ATTACHMENT C

Flood Impact Assessment

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Our Ref: L.M00676.FloodReport.001.00.docx

1 June 2026

Langtree Consulting Pty Ltd
Level 1, 14 Ingham Road
West End QLD 4810

Attention: Mr Brett Langtree

Dear Brett

RE: ANNANDALE CHRISTAIN COLLEGE: CARPARK AND BUILDING H – FLOOD IMPACT ASSESSMENT

Venant Solutions has completed a flood impact assessment (FIA) on a proposed development at Annandale Christian College (Lot 2 on RP850718) (the Site). It is proposed to replace Building H on the Site and extend the carpark that is located to the south of the drain to the north-east.

This report is for a development application. More detailed modelling of the Site including final civil design will be required in the future.

Background

The Site is located 6.8 km south-west of the Townville Central Business District and is within the Ross River catchment. There is a drain that runs through the Site from south-west to north-east parallel with Yolanda Drive. A smaller drain, which flows from south to north, joins this drain in the Site to the south-east of the proposed building and to the west of the carpark that will be extended. The drains do not break their banks in the 1% AEP event and as such Site inundation is largely due to local rainfall. Site locality is represented in Figure 1 and Figure 2.

Council has undertaken flood modelling and mapping of the catchment which shows that much of the Site is within the 1% AEP flood extent. Council provided their 2021 Ross River TUFLOW hydraulic model to Venant Solutions to undertake this impact assessment.

The scope of works for this report was:

- Update the supplied existing conditions TUFLOW model to better represent the Site.
- Incorporate any proposed developments on the Site into the TUFLOW model.
- Assess the impact of the proposed developments on the flood levels and velocities external to the Site.
- Advise 1% AEP flood levels at the proposed building.
- Prepare a report summarising the assessment findings.

The supplied TUFLOW model had the following basic characteristics:

- Run on TUFLOW version 2020-10-AA
- Topography based on Council's 2016 LiDAR
- 5 m grid size
- Uses TUFLOW's Sub Grid Sampling (SGS) feature

- Rain-on-grid inflow in the catchment containing the Site
- Rainfall losses were controlled by the Manning's 'n' layer.

Flood Impact Assessment

Existing Case Model

The TUFLOW model was cut down to better represent the Site and to reduce run times. The changes made were as follows and some of them can be seen in Figure 3 and Figure 4.

- The model was run using the same version of TUFLOW as the supplied model (version 2020-10-AA)
- The model was cut-down to a 2.17 km^2 portion in the southern side of the Ross River model. The new model extent is bounded by:
  - Fairlight Cres and Chatsworth Cres to the north
  - Weddel Dr and Andrew Ball Dr to the east
  - Robert Towns Boulevarde to the south
  - Casuarina Dr to the west
- Ground levels around the Site were revised based on ground level surveys:
  - *Combined Survey_GDA94.dwg* provided by Langtree Consulting Engineers
  - *Annandale Christian College detail rev 2 R2007.dwg* provided by Langtree Consulting Engineers and undertaken by Pin Point Surveys Pty Ltd
- Layered flow constrictions representing the footbridges across the drain that runs parallel with Yolanda Drive were included. The details of each bridge are shown in Table 1
- Buildings were updated to be represented by complete blockages rather than a Manning's 'n' value.
- Manning's 'n' surface roughness representation of the Site was refined. Manning's 'n' values corresponded to those used elsewhere in the model were used
- Quadtree was used to reduce the grid size to 1.25 m to increase the model resolution in the vicinity of the Site
- SGS sample distance decreased from 1 m to 0.5 m
  - This gives a 11 points per cell size in the 5 m grid area and 3 points per cell side in the 1.25 m grid area
- Existing Site stormwater pipe network added using details provided by Langtree Consulting (*1197_2-STRM.dwg*). Pipe IDs are shown in Figure 4. Pipe configurations are shown in Table 2
  - Pits were represented as Q pits with the 'field inlet' type as already used in the Ross River TUFLOW model

Table 1 Footbridge Properties

Bridge	Pier Form Loss	Deck Level (m AHD)	Deck Thickness (m)	Rail Height (m)	Rail Blockage (%)
West	0.178	8.11	1.3	1.0	30
Centre	0 (No piers)	8.18	0.5	1.2	30
East	0 (No piers)	7.98	0.33	1.2	30

Table 2 Existing Stormwater Pipes

Pipe ID	Configuration	Upstream Invert (m AHD)	Downstream Invert (m AHD)
1	1/150 mm RCP	6.3	6.2
2	1/150 mm RCP	6.2	6.1
3	1/150 mm RCP	6.1	6
4	1/150 mm RCP	6.2	6
5	1/100 mm RCP	6.25	6.15
6	1/150 mm RCP	6.1	6
7	1/150 mm RCP	6	5.9
8	1/100 mm RCP	6.15	6.1
9	1/150 mm RCP	6.1	6
10	1/225 mm RCP	6	5.9
11	1/225 mm RCP	5.9	5.6
12	1/150 mm RCP	6.2	6.1

The TUFLOW model was run to establish flood levels and extents across the Site and the drains adjacent to the Site under existing conditions for the 1% and 50% AEP events. Critical events were selected from the result grids supplied with the TUFLOW hydraulic model and shown in Table 8 of the supplied model report (AECOM 2021). The critical durations and temporal patterns for each AEP are shown in Table 3.

Table 3 Critical Events at Site

AEP	Duration (mins)	Temporal Pattern
1%	90	8731
50%	180 60	8787 8727

The differences in flood level and extent between the updated model and the supplied model results in the vicinity of the Site in the 1% AEP event, are presented in Figure 5 to 7:

- Figure 5 illustrates the results obtained after trimming the model extent only
- Figure 6 presents the same scenario as Figure 5, with the addition of the Quadtree area and the reduced SGS sample distance
- Figure 7 is the final model configuration

No change in flood level within ± 10 mm is shown in pale yellow. The green shades represent areas where there are reductions in flood level using the updated model and the orange/red shades represent areas where the flood level has increased. Pink areas indicate where there was formerly inundation and it is now dry (was wet now dry) and blue areas indicate the opposite (was dry now wet).

