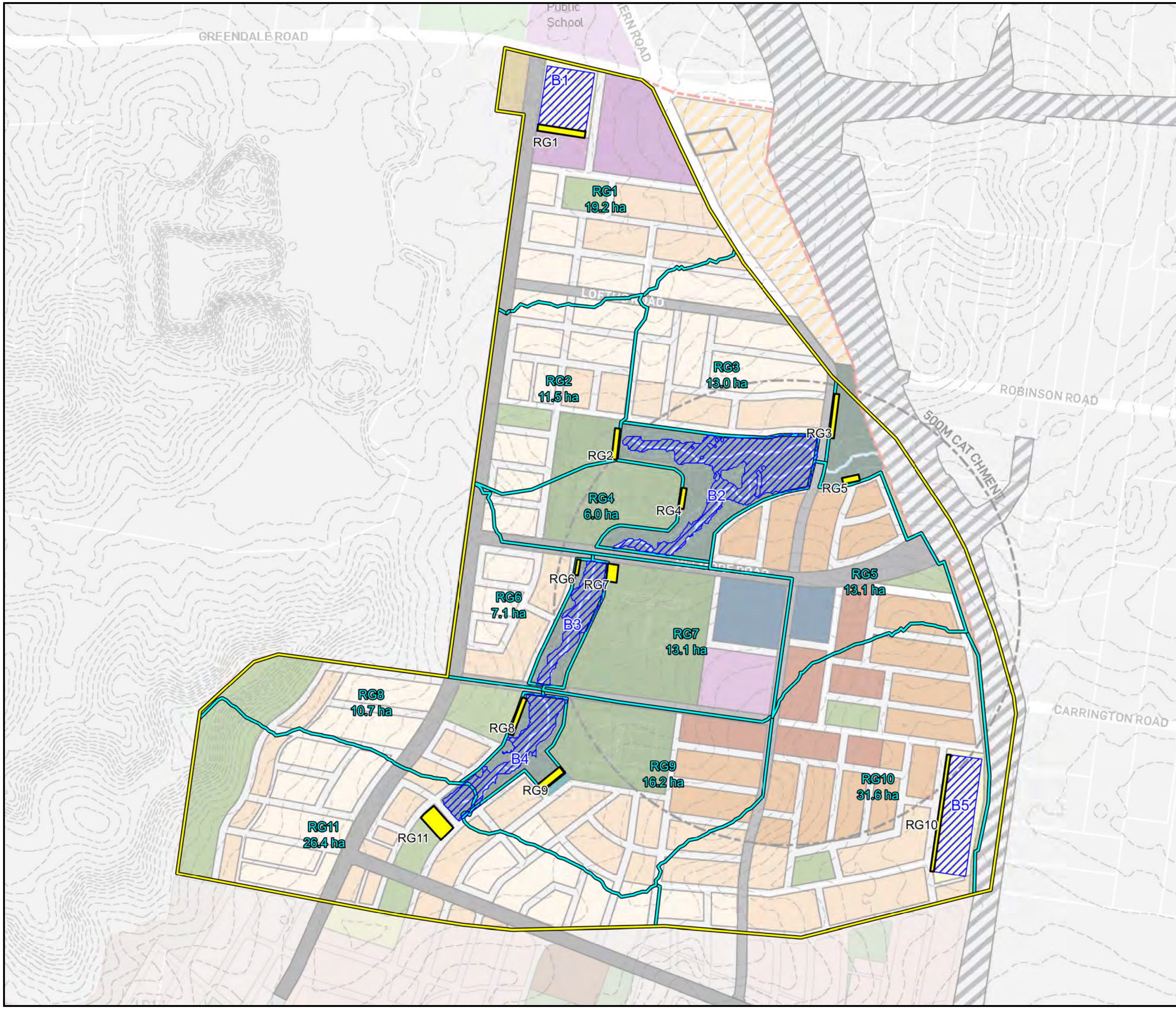
URBIS

SOUTH CREEK WEST - BRINGELLY SUB-PRECINCT 2

PRECINCT 2 REVISED FINAL ILP

DATE: 14.06.2022
JOB NO: P0030401
DWG NO: -
REV: B

APPENDIX B – FIGURES



J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

LEGEND

- Site Boundary
- Assumed Raingarden Catchments
- Indicative Basin Footprint
- Indicative Raingarden Footprint
- RG1 19.2 ha — Catchment ID, Area

NOTES

- Raingarden locations within riparian corridor subject to offest requirements and flood constraints

N

0 300 metres

Scale 1:7,500 @ A3

Projection: GDA 1994 MGA Zone 56

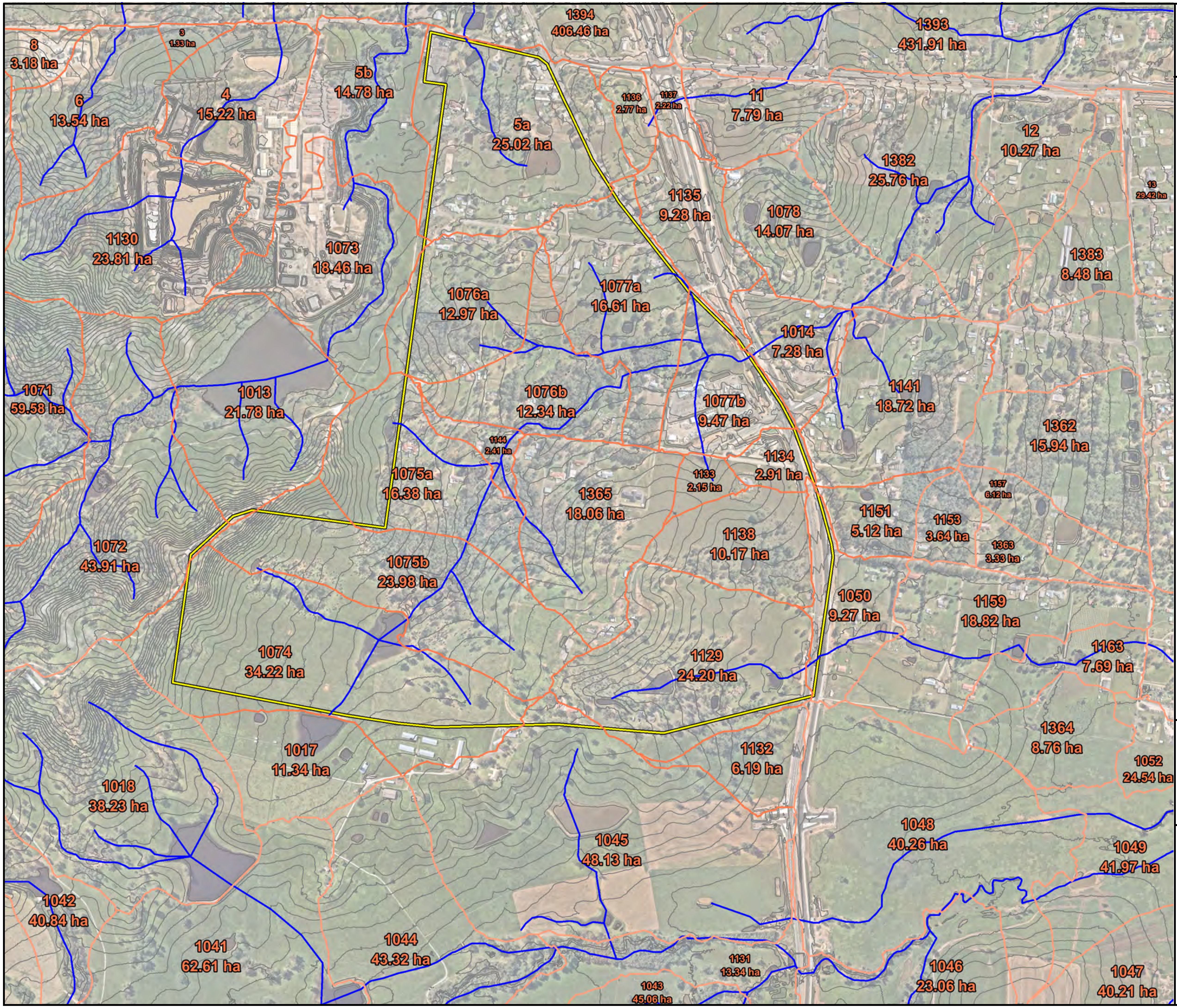
Figure 5-01

South Creek West Bringelly Sub-Precinct 2

Developed Conditions Water Cycle Management Plan

Date: 23/06/2022 Issue: D

Filename: "J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig5-01_DEV03_WQCP_D.wor"



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LEGEND

Site Boundary
Existing Conditions Catchment
1075a 16.38 ha — Catchment ID Area
Watercourse
2m Contours

N
0 — 380
metres
Scale 1:9,500 @ A3

Projection: GDA 1994 MGA Zone 56

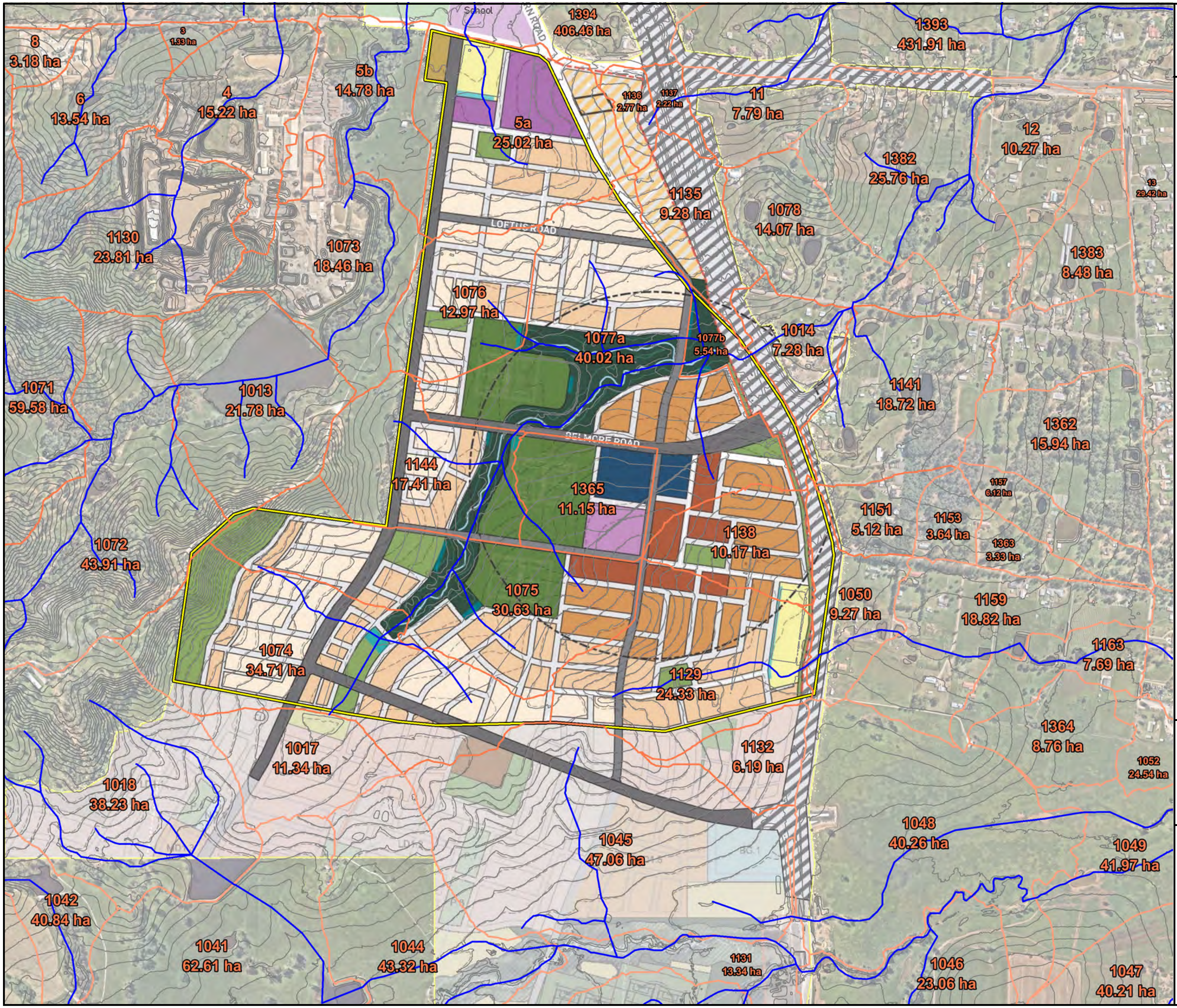
Figure 6-01

South Creek West Bringelly Sub-Precinct 2

Existing Conditions Catchment Plan

Date: 20/08/2021 Issue B

Filename: "J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig6-01_EX01_CP_B.wor"



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LEGEND

- Site Boundary
- Developed Conditions Catchment
- 1144 / 17.41 ha — Catchment ID / Area
- Watercourse
- 2m Contours

