Flood Impact Assessment

Port Douglas Estate – Stage 1A and 1B

Q184103

Prepared for

Port Douglas Land Developments

16 October 2019

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1	24/01/2019	Initial Report	GP	DW
2	04/04/2019	Revised Layout	GP	DW
3	16/10/2019	Revision after Council feedback	ZM	HD

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1 Introduction

Cardno was commissioned by Port Douglas Land Developments to undertake a Flood Impact Assessment (FIA) of the proposed Port Douglas Estate residential development located on Lot 2 of Plan SR431 off the Captain Cook Highway, Craiglie, QLD. Figure 1-1 below displays the locality of the proposed development.

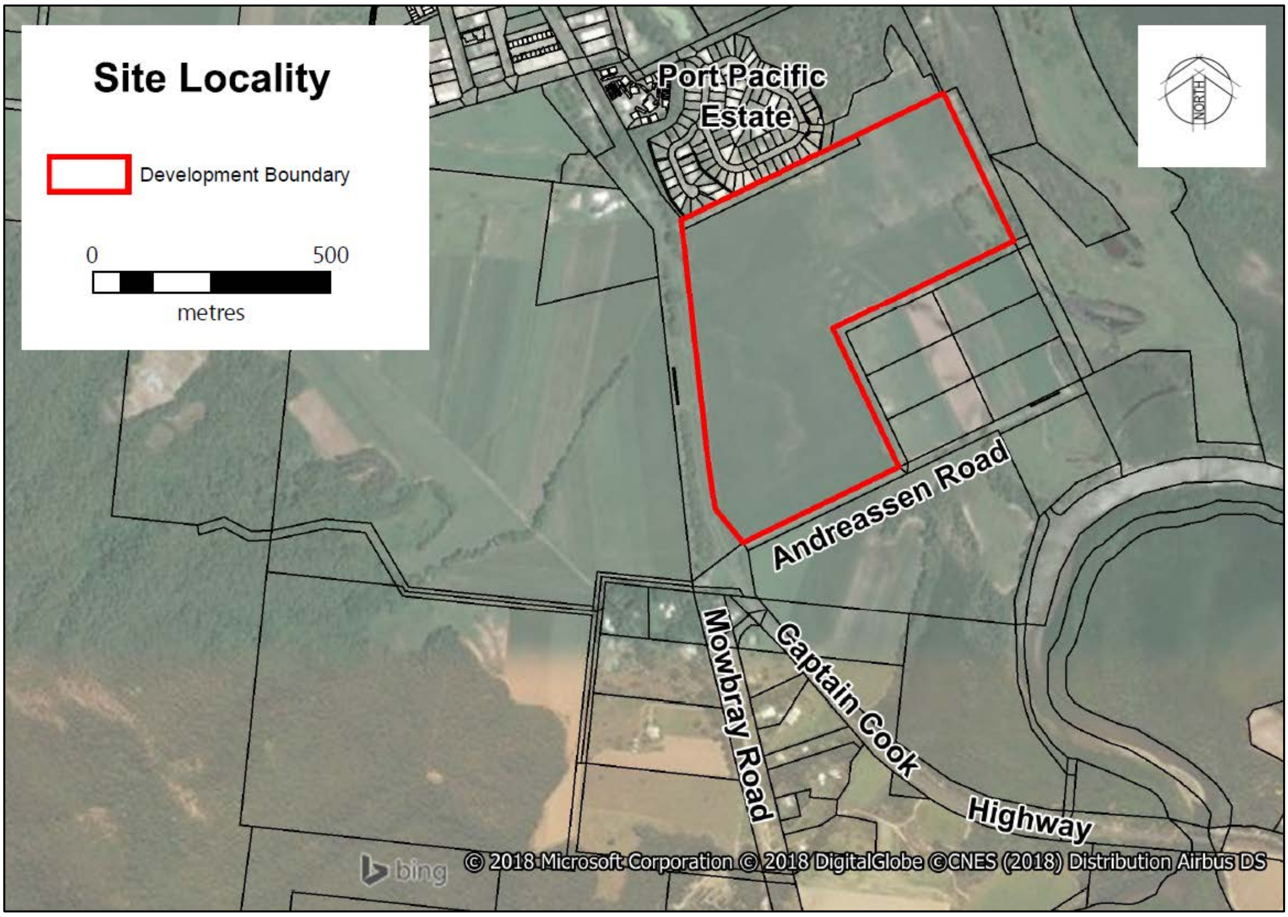


Figure 1-1 Site Locality – Port Douglas Estate

The aim of this FIA is to support a Development Application (DA) for Lot 2 on SR431 in regards to the reconfiguration of the lot into 32 lots plus a new road, balance lot, drainage lot and park. This DA will facilitate the first stage of the residential development, defined as Stage 1A and 1B, (Stage 1). Figure 1-2 displays the Proposed Plan of Reconfiguration.

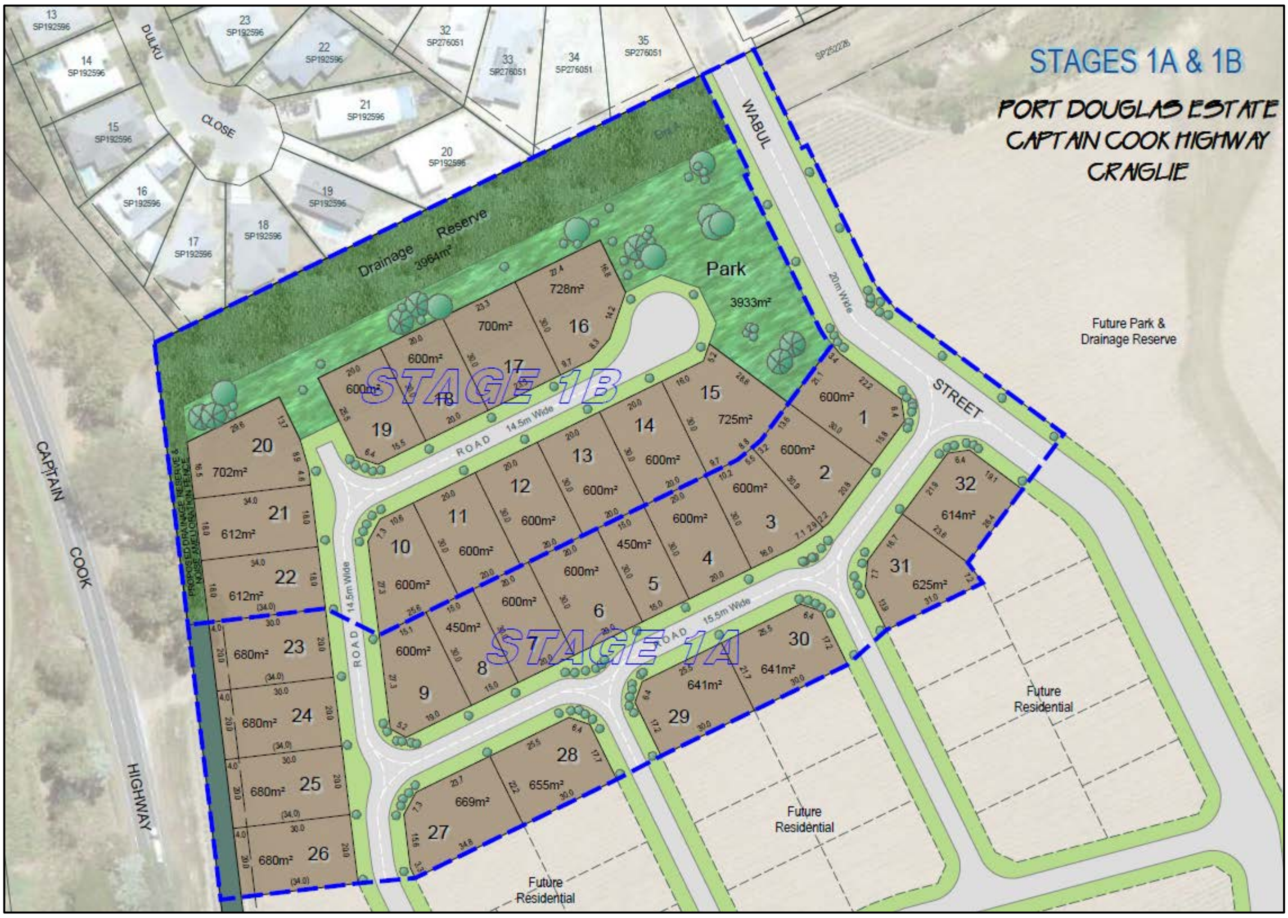


Figure 1-2 Proposed Plan of Reconfiguration

Stage 1 is located outside of the Storm Tide, 100 Year AEP flood extent and the Floodplain Assessment Overlay as prescribed in Councils Flood and Storm Tide Inundation Overlay Map (ref. Sheet – FST-020). However, as the future development area falls within all of these overlay areas, the following document has been completed to demonstrate the proposed Stage 1A and 1B are in compliance with the Douglas Shire Planning Scheme - Flood and Storm Tide Hazard Overlay Code.

The design allotment levels in Stage 1 of the Port Douglas Estate development will be designed to account for the impacts of Climate Change on the Craiglie Creek flood levels. Due consideration will be provided in regards to increases in rainfall intensities and increases in tidal tail water levels.

Access to Stage 1 is to be provided via Wabul Street across a multi-culvert bridge spanning the overland drainage reserve to the north. Additional future access to Stage 1 is to be provided with a connection through to Andreassen Road to the south. The site as a whole, is generally bounded by the Captain Cook Highway to the west, Port Pacific Estate to the north and farming land to the south.

Existing ground levels onsite range from approximately 8.2 mAHD in the south west corner grading down to 2.2 mAHD in the north east corner. There is a drainage gully traversing north across the site in which a majority of the onsite runoff is discharged north into the drainage corridor through the Port Pacific Estate. The site is currently utilised as crop farming land.

The Wabul Street crossing requires widening of the existing drainage reserve at the crossing location to accommodate the proposed culvert structures and ensure the smooth transition of flow into the culverts. Reference Drawing Q184103-CI-1262 (Appendix D), provides an indication of the channel widening required and details the proposed culvert structures.

The park area, identified in Figure 1-2 above, is to be used as flood storage to mitigate any volume lost through the development of Stage 1. For the purpose of this assessment, all residential lots and roads are to be filled above the 1% AEP flood level and the park area at the 20% AEP flood level in accordance with the Douglas Shire Planning Scheme - Flood and Storm Tide Hazard Overlay Code.

It is noted that development has occurred within the Port Pacific Estate site to the north on Lot 120 of Plan SP276038 of the drainage reserve and as such, it is vital that the proposed Port Douglas Estate does not adversely impact on the set freeboards of the southernmost lots. It was deemed necessary that all future development areas discharging into the northern drainage reserve be adequately represented within the Stage 1A and 1B hydraulic modelling to ensure appropriate freeboard for neighbouring lots could be maintained.

2 Decision Notice

2.1 Background

On the 28th May 2019, Douglas Shire Council issued a decision notice of approval subject to conditions being met. These conditions are detailed below, along with responses to each item.

2.2 Information Required

Further Drainage Study

13. The applicant is to update the stormwater modelling and reporting in accordance with the following requirements:

a. Provide further information on the model input parameters for review by its external stormwater reviewers;

b. Provide a further assessment of the check flow assessed using the rational method based on alternative time of concentration methods and provide commentary on any variance between the methods;

c. Undertake a sensitivity analysis for the peak flows in the model based on the upper bound assessment from the above check (or 15% increase in peak flows whichever is the greater). Note the assessment of peak flow rates is to enable assessment of the implications for the drain and culvert (and the flood level relative to existing housing);

d. It is unclear how the ground levels for the existing lots have been entered into the flood model and whether the current model set up excludes flow from entering existing lots. In order to properly understand the proposed drain and culverts operation and impacts, cross sections of the drain profile at regular intervals upstream and downstream from the culverts are required. The sections should show:

i. the proposed drain profile, including the need for a finish to stabilise the drain banks, such as rock lining;

ii. existing lot levels on the north side and proposed development levels on the south;

iii. the modelled peak flood level for the 5, 10- and 100-year AEP events, and

iv. the resulting freeboard;

e. In addition to the colour coding of the flood modelling outputs, flood levels are to be reported with 100mm contours or spot levels at maximum 50m intervals. This requirement is only for the 1% AEP model outputs but applies to both the existing and developed cases; and

f. The proposed culvert design concept is not supported as there is no capacity for overtopping within the drainage corridor. The flood modelling is to be revised for a culvert concept that has a road surface level a minimum of 250mm below the existing road level on the northern side.

Any ramping of the road levels is to occur outside the alignment of the drainage corridor. Modelling of the blockage scenarios is to be confirmed.

Because the culvert will not be able to achieve significant overtopping capacity, the modelling and reporting needs to clearly address blockage scenarios, sensitivity analysis and assessments of the severe storm impact as set out in QUDM Sections 7.23, &.24 and &.25.

The updated flood model and report together with an amended culvert design must be endorsed by the Chief Executive Officer prior to the issue of a Development Permit for Operational Works. All works must be carried out in accordance with the approved plan prior to the lodgement of the Survey Plan with Council for endorsement.

Response

Section 5 of the Flood Impact Assessment has been updated to provide further information on the hydraulic model input parameters.

Alternative methods of assessing time of concentration have been assessed. Section 4.1 details the methodology and results of assessment.

A climate change scenario has been assessed which accounts for a 20% increase in peak flows. This scenario was used as the sensitivity analysis to assess the impacts to existing houses and the proposed drain and culvert configuration.

Cross sections of the proposed drain detailing relevant information have been provided and are shown in Appendix D, drawing no. Q184103-CI-1262.

Contours of the peak flood levels within the 1% AEP event at 100mm intervals have been added to the output mapping shown in Appendices A and B for both the existing and developed cases.

As part of the new road design no ramping occurs inside the alignment of the drainage corridor. As part of the flood modelling, several blockage scenarios have been modelled. On the 22nd August 2019, Council accepted that the proposed configuration using 900mm high box culverts was an acceptable solution based on the proposed 20% blockage factor subject to a final review of this flood impact assessment (Appendix F). Refer to Section 5.5 for further details regarding the proposed culvert configuration.

Drainage Construction

14. The applicant / owner must undertake the development of the land in accordance with the findings of the updated Drainage Study.

Associated earthworks and landscaping must be completed in accordance with the approved plans prior to the lodgement of the Survey Plan with Council for endorsement.

Response

The earthworks design has been undertaken in accordance with the findings of this Flood Impact Assessment.

Reserves Over Drain

15. A Drainage Reserve containing all land below the top of the high bank and the area of additional drainage reserve (as outlined in Condition 3 above) adjacent to the top of the bank or the limit of the Q100 AEP event, whichever is the greater must be transferred to the Crown for Drainage Purposes. The land (reserve) must be transferred in conjunction with registration of the Plan of Survey for any lot release under Stage 1B. The existing drainage easement, over the part of the stormwater drain that is to be within the new Drainage Reserve, is to be rescinded at no cost to Council.

Response

See civil plans for proposed reserves (Appendix D).

Southern Diversion Drain

16. Where drainage channel improvements are identified in the flood study and or as a result of performance issues identified with the current drain, these works are to be identified on engineering drawings and included in the application for Operational Works.