Figure 5 shows no change in flood level around the Site. Figure 6 shows reductions in flood level in the drain parallel to Yolanda Drive. These are due to the reduced cell size improving the representation of the drain conveyance which allows more flow along the drain, particularly at some of the foot bridges across the drain. Downstream of the Site there are minor increases in flood level of around 13 mm in the drain. Figure 7 shows a significant reduction in flood level in the drain parallel to Yolanda Drive, with decreases of up to 900 mm. These reductions are mainly due to the better representation of the area under the east footbridge because of the survey resulting increased waterway area and hence flow through the bridge. Increases in flood level in the drain downstream of the Site are around 60 mm and are due to the increased flow capacity of the area immediately upstream as a result of the improved model.

Mapping for the existing case is presented as follows:

- Figure 8 Existing Model Peak Flood Depth – 1% AEP
- Figure 9 Existing Model Peak Flood Depth – 50% AEP
- Figure 10 Existing Model Peak Flood Velocity – 1% AEP
- Figure 11 Existing Model Peak Flood Velocity – 50% AEP

As the model is a rain on grid model the entire model is wet with areas of very shallow inundation that would not be considered flooding but surface runoff. Therefore, the mapping is filtered to remove inundation in areas where depth is less than 50 mm. This removes sheet flow but leaves channel flow and storage areas.

Proposed Case

The TUFLOW model was updated to represent the proposed development, which is shown in the attached plans (*1197_2-STRM.dwg and ACT01_SK-05_P6_FLOOR PLAN - GROUND FLOOR.dwg*). The following changes were made to the TUFLOW model and some of them can be seen in Figure 12.

- Updated stormwater pipe networks on Site as shown in the proposed plans. Pipe IDs are shown in Figure 12. Pipe configurations are shown in Table 4
  - Pits were represented as Q pits with the 'field inlet' type as already used in the Ross River TUFLOW model
- Building blockages on Site were updated to cover the extent of proposed building
- Proposed topography changes around the proposed building were included
- Manning's 'n' on Site were updated to better represent surface roughness of proposed plans around the proposed building and in the proposed carpark extension with associated changes to rainfall losses

Table 4 Proposed Stormwater Pipes

Pipe ID	Configuration	Upstream Invert (m AHD)	Downstream Invert (m AHD)
Prop_1	1/375 mm RCP	5.95	5.9
Prop_2	1/225 mm RCP	6	5.95
Prop_3	1/225 mm RCP	6	5.95
11	1/375 mm RCP	5.9	5.6

Results

Mapping for the proposed case is presented as follows:

- Figure 13 Proposed Model Peak Flood Depth – 1% AEP
- Figure 14 Proposed Model Peak Flood Depth – 50% AEP
- Figure 15 Proposed Model Peak Flood Velocity – 1% AEP
- Figure 16 Proposed Model Peak Flood Velocity – 50% AEP
- Figure 17 Proposed Case Change in Flood Level – 1% AEP
- Figure 18 Proposed Case Change in Flood Level – 50% AEP
- Figure 19 Proposed Case Change in Flood Velocity – 1% AEP
- Figure 20 Proposed Case Change in Flood Level – 50% AEP

Flood levels and velocities external to the Site are not impacted by the introduction of the proposed development in either the 1% or the 50% AEP flood events.

1% AEP flood levels at the sampling points for the proposed design's access points can be found in Table 5 as well as the minimum required building level based on a freeboard of 300 mm. All floor level requirements are met.

Table 5 Building H 1% AEP Flood Levels

	1% AEP Flood Level (m AHD)	Required Floor Level (m AHD)	Proposed Floor Level (m AHD)
GLA1	8.02	8.32	8.335
GLA2	N/A	N/A	8.335
East Entrance	6.95	7.25	8.335
Staff Lounge	N/A	N/A	8.335
Delivery Room	N/A	N/A	8.335
Lobby	7.81	8.11	8.335

Conclusions

The analysis reported on herein shows that the proposed development:

- Does not impede the flow of flood waters through the site or worsen flood flows external to the site
- Ensures any changes to the depth or velocity of flood waters are contained within the site
- Does not directly, indirectly or cumulatively worsen flood characteristics outside the development site, having regard to: increased scour and erosion
- Provides 1% AEP flood levels so that floor levels can be designed with appropriate freeboard