N

0 — 380 metres
Scale 1:9,500 @ A3

Projection: GDA 1994 MGA Zone 56

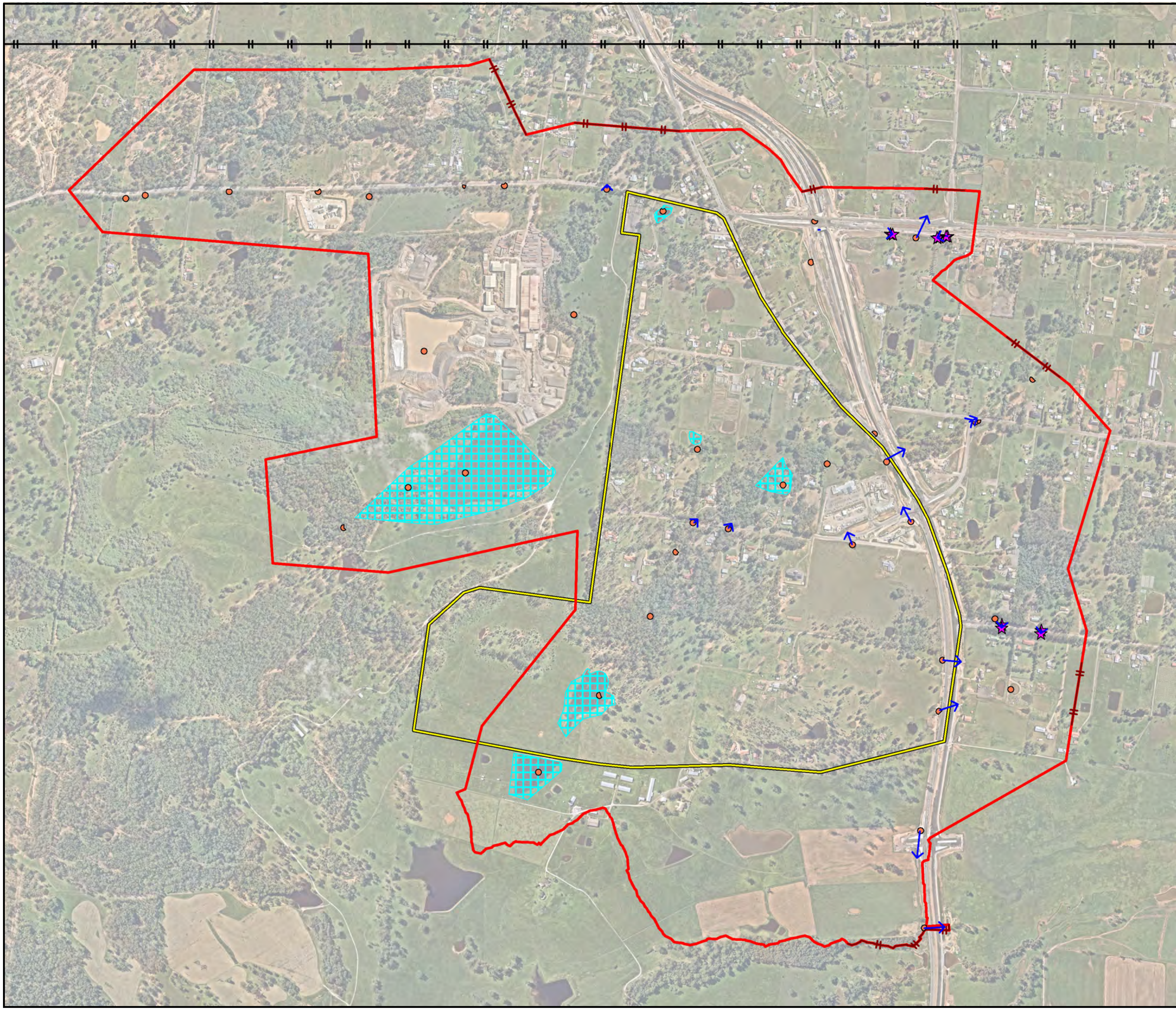
Figure 6-02

South Creek West Bringelly Sub-Precinct 2

Developed Conditions Catchment Plan

Date: 23/06/2022 Issue D

Filename: "J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig6-02_DEV03_CP_D.wor"



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LEGEND

TUFLOW MODEL ELEMENTS

- TUFLOW Model Boundary
- IWL Initial Water Level Area
- HQ Slope Boundary
- 2D LOC Boundary
- 1D NWK Culvert
- 2D SX Connection (Point)
- SA Catchment Inflow Boundary

N

0 460 metres
Scale 1:11,500 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-01

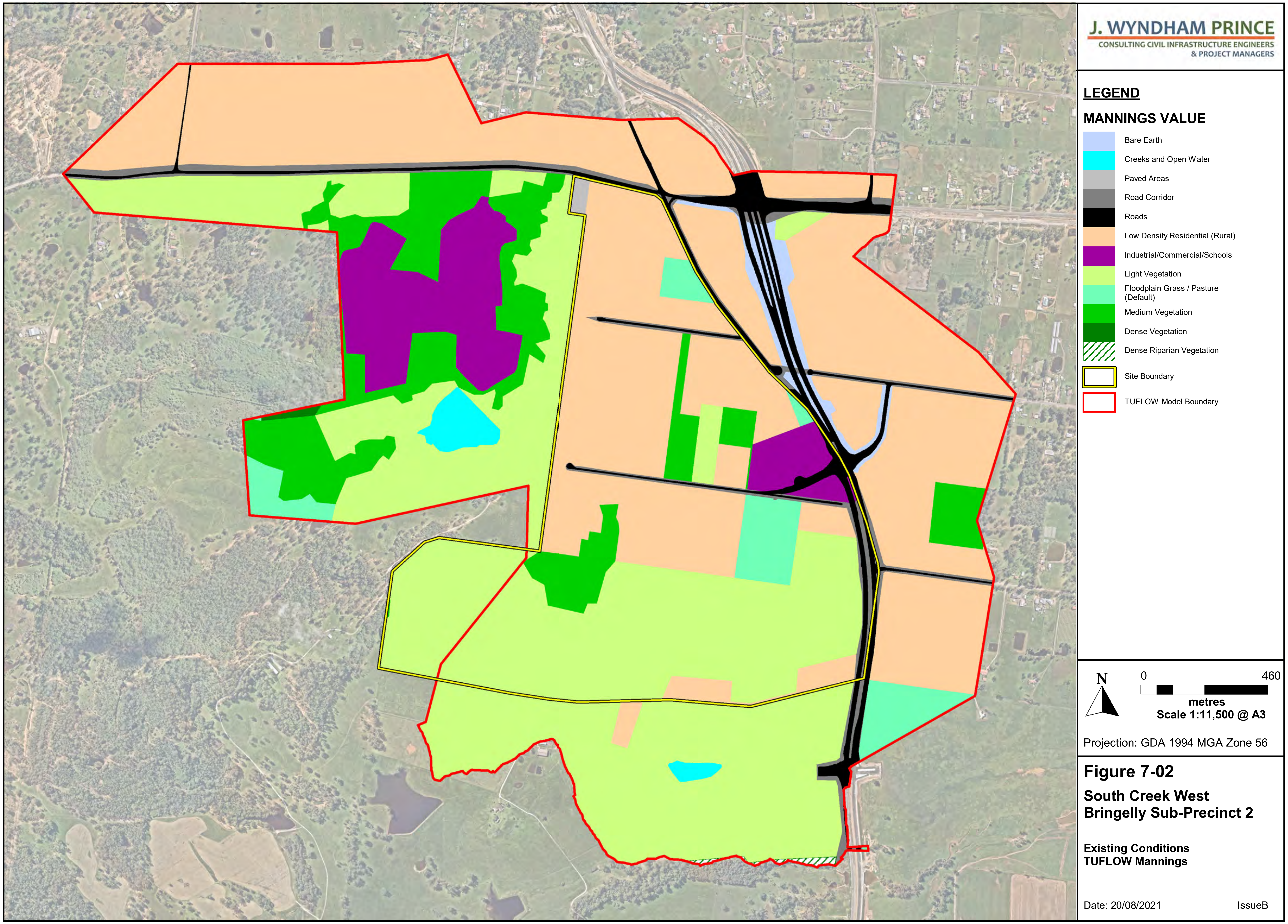
South Creek West Bringelly Sub-Precinct 2

Existing Conditions TUFLOW Setup

Sate: 20/08/2021

Issue B

Filename: "J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-01_EX01_TFS_B.wor"



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Projection: GDA 1994 MGA Zone 56

Figure 7-02

South Creek West
Bringelly Sub-Precinct 2

Existing Conditions
TUFLOW Mannings

Date: 20/08/2021 IssueB

Filename: "J:\110705 - SC West Bringelly Precinct02 - WCM\SW&E\Figures\110705-02_Fig7-02_EX01_TFM_B.wor"

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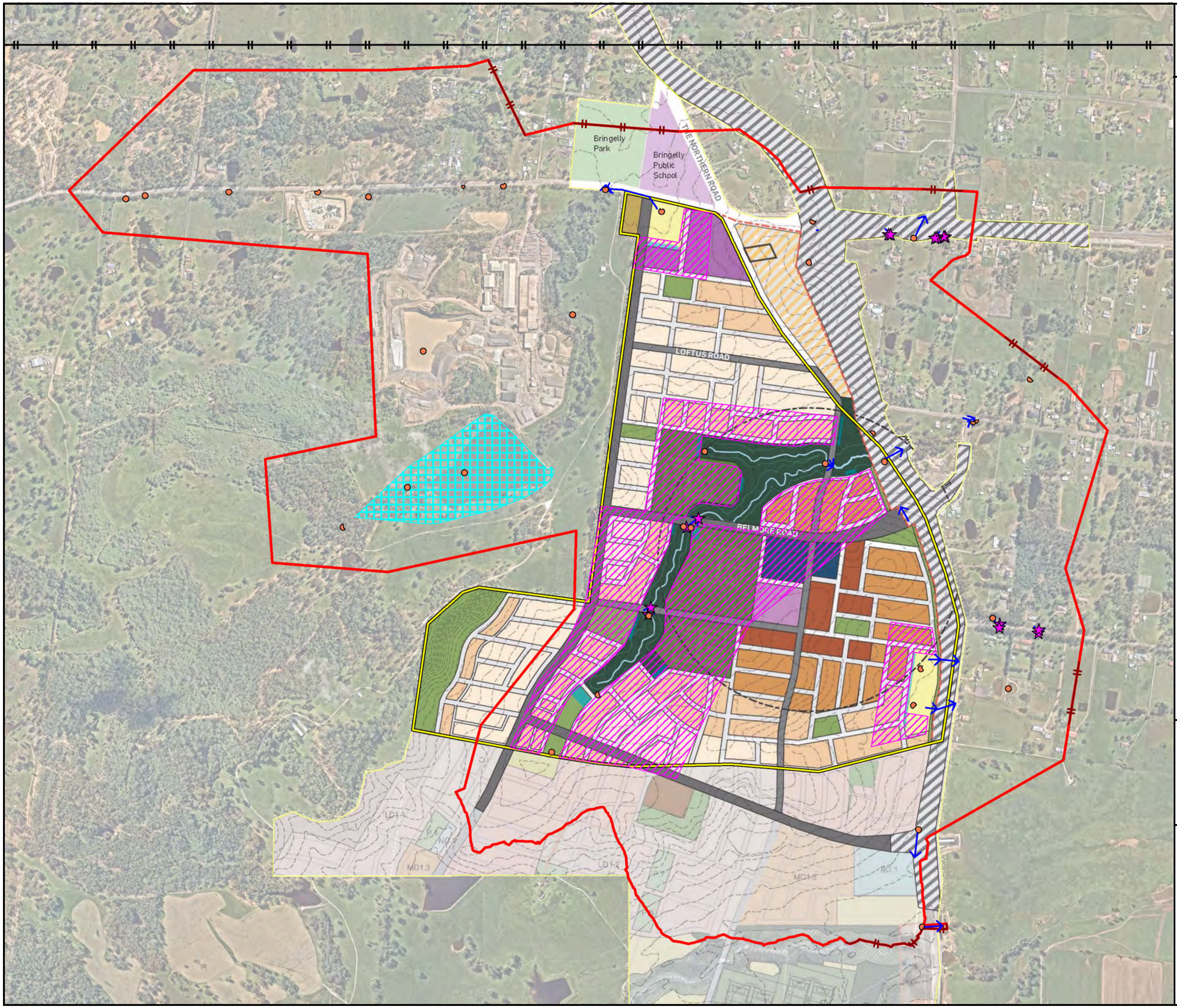

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LEGEND

TUFLOW MODEL ELEMENTS

- TUFLOW Model Boundary
- IWL Initial Water Level Area
- Terrain Modification (Z Shape)
- HQ Slope Boundary
- 2D LOC Boundary
- 1D NWK Culvert
- 2D SX Connection (Point)
- SA Catchment Inflow Boundary

N

0 460
metres
Scale 1:11,500 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-03

