CARSELDINE URBAN VILLAGE

UPDATED STORMWATER MANAGEMENT PLAN

DesignFlow

Prepared for Economic Development Queensland

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Disclaimer

Qualifications & Limitations

In preparing this report, Designflow has relied upon and assumed accurate data provided by Brisbane City Council (BCC) other sources. Unless otherwise stated in this report, Designflow has not attempted to verify the accuracy or completeness of any such information. The accuracy of this report is reliant upon the accuracy of this information.

This investigation is based upon BCC's established flood model of the Cabbage Tree Creek floodplain. While some refinements have been made to BCC's models to suit the current project, overall the modelling approach and assumptions have been applied consistently with that of the established models. Consequently, the model accuracy limitations of BCC's flood models also generally apply to this investigation.

Modelling for this investigation is based on a design event approach and assumptions that are consistent with current industry practice. It is important to be aware that real world flood events are random and highly variable. Consequently, observed and future flooding characteristics may not reflect those described in this report.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Designflow for use of any part of this report in any other context.

Study results should not be used for purposes other than those for which they were prepared.

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EXECUTIVE SUMMARY

Carseldine Urban Village (Lot 322 on SP172124) is a proposed development on a 45ha site, currently occupied by Queensland Government facilities and community sports fields. The development is to be undertaken by Economic Development Queensland (EDQ) and will involve the creation of lots for a mix of uses including commercial and retail, residential, retirement living and a sporting complex. This report presents the details of an Updated Stormwater Management Plan and supersedes the previously developed stormwater management plan for the site (Calibre, 2017).

The updated strategy includes two (2) bioretention basins that treat development runoff prior to discharge to Cabbage Tree Creek:

- Bioretention Basin B1 550m² with an overall footprint of ~1,500m²
- Bioretention Basin B2 250m² with an overall footprint of ~700m²

These basins are located outside of the Cabbage Tree Creek riparian corridor and will have low impact on existing vegetation. The proposed locations also avoids conflicts with the future busway corridor.

Flood impact assessment demonstrates no significant adverse impacts occurring external to the site as a result of development. Some minor afflux (up to 10mm) is observed along Cabbage Tree Creek immediately south of the development, however this afflux is contained within Cabbage Tree Creek and does not extend downstream.

Improved flood conditions are observed at the rail corridor in the north-east end of the site. This is because much of the site, which currently drains to the north-east corner, will be collected by pipe and road drainage and directed to Cabbage Tree Creek. Furthermore, during larger magnitude events, the proposed development filling restricts Cabbage Tree Creek breakout flow from entering this area.

1 INTRODUCTION

Carseldine Urban Village (Lot 322 on SP172124) is a proposed development on a 45ha site, currently occupied by Queensland Government facilities and community sports fields. The site is located approximately 14km north of Brisbane and is bounded by Beams Road to the north and Cabbage Tree Creek to the south. The development is to be undertaken by Economic Development Queensland (EDQ) and will involve the creation of lots for a mix of uses including commercial and retail, residential, retirement living and a sporting complex.

This report presents the details of an Updated Stormwater Management Plan for the development to meet the requirements under:

- State Planning Policy – SPP (DLGIP, 2017) for the operational stormwater quality objectives;
- Queensland Urban Drainage Manual (QUDM) for stormwater quantity management; and
- Brisbane City Council Planning Scheme

This report supersedes the previously developed stormwater management plan for the site (Calibre, 2017).

2 SITE CHARACTERISTICS

2.1 SITE LOCATION

The Carseldine Urban Village development is located approximately 14km north of Brisbane. The site is bounded by Beams road to the north, Cabbage Tree Creek to the south, Brisbane rail to the east and Dorville Road to the west.

Figure 1 shows the location of the site.

Figure 1: Locality plan

2.2 CLIMATE

Figure 2 provides a summary of the monthly rainfall based on climate statistics for Brisbane (station No 40223).

The annual average rainfall is 1,190 mm, whilst annual evaporation is approximately 1,950mm. The figure clearly indicates the seasonal nature of rainfall and evaporation with lower rainfall and evaporation periods during the winter months.

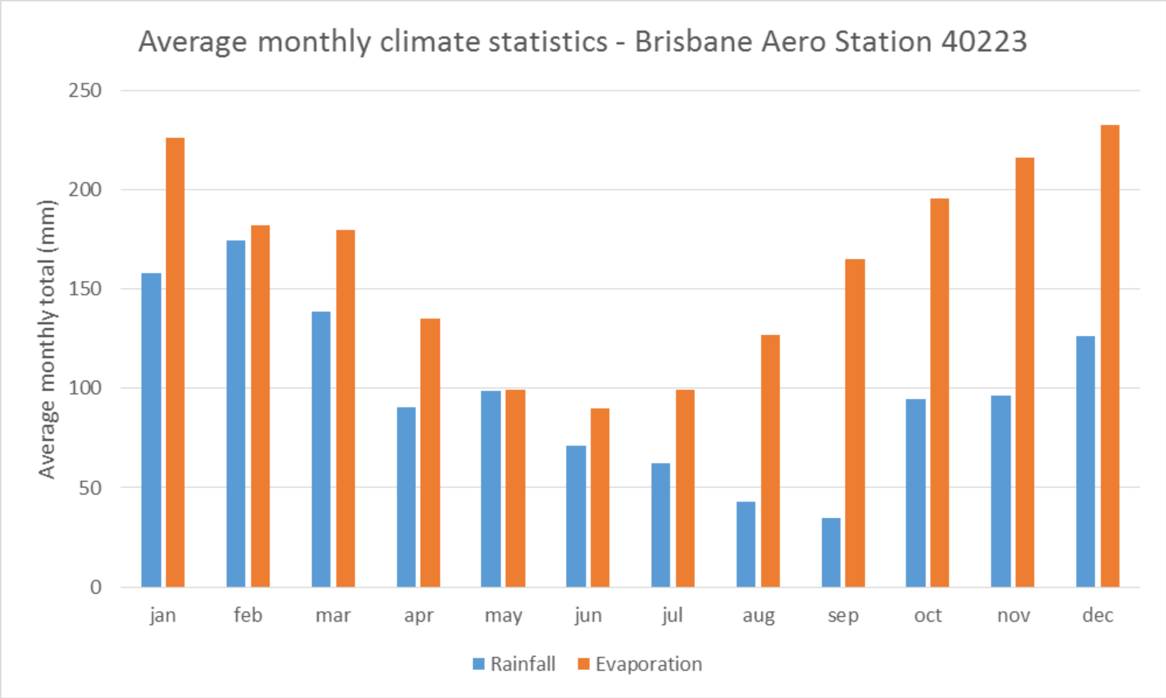


Figure 2 Average monthly climate statistics

2.3 TOPOGRAPHY, CATCHMENTS AND DRAINAGE

Ground levels across the site range from approximately RL28 at the high point located at the north western boundary of the development to approximately RL9.5 at the south eastern corner at Cabbage Tree Creek. Grades across the site are flat to moderate typically ranging from 0.5 to 10%.

The site is characterised by areas of low lying and poorly drained topography. Figure 3 shows the existing topography and general drainage of the current site. The majority of the site drainage is toward Cabbage Tree Creek to the south, whilst the north west section of the site drains northward. Flooding at the north east corner of the site is noted including local flooding of Beams Road.

In general, the northern bank of Cabbage Tree Creek is higher than adjacent ground levels further north within the site. This means flood flows are initially contained within Cabbage Tree Creek but then break out of the banks of the creek over the high point on the northern bank and inundate low lying and poorly drained areas within the site.

At the north eastern end of the site, low lying areas occur adjacent to the rail line and at the northern boundary of the exiting sports fields adjacent to Beams Road. This area appears to be providing an overland flow path for flood flows from Beams Road.

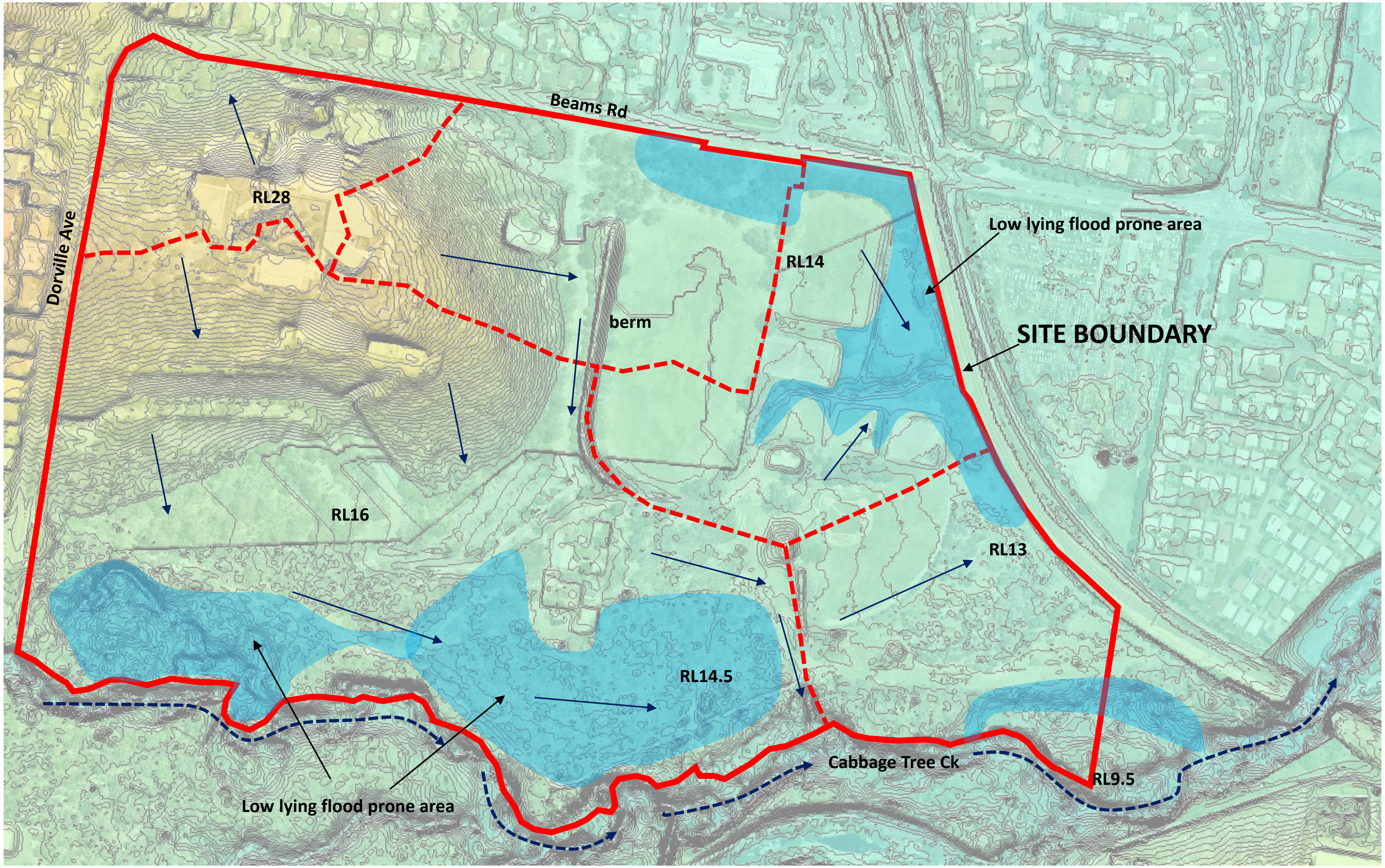


Figure 3: Topography and drainage

2.4 SOILS AND VEGETATION

Soils across the site are generally characterised by alluvial soils comprising surface clayey silt overlying medium to high plasticity silty clay and sandy clay, with interbedded layers of clayey sand, gravelly sand and gravel (SGS, 2017).

The site comprises of sports fields and government buildings in the northern half of the site. Extensive good value bushland is occurs in the southern half of the site including the Cabbage Tree Creek riparian corridor (refer Figure 1).

2.5 PROPOSED DEVELOPMENT

The Carseldine Urban Village development is located within a 45ha site. The site includes existing government facilities that are to be retained. Existing sports fields at the north eastern corner of the site are to be redeveloped, whilst a new sporting precinct will be constructed at the south eastern corner of the site. A future busway is planned at the southern boundary of the site. An existing research facility at the southern end of the site is planned to be decommissioned in 2020.

The overall development will include approximately 12.8ha of new commercial and residential development, and an approximated 5 ha of new sporting complex area.

The proposed development layout for Carseldine Urban Village, together with developed catchments and drainage is shown in Figure 4. The majority of the development runoff will discharge to the south to Cabbage Tree Creek.

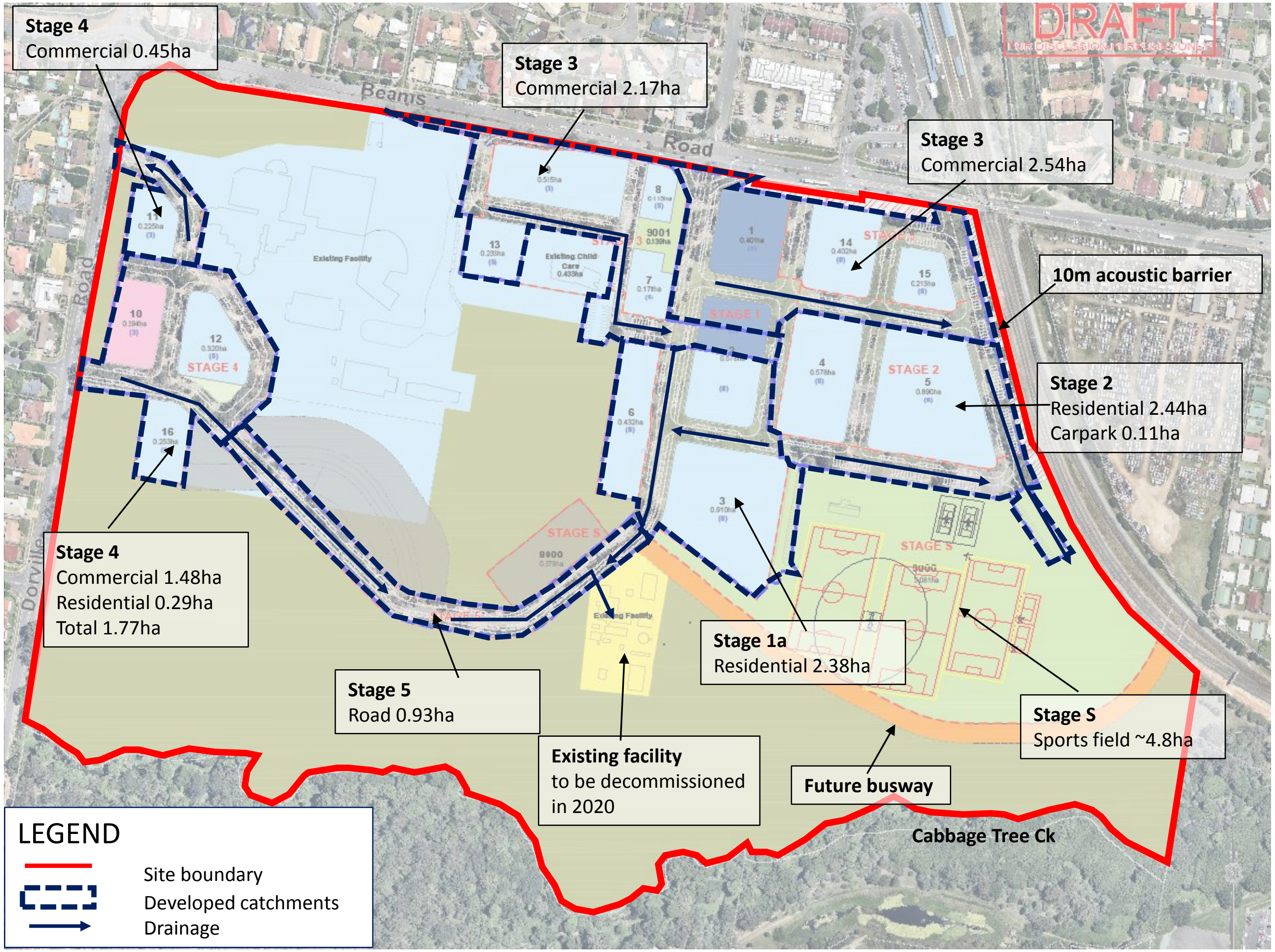


Figure 4 Proposed Carseldine Urban Village development

3 STORMWATER DESIGN OBJECTIVES

Stormwater management objectives have been established based on the following:

- *State Planning Policy (DLGIP, 2017)*
- *Queensland Urban Drainage Manual (2016)*
- *Brisbane City Council (BCC) Planning Scheme*

3.1 STORMWATER QUALITY

The stormwater quality management objectives that apply to the operational phase of the development are defined in the State Planning Policy (DLGIP, 2017) which applies load based objectives presented in Table 1.

Table 1 – Stormwater quality objectives

Constituent	Discharge criteria
Total suspended solids (TSS)	80% reduction in post developed mean annual load
Total phosphorous (TP)	60% reduction in post developed mean annual load
Total nitrogen (TN)	45% reduction in post developed mean annual load
Gross pollutants	90% reduction in post developed mean annual load

Construction phase erosion and sediment control objectives are outlined in Table A Appendix 2 of SPP (DLGIP, 2017). Detailed erosion and sediment control plans will be provided with the Operational Works application.

