Queensland Government

TECHNICAL MEMORANDUM

To:	Richard Bender - EDQ
From:	Ralph Williams – DesignFlow
Reviewed:	Shaun Leinster (RPEQ 15637) - DesignFlow
Date:	15 May 2020
Subject:	Carseldine Urban Village – Updated Flood Assessments to Support Stage 1 Development

Attachments

1. Updated local peak flood level impacts – 50%, 5%, 1% AEP
2. Blockage impacts 5%, 1% AEP (local)
3. Flood impact map – 1% AEP using ARR1987
4. Severe storm analysis 0.5% AEP - peak flood depths and blockage with 20% blockage (regional)
5. Hazard maps – 1% AEP (regional)

1 INTRODUCTION

This technical memorandum provides updated flood impact assessments for the Carseldine Urban Village development based on drainage and earthworks updates associated with Stage 1 development.

When reading this technical memorandum reference should be made to:

- *Carseldine Urban Village – Updated Stormwater Management Plan* (DesignFlow, October 2019) for details of the regional modelling of the development;
- *Technical memorandum - Carseldine Urban Village – Local flood assessment to support Stage 1 development (DesignFlow Technical Memorandum 10 October 2019)* for details related to model setup and assumptions made; and
- *Carseldine Urban Village – Addendum to Carseldine Urban Village – Pedestrian Bridge Hydraulic and Flood Impact Assessment* (DesignFlow 19 December 2019)

2 BACKGROUND

In support of the Carseldine Urban Village Stage 1 development application, DesignFlow completed a detailed local flood assessment, *Carseldine Urban Village – Local Flood Assessment to Support Stage 1 Development* (DesignFlow 10 October, 2019). The flood modelling was completed to inform detail drainage design for Stage 1 development and demonstrate no flood impacts external to the site as a result of the development.

The local modelling was completed using a WBNM rainfall runoff model that feeds local catchment hydrographs into a 1D/2D TUFLOW hydraulic model. Local modelling to support Stage 1 development previously did not include the flood barrier along the eastern boundary of the site (as recommended as part of the ultimate development mitigation in the Carseldine Urban Village – refer to *Updated*

Stormwater Management Plan (DesignFlow, October 2019)) as this was not originally intended to be included with Stage 1 works.

To demonstrate no external impacts without the flood barrier along the eastern boundary of the site for Stage 1, a one-way flapped 1200mm dia RCP was included at the culvert crossing the newly constructed south eastern outlet drain. This outlet arrangement was originally designed to allow development flows to discharge to Cabbage Tree Creek, but prevent Cabbage Tree Creek flows from backing up northwards through this drain. The inclusion of the one-way flap was deemed necessary at the time to avoid impacts along the rail corridor zone and potential local flooding issues within the development.

Subsequent discussions with EDQ and 3rd party reviews by BMT resulted in the following to be completed for Stage 1:

- Install the flood barrier along the eastern boundary of the site as part of Stage 1 works;
- Test the requirement for the flap valve on the 1200mm dia RCP culvert crossing;
- Sensitivity testing including blockage analysis and review of local model results using ARR1987 approach; and
- Severe storm impact assessment

The sections below summarises the modelling completed in response to these requests.

3 MODEL UPDATES

3.1 REGIONAL FLOOD MODEL UPDATES

The regional TUFLOW model has been used to complete a severe storm impact assessment, test blockage scenarios and review flood hazard ratings for the site.

The established Cabbage Tree Creek regional BCC TUFLOW model, as described in *Carseldine Urban Village – Updated Stormwater Management Plan (DesignFlow, October 2019)*, has been updated to include the new pedestrian bridge linking CUV with Aspley State school. Model updates associated with the new bridge crossing are described in *Carseldine Urban Village – Addendum to Carseldine Urban Village – Pedestrian Bridge Hydraulic and Flood Impact Assessment (DesignFlow 19 December 2019)*.

The one-way flap valve previously included on the 1200RCP culvert along the eastern outlet drain has been removed from the regional model.

3.2 LOCAL FLOOD MODEL UPDATES

The established TUFLOW model used to model the local impacts associated with the CUV development (refer to *Carseldine Urban Village – Local Flood assessment to Support Stage 1 Development* (DesignFlow, October 10 2019)) has been updated to include the flood barrier along the eastern boundary of the site. When updating the local flood model the most recent available detailed drainage and earthworks designs completed by Calibre Consulting, related to Stage 1, have been included. This includes earthworks changes to the development in and around Beams Road, particularly at the Village Heart.

The following updates have been applied to the local model.

3.2.1 Updates to the base case TUFLOW model

Cabbage Tree Creek has been excluded from the TUFLOW 2D domain. Instead, fixed tailwater boundary conditions at the various Cabbage Tree Creek outfalls, based on peak 20% AEP (Q5) Cabbage Tree Creek Flood Levels, have been applied (as recommended by 3rd party review completed by BMT)

Figure 1 and Table 1 summarise the existing catchments modelled. These are unchanged from the previous modelling.

Figure 1 Existing case catchments

Table 1 – Existing case catchments

WBNM ID	Area (ha)	Fraction Impervious (%)	Downstream ID
A1	10.546	59.6	A3
A2	4.582	65.4	A3
A3	3.424	28.4	A4
A4	0.902	45.5	A5
A5	0.799	49.9	A6
A6	2.738	83.3	A7
A7	13.295	52.1	OUT
B1	10.021	9.5	B2
B2	3.177	18.7	B3
B3	5.454	5.6	B6
B4A	1.291	84.7	B4B
B4B	1.054	20.3	B4C
B4C	2.282	12.3	B5
B5	2.514	0.0	B7
B6	1.746	0.0	B7
B7	3.345	4.2	B8
B8	5.174	3.6	OUT

3.2.2 Updates to the developed case TUFLOW model

The following updates have been applied to the developed case model:

- Exclude Cabbage Tree Creek from the TUFLOW 2D domain as per the new base case
- Incorporate latest earthworks and drainage designs by Calibre Consulting (24 April, 2020)
- Adjust developed case catchment boundaries to suit latest civil design and re-run hydrology model (**Note**: ultimate developed conditions are modelled)
- Remove the one-way flood flap on the 1200mm dia RCP eastern outfall
- Updates to the inlet assumptions at the upstream end of the main site drainage line near the proposed western entrance from Beams Road. TUFLOW modelling now assumes that the full 1% AEP (Q100) flow rate from sub-catchment B4A (0.86 m^3/s) along with up to 0.42 m^3/s from Beams Rd will be collected and piped through the development
- The flood barrier adjacent to the railway corridor has been included – a minimum freeboard of 500mm above 1%AEP regional ultimate developed flood levels is provided
- Initial water levels have been applied to the bioretention systems at the top of the extended detention zone

Table 2 and Figure 2 summarise the developed case catchments modelled, whilst Figure 3 summarises the model updates.