South Creek West Breingelly Sub-Precinct 2

Developed Conditions TUFLOW Setup

Date: 23/06/2022 Issue D

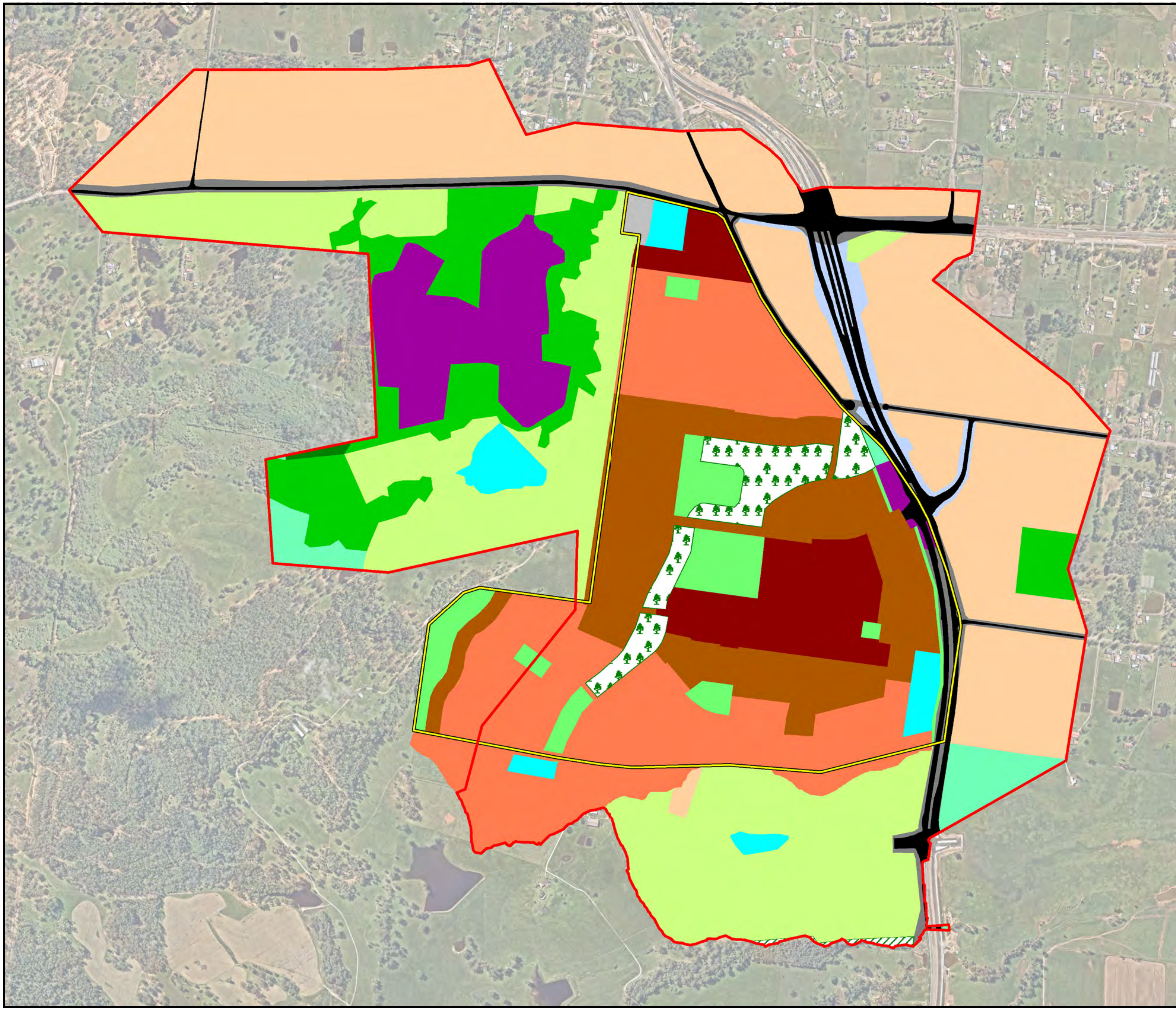


Figure 7-04

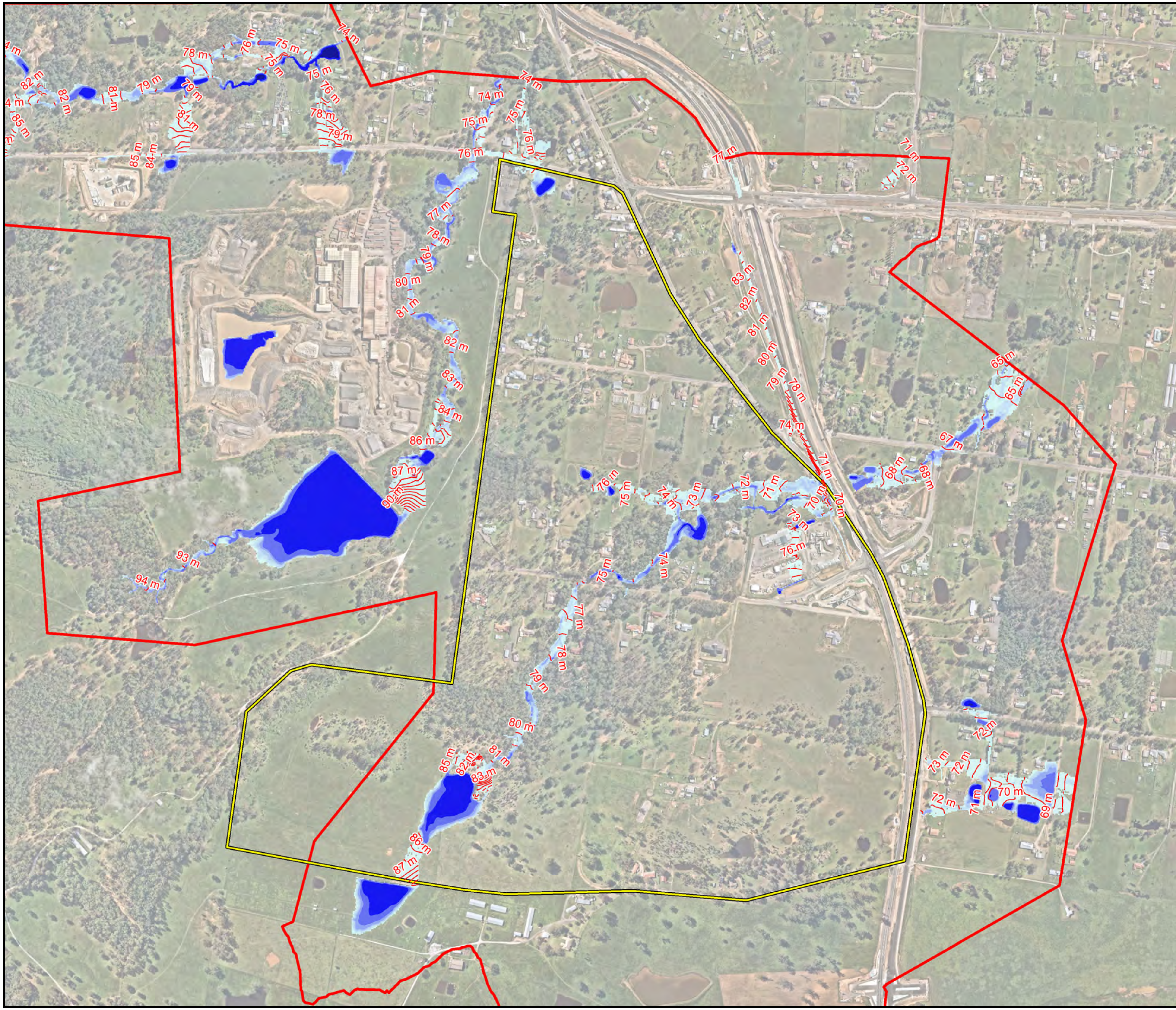
South Creek West Bringelly Sub-Precinct 2

Developed Conditions TUFLOW Mannings

Date:20/08/2021

Issue: C

Filename: "J:\110705 - SC West Bringelly Precinct02 - WCM\SW&E\Figures\110705-02_Fig7-04_DEV01_TFM_C.wor"



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

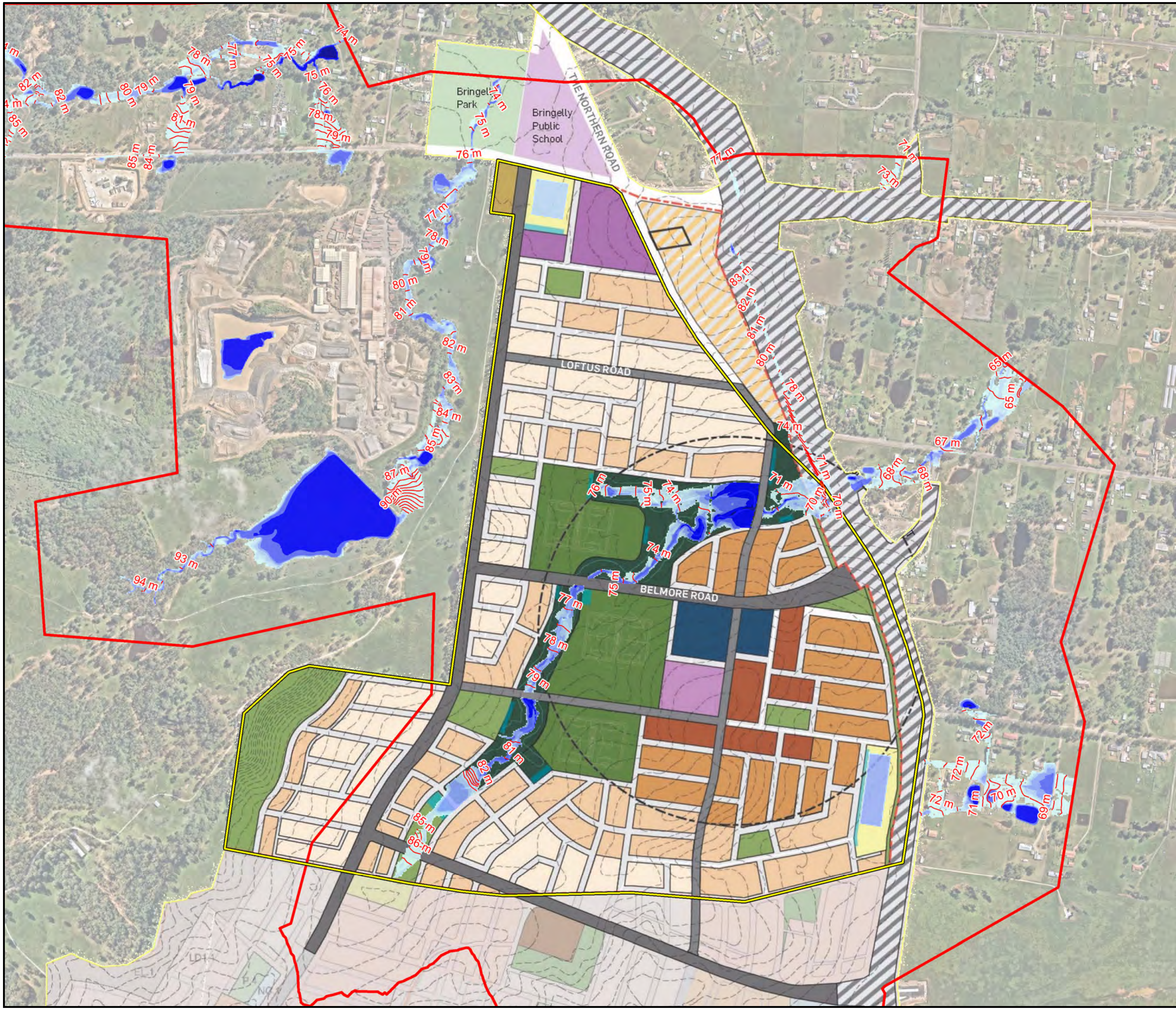
Figure 7-05

South Creek West
Bringelly Sub-Precinct 2

50% AEP
Existing Conditions
Flood Depths and Levels

Date: 20/08/2021 Issue: A

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-05_EX01_50pc_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

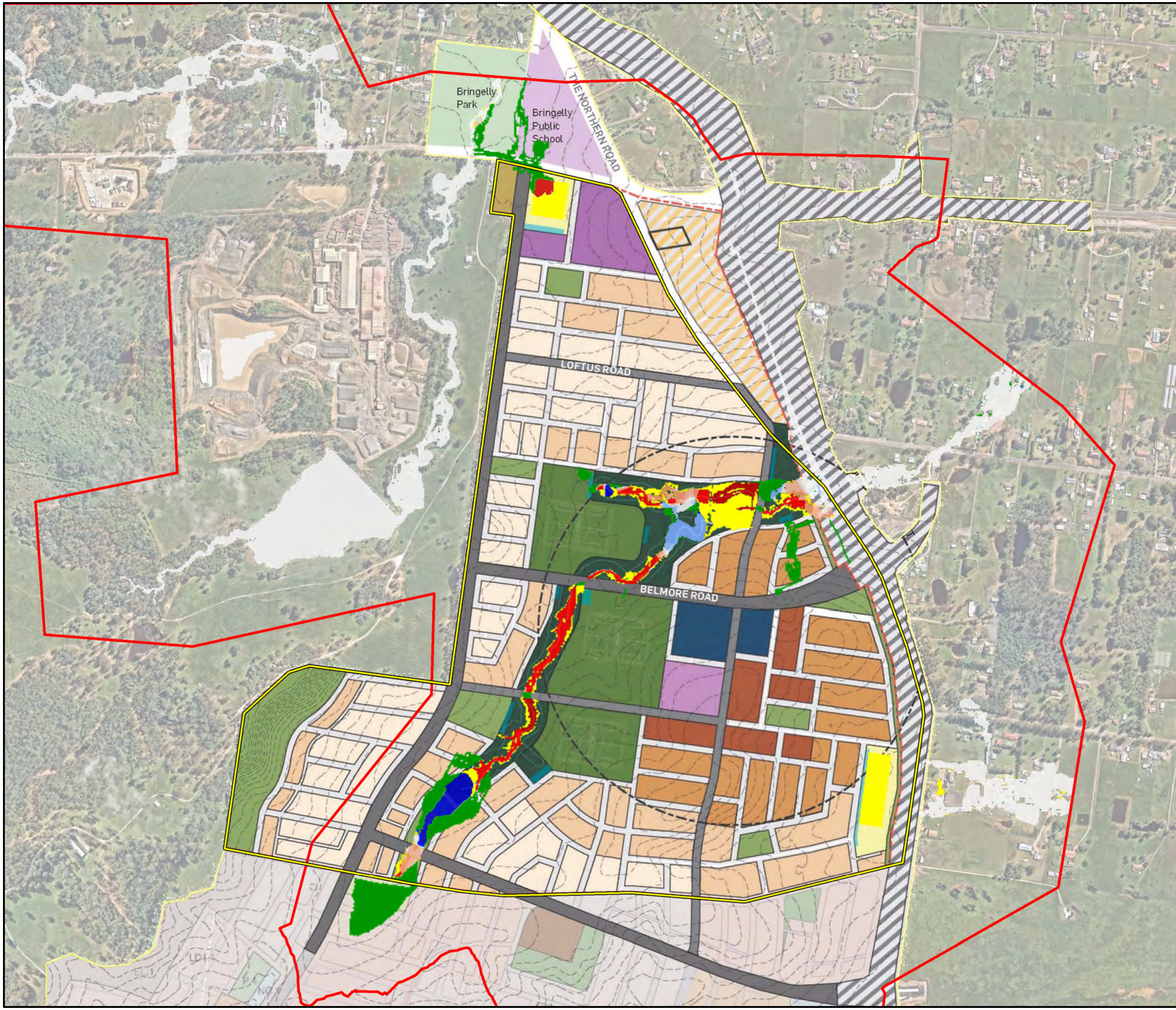
Figure 7-06

South Creek West Bringelly Sub-Precinct 2

50% AEP
Developed Conditions
Flood Depths and Levels

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-06_DEV03_50pc_DEP_C.wor



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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.10 to 0.50
- -0.05 to 0.10
- -0.02 to 0.05
- -0.01 to 0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- 0.50 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