3.2 FLOODING

The flood management objectives applicable to the site are presented in Table 2. Carseldine Urban Village development lies within Brisbane City Council (BCC) mapped City Wide Waterway corridor zone.

Table 2 Flood objectives

Criterion	Design Objective
No worsening hydraulic conditions	No worsening hydraulic impact to be demonstrated external to the site for the critical duration storm for the 2-100yr events
BCC flood overlay code PO2 Development within a creek/waterway flood planning area	a). Maintains conveyance of flood waters to allow flow and debris to pass predominantly unimpeded through the site b). does not concentrate, intensify or divert floodwater onto upstream, downstream or adjacent properties c). will not result in a material increase in flood levels or flood hazard on upstream, downstream or adjacent properties
BCC Flood overlay code PO8 Development for filling or excavation in an area affected by creek/waterway flooding	Does not directly, indirectly or cumulatively cause any material increase in flooding or hydraulic hazard or involve significant redistribution of flood storage from high to lower areas in the floodplain

4 STORMWATER MANAGEMENT STRATEGY

The stormwater management strategy for the Carseldine Urban Village development has been developed based on discussions with EDQ and field inspections to identify opportunities and constrains.

When developing the strategy a number of guiding principles were considered:

- achieve obligations under the State Planning Policy, BCC planning scheme policy and Queensland Urban Drainage Manual
- ensure stormwater management systems are functionally feasible within the constraints of the development and drainage levels
- avoid numerous stormwater management sites
- avoid works within the Cabbage Tree Creek riparian buffer zone
- minimize impacts on existing good value vegetation
- avoid works encroaching into the future busway corridor
- minimize the need for an on-site flood basin, where possible
- utilization of the 10m wide acoustic barrier at the eastern boundary of the site for drainage conveyance and treatment

Figure 5 shows the stormwater management strategy for the Carseldine Urban Village development. The strategy has been developed considering the proposed drainage for the development. This includes pipe drainage for minor storm events and overland flows for flows exceeding pipe capacity.

Performance assessments of the proposed management strategy are presented in Section 5 (water quality) and Section 6 (flood assessments).

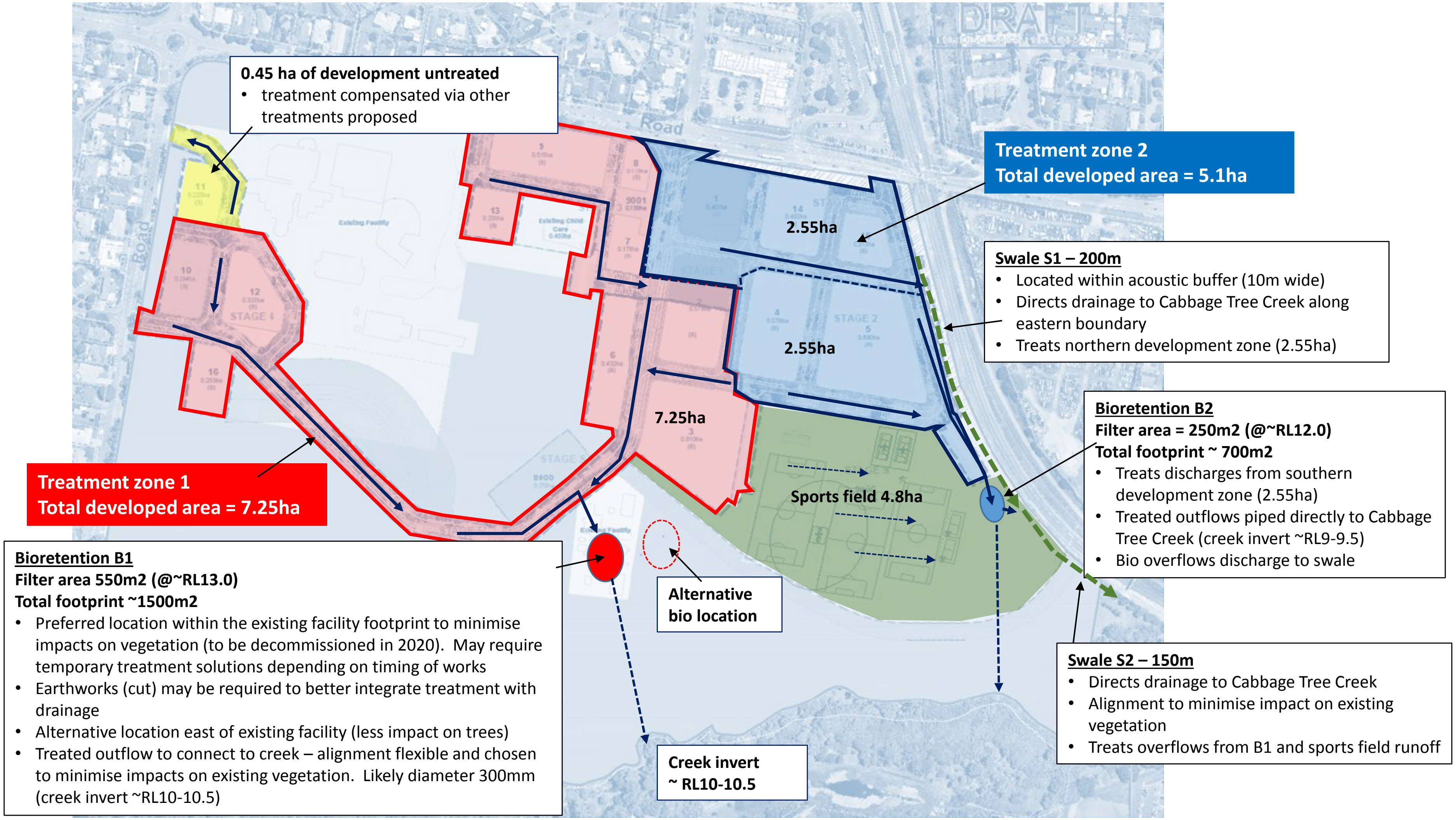


Figure 5 Stormwater Management Strategy Carseldine Urban Village

Table 3 Stormwater treatment elements

ID	Treatment		Catchment	Comment
	Type	Area/length	ha	
B1	Bioretention	550m²	7.25	Treats western half of development. Bio located in existing research facility to be decommissioned in 2020
B2	Bioretention	250m²	2.55	Treats southern half of eastern development zone. Treated flows pipes to Cabbage Tree Ck. Overflows report to Swale S2
S1	Swale	200m	2.55	Treats northern half of eastern development zone
S2	Swale	150m	B1+S1+sportsfield (4.8ha)	Conveys eastern development discharges to Cabbage Tree Ck. Provides treatment for bio B2 overflows and sports field runoff. Location of swale is flexible to minimise impact on existing vegetation
TOTAL			17.15	

4.1 STORMWATER TREATMENT

The treatment strategy includes two bioretention basins treating the two main development zones as shown in Figure 5. A swale at the eastern boundary of the site will also provide a treatment function prior to discharge to Cabbage Tree Creek.

Treatment zone 1

Bioretention basin B1 (filter area 550m² at ~RL13.0) is proposed to be located within the footprint of the existing research facility at the southern end of the site. This area, covering approximately 6,500m², is due to be decommissioned in 2020. The location aligns with the general drainage low point of the development that discharges to the bioretention basin (7.25ha development area). Utilising this footprint for treatment avoids impacts on good value vegetation within the Cabbage Tree Creek riparian corridor. This treatment site could be incorporated as part of a future park for this decommissioned site, and may even facilitate opportunities for stormwater reuse, to supply harvested water for sports field irrigation.

Existing ground levels at the existing facility range from approximately RL14.5 to RL15.5. Based on preliminary earthworks levels for the Stage 5 road, the road low point adjacent to this facility is ~RL14.8. Thus bioretention basin filter surface levels will be in the order of RL13.0 to receive runoff from piped drainage.

Current ground levels will need to be cut ~1.5-2.5m to reach the proposed bioretention basin filter level. Options to lower this site once decommissioned can be explored as part of detail design to better integrate treatment. This also provides additional flood storage. As a minimum, earthworks levels can be lowered to the 5% Annual Exceedance Probability (Q20) level (~RL14.75 - refer to Section 6 later) should this area be converted to park use.

Treated outflows from the bioretention basin are proposed to be piped to Cabbage Tree Creek. This will require a pipe run of ~ 130m. Creek inverts at the outfall are in the order of RL10-10.5, facilitating free drainage from the bioretention basin. The alignment of the treatment outfall pipe is flexible and can be chosen to minimise impact on exiting trees.

Treatment zone 2

The development area that is served by treatment zone 2 is ~5.1ha plus ~4.8ha of sports fields. Treatment is facilitated via a swale within the acoustic barrier at the eastern boundary of the site, and Bioretention Basin B2 (250m^2 at RL12.0) located at the eastern boundary of the site within the sports field complex.

Drainage discharges from the northern half of this development zone are proposed to be treated via the Swale (S1) within the acoustic barrier. This provides an approximate 200m length of treatment. Further treatment will be provided in Swale S2 downstream (150m)

Discharges from the southern half of this development zone are proposed to be treated via Bioretention Basin B2. Based on preliminary development earthworks levels for Stage 2 development (~RL13.5) a bioretention filter level of ~RL12.0 is proposed. Existing ground levels at the proposed bioretention basin location are ~RL13.0.

Treated outflows from the bioretention basin are proposed to be piped to Cabbage Tree Creek. This will require a pipe run of ~ 200m. Creek inverts at the outfall are in the order of RL9.5, facilitating free drainage from the bioretention basin. The alignment of the treatment outfall pipe is flexible and can be chosen to minimise impact on exiting trees.

Overflows from the bioretention basin will spill into the adjacent swale and undergo further treatment prior to discharge to Cabbage Tree Creek.

Stage S Sports field

The sports field zone (~4.8ha) is characterised by mostly pervious grassed surfaces. Runoff from this zone will discharge across wide buffer zones as well as local drainage swales prior to discharge to Cabbage Tree Creek. Carpark areas within the sports field are directed to the main bioretention basins for treatment.

Stage 4 development zone

Stage 4 development covers an area of 0.45ha. No local treatment is included within the development area, however other treatments proposed as part of this strategy have been sufficiently sized to compensate (i.e. over-treat) for the treatment of this area.

4.1.1 Staging of treatments

For the Carseldine development, sequencing of construction activities and completed bioretention basins needs to be carefully managed to avoid treatments being completed too early and adversely affected by construction sediment. It is also important that construction sediment loads are well managed as these represent a high risk to downstream waterways. Appropriate sediment control measures will be detailed during operational works submission.

For completed stages of work, treatment must be demonstrated to meet SPP load based objectives. The following table provides a summary of the main construction activities and sequencing of treatments to cater for both construction sediment loads and operational phase water quality.

Table 4 Staging of works

Development stage	Area (ha)	Construction sediment management	Operational phase treatment
Stage S	4.8	Erosion control in accordance with IECA (2008). Construction sediment pond sized for maximum disturbed are	Swale S2
Stage 1,3,4,5	7.25	Erosion control in accordance with IECA (2008). Construction sediment pond sized for maximum disturbed area	Bioretention Basin B1 – at 80-90% build out complete Bioretention basin B1. Note Bioretention Basin B1 is proposed to be located at the existing research facility to be decommissioned in 2020.
Stage 2,3	5.0	Erosion control in accordance with IECA (2008). Construction sediment pond sized for maximum disturbed area	Bioretention Basin B2 and swale S1 – at 80-90% build out complete Bioretention basin B2

5 STORMWATER QUALITY TREATMENT ASSESSMENT

MUSIC modelling was conducted to quantitatively assess the stormwater treatment performance of the proposed stormwater treatment strategy. MUSIC version 6.3 was used for the assessment and the parameters have been established in accordance with the MUSIC Modelling Guidelines for South East Queensland (Water by Design, 2010).

Details of the modelling assumptions, parameters used and results are presented in the following sections.

5.1 MODEL STRUCTURE

The structure of the MUSIC model is shown in Figure 6 with the general data upon which the model is based provided in Table 5.

Catchments have been derived from the proposed masterplan layout, considering the pipe drainage system that would apply (refer to Figure 5 previously). Only areas under development are included in the model.

The model adopts a lumped catchment approach.

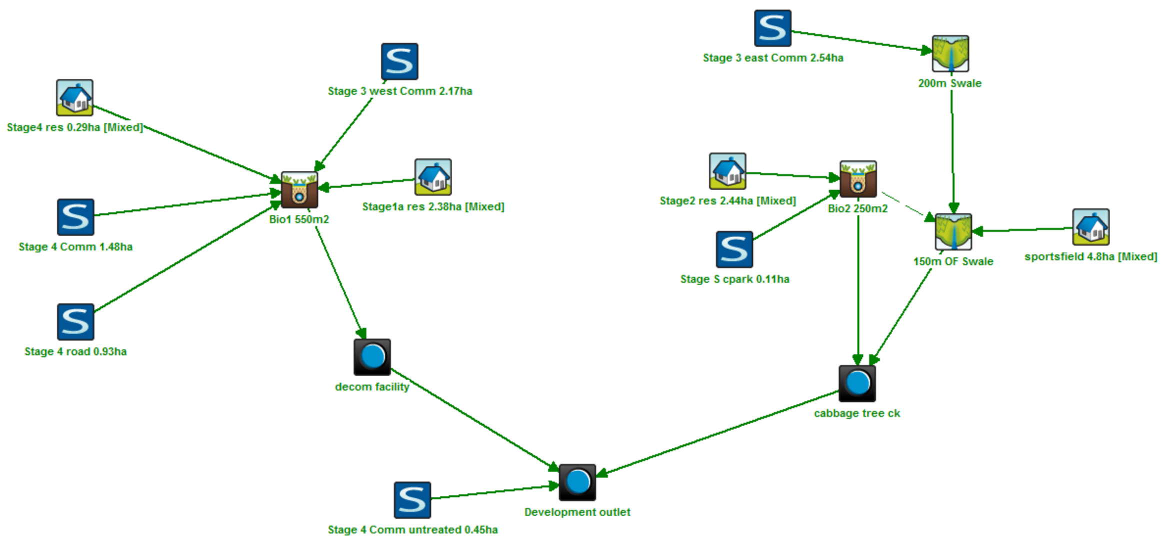


Figure 6 MUSIC model

Table 5 MUSIC model data summary

Parameter	Value
Source Data	
Rainfall data set	1990-1900 – Brisbane Aero Station No. 40223
Modelled time step	6 minute
Mean annual rainfall 1980--1990	1155 mm (for the period used)
Potential evapotranspiration	1,526mm (Table 3.1 Music modelling guidelines for SEQ)
Soil properties (runoff generation parameters)	Table 3.7 Music Modelling Guidelines for SEQ
Pollutant concentrations (base and storm flow concentration parameters)	Table 3.9 Music Modelling Guidelines for SEQ
Percent impervious	Table 3.6 Music Modelling Guidelines for SEQ Residential/mixed use (50dw/ha): 80% impervious Retail/commercial: 90% impervious Road: 90% impervious
Treatment Devices	
Bioretention	Filter media depth = 0.6 m Extended detention depth = 0.3 m Seepage = 0 mm/hr Saturated hydraulic conductivity 200mm/hr TN content[1] 400 mg/kg Orthophosphate content[1] 30mg/kg
Swale	Base width = 1m Top width = 10m Depth = 0.5m Vegetation height = 0.25m Slope 0.4%

Note:

1. Water By Design have recently completed a review of important default values for bioretention basins. In terms of bioretention the parameters adopted are consistent with new values for filter media OP and TN content recently adopted by Healthy Waterways

5.2 RESULTS

The results of the MUSIC modelling are presented in Table 6.

Table 6 Summary of MUSIC modelling – Carseldine Urban Village

Treatment ID	Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction achieved (%)	Water quality objective
CARSELDINE URBAN VILLAGE					
Bio B1 Filter area 550m²	TSS TP TN	16100 36.3 213	3420 10.1 104	78.7 72.1 51.2	Water quality objective applies to the combined site discharge
Bio B2 Filter area 250m²	TSS TP TN	4810 9.73 66	723 2.24 28.2	85 76.9 57.3	
Swale S1 Length = 200m	TSS TP TN	5490 13.8 81.4	516 3.71 57.6	90.6 73.1 29.3	
Swale S2 Length = 150m	TSS TP TN	2810 9.54 108	1350 7.04 93.9	51.9 26.2 13.3	
Stage 4 catchment 0.45ha untreated	**TSS** **TP** **TN**	**956** **2.49** **14.4**	**956** **2.49** **14.4**	**0** **0** **0**	
TOTAL	**TSS** **TP** **TN**	**28900** **66.2** **408**	**5760** **20** **223**	**80.1** **69.8** **45.4**	**80** **60** **45**

The results demonstrate that load based objectives are achieved for the Carseldine Urban Village Development.

6 FLOOD ASSESSMENT

Flood modelling has been based on Brisbane City Council (BCC) supplied URBS and TUFLOW regional flood models for Cabbage Tree Creek. These models have been updated as necessary to make suitable for an impact assessment of the Carseldine Urban Village development.

The following describes model updates made to the Council supplied URBS and TUFLOW models to complete assessments on the impacts of the development.

6.1 URBS

URBS has been used to generate flows for the pre-developed and developed case scenarios for incorporation into TUFLOW. The following describes the model updates and assumptions used.

6.1.1 Pre-developed catchments

The Council supplied URBS model includes 70 sub catchments that delineate the approximate 43.1km² Cabbage Tree Creek catchment. URBS catchments covering the Carseldine Urban Village development zone within the Cabbage Tree Creek catchment have been refined to allow better representation of local catchment flooding characteristics in and around the development.