Existing scouring\ring of the drain batters and banks is to be investigated and advice is to be provided on the soil type, lining and upgrades necessary to address the long-term stability of the channel. It is expected that a revised flatter batter profile will need to be considered. Information on the selected batter profile, lining type or vegetation stabilisation and soil types together with advice on the stream flow velocities will be required to support the proposed drain design.

Access ramps suitable for maintenance plant and equipment are to be provided on each side of the culvert structure to enable maintenance access the drain and culverts.

A plan of the drain improvement works must be endorsed by the Chief Executive Officer prior to the issue of a Development Permit for Operational Works.

All works must be carried out in accordance with the approved plans, to the requirements and satisfaction of the Chief Executive Officer, prior to the lodgement of the Survey Plan with Council for endorsement.

Response

Drainage channel improvements as a result of performance issues within the existing drain areas are shown on engineering drawings.

Stream flow velocities within the southern diversion drain have been provided within the report to assist in addressing the long term stability of the channel. Consideration will be given to these velocities during detailed design.

3 Background

3.1 Existing Modelling

Cardno has previously undertaken a flood study with regards to the Port Pacific Estate, located to the north of the proposed Port Douglas Estate. The purpose of this flood study was to investigate hydraulic conditions within the Port Pacific site and recommend mitigation options to alleviate adverse flooding within the surrounding catchment. The assessment was detailed within the report *"Port Pacific Estate, Port Douglas – Flood Study (dated 11 August 2009)"*. The construction of Port Pacific Estate was divided into five development stages and to date, only stages one to four have been constructed.

The flood study consisted of a detailed hydrological Watershed Bounded Network Model (WBNM) that assessed peak design flows from the local upstream catchment. A two-dimensional hydraulic TULOW model was also created to assess flooding conditions within the Port Pacific Estate and surrounding catchment.

Due to the close proximity of the Port Douglas Estate development, it is proposed to adopt the modelling created within the Port Pacific Estate flood study to assess flooding conditions within the subject site and determine flooding impacts resulting from the proposed development.

3.2 Limitations of Existing Modelling

A review of the existing modelling data identified a number of key limitations that needed to be addressed before assessing flooding conditions within the Port Douglas Estate site. The identified limitations are as follows:

Catchment Delineation; The upstream local catchments assessed within the existing WBNM modelling were delineated based on rough contour data. Since this time, newer, 2010 LiDAR data has become available and thus the catchment boundaries were redrawn based on the more recent dataset.

Model Extent: It was identified that the existing hydrologic and hydraulic models did not extend far enough to the south to fully capture the Port Douglas Estate development and its associated catchment. As such, both the hydrologic and hydraulic model were extended to fully encapsulate this area.

4 Hydrologic Analysis

4.1 Time of Concentration

The time of concentration for the two main catchments was calculated using two different methodologies, as described in the Queensland Urban Drainage Manual (QUDM), Section 4.06.11: the Bransby-Williams' Equation and the Modified Friend's Equation.

The formula for the Bransby-Williams' Equation is:

$$t_c = \frac{58L}{A^{0.1}S^{0.2}}$$

where: t_c = time of concentration of the catchment (min)
L = length of flowpath from the outlet to the catchment divide (km)
A = catchment area (ha)
S = equal area slope (%)

The formula for the Modified Friend's Equation is:

$$t_c = \frac{800L}{ChA^{0.1}S^{0.4}}$$

where: t_c = time of concentration of the catchment (min)
L = length of flowpath from the outlet to the catchment divide (km)
Ch = Chezy's coefficient at the site = $R^{1/6}/n$
R = hydraulic radius = $0.65R_s$ (where the slope varies along the stream)
R_s = hydraulic radius at the site (m)
n = average Manning's n roughness along the stream
A = catchment area (ha)
S = equal area slope (%)

Using these equations, the time of concentration for two selected catchments were compared, as shown in Table 4-1. The peak flows generated using the different time of concentration values were calculated using the rational method and are shown in Table 4-2. As shown there is no major difference between the two methods.

Table 4-1 Time of Concentration

Parameter	Catchment Y	Catchment Q
Stream Length (m)	1800	2060
Catchment Area (ha)	107	121.3
Equal Area Slope (%)	2.3	4.9
Hydraulic Radius at Outlet (m)	1	0.75
Average Manning's n	0.08	0.08
Time of Concentration – Bransby Williams (min)	55.6	54.2
Time of Concentration – Modified Friends (min)	55.8	49.1

Table 4-2 Time of Concentration Peak Discharge Comparison

Time of Concentration Method	Catchment Y- Rational Method Peak Discharge (m^3/s)	Catchment Q- Rational Method Peak Discharge (m^3/s)
Bransby Williams	29.8	34.2
Modified Friends	29.8	35.9
Difference (m^3/s)	0.0	1.8

4.2 Coefficient of Runoff

The coefficient of runoff for the catchment was determined in accordance with the FNQROC Development Manual (Version No. 03/17) and the Queensland Urban Drainage Manual (2013.

The catchments are generally undeveloped, thus a 10 year coefficient of runoff of 0.70 was adopted with the coefficient of runoff for the 100 year AEP event 0.84.

4.3 WBNM Model

A WBNM hydrologic model of the catchments was established. The layout of the model is shown in Figure 4-1.

In accordance with the existing flood study for the area, design rainfall data for the catchment was determined in accordance with Australian Rainfall & Runoff (ARR1987). The information used is as follows:

- 2 Year AEP, 1-hour Intensity 60 mm/h
- 2 Year AEP, 12-hour Intensity 13 mm/h
- 2 Year AEP, 72-hour Intensity 5.0 mm/h
- 50 Year AEP, 1-hour Intensity 100 mm/h
- 50 Year AEP, 12-hour Intensity 27.5 mm/h
- 50 Year AEP, 72-hour Intensity 9.5 mm/h
- Regional Skewness 0.15
- Geographical Factor F2 3.86
- Geographical Factor F50 17.1

The design rainfall losses adopted for the analysis were:

Pervious Area Initial Loss = 0 mm

Continuing Loss = 2.5 mm/h

Impervious Area Initial Loss = 0 mm

Continuing Loss = 0 mm/h

A Lag Parameter of 1.50 was used in the WBNM model. Studies carried out using WBNM have found that the average value of the Lag Parameter across a wide range of catchments is between 1.30 and 1.80 (ref. WBNM User Manual). Thus, the adopted value of 1.50 is within the accepted bounds. A non-linearity exponent of 0.77 was also used and each catchment was assumed completely pervious.

The WBNM model was run for a range of storm durations, from 25 minutes to 3 hours, with the 1.5 hour event producing the peak discharge from each catchment. The peak 100 year discharges calculated by the WBNM model are:

Catchment Y - 29.7 m^3/s Catchment Q - 38.6 m^3/s

Catchment X - 29.6 m^3/s Catchment V - 14.9 m^3/s

This result shows that the peak flows calculated by the WBNM model agree well with those from the Rational Method (refer Section 3). As discussed above, the existing Cardno WBNM model for the area was adopted to assess peak design discharges from the local upstream catchment. Figure 4-1 summarises the revised catchment delineation and WBNM model layout. Catchment X discharges directly into the drainage reserve to the north of the Stage 1 and Catchment V discharges to the south of the site boundary.

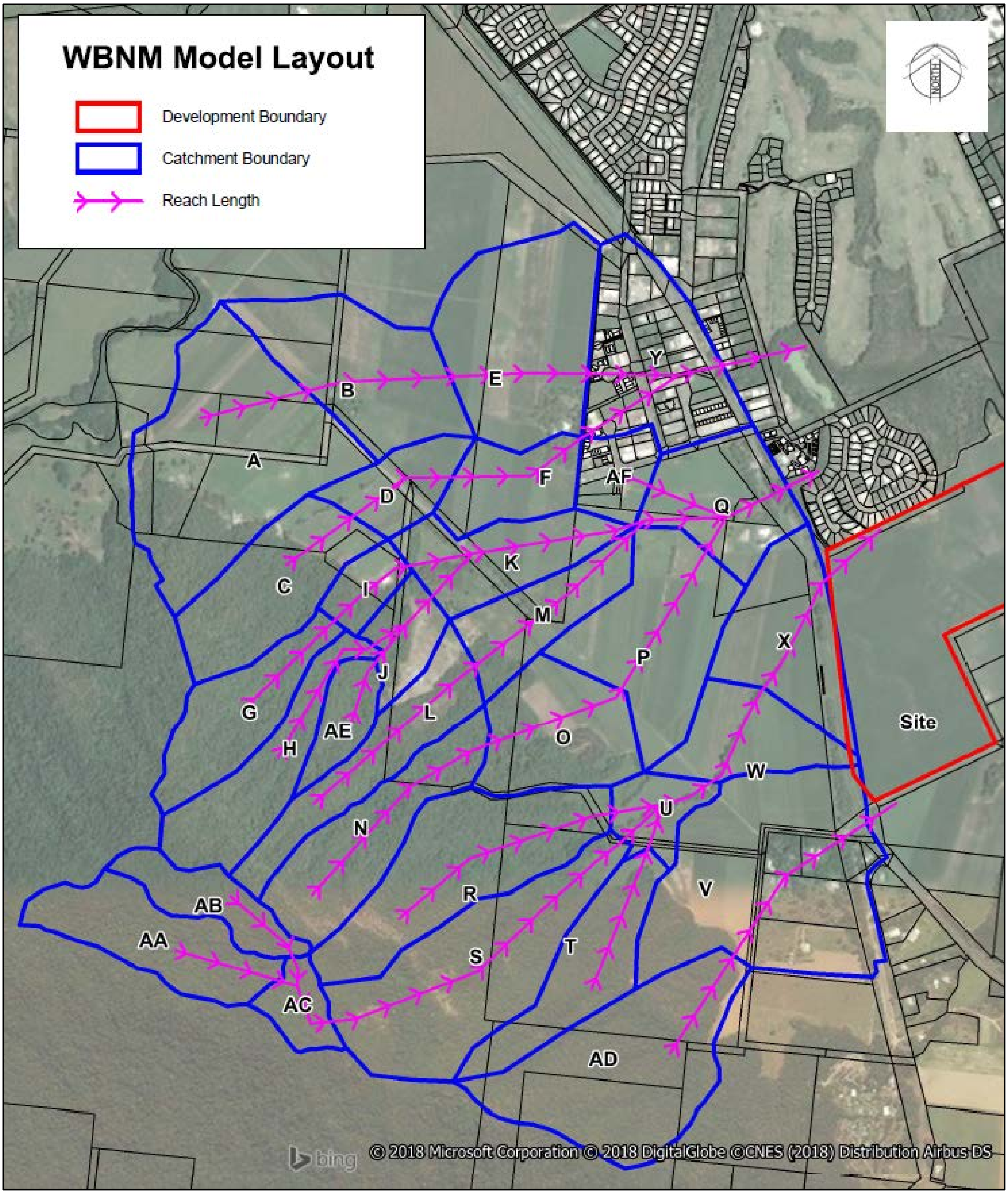


Figure 4-1 WBNM Model Layout

Table 4-3 below summarises the catchment areas adopted within the WBNM model.

Table 4-3 WBNM Catchment Areas

Catchment ID	Area (ha)	Catchment ID	Area (ha)
A	27.80	N	13.21
B	15.72	O	12.44
E	20.35	P	16.87
C	13.36	Q	10.91
D	5.99	R	19.25
F	7.30	AA	11.83
AF	4.46	AB	6.16
Y	16.38	AC	3.59
G	10.36	S	22.83
I	3.38	T	10.89
H	10.76	U	4.49
AE	4.25	W	8.74
J	4.56	X	12.60
K	10.00	AD	22.34
L	11.11	V	29.33
M	8.56		

4.4 Verification

A Rational Method calculation was completed to verify that the WBNM peak discharges were of the correct order of magnitude. The time of concentration was calculated and verified using two different methodologies, as described in the Queensland Urban Drainage Manual (QUDM). Table 4-4 below summarises the Rational Method parameters adopted in the calculation. A C_{10} value of 0.7 was adopted in accordance with Section 4 of QUDM. Design rainfall intensities for Port Douglas were obtained using the Intensity-Frequency-Duration data contained in FNQROC Development Manual (Version No. 03/17).

Table 4-4 Rational Method Parameters

Catchment ID	Area (ha)	Reach Length (m)	Equal Area Slope (%)	Time of Concentration (min)
Catchment Y	107.30	1800	2.34	56
Catchment Q	121.30	2060	4.92	50
Catchment X	100.70	2810	9.97	57
Catchment V	52.17	1630	5.76	45

Table 4-5 summarises the peak 1% AEP rational discharges and the peak 1% AEP WBNM discharges at each of the catchments outlets.

Table 4-5 Peak Discharge Comparison

Catchment ID	Rational Method Peak Discharge (m^3/s)	WBNM Peak Discharge (m^3/s)	Difference (m^3/s)
Catchment Y	29.8	29.72	-0.08
Catchment Q	35.9	38.59	2.69
Catchment X	28.34	29.55	1.22
Catchment V	16.92	14.95	-1.97

The results show that the peak flows calculated by the WBNM model agree well with those from the Rational Method (Refer Section 3.4). Thus, it was considered that the WBNM model could be used to calculate the discharge hydrographs from the upstream catchments.

5 Hydraulics

As previously discussed, the existing Cardno two dimensional TUFLOW hydraulic model for the areas was adapted to model flooding conditions within the Port Douglas Estate development. It was identified that the existing hydraulic model did not extend far enough to the south to fully capture the site and as such, the hydraulic model was extended to fully encapsulate this area. Figure 5-1 displays the TUFLOW model extent and setup. The following section discusses the TUFLOW model setup.