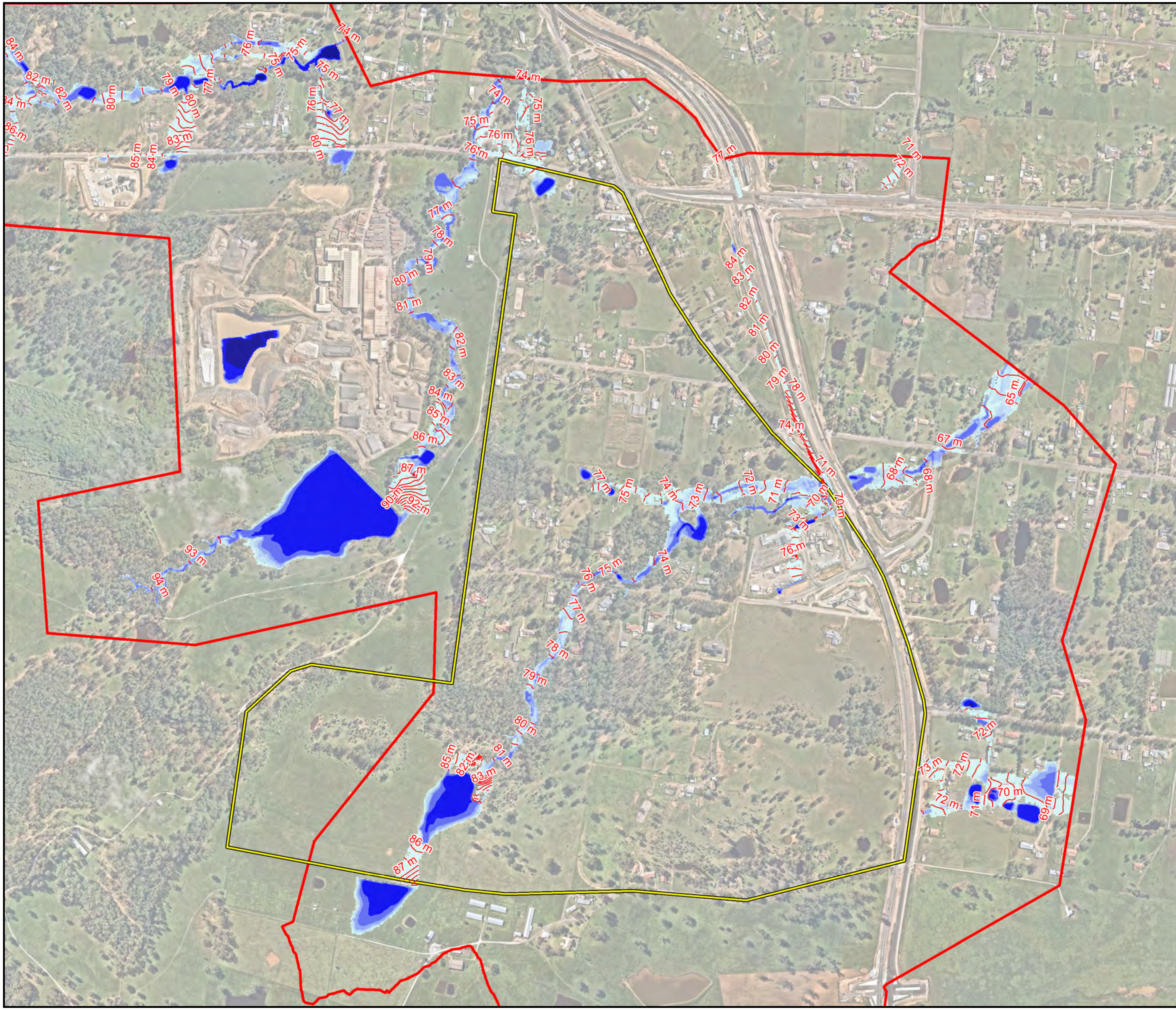
Figure 7-07

South Creek West Bringelly Sub-Precinct 2

50% AEP
Developed - Existing
Flood Difference

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct02 - WCM\SW&E\Figures\110705-02_Fig7-07_DEV03-EX01_50pc_FDM_C.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 — 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-08

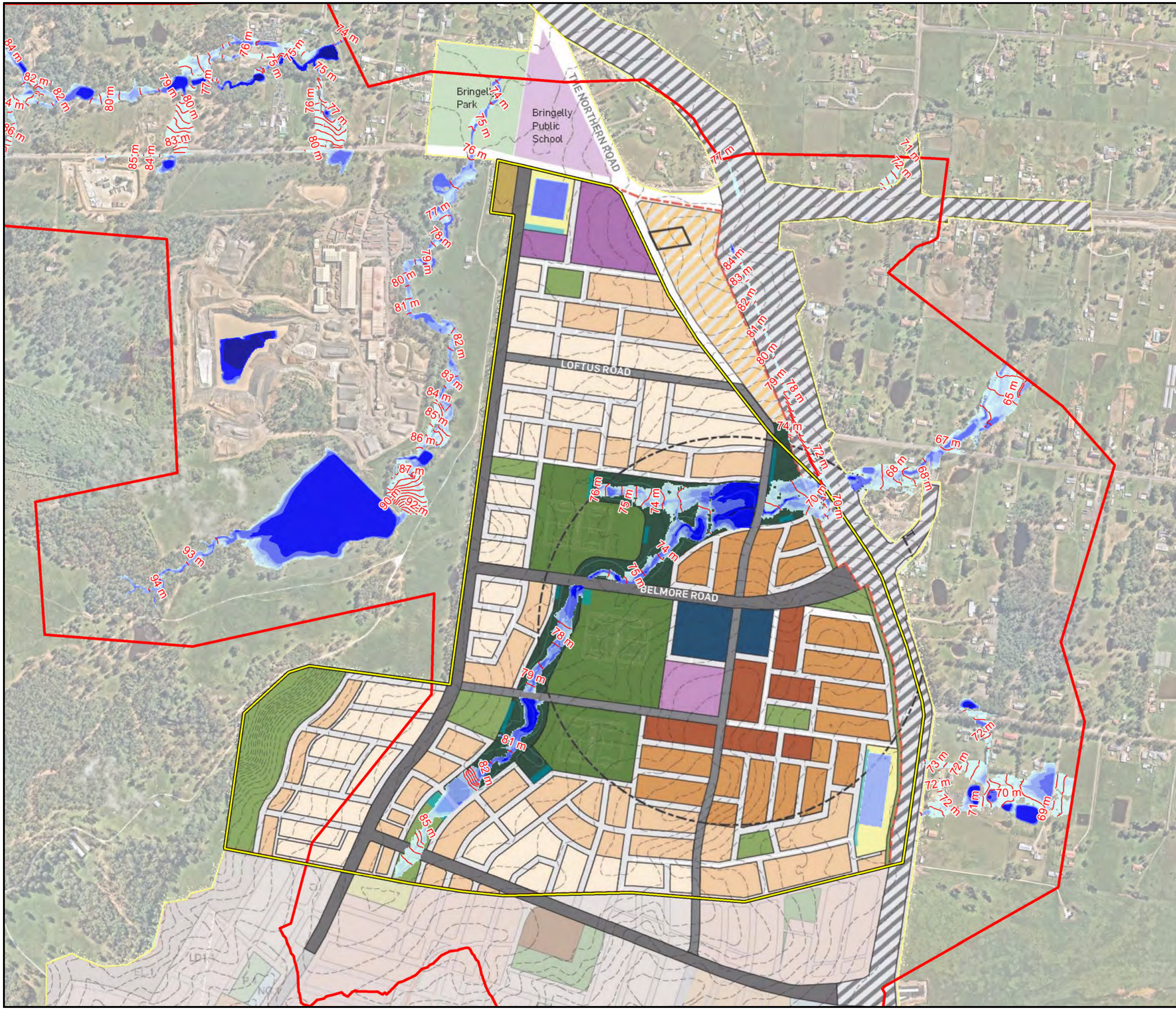
South Creek West Bringelly Sub-Precinct 2

20% AEP
Existing Conditions
Flood Depths and Levels

Date: 20/08/2021

Issue: A

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-08_EX01_20pc_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 — 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-09

South Creek West Bringelly Sub-Precinct 2

20% AEP
Developed Conditions
Flood Depths and Levels

Date: 23/06/2022   Issue: B

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-09_DEV03_20pc_DEP_B.wor

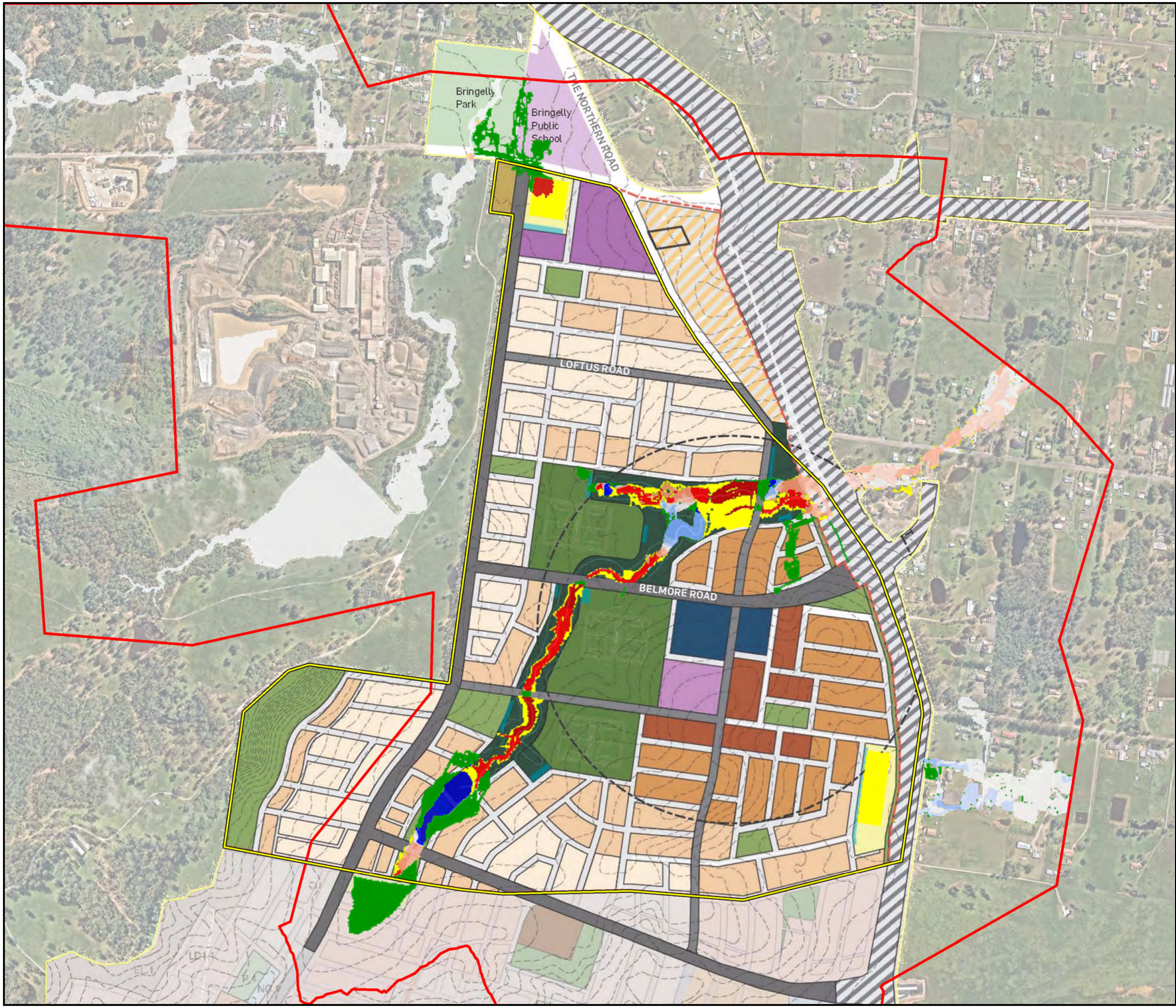

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Figure 7-10

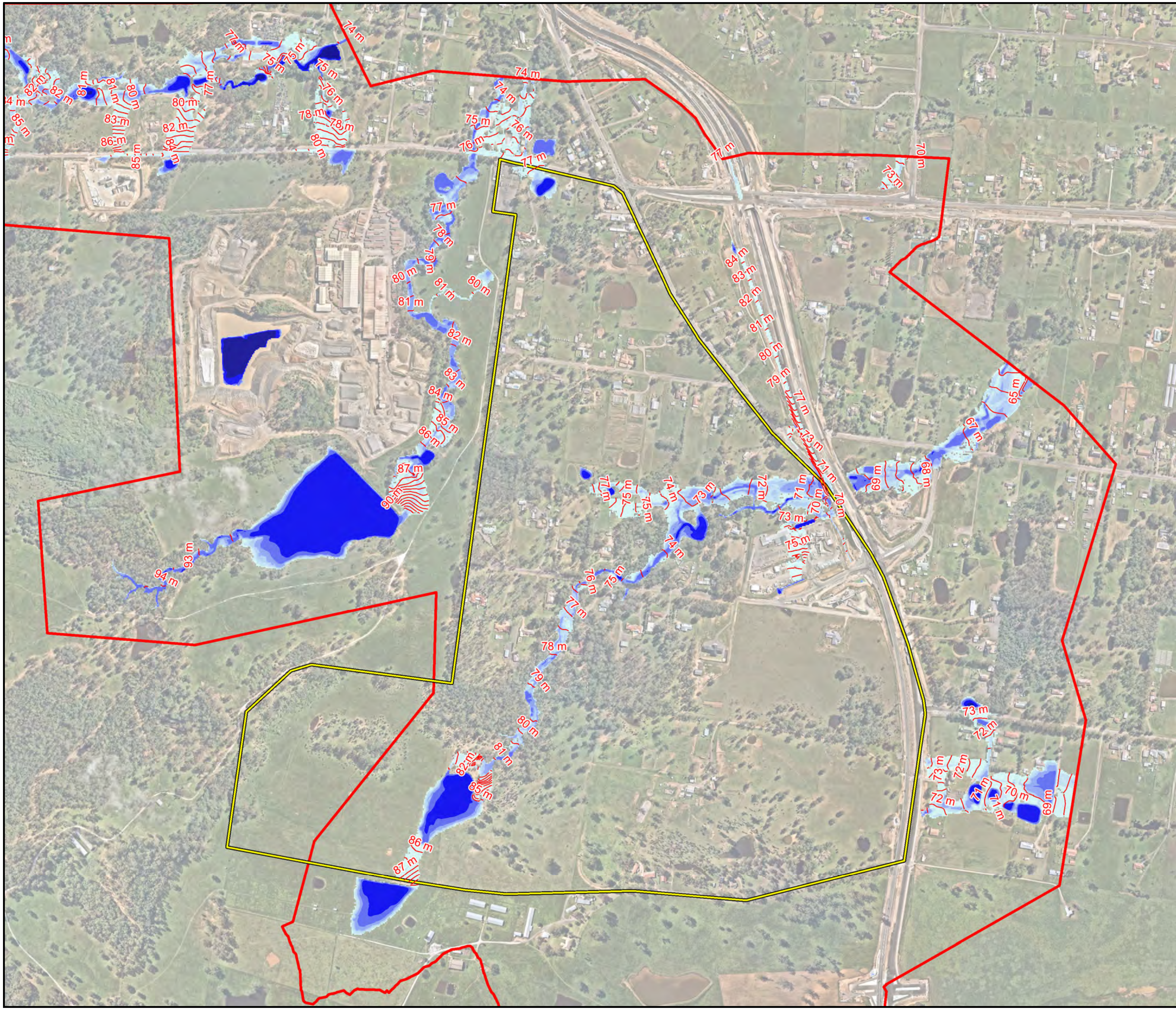
South Creek West Bringelly Sub-Precinct 2

