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2 July 2018

North Byron Parklands
PO Box 517
Bangalow NSW 2479

Attention: Mat Morris

RE: NORTH BYRON PARKLANDS FLOOD MODELLING

1 Introduction

1.1 Project Requirements

North Byron Parklands is seeking to develop further portions of their site at Yelgun. BMT has been engaged to provide flooding related services associated with the proposed South East (SE) carpark extension at the existing Parklands site. It is understood that this is associated with the development consent for the expanded site operations (to 50,000 patrons per day).

Currently, Byron Shire Council has concerns with the potential future development of the SE carpark, the concerns raised by Council are stated below,

"The proposed car park is located on land below the 1:100 year level flood. The land though is also affected by flooding down to the 1:5 year event. The following maps have been sourced from Council's GIS flood mapping layers. Map 1 depicts the constraints of a 1:5 year event in the vicinity of the proposed south east car park. The land is also identified in Council's mapping as an Ecological Wetland and in terms of the Standard instrument the land is likely to be defined as a wetland and natural waterbody. The proposed south east car park is likely to require filling, land shaping and drainage works. The Department will need to be satisfied the development complies with Clause 24 Development of Flood Liable Land of Byron LEP 1988, which has limitations on filling of flood prone land and Clause 6.3 Flood Planning of Byron LEP 2014 where applicable. Any engineering works in that regard should be carefully modelled so that the full extent on the flood plain can be understood, Ecologically an assessment of the suitability of the site for a car park and environmental impacts on threatened species and in particular wallum frog species is recommended, with the proposed car park area being predominantly within a buffer to SEPP 14 Wetlands and as mapped by the Draft Coastal Management SEPP."

BMT have investigated the flood related elements of this concern raised by Council. BMT completed earlier flood modelling in 2010 which initially assessed the flood behaviour and response of the initial North Byron Parklands development.

1.2 Planning Context

Clause 24 Development of Flood Liable Land of Byron LEP 1998 identifies under part 2 that "a person shall not erect a dwelling-house, or any other building, or carry out filling or construction of levees on land

that is flood liable, except with the consent of the council.” Further, part 3 it identifies that, “council shall not consent to the erection of a building or the carrying out of a work on flood liable land unless:

- (a) the council is satisfied that:*
 - (i) the development would not restrict the flow characteristics of flood waters,*
 - (ii) the development would not increase the level of flooding on other land in the vicinity,*
 - (iii) the structural characteristics of any building or work the subject of the application are capable of withstanding flooding, and*
 - (iv) the building is adequately flood proofed, and*
- (b) satisfactory arrangements are made for access to the building or work during a flood.*

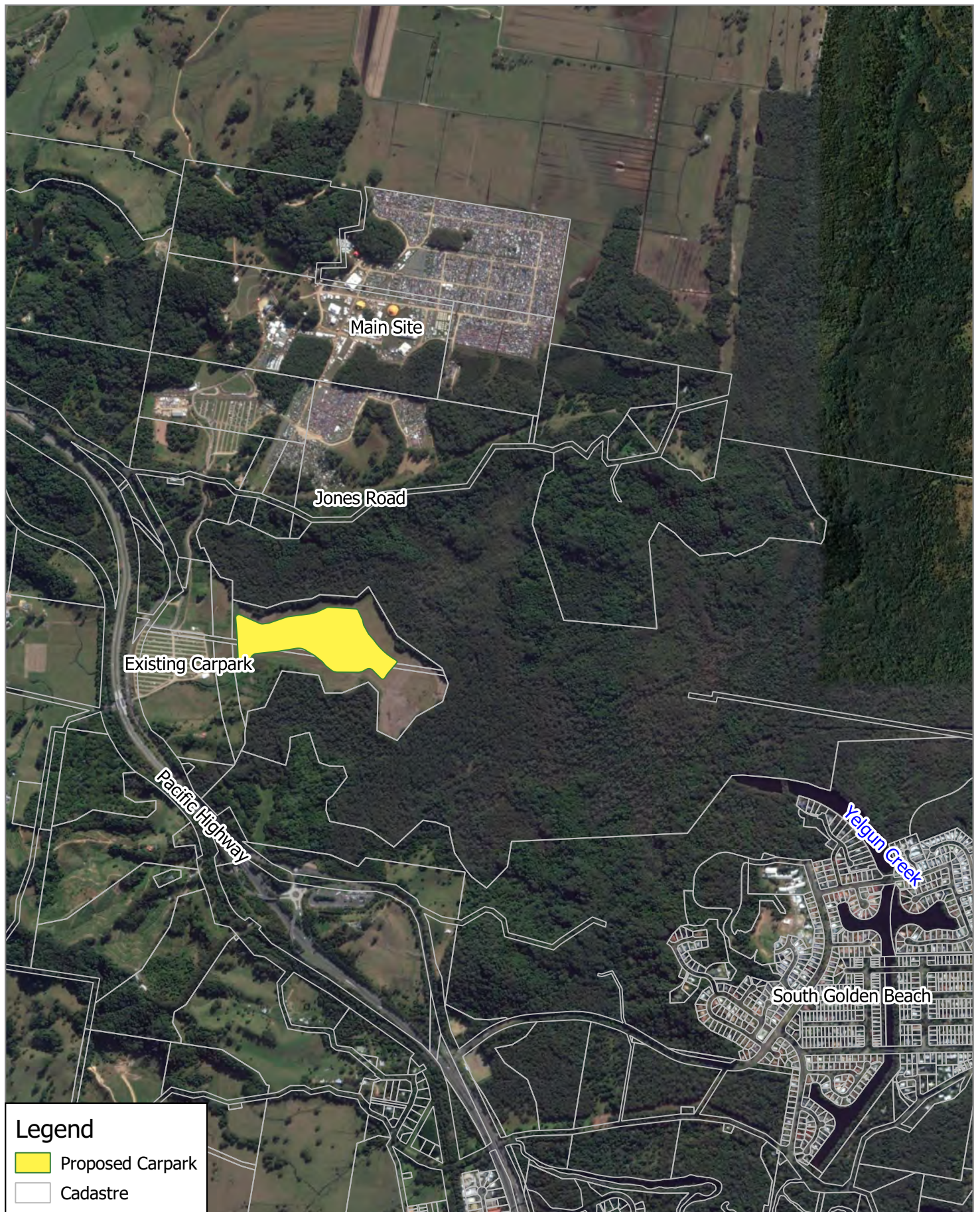
Clause 6.3 and 6.4 of Byron LEP 2014 provides a number of higher level objectives for Council to apply in assessing the viability of developments in relation to flood hazard and flood impact.

These clauses are further considered as part of Chapter C2 of DCP 2014 (Areas Affected by Flood). Within Table C.2.1 (Flood Planning Matrix) of this DCP, the proposed development may be considered as “development in all other areas”. On this basis, the flood planning matrix identifies requirements for fill levels (although mainly targeted for residential dwellings), flood effect and evacuation and access.

Based on our review of Councils LEP/DCP requirements BMT are seeking to demonstrate that the proposed south east carpark does not adversely impact off-site flood levels (afflux), does not change flow characteristics (hydrology) and is consistent with existing approved arrangements for access/egress to the carpark in a flood event which essentially involves an access route from the proposed carpark to the site’s eastern boundary which remains flood free in the 1% AEP event.

1.3 Understanding of the Site and Proposed Development

North Byron Parklands is located on the eastern side of the Pacific Highway in the north eastern corner of Byron Shire, NSW. The site of the proposed south east car park is on the south side of Jones Road. The site locality is shown in Figure 1.



Legend

- Proposed Carpark
- Cadastre

Title: Site Locality

Figure:

1

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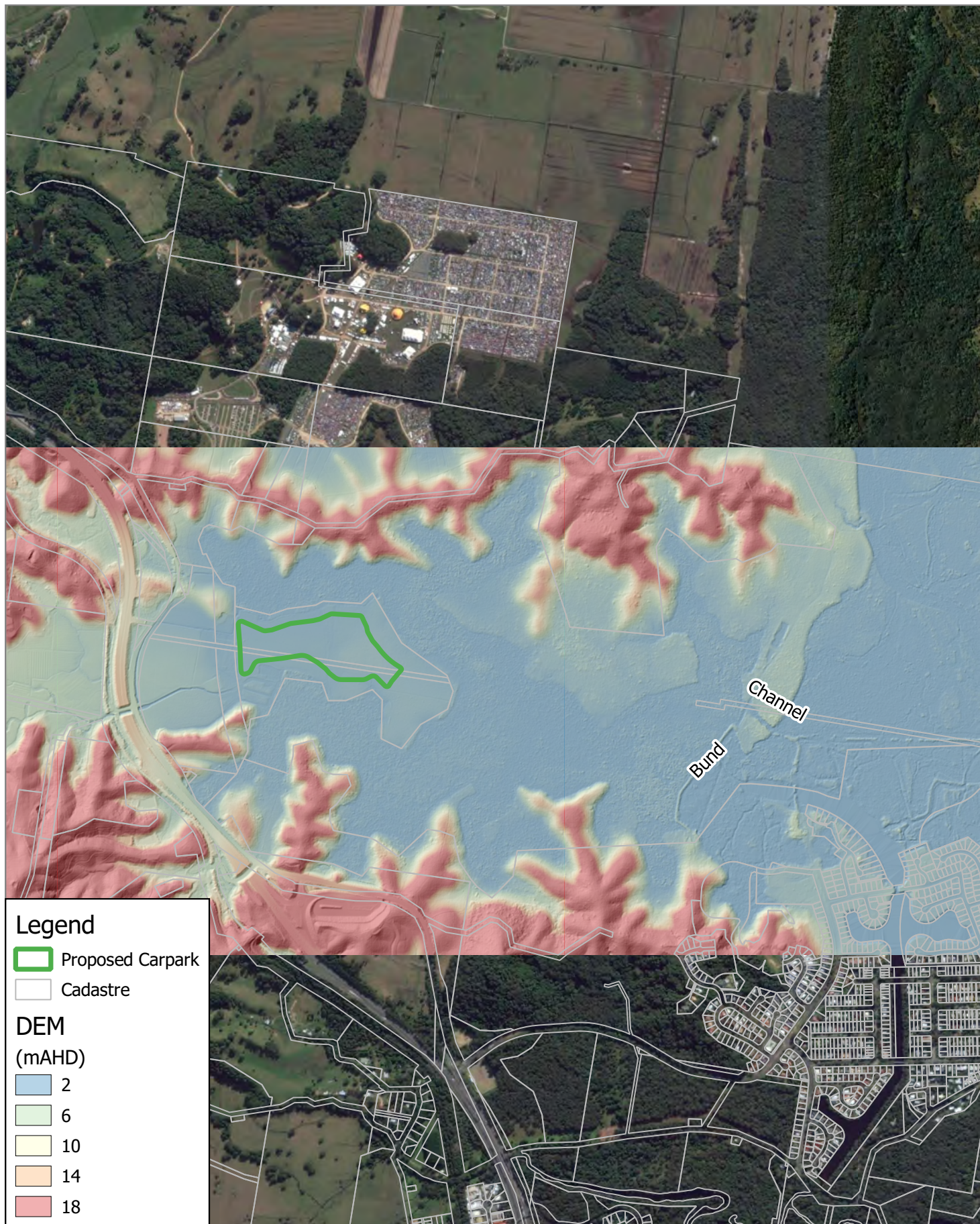
Hydrologically, the North Byron Parklands site is split into two sections, divided by the east-west alignment of Jones Road. To the north of Jones Road exists the main entertainment areas, camping grounds, etc. The majority of the northern area is within the Crabbes Creek floodplain, which itself is part of the Mooball Creek catchment.