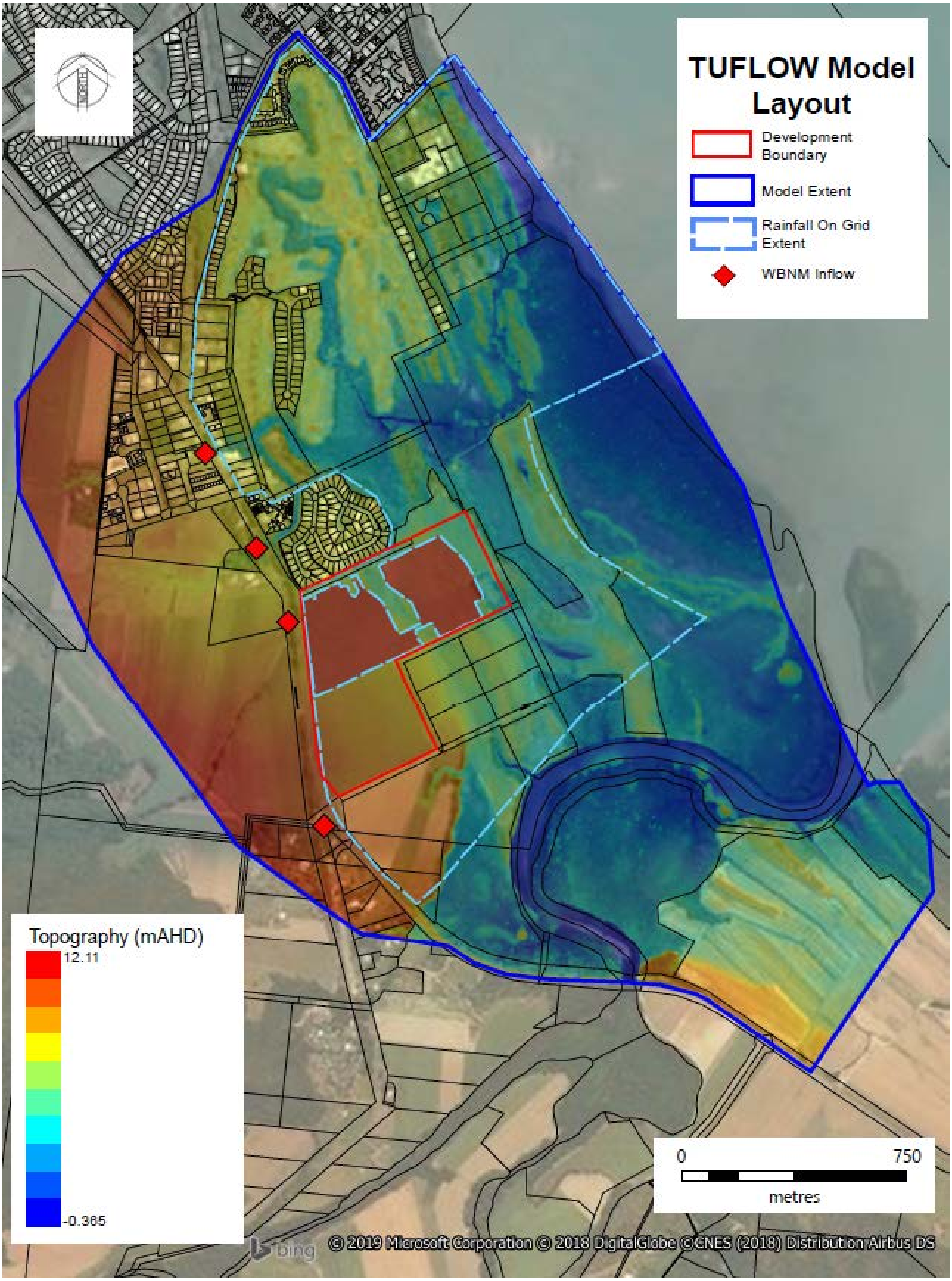


Figure 5-1 TUFLOW Model Layout

5.2 Model Extent

The hydraulic model extent was setup to represent the local catchment flooding from the upstream catchment system. Model inflows and boundaries were set a sufficient distance from the development extent to allow for the accurate representation of flow paths and to avoid instabilities. Figure 5-1 displays the TUFLOW model extent.

5.3 Topographic Data, Grid Cell Size and Time Step

A digital terrain model (DTM) of the study area was set up based on the following data:

- 2010 LiDAR survey (acquired from the Department of Natural Resources and Mines (DNRM))
- 2019 Detailed Survey
- Port Pacific Stage 4 and Stage 5

To provide an appropriate level of detail and achieve reasonable run times, the study area was represented by a 5 metre grid. A time step of 2.5 seconds was adopted to maintain stability and appropriate run times. Figure 5-1 displays the topography surface utilised in the TUFLOW model.

5.4 Model Inflows

Inflow into the hydraulic TUFLOW model was achieved using a split of design storm hydrographs from the WBNM model and rainfall on grid. The upstream inflows were represented as point inflows, inserted to the west of the Captain Cook Highway an appropriate distance upstream of the site. Inflows within and downstream of the site were represented using a rainfall on grid modelling approach. Refer to Figure 5-1 for detail regarding the location of the upstream WBNM inflows and the area represented using rainfall on grid techniques.

In the developed scenario, inflows within the site were concentrated as SA_RF polygons, discharging the rainfall volume directly to the respective discharge locations of the development. Figure 5-2 highlights the discharge locations and concentrated areas.

Figure 5-2 TUFLOW Model Detail

5.5 1D Links

Culverts were input into the TUFLOW model as 1-dimensional flow links. Inlet and outlet loss coefficients of 0.5 and 1.0 respectively were used for all structures. The TUFLOW model checks the operation of culverts under both inlet and outlet flow control, for Class 1 (free water surface) and Class 2 (submerged entrance) conditions. Figure 5-2 displays the culverts adopted within the TUFLOW modelling.

Of particular interest is the culvert being used underneath the extension to Wabul Drive. Table 5-1 shows the details of the proposed culvert configuration. Several sizes and blockage factors were tested to assess the impacts to existing lots and the trafficability of the road for various recurrence intervals. The likelihood of the culverts being blocked beyond 20% was deemed unlikely due to the upstream culverts (Captain Cook Highway) having a less overall aperture area of 7.5m^2 when compared to the proposed 17m^2 culvert configuration. As such the 20% blockage was considered adequate. 0.9 m high RCBC's were used due to smaller size RCBC's causing impacts to surrounding areas as well as the inability to maintain smaller culverts.

Table 5-1 Wabul Extension Proposed Culvert Configuration

TUFLOW ID	Type	Manning's Number	Upstream Invert (mAHD)	Downstream Invert (mAHD)	Number of	Size (m)	Blockage Factor
Mit_K	RCBC	0.014	1.8	1.75	7	2.7 X 0.9	20%

Details of the proposed drain including culvert details, relevant lot levels and relevant flood levels are shown in Appendix D (Civil Drawings Q184103-CI-1263 and Q184103-CI-1264.

5.6 Floodplain Roughness

The Manning's n roughness values applicable to the study area were determined from site inspections and aerial photography. The values used are summarised in Table 5-2.

Table 5-2 Manning's n Values

Location	Manning's n
Road Reserves	0.02
Golf Course	0.035
Heavily Grassed or Vegetated Areas	0.08
Densely Treed/Mangrove Areas	0.15
Commercial Precincts	0.20

5.7 Downstream Boundary Condition

The downstream boundary of the TUFLOW model is located at the outfall of Craiglie Creek to the Pacific Ocean, near Port Douglas. Relevant ocean levels are as follows.

- The Highest Astronomical Tide (HAT) level at Port Douglas is 1.78 mAHD (ref. Queensland Tide Tables 2012, Queensland Government).
- The 100 year storm tide level in the vicinity of Port Douglas (i.e. at Oak Beach) is 1.9 mAHD (ref. Queensland Climate Change and Community Vulnerability to Tropical Cyclones – Ocean Hazards Assessment Stage 3, Queensland Government, July 2004). An allowance of 300 mm was added to this level to account for wave setup at the coastline.

Based on these levels, a 100 year storm tide level of 2.2 mAHD was adopted for the existing 100 year event, and a Highest Astronomical Tide level of 1.78 mAHD was adopted for the smaller events.

5.8 Climate Change

The allotment fill levels in the Port Douglas Estate development will be designed to account for the impacts of Climate Change on the Craiglie Creek flood levels.

Recent climate change investigations (ref. Increasing Queensland's resilience to inland flooding in a changing climate: Final Scientific Advisory Group report – Derivation of a rainfall intensity figure to inform an effective interim policy approach to managing inland flooding risks in a changing climate, Department of Environment and Resource Management, 2010) recommend that an allowance for a 20% increase in design rainfall intensities should be adopted for climate change.

The current projection for sea level rise by the International Panel on Climate Change (IPCC, 2007) is 800 mm by the Year 2100.

An analysis was therefore carried out for the 100 year AEP event, incorporating the following elements of climate change:

- increase in rainfall intensity of 20%; and
- sea level rise of 800 mm (i.e. giving a tailwater level = 3.0 mAHD).

5.9 Modelling Scenarios

To assess flooding impacts resulting from the proposed Stage 1A and 1B (Stage 1) of the Port Douglas Estate, the following modelling scenarios were assessed:

Existing Case - An existing case model simulation representing current hydraulic conditions. This scenario adopts the existing modelling created for the neighbouring Port Pacific development with minor revisions to the model extent and hydrologic inflows. Existing lots to the north of the proposed development were modelled using survey provided.

Developed Case - A developed case model simulation representing the development of Stage 1 of the Port Douglas Estate. For the purpose of this assessment, the Stage 1 area was modelled using a design surface DEM.

The proposed bridge crossing on Wabul Street, providing access to Stage 1 was also detailed within the hydraulic model. The crossing was represented with seven 2700 x 900 mm Reinforced Concrete Box Culverts (RCBC's). Refer to Appendix D Reference Drawing Q184103-CI-1262 (attached to this document) for design detail regarding the culvert sizing and layout. Earthworks to widen the drainage channel both upstream and downstream of the crossing structure to accommodate the proposed culverts and allow for the smooth transition of flow was required. The road level across the structure was set to approximately 3.28 mAHD as shown in Q184103-CI-1263.

Stage 1 was represented in the model with a design DEM surface. Rough fill was included for the future development areas that will likely drain to the north of the site. It was deemed necessary to represent all future runoff into the drainage reserve when assessing Stage 1A and 1B development to ensure adequate freeboard of the adjacent residential properties was maintained.

It was noted that the drainage channel profile immediately upstream of the site was not adequately represented in the LiDAR surface. This was likely due to the heavy vegetation in the drainage reserve at this location. As such, the channel was modified in this area (refer Figure 5-2) to ensure adequate conveyance into the northern drainage channel. This drainage detail was included in the Stage 1 design DEM.

Earthworks within the drainage gully/reserve immediately east of Wabul Street were required to allow for the free drainage and attenuation of the future development areas. The base of the gully was set to an elevation of 2.4 mAHD for the purposes of this assessment however it is noted that optimization of the earthworks required will be undertaken during the design of the future development areas (refer Figure 5-2)

The hydraulic model was then simulated for the 2 year to 100 year event for the 60, 90 and 120 minute critical storm durations. The 100 year + climate change event was assessed.

A 100yr + climate change extreme event was also modelled to identify possible impacts. During this event the proposed culverts on Wabul Street were modelled with 100% blockage with results shown in Appendix E.

6 Model Results

Detailed mapping of peak flood level, depth and velocity has been provided for both existing and developed scenarios in Appendix A and B of this report. Detailed impact mapping has been provided in Appendix C.

6.1 Existing Scenario – Model Results

The existing modelling results show minor inundation of the Stage 1A and 1B development area in the design 1% AEP flood event. A majority of the inundation observed can be attributed to pockets present in the topographic surface due the existing cropping land use. The deeper body of flooding present in the north west corner of the Stage 1B area has been identified as storage offset from the adjacent drainage reserve. It is acknowledged that additional flood storage will need to be provided elsewhere within the Stage 1B area to offset any losses resulting from the filling of this storage volume.

The area of proposed fill within Stage 1A and 1B do not coincide with any existing overland conveyance paths through the site. The existing modelling shows all conveyance flows to be contained within the drainage reserve to the north and as such, the filling of the Stage 1A and 1B area should result in minimal impact to existing flooding conditions within the drainage reserve.

Peak velocities within the drainage reserve varying from 2 m/s at the north west corner of the site down to 1 m/s at the proposed Wabul Street bridge crossing were evident in the 1% AEP event.

Vehicle access into Wabul Street “stub” road is restricted as water depth is up to 300 mm deep during the 1% AEP flood event, this reduces in the developed scenario.

6.2 Developed Scenario – Model Results

The flood impact mapping provided in Appendix C demonstrates the proposed Stage 1 works do not result in actionable nuisance flooding external to the site. The design achieves flood level reductions within the drainage channel to the north west of Stage 1 maintaining the freeboard of adjacent properties. Slight increases in flood levels can be seen within the drainage reserve to the north east of the site however this are minor in nature and are contained within the existing channel.

Minor increases in flood level (11-15 mm) are apparent on Lot 119 on SP276040 and Lot 20 on SP 144728 to the north east during the 1%CC AEP event. Impacts are also noted to the East on Lot 5, AP13754. It must be noted that these impacts are likely resulting from the concentration of post development flow from the future development areas. The concentration of discharge from the future development areas was incorporated into the Stage 1 modelling to represent a realistic tail water level in the northern drainage reserve, ensuring the Wabul Street culverts were adequately sized. The flooding afflux observed occurs in currently undeveloped areas or is designated reserve. These impacts are minor in nature, occur in areas where the existing flood levels are up to 2 metres deep and future stages of development will ensure these impacts are minimised. Further, the majority of impacts noted are on reserve or state land.

Peak velocities less than 1.5 m/s are indicated within the drainage reserve during the 1% AEP design event. A velocity of approximately 1.3 m/s can be seen at the downstream face of the Wabul Street culvert structures. Minor increases in channel velocity are apparent within the drainage reserve at the north east corner of the site and it is recommended that scour protection be assessed at this location during the detailed design stage of this assessment.

Vehicle access across the Wabul Street crossing is limited in the 1% AEP flood event (flooding depth up to 400mm). Flood level reductions of up to 40 mm can be observed on Milman Drive to the north of the Wabul Street crossing. As such, Milman Drive is not impacted by the proposed Port Douglas Estate design.

7 Conclusion

Cardno was commissioned by Port Douglas Land Developments to undertake a Flood Impact Assessment (FIA) of the proposed Stage 1A and 1B of the Port Douglas Estate residential development located on Lot 2 of Plan SR431 off the Captain Cook Highway, Craiglie, QLD.

Cardno has undertaken detailed flood modelling of the catchment during the design of the neighbouring Port Pacific Estate and it was proposed to adopt the existing modelling for use in the Port Douglas Estate assessment. A review of the existing modelling identified a number of key limitations that needed to be addressed before assessing flooding conditions within the Port Douglas Estate including the delineation of upstream catchments and the model extent. The limitations were addressed and the model was simulated for a range of design storm events up to and including the 1% AEP + Climate Change.

The modelling results demonstrate the proposed Stage 1A and 1B (Stage 1) development, designed as discussed in the above report, do not result in any actionable nuisance flooding external to the site and are in accordance with the *Douglas Shire Planning Scheme - Flood and Storm Tide Hazard Overlay Code.*

Minor increases in flood level (11-15 mm) are also apparent on Lot 119 on SP276040 and Lot 20 on SP 144728 to the north east during the 1%CC AEP event. It must be noted that these impacts are likely resulting from the concentration of post development flow from the future development areas. The concentration of discharge from the future development areas was incorporated into the Stage 1 modelling to represent a realistic tail water level in the northern drainage reserve, ensuring the Wabul Street culverts were adequately sized. Further, the flooding afflux observed occurs in currently undeveloped. The impacts are minor in nature, occur in areas where the existing flood levels are up to 2 metres deep and the majority of the impacts shown are located on reserve or state land.

There is a localised area of impact at the north west of the development that is contained within the road reserve. This increase in water level is offset by reductions in water levels directly upstream, suggesting that it is a result of channel improvements at this location.