Sub-catchment 29 in the URBS model covers the proposed Carseldine Urban Village development zone. This has been split into 5 sub-catchments (291 to 295) to represent in finer detail site drainage based on existing topography obtained from Council supplied DEM model and ground truthing of current drainage.

Pervious and impervious fractions have been updated for these catchments, together with catchment slopes. Catchment slopes have been updated and estimated using the equal area method for each new sub catchment modelled.

All other URBS catchments have been retained as per the original Council supplied model setup, including catchment slopes.

Figure 7 shows the predeveloped catchments relevant to the Carseldine Urban Village development. Table 7 provides a summary of sub-catchment land uses, areas and slopes modelled in and around the development. URBS model land use is applied by using various land use categories within each sub-catchment. URBS model land use categorisation has been adopted in accordance with the BCC model. Land use categories and associated fractions impervious values are:

- Urban Low Density (10% Impervious)
- Urban Medium Density (50% Impervious)
- Urban High Density (90% Impervious)
- Rural (0% Impervious)

Table 7 Pre-developed catchments

ID	Area ha	Land use (%)				Catchment Slope %
		Low density	Medium density	High density	Rural	
291	18.63	0%	0%	18.0%	82.0%	1.14
292	6.57	0%	0%	9.7%	90.3%	2.04
293	6.52	0%	0%	3.6%	96.4%	0.63
294	5.09	0%	0%	0%	100%	0.55
295	82.15	0%	19.3%	38.3%	42.4%	0.70
32	36.52	0%	83.3%	3.8%	12.8%	1.30

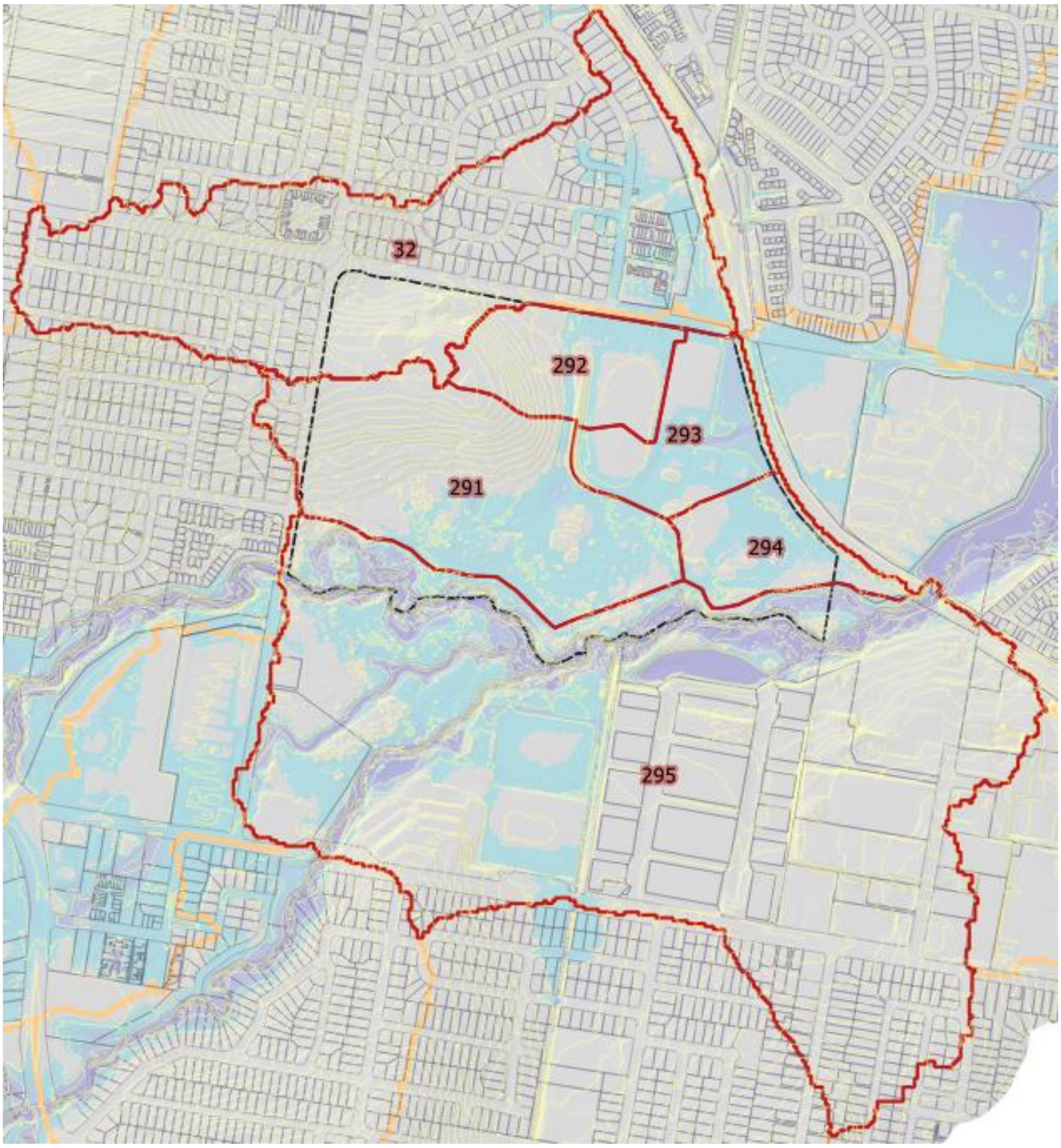


Figure 7 Refined URBS sub-catchments relevant to the development

6.1.2 Developed case catchments

Sub-catchments where development applies were adjusted to represent the proposed development for Carseldine Urban Village. This applies to sub catchments 291, 292, 293, 294 and 32.

Catchment land uses have been adjusted to account for the increased impervious area associated with the development. Minor adjustments to sub-catchment boundaries have also been applied, where necessary.

Pervious and impervious areas were derived based on expected fraction impervious values for the various land uses. Percent impervious values applied to each land use were based on recommended values in QUDM (2007). The following values have been applied:

- pre-developed vegetation: 0%
- Urban residential: 90%
- Retail/commercial: 90%
- Sports fields: 0%

Modelled catchment areas and slopes for post developed conditions are summarised in Table 8.

Table 8 Carseldine Urban Village development - modelled catchment areas and slopes

ID	Area	Land use (%)				Catchment
	ha	Low density	Medium density	High density	Rural	Slope %
291	18.86	0%	0%	34.1%	65.9%	1.14
292	6.62	0%	0%	84.67%	15.33%	2.04
293	6.52	0%	0%	81.89%	18.11%	0.63
294	5.09	0%	0%	6.8%	93.2%	0.55
295	82.15	0%	19.3%	38.3%	42.4%	0.70
32	36.52	0%	83.94%	5.07%	10.99%	1.30

6.1.3 Rainfall

Design event modelling has been undertaken using Australian Rainfall and Runoff (ARR, 1987) industry standard approach of modelling multiple design rainfall burst durations and extracting the maximum values from these events.

Rainfall parameters were based on the following:

- Temporal Patterns were based on the Australian Rainfall and Runoff (1987) publication. Zone 3 is applied to this site.
- Rainfall Intensity Frequency Duration (IFD) data used is consistent with that used in previous modelling, based on AR&R.

Design storms for the 2, 5, 10, 20, 50 and 100 year events have been modelled for the 60, 90, 120, 180 and 360 minute duration storms.

Design event rainfall is retained as per the Council supplied URBS model.

Rainfall losses and roughness values

Loss rates are retained as per the Council supplied URBS model. The following loss rates are used for the pervious areas for all events modelled:

- initial loss – 10 mm
- continuing loss – 0mm/hr

Zero initial and continuing loss is applied to the impervious fractions.

6.2 TUFLOW

Flood modelling has been carried out using a refined version of BCC's Cabbage Tree Creek TUFLOW model. The following updates have been made to the model for this investigation:

- The model has been updated to a recent version of TUFLOW (2016-03-AE_64 _iSP_w64)
- The TUFLOW grid has been reduced from 4m down to 3m to allow improved resolution of the floodplain.
- Inflow hydrographs have been extracted from the refined URBS sub-catchments.
- TUFLOW 'gully' lines have been incorporated to improve model representation of local gullies in the study area. In particular, the existing drain adjacent to the railway has been modelled using a 'gully' line.
- Inflow hydrographs from the refined URBS sub-catchments have been applied using 2d_sa polygons that have been trimmed to control where flows are input to the TUFLOW model.

All other model parameters and assumptions remain unchanged.

6.2.1 Development earthworks

For the purposes of modelling, the development has been modelled above the 1% AEP level. Areas outside of the development zone are retained at existing levels. This is a conservative approach given the sports field area can be lowered to the 5% AEP level. Updated flood modelling is planned to occur once development earthworks are refined by others.

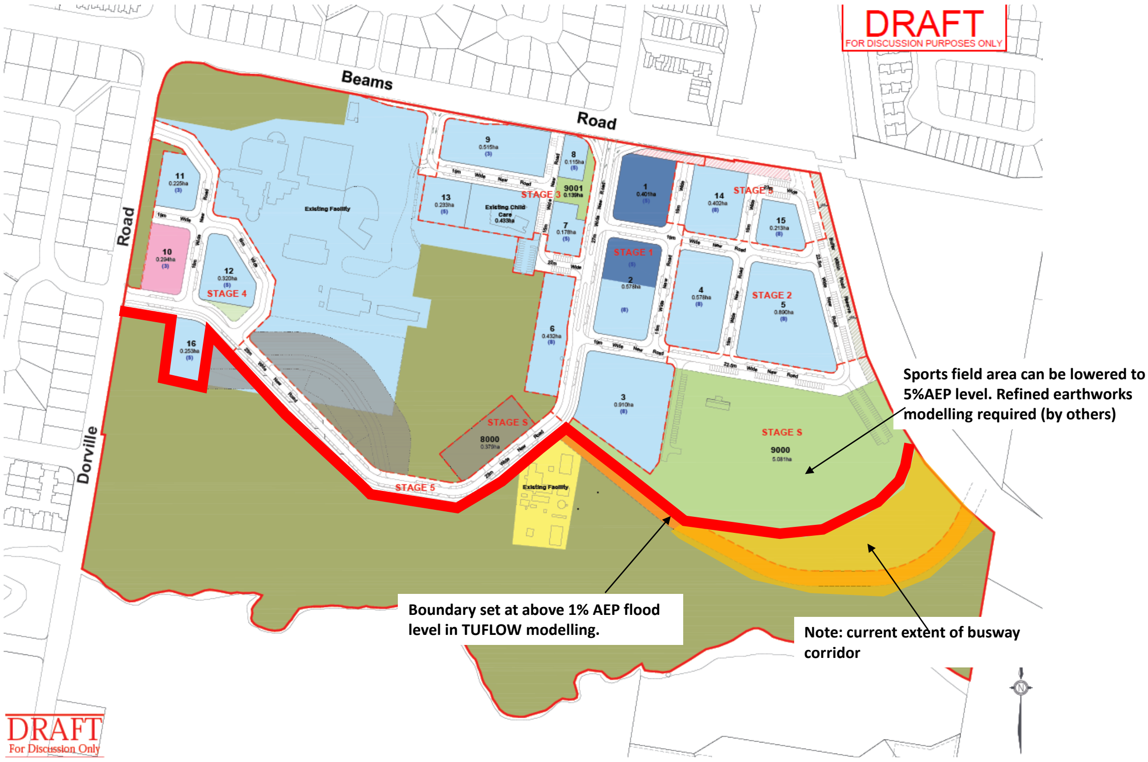


Figure 8 TUFLOW earthworks delineation

6.3 RESULTS

Table 9 summarises peak flows immediately upstream of the Railway Bridge at Cabbage Tree Creek (reporting point 10), whilst Table 10 summarises peak water levels for pre and post conditions at various reporting location both within and external to the site. Numbers highlighted in red indicate an increase from pre-developed levels. Figure 9 provides locations of reporting points.

Appendix A provides flood depth and impact maps for model runs. These include:

- Figure A1: Base case 39%AEP (Q2) flood depth
- Figure A2: Base case 5% AEP (Q20) flood depth
- Figure A3: Base case 1% (Q100) flood depth
- Figure A4: Developed case 39% AEP (Q2) flood depth
- Figure A5: Developed case 5% AEP (Q20) flood depth
- Figure A6: Developed case 1% AEP (Q100) flood depth
- Figure A7: Flood impact map 39% AEP (Q2)
- Figure A8: Flood impact map 20%AEP (Q5)
- Figure A9: Flood impact map 10% AEP (Q10)
- Figure A10: Flood impact map 5% AEP (Q20)
- Figure A11: Flood impact map 2% AEP (Q50)
- Figure A12: Flood impact map 1% AEP (Q100)
- Figure A13: Regional flood impact map 39% AEP (Q2)
- Figure A14: Regional flood impact map 1% AEP (Q100)

Table 9 Peak flows – Cabbage Tree Creek - Railway Bridge (point 10)

AEP	Peak flow (m³/s)			Difference
	Pre	Post	Difference	%
39% (Q2)	74.85	74.67	-0.18	-0.2%
20% (Q5)	103.85	103.93	0.08	0.1%
10% (Q10)	123.68	123.49	-0.19	-0.2%
5% (Q20)	148.8	148.45	-0.35	-0.2%
2% (Q50)	178.5	177.56	-0.94	-0.5%
1% (Q100)	203.13	203.54	0.41	0.2%