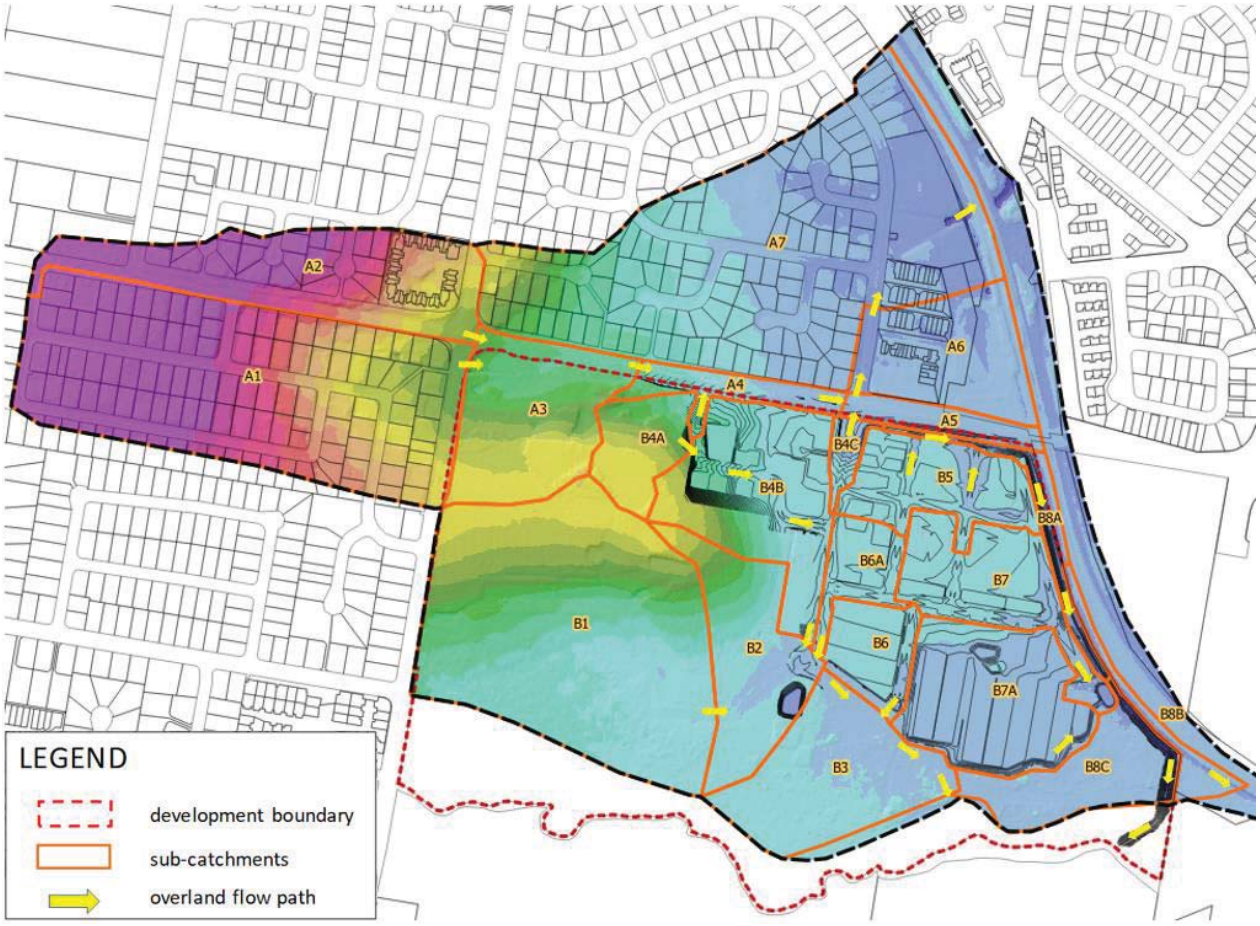

Figure 2 – Local model developed case catchments

Table 2 – Developed case catchments

WBNM ID	Area (ha)	Fraction Impervious (%)
A1	10.546	59.6
A2	4.582	65.4
A3	3.424	28.4
A4	0.950	56.7
A5	0.799	Inca49.9
A6	2.738	83.3
A7	13.295	52.1
B1	10.021	9.5
B2	2.952	22.2
B3	3.504	8.6
B4A	1.328	89.3
B4B	3.841	75.7
B4C	0.354	88.5
B5	2.198	89.8
B6	1.235	84.9
B6A	1.014	90.0
B7	2.545	83.7
B7A	3.528	22.6
B8A	0.763	25.6
B8B	0.640	34.9
B8C	2.090	0.2

Figure 3 – Local model developed case model updates

4 FLOOD IMPACT ASSESSMENT

4.1 LOCAL IMPACTS

The local model was run with no flap valve on the 1200mm dia RCP, with model updates as described in Section 3. Attachment 1 provides the updated flood impact maps for the 50%, 5% and 1% AEP events. Figures 4 to 6 illustrate key outcomes for each event.

The results indicate that:

- Improved flood conditions along the rail corridor zone for all events modelled – flood levels are typically 100-200mm lower
- Significantly less nuisance flooding now occurs along Beams Road – areas that previously flooded along Beams Road for the 50% AEP no longer flood
- 100-200mm lower ponding depths in flooded areas along Beams Road in less frequent events
- Reduced flood impacts to areas north of Beams Road in existing urban areas
- Lower flows expected along Beams Road due to diversions of Beams Road flows south to Cabbage Tree Creek (1% AEP flows along Beams Road reduced from 0.66m^3/s to 0.55m^3/s)
- Localized impacts (50-100mm in the 1% AEP) at Beams Road due to closing off of the existing access into the site

50% AEP (2yr) impacts

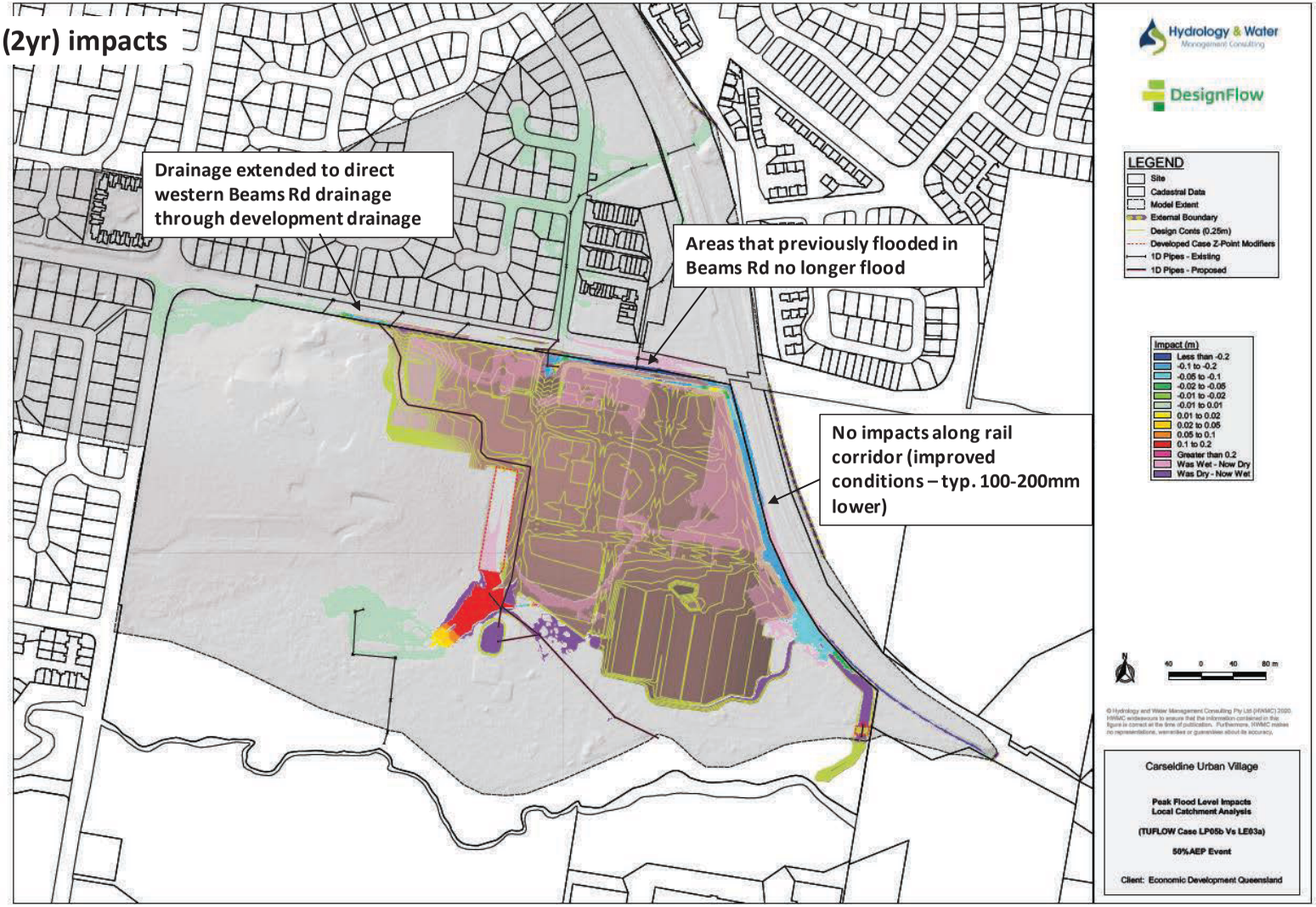

Figure 4 50% AEP (2yr) flood impacts

5% AEP (20yr) impacts

Figure 5 5% AEP (20yr) flood impacts

1% AEP (100 yr) impacts

Figure 6 1% AEP (100yr) flood impacts

4.2 DISCUSSION ON LOCALISED IMPACTS AT BEAMS ROAD

The localised impacts at Beams Road are considered non-actionable nuisance flooding for the following reasons:

- The change in flooding occurs as a result of closing off the existing entry to the site meaning the road profile and kerb alignments have changed making impacts unavoidable. This kind of change is very typical of road works and is accepted provided QUDM requirements are achieved
- Resultant peak flood depths at the kerb are less than 200mm in the 1% AEP – this is compliant with QUDM requirements for roads where flow depths are to be less than 250mm (refer to QUDM Table 7.4.4 flow limits for "longitudinal" flow during major storm – site condition: flow conditions at kerb for flow along a road (no risk to life))
- Velocity x depth values are less than 0.2m^2/s – this is compliant with QUDM requirements for roads where depth x velocity product are to be less than 0.6m^2/s (refer to QUDM Table 7.4.4 flow limits for "longitudinal" flow during major storm – site condition: flow conditions at kerb for flow along a road (no risk to life)
- Less flows now travel down Beams Road due to diversions of Beams Road flows southward through the development (1% AEP flows reduced from 0.66m^3/s to 0.55m^3/s at the impact zone).
- Road area impacted is minor in the context of the current flooding issues that occur along Beams Road. Beams Road currently floods extensively in less frequent events, the resultant localized impacted area will not detrimentally impact on anyone or cause unsafe road conditions
- The overall flood impact on Beams Road is a significant improvement in the current flood conditions with 100 to 200mm lower flood depths expected in areas that currently experience significant flooding

Figure 7 illustrates the flood impacts at Beams Road for the 1% AEP.