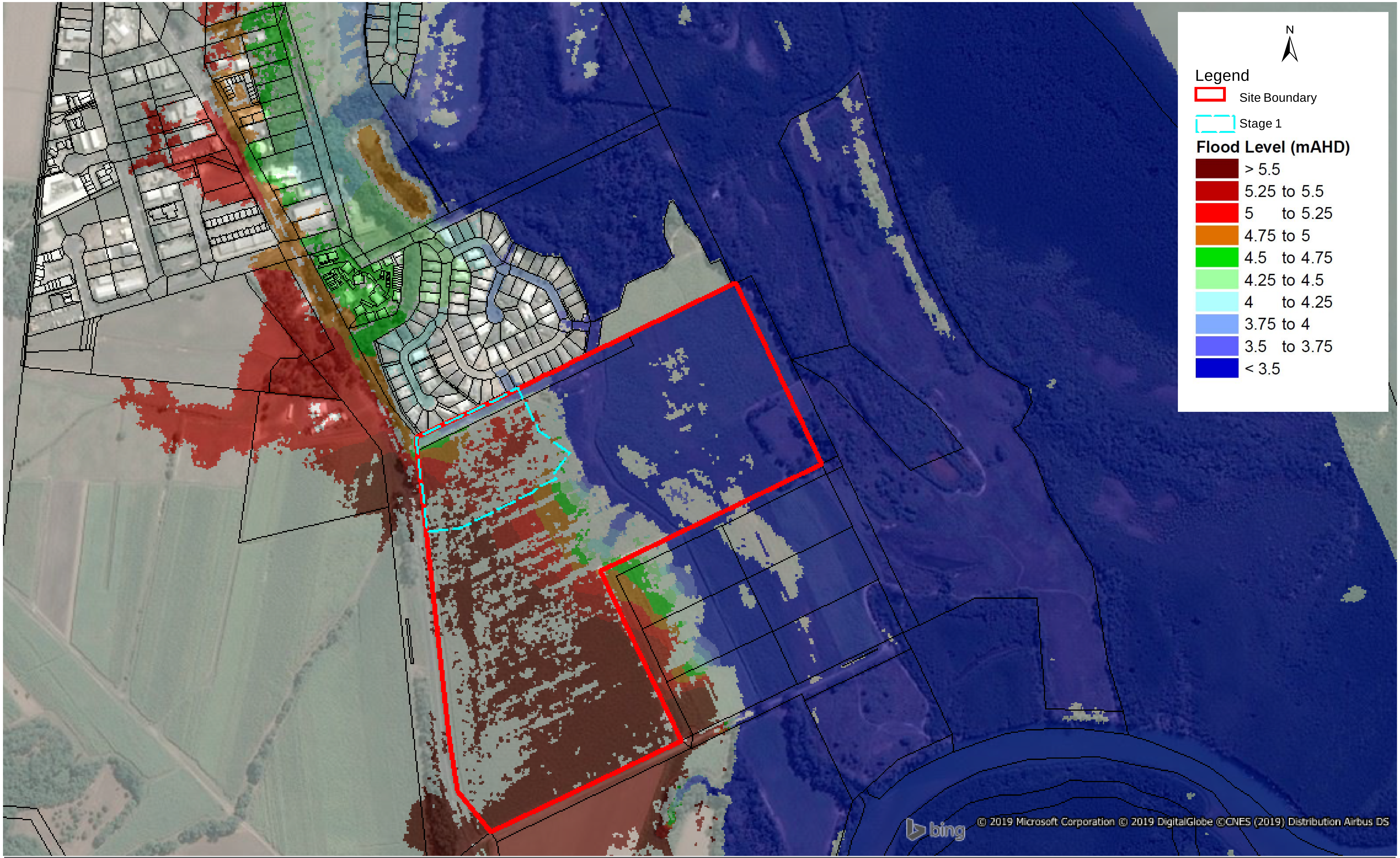
Vehicle access across the Wabul Street crossing is limited in the 1% AEP flood event (flooding depth up to 400mm). Flood level reductions of up to 30 mm can be observed on Milman Drive to the north of the Wabul Street crossing. As such, Milman Drive is not impacted by the proposed Port Douglas Estate design.

Detailed mapping of peak flood level, depth and velocity has been provided for both existing and developed scenarios in Appendix A and B of this report. Detailed impact mapping has been provided in Appendix C.

APPENDIX

A

EXISTING FLOODING



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

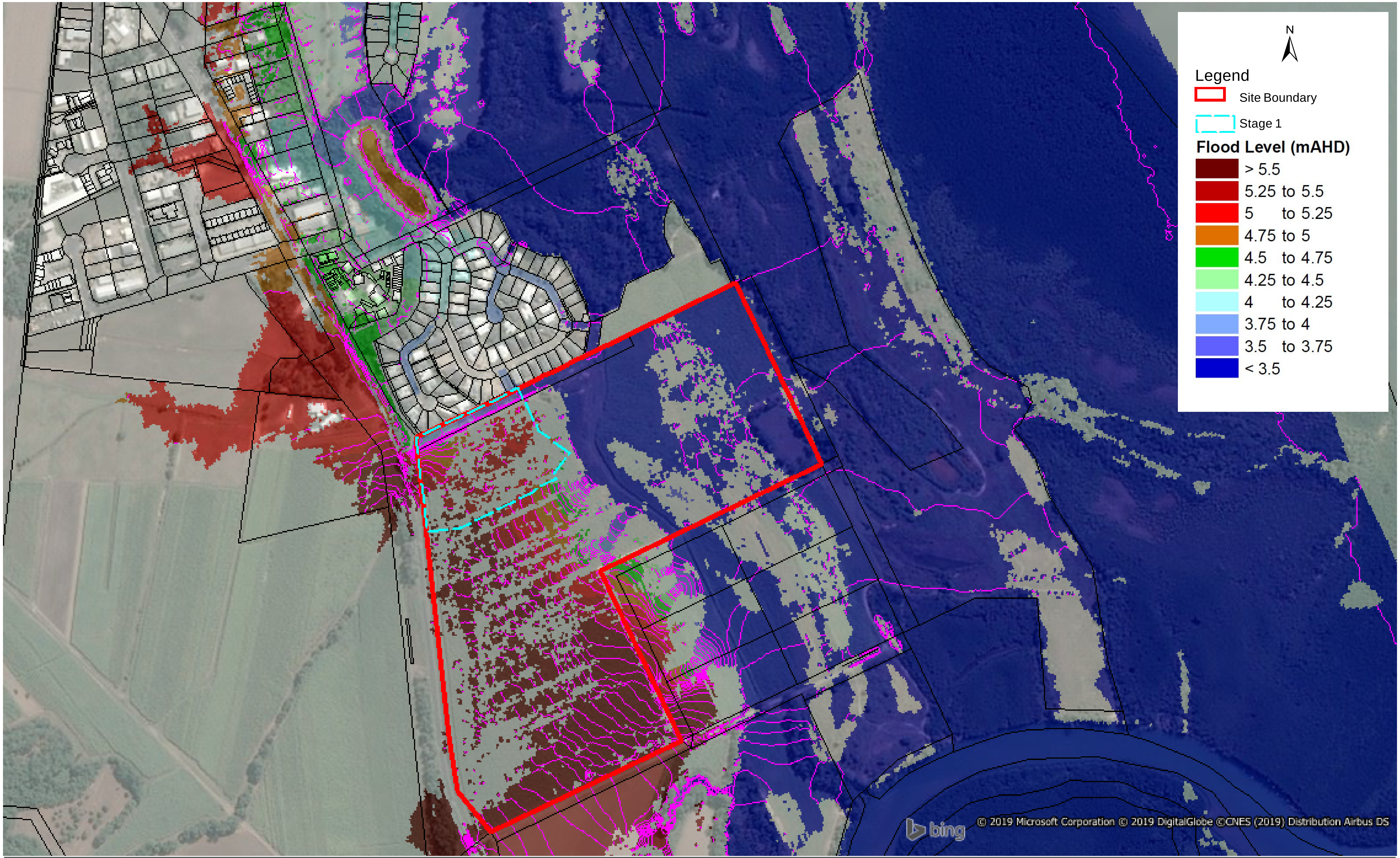
0 500
metres

APPENDIX A.1.1
EXISTING 1% AEP CC EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppA.1



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

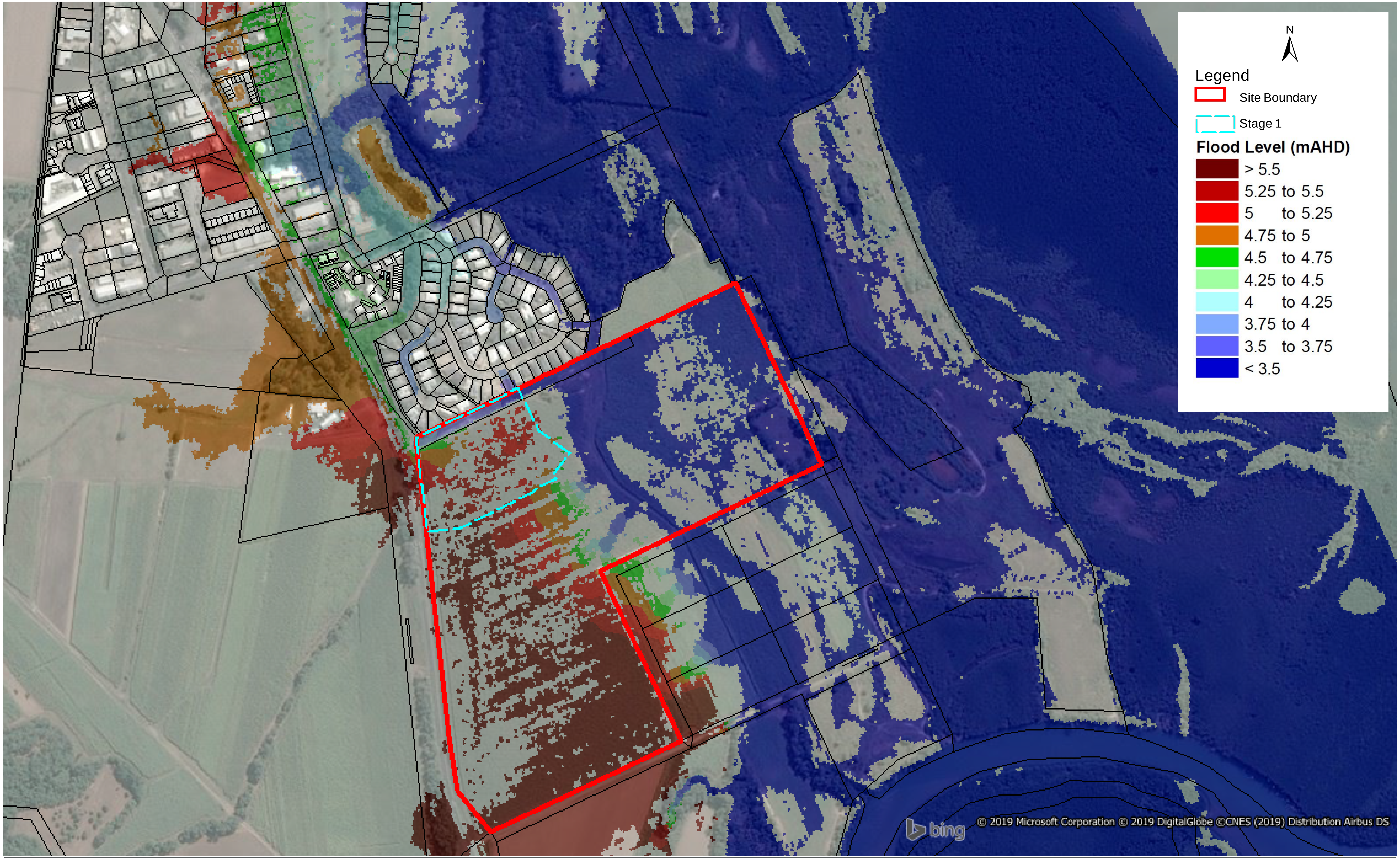
0 500
metres

APPENDIX A.1.2
EXISTING 1% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppA.1



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.1.3
EXISTING 2% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppA.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.1.4
EXISTING 5% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppA.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.1.5
EXISTING 10% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppA.1

Cardno
Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.1.6
EXISTING 20% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppA.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