20% AEP
Developed - Existing
Flood Difference

Date: 23/06/2022

Issue: B

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-10_DEV03-EX01_20pc_FDM_B.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

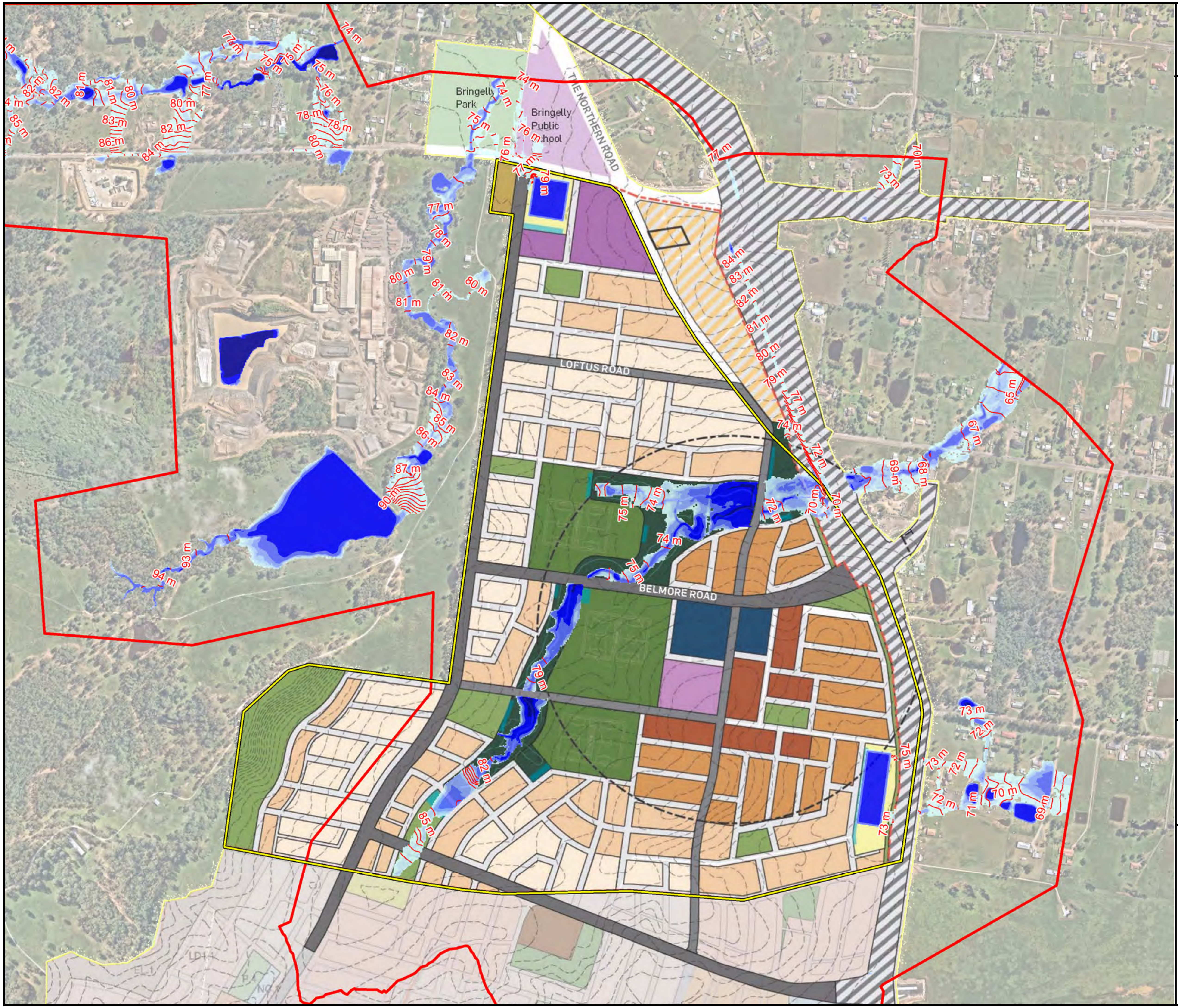
Figure 7-11

South Creek West Bringelly Sub-Precinct 2

5% AEP
Existing Conditions
Flood Depths and Levels

Date: 20/08/2021 Issue: A

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-11_EX01_05pc_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 — 360 metres

Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

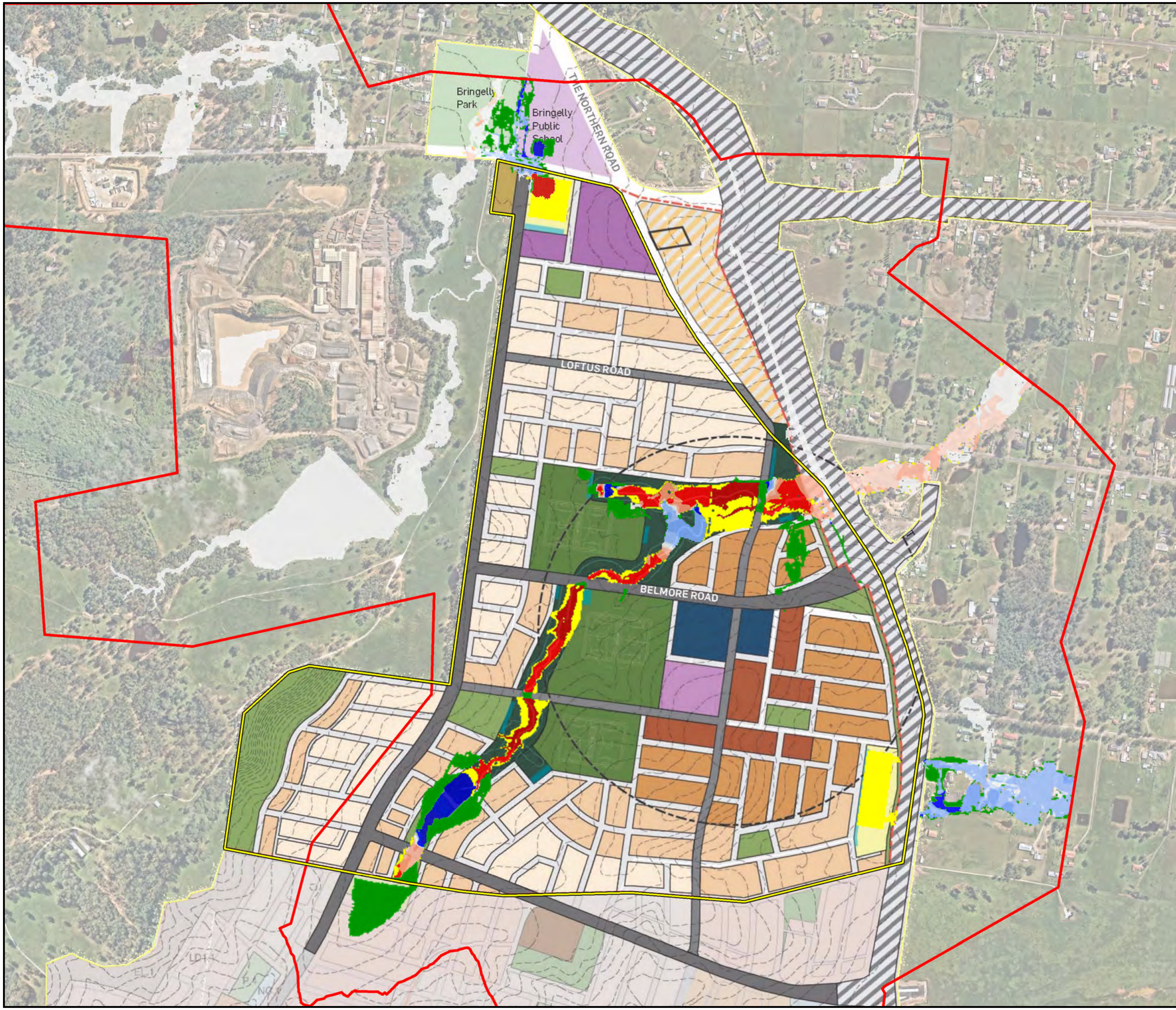
Figure 7-12

South Creek West Bringelly Sub-Precinct 2

5% AEP
Developed Conditions
Flood Depths and Levels

Date: 23/06/2022 Issue: B

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-12_DEV03_05pc_DEP_B.wor



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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.10 to 0.50
- -0.05 to 0.10
- -0.02 to 0.05
- -0.01 to 0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- 0.50 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 360 metres

Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-13

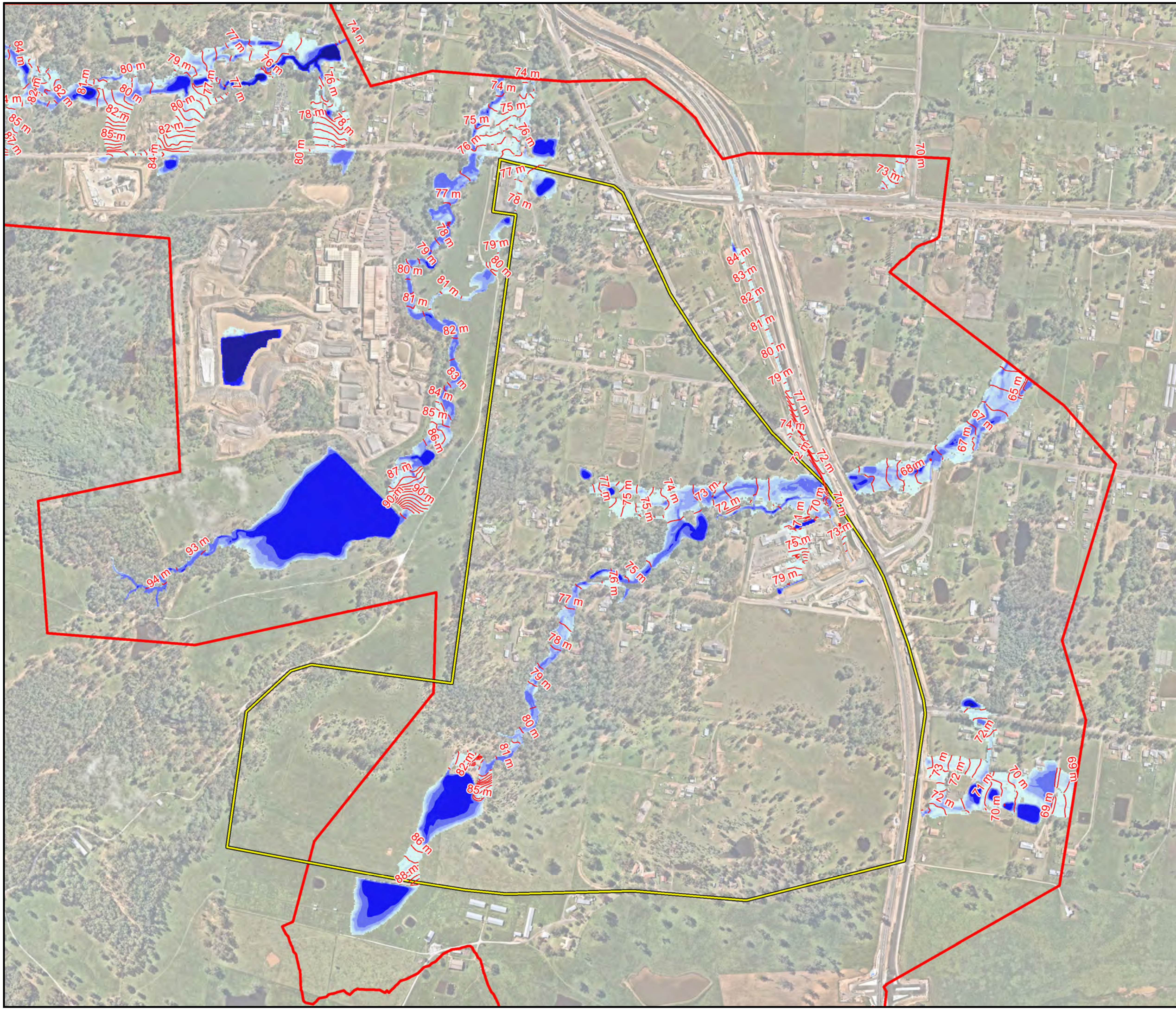
South Creek West Bringelly Sub-Precinct 2

5% AEP
Developed - Existing
Flood Difference

Date: 23/06/2022

Issue: B

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-13_DEV03-EX01_05pc_FDM_B.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 — 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