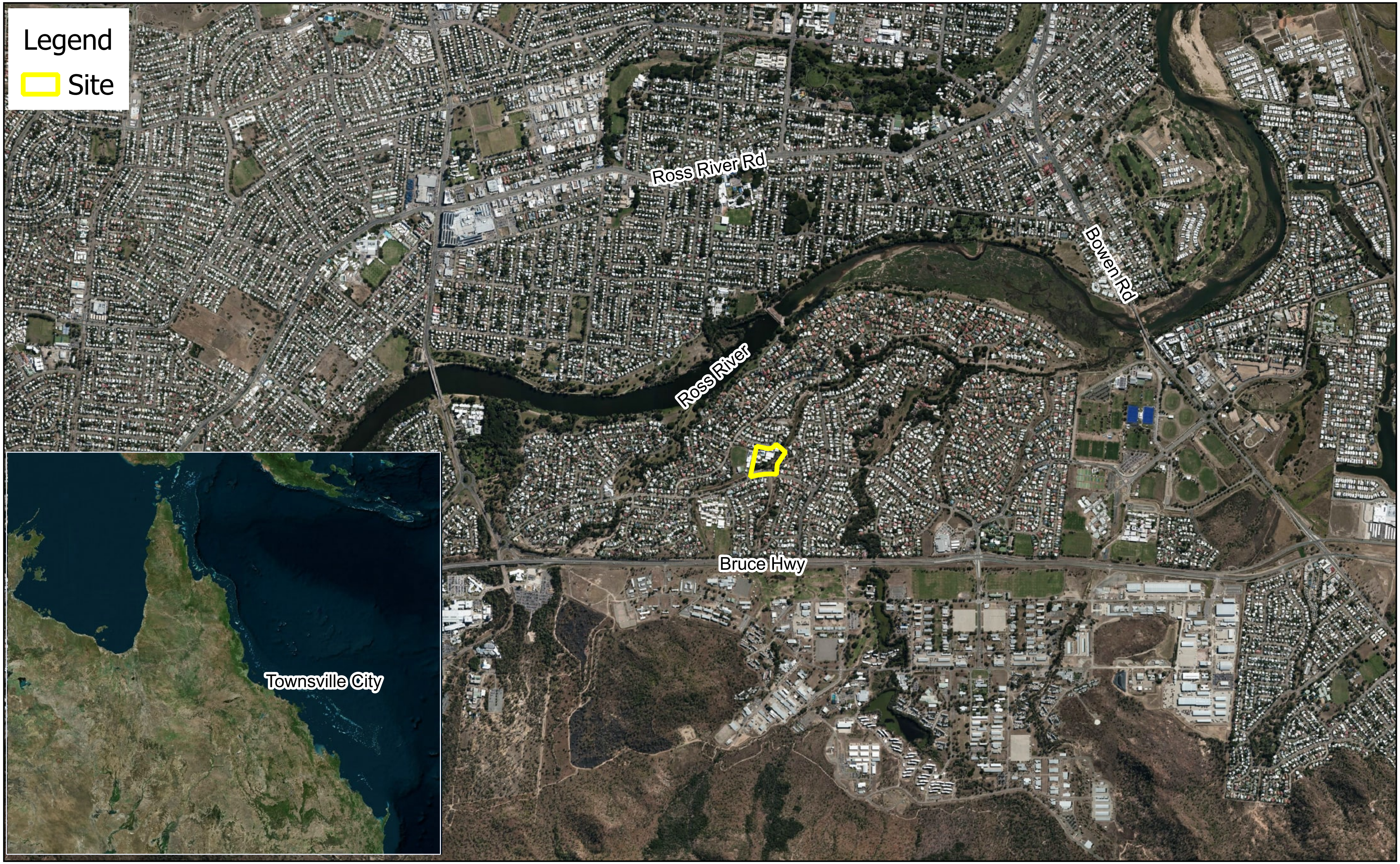
Yours sincerely,

Richard Gale
Senior Engineer

Dr Mark Jempson
Reviewer
RPEQ (11111)

References

AECOM (2021), Base-line Flooding Assessment: Ross River Flood Study – Volume 1 – Report, Australia.



Title: Annandale Christain College: Carpark and Building H Site Locality	Figure: 1	Rev: A	0 500 1,000 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig1_Site_Locality.qgz	By: TL	May 2026		

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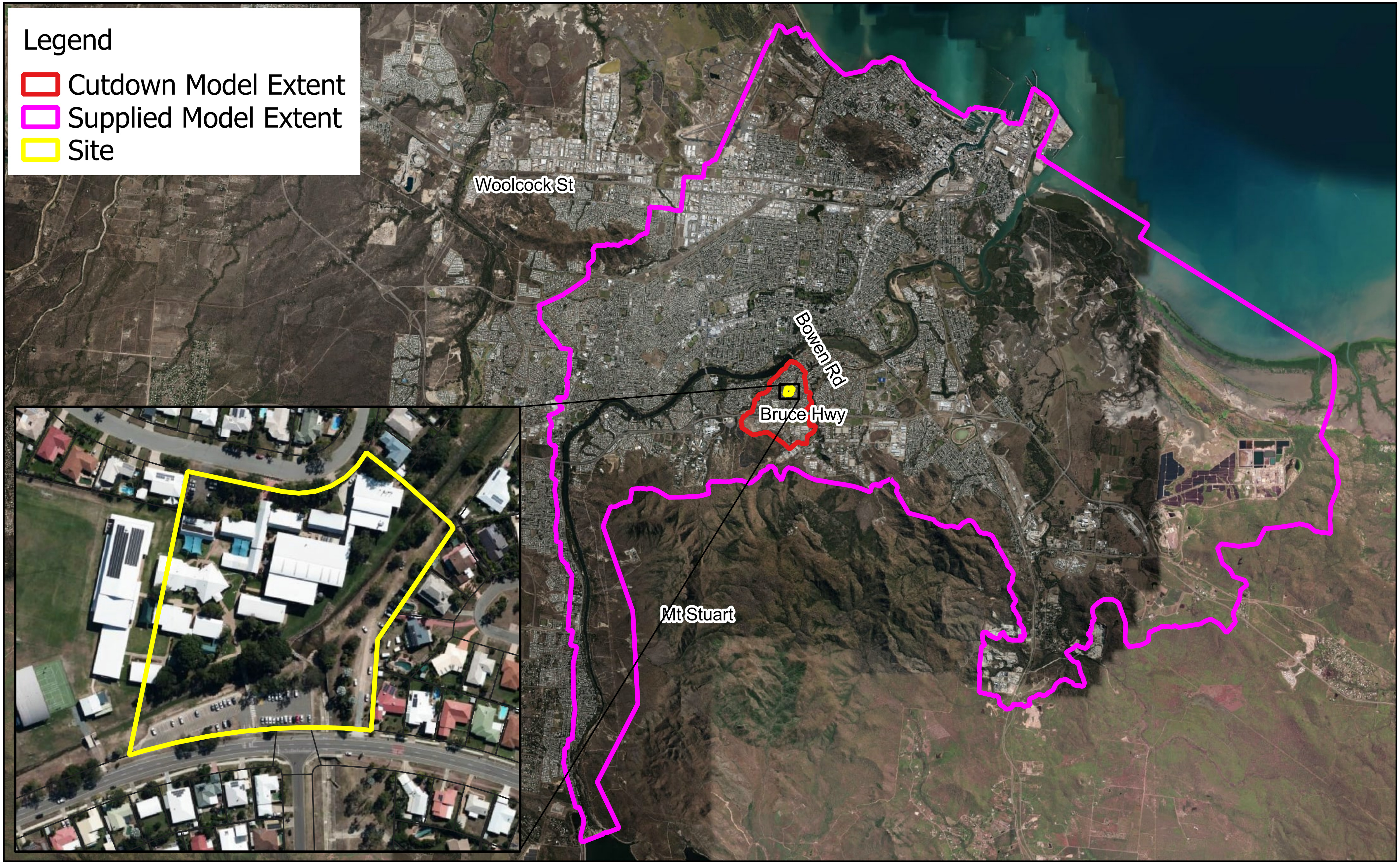
Title: Annandale Christain College: Carpark and Building H Site Locality - Zoom	Figure: 2	Rev: A	0 40 80 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig2_Site_Locality_Zoom.qgz				By: TL · May 2026	www.venantsolutions.com.au