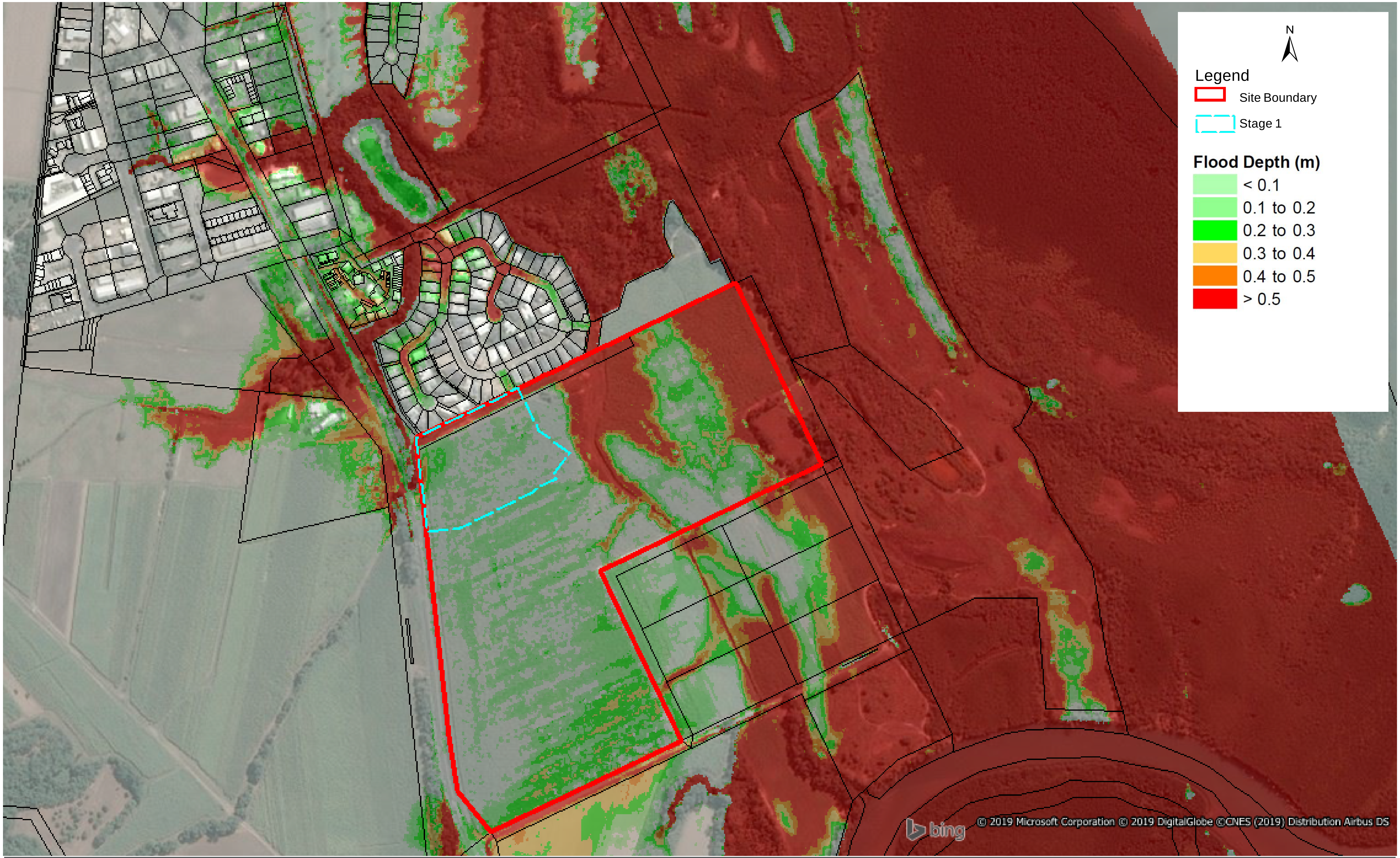
APPENDIX A.1.7

EXISTING 39% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppA.1



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

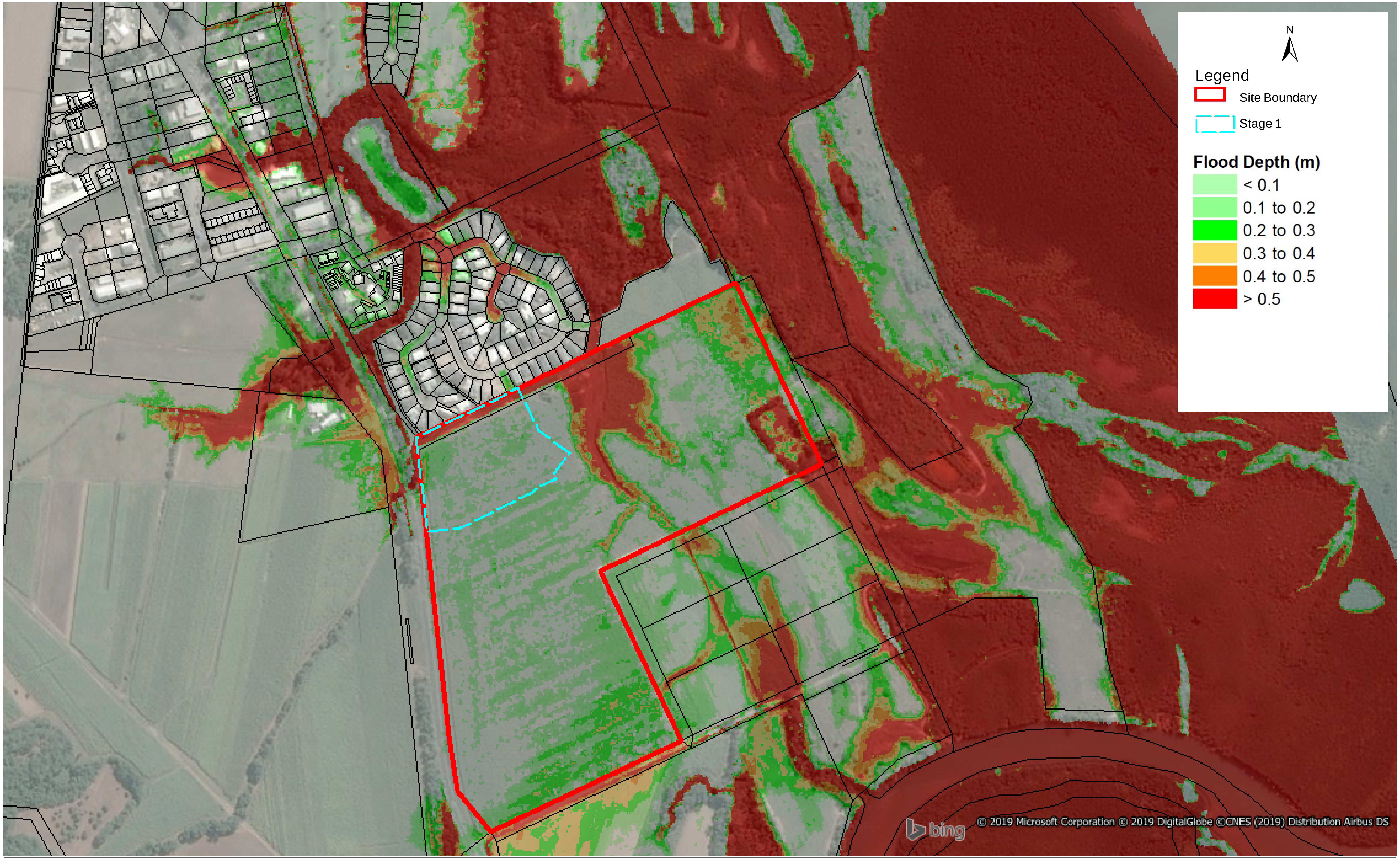
0 500
metres

APPENDIX A.2.1
EXISTING 1% AEP CC EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

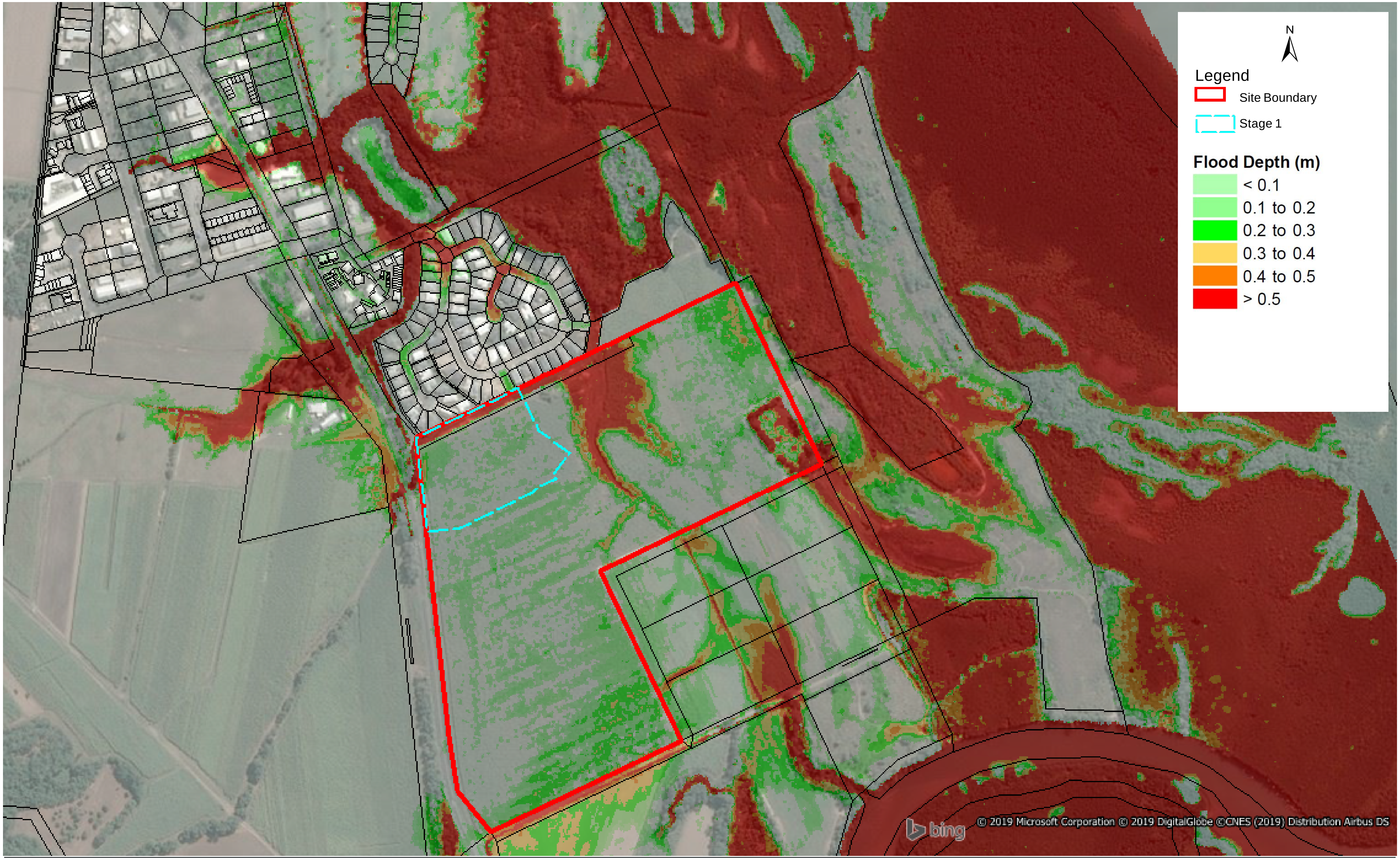
0 500
metres

APPENDIX A.2.2
EXISTING 1% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2



Cardno

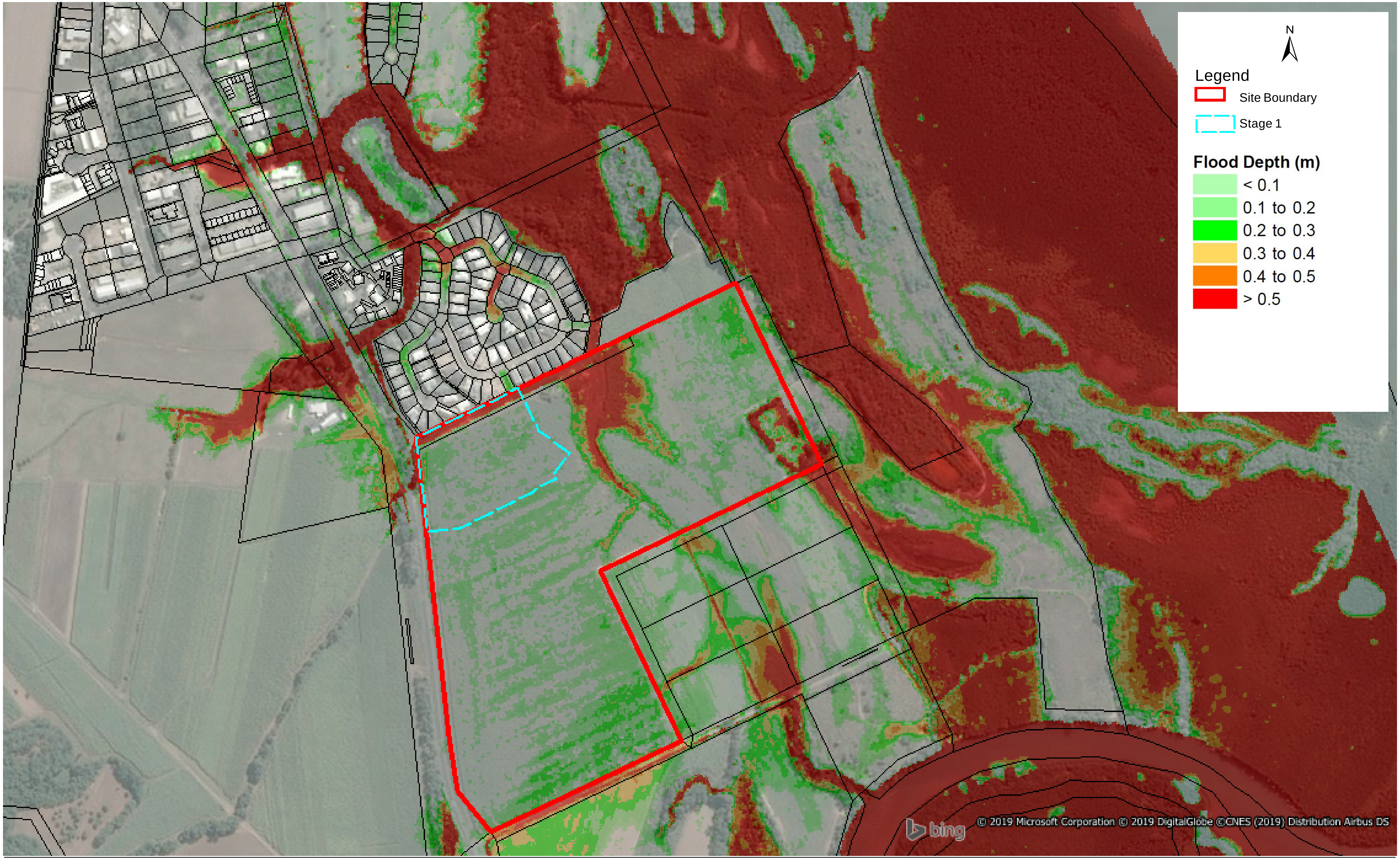
Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.2.3
EXISTING 2% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment
Port Douglas Estate
AppA.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