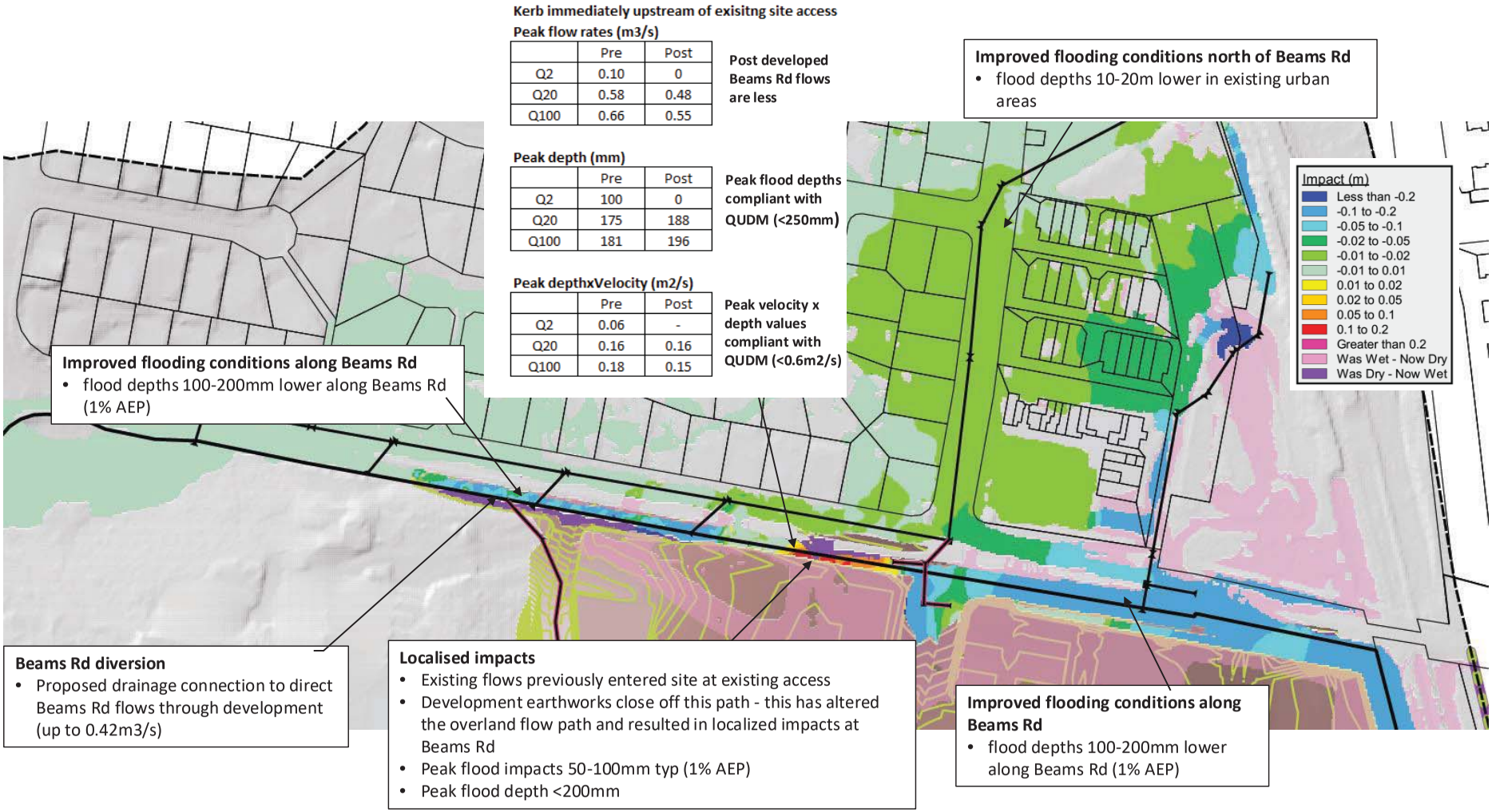

Figure 7 – Beams Road flood impacts

5 SENSITIVITY TESTING

Model runs have been completed to review the overall flood performance under varying model conditions. Sensitivity runs completed include:

- Blockage testing of the 1200mm RCP along the eastern outfall swale
- Review of flood impacts using ARR 1987 approach (as per 3rd party review requirements)

5.1 BLOCKAGE ANALYSIS

Blockage of the 1200mm RCP along the eastern outfall swale has been applied to review flood impacts to ensure:

- no flooding of the development
- no adverse flooding external to the site
- adequacy of the 500mm flood barrier freeboard

Testing has been completed for both local and regional model runs under design and severe storm blockage scenarios. Blockage values have been derived from QUDM Table 10.1.1. Table 3 summarises the runs completed:

Table 3 Blockage scenarios

Scenario	AEP and Blockage value
Local model:	
Design blockage	1% AEP with 20% blockage
Severe blockage	5% AEP with 100% blockage
Regional model:	
Severe storm blockage	0.5% AEP with 20% blockage

Attachment 2 shows the local flood impacts versus the 1% AEP base case flood levels for each scenario tested. Attachment 4 shows the flood impact for the regional severe storm blockage analysis above the developed 1% AEP event to review the design flood barrier freeboard.

Results indicate that no flooding of the development is expected to occur for the model scenarios tested. The results also indicate that no adverse flooding is expected external to the site.

Under a severe storm blockage scenario (0.5% AEP with 20% blockage), peak water depths adjacent to the flood barrier are ~415mm higher than the developed 1% AEP flood levels. This is below the 500mm freeboard provided above 1% AEP flood levels (i.e. the flood barrier is not expected to overtop during a severe storm blockage scenario).

5.2 ARR 1987

In accordance with 3rd party review requirements, scenario testing using the ARR1987 approach has been completed. This was suggested given the regional flood model (based on BCC Cabbage Tree Creek flood model) was run using ARR 1987 methods, whereas the local modelling has been completed using the latest ARR approaches. Attachment 3 shows the local flood impacts for the 1%

AEP event. Impacts are similar to those found with the current ARR approach, with flood improvements along the rail corridor and Beams Rd.

6 SEVERE STORM IMPACT ASSESSMENT

A severe storm impact assessment has been completed to review the performance of the flood barrier along the eastern boundary of the site for flows in excess of the design storm event. To support the severe storm impact assessment, flood modelling above the design 1% AEP event has been completed together with a risk assessment specific to the flood barrier. These are described in the following sections.

6.1 FLOOD BARRIER GENERAL OPERATION AND FUNCTION

The flood barrier acts to constrain and direct flows along the eastern boundary of the development to avoid flood impacts external to the site boundary along the rail corridor. The flood barrier extends from the 1200mm dia eastern outlet culvert to within 100m of Beams Road (refer to Figure 3 previously). This ensures that the existing overland flow path at the north eastern end of the site is retained and also retains the existing flow path along the rail corridor connecting to Cabbage Tree Creek. This results in flood waters on both sides of the flood barrier, particularly during less frequent regional events when Cabbage Tree Creek flows backwater through the site and are directed along the eastern boundary to the overland flow path.

A minimum 500mm freeboard is provided above the expected ultimate developed regional 1% AEP flood levels.

6.2 SEVERE STORM MODELLING

Severe storm model runs have been completed for the 0.5% AEP (200 year ARI event) regional flood event with a 20% blockage applied to the 1200mm RCP eastern outfall culvert. This is in accordance with QUDM Table 10.4.1 for severe storm blockage analysis.

This model accounts for full development of the Carseldine Urban Village and includes the new pedestrian bridge crossing Cabbage Tree Creek that connects Carseldine Urban Village with Aspley State School.

Figure 8 shows the peak flood level impacts above the 1% AEP flood values. Peak flood impacts above the 1% AEP flood values are ~415mm. A 500mm freeboard is provided above 1% AEP values, as such no overtopping of the flood barrier is anticipated during this severe storm event.

Attachment 4 provides flood depth maps for the 0.5% AEP for the existing case and for the full developed scenario with 20% blockage applied. The impact map above the developed 1% AEP flood levels is also included.

Under severe storm conditions peak flood depths from the base of the wall are typically less than 1.35m. The maximum difference in flood levels on either side of the flood barrier (development side v rail corridor side) are typically less than 0.5m.