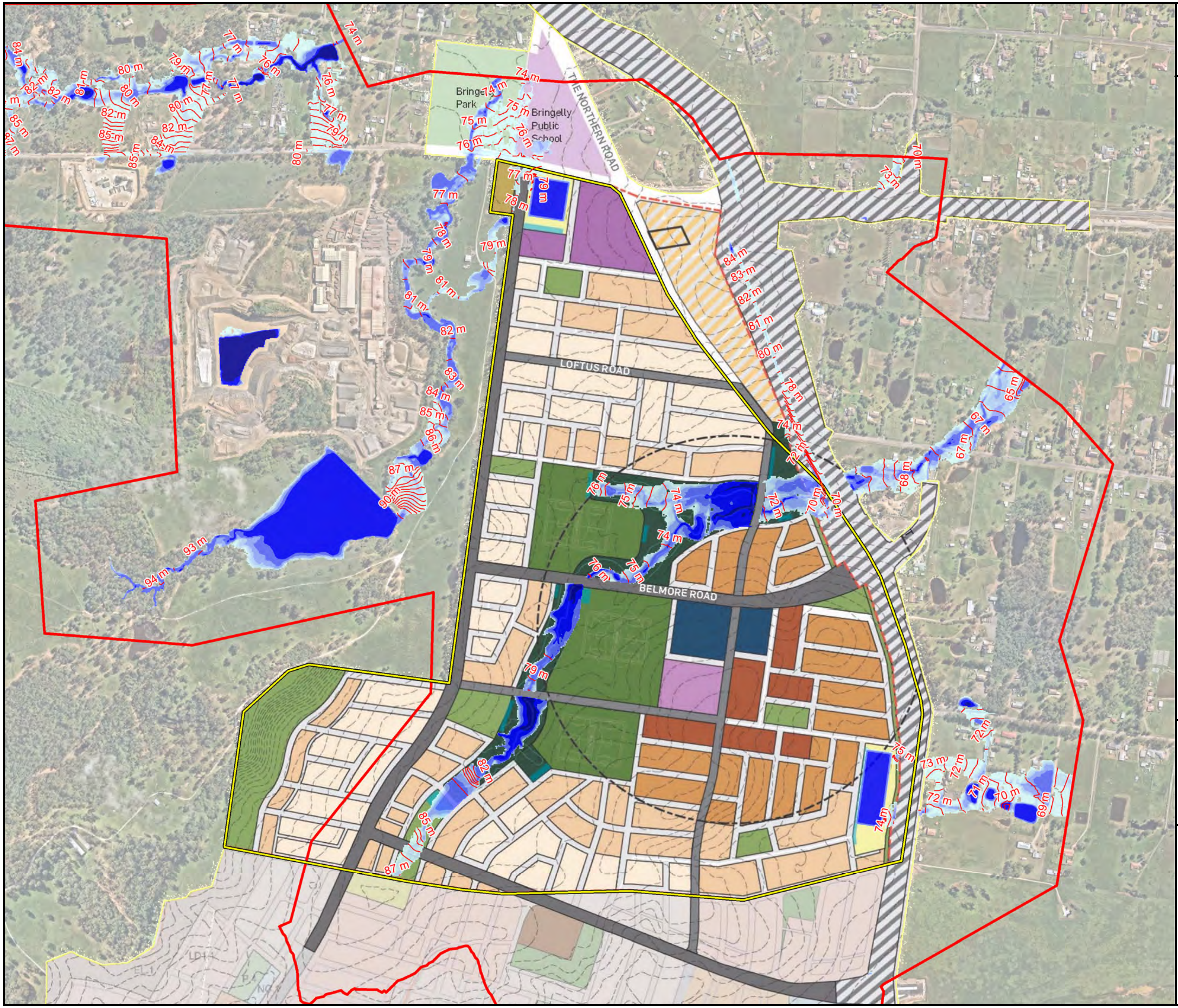
Figure 7-14

South Creek West Bringelly Sub-Precinct 2

1% AEP
Existing Conditions
Flood Depths and Levels

Date: 20/08/2021 Issue: A

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-14_EX01_01pc_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 — 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-15

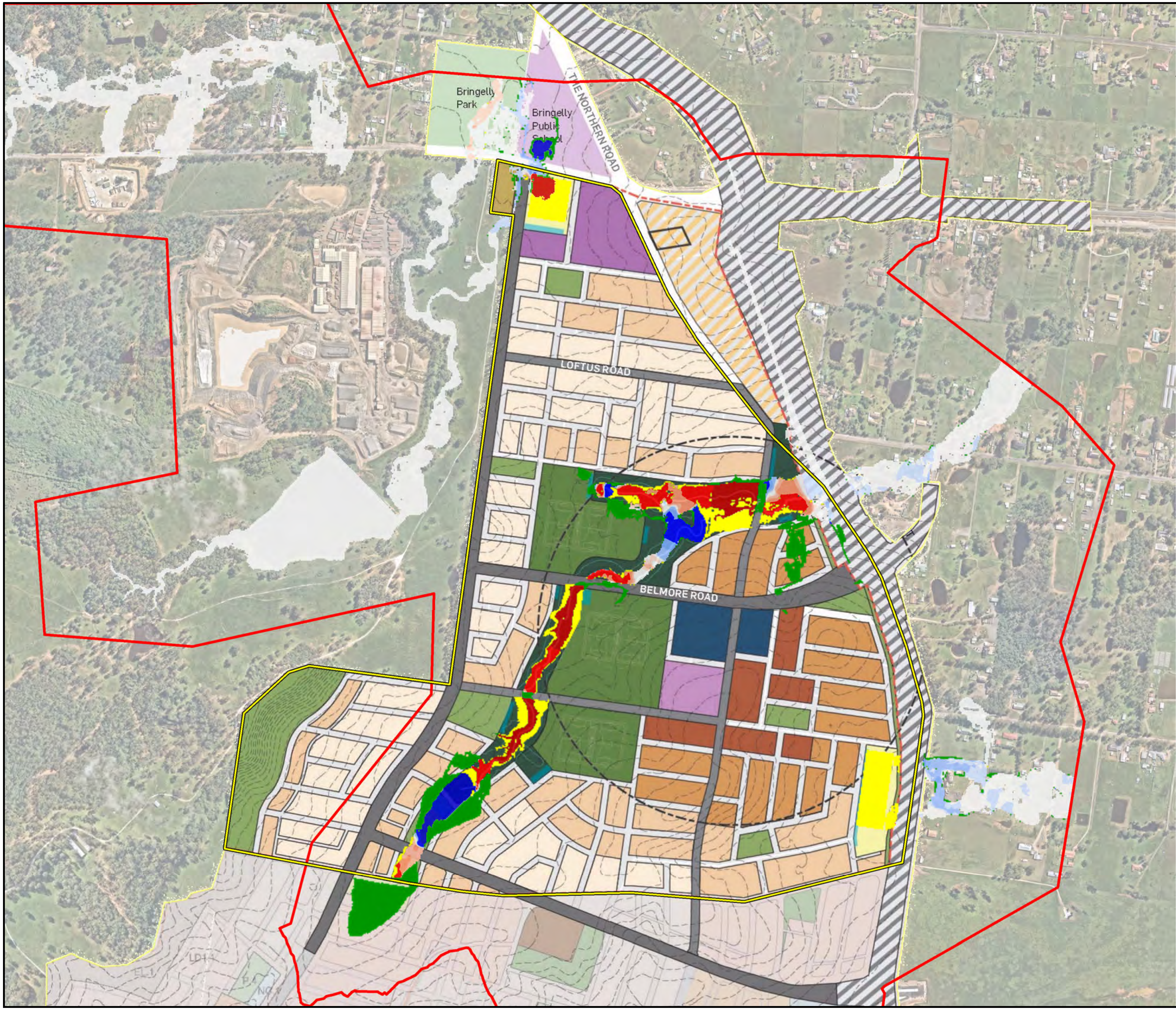
South Creek West Bringelly Sub-Precinct 2

1% AEP
Developed Conditions
Flood Depths and Levels

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-15_DEV03_01pc_DEP_C.wor

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-16_DEV03-EX01_01pc_FDM_C.wor



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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.10 to 0.50
- -0.05 to 0.10
- -0.02 to 0.05
- -0.01 to 0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- 0.50 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- Study Area
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

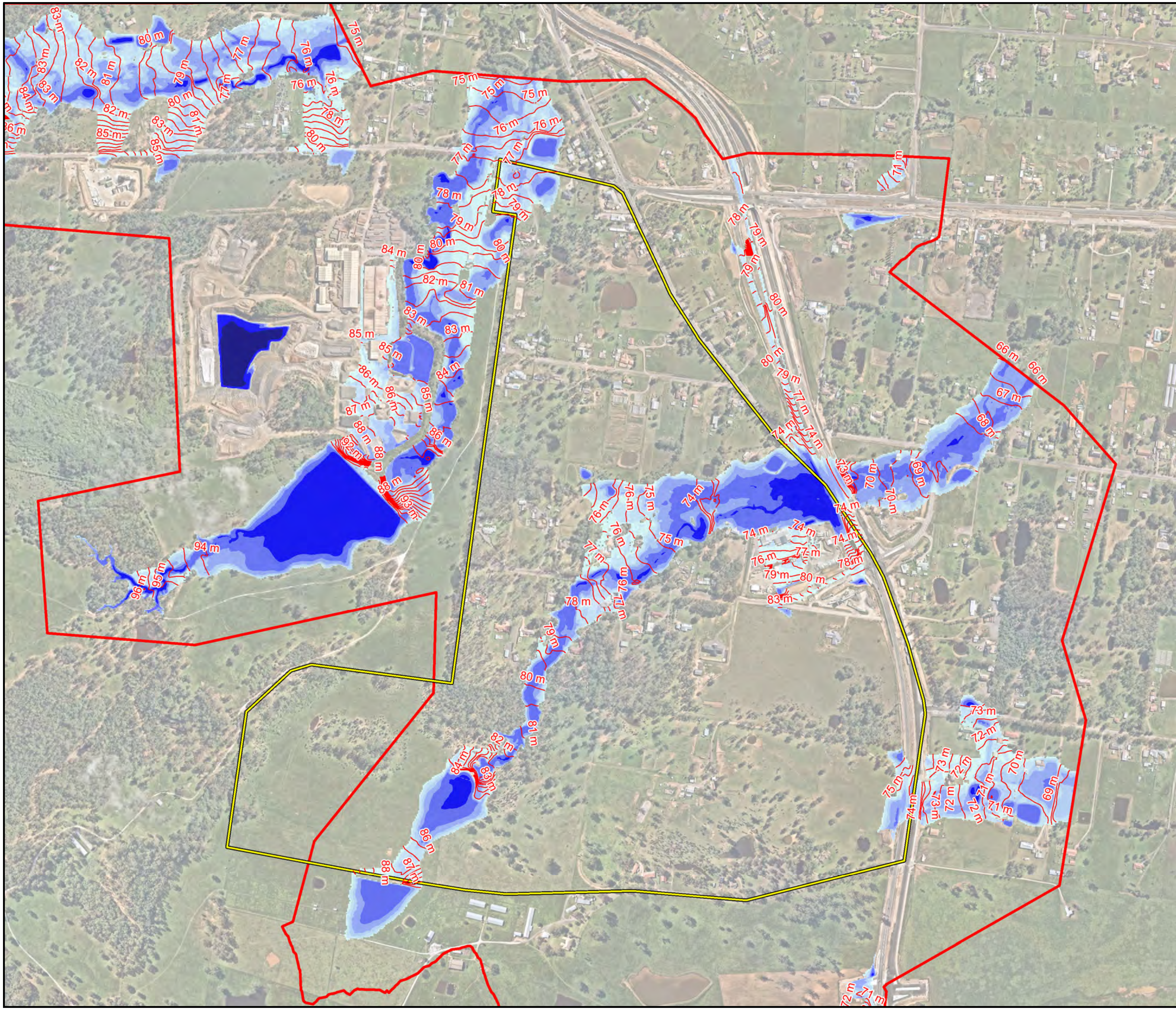
Projection: GDA 1994 MGA Zone 56

Figure 7-16

South Creek West
Bringelly Sub-Precinct 2

1% AEP
Developed - Existing
Flood Difference

Date: 23/06/2022 Issue: C



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

Site Boundary

TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

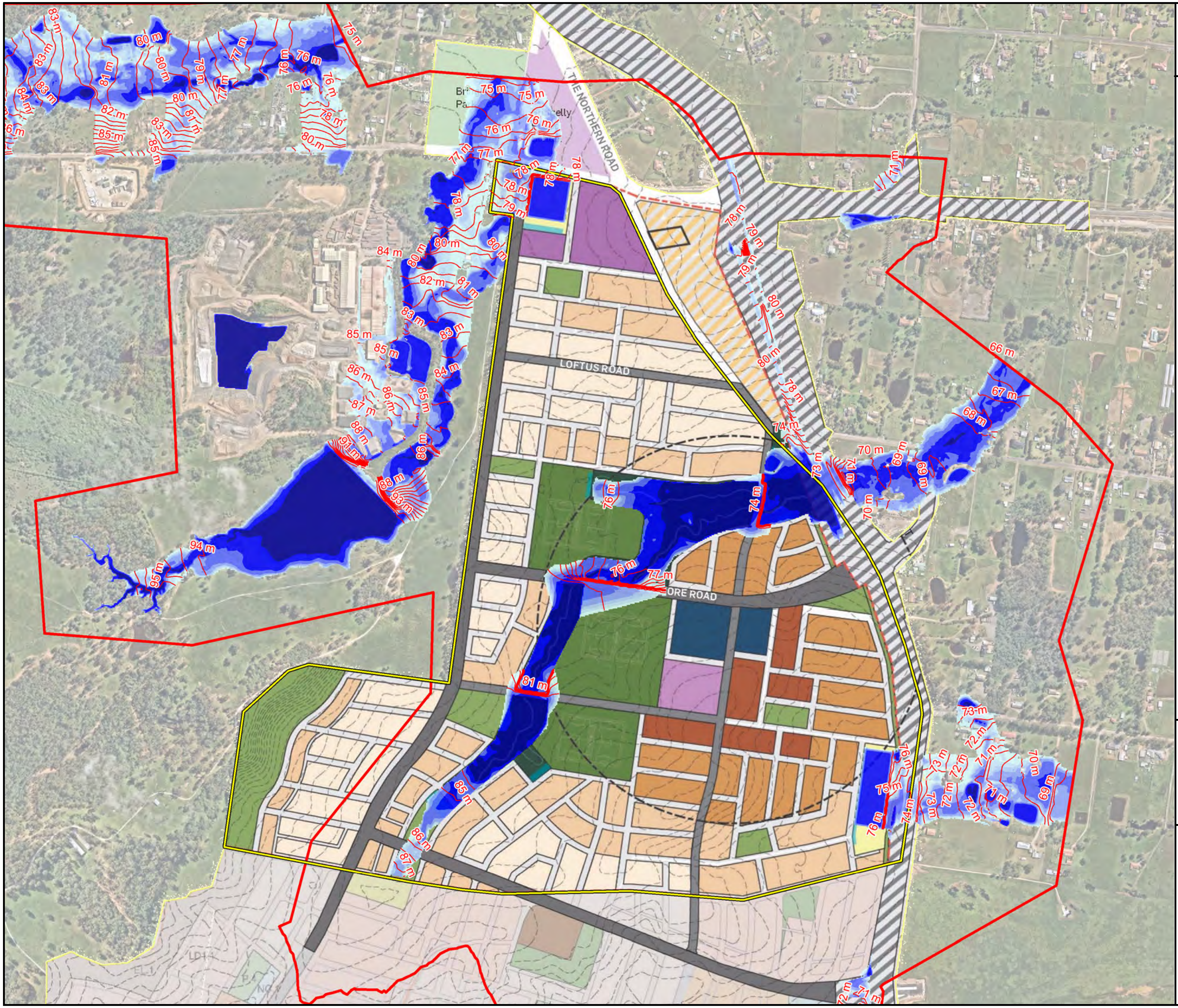
Figure 7-17

South Creek West Bringelly Sub-Precinct 2

Probable Maximum Flood
Existing Conditions
Flood Depths and Levels

Date: 20/08/2021 Issue: A

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-17_EX01_PMF_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- Site Boundary
- TUFLOW Model Boundary