Title: Annandale Christain College: Carpark and Building H
Model Extent Comparison

Figure:	Rev:
3	A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig3_Cutdown_Model_Extent.qgz

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Title: Annandale Christain College: Carpark and Building H
Model Schematisation - Existing Case

Figure: 4

Rev: A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig4_Existing_Case_Model_Schematisation.qgz

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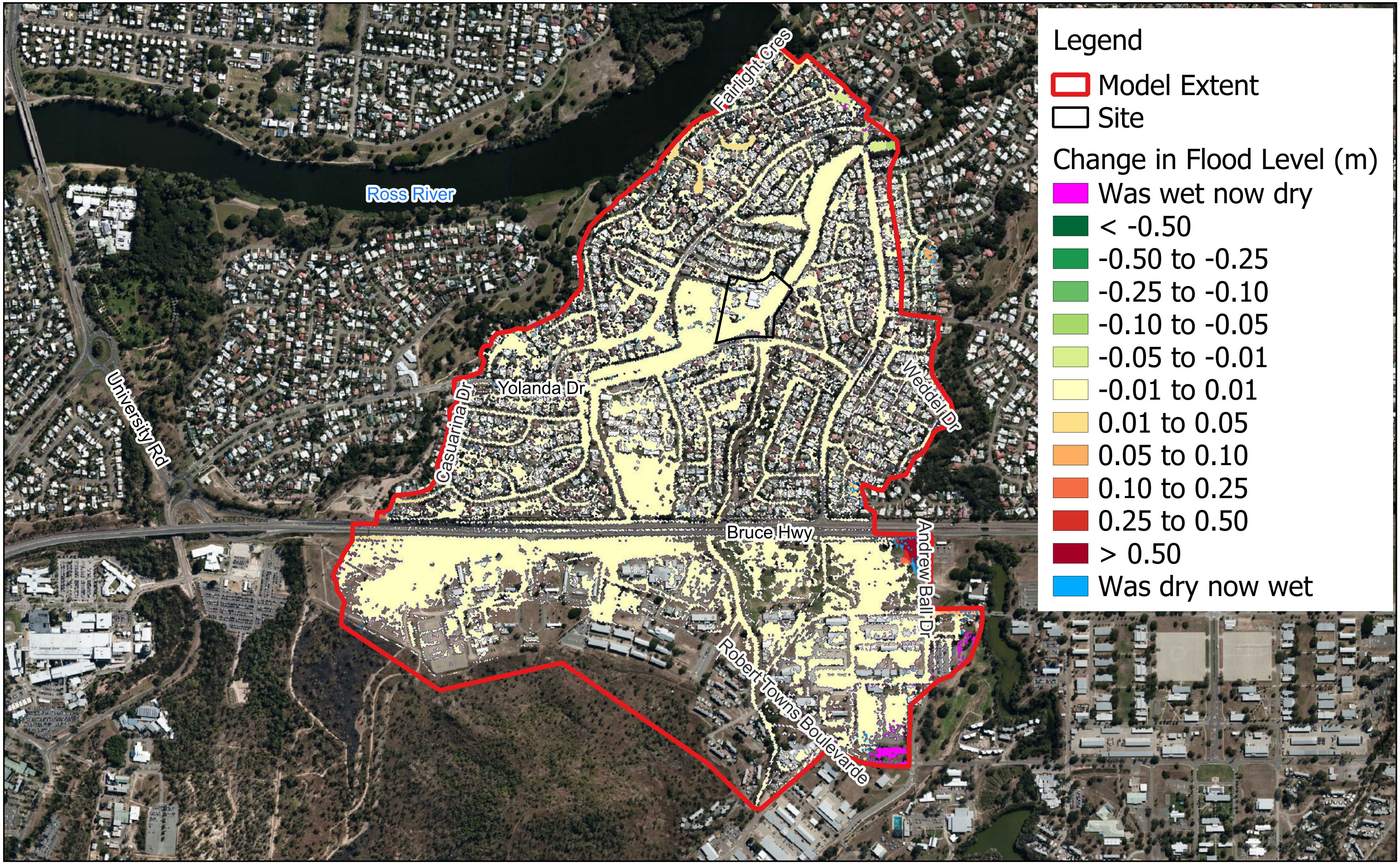

Title: Annandale Christain College: Carpark and Building H
Change in Flood Level 1% AEP - Cutdown Model Extent

Figure: 5

Rev: A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig5_Dif_ACC__RR_E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_003_h_Max_v6.qgz