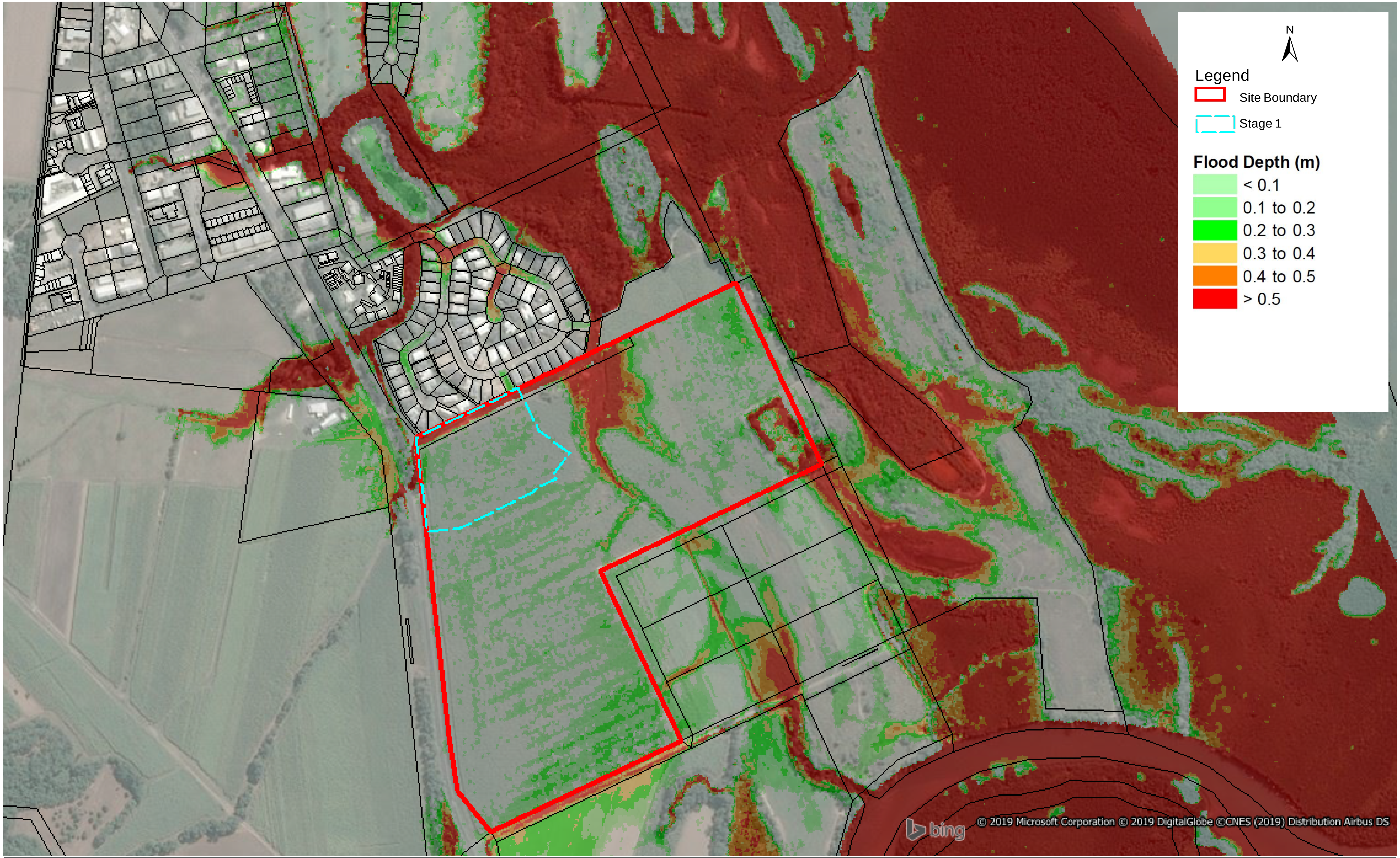
0 500
metres

APPENDIX A.2.4
EXISTING 5% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

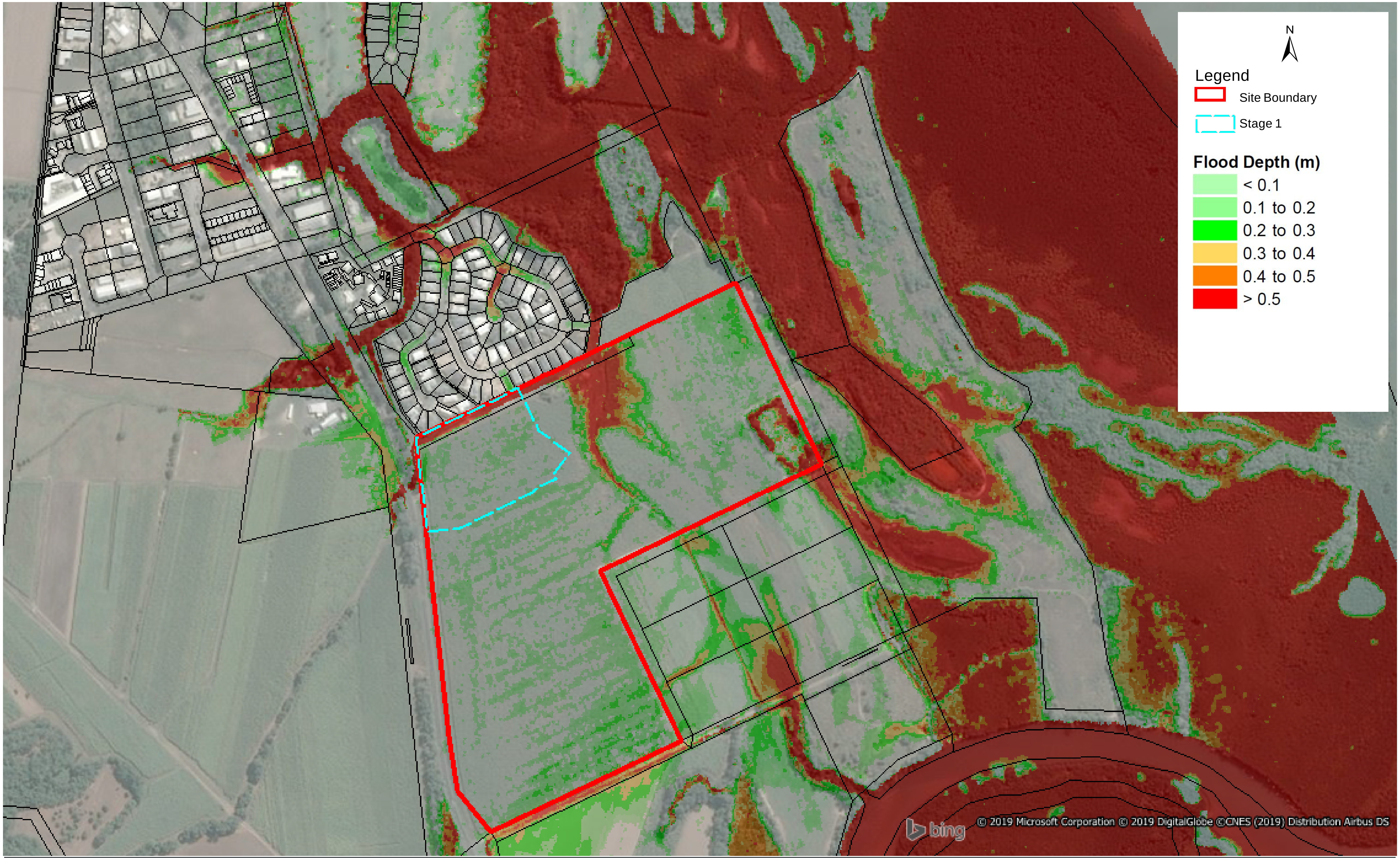
0 500
metres

APPENDIX A.2.5
EXISTING 10% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

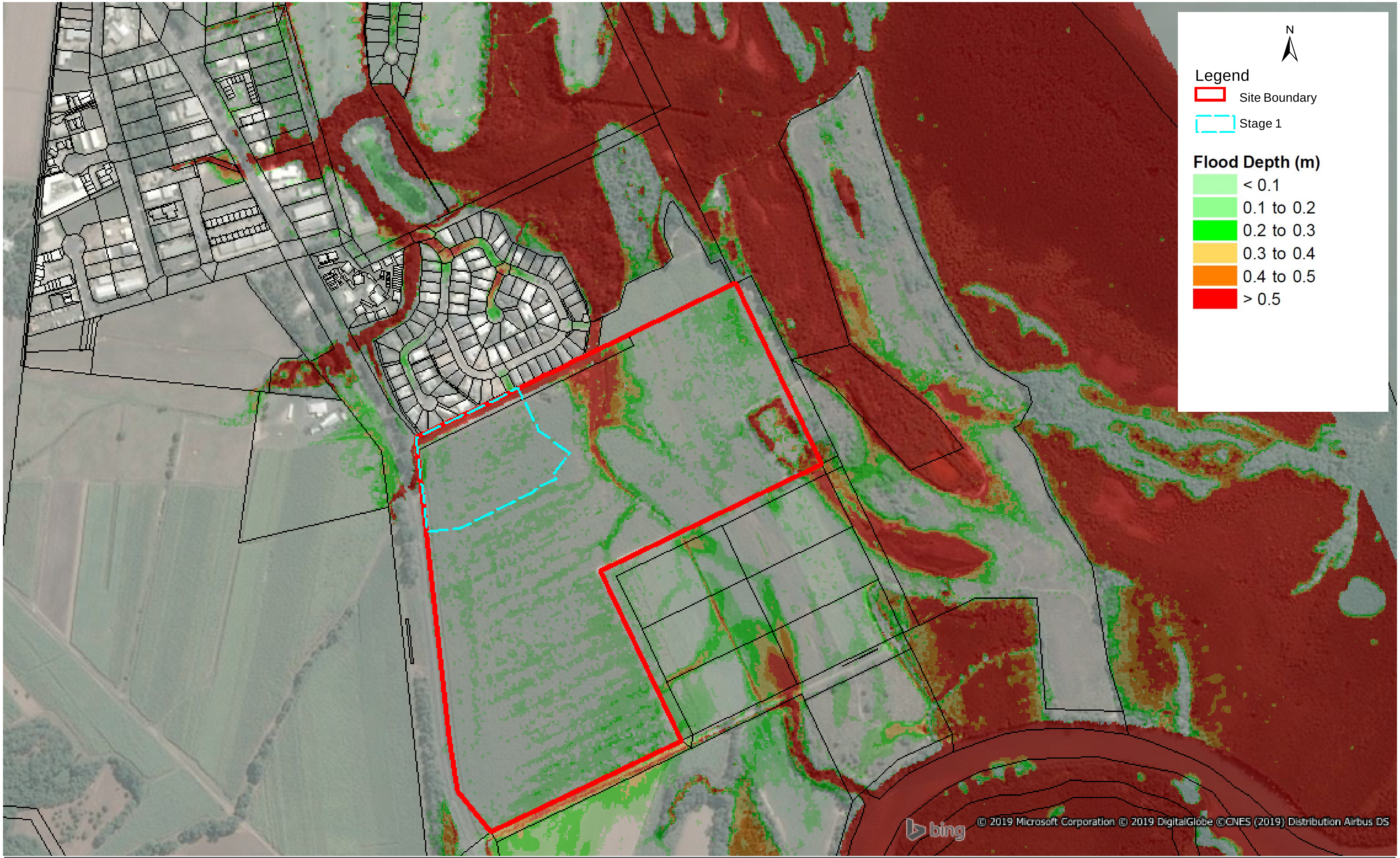
0 500
metres

APPENDIX A.2.6
EXISTING 20% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.2.7
EXISTING 39% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppA.2

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

APPENDIX A.3.1
EXISTING 1% AEP CC EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

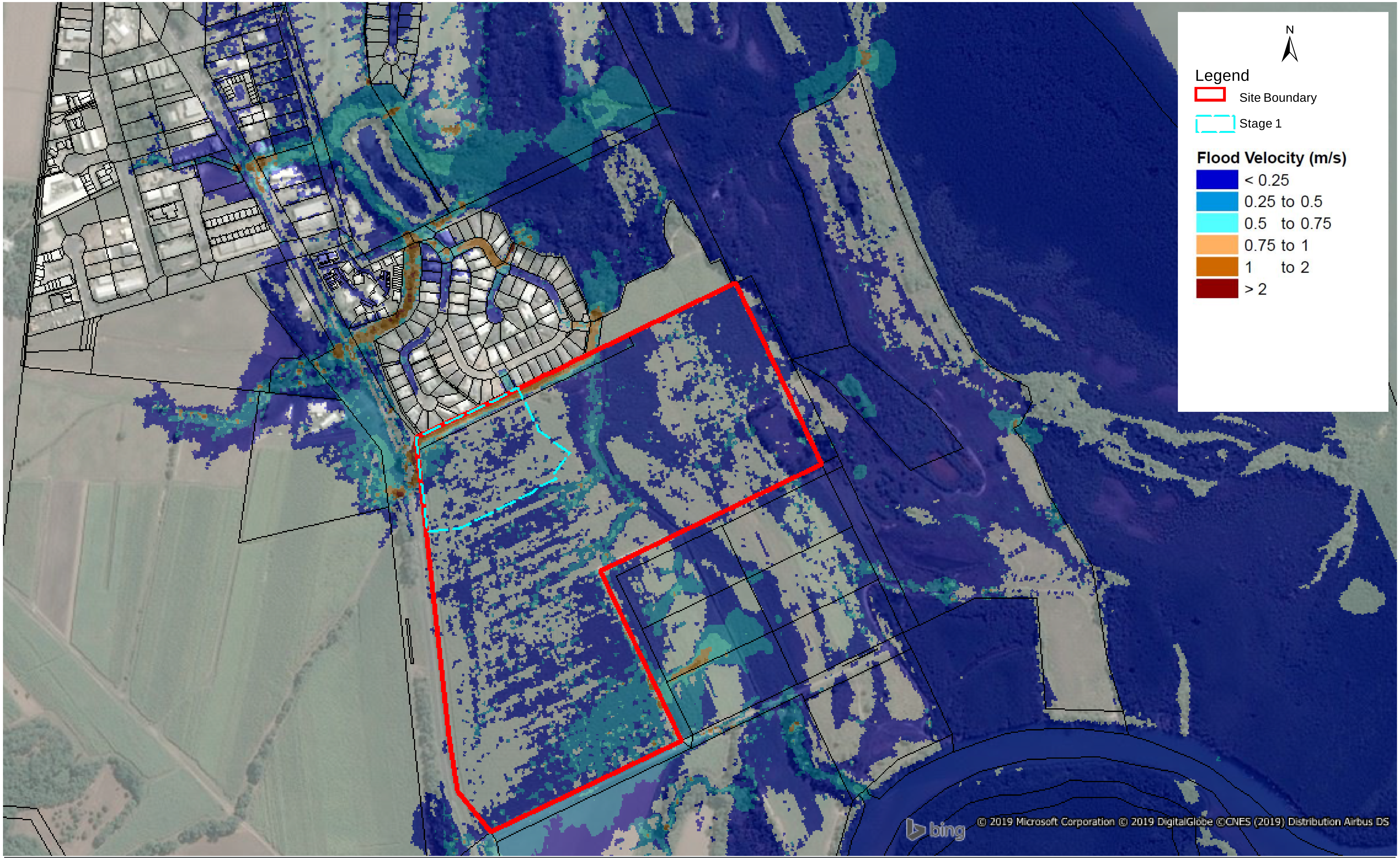
0 500
metres

APPENDIX A.3.2
EXISTING 1% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.3.3
EXISTING 2% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.3.4
EXISTING 5% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date 28/08/2019
Size A3
Scale 1:6000

0 500
metres

APPENDIX A.3.5
EXISTING 10% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 — 500 metres

APPENDIX A.3.6
EXISTING 20% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppA.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX A.3.7
EXISTING 50% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

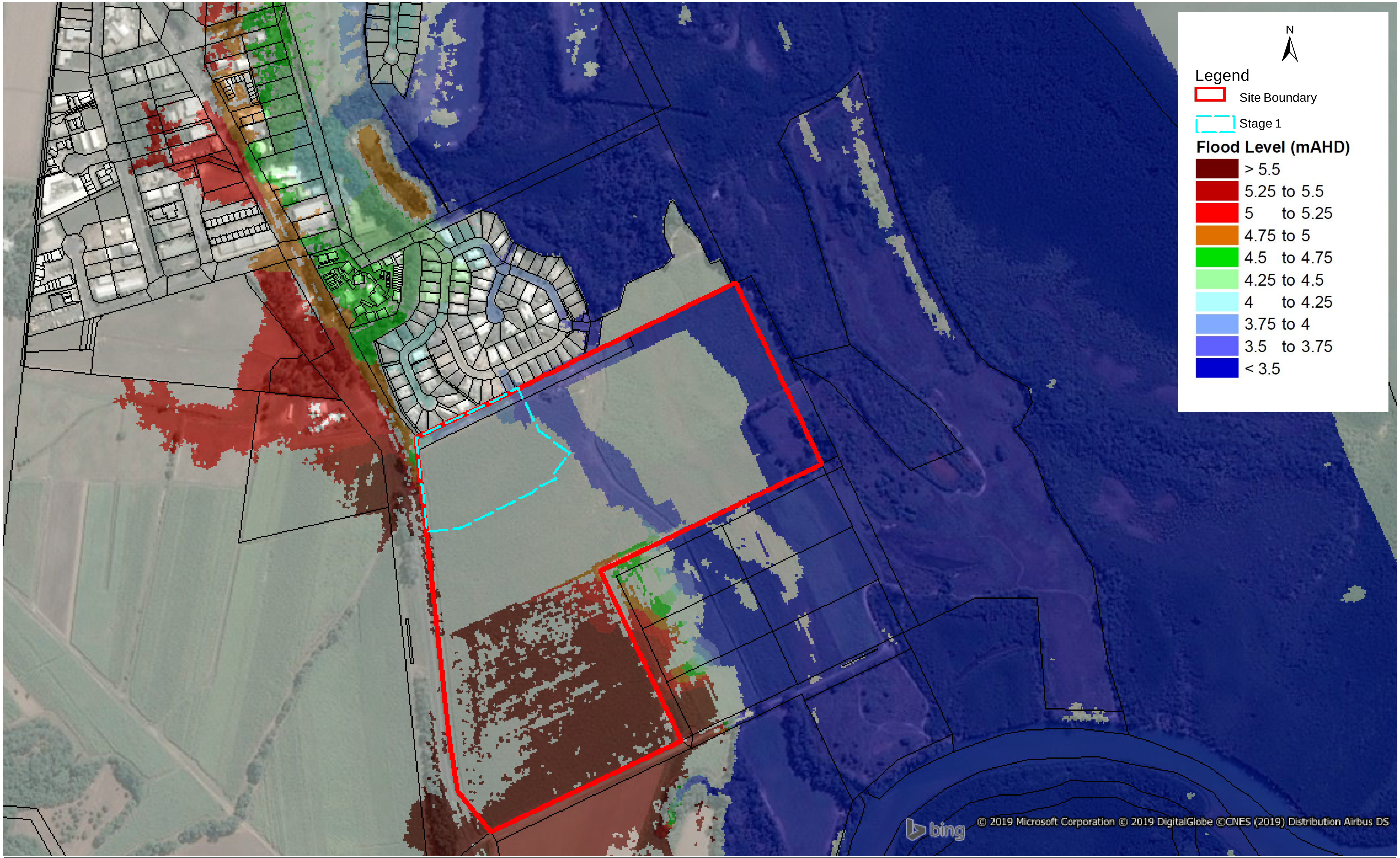
Port Douglas Estate

AppA.3

APPENDIX

B

DEVELOPED FLOODING



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

APPENDIX B.1.1
DEVELOPED 1% AEP CC EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppB.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.1.2
DEVELOPED 1% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppB.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.1.3
DEVELOPED 2% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppB.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.1.4
DEVELOPED 5% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppB.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.1.5
DEVELOPED 10% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppB.1