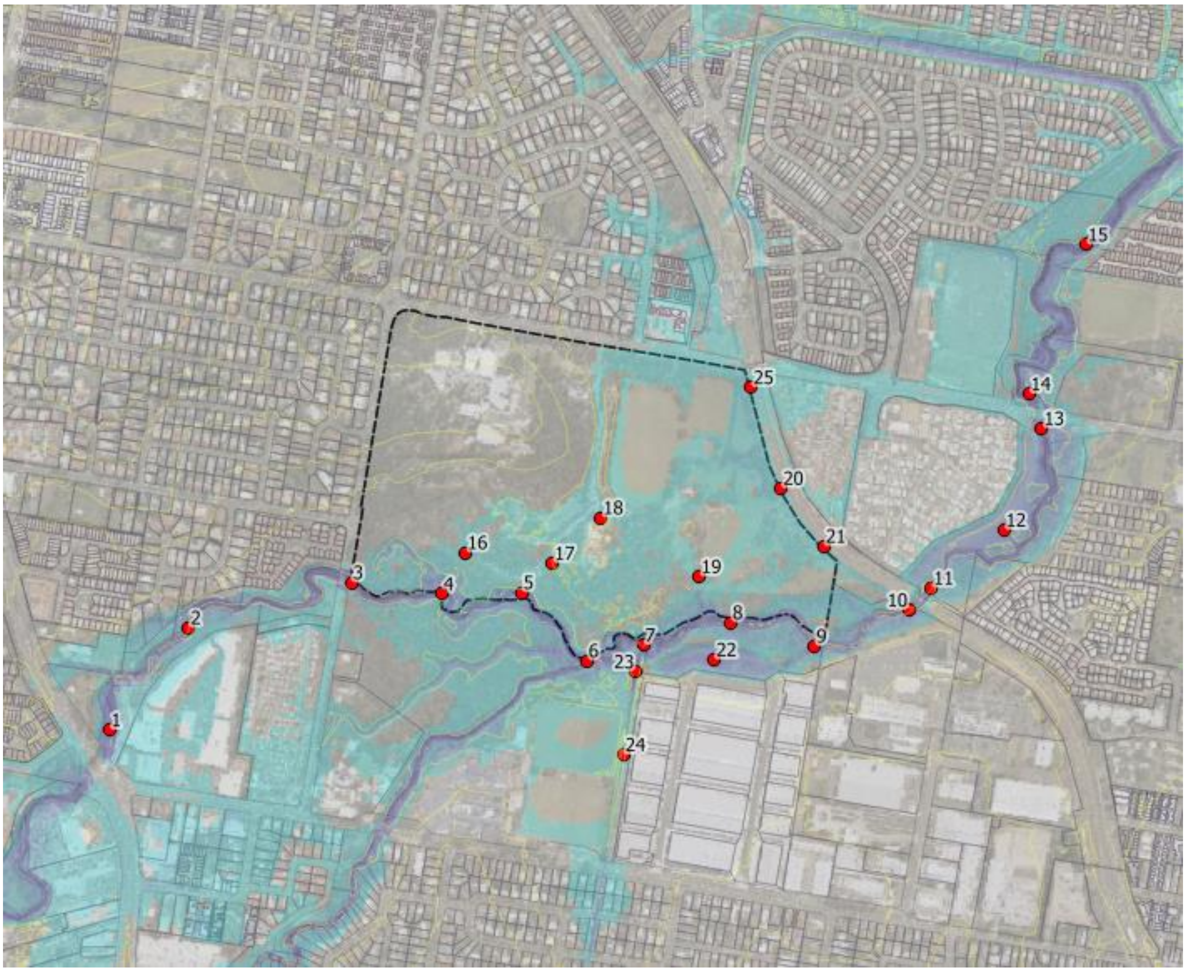


Figure 9 Reporting locations

Table 10 Peak water levels

ID	Water levels (mAHD)																	
	Q2			Q5			Q10			Q20			Q50			Q100		
	pre	post	difference	pre	post	difference	pre	post	difference	pre	post	difference	pre	post	difference	pre	post	difference
1	17.791	17.791	0.000	18.270	18.270	0.000	18.532	18.532	0.000	18.804	18.804	0.000	18.999	18.999	0.000	19.077	19.077	0.000
2	16.866	16.866	0.000	17.364	17.364	0.000	17.638	17.638	0.000	17.942	17.942	0.000	18.169	18.169	0.000	18.262	18.262	0.000
3	15.474	15.474	0.000	16.009	16.009	0.000	16.274	16.274	0.000	16.544	16.544	0.000	16.718	16.718	0.000	16.779	16.779	0.000
4	15.163	15.164	0.000	15.695	15.695	0.000	15.956	15.956	0.000	16.220	16.220	0.000	16.374	16.374	0.000	16.429	16.429	0.000
5	14.548	14.549	0.001	15.089	15.089	0.000	15.326	15.326	0.000	15.550	15.551	0.000	15.709	15.710	0.001	15.801	15.802	0.000
6	13.731	13.735	0.004	14.217	14.221	0.004	14.467	14.470	0.003	14.742	14.745	0.002	15.054	15.056	0.002	15.274	15.275	0.001
7	13.378	13.384	**0.006**	13.831	13.838	**0.007**	14.070	14.073	0.003	14.343	14.347	0.004	14.646	14.650	0.004	14.884	14.886	0.002
8	12.924	12.933	**0.009**	13.303	13.313	**0.010**	13.502	13.510	**0.008**	13.725	13.734	**0.008**	13.974	13.977	0.003	14.204	14.211	**0.007**
9	12.292	12.299	**0.006**	12.663	12.672	**0.008**	12.872	12.878	**0.006**	13.140	13.147	**0.007**	13.463	13.458	-0.004	13.755	13.763	**0.008**
10	11.684	11.683	-0.001	12.090	12.090	0.001	12.349	12.349	0.000	12.713	12.713	0.000	13.124	13.111	-0.013	13.476	13.485	**0.009**
11	11.405	11.403	-0.002	11.806	11.805	0.000	12.048	12.047	-0.001	12.323	12.323	0.000	12.580	12.573	-0.007	12.763	12.767	0.004
12	11.134	11.131	-0.003	11.580	11.580	0.000	11.845	11.844	-0.001	12.135	12.135	0.000	12.391	12.384	-0.007	12.569	12.573	0.004
13	11.030	11.027	-0.003	11.491	11.490	0.000	11.760	11.759	-0.001	12.050	12.050	0.000	12.301	12.294	-0.007	12.471	12.475	0.004
14	10.956	10.953	-0.002	11.401	11.401	0.000	11.653	11.652	-0.001	11.914	11.914	0.000	12.130	12.124	-0.006	12.279	12.282	0.004
15	9.854	9.851	-0.003	10.352	10.352	0.000	10.605	10.603	-0.001	10.859	10.859	0.000	11.080	11.078	-0.002	11.251	11.255	0.004
16	dry	dry	NA	dry	dry	NA	dry	dry	NA	16.112	16.112	0.000	16.241	16.241	0.000	16.283	16.283	0.000
17	dry	dry	NA	dry	dry	NA	dry	dry	NA	15.040	15.040	0.000	15.151	15.172	**0.021**	15.209	15.255	**0.047**
18	dry	dry	NA	dry	dry	NA	dry	dry	NA	dry	dry	NA	dry	14.938	**0.144**	14.780	15.044	**0.264**
19	dry	dry	NA	dry	dry	NA	dry	dry	NA	dry	dry	NA	dry	14.443	**0.264**	14.274	14.552	**0.278**
20	13.047	12.871	-0.176	13.135	12.939	-0.196	13.189	12.990	-0.199	13.256	13.045	-0.211	13.342	13.101	-0.241	13.496	13.469	-0.027
21	12.799	12.672	-0.127	12.975	12.777	-0.198	13.049	12.824	-0.225	13.164	12.880	-0.283	13.306	13.098	-0.208	13.490	13.475	-0.014
22	11.926	11.953	**0.027**	12.718	12.727	**0.009**	12.947	12.955	**0.008**	13.269	13.280	**0.011**	13.717	13.719	0.002	14.040	14.049	**0.009**
23	13.393	13.398	**0.006**	13.855	13.863	**0.008**	14.116	14.110	-0.006	14.398	14.407	**0.009**	14.725	14.734	**0.009**	14.990	14.991	0.001
24	14.969	14.969	0.000	15.223	15.224	0.000	15.275	15.264	-0.011	15.324	15.317	-0.007	15.357	15.358	0.001	15.403	15.402	-0.001
25	13.113	dry	-0.076	13.180	dry	-0.143	13.222	dry	-0.185	13.278	12.998	-0.280	13.353	13.104	-0.249	13.489	13.454	-0.035

6.3.1 Peak flows

Peak flows upstream at the Railway Bridge over the range of storm events up to the 2% AEP (Q50) are effectively retained at or below predeveloped levels. For the 1% AEP (Q100) a minor increase is observed and represents a 0.2% increase. No adverse impacts downstream of the Bridge are observed.

6.3.2 Flood inundation

Existing case flood inundation maps indicate flooding of low lying areas at the north eastern corner of the site occurs on a frequent basis. Figure 10 shows inundation mapping for the minor 39% AEP event. Inundation in this area is caused by local site runoff and may also be influenced by local flooding from Beams Rd. Minor event flood inundating over Beams Road is also predicted.

At the 5% AEP (see Figure 11) breakout from Cabbage Tree Creek occurs along the northern bank at the western end of the site. These breakout flows are then predicted to flow generally in a north-east direction at shallow depths through the site. Inundation in the north-east of the site is constrained west of the rail corridor.

In the 1% AEP event (refer to Figure 12) there is a significant increase in the inundation area of breakout flows through the site. While there is a large increase in the inundation extent, the actual flood depths predicted over most of this area remain small (typically less than 250mm). Inundation is also predicted to occur across the rail corridor at the north eastern boundary of the site and extends along Beams Road and adjacent existing developed areas to the east. Flow depths are noted to be mostly less than 250mm in this case, except for low lying areas adjacent to the rail corridor.

Flooding across the site resulting from Cabbage Tree Creek breakout flows is characterised by shallow (typically less than 250mm), conveyance dominated flows. Consequently, flood storage influences are expected to be minor. For this reason, it would be expected that a loss of floodplain storage in these areas would be unlikely to cause significant adverse flood impacts. This is discussed in the following section.

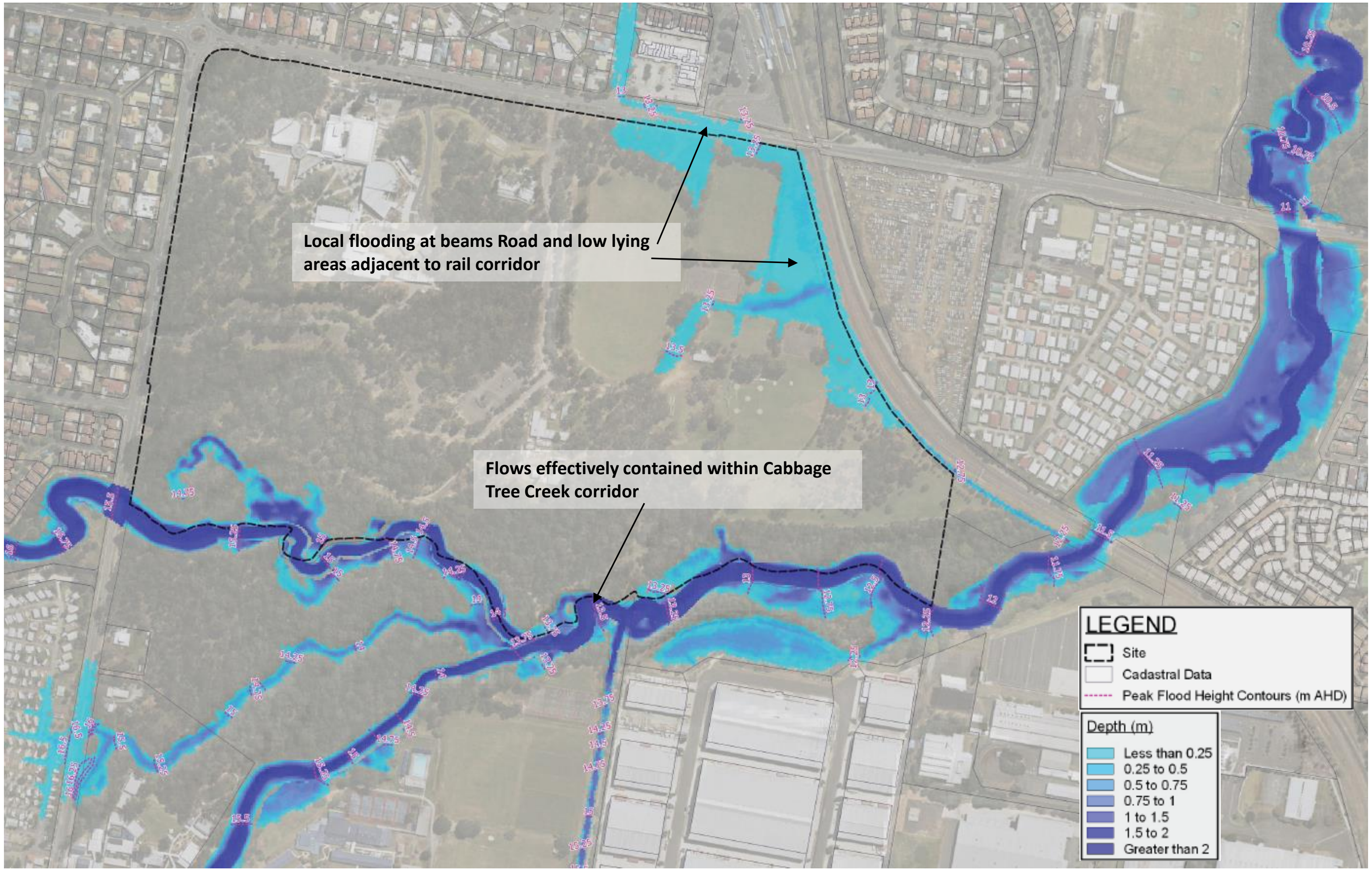


Figure 10 39% AEP (Q2) flood inundation - existing conditions

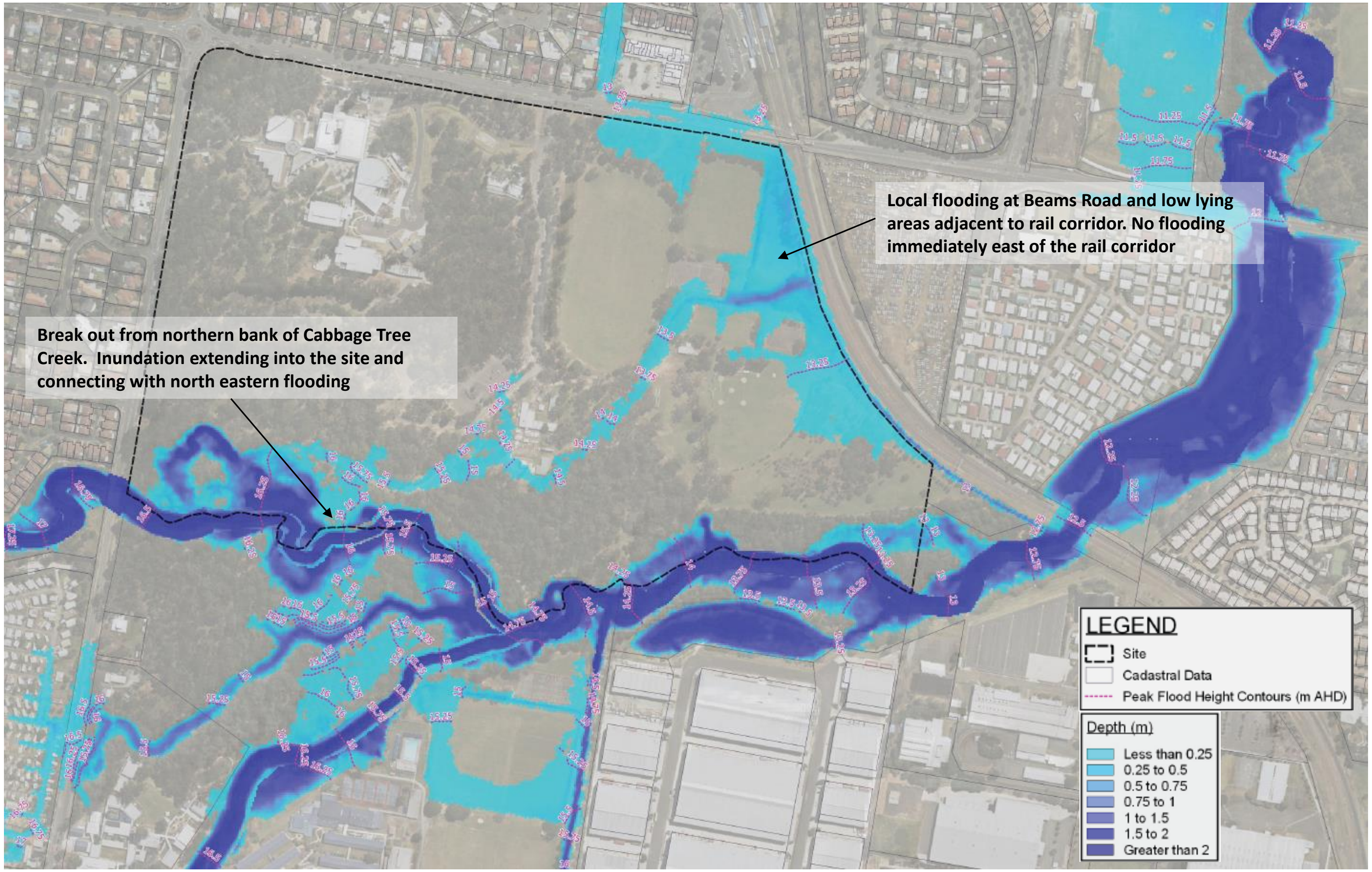


Figure 11 5% AEP (Q20) flood inundation - existing conditions

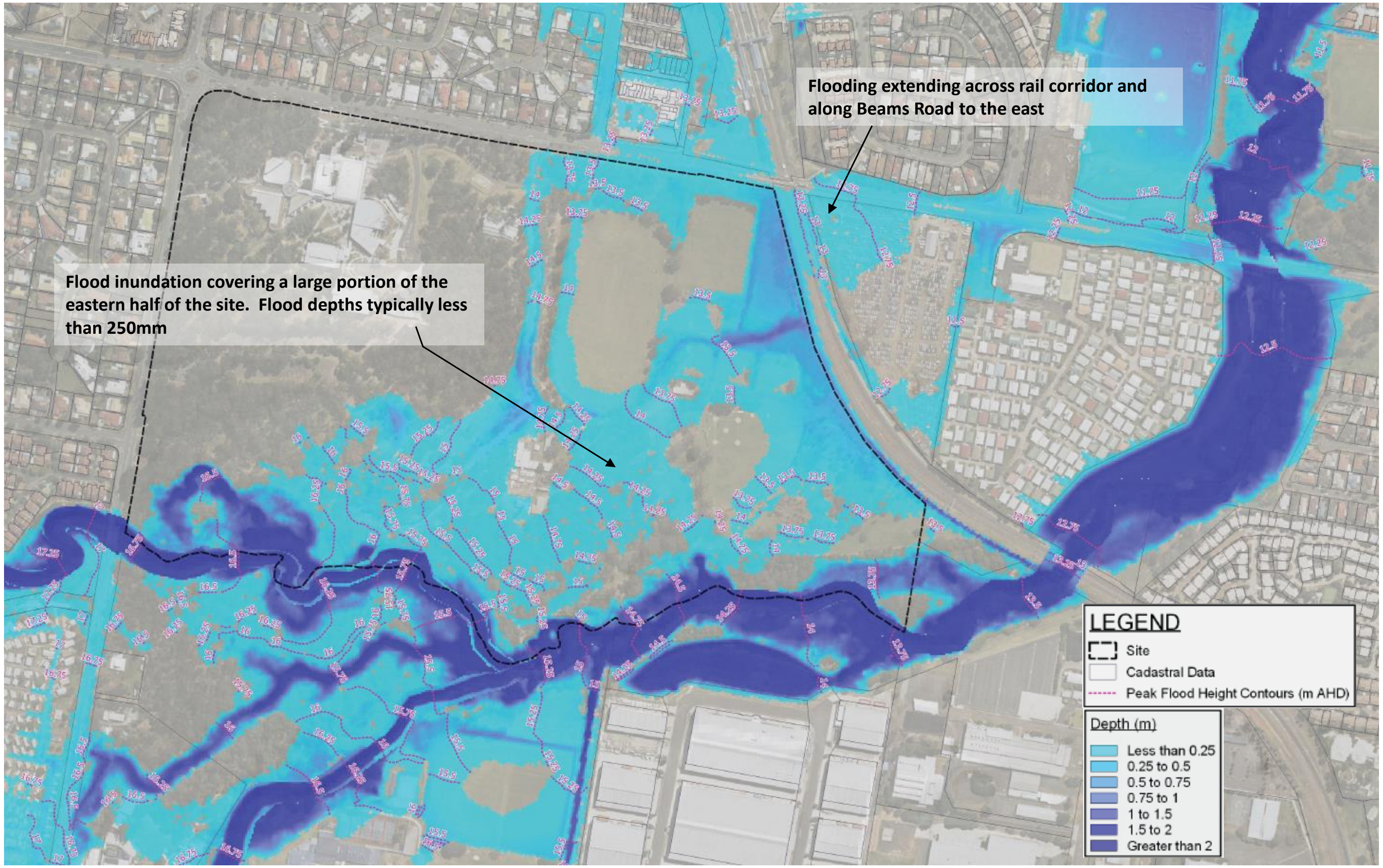


Figure 12 1% AEP (Q100) flood inundation - existing conditions

6.3.3 Flood impacts

Table 10 previously summarises peak water levels for pre and post conditions at various reporting locations for the 39% AEP (Q2) to 1% AEP (Q100) model runs. Flood impacts maps for the 39% AEP (Q2) to 1% AEP (Q100) are included in Appendix A.