Assumptions:

- 0.5% AEP (200 year event) – regional flood event
- Ultimate development conditions
- Flood barrier included along eastern boundary – 500mm freeboard above developed 1% AEP
- 1200RCP with 20% blockage
- Pedestrian bridge over Cabbage Tree Creek included

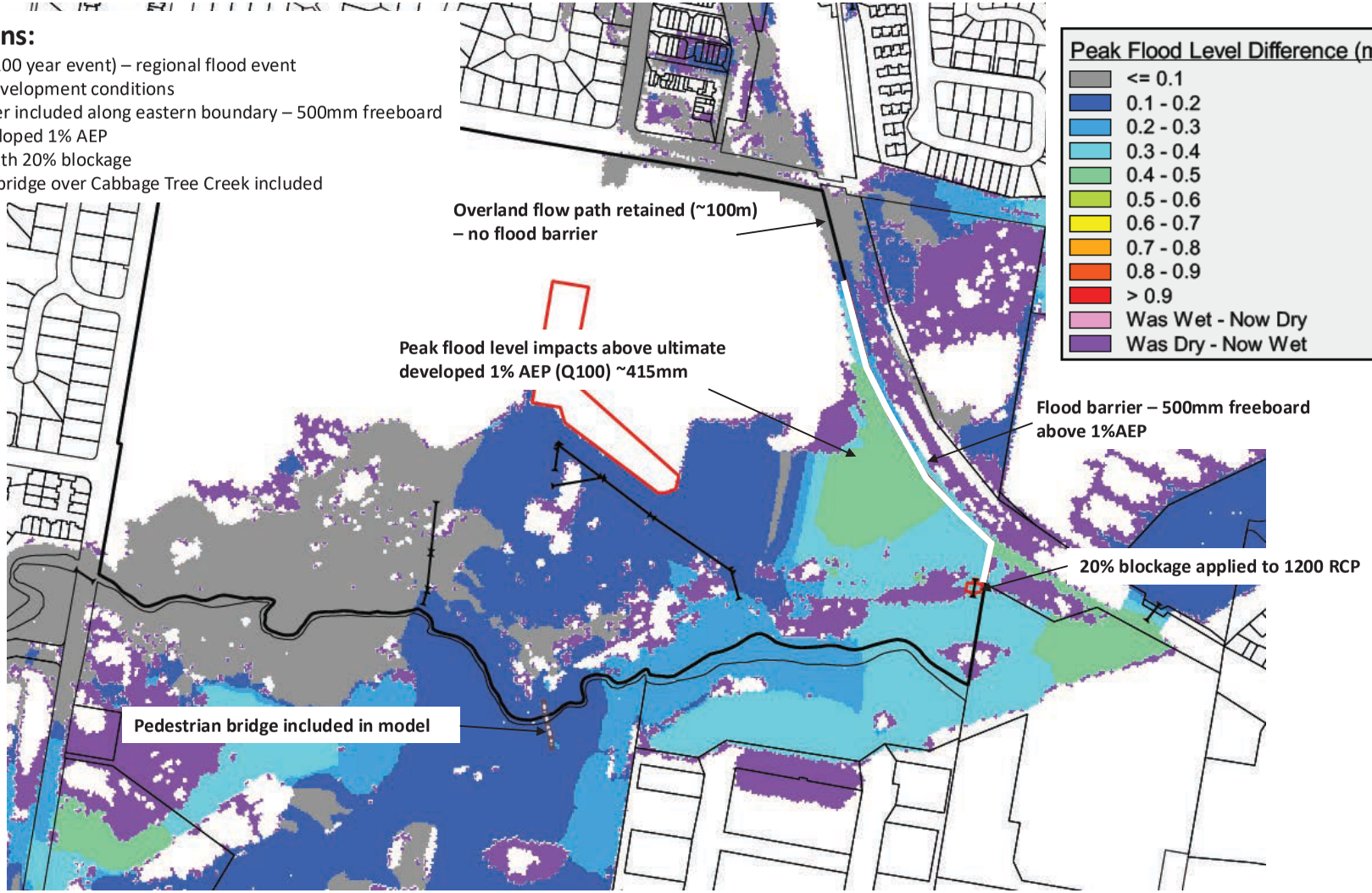

Figure 8 0.5% AEP with 20% blockage applied to 1200mm RCP - peak flood level impacts above ultimate developed 1% AEP

6.3 RISK ASSESSMENT

A risk assessment has been completed for the flood barrier to review two potential items and the consequence of these occurring:

- Overtopping of the flood barrier
- Undermining of the flocd barrier

Table 4 provides a summary of the overall risk rating.

6.3.1 Overtopping

Events that potentially could overtop the flood barrier are considered rare (less than 0.5% chance of occurring in any one year). The flood barrier will be structurally designed and certified to cater for maximum loads associated with flood waters to the top of wall on one side only, with no flood waters assumed on the other. This is a conservative approach given under the severe storm modelling scenario, whilst the maximum flood depth from the base of the wall is 1.35m, the maximum difference in flood levels on either side of the wall is no more than 0.5m.

Under existing conditions, flooding of the rail line immediately south of Beams Road can be expected to have a 2% probability of occurring in any particular year (i.e. on average once every 50 years). During extreme events when overtopping could potentially occur (<0.5%AEP or >200 year), the rail line will have already been extensively flooded as a result of regional backwatering (refer to Attachment 4). Flood depths in the order of 400mm above the rail line occur south of Beams Road during the 0.5% AEP under existing conditions. The consequence of overtopping of the flood barrier on the rail line is thus considered minor in the context of the current flooding issues along the rail line. Refer to Attachment 4 for peak flood depths during the 0.5% AEP event.

The overall risk rating of an overtopping event is considered an acceptable low risk.

6.3.2 Undermining and failure

Undermining of the flood barrier wall has the potential to cause failure of the flood barrier. Undermining will likely occur as a result of erosion at the base of the wall from flood flows as they are conveyed along the flood barrier either from local flows discharging to Cabbage Tree Creek or regional backwatering from Cabbage Tree Creek.

Conveyance events along the wall will occur from time to time, when either the capacity of the drainage swale adjacent to the flood barrier is exceeded during local food events or when regional floods backwater though the development. These events have the potential to cause scour along the base of the wall if velocities and shear values are excessive. The site has a low dispersive and erosive soil potential.

The design of the flood barrier will take into account expected velocity and shear values at the wall interface for the varying flows regimes. Based on a range of model scenarios from frequent (50% AEP) to rare (0.5% AEP) velocities are typically less than 0.7m/s and not expected to exceed 1.1m/s. These are considered non-erosive.

Foundations will be designed for the expected shear and scour potential. Foundations will be set at an appropriate depth greater than potential scour depths. Areas abutting the flood barrier will be

turfed to avoid exposure of bare soils. With appropriate foundation design, no undermining of the barrier foundations is anticipated for the range of operating conditions from frequent to rare.

The overland flow path at the north east corner of the site is retained (~100m). This retains the overland flow path for less frequent regional flows and manages flood heights on both sides of the flood barrier. The maximum flood difference on either side of the wall is expected to be less than 500mm during severe storm events.

The overall risk rating of undermining of the flood barrier is considered an acceptable low risk.

Table 4 Flood barrier risk assessment

SAFETY IN DESIGN ANALYSIS:

Identify all applicable safety issues for the project									
Select relevant	List potential safety issues	Consequence	Likelihood	Risk Rating	Risk Control Measures	Residual Risk Rating			Risk Manager
						Consequence	Likelihood	Risk	
☑	Overtopping of flood barrier	D	3	M	500mm freeboard provided to contain 0.5% AEP with 20% blockage Barrier wall structurally designed and certified – loads assume full hydraulic load on one side only	D	5	L	Designer
☑	Undermining/failure of flood barrier	C	3	S	Barrier wall foundation structurally designed and certified Expected peak velocities for a range of events (50% to 0.5% AEP) up to 1.1 m/s – non-scour velocity Overland flow path (~100m) retained at NE end of the site – maximum water level difference on either side of flood barrier in severe storm events <500mm Soils non-dispersive Zone abutting barrier wall to be turfed	D	4	L	Designer

RISK ASSESSMENT AND CONTROL:

Assign a 'consequence' and 'likelihood' for each safety in design issue identified for the project.					
CONSEQUENCE			LIKELIHOOD		
Rank	Consequence	Description	Rank	Likelihood	Description
A	Catastrophic	Death; Large scale and long-term harm to the environment	1	Almost Certain	Is expected to occur fairly often
B	Major	Permanent disability; severe environmental damage	2	Likely	Will probably occur with some regularity
C	Critical	Lost time injury; moderate environmental damage	3	Possible	Might occur from time to time
D	Marginal	Medical treatment injury; minor environmental damage	4	Unlikely	Could occur at some time
E	Negligible	First aid treatment; No harm to the environment	5	Rare	May occur only in exceptional circumstances

RISK RATING MATRIX:

Assign a risk rating for each section of works					
Risk Matrix:	A	B	C	D	E
1	H	H	H	S	S
2	H	H	S	S	M
3	H	H	S	M	L
4	H	S	M	L	L
5	S	S	M	L	L

H: High Risk S: Significant Risk M: Moderate Risk L: Low Risk

6.4 FLOOD HAZARD AND PUBLIC SAFETY

Flood hazard maps for the 1% AEP under existing and ultimate developed cases are included in Attachment 5.

Figure 9 illustrates the classification used to determine flood hazard (source: Technical flood risk management guideline: Flood hazard. Australian Institute for Disaster Resilience, 2012).