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.1.6
DEVELOPED 20% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment

Port Douglas Estate

AppB.1

Cardno

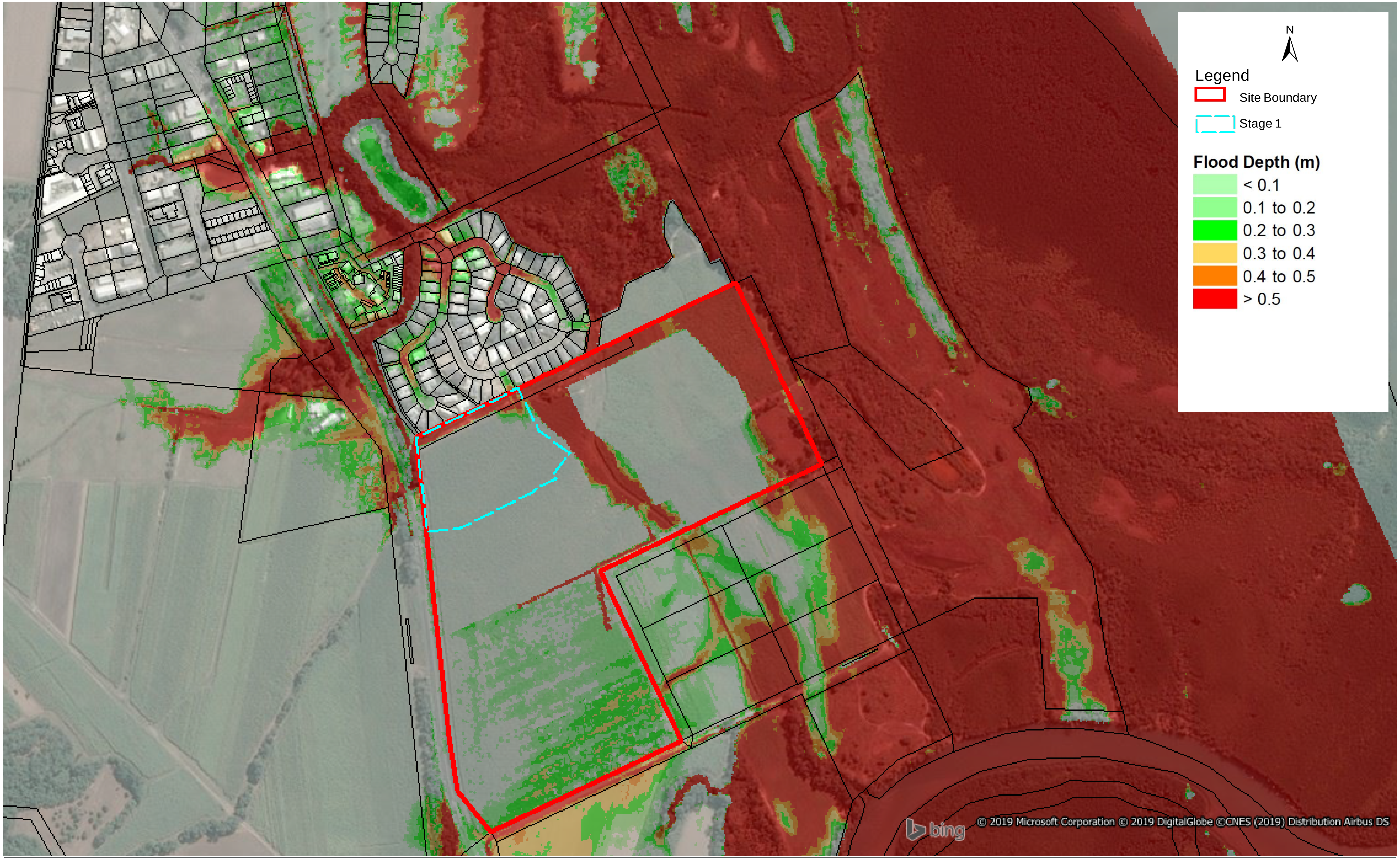
Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 — 500 metres

APPENDIX B.1.7
DEVELOPED 39% AEP EVENT - PEAK FLOOD LEVEL

Flood Impact Assessment
Port Douglas Estate
AppB.1



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

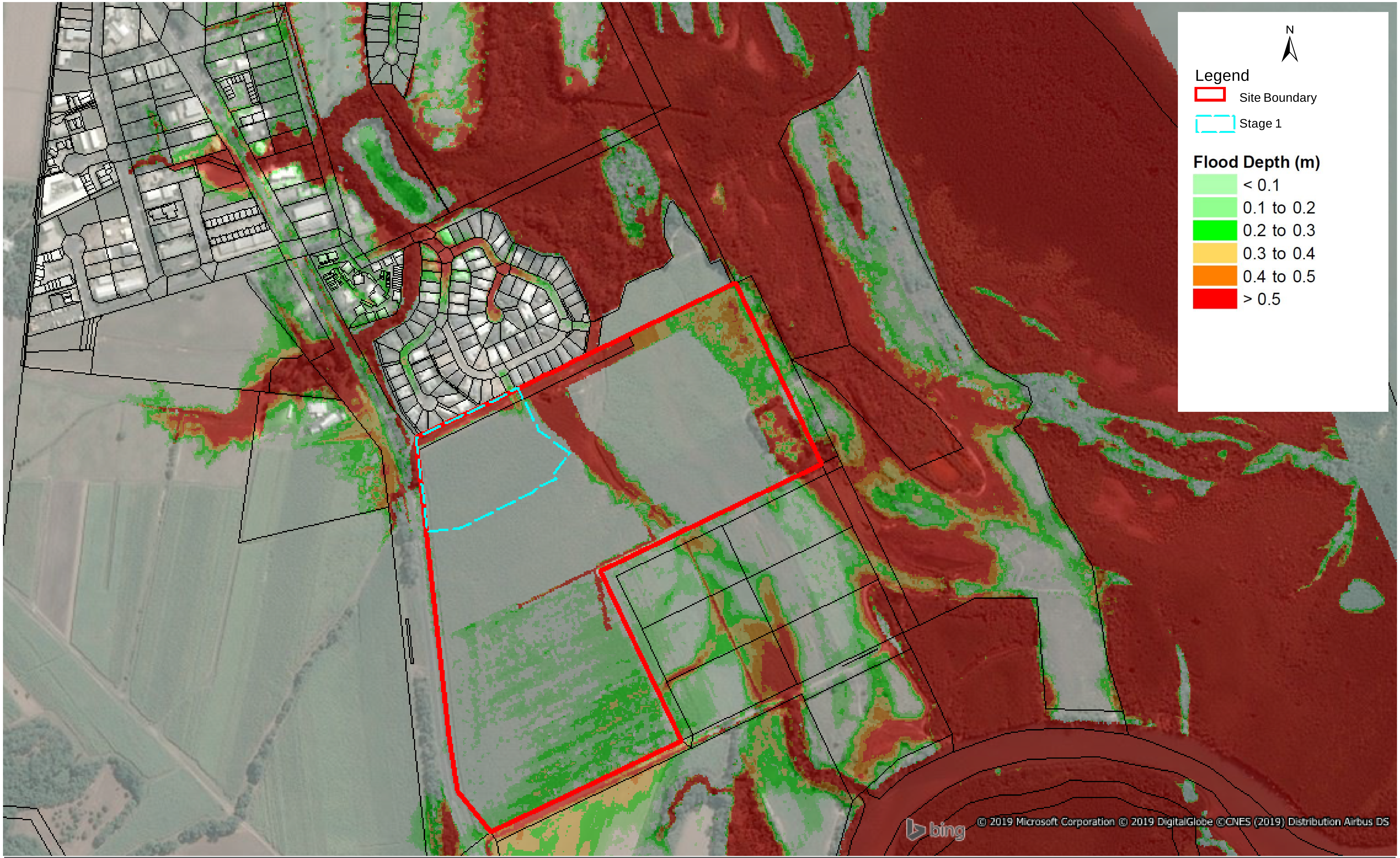
0 500
metres

APPENDIX B.2.1
DEVELOPED 1% AEP CC EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

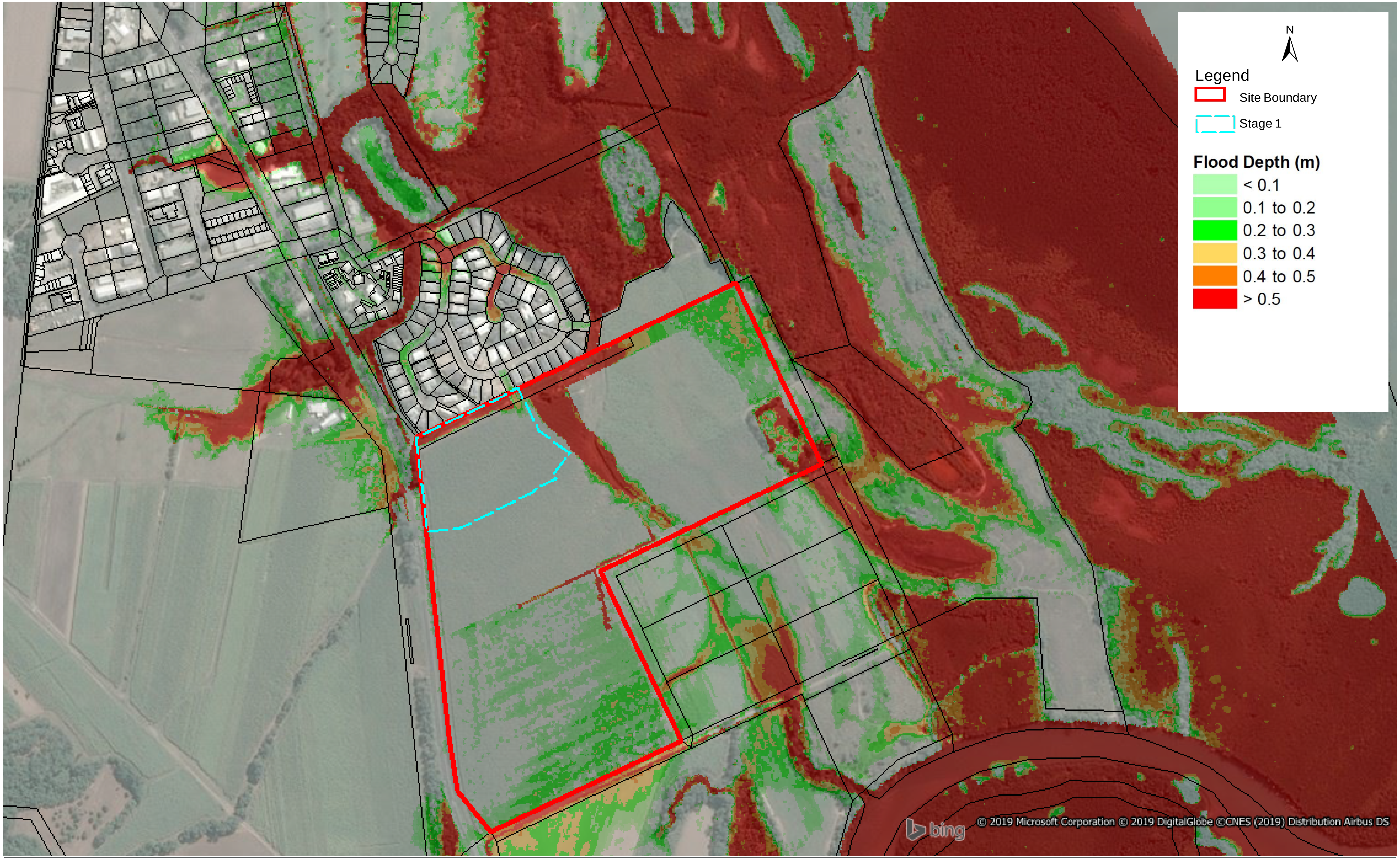
0 500
metres

APPENDIX B.2.2
DEVELOPED 1% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
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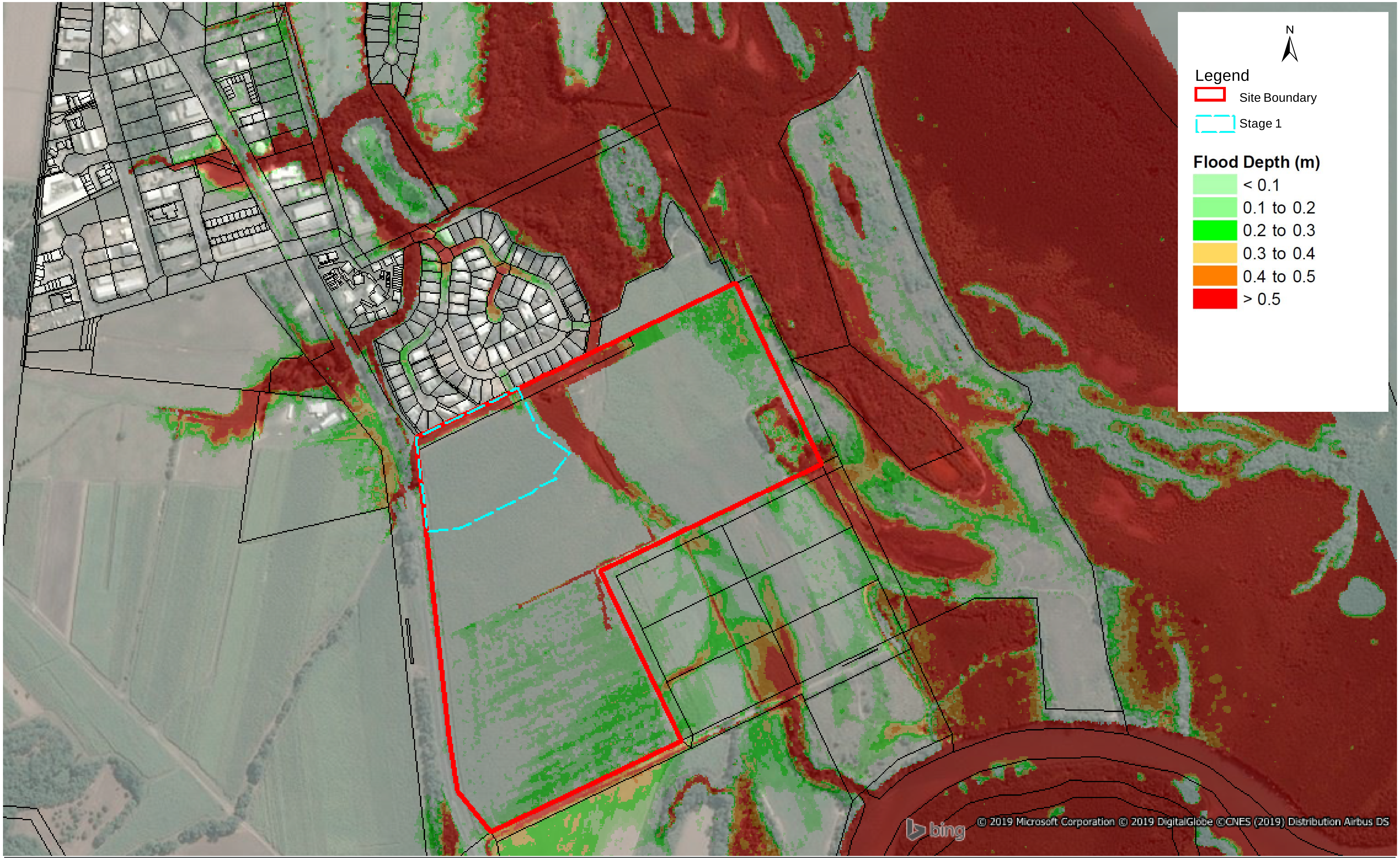
metres