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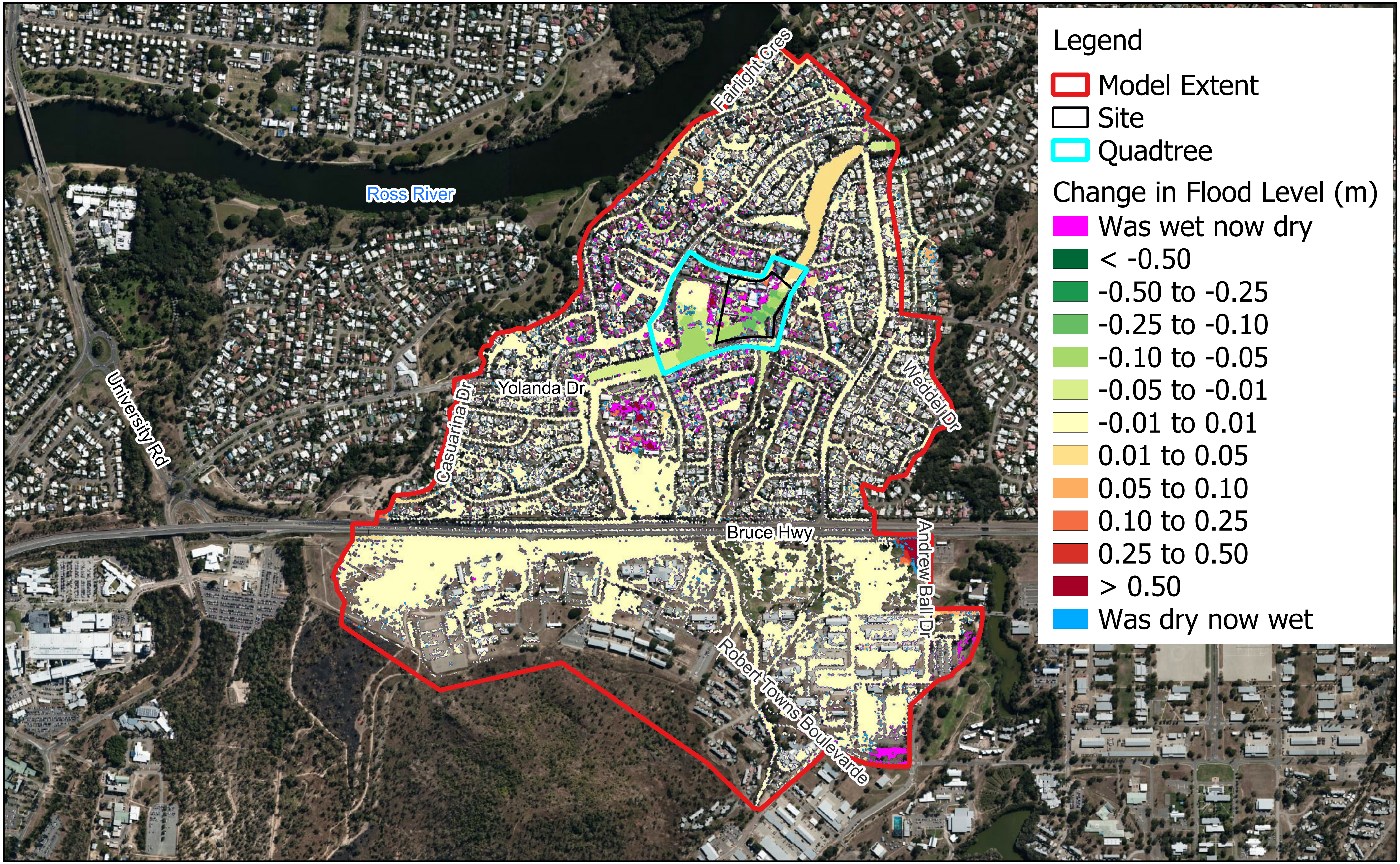

Title: Annandale Christain College: Carpark and Building H
Change in Flood Level 1% AEP - Reduce Cell Size

Figure: 6

Rev: A

0 200 400 m

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig6_Dif_ACC__RR_E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_004_h_Max_V3.qgz

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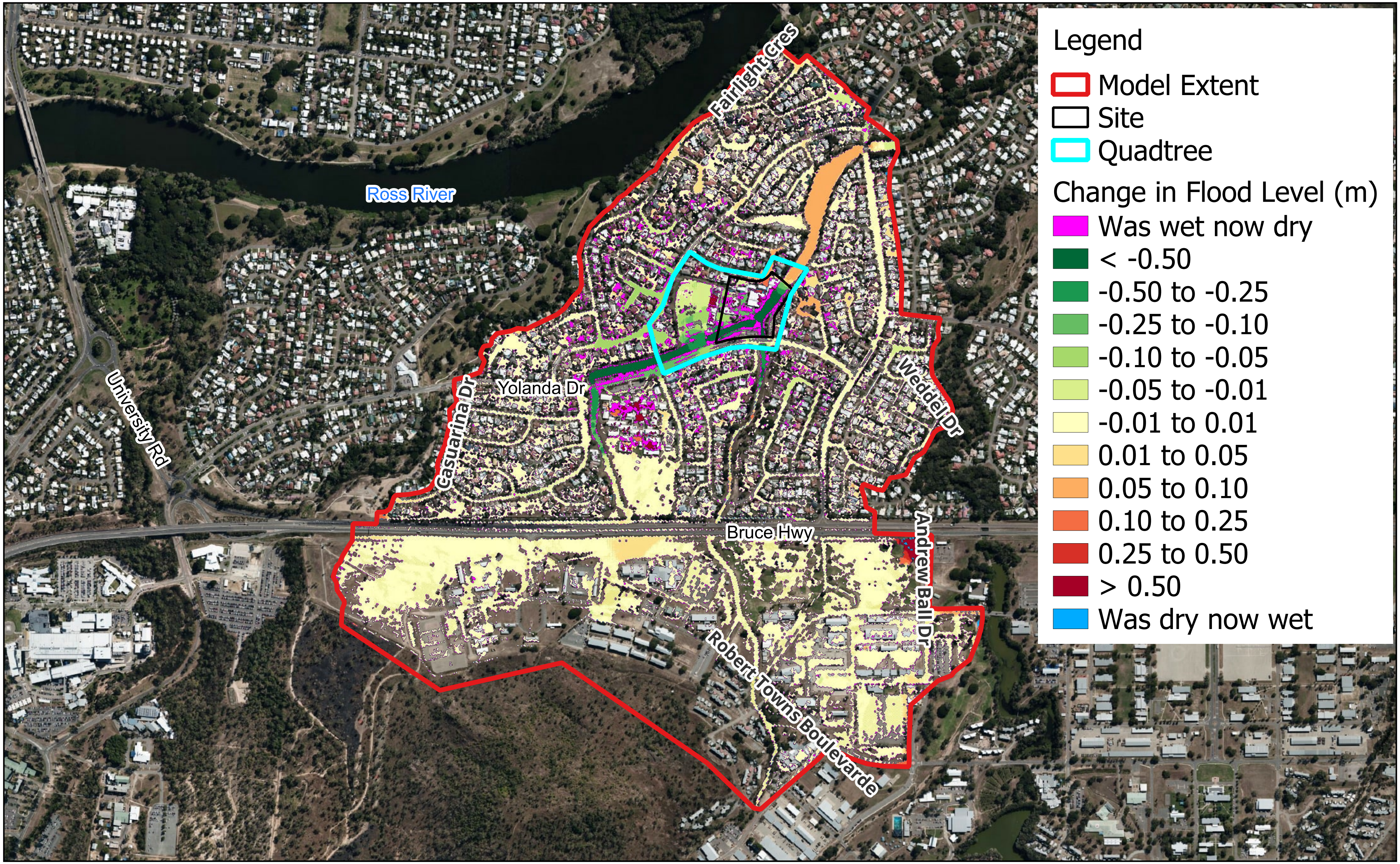