N

0 360 metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

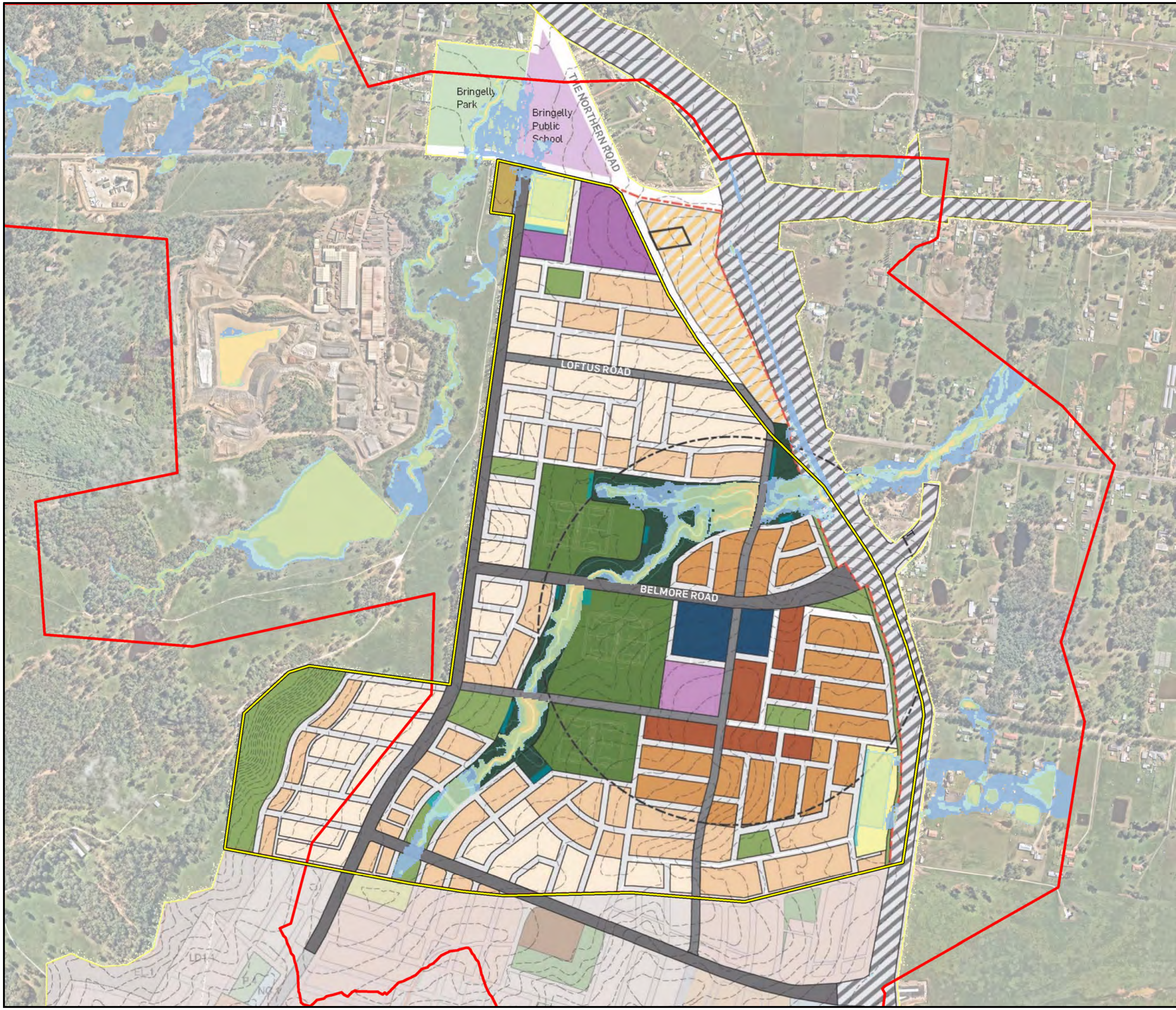
Figure 7-18

South Creek West Bringelly Sub-Precinct 2

Probable Maximum Flood Developed Conditions Flood Depths and Levels

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-18_DEV03_PMF_DEP_C.wor



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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- Site Boundary
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

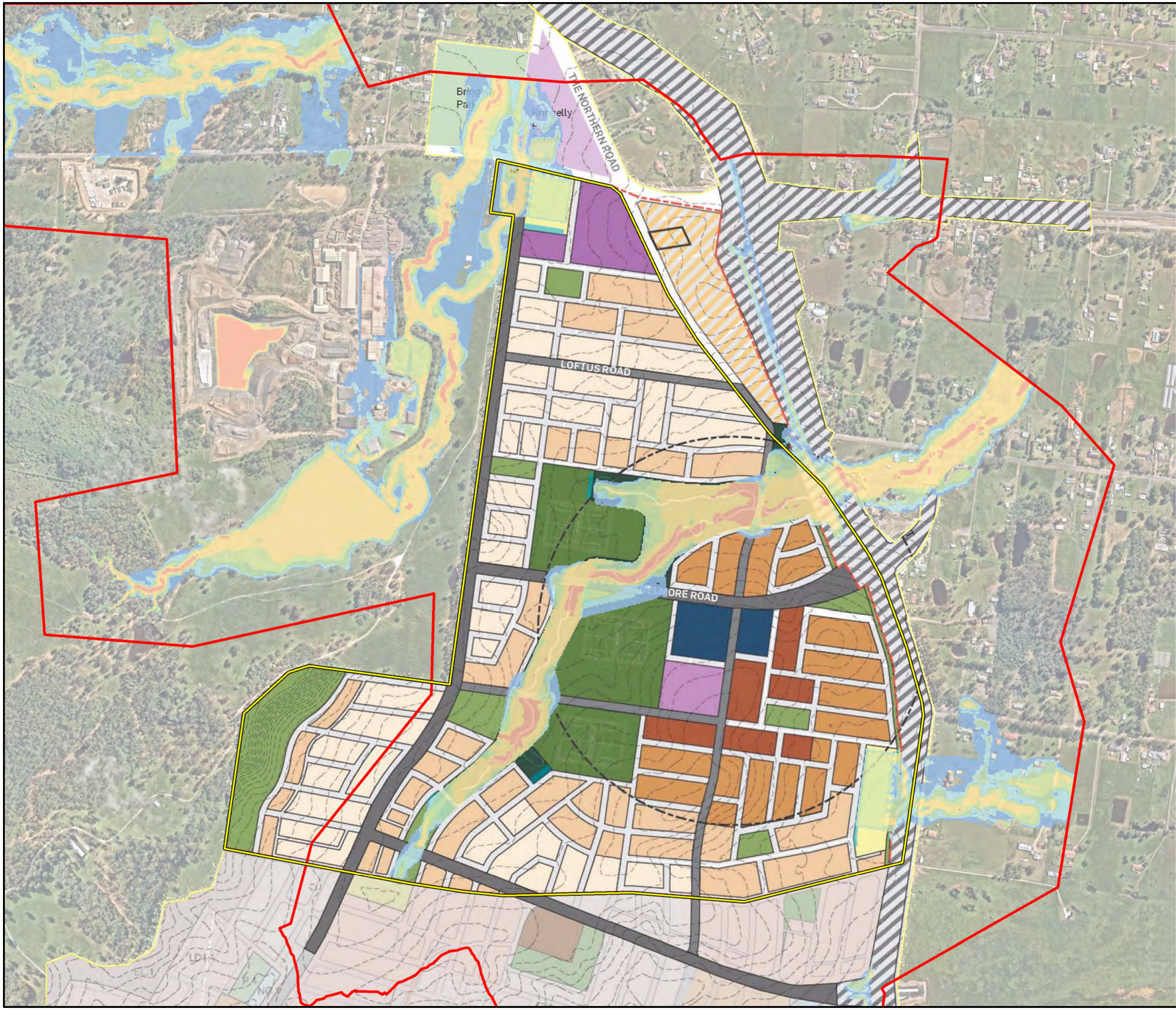
Figure 7-19

South Creek West Bringelly Sub-Precinct 2

1% AEP
Developed Conditions
Flood Hazard

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-19_DEV03_01pc_HAZ_C.wor



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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- Site Boundary
- TUFLOW Model Boundary

N

0 360
metres
Scale 1:9,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7-20

South Creek West Bringelly Sub-Precinct 2

Probable Maximum Flood Developed Conditions Flood Hazard

Date: 23/06/2022 Issue: C

Filename: J:\110705 - SC West Bringelly Precinct\02 - WCM\SW&E\Figures\110705-02_Fig7-20_DEV03_PMF_HAZ_C.wor

APPENDIX C – MUSIC MODEL DATA

Modelling Inputs and Assumptions

The MUSIC Modelling has used a series of default Camden Council MUSIC-Link assumptions and parameters. Details are provided below.

- The water quality treatment approach reflects the treatment of the Bringelly Precinct only;
- An indicative MUSIC model catchment plan assumes existing conditions catchment delineation will generally be maintained in the Precinct grading and is shown in Figure 5-01 in Appendix B;
- R3, R4, school, industrial and commercial areas are assumed to provide on-lot stormwater quality treatment measures that achieve statutory pollutant removal targets prior to discharge to the regional system, however public roads within these land use areas (assumed to be 30% of the catchment within these on-lot treatment areas) are to be catered for in regional devices;
- The proposed low density residential development has a lot mix of normal residential to large-lot residential including medium density residential, as such, lot area with an average of 75% impervious is assumed overall within the precinct;
- Camden Council DCP requires a minimum 30% landscaped area for both low and medium density lots, however, a slightly higher 80% impervious has been adopted for the medium density development, consistent with Camden Council Engineering Guidelines (CC, 2009).
- The MUSIC model catchments have been split into the roof, road, urban previous and urban impervious.

Water Quality Management Measures

Details as to the rainwater tank, Gross Pollutant Traps and Bioretention Raingarden are provided below.

Rainwater Tank

Rainwater tanks were modelled for the Study Area based on the following design assumptions:

- All low-density residential lots are considered to have rainwater tank;
- 50% of the roof areas from these lots will be directly connected to rainwater tanks;
- Rainwater tank re-use of 50 kL/y/dwelling for landscape irrigation and a daily use of 0.15 kL/day/dwelling for internal use is conservatively adopted on the NSW MUSIC Modelling Guidelines (BMTWBM 2015) for a typical 3 person household with rainwater plumbed for washing machine and toilet flushing. See Plate C-1 below extracted from the NSW MUSIC Modelling Guidelines (BMTWBM 2015);

Table 6-1 Typical Water Demands for Single Dwellings (derived from data provided by Sydney Water, 2015)

Water Use	Single dwellings (litres/day/dwelling)					
	Number of occupants					
	1	2	3	3.05	4	5
Indoor Uses						
Toilets	27	54	80	82	107	134
Toilets + Washing Machine	58	115	173	176	231	289
Toilets + Washing Machine + Hot Water	106	212	318	324	425	531
All uses	162	325	487	495	649	812
Outdoor Uses						
All uses	151	151	151	151	151	151

Plate C-1 – Rainwater Tank Re-use rates, (Table 6-1, NSW MUSIC Modelling Guidelines (BMTWBM, 2015))

- All low-density residential developments are expected to incorporate rainwater tanks to comply with BASIX guidelines. Therefore, a standard 3 kL tank with a surface area of 1.7 m² per tank has been adopted.

Gross Pollutant Traps

Gross Pollutant Traps (GPTs) have been provided to filter stormwater prior to discharge into the bioretention raingardens. A vortex style GPT node has been adopted in MUSIC as per Council's request within the Bringelly Precinct.

The expected pollutant removal rates adopted within the model is provided in Table C-1. Such devices may include proprietary GPTs such as a Humeceptor or CDS unit (or equivalent). For the purposes of MUSIC modelling it was assumed that the GPTs will be located upstream of bioretention raingarden.

Table C-1 – GPT Input Parameters

Pollutant	Input	Output
TSS (mg/L)	0	0
	75	75
	1000	300
TP (mg/L)	0	0
	0.5	0.5
	10	7
TN (mg/L)	0	0
	50	50
GP (kg/ML)	0	0
	100	2

A 4 EY (3 month ARI) treatable flow rate has been adopted, as the capture of flow volumes greater than this did not provide any significant increase in performance. Table C-2 provides a summary of the GPT performance for a typical 10 ha residential catchment with 4 EY treatable flow rate, and Table C-3 provides a summary of results for the same catchment with a 2 EY (6 month ARI).

Table C-2 – GPT Performance for Typical 10 ha residential Catchment with 4EY Treatable Flow

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	10100	0	5450	4650	85.0%	46.0%
TP	20.5	0.0	19.2	1.3	65.0%	6.3%
TN	134	0.0	122	12.0	45.0%	9.0%
Gross Pollutants	1460	0	36.1	1424	90.0%	97.5%

Table C-3 – GPT Performance for Typical 10 ha residential Catchment with 2EY Treatable Flow

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	10100	0	5340	4760	85.0%	47.1%
TP	20.5	0.0	19.2	1.3	65.0%	6.3%
TN	134	0.0	122	12.0	45.0%	9.0%
Gross Pollutants	1460	0	28.4	1432	90.0%	98.1%

Comparison between Table C-2 and C-3 confirms that only a marginal increase in TSS (1.1%) and Gross Pollutants (0.6%) is gained but adopting a higher treatable flow, and no improvement in TP or TN removal is achieved. Therefore, capture and treatment of the 4EY flow from the catchment is deemed a practical approach that ensures GPTs are not oversized.