To the south of Jones Road (and encompassing the proposed south east carpark) are the existing car parking areas, check in and bus drop off zone. This southern area is located on the Billinudgel and Yelgun Creek floodplain, which is a tributary of Marshalls Creek. There are three sets of culverts at the western site boundary, passing under the Pacific Highway and Tweed Valley Way.

The elevations for the site (based on 2010 LiDAR) are shown as a digital elevation model in Figure 2.

To illustrate the behaviour of the catchment during a flood, flood velocity vectors (larger arrows represent higher velocities) and depths (darker blue representing deeper water) for a 10% AEP flood event are shown in Figure 3. The results captured during the initial stages of this flood and are not meant to represent peak flood levels. The images highlight that there is an existing flowpath from Yelgun Creek that conveys flood flows from south of the site north and east to Billinudgel Creek.

The outflow from the Yelgun / Billinudgel Creek catchments are limited by the bund and channel to the east of the site, north of South Golden Beach. These features are highlighted in the DEM presented in Figure 2. For larger flood events this causes water in the Yelgun / Billinudgel Creek catchments to pond behind the bund resulting in low water level gradients and velocities. The eastern part of the proposed site in flood events typically has a flat flood gradient indicative of a flood storage area, whereas the south and western sections of the site do show flood gradients at the peak more representative of a flood conveyance area.



Title:

Digital Elevation Model LPI 2010

Figure:

2

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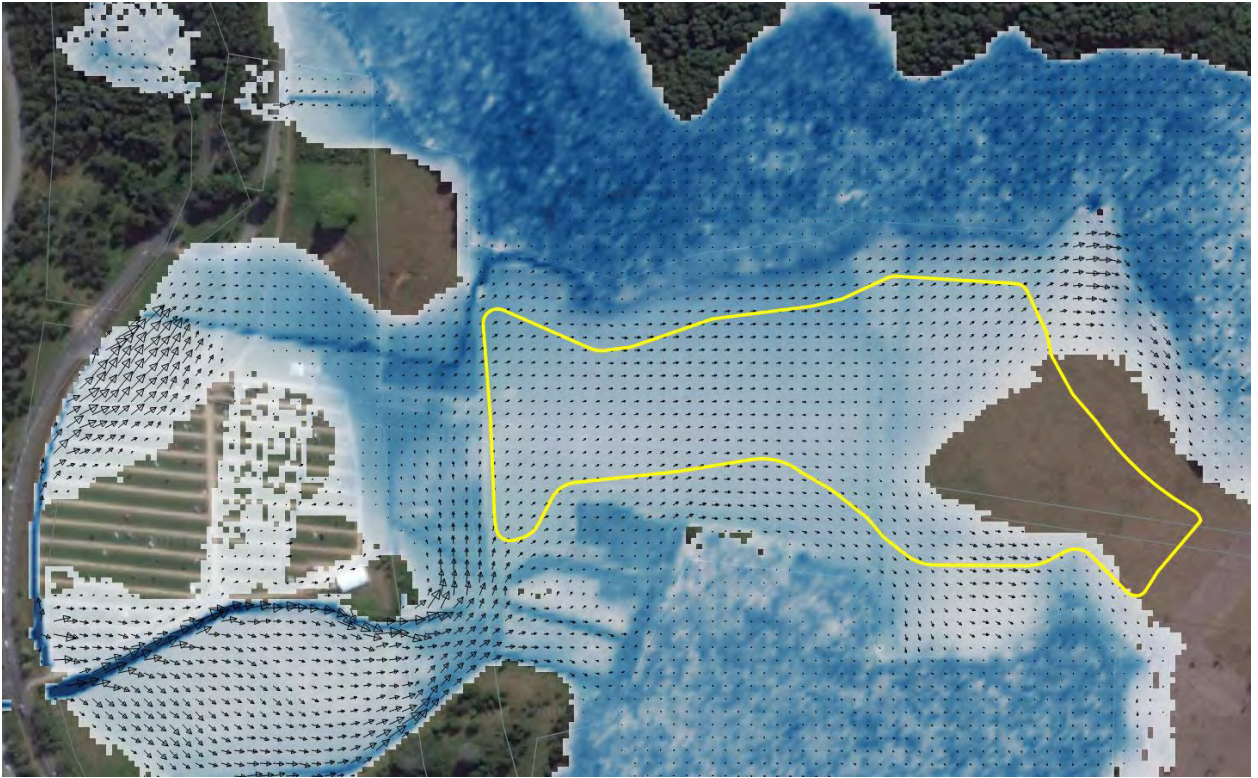


Figure 3 Existing Flow-paths and depths for a 10% AEP Flood Event

The proposed development layout is shown in Figure 4. The carpark is comprised of an exterior loop collector road with internal north south spines which allow vehicle egress to grassed parking areas. The internal spines are to be comprised of decomposed granite (deco) or equivalent and rolled in place to form a firm surface. The exterior loop road is to be surfaced in deco (southern loop) and bitumen (northern loop). The northern branch of the loop road is to be elevated to provide 1% AEP flood free egress from the carpark to the main entrance on Tweed Valley Way in accordance with the requirements existing project approvals.

The proposed south east carpark site itself is relatively flat with elevations ranging from approximately 2.5 to 3.5m AHD.

The landform of the proposed carpark is that it would have an elevated central spine to promote drainage to the north and south with a swale to be provided in the internal edge of the loop road to collect runoff. This runoff will be directed through spaced drainage outlets to prevent water from backing up. The southern loop road would be slightly elevated or at natural surface levels, with the northern loop road elevated above the 1% AEP flood event level which from modelling has been determined to be 3.5m AHD based on the regional flood model.