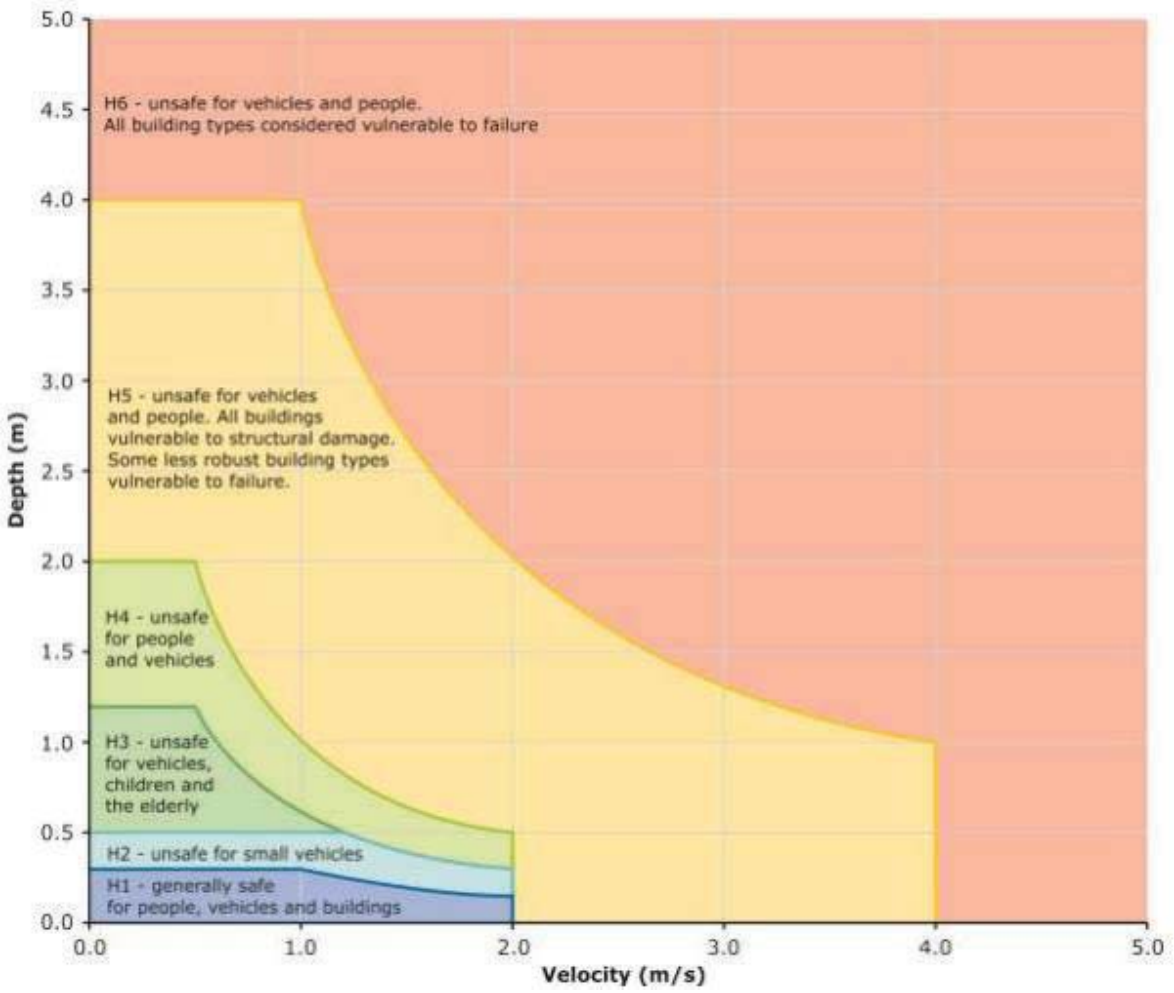

Figure 9 – General flood hazard vulnerability curves

Figure 10 summarises the hazard rating for the site under existing and fully developed conditions for the 1% AEP.

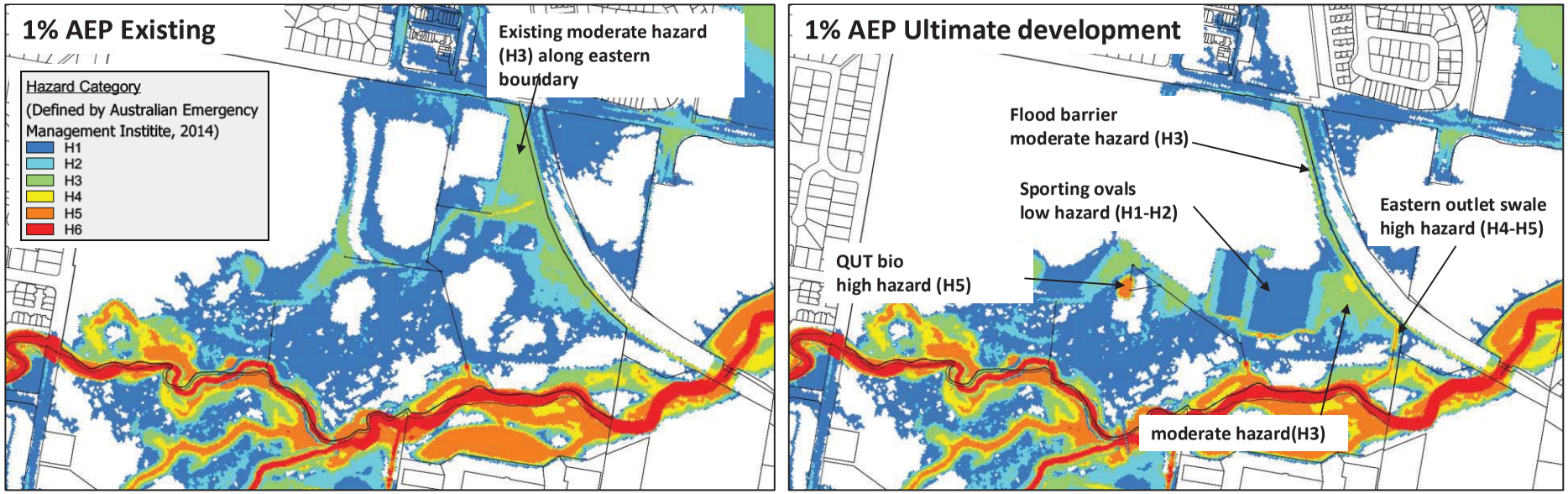

Figure 10 Flood hazard associated with the 1% AEP

Flood hazard maps indicate under existing conditions extensive areas of the site are flooded, with hazard ratings typically from H1 to H3. Moderate hazard areas (H3) are noted in the lower lying flooded areas along the eastern boundary of the site.

Under fully developed conditions the overall area of inundation across the site has decreased. Hazard ratings still typically range from H1 to H3, maintaining similar hazard ratings that are currently expected at the site. The hazard rating over the flooded sports field zone is H1, representing a safe flooded zone. Areas adjacent to the flood barrier typically have a moderate hazard rating of H3. Localised higher H5 ratings are noted, mainly along drainage swales where deeper flows can be expected. The bioretention basin within the former QUT site (H5 rating) will be fenced off and no public access will be available.

6.4.1 Public safety

To mitigate any potential public safety issues, flood warning and/or flood depth markers are recommended in areas where higher risks could be expected. This includes:

- Sporting ovals which are anticipated to flood once every 20 years – whilst the hazard rating for the flooded sporting oval is low (H1-H2), flood warning signs are recommended to warn the public of possible flooding
- Areas adjacent to the flood barrier – flood depth markers along the flood barrier wall are suggested – general hazard rating along the flood barrier is H3
- Areas adjacent to the eastern drainage swale – both flood depth markers and flood warning signs are recommended (hazard rating H5)

It must be noted access to higher risk areas such as the drainage swale in less frequent events will be restricted by the fact that areas adjacent to these zones will be flooded with a generally low hazard flood environment.

Figure 11 – Standard flood warning signs

7 CONCLUSION

The updated flood impact assessments for the Carseldine Urban Village development, based on drainage and earthworks updates associated with Stage 1 development, have now been completed. With the inclusion of the flood barrier along the eastern boundary of the site as part of Stage 1 works, no flap valve is required on the 1200mm dia RCP culvert to manage external impacts within the rail corridor.

Local model updates indicate an improvement in flooding along the rail corridor (typically 100-200mm in 1% AEP), Beams Road (typically 100-200mm in 1% AEP) and areas to the north of Beams Road (typically 10-50mm in 1% AEP). Minor localised impacts occur at Beams Road as a result of the closure of the existing access into the site. These localised impacts are unavoidable and considered a non- actionable nuisance and the resulting flows along Beam Road are fully compliant with the requirements of QUDM for roads.

Sensitivity testing, including blockage analysis has confirmed that the development is not expected to flood, nor is the flood barrier expected to overtop.