Flood impact maps demonstrate no significant adverse impacts occurring external to the site as a result of the development. Some minor afflux (up to 10mm) is observed along Cabbage Tree Creek immediately south of the development (reporting points 7, 8 and 9 in Figure 9), however this afflux is contained within Cabbage Tree Creek and does not extend downstream.

Less frequent flood events (2% AEP and above) afflux up to ~300mm is noted to occur in the riparian corridor between the southern boundary of the development zone and Cabbage Tree Creek (refer to Figure 13). This afflux is contained within the site boundary and does not extend external to the site.

Improved flood conditions are observed at the rail corridor in the north-east end of the site. This is because much of the site which currently drains to the north-east corner will instead be collected by pipe and road drainage and directed to Cabbage Tree Creek. Furthermore, during larger magnitude events, the proposed development filling restricts Cabbage Tree Creek breakout flow from entering this area.

It is noted that some localised flood level increases are shown on the impact maps for various design events. These impacts should be interpreted within the context of numerical model results of a regional floodplain. It is to be expected that model accuracy limitations will result in some localised minor 'impacts' which are not meaningful. For example, minor changes to water level within the main creek channel (less than 10mm) can cause larger impacts to occur on adjacent floodplain and tributaries which then show up on impact maps. These impacts are not meaningful and are an accuracy limitation of the model. Overall, the results of the modelling from this investigation show that the proposed development is not predicted to cause any meaningful adverse flood impacts offsite within an accuracy limit of +/- 10mm.

Note: Flood impacts presented in this report are considered conservative because the proposed sport fields are assumed to be filled above the 1% AEP event. This area, representing approximately 5ha, requires a minimum immunity of 5% AEP, and therefore it is likely that final design levels through this area will be reduced and will allow for flood inundation during events greater than the 5% AEP. Model refinement will be completed once updated earthworks models are developed (by others).

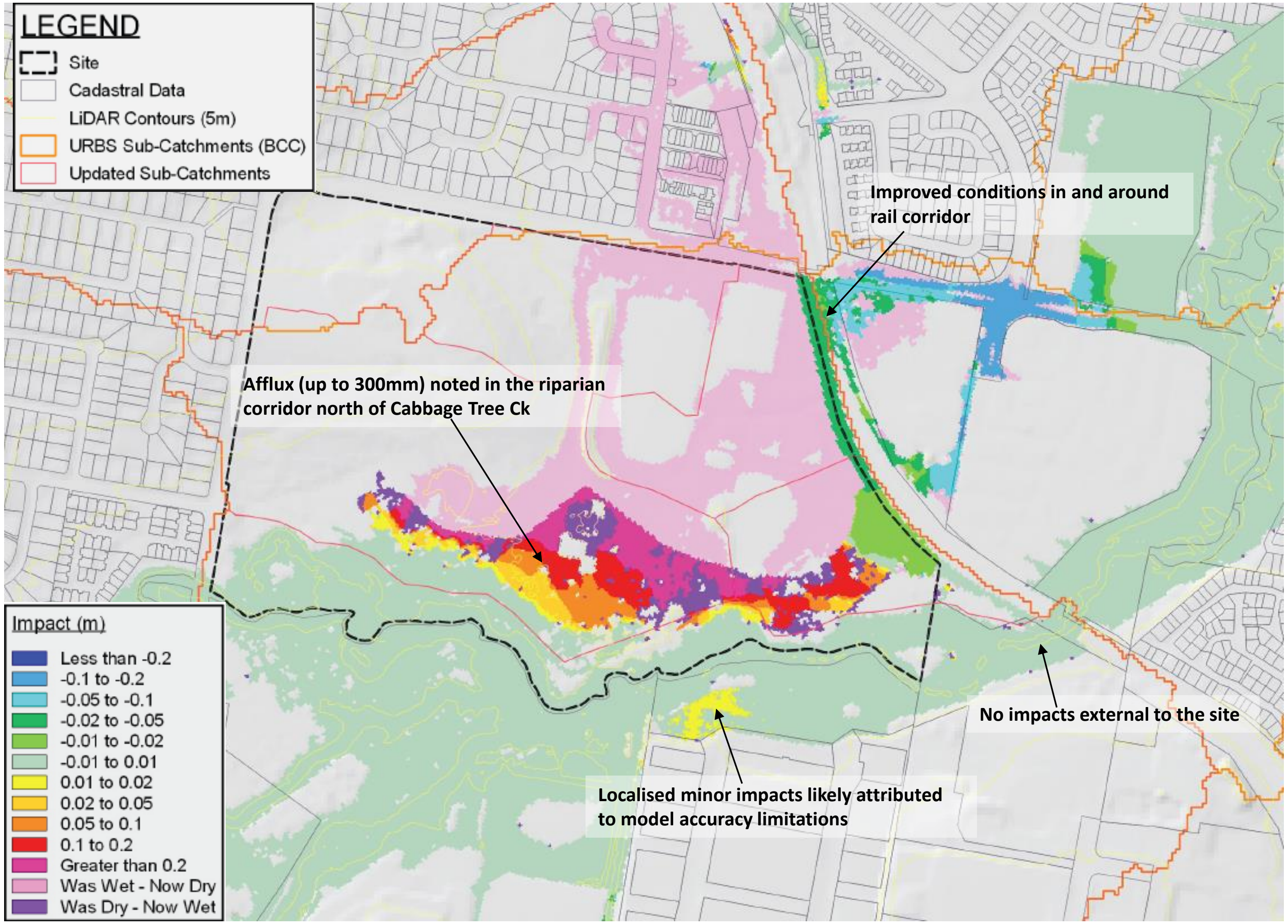


Figure 13 1%AEP flood impacts

6.3.4 Flood storage

An assessment of the impacts of development on flood storage has been completed for the 1% AEP event. This is to review compensatory earthworks, in line with BCC compensatory earthworks planning scheme policy for developments within mapped creek corridors.

Flood storage volumes within the site boundary have been calculated for the existing case and developed case scenarios. In the developed case scenario, no flooding of the sports fields up to the 1 % AEP event is assumed. Table 11 summarises the estimated flood storage volumes, based on the current model assumptions.

Table 11 Flood storage volumes

Scenario	Flood storage (m^3)
Existing conditions	38,386
Developed case	23,395
Loss in storage	14,991

Overall, the flood modelling and associated conservative assumptions predict that a loss of flood storage will occur. Despite this, the modelling also demonstrate that no significant adverse offsite flood impacts are expected to occur. This is because the storage loss is relatively minor in the context of the regional floodplain and also the site largely serves a flood conveyance (or overland flow) function as opposed to a flood storage function for Cabbage Tree Creek floodwaters.

While modelling has demonstrated that the loss of floodplain storage is of no consequence, it is also noted that as design progresses, there is opportunity to achieve the floodplain storage balance (or close to a balance) via the following design refinements:

- Building the sports fields to 5% AEP level (minimum earthworks level ~RL13) – gains in the order of 5,000 to 7,500m^3 could be expected based on flood inundation maps
- Gain in storage over treatment areas 2,000-3,000m^3
- Lowering existing facility to be decommissioned in 2020 to 5% AEP level (~RL14.75) – 2,000-3,000m^3

The overall gains in storage that are practically achievable as design progresses are likely to fully or closely offset the loss of storage that is currently estimated.

7 MAINTENANCE

WSUD infrastructure such as bioretention basins require ongoing inspection and maintenance to ensure they establish and operate in accordance with the design intent. Potential problems associated with WSUD as a result of poor maintenance include:

- Decreased aesthetic amenity;
- Reduced functional performance;
- Public health and safety risks; and
- Decreased habitat diversity (dominance of exotic weeds).

7.1 MAINTENANCE PLAN

A Maintenance Plan will be required prior to handover of WSUD assets. The plan will provide detailed guidance around maintenance of WSUD assets, as well as frequency of maintenance activities. The manual will include performance inspection checklists. The document will be consistent with the methodologies and principles detailed in Maintaining WSUD Assets (Water by Design, 2012).

The maintenance plan and checklists will be a living document and can be refined where required in collaboration with Council assets and maintenance departments to ensure the structure and frequency of maintenance is consistent with current Council procedures. This will also provide an opportunity for transfer of knowledge in this regard to allow Council to effectively operate the sediment ponds and bioretention basin.

7.1.1 Bioretention basins

Typical maintenance of bioretention systems during operation will involve:

- Routine inspection of the bio-retention system profile to identify any areas of obvious increased sediment deposition, scouring from storm flows, rill erosion of the batters from lateral inflows, damage to the profile from vehicles and clogging of the bio-retention system (evident by a 'boggy' filter media surface).
- Routine inspection of inflows systems, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages.
- Removal of sediment where it is smothering the bio-retention system vegetation.
- Repairing any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.
- Tilling of the bioretention system surface, or removal of the surface layer, if there is evidence of clogging.
- Regular watering/ irrigation of vegetation until plants are established and actively growing.
- Removal and management of invasive weeds (herbicides should not be used).

- Removal of plants that have died and replacement with plants of equivalent size and species as detailed in the plant schedule.
- Pruning to remove dead or diseased vegetation material and to stimulate growth.
- Vegetation pest monitoring and control.

Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage.

8 CONCLUSION

An updated stormwater management strategy has been developed for the Carseldine Urban Village to meet the requirements of the State Planning Policy (DLGIP, 2017), QUDM and Brisbane City Council Planning Scheme.

Stormwater Treatment

The updated strategy includes two (2) bioretention basins that treat development runoff prior to discharge to Cabbage Tree Creek:

- Bioretention Basin B1 550m^2 with an overall footprint of ~1,500m^2
- Bioretention Basin B2 250m^2 with an overall footprint of ~700m^2

Bioretention basin B1 is proposed to be located within the existing research facility site (~6,500m^2) due to be decommissioned in 2020. The location aligns with the general drainage low point of the development that discharges to the bioretention basin. Utilising this footprint for treatment avoids impacts on good value vegetation within the Cabbage Tree Creek riparian corridor. This treatment site could be incorporated as part of a future park for this decommissioned site, and may even facilitate opportunities for stormwater reuse, to supply harvested water for sports field irrigation. Earthworks (cut) may be required at this site to better integrate the proposed treatment and provide some additional flood storage.

Bioretention basin B2 is proposed to be located at the eastern boundary of the site within the proposed sports field complex. A swale along the 10 m wide acoustic barrier is also proposed to improve drainage and provide a treatment function prior to discharge to Cabbage Tree Creek.

Flooding

Flood assessment completed for this study are considered conservative and have assumed no flooding of the proposed sports field area up to the 1% AEP. Overall, the flood modelling and associated conservative assumptions predict that a loss of flood storage will occur as a result of development. Despite this, the modelling also demonstrates that no significant adverse offsite flood impacts are expected to occur. This is because the storage loss is relatively minor in the context of the regional floodplain and also the site largely serves a flood conveyance (i.e. overland flow) function as opposed to a flood storage function for Cabbage Tree Creek floodwaters.

While modelling has demonstrated that the loss of floodplain storage is of no consequence, it is also noted that as design progresses, there is opportunity to achieve the floodplain storage balance (or close to a balance) via the following design refinements:

- building the sports fields to Q20 level (minimum earthworks level ~RL13) – gains in the order of 5,000 to 7,500m^3 could be expected based on flood inundation maps

- gain in storage over treatment areas 2,000-3,000m^3
- lowering existing facility to be decommissioned in 2020 to Q20 level (~RL14.75) – 2,000-3,000m^3

The overall gains in storage that are practically achievable as design progresses are likely to fully or closely offset the loss of storage that is currently estimated.

9 REFERENCES

Australian Rainfall and Runoff (1987). *A Guide to Flood Estimation*. Engineers Australia

Calibre (2017). *Flood Impact Assessment & Concept Stormwater Management Plan – Carseldine Urban Village (Master Plan).* Prepared for Economic Development Queensland.

DLGIP (2017). *State Planning Policy*

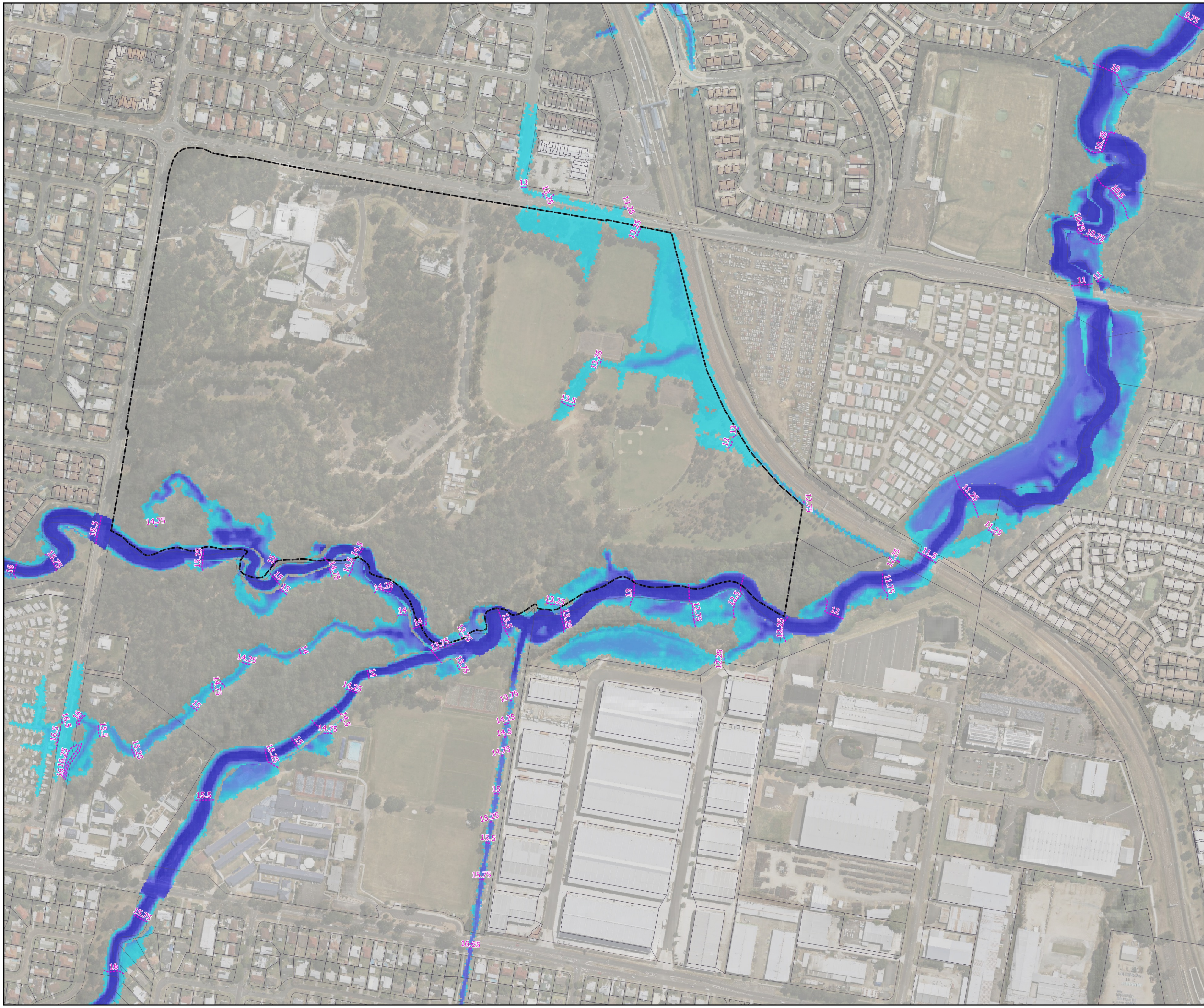
Healthy Waterways (2010). *MUSIC Modelling Guidelines*

International Erosion Control Association (2008). *Best Practice Erosion and Sediment Control*

QUDM (2007). *Queensland Urban Drainage Manual*. Second Edition 2007. Department of Natural Resources and Water

SGS (2017). *Geotechnical Investigation Report – Carseldine Urban Village*, *Beams Road*, *Carseldine.* Prepared for Economic Development Queensland.