Title:	Figure:	Rev:			
Annandale Christain College: Carpark and Building H Change in Flood Level 1% AEP - Final Model (Inc. Survey)	7	A	0 200 400 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig7_Dif_ACC_E01_009__RR_E01_001_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_h_Max.qgz				By: TL May 2026	www.venantsolutions.com.au

Document Set ID: 28584010
Version: 2, Version Date: 09/07/2026

Title: Annandale Christain College: Carpark and Building H Peak Flood Depth and Level 1% AEP - Existing Case	Figure: 8	Rev: A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig8_ACC_E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_d_Max.qgz				By: TL	May 2026

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Title:	Figure:	Rev:		
Annandale Christain College: Carpark and Building H Peak Flood Depth and Level 50% AEP - Existing Case	9	A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig9_ACC_E01_50pAEP_MHWS_5m_R1_009_d_MaxMax.qgz			By: TL	May 2026

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Title: Annandale Christain College: Carpark and Building H
Peak Flood Velocity 1% AEP - Existing Case

Figure: 10

Rev: A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig10_ACC_E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_V_Max.qgz

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Document Set ID: 28584010
Version: 2, Version Date: 09/07/2026

Title: Annandale Christain College: Carpark and Building H Peak Flood Velocity 50% AEP - Existing Case	Figure: 11	Rev: A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig11_ACC_E01_50pAEP_MHWS_5m_R1_009_V_MaxMax.qgz			By: TL	May 2026

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Title: Annandale Christain College: Carpark and Building H
Model Schematisation - Proposed Case

Figure: 12

Rev: A

0 15 30 m

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig12_Proposed_Case_Model_Schematisation.qgz

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Title: Annandale Christain College: Carpark and Building H Peak Flood Depth and Level 1% AEP - Proposed Case	Figure: 13	Rev: A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig13_ACC_D103_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_d_Max.qgz				By: TL	May 2026	www.venantsolutions.com.au

Title: Annandale Christain College: Carpark and Building H
Peak Flood Depth and Level 50% AEP - Proposed Case

Figure:	Rev:		
14	A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig14_ACC_D103_50pAEP_MHWS_5m_R1_009_d_MaxMax.qgz

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Title: Annandale Christain College: Carpark and Building H Peak Flood Velocity 1% AEP - Proposed Case	Figure: 15	Rev: A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig15_ACC_D103_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_V_Max.qgz				By: TL	May 2026

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Title:	Figure:	Rev:		
Annandale Christain College: Carpark and Building H Peak Flood Velocity 50% AEP - Proposed Case	16	A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig16_ACC_D103_50pAEP_MHWS_5m_R1_009_V_MaxMax.qgz

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Title: Annandale Christain College: Carpark and Building H
Change in Flood Level 1% AEP

Figure: 17

Rev: A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig17_Dif_ACC_D103__E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_h_Max.qgz

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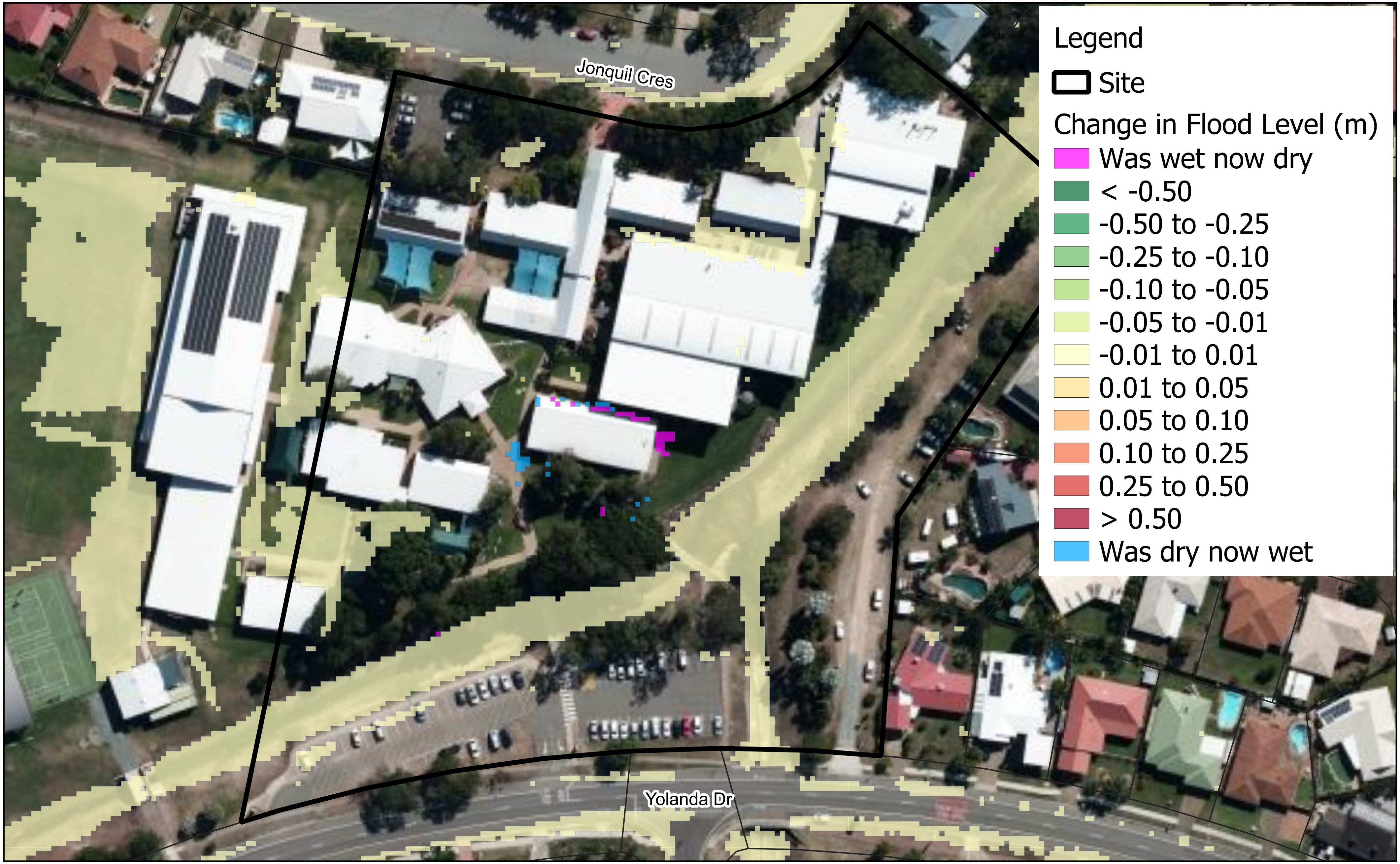