A high flow bypass link within the MUSIC model reflects flows in excess of the treatable flow bypassing both the bio-retention raingarden and GPT. The final hydraulic arrangement for each devise will be subject to a detailed design process to support the future development application.

Bioretention Raingarden

The design parameters adopted for the bioretention raingarden are shown in Table C-4. The filter media receives flow having firstly being treated by the GPT at each outlet. Bioretention raingarden systems are proposed in 11 locations across the Bringelly Precinct in order to achieve the statutory pollutant reduction targets.

Two (2) bioretention raingardens are co-located within the detention basins B1 and B5, while the other bio-retention devices will be perched along the edge of the central riparian corridor. The bio-retention raingardens will also attenuate first flush flows to reduce the risk of stream erosion within the watercourses.

Table C-4 – Bioretention Raingarden Input Parameters

Raingarden Parameter	10 ha Low Density Catchment	10 ha Medium Density Catchment
High Flow Bypass (m^3/s)	100	
Extended Detention Basin (m)	0.3	
Surface Area (m^2)	704	638
Filter Area (m^2)	640	580
Filter Depth	0.5	
Unlined Filter Media Perimeter (m)	0.01	
Saturated Hydraulic Conductivity (mm/h)	100	
TN Content of Filter Media (mg/kg)	750	
Orthophosphate Content of Filter Media (mg/kg)	40	
Exfiltration Rate (mm/hr)	0	
Overflow Weir Width (m)	Varies (target 0.10 m - 0.15m weir depth)	
Base Lined	Yes	
Vegetated with effective Nutrient removal Plants	Yes	
Underdrain Present	Yes	
Submerged Zone with Carbon Present	No	

The flow received by the raingarden is assumed to be limited by the treatable flow rate managed in a GPT upstream. Hence the high flow bypass in the raingarden can be retained at the default rate of 100 m^3/s. The overflow weir width should reflect the detailed design. For the purposes of this assessment it has been assumed that when in bypass, the weir depth (through an outlet pit or embankment) does not exceed 150 mm at the full treatable flow rate. The weir width is set accordingly.

On-lot Treatment

All medium and high density residential development, together with commercial/industrial and school developments are assumed to provide on-lot stormwater quality treatment to achieve the required statutory pollution reduction targets of 85% (TSS), 65% (TP), 45% (TN) and 90% Gross pollutants prior to discharge to the public street drainage system.

It is anticipated that these on-lot devices could comprise proprietary stormwater quality management devices or traditional bio-retention raingardens.

A generic node reflecting on-lot pollutant reductions is incorporated in the MUSIC model. It is important to note that the SEI requirements are comfortably met in the regional devices, and therefore no on-lot SEI assessment is deemed necessary.

MUSIC MODELLING WORKSHEET
South Creek West - Bringelly Precinct Rezoning Assessment

	Catchment Division						Node Inputs: Catchment Split Road/Roof/Impervious/Pervious						
Catchment	**Total Catchment Area (ha)**	**R2 Lot Area (ha)**	**No. Lots**	**Avg Lot Size (m²)**	**Road Reserve Area (ha)**	**Active Open Space**	**Road (ha)**	**Driveways (ha)**	**R2 Roof to Tank (ha)**	**R2 Roof Bypass (ha)**	**Other Impervious (ha)**	**Pervious Areas (ha)**	**Effective % Impervious**
Typical 10 ha Low-Density	10.000	6.000	106	566	3.000	1.000	2.700	0.600	1.800	1.800	0.600	2.500	75%
Typical 10 ha Medium-Density	10.000	6.400	183	350	3.000	0.600	2.700	0.640	--	3.840	0.820	2.000	80%

Low density dwellings/ha	17.68
Medium density dwellings/ha	28.565

	Node Inputs: Rainwater Tanks					
Catchment	**Hi Flow Bypass**	**Equivalent Pipe dia (mm)**	**Daily Demand (kL)**	**Annual Demand (kL/yr)**	**Total Tank Volume (m^3)**	**Tank Surface Area (m^2)**
Typical 10 ha Low-Density	0.39300	515	15.9	5304	254.6	180.3

	R2 Lots	
Overflow Pipe Diameter	50	mm
PET - Rain for landscape area	50	kL/year/dwelling
Assumed Daily Demand	150	L/day
Adopted Tank Size	3	kL
Assumed 80% is useable (w/o topups)	80	%
Useable tank	2.4	kL
Tank Surface Area per Dwelling	1.7	m^2
I5min/1yr	78.6	mm/hr

Input
MUSIC Input

	Cat. Area (ha)	Treatable Flow Calculation				
		Tc* (min)	**%Imperv.**	**1yr Flow (m^3/s)**	**3mth Flow (m^3/s)**	**6mth Flow (m^3/s)**
GPT Treatable flow (low density)	10.000	8.5	75%	1.125	0.585	0.821
GPT Treatable flow (medium density)	10.000	8.5	80%	1.164	0.605	0.850

%Impervious	
R2 Lots	75%
R3 Lots	80%
Road Reserve	90%
Active Open Space	30%

% Breakdown R2 of lot area		**% Breakdown R3 of lot area**	
Roof	60%	Roof	60%
Roof to Tank	30%	Roof to Tank	30%
Roof Bypass Tank	30%	Roof Bypass Tank	30%
Driveways	10%	Driveways	10%
Other Impervious	5%	Other Impervious	10%
Pervious Areas	25%	Pervious Areas	20%

Typical 10 ha low density residential catchment

	% Catchment	**Area (ha)**	**% Impervious**
Roads	30%	3.00	90%
Lots	60%	6.00	75%
Open Space	10%	1.00	30%

APPENDIX D –MUSIC-LINK REPORT

MUSIC-*link* Report

Project Details		Company Details	
Project:	Bringelly Precinct	**Company:**	J. Wyndham Prince
Report Export Date:	12/06/2020	**Contact:**	David Crompton
Catchment Name:	110628-03 MU1	**Address:**	77 Union Road Penrith NSW 2750
Catchment Area:	10ha	**Phone:**	47203340
Impervious Area*:	150.0%	**Email:**	dcrompton@jwprince.com.au
Rainfall Station:	67035 LIVERPOOL(WHITLAM		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1985 - 31/12/1994 11:54:00 PM		
Mean Annual Rainfall:	783mm		
Evapotranspiration:	1261mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.33		
Study Area:	Camden City Council		
Scenario:	Camden City Council		

* 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 LD 10ha	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	12%	Bio Retention Node	2	Urban Source Node	15
TSS	85%	Rain Water Tank Node	1	Forest Source Node	1
TP	65.2%	GPT Node	2		
TN	49.3%	Generic Node	4		
GP	99%				

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention (580 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (580 m�)	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention (640 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (640 m�)	PET Scaling Factor	2.1	2.1	2.1
Forest	10 ha Forest	Area Impervious (ha)	None	None	0
Forest	10 ha Forest	Area Pervious (ha)	None	None	10
Forest	10 ha Forest	Total Area (ha)	None	None	10
GPT	LD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.585
GPT	MD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.605
Rain	Rainwater Tank	% Reuse Demand Met	None	None	48.23
Receiving	Receiving Node	% Load Reduction	None	None	74.1
Receiving	Receiving Node	GP % Load Reduction	90	None	99.2
Receiving	Receiving Node	TN % Load Reduction	45	None	79.2
Receiving	Receiving Node	TP % Load Reduction	65	None	83.5
Receiving	Receiving Node	TSS % Load Reduction	85	None	88.5
Urban	LD Driveway (0.6 ha)	Area Impervious (ha)	None	None	0.6
Urban	LD Driveway (0.6 ha)	Area Pervious (ha)	None	None	0
Urban	LD Driveway (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	LD Impervious (0.3 ha)	Area Impervious (ha)	None	None	0.3
Urban	LD Impervious (0.3 ha)	Area Pervious (ha)	None	None	0
Urban	LD Impervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Open Space (1.0 ha)	Area Impervious (ha)	None	None	0.301
Urban	LD Open Space (1.0 ha)	Area Pervious (ha)	None	None	0.698
Urban	LD Open Space (1.0 ha)	Total Area (ha)	None	None	1
Urban	LD Pervious (1.5 ha)	Area Impervious (ha)	None	None	0
Urban	LD Pervious (1.5 ha)	Area Pervious (ha)	None	None	1.5
Urban	LD Pervious (1.5 ha)	Total Area (ha)	None	None	1.5
Urban	LD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	LD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	LD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	LD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	LD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	LD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Roof (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof (1.8 ha)	Total Area (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof to tank (1.8 ha)	Total Area (ha)	None	None	1.8
Urban	MD Driveway (0.64 ha)	Area Impervious (ha)	None	None	0.64

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	MD Driveway (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Driveway (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Impervious (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Impervious (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Open Space (0.6 ha)	Area Impervious (ha)	None	None	0.178
Urban	MD Open Space (0.6 ha)	Area Pervious (ha)	None	None	0.421
Urban	MD Open Space (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	MD Pervious (1.28 ha)	Area Impervious (ha)	None	None	0
Urban	MD Pervious (1.28 ha)	Area Pervious (ha)	None	None	1.28
Urban	MD Pervious (1.28 ha)	Total Area (ha)	None	None	1.28
Urban	MD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	MD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	MD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	MD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	MD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	MD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	Roof (3.84 ha)	Area Impervious (ha)	None	None	3.84
Urban	Roof (3.84 ha)	Area Pervious (ha)	None	None	0
Urban	Roof (3.84 ha)	Total Area (ha)	None	None	3.84

Only certain parameters are reported when they pass validation

MUSIC-*link* Report

Project Details		Company Details	
Project:	Bringelly Precinct	**Company:**	J. Wyndham Prince
Report Export Date:	12/06/2020	**Contact:**	David Crompton
Catchment Name:	110628-03 MU1	**Address:**	77 Union Road Penrith NSW 2750
Catchment Area:	10ha	**Phone:**	47203340
Impervious Area*:	159.9%	**Email:**	dcrompton@jwprince.com.au
Rainfall Station:	67035 LIVERPOOL(WHITLAM		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1985 - 31/12/1994 11:54:00 PM		
Mean Annual Rainfall:	783mm		
Evapotranspiration:	1261mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.33		
Study Area:	Camden City Council		
Scenario:	Camden City Council		

* 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 MD 10ha	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	2.25%	Bio Retention Node	2	Urban Source Node	15
TSS	85.1%	Rain Water Tank Node	1	Forest Source Node	1
TP	66.3%	GPT Node	2		
TN	53.2%	Generic Node	4		
GP	99.3%				

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention (580 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (580 m�)	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention (640 m�)	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention (640 m�)	PET Scaling Factor	2.1	2.1	2.1
Forest	10 ha Forest	Area Impervious (ha)	None	None	0
Forest	10 ha Forest	Area Pervious (ha)	None	None	10
Forest	10 ha Forest	Total Area (ha)	None	None	10
GPT	LD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.585
GPT	MD Vortex GPT	Hi-flow bypass rate (cum/sec)	None	99	0.605
Rain	Rainwater Tank	% Reuse Demand Met	None	None	48.23
Receiving	Receiving Node	% Load Reduction	None	None	74.1
Receiving	Receiving Node	GP % Load Reduction	90	None	99.2
Receiving	Receiving Node	TN % Load Reduction	45	None	79.2
Receiving	Receiving Node	TP % Load Reduction	65	None	83.5
Receiving	Receiving Node	TSS % Load Reduction	85	None	88.5
Urban	LD Driveway (0.6 ha)	Area Impervious (ha)	None	None	0.6
Urban	LD Driveway (0.6 ha)	Area Pervious (ha)	None	None	0
Urban	LD Driveway (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	LD Impervious (0.3 ha)	Area Impervious (ha)	None	None	0.3
Urban	LD Impervious (0.3 ha)	Area Pervious (ha)	None	None	0
Urban	LD Impervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Open Space (1.0 ha)	Area Impervious (ha)	None	None	0.301
Urban	LD Open Space (1.0 ha)	Area Pervious (ha)	None	None	0.698
Urban	LD Open Space (1.0 ha)	Total Area (ha)	None	None	1
Urban	LD Pervious (1.5 ha)	Area Impervious (ha)	None	None	0
Urban	LD Pervious (1.5 ha)	Area Pervious (ha)	None	None	1.5
Urban	LD Pervious (1.5 ha)	Total Area (ha)	None	None	1.5
Urban	LD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	LD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	LD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	LD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	LD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	LD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	LD Roof (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof (1.8 ha)	Total Area (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Impervious (ha)	None	None	1.8
Urban	LD Roof to tank (1.8 ha)	Area Pervious (ha)	None	None	0
Urban	LD Roof to tank (1.8 ha)	Total Area (ha)	None	None	1.8
Urban	MD Driveway (0.64 ha)	Area Impervious (ha)	None	None	0.64

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	MD Driveway (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Driveway (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Impervious (ha)	None	None	0.64
Urban	MD Impervious (0.64 ha)	Area Pervious (ha)	None	None	0
Urban	MD Impervious (0.64 ha)	Total Area (ha)	None	None	0.64
Urban	MD Open Space (0.6 ha)	Area Impervious (ha)	None	None	0.178
Urban	MD Open Space (0.6 ha)	Area Pervious (ha)	None	None	0.421
Urban	MD Open Space (0.6 ha)	Total Area (ha)	None	None	0.6
Urban	MD Pervious (1.28 ha)	Area Impervious (ha)	None	None	0
Urban	MD Pervious (1.28 ha)	Area Pervious (ha)	None	None	1.28
Urban	MD Pervious (1.28 ha)	Total Area (ha)	None	None	1.28
Urban	MD Road (2.7 ha)	Area Impervious (ha)	None	None	2.7
Urban	MD Road (2.7 ha)	Area Pervious (ha)	None	None	0
Urban	MD Road (2.7 ha)	Total Area (ha)	None	None	2.7
Urban	MD Road Pervious (0.3 ha)	Area Impervious (ha)	None	None	0
Urban	MD Road Pervious (0.3 ha)	Area Pervious (ha)	None	None	0.3
Urban	MD Road Pervious (0.3 ha)	Total Area (ha)	None	None	0.3
Urban	Roof (3.84 ha)	Area Impervious (ha)	None	None	3.84
Urban	Roof (3.84 ha)	Area Pervious (ha)	None	None	0
Urban	Roof (3.84 ha)	Total Area (ha)	None	None	3.84

Only certain parameters are reported when they pass validation