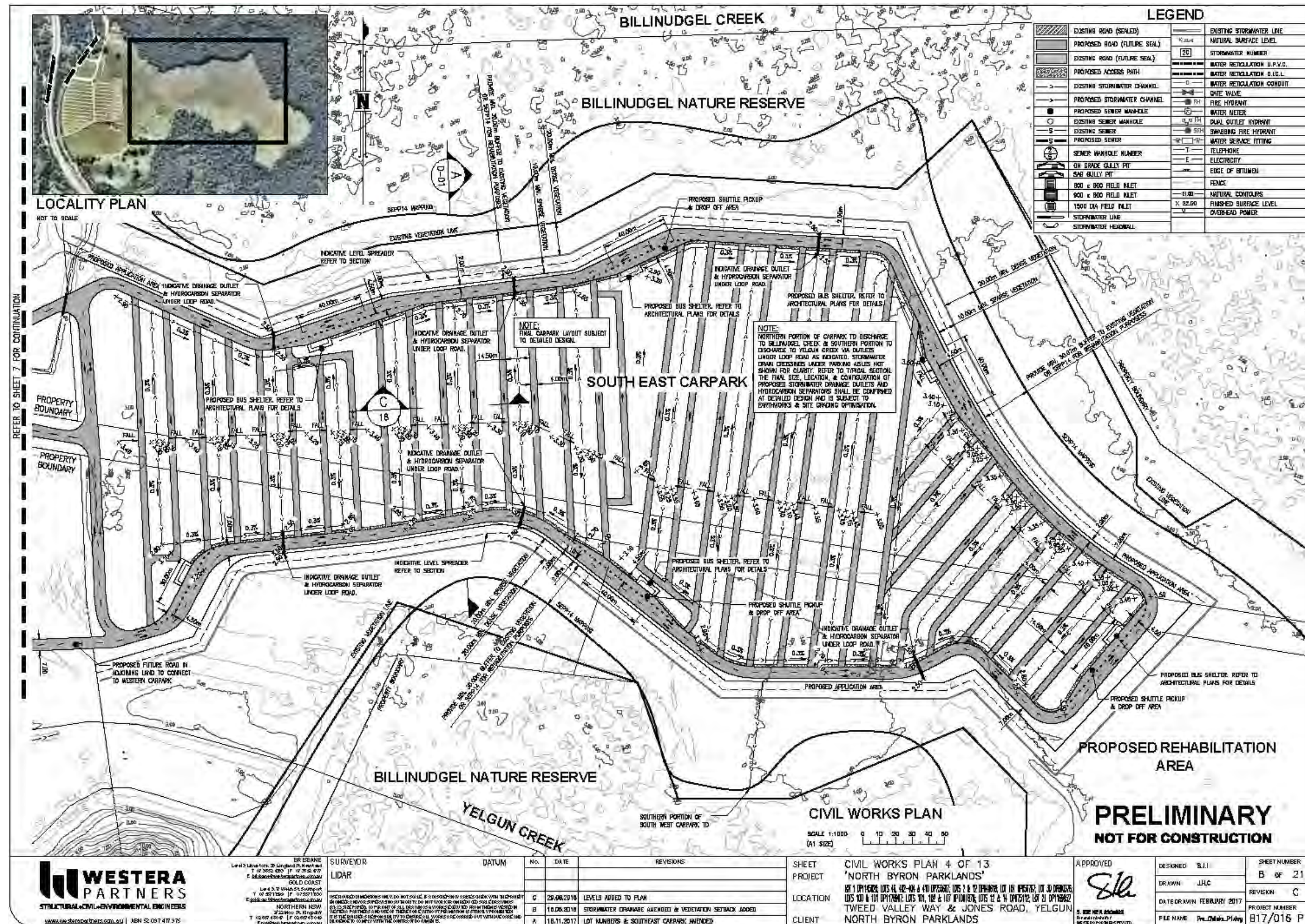
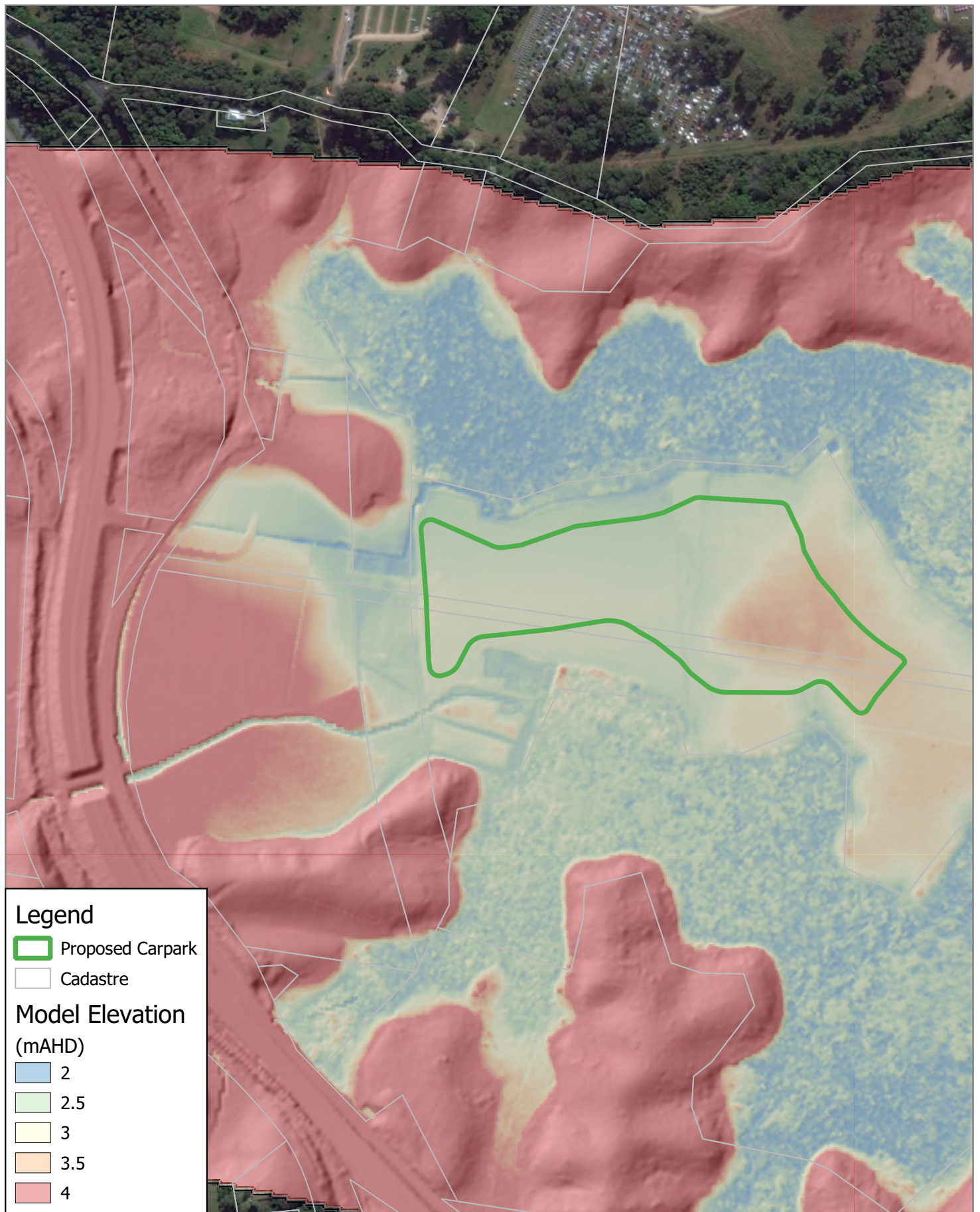


Figure 4 South East Carpark Proposal - Layout

The level of the northern loop road is maintained to the west of the proposed carpark as shown in Figure 5 to ensure access is maintained to the Tweed Valley Way.

The existing model elevations for the site are presented in Figure 5 and the proposed elevations are shown in Figure 6.



Legend

- Proposed Carpark
- Cadastre

Model Elevation

(mAHD)

- 2
- 2.5
- 3
- 3.5
- 4

Title:

Model Elevations: Existing Case

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0 75 150 225 300 m

Figure:

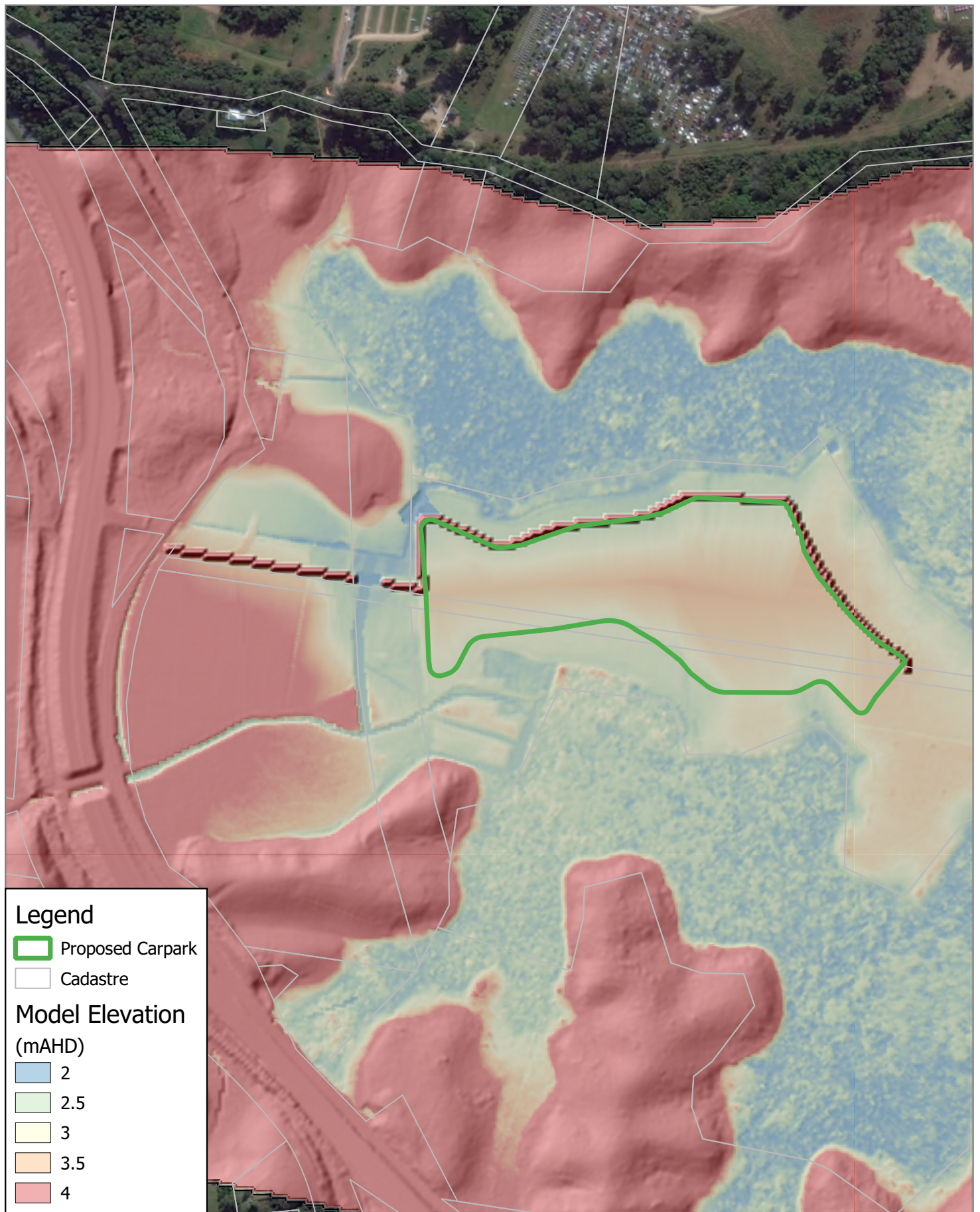
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Legend

- Proposed Carpark
- Cadastre

Model Elevation

(mAHD)

- 2
- 2.5
- 3
- 3.5
- 4

Title:

Model Elevations: Developed Case

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Figure:

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2 Methodology

2.1 General Approach

The general approach applied to the assessment of the proposed south east carpark has included:

- (1) Retrieve and verify the existing flood models (hydrology and hydraulics) developed for the original assessment of the North Byron Parklands.
- (2) Create higher resolution hydraulic model of the site to allow for impact assessment, by reducing the existing model cell size from 30m to 5m.
- (3) Update the existing flood models with new local site data as appropriate such as LiDAR to ensure models represent the current site conditions as accurately as possible. Due to the similarity of the future proposed land use of the carpark areas to the current land use there was no need to update the existing hydrology models. It was noted that more recent LiDAR information was available for the site and the decision was made to import the 2010 LPI dataset into the TUFLOW model.
- (4) As the previous assessments were completed in 2010 there have been a number of changes made to the underlying TUFLOW hydraulic package. Due to the creation of a new high resolution model, the latest 2018-03-AB version of TUFLOW was utilised.
- (5) Simulate the base case design flood events, including the 20%, 10% and 1% Annual Exceedance Probability (AEP) flood events for the critical duration flood event, with the model outputs being referred to as the 'existing' case.
- (6) Updating the existing site digital elevation model to represent the future proposed south east carpark landform. This information has been obtained from the civil engineer (Westera) completing the carpark civil design.
- (7) Simulate design flood events using the updated hydraulic model to produce 'developed' case results.
- (8) Calculation of flood impacts, i.e. change in peak water levels between the base case and developed case flood events.