APPENDIX A – TUFLOW MODEL OUTPUTS



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Peak Flood Height Contours (m AHD)

Depth (m)
Less than 0.25
0.25 to 0.5
0.5 to 0.75
0.75 to 1
1 to 1.5
1.5 to 2
Greater than 2

FIGURE A1

N

50 0 50 100 m

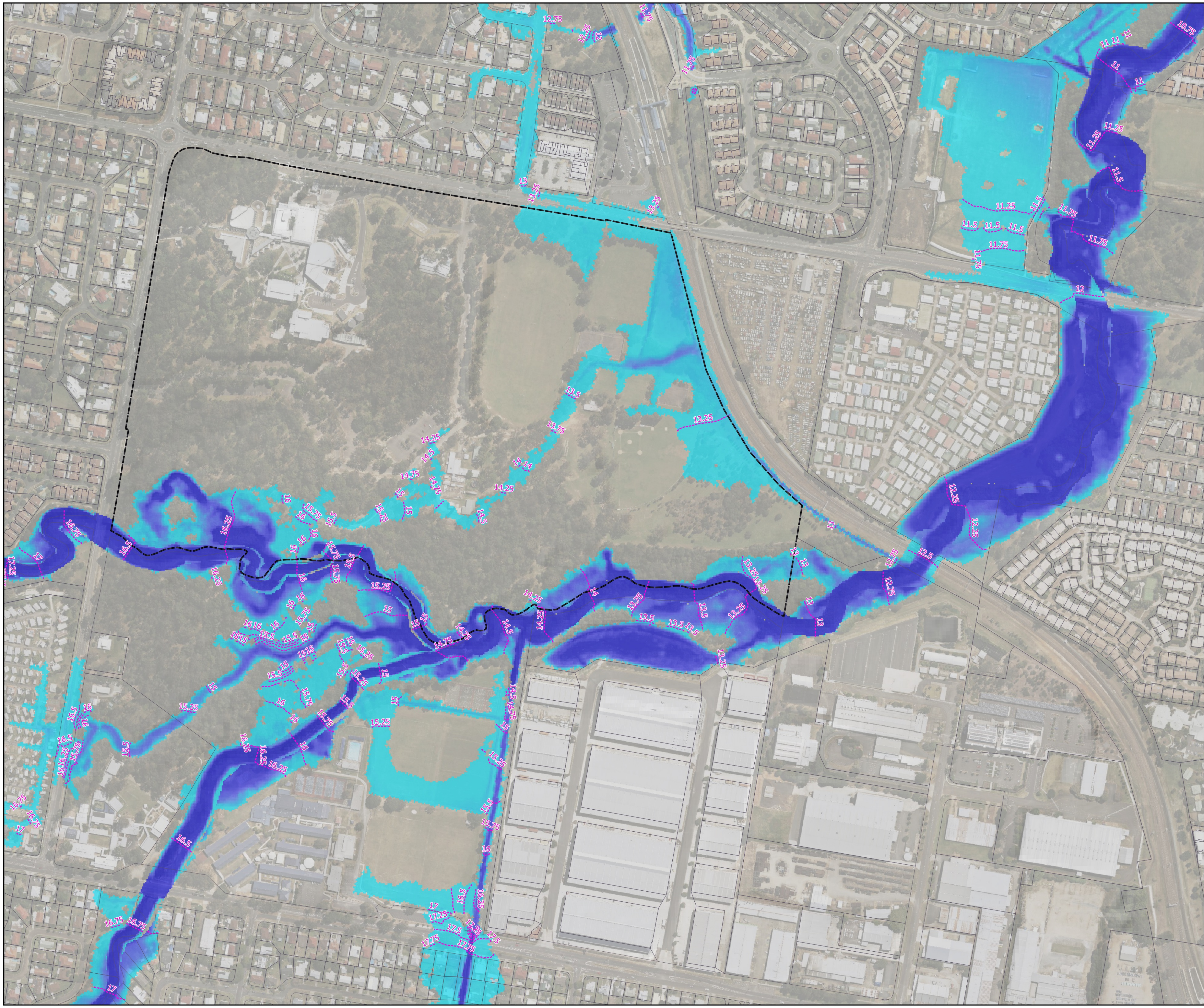
Carseldine Urban Village

Peak Flood Depth &
Peak Flood Level Contours

Existing Case
(TUFLOW ID B01c)

39% AEP Event (Q002)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Peak Flood Height Contours (m AHD)

Depth (m)

- Less than 0.25
- 0.25 to 0.5
- 0.5 to 0.75
- 0.75 to 1
- 1 to 1.5
- 1.5 to 2
- Greater than 2

FIGURE A2

N

50 0 50 100 m

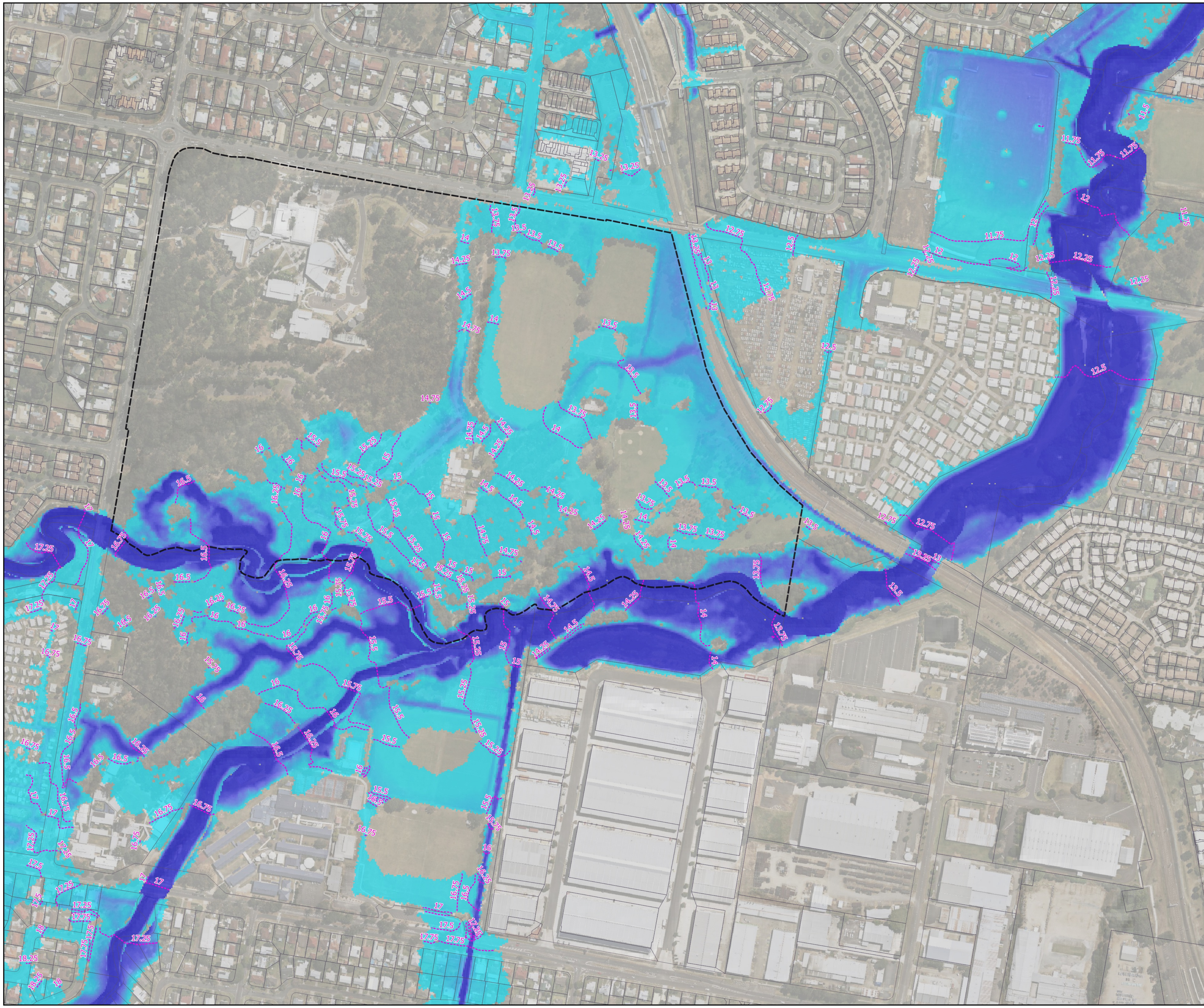
Carseldine Urban Village

Peak Flood Depth & Peak Flood Level Contours

Existing Case (TUFLOW ID B01c)

5% AEP Event (Q020)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

Site

Cadastral Data

Peak Flood Height Contours (m AHD)

Depth (m)

Less than 0.25

0.25 to 0.5

0.5 to 0.75

0.75 to 1

1 to 1.5

1.5 to 2

Greater than 2

FIGURE A3

N

50 0 50 100 m

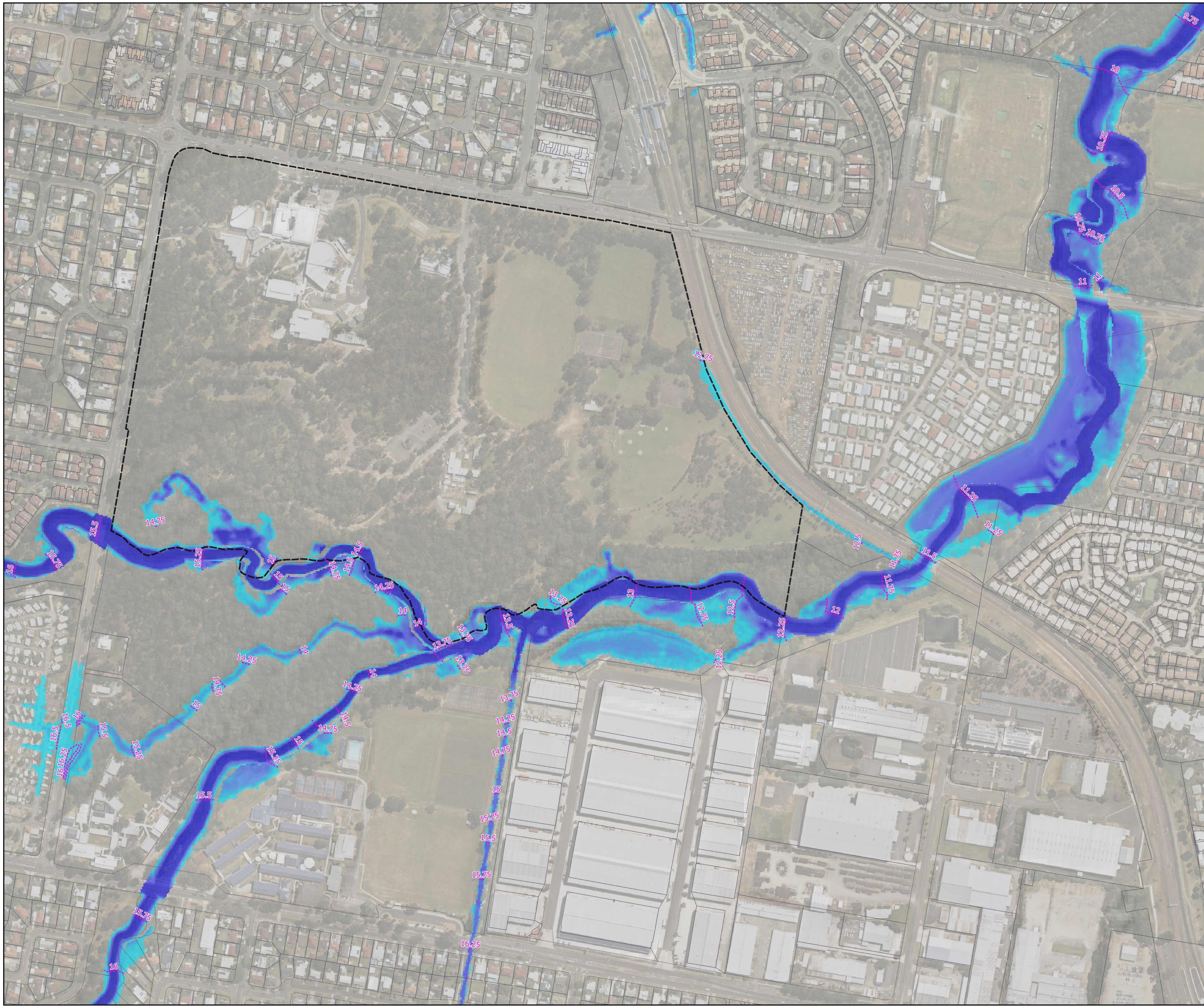
Carseldine Urban Village

Peak Flood Depth &
Peak Flood Level Contours

Existing Case
(TUFLOW ID B01c)

1%AEP Event (Q100)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Peak Flood Height Contours (m AHD)

Depth (m)

- Less than 0.25
- 0.25 to 0.5
- 0.5 to 0.75
- 0.75 to 1
- 1 to 1.5
- 1.5 to 2
- Greater than 2

FIGURE A4

N

50 0 50 100 m

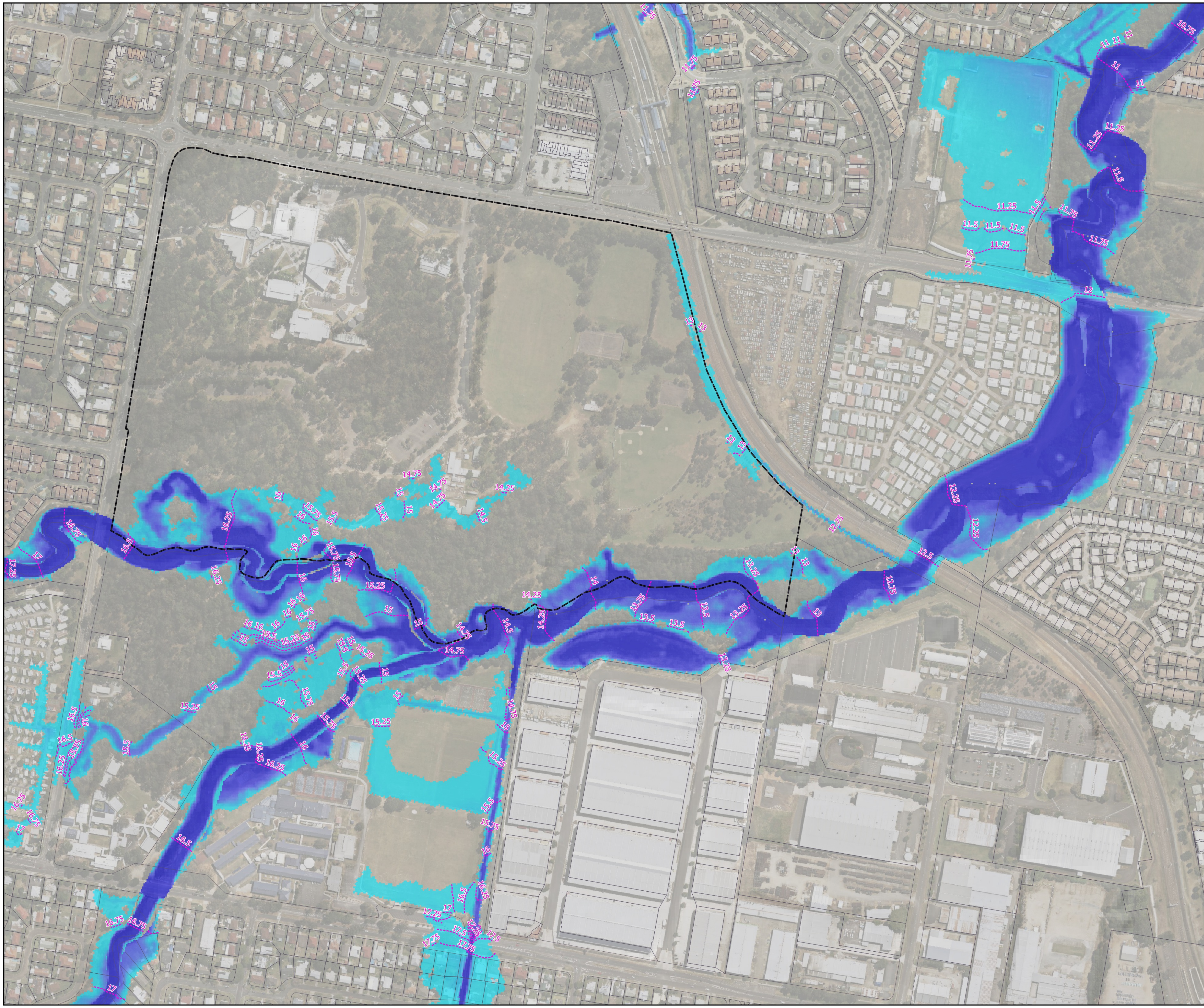
Carseldine Urban Village

Peak Flood Depth &
Peak Flood Level Contours

Proposed Case
(TUFLOW ID P01a)

39% AEP Event (Q002)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Peak Flood Height Contours (m AHD)

Depth (m)

- Less than 0.25
- 0.25 to 0.5
- 0.5 to 0.75
- 0.75 to 1
- 1 to 1.5
- 1.5 to 2
- Greater than 2