Title: Annandale Christain College: Carpark and Building H
Change in Flood Level 50% AEP

Figure: 18

Rev: A

0 20 40 m

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Title:

Annandale Christain College: Carpark and Building H
Peak Flood Velocity 1% AEP

Figure: 19

Rev: A

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Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig19_Dif_ACC_D103__E01_1pAEP_1.5h_8731_1pAEP_TPS_ST_5m_R1_009_V_Max.qgz

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Title: Annandale Christain College: Carpark and Building H Peak Flood Velocity 50% AEP	Figure: 20	Rev: A	0 20 40 m	This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.	VENANT SOLUTIONS
Filename: S:\Projects\M00676.RG.AnnandaleChristianCollegeCarpark\GIS\Drawings\L.M00676.001.00\Fig20_Dif_ACC_D103_009__E01_009_50pAEP_MHWS_5m_R1_V_MaxMax.qgz			By: TL	Jun 2026	www.venantsolutions.com.au

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ATTACHMENT D

Hydrological and Hydraulic Assessments

CATCHMENT HYDROLOGY
(RATIONAL METHOD - URBAN CATCHMENT)

LANGTREE
CONSULTING ENGINEERS

Project Name: Annandale Christian College
Location: Catchment E1 (Pre-development)

Input
Output

(1) Guidelines
- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Standard inlet time — *- refer QUDM 2017, Section 4.6.4 & 4.6.5*

Using standard inlet time

t (mins) = 5.0

b) Pipe travel time

$t = L/(60 . V) = n . L/(60R^{2/3} . S^{1/2})$

n = 0.0
L = 107.0
R = 0.1
S = 0.01

t (mins) = 0.5

c) Total t_c

Total time (min) = 5.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^tI_y \times A$ — *- refer QUDM 2017, Section 4.3*

where:
Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^tI_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 20

A (ha) = 0.4 — 3,960 m2
t_c (mins) = 5.5
Rainfall intensity, I (mm/hr) = 226.7
${}^1I_{10}$ (mm/hr) = 64.1

Impervious area = 2,697

Fraction impervious, f_i = 0.68 — *- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F = 1.05 — *- refer QUDM 2017, Table 4.5.2*

C_{10} = 0.84 — *- refer QUDM 2017, Table 4.5.3 & 4.5.4*
C_y = 0.88

Q (m^3/s) = 0.220

HYDRAULICS ASSESSMENT

(PIPE CAPACITY - FLOWING FULL CONDITION)

Manning's Equation

Project Name: Annandale Christian College

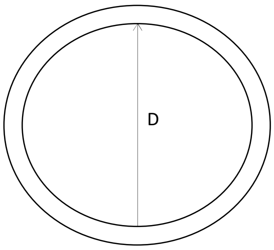
Location: Catchment E1 (Pre-development)

Input	
Output	

(1) Design Flow

Q_{Des} = 0.220 m^3/s

(2) Pipe Flow



Pipe Properties

Diameter, D =	225	mm
Material =	Concrete	
Manning's, n =	0.013	
Pipe length =	51.8	m
USIL =	6.54	m
DSIL =	5.77	m
Slope =	0.0148	m/m
No. of cell =	1	

Manning's Calculation:

Flow Areas

A = 0.040 m^2

Wetted Perimeters

P = 0.707 m

Hydraulic Radius

R = 0.056 m

Capacity

Q = 0.055 m^3/s

Velocity:	**1.374**	**m/s**	**OK**
Total Capacity:	**0.055**	**m^3/s**	**WARNING!! - PROPOSED PIPES BELOW CAPACITY**

Pipe Design:

Pipe Material	**Concrete**	
Pipe Diameter	**225**	**mm**
No. of Cell	**1.0**	
Pipe Slope	**0.0148**	**m/m**

CATCHMENT HYDROLOGY
(RATIONAL METHOD - URBAN CATCHMENT)

LANGTREE CONSULTING ENGINEERS

Project Name: Annandale Christian College
Location: Catchment P1 (Post-development)

Input
Output

(1) Guidelines
- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

(2) Time of Concentration (t_c)

a) Standard inlet time — *- refer QUDM 2017, Section 4.6.4 & 4.6.5*

Using standard inlet time

t (mins) = 5.0

b) Pipe travel time

$t = L/(60 . V) = n . L/(60R^{2/3} . S^{1/2})$

n = 0.0
L = 107.0
R = 0.1
S = 0.01

t (mins) = 0.5

c) Total t_c

Total time (min) = 5.5

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^tI_y \times A$ — *- refer QUDM 2017, Section 4.3*

where:
Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years
C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years
A = area of catchment (ha)
${}^tI_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y = 20

A (ha) = 0.4 — 4,356 m2
t_c (mins) = 5.5
Rainfall intensity, I (mm/hr) = 226.7
${}^1I_{10}$ (mm/hr) = 64.1