Severe storm impact assessments have demonstrated that the flood barrier is not expected to overtop under severe storm conditions (0.5% AEP). A risk assessment of the flood barrier has rated the residual risk of overtopping and undermining as an acceptable low risk.

Flood hazard maps demonstrate that overall the flood hazard rating of the site is similar to the current hazard rating. A number of mitigation measures such as flood warning signs and flood depth indicators are proposed to ensure the risk to the public is managed.

Prepared by:

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Reviewed/Certified by:

Shaun Leinster

RPEQ 15637

DesignFlow

Attachments:

1. Updated flood impact maps 50%, 5% and 1% AEP (local)
2. Blockage analysis 5% and 1% AEP (local), 0.5% AEP (regional)
3. Flood impact map – 1% AEP using ARR1987 (local)
4. Severe storm analysis 0.5% AEP - peak flood depths and impacts with 20% blockage (regional)
5. Hazard maps 1% AEP (regional)

ATTACHMENT 1 – UPDATED FLOOD IMPACT MAPS – 50%, 5% AND 1% AEP (LOCAL)

Hydrology & Water Management Consulting

DesignFlow

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP05b Vs LE03a)

50%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP05b Vs LE03a)

5%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP05b Vs LE03a)

1%AEP Event

Client: Economic Development Queensland

ATTACHMENT 2 – BLOCKAGE ANALYSIS – 5% AND 1% AEP (LOCAL)

Hydrology & Water Management Consulting

DesignFlow

Carseldine Urban Village

Peak Flood Level Impacts

Proposed Develoment with 20% Blockage of 1200mm Outlet Pipe

(TUFLOW Case LP05b_B1 Vs LE03a)

1%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

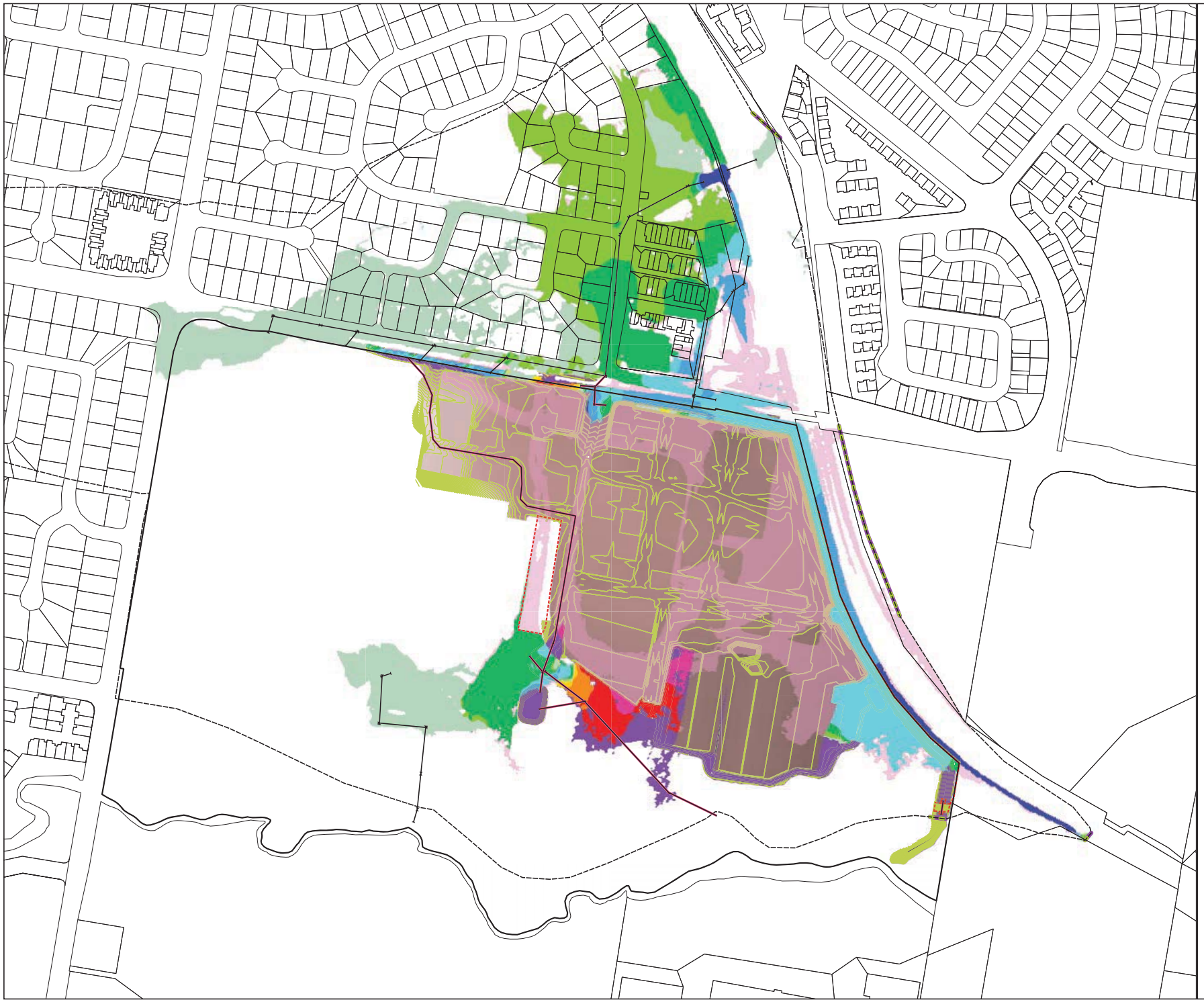
Carseldine Urban Village

Peak Flood Level Comparison:

5%AEP Proposed Case with Extreme Blockage vs 1%AEP Existing Base Case

(TUFLOW Case LP05b_B2 Vs LE03a)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.25m)
- Developed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

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

N

40 0 40 80 m

Carseldine Urban Village

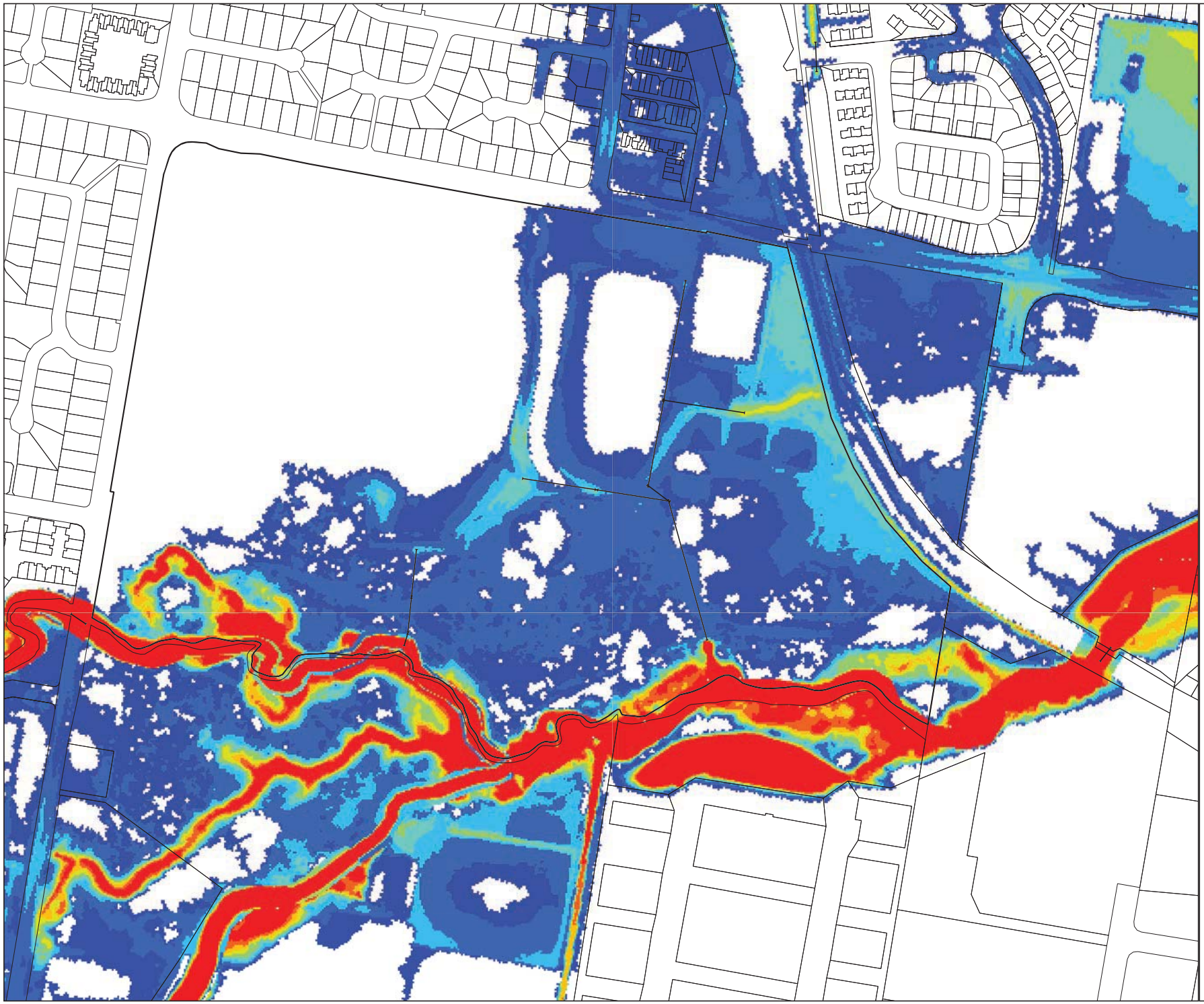
Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP05b_87 Vs LE03a_87)