Between points 5 and 6 several mitigation assessments were undertaken in respect of cross drainage on the elevated northern section of the loop road to produce acceptable flood impacts.

2.2 Hydraulic Modelling

The regional flood model for the area utilises a 30m grid cell for the rural areas including the proposed carpark site (a higher resolution is used in urban areas). The ability to accurately represent the proposed development (particularly the elevated portion of the loop road) was limited at this resolution, and a higher resolution 5m cell was created.

This high resolution model was created for the purpose of a flood impact assessment, which looks at the relative difference in peak water levels. Peak water levels predicted by the high resolution model were compared with the regional model, but no calibration of this higher resolution model was performed. For absolute water levels, the calibrated regional flood model adopted by council should be used.

The extent and model configuration is presented in Figure 7.

The model covers the site from upstream of the Pacific Motorway to downstream of the bund on Yelgun Creek. At the upstream and downstream boundaries of the high resolution model, the boundary conditions have been extracted from the regional flood model (i.e. water level boundary and inflow boundary represented on Figure 7).

The elevation data used for the high resolution model is the LPI LiDAR data collected in 2010. The regional flood model uses an earlier dataset collected in 2007. For the land-use areas, Manning's n values, local inflow boundaries and hydraulic structures, these have been kept consistent with those used in the regional flood model.

Hydraulic modelling was completed using TUFLOW version 2018-03-AB.

Peak water levels on the proposed site were compared for the 1% AEP for the 12 and 24 hour durations and it was determined that the 24 hour event produced the higher peak water levels and as such all flood modelling presented in this report is based on 24 hour duration flood events.

As detailed design for the road and cross drainage structures (for storm water and flood water) has not been provided, initial model runs without any cross-drainage structures showed significant predicted flood affluxes to the south of the northern section of the loop road. The existing flow path from the south (Yelgun Creek) to the north (Billinudgel Creek), as described in section 1.3 is important for the flood behaviour on the site and surrounding areas. As a portion of the loop road is to be above the 1% AEP for flood evacuation, flood conveyance underneath this is important to prevent off-site affluxes for a range of flood events.

To allow for flood water to be conveyed as it currently is, flow conveyance structures were provided to mitigate affluxes. This consists of a conveyance channel (15m wide) from Yelgun Creek to the north. The channel has an invert level of 2.4 mAHD at the southern end and 2.1 mAHD at the northern end. These elevations represent a minor lowering of existing channel elevations.

Additionally, in order to allow flows to pass under the loop road, a 35m wide opening has been provided in the vicinity of the current major flowpath. For detailed design, this opening would likely be designed as bank of culverts. The loop road provides a constriction to flow at the north western corner of the proposed carpark, a lowering of ground elevations by 1m in this area has been modelled to reduce this constriction. These afflux mitigation modifications are presented in Figure 8.

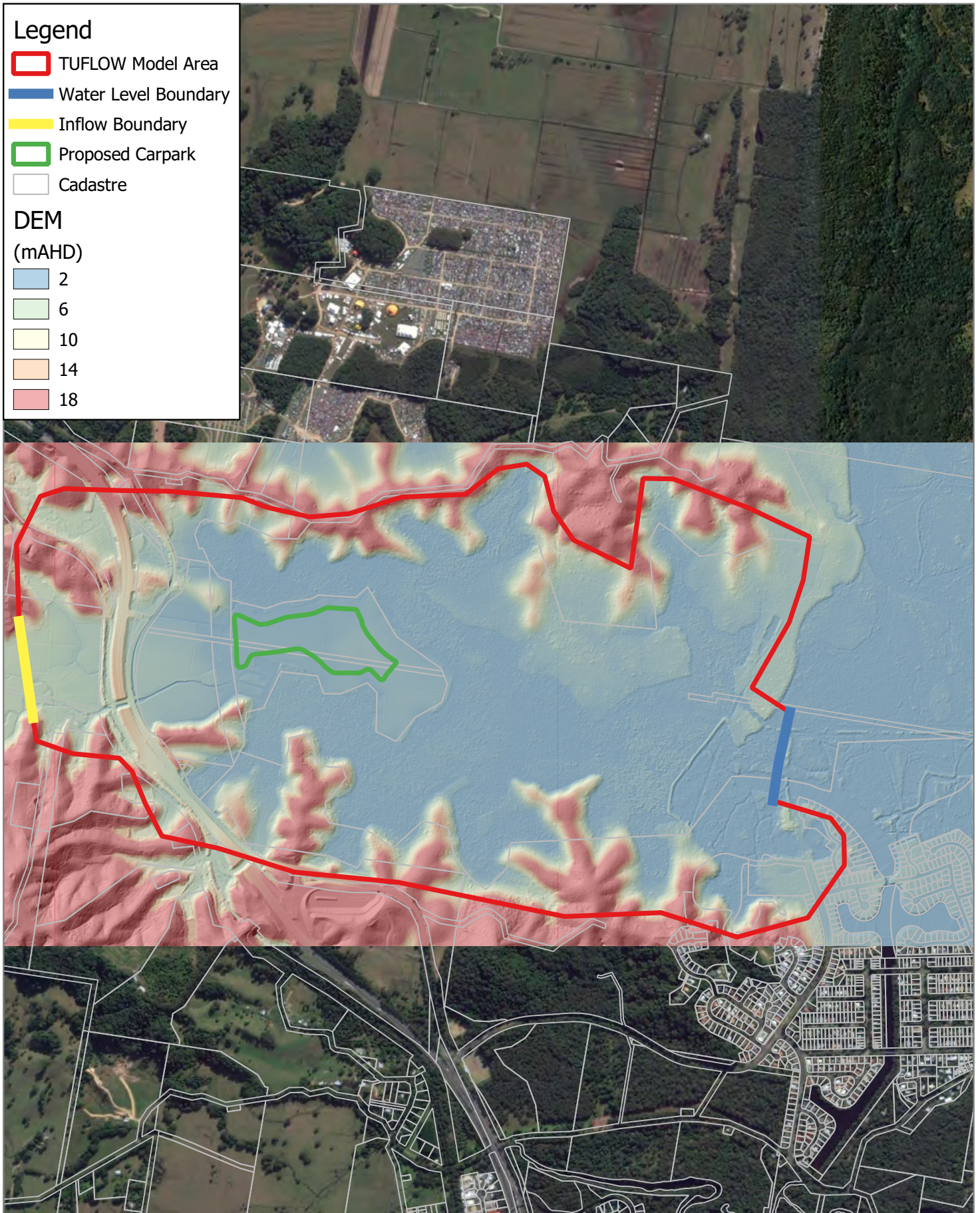
Legend

-  TUFLOW Model Area
-  Water Level Boundary
-  Inflow Boundary
-  Proposed Carpark
-  Cadastre

DEM

(mAHD)

-  2
-  6
-  10
-  14
-  18



Title:

TUFLOW Model Layout

Figure:

7

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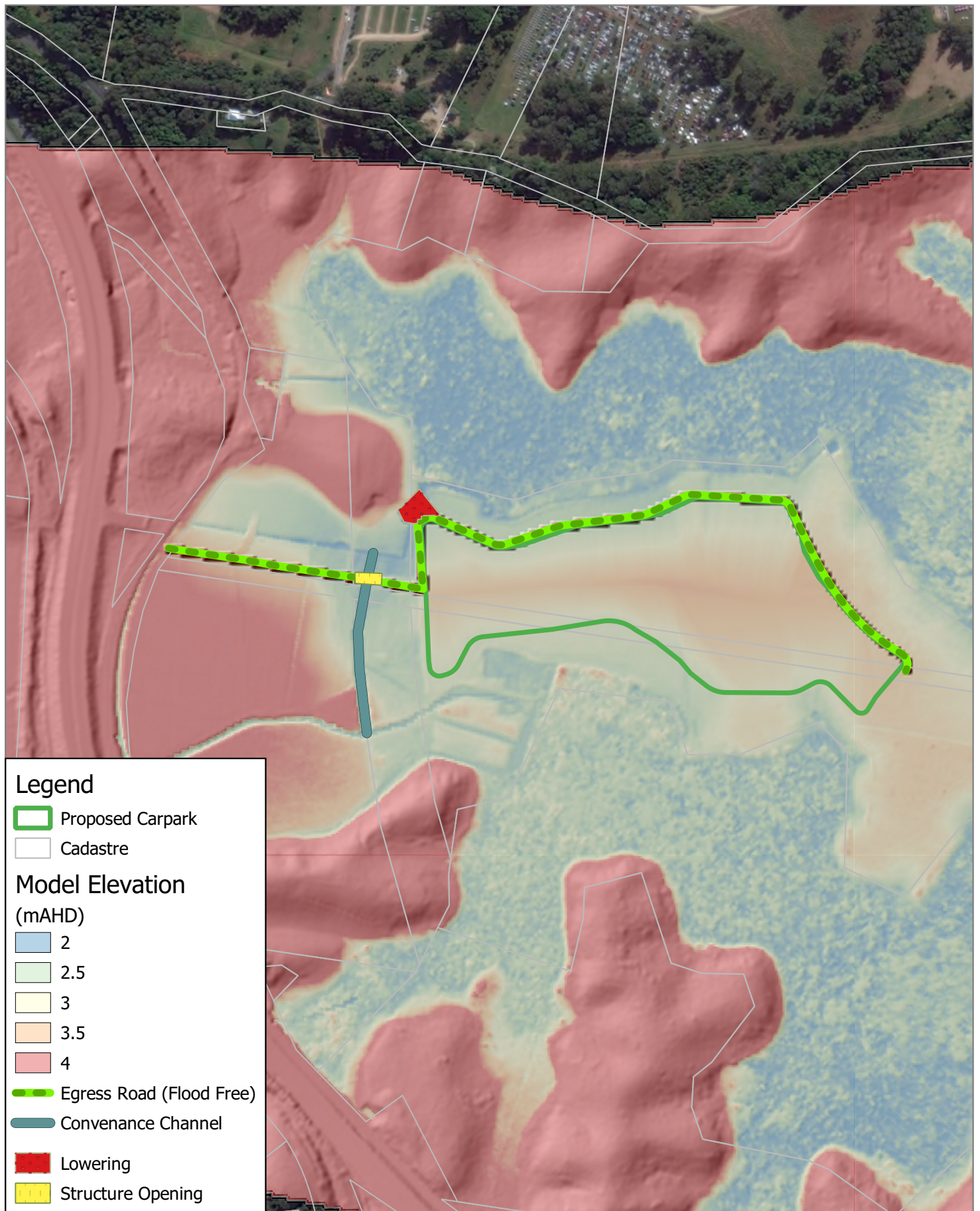


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Title:

Afflux Mitigations

Figure:

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3 Flood Modelling Results

3.1 Results

Flood behaviour has been modelled for the site, for three design events; 20% AEP, 10% AEP and the 1% AEP. For these events both the existing case and also the proposed developed configuration including the flood mitigation options (as detailed in Section 2.2) have been modelled.

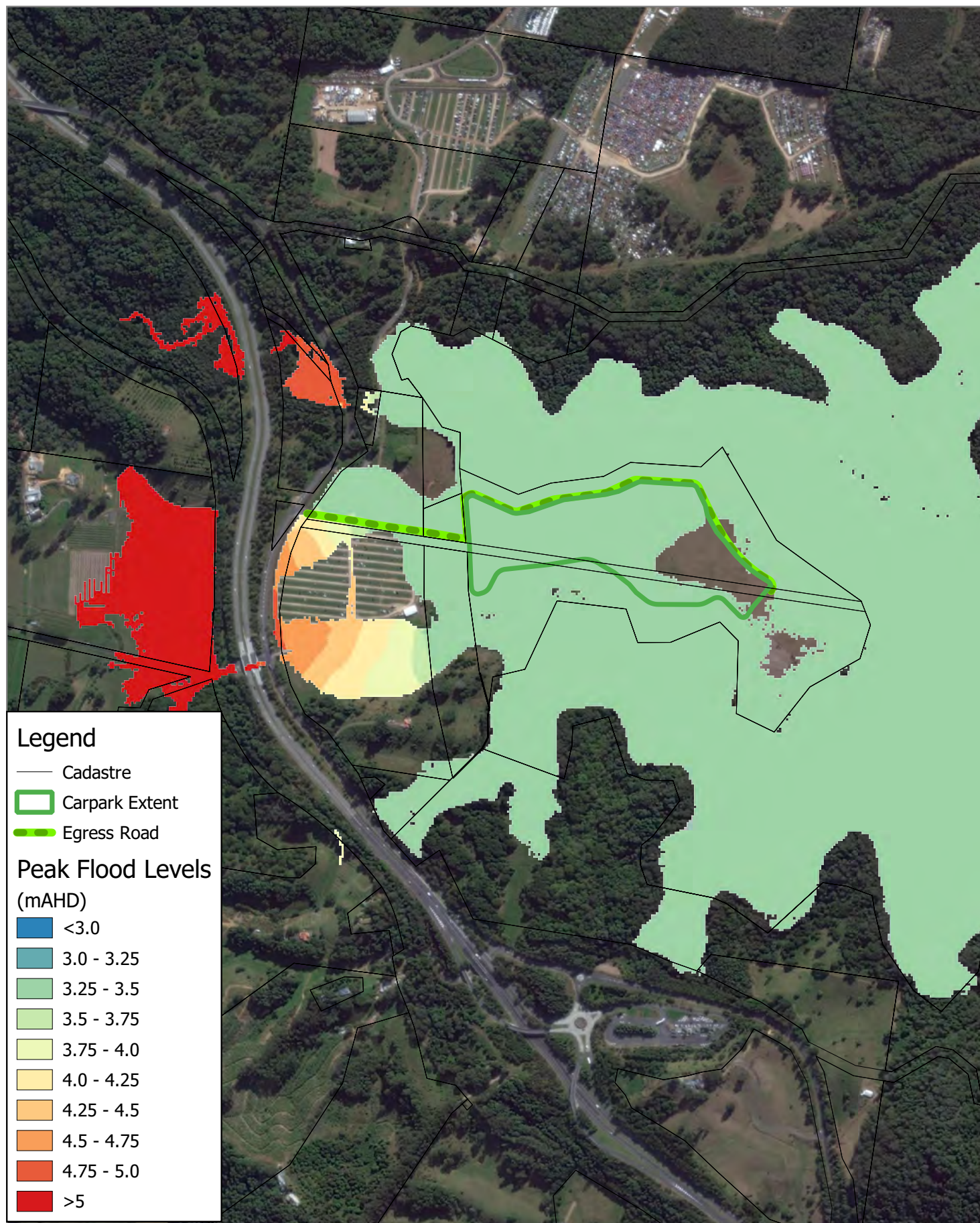
3.1.1 Peak Flood Levels

Modelled peak flood levels for the existing case are presented in Figure 9 through Figure 11. Modelled peak flood levels for the developed case are presented in Figure 12 through Figure 14.

3.1.2 Flood Impacts

For the three flood events the peak flood levels for the existing case are subtracted from the developed case. A positive afflux indicates that the peak water levels are predicted to increase and a negative value indicates that the peak water levels are predicted to decrease. The peak flood impacts are presented in Figure 15 through Figure 17.

For all three flood events there are some flood impacts predicted to the south of the egress road. No significant off site affluxes are predicted.



Title:

Peak Flood Levels 20% AEP Event: Existing Case

Figure:

9

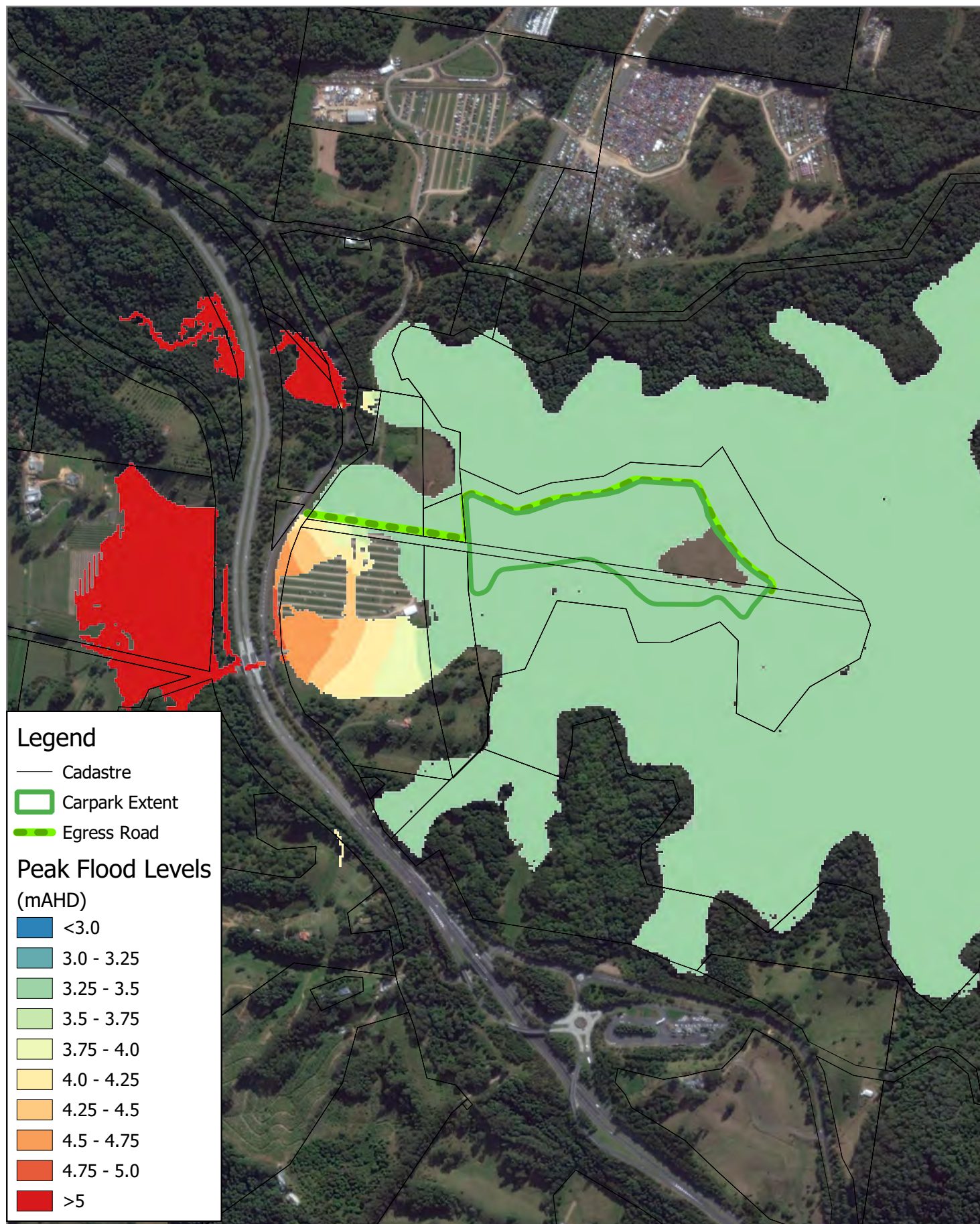
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Title:

Peak Flood Levels 10% AEP Event: Existing Case

Figure:

10

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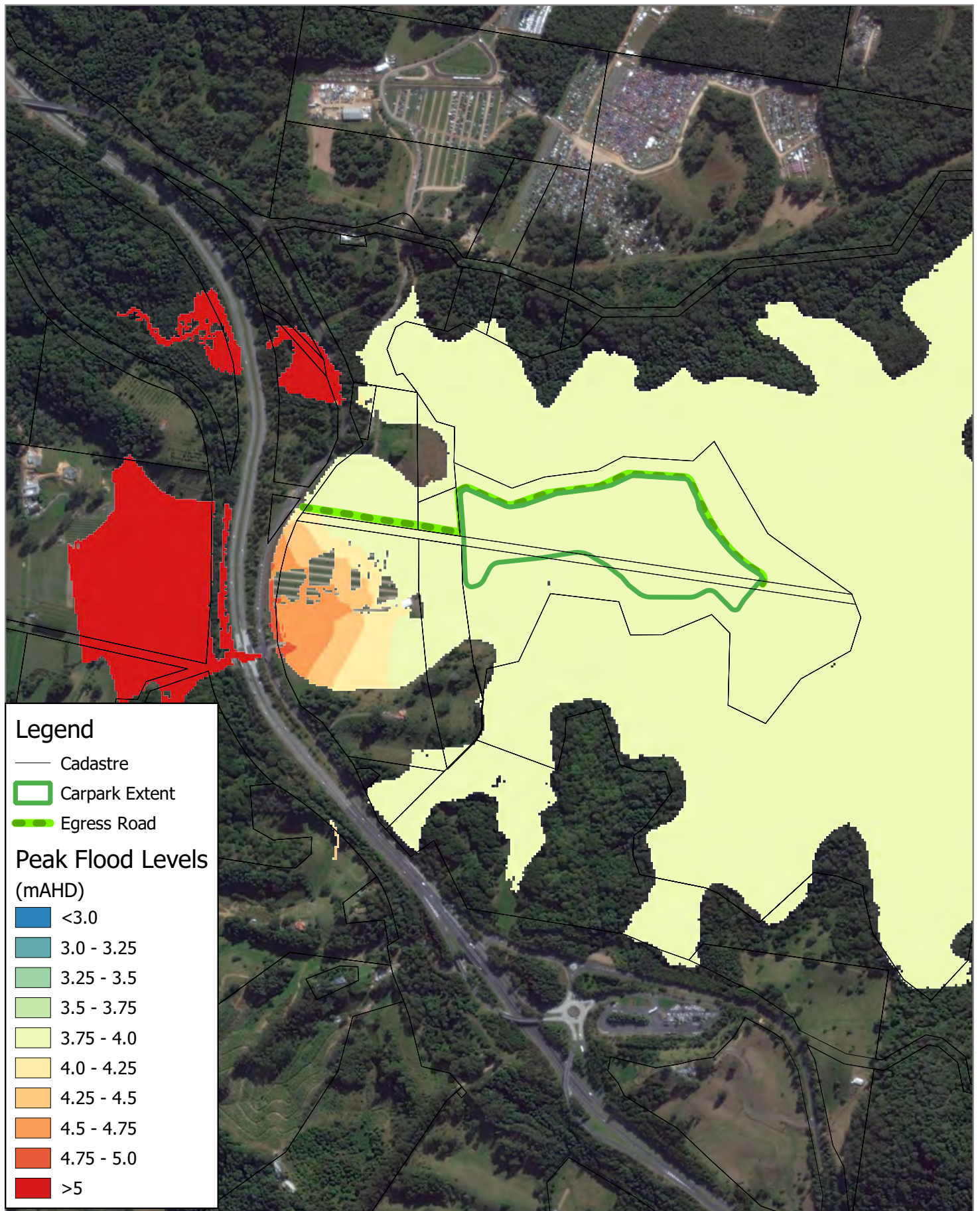
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Title:

Peak Flood Levels 1% AEP Event: Existing Case

Figure:

11

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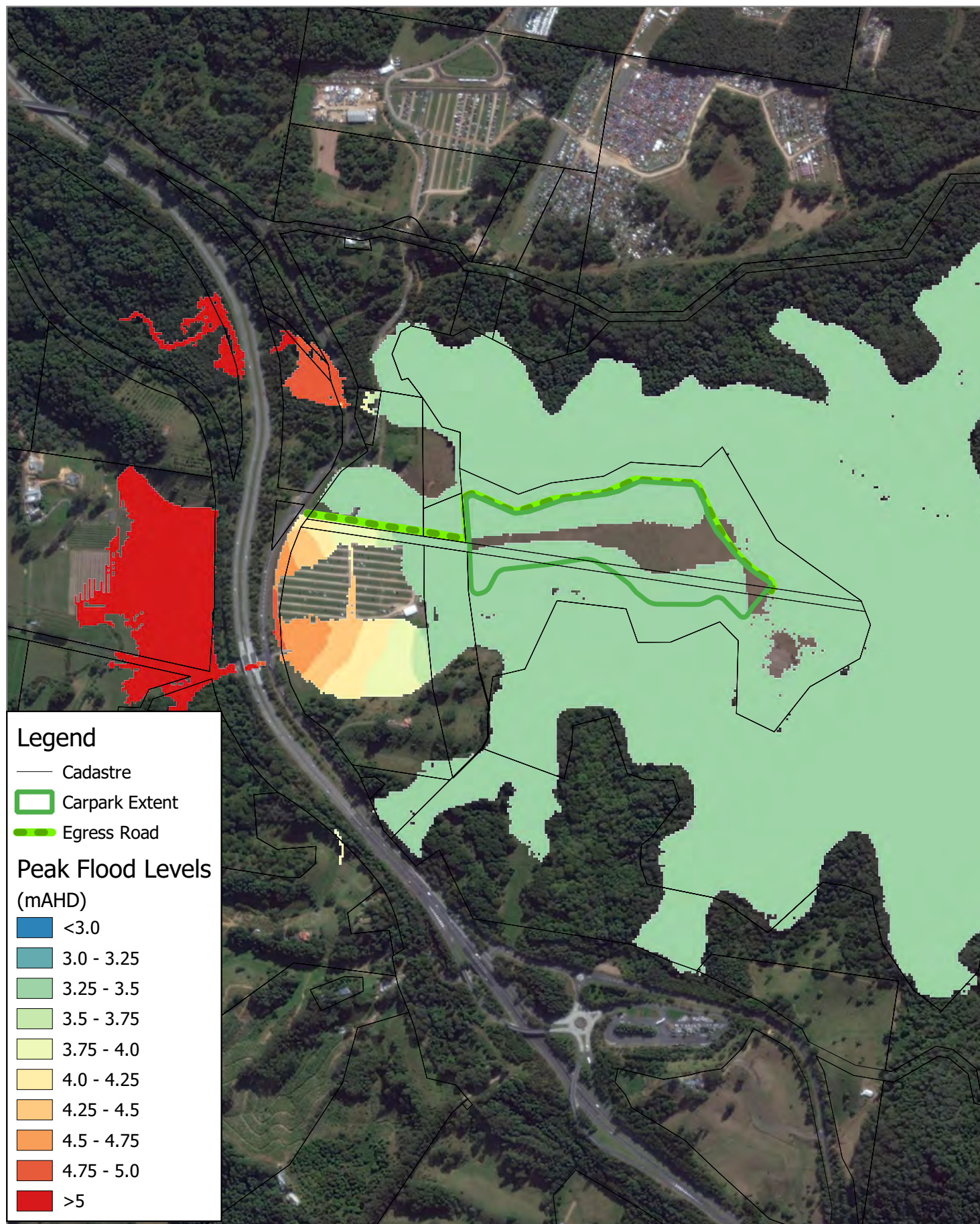


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Title:

Peak Flood Levels 20% AEP Event: Developed Case

Figure:

12

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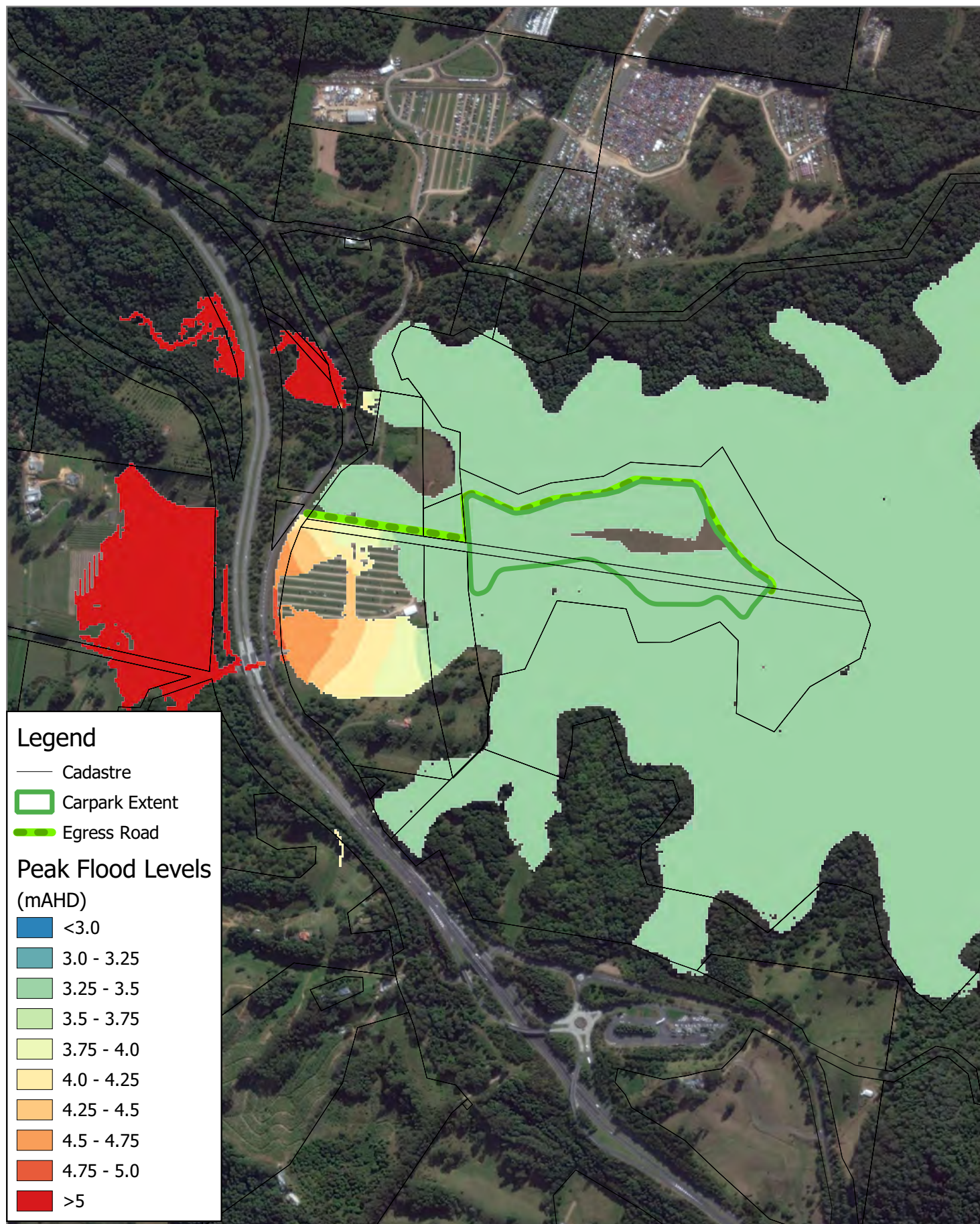
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Title:

Peak Flood Levels 10% AEP Event: Developed Case

Figure:

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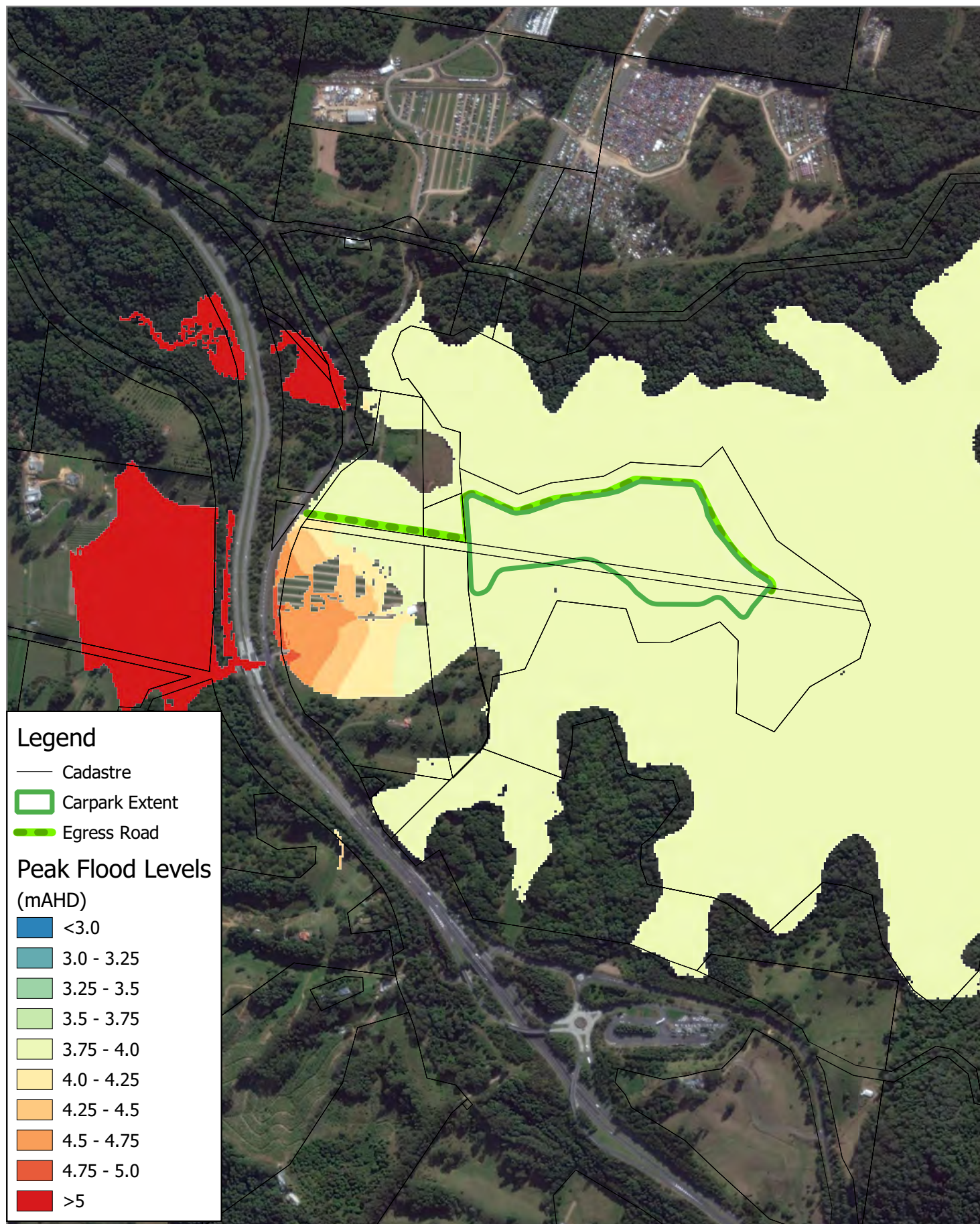


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Title:

Peak Flood Levels 1% AEP Event: Developed Case

Figure:

14

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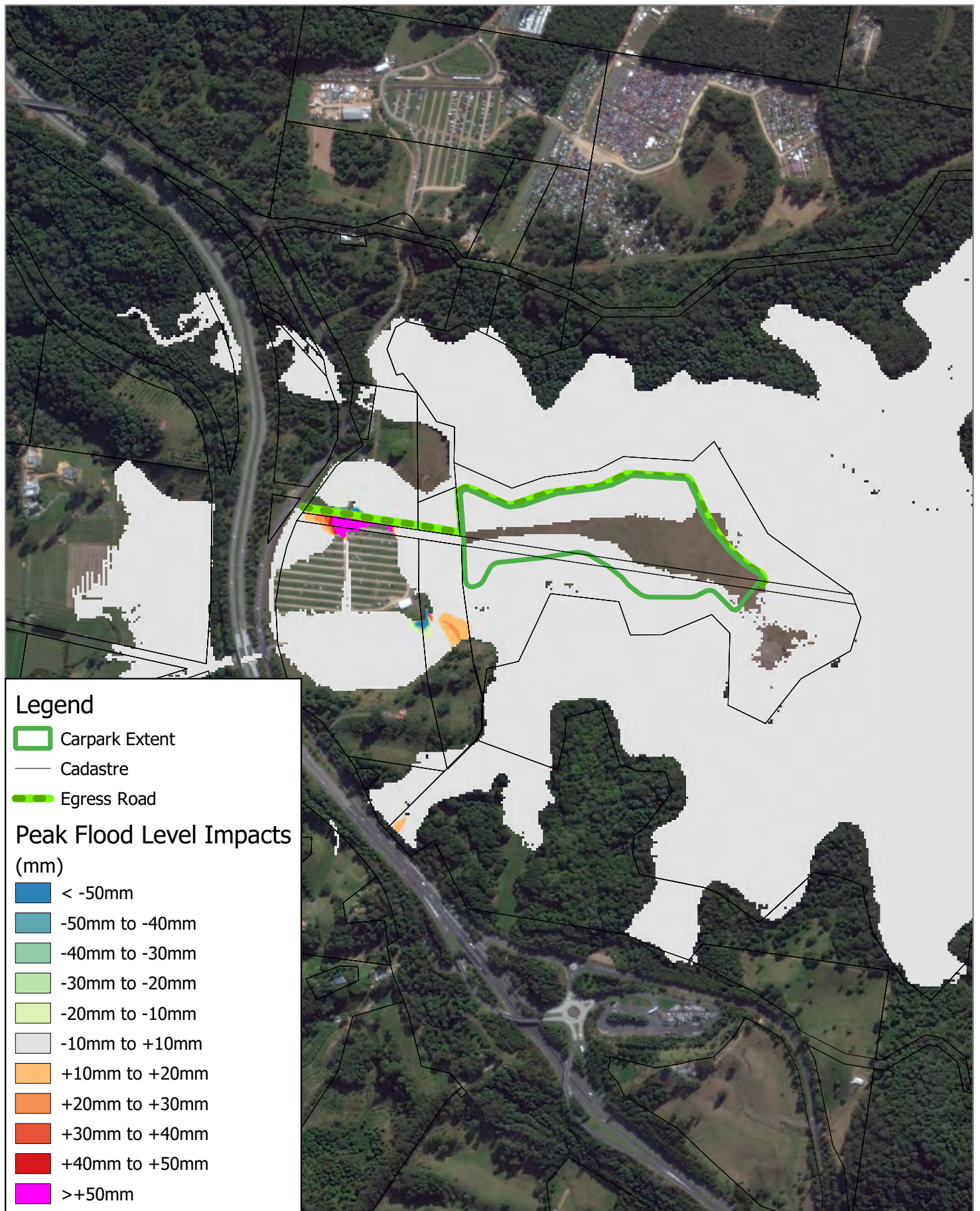
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Title:

Peak Flood Level Impacts: 20% AEP

Figure:

15

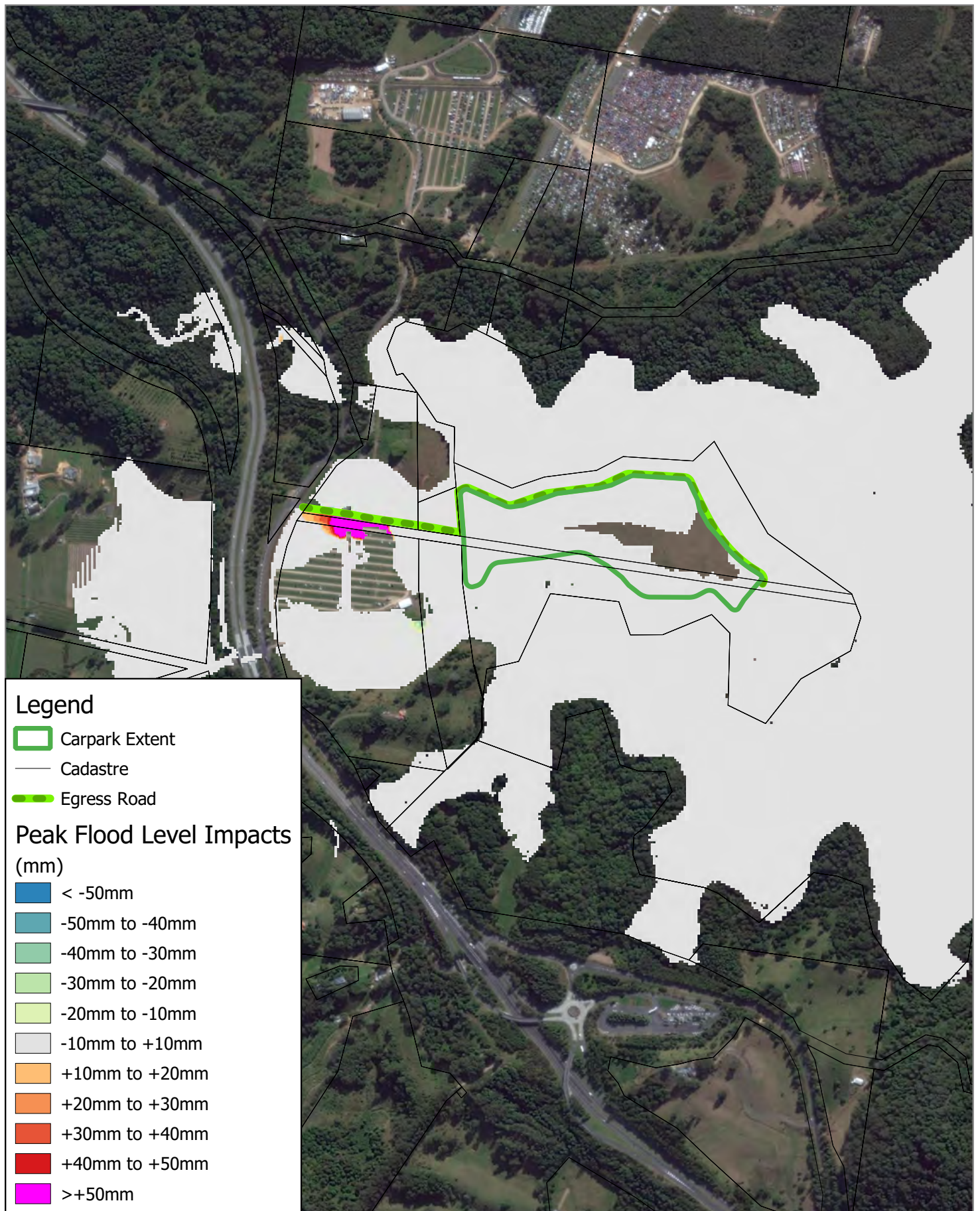
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Title:

Peak Flood Level Impacts: 10% AEP

Figure:

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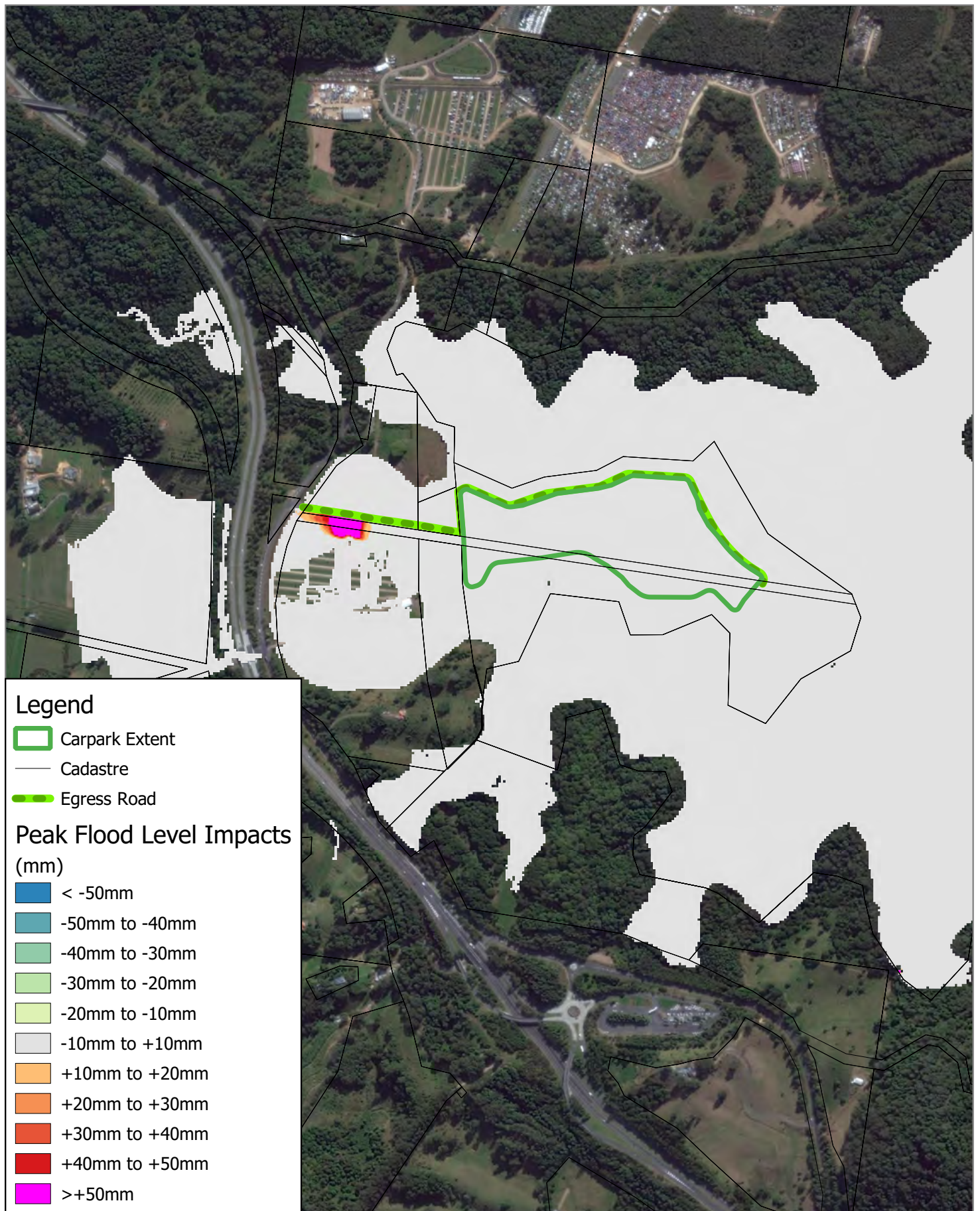


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Title:

Peak Flood Level Impacts: 1% AEP

Figure:

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4 Conclusions

The assessment of the proposed development indicates negligible peak flood level impacts for the 20%, 5% and 1% AEP event.

Assessment completed by BMT has identified the need for conveyance to be provided under the proposed elevated northern section of the loop road to preserve existing flood conveyance pathways and alleviate flood impact. Additionally, there was an identified need for lowering and channelling within the site boundaries to promote this flow by reducing existing flow constriction areas or points.

Detailed design of the proposed south east carpark is required with integration of these proposed flood conveyance measures. These refined designs should be reassessed within the higher resolution hydraulic flood models developed for this assessment.

The flood modelling outcomes satisfy the requirements of Clause 24 Development of Flood Liable Land of Byron LEP 1998 (and clause 6.3 and 6.4 of Byron LEP 2014), which effectively identify that the proposed development should not restrict the flow characteristics of flood waters, or increase the level of flooding on other land in the vicinity of the development (i.e. offsite impact).

We trust the above is satisfactory for initial assessment purposes. BMT looks forward to continuing to assist the design assessment of the proposed development. Please contact Phillip Ryan on 02 6687 1011 for further information

Yours Faithfully
BMT

Phillip Ryan
Senior Flood Engineer