APPENDIX B.2.3
DEVELOPED 2% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
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0 500
metres

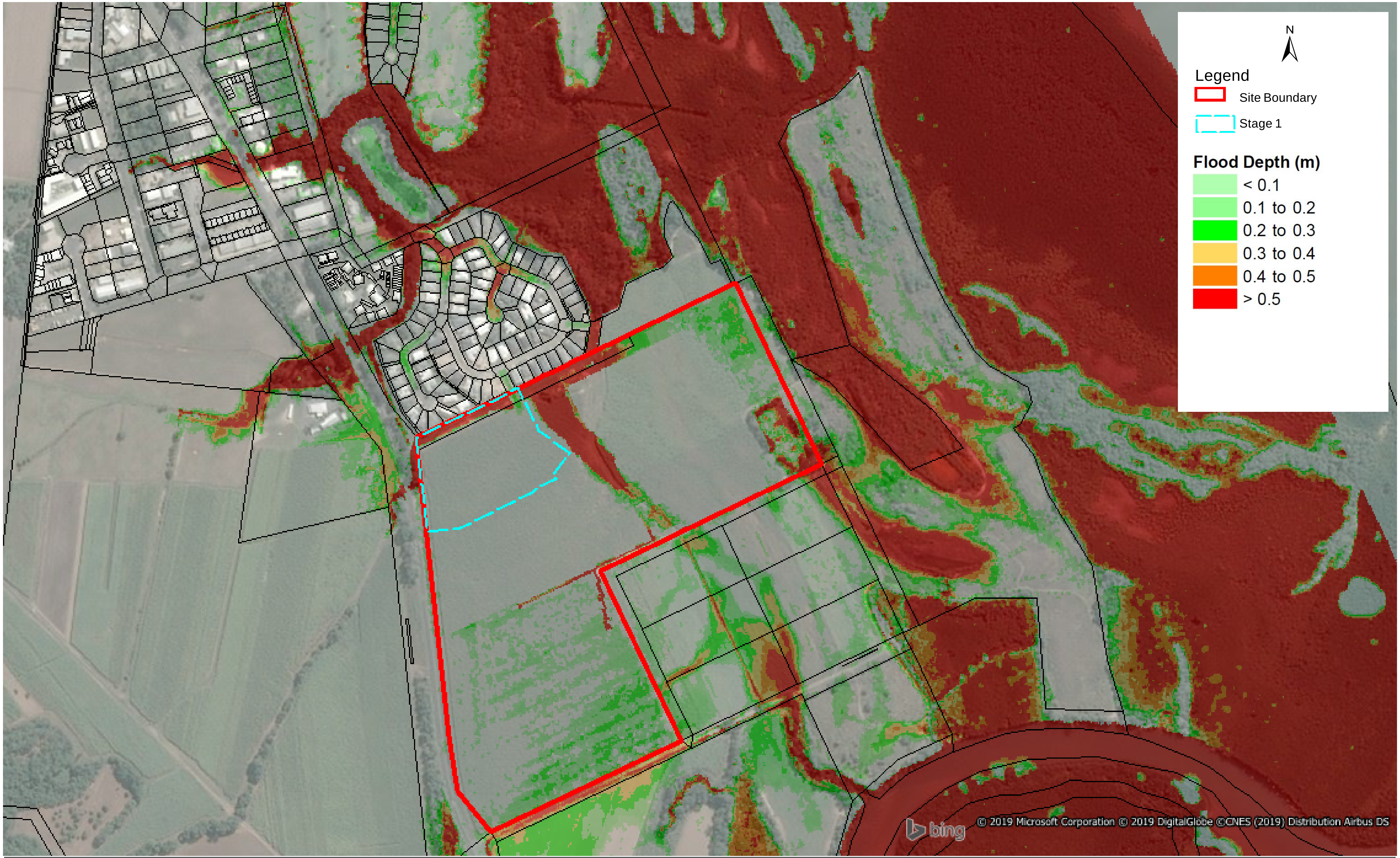
APPENDIX B.2.4

DEVELOPED 5% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2



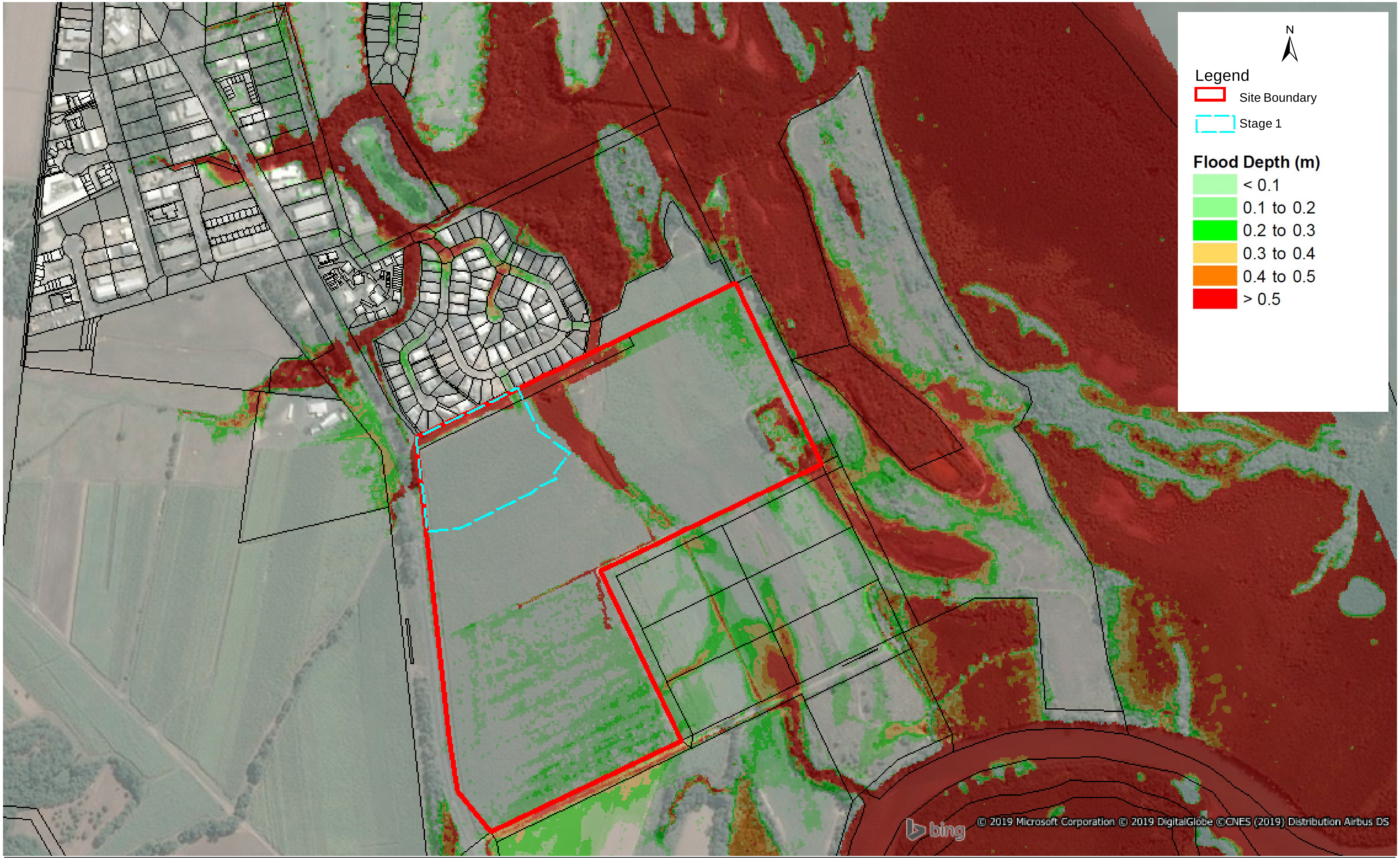
Cardno
Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.2.5
DEVELOPED 10% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment
Port Douglas Estate
AppB.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

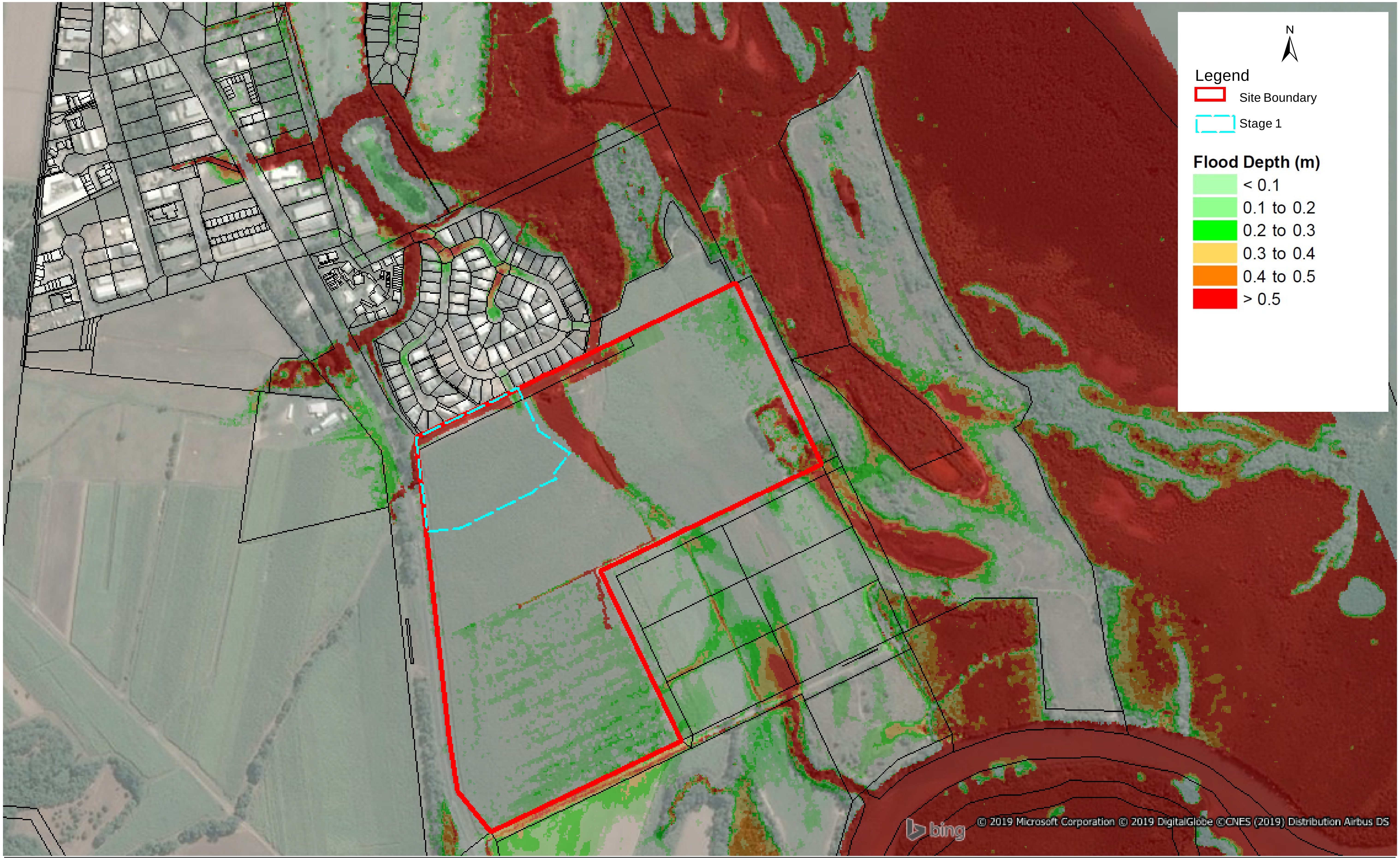
0 500
metres

APPENDIX B.2.6
DEVELOPED 20% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2



Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.2.7

DEVELOPED 39% AEP EVENT - PEAK FLOOD DEPTH

Flood Impact Assessment

Port Douglas Estate

AppB.2

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.1

DEVELOPED 1% AEP CC EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

Cardno
Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.2
DEVELOPED 1% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.3
DEVELOPED 2% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment
Port Douglas Estate
AppB.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.4
DEVELOPED 5% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

APPENDIX B.3.5
DEVELOPED 10% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.6
DEVELOPED 20% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX B.3.7
DEVELOPED 39% AEP EVENT - PEAK FLOOD VELOCITY

Flood Impact Assessment

Port Douglas Estate

AppB.3

APPENDIX

C

FLOODING IMPACT

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX C.1
DEVELOPED 1% AEP CC EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment
Port Douglas Estate
AppC

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX C.2
DEVELOPED 1% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment

Port Douglas Estate

AppC

APPENDIX C.3
DEVELOPED 2% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment

Port Douglas Estate

AppC

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX C.4
DEVELOPED 5% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment
Port Douglas Estate
AppC

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX C.5
DEVELOPED 10% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment
Port Douglas Estate
AppC

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

APPENDIX C.6
DEVELOPED 20% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment

Port Douglas Estate

AppC

Cardno

Level 11, North Tower, 515 St Pauls Terrace
Fortitude Valley QLD 4006
Tel. 07 3369 9822

Date
28/08/2019
Size
A3
Scale
1:6000

0 500
metres

APPENDIX C.7
DEVELOPED 39% AEP EVENT - PEAK FLOOD IMPACTS

Flood Impact Assessment
Port Douglas Estate
AppC