FIGURE A5

N

50 0 50 100 m

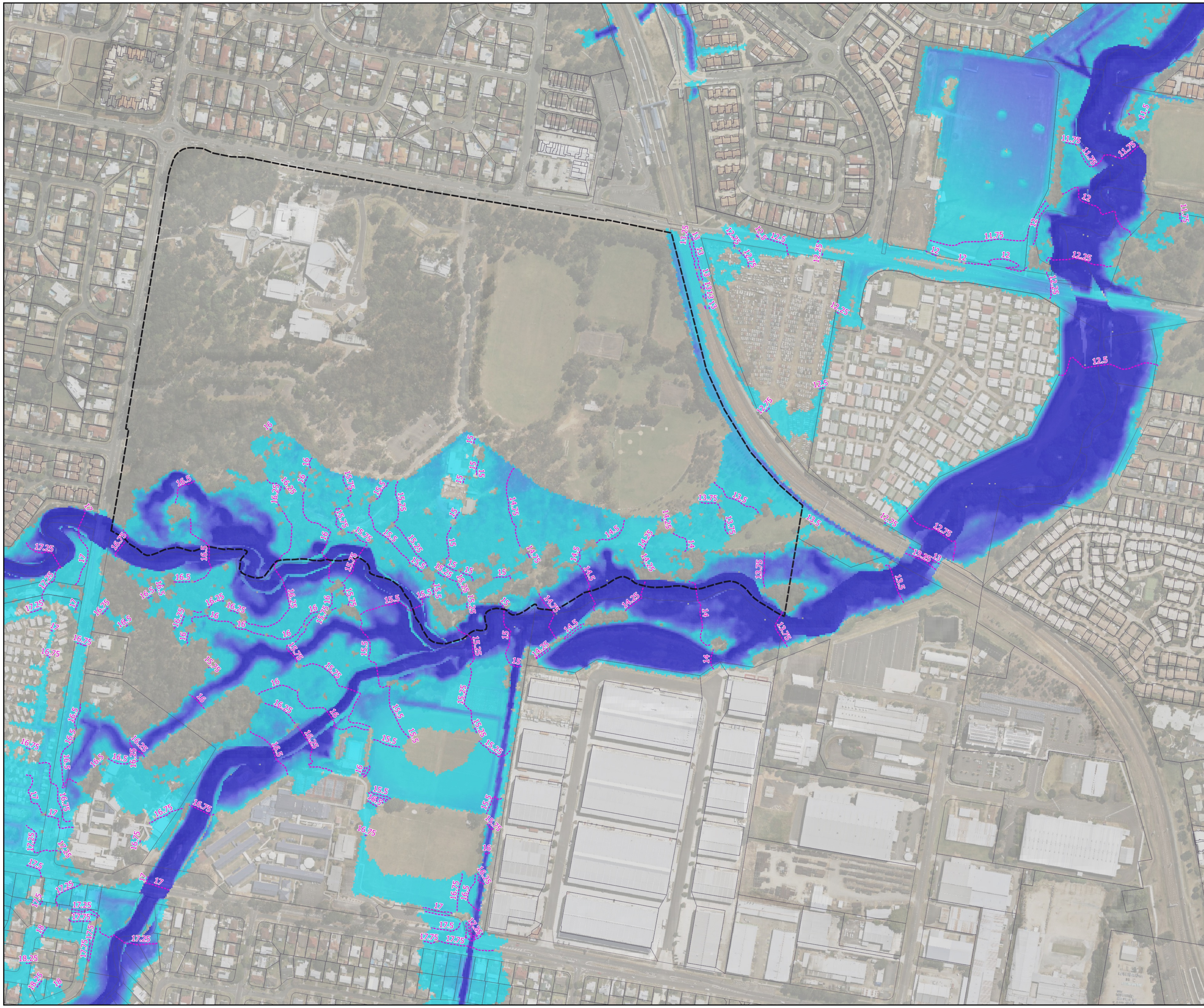
Carseldine Urban Village

Peak Flood Depth & Peak Flood Level Contours

Proposed Case (TUFLOW ID P01a)

5% AEP Event (Q20)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Peak Flood Height Contours (m AHD)

Depth (m)

- Less than 0.25
- 0.25 to 0.5
- 0.5 to 0.75
- 0.75 to 1
- 1 to 1.5
- 1.5 to 2
- Greater than 2

FIGURE A6

N

50 0 50 100 m

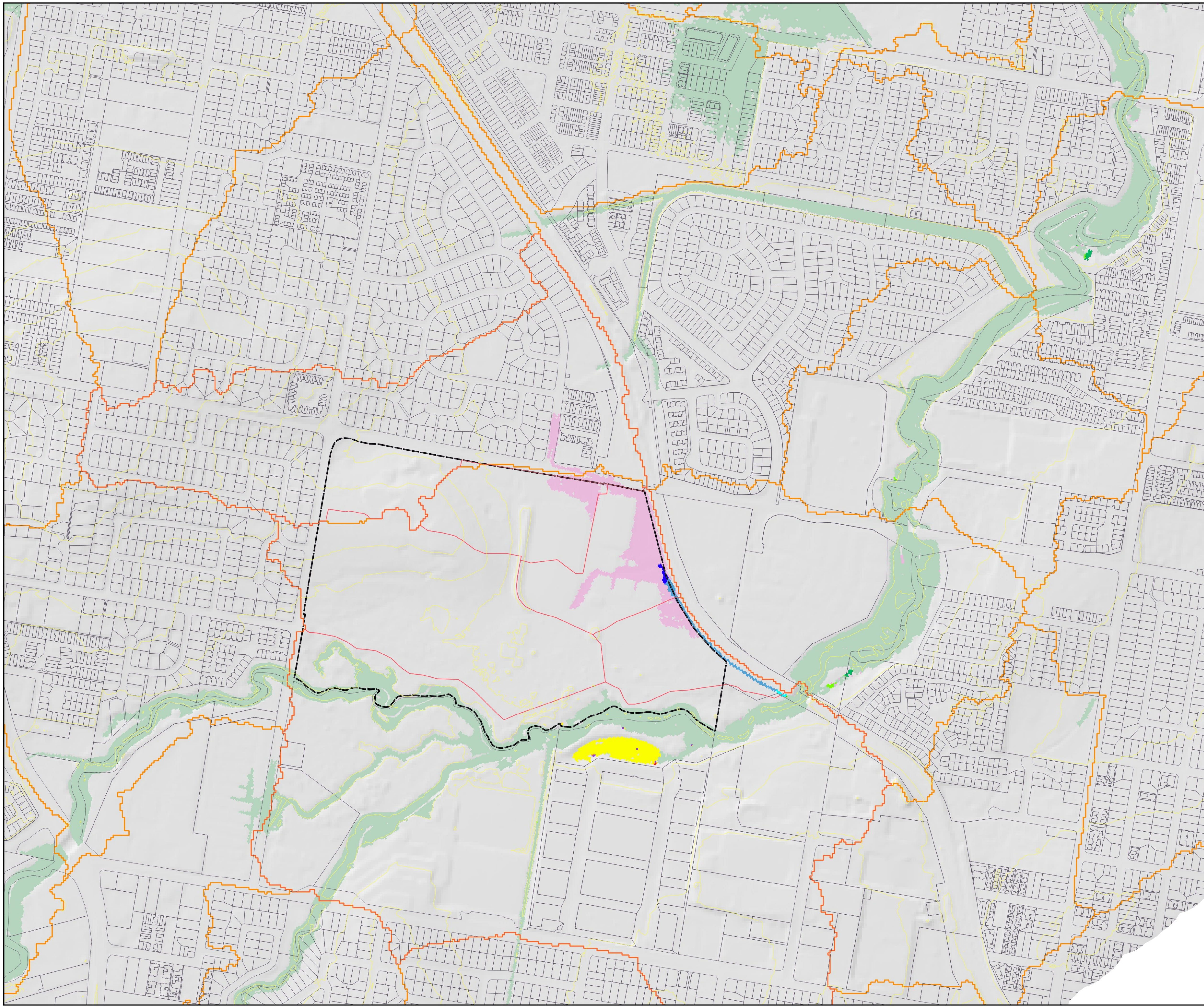
Carseldine Urban Village

Peak Flood Depth &
Peak Flood Level Contours

Proposed Case
(TUFLOW ID P01a)

1%AEP Event (Q100)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A7

N

80 0 80 160 m

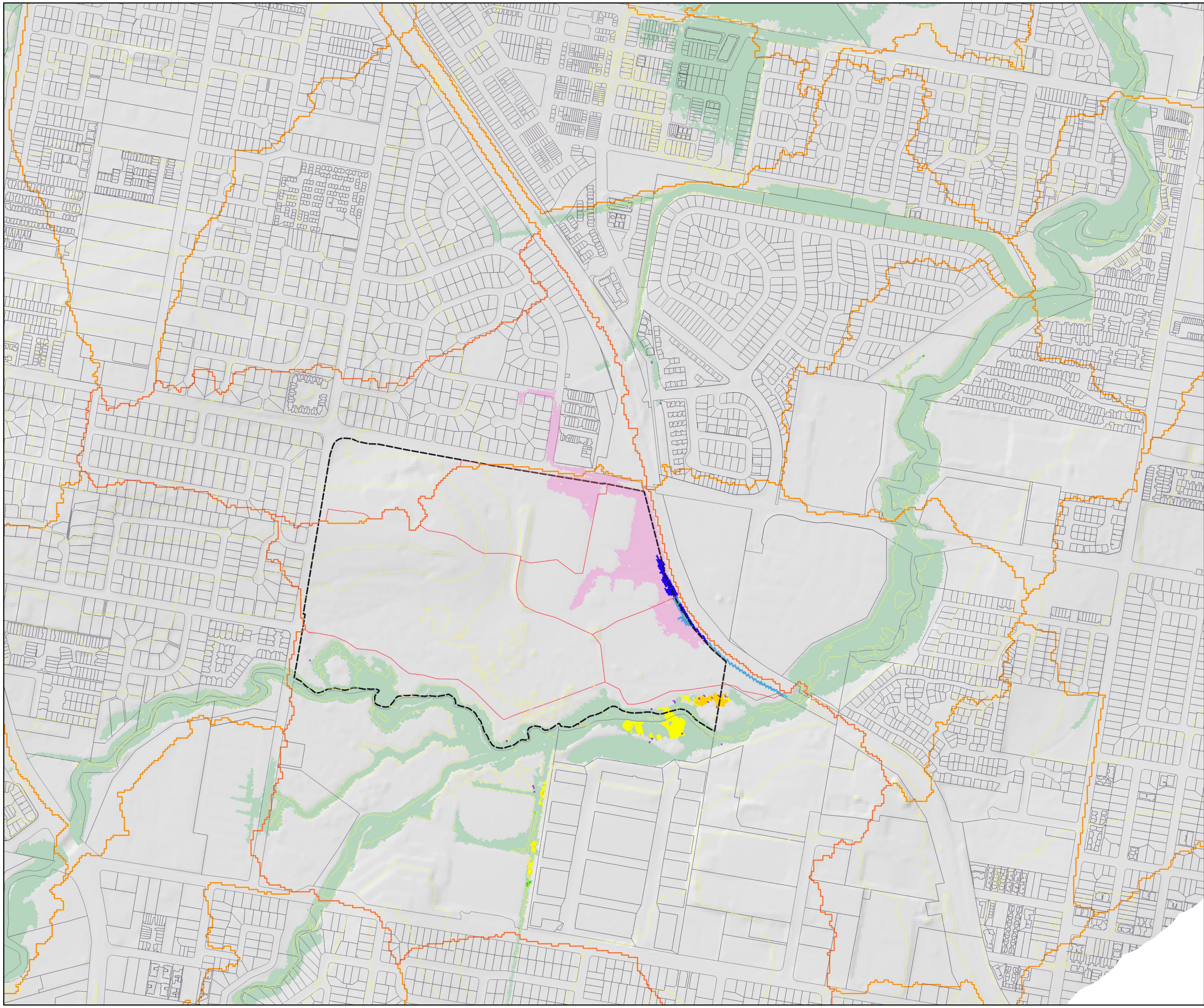
Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

39% AEP Event (Q2)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A8

N

80 0 80 160 m

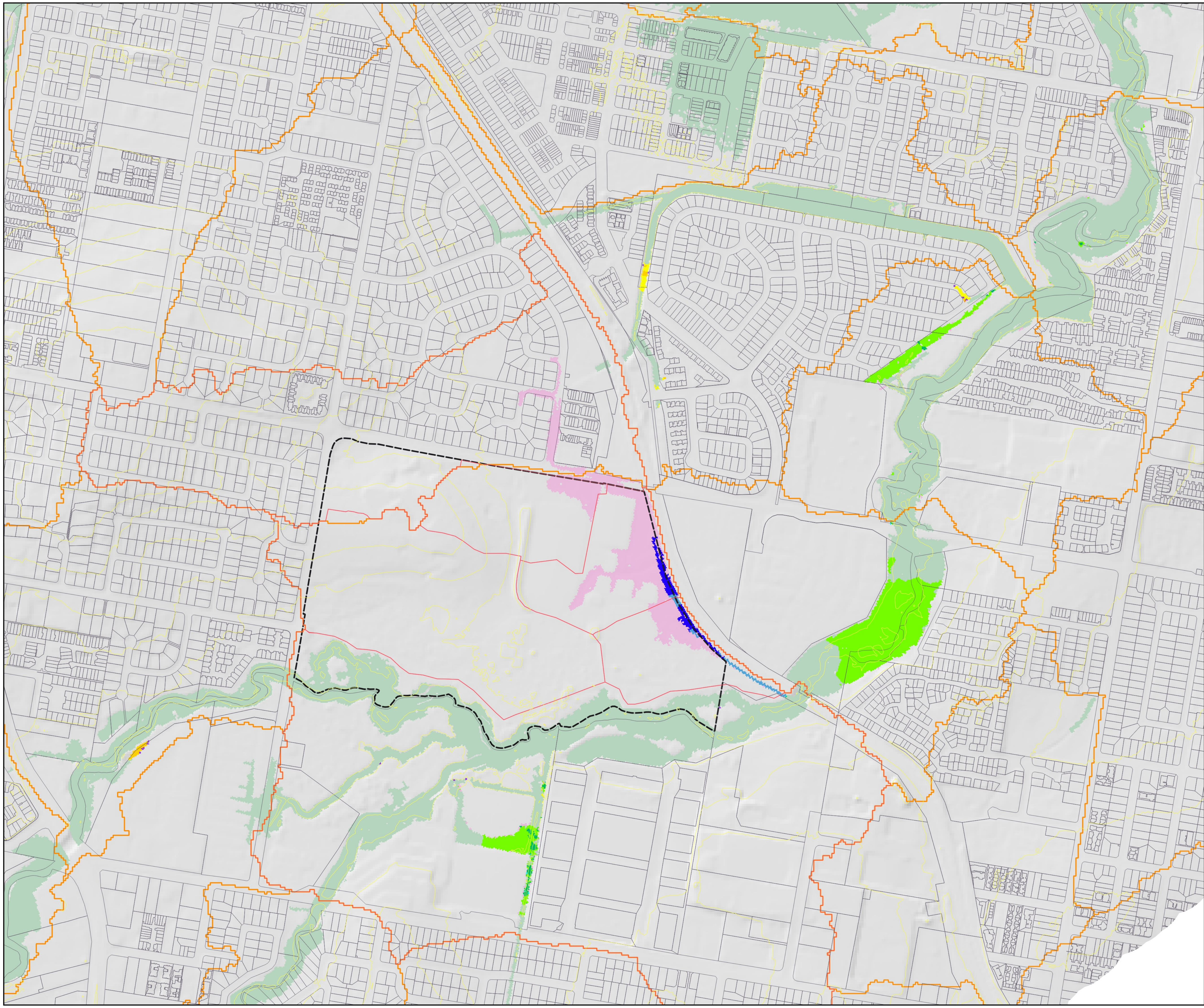
Carseldine Urban Village

Peak Flood Level Impacts Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

20% AEP Event (Q5)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A9

N

80 0 80 160 m

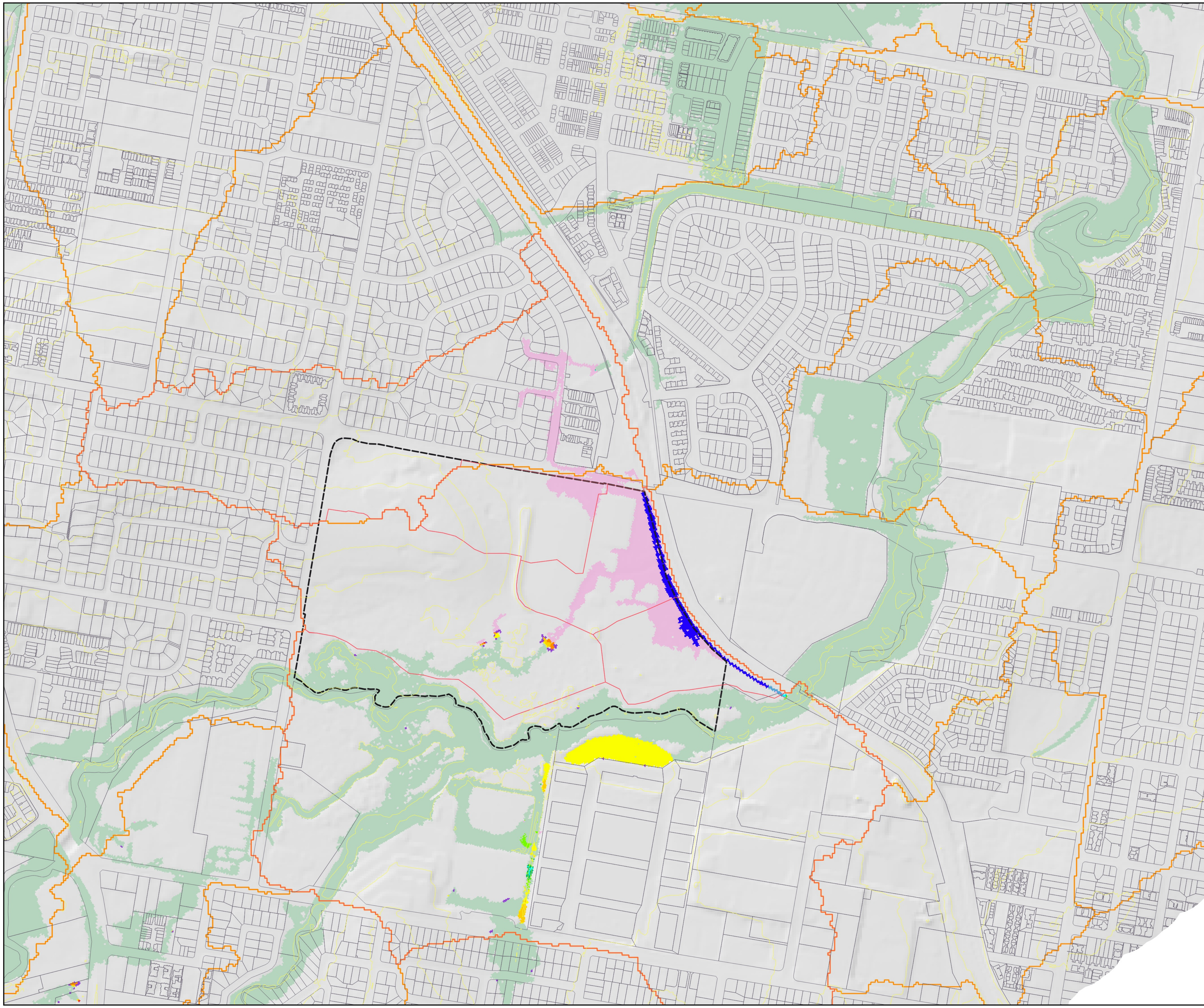
Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