1%AEP Event
Based on ARR 87 Rainfall

Client: Economic Development Queensland

ATTACHMENT 4 – SEVERE STORM ANALYSIS 0.5% AEP – FLOOD DEPTH AND IMPACT WITH 20% BLOCKAGE (REGIONAL)



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- 1D Pipes

Peak Flood Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

N

40 0 40 80 m

Carseldine Urban Village

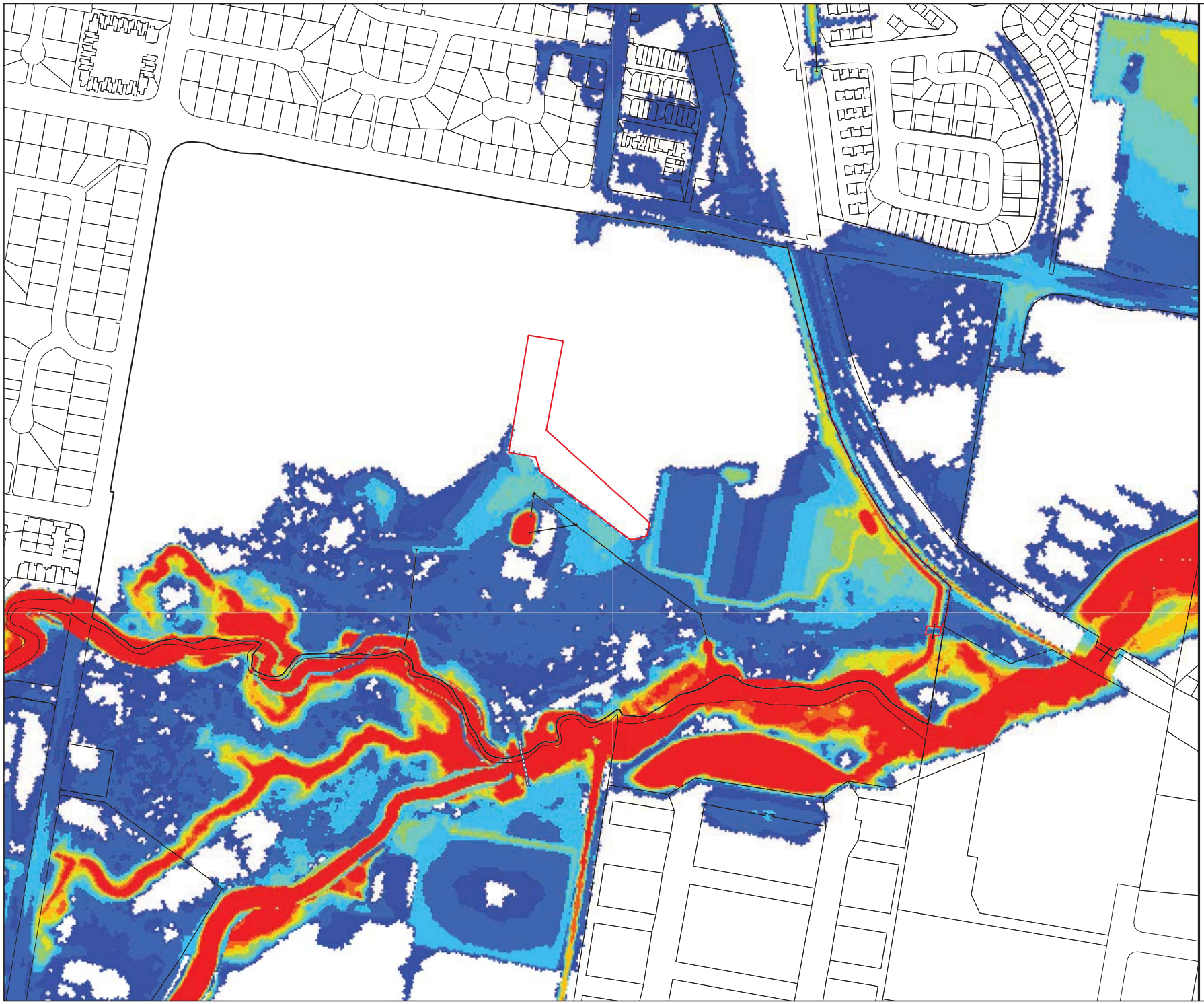
Peak Flood Depths

Base Case

(TUFLOW Case B03a)

0.2% AEP
Cabbage Tree Creek Event

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

Carseldine Urban Village

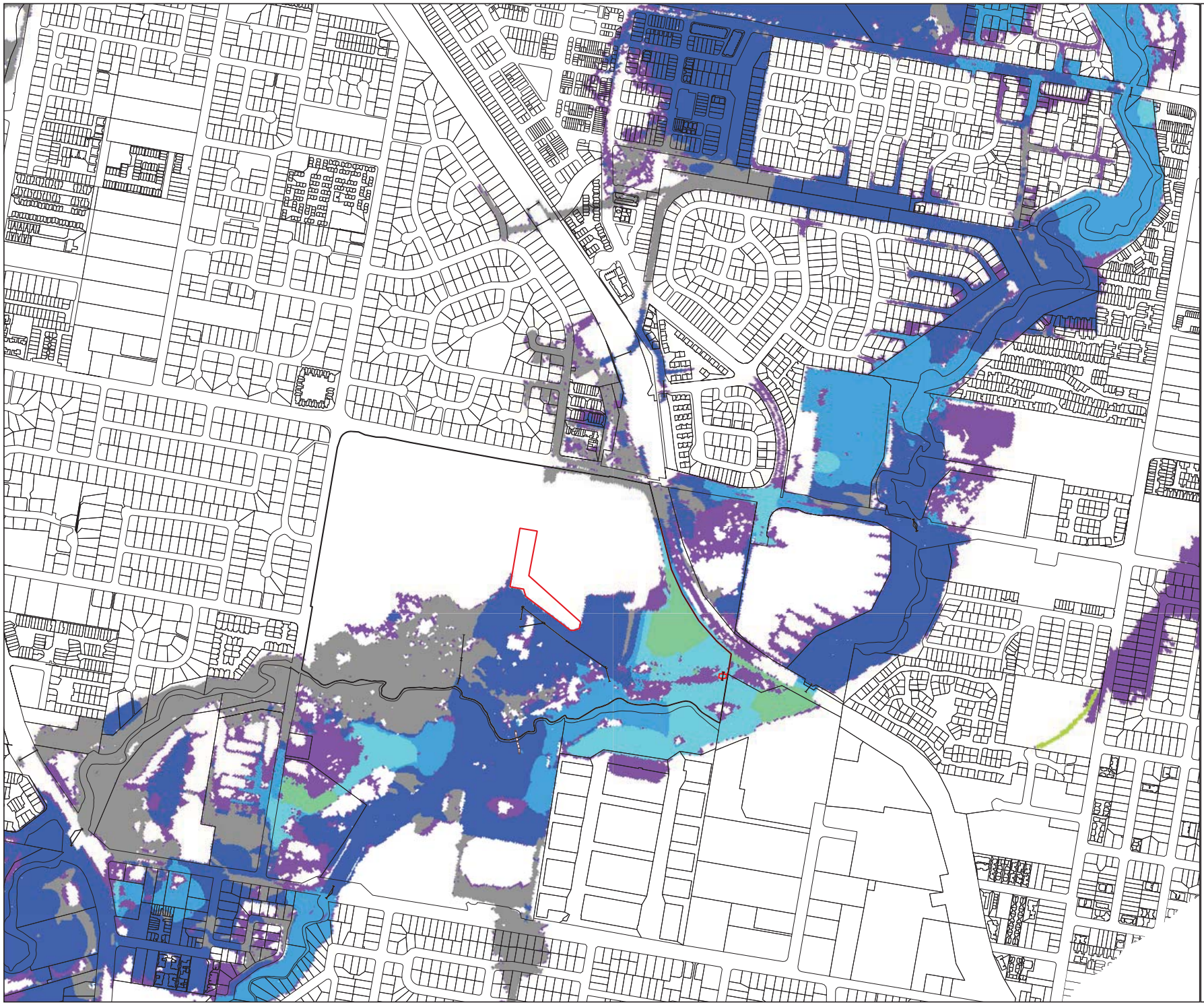
Peak Flood Depths

Proposed Case

(TUFLOW Case P04c_B1)