Impervious area = 3,026

Fraction impervious, f_i = 0.69 — *- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F = 1.05 — *- refer QUDM 2017, Table 4.5.2*

C_{10} = 0.86 — *- refer QUDM 2017, Table 4.5.3 & 4.5.4 (Fraction impervious 0.8 adopted)*
C_y = 0.90

Q (m^3/s) = 0.248

HYDRAULICS ASSESSMENT

(PIPE CAPACITY - FLOWING FULL CONDITION)

Manning's Equation

Project Name: Annandale Christian College

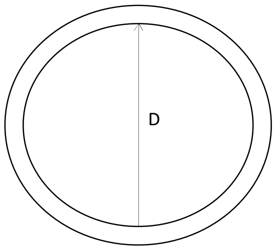
Location: Catchment P1 (Post-development)

Input	
Output	

(1) Design Flow

Q_{Des} = 0.248 m^3/s

(2) Pipe Flow



Pipe Properties

Diameter, D =	375	mm
Material =	Concrete	
Manning's, n =	0.013	
Pipe length =	58.6	m
USIL =	6.75	m
DSIL =	5.58	m
Slope =	0.0200	m/m
No. of cell =	1	

Manning's Calculation:

Flow Areas

A = 0.110 m^2

Wetted Perimeters

P = 1.178 m

Hydraulic Radius

R = 0.094 m

Capacity

Q = 0.248 m^3/s

Velocity:	**2.245**	**m/s**	**OK**
Total Capacity:	**0.248**	**m^3/s**	**OK**

Pipe Design:

Pipe Material	**Concrete**	
Pipe Diameter	**375**	**mm**
No. of Cell	**1.0**	
Pipe Slope	**0.0200**	**m/m**

CATCHMENT HYDROLOGY
(RATIONAL METHOD - URBAN CATCHMENT)

LANGTREE CONSULTING ENGINEERS

Project Name: Annandale Christian College
Location: Catchment P2 (Post-development)

(1) Guidelines
- Queensland Urban Drainage Manual (QUDM) 2017
- Bureau of Meteorology (BOM)

Input
Output

(2) Time of Concentration (t_c)

a) Friend's equation *- refer QUDM 2017, Section 4.6.4 & 4.6.5*

$t = (170.\, n\, .\, L^{0.333}) / S^{0.2}$

n =	0.015	
L =	48.0	m
S =	0.50	%
t (mins) =	10.6	

b) Channel flow time

Open Channel flow travel time formula:

Channel length, L (m) =	83
USIL (m) =	608.92
DSIL (m) =	604.50
Channel slope, S (m/m) =	0.0533
Mannings roughness , n =	0.035
Hydraulic radius , R (m) =	0.10
Channel flow travel time (mins) =	1.0
Total time (min) =	10.6

(3) Design Flow (Q)

$Q_y = 0.00278 \times C_y \times {}^{t}I_y \times A$ *- refer QUDM 2017, Section 4.3*

where:

Q_y = peak flow rate (m^3/s) for annual exceedence probability (AEP) of 1 in 'y' years

C_y = coefficient of discharge (dimensionless) for AEP of 1 in 'y' years

A = area of catchment (ha)

${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years

t = the nominal design storm duration as defined by the time of concentration (t_c)

Design ARI, y =	20	
A (ha) =	0.1	882 m2
t_c (mins) =	10.6	
Rainfall intensity, I (mm/hr) =	184.3	
${}^{1}I_{10}$ (mm/hr) =	64.1	
		Impervious area = 614
Fraction impervious, f_i =	0.80	*- refer QUDM 2017, Table 4.5.1*
Frequency Factor, F =	1.05	*- refer QUDM 2017, Table 4.5.2*
C_{10} =	0.86	*- refer QUDM 2017, Table 4.5.3 & 4.5.4 (Fraction impervious 0.8 adopted)*
C_y =	0.90	
Q (m^3/s) =	**0.041**	

HYDRAULICS ASSESSMENT

(OPEN DRAIN CAPACITY - TRAPIZOIDAL)

Manning's Equation

Project Name: Annandale Christian College

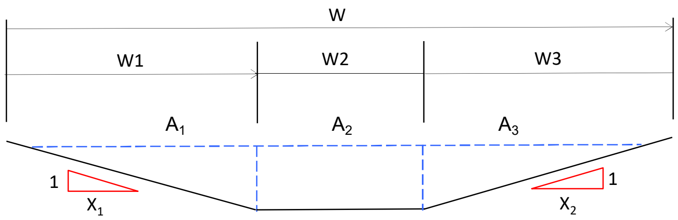
Location: Catchment P2 (Post-development)

Input	Output

(1) Design Flow

Q_{Des} = 0.041 m^3/s

(2) Open Drain - Trapizoidal



Channel Properties

X_1 =	2.0			
X_2 =	2.0			
Material =	Grass			
Manning's, n =	0.035			
Channel length =	38	m		
USIL =	7.5	m		
DSIL =	7.3	m		
Slope =	0.0050	m/m	0.50	%
Base width =	0.40	m		
Flow depth =	0.15	m		
Freeboard =	0.15	m		

Manning's Calculation:

Flow Areas

A_1 =	0.023	m^2
A_2 =	0.060	m^2
A_3 =	0.023	m^3

Wetted Perimeters

P_1 =	0.335	m
P_2 =	0.400	m
P_3 =	0.335	m

Hydraulic Radius

R = 0.098 m

Capacity

Q = 0.045 m^3/s

Velocity:	**0.430**	**m/s**	**OK**
D_g x V_{ave}:	**0.064**	**m^2/s**	**OK**
Total Capacity:	**0.045**	**m^3/s**	**OK**

Trap-Drain Design:

Top width, W1	**0.60**	**m**
Top width, W2	**0.40**	**m**
Top width, W3	**0.60**	**m**
Total Width, W	**1.600**	**m**
Base width	**0.400**	**m**
Side Slope (LHS)	**1 on 2**	
Side Slope (RHS)	**1 on 2**	
Channel Depth	**0.300**	**m**
Channel Slope	**0.005**	**m/m**