10% AEP Event (Q10)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A10

N

80 0 80 160 m

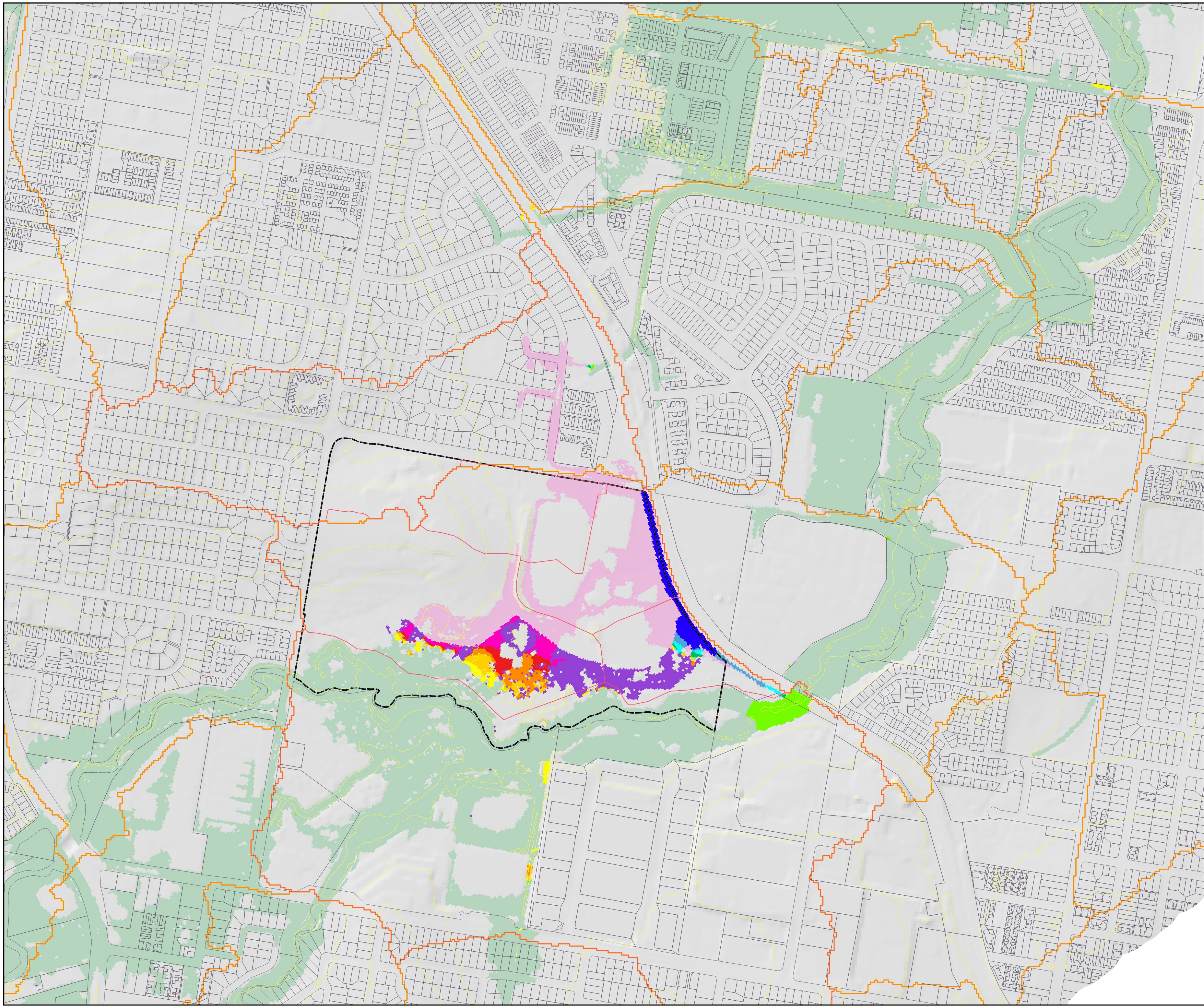
Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

5% AEP Event (Q20)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A11

N

80 0 80 160 m

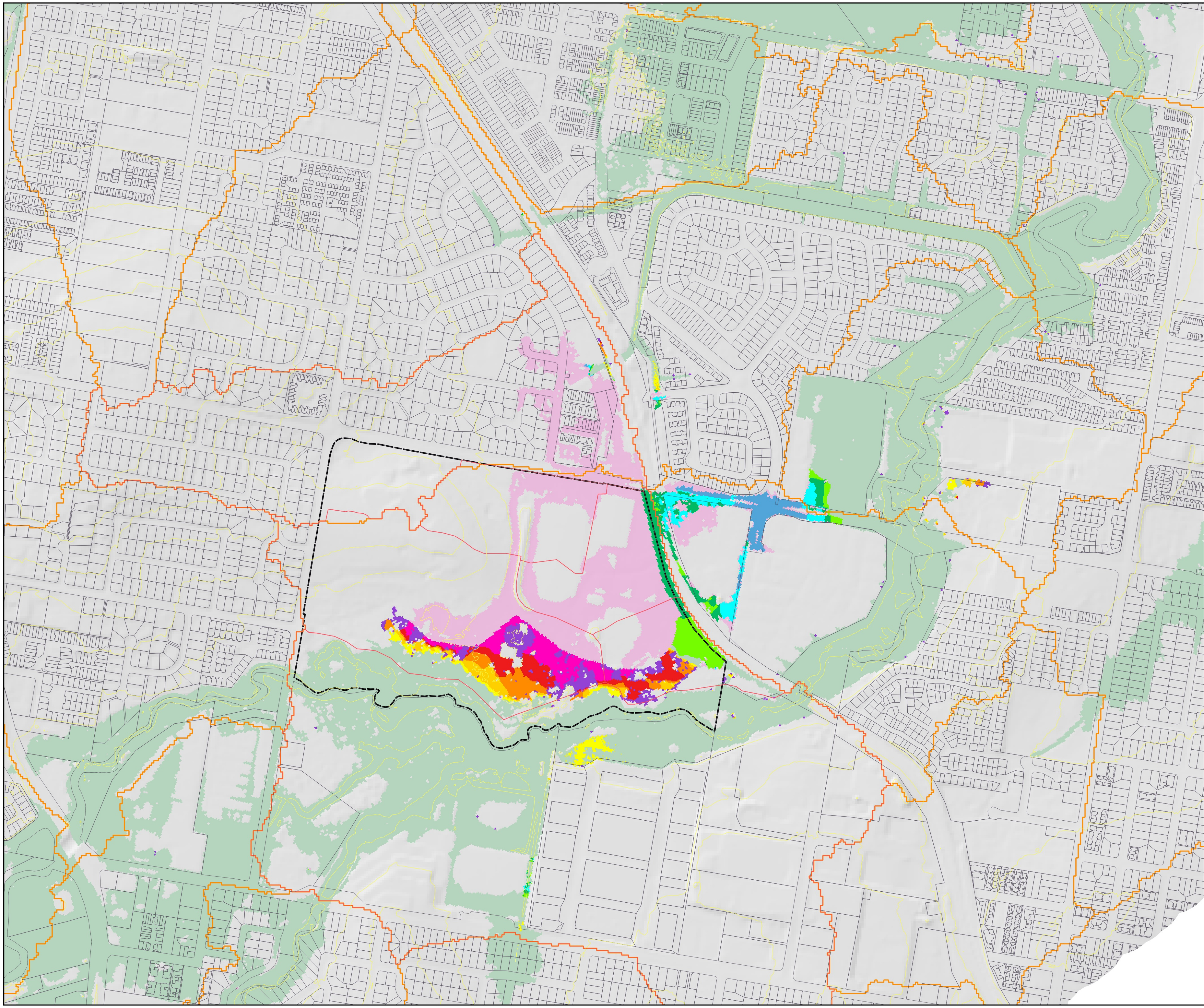
Carseldine Urban Village

Peak Flood Level Impacts Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

2% AEP Event (Q50)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A12

N

80 0 80 160 m

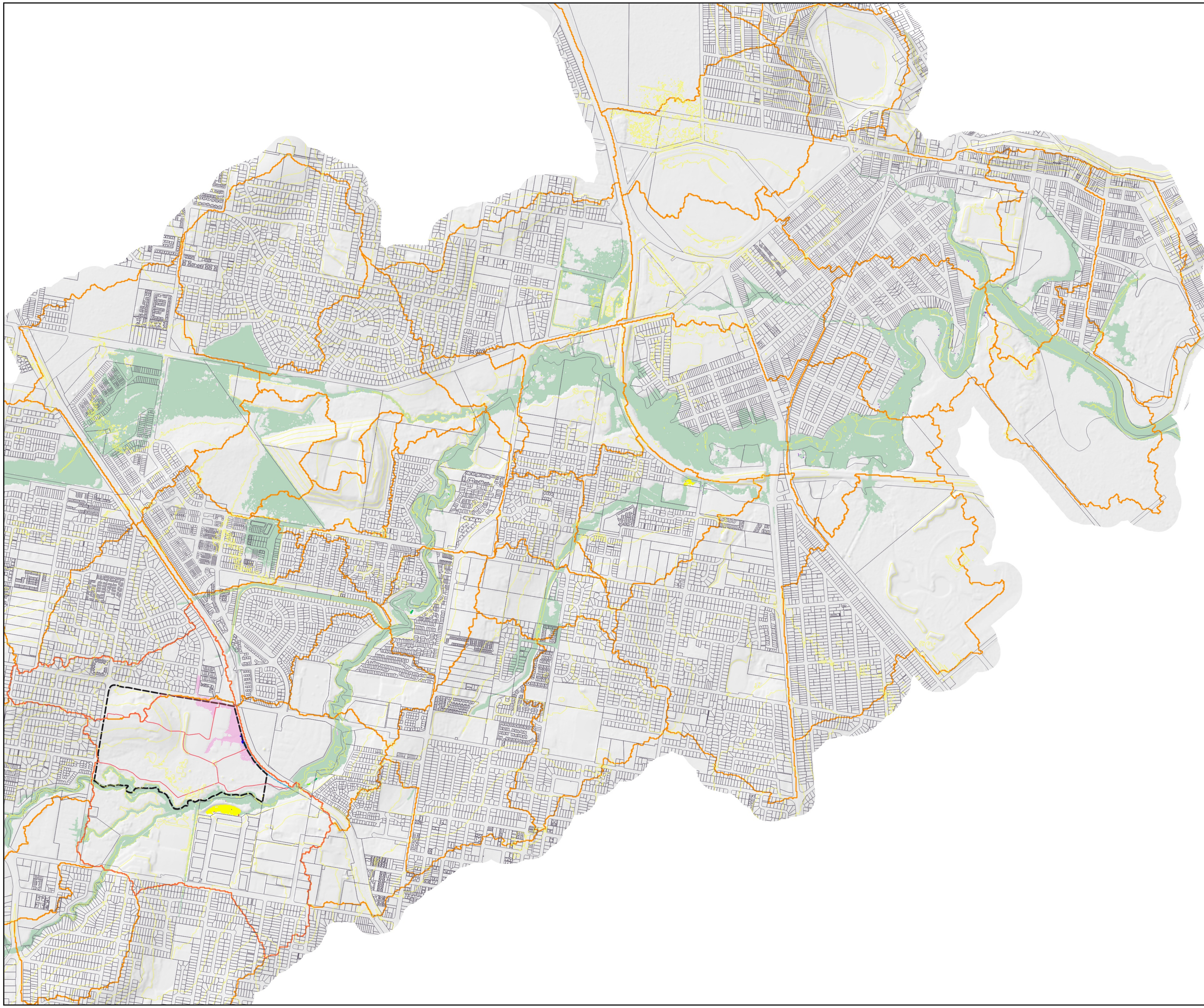
Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

1%AEP Event (Q100)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A13

N

200 0 200 400 m

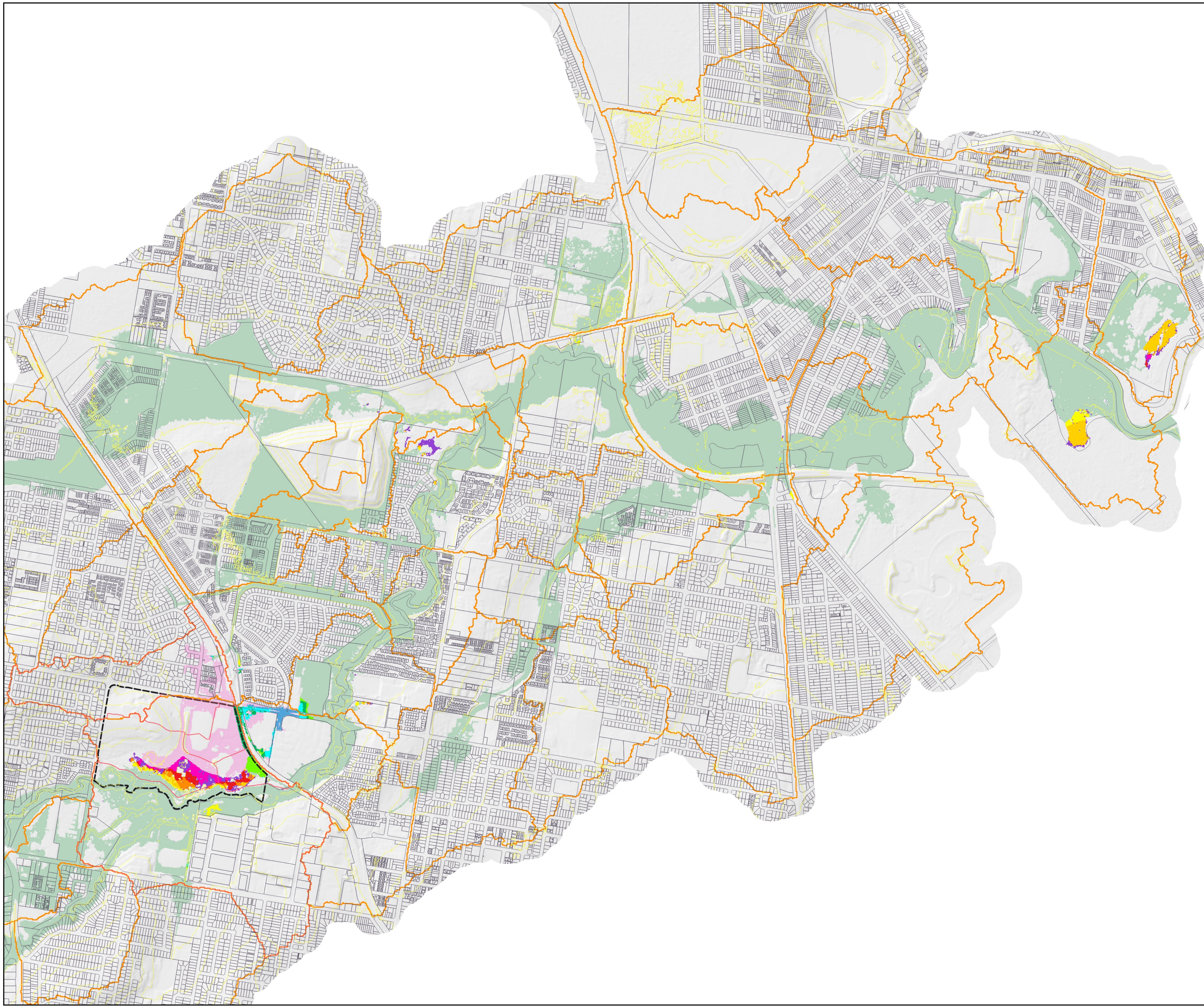
Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

39% AEP Event (Q2)

Client: Economic Development Queensland



LEGEND

- Site
- Cadastral Data
- LiDAR Contours (5m)
- URBS Sub-Catchments (BCC)
- Updated Sub-Catchments

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -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 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

FIGURE A14

N

200 0 200 400 m

Carseldine Urban Village

Peak Flood Level Impacts
Proposed Vs Existing Case

(TUFLOW Case P01a Vs B01c)

1%AEP Event (Q100)

Client: Economic Development Queensland