0.2% AEP
Cabbage Tree Creek Event

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- 1D Pipes
- Bridge (2d_lfcsh)
- Z-Point Modifier

Peak Flood Level Difference (m)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- > 0.9
- Was Wet - Now Dry
- Was Dry - Now Wet

N

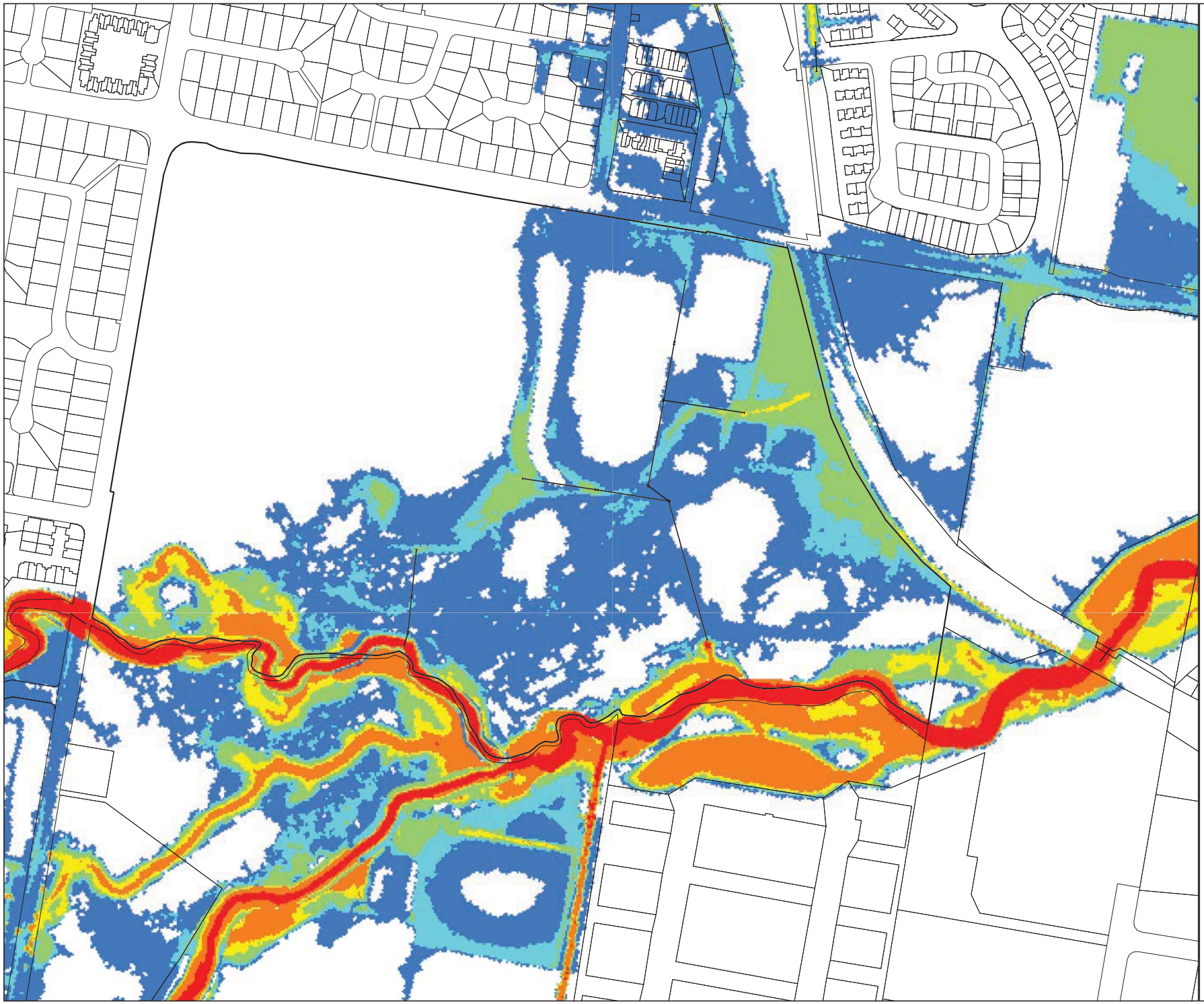
80 0 80 160 m

Carseldine Urban Village

Peak Flood Level Difference: Q200 minus Q100

CUV Plus Pedestrian Bridge Case (TUFLOW Case P04c_B1)

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- 1D Pipes

Hazard Category

(Defined by Australian Emergency Management Institite, 2014)

- H1
- H2
- H3
- H4
- H5
- H6

N

40 0 40 80 m

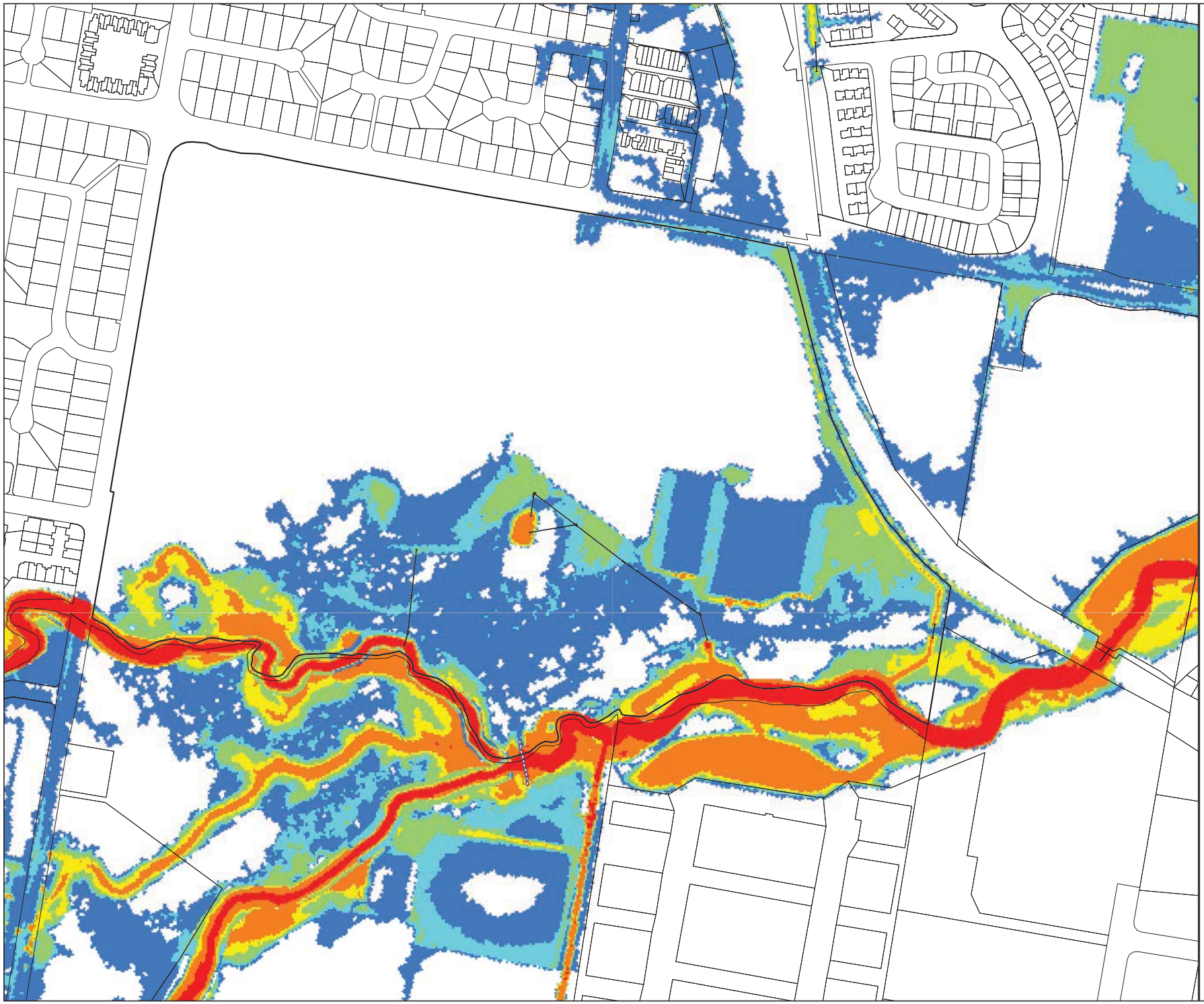
Carseldine Urban Village

Peak Flood Hazard
Regional Catchment Analysis

Base Case
(TUFLOW Case B03a)

1%AEP Event

Client: Economic Development Queensland



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- 1D Pipes
- Bridge (2d_lfcsh)

Hazard Category

(Defined by Australian Emergency Management Institite, 2014)

- H1
- H2
- H3
- H4
- H5
- H6

N

40 0 40 80 m

Carseldine Urban Village

Peak Flood Hazard
Regional Catchment Analysis

Proposed CUV & Pedestrian Bridge
(TUFLOW Case P04c)

1%AEP Event

Client: Economic Development Queensland